



# Intercollegiate MRCS Revision Notes

**2006**

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## Forward

These revision notes have been written to aide candidates preparing for postgraduate surgical examinations, in particular the Intercollegiate MRCS and have been prepared to complement standard surgical textbooks. They have been edited to the same format as the MRCS syllabus and are presented as a unique combination of notes and bullet points. Each section has a bibliography of recently published review and original articles which have been selected for their relevance and readability. Pressure of space has necessitated a selective approach to the topics included. It is however, hoped that along with the Royal College of Surgeons of England STEP Course, the Royal College of Surgeons of Edinburgh SELECT Course and standard surgical texts they will prove a useful revision tool. Variations in surgical practice will inevitably mean that there will be disagreement with some of the views and recommendations presented. In these contentious areas an attempt has been made to include opinions that are not too extreme and will hopefully satisfy most examiners.

To complement the book, a web site has been established with clinical images, x-rays, pathology slides, a selection of clinical and basic science multiple choice questions and reviews of recent papers and much more.

Both the web site and these notes have evolved with time. Publishing these notes on the internet has allowed them to be updated on a regular basis. In order for them to remain relevant to trainees' needs it is essential that feedback is received from both trainees and trainers regarding their format and content. If you have suggestions or comments they will gladly be received.

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## Perioperative care

### Assessment of fitness for surgery

#### *Preoperative assessment*

##### ASA Grading

- Medical co-morbidity increases the risk associated with anaesthesia and surgery
- American Society of Anesthesiologists (ASA) grade is the most commonly used grading system
- ASA accurately predicts morbidity and mortality
- 50% of patients presenting for elective surgery are ASA grade 1
- Operative mortality for these patients is less than 1 in 10,000.

Table 1 American Society of Anaesthesiologists (ASA) grade and predicated mortality

	Definition	Mortality (%)
I	Normal healthy individual	0.06
II	Mild systemic disease that does not limit activity	0.4
III	Sever systemic disease that limits activity but is not incapacitating	4.5
IV	Incapacitating systemic disease which is constantly life-threatening	23
V	Moribund, not expected to survive 24 hours with or without surgery	51

##### Interpretation of ASA Grading

Table 2 Interpretation of cardiovascular disease

	ASA Grade 2	ASA Grade 3
Angina	Occasional use of GTN	Regular use of GTN or unstable angina
Hypertension	Well controlled on single agent	Poorly controlled. Multiple drugs
Diabetes	Well controlled. No complications	Poorly controlled or complications

Table 3 Intreptation or respiratory disease

	ASA Grade 2	ASA Grade 3
COPD	Cough or wheeze. Well controlled	Breathless on minimal exertion
Asthma	Well controlled with inhalers	Poorly controlled. Limiting lifestyle



### Preoperative investigations

- The request for pre-operative investigations should be based on:
  - Factors apparent from the clinical assessment
  - The likelihood of asymptomatic abnormalities
  - The severity of the surgery contemplated
- Pre-operative investigations rarely uncover unsuspected medical conditions
- Inefficient as a means of screening for asymptomatic disease
- 5% of patients have abnormalities on investigations not predicted by a clinical assessment
- Only 0.1% of these investigations ever change the patients management
- Over 70% of pre-operative investigations could be eliminated without adverse effect

Table 4 Indications for preoperative investigations

	Indication
Full blood count	All adult women Men over the age of 60 years Cardiovascular or haematological disease
Urea & electrolytes	All patients over 60 years Cardiovascular and renal disease Diabetics Patients on steroids, diuretics, ACE inhibitors
ECG	Men over 40 years Women over 50 years Cardiovascular disease Diabetics
Chest X-ray	Cardiovascular and respiratory disease Malignancy Major thoracic and upper abdominal surgery

### Pre-operative fasting

- General anaesthesia increases risk of aspiration of gastric contents
- Traditionally patients have been starved since midnight prior to elective surgery
- Now known that clear fluids leave stomach within two hours
- Clear fluids do not increase volume or acidity of gastric contents
- For emergency surgery oral intake should be restricted
- Many surgical emergencies are associated with delayed gastric emptying

### Nice Guidelines (2003)

- The National Institute for Clinical Excellence has produced guidelines on preoperative tests
- These tests include
  - Chest x-ray
  - ECG
  - Full blood count
  - Clotting screen
  - Renal function
  - Random blood glucose
  - Urinalysis
  - Blood gases



- Lung function tests
- Recommendations are graded
  - Red - not required
  - Amber - test to considered
  - Green - recommended
- Recommendations are based on
  - Age
  - ASA Grade of patient
  - Grade of surgery

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## Tests of respiratory, cardiac and renal disease

### Respiratory function

- Lung function tests should be able to predict the type and severity of lung disease
- Can predict risk of complications and postoperative mortality
- Tests fall in to three categories
  - Lung mechanics
  - Gas exchange
  - Control of breathing
- Useful radiological investigations include chest x-ray and high-resolution thoracic CT
- Arterial blood gases may be helpful

### Lung function tests

- Allows assessment of :
  - Lung volumes
  - Airway calibre
  - Gas transfer

### Spirometry

- Lung volumes are assessed with spirometry
- Volumes measured include:
  - IC = Inspiratory capacity
  - IRV = Inspiratory reserve volume
  - TV = Tidal volume
  - VC = Vital capacity
  - FRC = Functional residual capacity
  - RV = Residual volume
  - ERV = Expiratory reserve volume
  - TLC = Total lung capacity

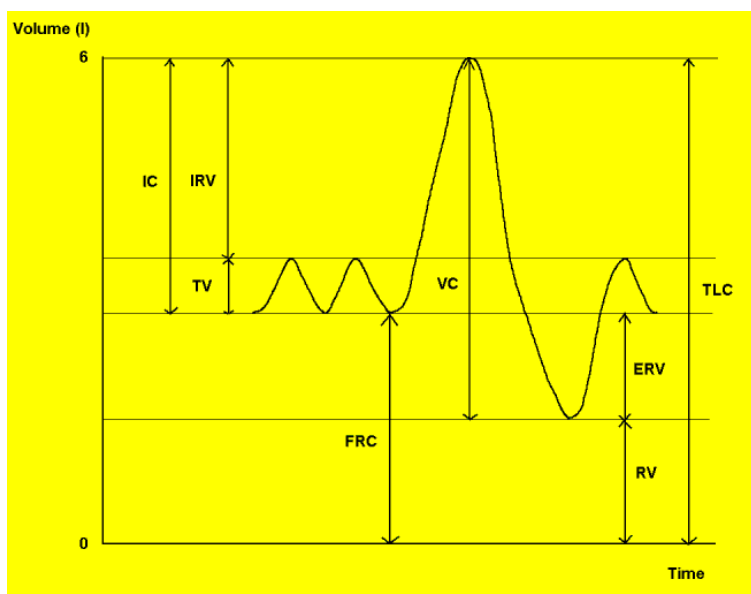


Figure 1 Respiratory volumes





### Peak flow rates

- Airway calibre can be assessed by peak flow measurements
- Requires co-operation and maximum voluntary effort of the patient
- Flow rates measured include:
  - FVC = Forced vital capacity
  - FEV<sub>1</sub> = Forced expiratory volume in one second
- Absolute values depend on height, weight, age, sex and race
- FEV<sub>1</sub> / FVC ratio is important
- Lung function can be classified as:
  - Normal
  - Restrictive
  - Obstructive
- In restrictive lung disease FVC is reduced but FEV<sub>1</sub>/FVC is normal
- In obstructive lung disease FVC is normal or reduced and FEV<sub>1</sub>/FVC is reduced

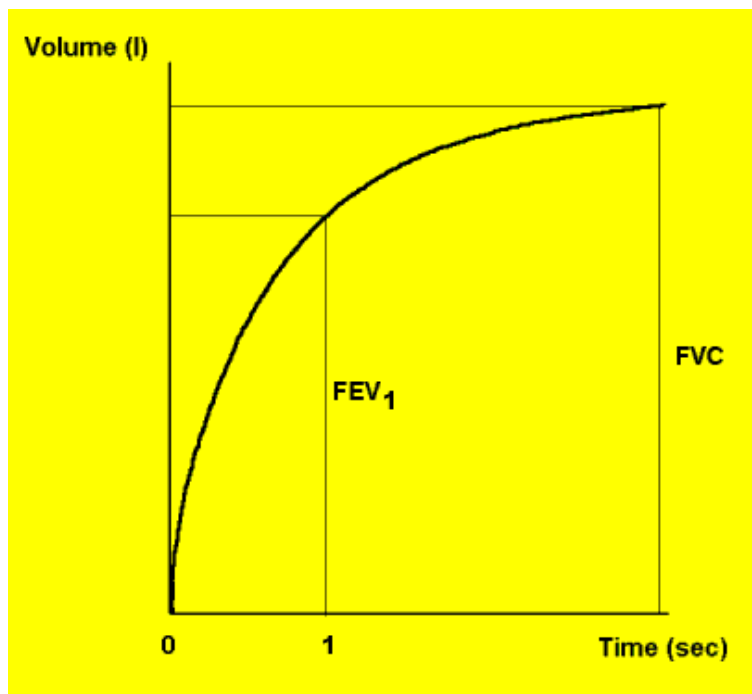


Figure 2. Forced vital capacity and forced expiratory volume

### Gas transfer

- Arterial blood gases are best measure available of gas transfer
- Also allow assessment of ventilation / perfusion mismatch
- Important parameters to measure are:
  - pH
  - Partial pressure of oxygen
  - Partial pressure of carbon dioxide
- Pulse oximetry gives an indirect estimate of gas transfer
- Technique is unreliable in the presence of other medical problems (e.g. anaemia)



### **Cardiac function**

- Simple non-invasive and more complicated invasive tests of cardiac function exist

#### ***Non-invasive***

- Chest x-ray
- ECG
- Echocardiography
- Exercise test

#### ***Invasive***

- Coronary angiography
- Thallium scanning

#### ***Chest x-ray***

- Routine chest x-ray is not recommended
- It is indicated in the presence of cardiorespiratory symptoms or signs
- Important signs associated with increased cardiac morbidity are:
  - Cardiomegaly
  - Pulmonary oedema
  - Change in the cardiac outline characteristic of specific diseases

#### ***ECG***

- Resting ECG is normal in 25-50% of patients with ischaemic heart disease
- Characteristic features of ischaemia or previous infarction may be present
- Exercise ECG provides a good indication of the degree of cardiac reserve
- 24-hour monitoring is useful in the detection and assessment of arrhythmias

#### ***Echocardiography***

- Can be performed percutaneously or transoesophageal
- Two-dimensional echocardiography allows assessment of
  - Muscle mass
  - Ventricular function / ejection fraction
  - End-diastolic and end-systolic volumes
  - Valvular function
  - Segmental defects
- Doppler ultrasound allows assessment of valvular flow and pressure gradients

#### ***Nuclear medicine***

- Myocardial scintigraphy allows assessment of myocardial perfusion
- Radiolabelled thallium is commonest isotope used
- Areas of ischaemia or infarction appear as 'cold' spots
- Vasodilators can be used to evaluate reversibility of ischaemia
- Radiolabelled albumin or red cells can be used to assess ejection fraction
- Such dynamic studies are performed 'gated' to the ECG

#### ***Renal function***

- Glomerular filtration rate is the gold standard test of renal function
- Can be calculated by measuring creatinine clearance rate
- Requires 24-hour urine collection
- Serum creatinine allows a good estimate of renal function



- Use of serum creatinine may be inaccurate in patients with:
  - Obesity
  - Oedema
  - Pregnancy
  - Ascites

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## Management of associated medical conditions

### Conditions rendering patients at increased anaesthetic risk

- Difficult airway
- Obesity
- Cardiac disease
- Respiratory disease
- Gastrointestinal disease
- Renal failure
- Diabetes
- Haematological disorders
- Allergic reactions

### Cardiovascular disease

- Several scoring systems exist for stratifying cardiac risk prior to non-cardiac surgery
- Simple to use and identify patients in need of further investigation

#### *Eagle index*

- One point allocated for each of:
  - History of myocardial infarction or angina
  - Q wave on preoperative ECG
  - Non-diet controlled diabetes mellitus
  - Age more than 70 years
  - History of ventricular arrhythmia
- If total score is:
  - No points is low risk
  - 1 or 2 points is intermediate risk
  - More than 2 points is high risk
- Low risk patients require no further investigation
- Intermediate risk patients require exercise ECG and thallium scan
- High risk patients require coronary angiography prior to major surgery

#### *Revised cardiac risk index*

- One point allocated for each of:
  - High-risk surgery
  - Ischaemic heart disease
  - History of congestive heart failure
  - History of cerebrovascular disease
  - Insulin therapy for diabetes mellitus
  - Renal impairment
- Risk of major cardiac event during surgery:
  - No points is 0.5%
  - 1 point is 1.3%
  - 2 points is 4%
  - More than 2 points is 10%



### **Myocardial Infarction**

- Elective surgery should be deferred for 6 months after a myocardial infarct
- Risk factors for postoperative myocardial re-infarction:
  - Short time since previous infarct
  - Residual major coronary vessel disease
  - Prolonged or major surgery
  - Impaired myocardial function
- Risk of postoperative re-infarction after a previous MI is:
  - 0-3 months is 35%
  - 3-6 months is 15%
  - More than 6 months is 4%
  - 60% of post operative myocardial infarcts are silent
  - The mortality of re-infarction is approximately 40%

### **Hypertension**

- In patients with hypertension need to assess:
  - Degree of hypertension
  - Presence of end organ damage
- Risk of cardiovascular morbidity is increased in poorly controlled hypertension
- Risk is present if diastolic pressure is greater than 95 mmHg
- Elective surgery should be cancelled if diastolic pressure is greater than 120 mmHg



### ***Respiratory disease***

- Patients with lung disease are at increased risk of respiratory complications
- The complications include:
  - Bronchospasm
  - Atelectasis
  - Bronchopneumonia
  - Hypoxaemia
  - Respiratory failure
  - Pulmonary embolism
- In addition to routine preoperative investigations need to consider:
  - Chest radiography
  - Spirometry
  - Arterial blood gases
- Upper respiratory tract infections increase the risk postoperative chest complications
- Elective surgery should be deferred for 2-4 weeks

### ***Smoking***

- Doubles the risk of pulmonary complications
- Increased risk persists for 3-4 months after stopping smoking
- Smoking increases blood carboxyhaemoglobin
- Increased carboxyhaemoglobin persists for 12 hours after last cigarette



### **Obesity**

- Morbidity and mortality after all surgery is increased in the obese
- Risk is increased even in the absence of other disease
- Body mass index (BMI) is best measure of degree of obesity
- $BMI = \text{Weight (Kg)} / \text{height (m)}^2$
- Normal BMI is 22-28
- BMI greater than 28 equates to significantly overweight
- BMI greater than 35 equals morbid obesity
- Patients are at risk of numerous complications
- ITU or HDU bed may be required postoperatively

### **Cardiovascular**

- Hypertension
- Ischaemic heart disease
- Cerebrovascular disease
- Deep venous thrombosis
- Difficult vascular access

### **Respiratory**

- Difficult airway
- Difficult mechanical ventilation
- Chronic hypoxaemia
- Obstructive sleep apnoea
- Pulmonary hypertension
- Postoperative hypoxaemia

### **Other complications**

- Gastro-oesophageal reflux
- Abnormal liver function
- Insulin resistance and Type 2 diabetes
- Poor postoperative pain control
- Unpredictable pharmacological response



### ***Diabetes mellitus***

- Pre and perioperative management depends on severity of disease.

#### ***Diet controlled diabetes***

- No specific precautions.
- Check blood sugar
- Consider glucose-potassium-insulin (GKI) infusion if more than 12 mmol/l.

#### ***Oral hypoglycaemics***

- Stop long acting sulphonylureas (e.g. chlorpropamide) 48 hours prior to surgery
- Omit short acting agents on morning of operation
- Restart oral hypoglycaemics when eating normally
- Consider GKI infusion for major surgery

#### ***Insulin dependent diabetes***

- Convert long acting insulins to 8-hourly Actrapid
- Place early on operating list
- Give GKI infusion until eating normally

#### ***GKI infusion***

- Made up as:
  - 15 u insulin
  - 10 mmol potassium chloride
  - 500 ml 10% dextrose
- Infused at a rate of 100 ml /hr.





## Obstructive Jaundice

- Operative morbidity and mortality is increased in patients with jaundice

Table 5 Adverse effects of jaundice

System	Effect
Coagulation	Reduces the absorption of fat soluble vitamins Reduces production of factors II, VII, IX, X Disorders can be reversed with Fresh Frozen Plasma or Vitamin K
Immune	Reduced wound healing Increased risk of infection
Hepato-renal	Acute renal failure in patient with jaundice Probably due to systemic endotoxaemia Requires adequate hydration and diuretics Value of mannitol unproven
Metabolism	Half life of many analgesics is prolonged (e.g. morphine).

## Chronic renal failure

- Chronic renal failure affects multiple organ systems
- Effects that need to be considered by both surgeons and anesthetists include
  - Electrolyte disturbances
  - Impaired acid-base balance
  - Anaemia
  - Coagulopathy
  - Impaired autonomic regulation
  - Protection of veins, shunts and fistulae

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## **Anaemia**

### **Causes of anaemia**

#### ***Decreased haemoglobin production***

- Reduced haemoglobin synthesis
  - Iron deficiency
  - Thalassaemia
  - Chronic disease
- Reduced DNA synthesis
  - Megaloblastic anaemia
  - Reduced stem cell production
  - Aplastic anaemia
- Myeloproliferative disorders
  - Bone marrow infiltration
  - Carcinoma
  - Lymphoma
- Toxic injury
  - Radiotherapy
  - Chemotherapy
  - Infection

#### ***Increased red cell destruction***

- Blood loss – acute or chronic
- Haemolysis – intrinsic
  - Membrane disorders – hereditary spherocytosis, elliptocytosis
  - Haemoglobinopathies – sickle cell disease
  - Glycogenolysis – pyruvate kinase deficiency
  - Oxidation – G6PD deficiency
- Haemolysis – extrinsic
  - Immune – warm or cold antibodies
  - Microangiopathic – DIC, TTP
  - Haemolytic uraemic syndrome
  - Infection – e.g. clostridial bacteraemia
  - Hypersplenism

### **Classification of anaemia**

#### ***Hypochromic microcytic***

- MCV less than 80 fl
- MCH less than 27 pg
- Causes include:
  - Iron deficiency
  - Thalassaemia trait
  - Anaemia of chronic disease
  - Lead poisoning
  - Sideroblastic anaemia

**Normochromic normocytic**

- MCV 80-95 fl
- MCH greater than 27 pg
- Causes include:
  - Haemolytic anaemias
  - Anaemia of chronic disease
  - Acute blood loss
  - Mixed deficiencies
  - Bone marrow failure
  - Renal disease

**Macrocytic anaemia**

- MCV great than 95 fl
- Causes include:
  - Megaloblastic anaemia (B12 or folate deficiency)
  - Non-megaloblastic causes (alcohol, liver disease)

**Preoperative anaemia**

- Tissue oxygenation is dependent on
  - Arterial oxygen content
  - Capillary blood flow
  - Position on the oxygen dissociation curve
- Haemoglobin concentration affects all of these factors
- Anaemia reduces arterial oxygen content
- Reduced plasma viscosity increases capillary blood flow
- Increases 2,3 DPG and shifts dissociation curve to the right
- Both anaemia and polycythaemia increase postoperative mortality
- Perioperative haemoglobin concentration of approximately 10 g/dl is ideal
- Preoperative transfusion may:
  - Induce immunosuppression
  - Increase risk of infection
  - Increase risk of tumour recurrence
- If transfusion is required it should be given at least 2 days preoperatively
- Blood transfused immediately prior to operation has reduced O<sub>2</sub> carrying capacity

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## Iron deficiency anaemia

- Iron deficiency is commonest cause of anaemia worldwide
- Results in hypochromic and microcytic red blood cells
- Diagnosis of iron deficiency is usually straightforward
- Determining the cause can be difficult

## Iron metabolism

- The body contains about 5g of iron
- 70% is found in haemoglobin
- Daily dietary requirements are about 1 mg in a man and 3 mg in a women
- An average diet contains about 15 mg of iron daily only 5-10% of which is absorbed
- Absorption occurs in the ferrous form in the upper part of small intestine
- Iron is carried to bone marrow by plasma transferrin
- Iron is stored bound to ferritin and as haemosiderin
- About 1 mg of iron is lost per day in urine, faeces and shed cells
- Menstrual losses account for an extra 20 mg per month

## Clinical features

- Depend of rate of onset
- If insidious then symptoms are often few
- Commonest symptoms are of lethargy and dyspnoea
- Skin atrophy occurs in about 30% of patients
- Nail changes include koilonychia (spoon shaped nails)
- Patients may also develop angular stomatitis and glossitis
- Oesophageal and pharyngeal webs may be seen
- Examination should be directed to possible underlying cause

## Causes of iron deficiency

- Increased blood loss - uterine, GI tract, urine
- Increased demands - prematurity, growth, child-bearing
- Malabsorption - post-gastrectomy, coeliac disease
- Poor diet

## Investigations

- The following investigations may be required:
  - Full blood count and blood film examination
  - Haematinic assays (serum ferritin, vitamin B<sub>12</sub> and folate)
  - Faecal occult bloods
  - Mid-stream urine
  - Endoscopic or barium studies of the GI tract
- Diagnosis of iron deficiency will be based on
  - Reduced haemoglobin (men <13.5 g/dl, women <11.5 g/dl)
  - Reduced mean cell volume (<76 fl)
  - Reduced mean cell haemoglobin (<27 pg)
  - Reduced mean cell haemoglobin concentration (<300 g/l)
  - Blood film - microcytic, hypochromic red cells
  - Reduced serum ferritin (<10 µg/l)
  - Reduced serum iron (men < 14µmol/l, women <11µmol/l)



- Increased serum iron binding capacity ( $>75 \mu\text{mol/l}$ )
- Diagnostic bone marrow examination is rarely required

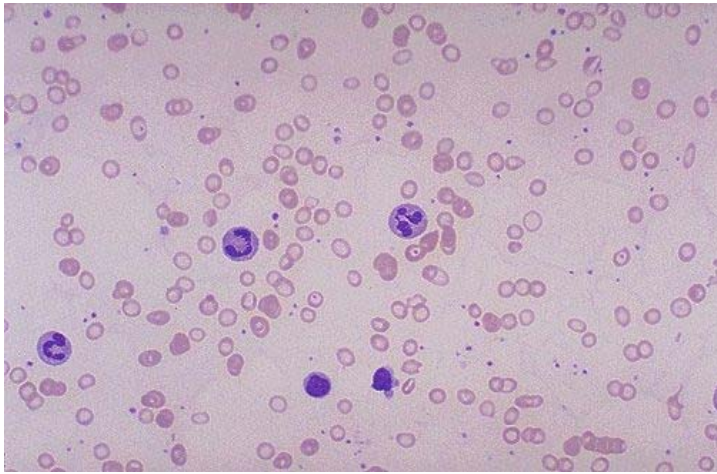


Figure 3 Hypochromic microcytic anaemia due to iron deficiency

- Other causes of a hypochromic microcytic anaemia include:
  - Anaemia of chronic disease
  - Thalassemia trait
  - Sideroblastic anaemia

### Management

- Management of iron deficiency anaemia relies on:
  - Identification and management of the underlying cause
  - Iron replacement therapy

### *Iron replacement therapy*

- Oral replacement with ferrous salts are the preferred option.
- Preparations include ferrous sulphate, fumarate and gluconate
- Provide approximately 200 mg of iron per day
- Side effects include epigastric pain, constipation and diarrhoea
- Effective treatment should increase haemoglobin concentration by 1 g/l/day
- Should continue for three months after normal haemoglobin achieved
- Intravenous iron preparations are available on named patient basis
- Severe side effects (e.g. anaphylaxis) may occur
- Injections can result in skin staining and arthralgia
- Should only be used when patients can not tolerate oral preparation

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## Sickle cell anaemia

### Pathology

- Normal haemoglobin has 2 x  $\alpha$  and 2 x  $\beta$  chains
- In sickle cell disease single amino acid substitution occurs on  $\beta$  chain
- Valine substituted for glutamic acid at position 6
- The resulting Hb S is less soluble than Hb A
- Sickle haemoglobin gene is inherited as autosomal recessive
- Commonly seen in patients of Afro-Caribbean descent
- Sickle cell anaemia occurs in homozygotes
- Sickle cell trait occurs in heterozygotes
- When deoxygenated haemoglobin undergoes polymerisation and forms characteristic sickle cells

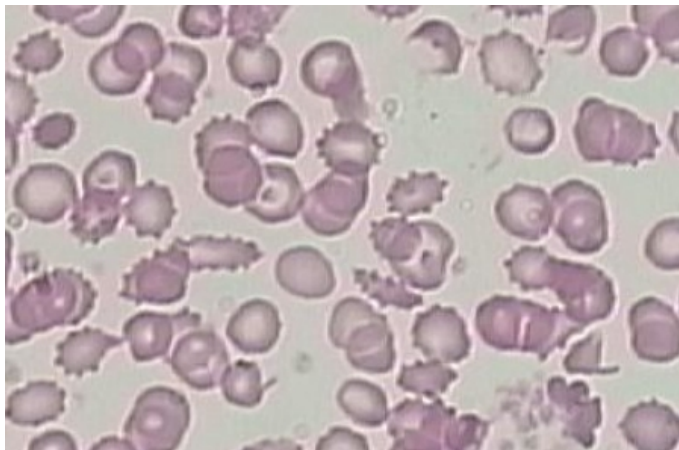


Figure 4 Sickle cell anaemia

- Blockage of small vessels results in vaso-occlusive events
- Sickling may be precipitated by infection, fever, dehydration, cold, hypoxia

### Clinical features

- Patients have chronic haemolytic anaemia with high reticulocyte counts
- At increased risk of infection by encapsulated bacteria
- Acute complications include:
  - Painful crises
  - Worsening anaemia
  - Acute chest symptoms
  - Symptoms and signs of neurological or ocular events
  - Priapism
- Diagnosis can be confirmed by:
  - Sickle solubility test
  - High performance liquid chromatography

### Prevention of complications

- Patient and parent education is important
- Patients need to avoid the cold, dehydration, etc
- Antibiotic prophylaxis should be considered in children less than 5 years



- Usually phenoxymethylpenicillin is the antibiotic of choice
- Children should be vaccinated with the pneumococcal vaccine

#### ***Peri-operative precautions***

- Patients at high risk of acute sickling complications under general anaesthesia
- Require careful pre and peri-operative management
- Transfusion may be required to ensure Hb of 9-10 g/dL
- Preoperative exchange transfusion is rarely required
- Need to:
  - Avoid dehydration
  - Avoid hypoxia
  - Control intra and postoperative pain

#### ***Management of complications***

- Patients with suspected complications require:
  - Intravenous fluids
  - Adequate pain relief often with opiates
  - Oxygen
  - Early antibiotic therapy if suspected infection

#### ***Painful crises***

- 60% of patients with sickle cell anaemia will have one episode per year
- Bony crises result from localised ischaemia
- Avascular necrosis may occur
- Treatment involves rest and analgesia
- Abdominal crises present with pain, vomiting, distension and features of peritonism
- 40% of adolescents with sickle cell anaemia will have gallstones

#### ***Anaemia***

- Worsening anaemia often presents with tiredness and cardiac failure
- Results from acute splenic sequestration or aplastic crisis
- In both situations urgent transfusion may be required

#### ***Acute chest syndrome***

- Presents with chest pain, cough, fever and tachypnoea
- Accompanied by clinical and radiological features of consolidation
- Chlamydia and Mycoplasma are important aetiological agents
- Require parenteral antibiotic therapy - usually erythromycin

#### ***Acute neurological events***

- A stroke occurs in approximately 10% of patients before the age of 20 years
- All acute neurological symptoms require investigation
- Acute stroke requires urgent exchange transfusion

#### ***Priapism***

- Occurs in about 20% of males before the age of 20 years
- If lasts for more than a few hours can result in erectile impotence
- Blood should be aspirated from corpora cavernosa
- Intra-cavernosal injection of alpha agonist (e.g. phenylephrine) may be of benefit



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## Preparation for surgery

### *Informed consent*

- Patients autonomy must be respected at all times
- Patients can determine what treatment that they are or are not willing to receive
- They have the right to decide not to undergo a treatment
- This could adversely affect outcome or result in their death
- Patients must be given sufficient information to make these decisions
- Obtaining informed consent is not an isolated event
- It involves a continuing dialogue between doctor and patient

### *Types of consent*

- Express consent - oral or written
  - Needed for most investigations or treatments with risks attached
- Implied consent
  - Non-written consent when patient co-operates with a particular action
  - e.g. physical examination

### *Information required*

- When obtaining consent patients should be informed of:
  - Details of diagnosis and prognosis with and without treatment
  - Uncertainties about the diagnosis
  - Options available for treatment
  - The purpose of a proposed investigation or treatment
  - The likely benefits and probability of success
  - Any possible side effects
  - A reminder that the patients can change their mind at any stage
  - A reminder that the patients has the right to a second opinion
- All questions should be answered honestly
- Information should not be withheld that might influence the decision making process
- Patients should not be coerced
- The person who obtains consent must be:
  - Suitably trained and qualified
  - Have sufficient knowledge of the proposed treatment and its risks

### *Specific problems*

- No-one else can make a decision on behalf of a competent adult
- No-one can give or withhold consent on behalf of a mentally incapacitated patient
- Court approval should be obtained for controversial treatments not directed at a mental disorder
- In an emergency a life-saving procedure can be performed without consent
- All actions must, however, be justifiable to ones peers

### *Children*

- At age of 16 years a child can be presumed to have the capacity to decide on treatment
- Below the age of 16 years the child may have the capacity to decide depending on their ability to understand what the treatment involves
- If a competent child refuses treatment a person with parental responsibility may authorise treatment which is in the child's best interests



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### **Risk assessment and management**

- We all take risks in everyday life
- The degree of risk taken depends on the perceived benefit
- Most decisions are made on previous experiences
- Risk assessment forms an integral part of patient care
- An assessment needs to be made of the risks vs. benefits for an procedure performed
- These will then influence decisions made by the surgeon or the patient

### **Risk assessment models**

- Assessment of risk in surgery depends on many factors
- These involve knowledge of the:
  - Patient
  - Disease
  - Comorbidities
  - Proposed surgery
  - Physiological status

### **Risk assessment tools**

- Decision making is rarely simple and straight forward
- Risk assessment tool in common use include
  - Goldman Cardiac Risk Index
  - Parsonnet Score
  - POSSUM
  - Injury Severity Score
  - Revised Trauma score
  - APACHE I, II and III

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## Principles of anaesthesia

### Local and regional anaesthesia

- Local anaesthetic agents act by reducing membrane permeability to sodium
- Act on small unmyelinated C fibre before large A fibres
- Reduce pain and temperature sensation before touch and power

### Lignocaine

- Lignocaine is a weak base ( $pK_a = 7.8$ )
- At physiological pHs mainly ionised
- Has a duration of action of about one hour
- With addition of adrenaline duration of action can be increased to 2 hours
- Main toxicity is on central nervous and cardiovascular systems
- Plain lignocaine should be used for local anaesthesia in digits and appendages
- Adrenaline containing solutions can cause tissue ischaemia.

Table 6 Maximum doses of local anaesthetic (average adult)

	Plain solution	With adrenaline
Lignocaine	200 mg (20 ml of 1%)	500 mg (50 ml of 1%)
Bupivacaine	150 mg (30 ml of 0.5%)	200 mg (40 ml of 0.5%)
Prilocaine	400 mg (80 ml of 1.5%)	600 mg (120 ml of 1.5%)

### Spinal and epidural anaesthesia

- Spinal anaesthesia
  - Local anaesthetic or opiate into CSF below termination of cord at L1
- Epidural anaesthesia
  - Local anaesthetic or opiate into fatty epidural space
- Both can produce good anaesthesia for up to 2 hours
- The quality of the block is often better with a spinal
- Epidural anaesthesia is technically more demanding

### Contraindications

- Pre-existing neurological disease
- Coagulopathy

Table 7 Complications of spinal and epidural anaesthesia

	Characteristic	Spinal	Epidural
Immediate	Hypotension	Common	Less common
	LA toxicity	Rare	Occasional
	High Blockade	Occasional	Occasional
Early	Urinary retention	Common	Less common
	Headache	1-5%	Never unless dural puncture
	Local infection	Almost never	Uncommon
	Meningism	Uncommon	Very rare
	Epidural haematoma	Almost never	Very rare
	Backache	Common	Common



### **Hypotension**

- Sympathetic outflow from spinal cord occurs between T1 and L2
- Blocked to varying degrees in both spinal and epidural anaesthesia
- The higher the block the greater the degree of blockade
- In hypovolaemic patients there is a greater risk of hypotension
- Hypotension during spinal and epidural anaesthesia usually requires fluid resuscitation

### **Post spinal headache**

- Seen following between 1 - 5% of spinal anaesthetics
- Usually due to CSF leak
- In most patients is settles after about 3 days
- Headache is characteristically occipital
- Worse on standing and relieved by lying down
- Initial treatment is with bed rest, simple analgesia and fluids
- If persists consider 'blood-patch'
- Patients own blood injected into epidural space

### **Postoperative epidural infusions**

- Attenuates postoperative stress response
- Improves postoperative pain control
- Reduces incidence of postoperative pulmonary complications
- Allows more rapid return of gastrointestinal function
- Reduces duration of hospital stay

### **Opioid alone**

- Allows opioid analgesia without sedation
- No motor or sympathetic blockade
- Quality of analgesia can however be variable
- Itch is common
- Serious respiratory depression can occur after stopping infusion

### **Local anaesthetic alone**

- Potential for complete anaesthesia
- No sedative effects or respiratory depression
- Sympathetic and motor blockade are common
- Cardiovascular side effects can occur
- Block occasionally patch or unilateral

### **Combination of LA and opioid**

- Synergy between sites of action
- Reduced doses of both drugs
- Optimal analgesia possible



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### **Premedication and induction**

- General anaesthesia is a drug-induced state of unresponsiveness
- Has three phases
  - Induction
  - Maintenance
  - Reversal and recovery
- Usually achieved by the use of a combination of agents

### **Premedication**

- Is the administration of drugs prior to an anaesthetic
- Has three potentially useful effects:
  - Anxiolysis
  - Reduced bronchial secretions
  - Analgesia
- Anxiolysis if needed can be achieved with either benzodiazepines or phenothiazines
- Opiate analgesics also have useful sedative properties
- Reduction of secretions is not as important today with modern inhalational agents
- Ether was notorious for stimulating bronchial secretions
- If required secretions can be reduced with hyoscine
- Also reduce salivation and prevents bradycardia
- Analgesia best achieved with strong opiates

### **Principles of premedication**

- Anxiolysis
- Analgesia
- Amnesia
- Antiemetic
- Antacid
- Anti-autonomic
- Adjuncts

### **Drugs used**

- Anxiolysis - benzodiazepines, phenothiazines
- Analgesia - opiates, non-steroids anti-inflammatories
- Amnesia - benzodiazepines, anticholinergics
- Antiemetic - anticholinergics, antihistamines, 5HT antagonist
- Antacid - Alginates, proton pump inhibitors
- Anti-autonomic - anticholinergics, beta-blockers
- Adjuncts - Bronchodilators, steroids

### **Induction of anaesthesia**

- Induction agents are usually administered intravenously
- Distributed to organs with a high blood flow (e.g. brain)
- Highly lipid soluble and rapidly cross blood brain barrier
- With falling blood levels they are rapidly redistributed from brain
- Have rapid onset and without maintenance would have rapid recovery

### **Thiopentone**

- Short-acting barbiturate



- First used at Pearl Harbour in 1942
- Depresses myocardium
- In hypovolaemic patient can induce profound hypotension

#### **Propofol**

- Has very short half-life
- Can cause hypotension
- Can also be used for maintenance of anaesthesia as an infusion

#### **Rapid-sequence induction**

- Rapid induction of anaesthesia
- Cricoid pressures used to reduce risk of aspiration
- Pressure released once tracheal intubation with a cuffed tube has been achieved
- Achieved by the use of thiopentone and suxamethonium
- Used for patients with:
  - None fasted
  - History of gastro-oesophageal reflux
  - Emergency trauma patients
  - Intestinal obstruction
  - Pregnancy
  - Intra-abdominal pathology that will delay gastric emptying

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### **Maintenance of anaesthesia**

- Balanced anaesthesia has three aspects to it
  - Hypnosis - suppression of consciousness
  - Analgesia - suppression of physiological responses to stimuli
  - Relaxation - suppression of muscle tone and relaxation
- Anaesthesia is normally maintained with inhaled volatile gases
- They are lipid soluble hydrocarbons
- They have high saturated vapour pressures
- Modern agents are potent, non-inflammable and non-explosive
- MAC = Minimum alveolar concentration
- It is the alveolar concentration required to keep 50% of population unresponsive

### **Adverse effects of inhalational anaesthetic agents**

#### **Cardiovascular**

- Decreased myocardial contractility
- Reduced cardiac output
- Hypotension
- Arrhythmias
- Increased myocardial sensitivity to catecholamines

#### **Respiratory**

- Depress ventilation
- Laryngospasm and airway obstruction
- Decreased ventilatory response to hypoxia and hypercapnia
- Bronchodilatation

#### **Central nervous system**

- Increased cerebral blood flow
- Reduced cerebral metabolic rate
- Increased risk of epilepsy
- Increased intracranial pressure

#### **Others**

- Decreased renal blood flow
- Stimulate nausea and vomiting
- Precipitate hepatitis

### **Specific anaesthetic agents**

#### **Halothane**

- Potent anaesthetic but poor analgesic agent (MAC = 0.75)
- Can be used for gaseous induction in children
- 20% is metabolised in the liver and can cause hepatic dysfunction
- Occasionally causes severe hepatitis that can progress to liver necrosis
- Depressed myocardial contractility and can induce arrhythmias

#### **Isoflurane**

- Potent anaesthetic but poor analgesic agent (MAC = 1.05)
- Less cardiotoxic but causes greater respiratory depression



- Reduces peripheral resistance and cause a 'coronary steal'
- Few adverse effects have been reported

#### **Nitrous oxide**

- Weak anaesthetic agent (MAC = 103)
- Can not be used as an anaesthetic agent alone without causing hypoxia
- Very potent analgesic agent
- Used as 50% N<sub>2</sub>O / 50% O<sub>2</sub> mixture = 'Entonox'
- Used in anaesthesia mainly for its analgesic properties

#### **Muscle relaxants**

- Muscle relaxants are either depolarising or non-depolarising agents

#### **Depolarising agents**

- e.g. suxamethonium
- Act rapidly within seconds and last for approximately 5 minutes
- Used during induction of anaesthesia

#### **Side effects:**

- Histamine release producing a 'scoline rash'
- Bradycardia
- Somatic pain resulting from fasciculation
- Hyperkalaemia
- Persistent neuromuscular blockade = 'scoline apnoea'
  - Affects 1:7000 of population
  - Due to pseudocholinesterase deficiency
- Malignant hyperpyrexia
  - Affects 1:100,000 of population
  - Due to increased calcium influx and uncontrolled metabolism
  - Rapid increase in body temperature with increased PaCO<sub>2</sub>
- Increased intra-ocular pressure
- Increased gastric pressure

#### **Non-depolarising agents**

- e.g. vecuronium
- Act over 2-3 minutes and effects last for 30 minutes to one hour
- Competitive antagonism of acetylcholine receptor
- Used for muscle relaxation

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## Monitoring of the anaesthetised patient

### *Invasive and non-invasive monitoring*

- Cardiac output is the 'gold standard' measure of cardiovascular function
- Measurement normally requires invasive pressure monitoring
- Cardiovascular function can however be assessed non-invasively with:
  - Electrocardiogram
  - Blood pressure
  - Central venous pressure
  - Urine output
- BP can be monitored with a cuff (intermittent) or arterial line (continuous)
- In the absence of vasoconstriction provides a good estimate of cardiac output

### The ECG

- Provides information on heart rate and rhythm
- Also serves as valuable monitor of electrolyte abnormalities
- A 12-lead ECG provides information on myocardial ischaemia or infarction
- ECG monitoring essential for:
  - All patients in ITU or HDU
  - Patients with poor cardiac reserve
  - Patients receiving vasoactive drugs
  - Patients with drug toxicity
  - Monitoring of electrolyte disturbances

### Arterial pressure monitoring

- Invasive arterial pressure monitoring requires:
  - An arterial cannula
  - A monitoring line
  - A transducer
  - A monitoring system
- Provides information on:
  - Systolic and diastolic pressure
  - Arterial waveform
- Complications and problems associated with invasive monitoring include:
  - Over and under dampening
  - Incorrect zeroing
  - Haematoma
  - Distal ischaemia
  - Inadvertent drug injection
  - Disconnection and haemorrhage
  - Infection

### Central venous pressure

- Clinical assessment of jugular venous pressure is unreliable
- Central venous system can be cannulated by internal jugular or subclavian route
- Complications of CVP lines include:
  - Pneumothorax
  - Arterial puncture
  - Air embolism
  - Infection



- Site at which transducers are zeroed are very variable
- Also change with patient movement
- Changes in pressure rather than absolute values are important
- A fluid bolus = 200 ml of colloid given as quickly as possible
- A low CVP with transient increase with fluid bolus is hypovolaemia
- A high CVP with persistent increase with fluid bolus is hypervolaemia
- CVP measurement allows assessment of the cardiac pre-load

#### **Cardiac output and left sided pressures**

- If both ventricle are functioning normally pre-load will allow assessment of cardiac output
- Ischaemic heart disease or sepsis LV function can be reduced
- Pulmonary hypertension reduces RV function
- In these situation assessment of left heart pressures may be important
- Also a measure of cardiac output may be need
- Cardiac output can be measured either
  - Invasively - pulmonary artery catheter
  - Non-invasively - oesophageal doppler

#### **Swan-Ganz catheter**

- Balloon-tipped catheter inserted through central vein
- Floated through right side of heart into pulmonary artery
- Balloon allows 'wedging' in branch of pulmonary artery
- Pressure recorded is pulmonary capillary wedge pressure
- Good estimate of left atrial pressure
- Tip of catheter contains a thermistor
- Cardiac output can also be measured using thermodilution principal
- If blood pressure and cardiac output are known vascular resistance can be calculated

#### **Complications of a Swan-Ganz catheter**

- Arrhythmias
- Knotting and misplacement
- Cardiac valve trauma
- Pulmonary infarction
- Pulmonary artery rupture
- Balloon rupture
- Catheter thrombosis or embolism

#### **Primary haemodynamic data**

- Heart rate
- Mean arterial pressure
- Central venous pressure
- Mean pulmonary artery pressure
- Mean pulmonary artery occlusion pressure
- Cardiac output
- Ventricular ejection fraction



### ***Derived haemodynamic data***

- Cardiac index
- Stroke volume
- Stroke volume index
- Systemic vascular resistance
- Systemic vascular resistance index
- Pulmonary vascular resistance index
- Left ventricular stroke work index
- Right ventricular stroke work index
- Oxygen delivery
- Oxygen consumption

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## Care of the patient under anaesthesia

### *Prevention of injuries in the anaesthetised patient*

- General anaesthesia removes many of the bodies natural protective mechanisms
- Iatrogenic injury is therefore possible
- Many of these injuries can produce lasting disability
- Can also lead to litigation
- Recognition of risks and prevention is essential

### *Injuries in the anaesthetised patient*

#### *Nerve injuries*

- Brachial plexus
- Ulnar nerve
- Radial nerve
- Common peroneal nerve

#### *Tissue injuries*

- Corneal abrasions
- Teeth or crowns
- Diathermy burns
- Dislocations or fractures

#### *Anaesthetic*

- Drug reactions
- Hypoxia
- Awareness

#### *Nerve injuries*

- The incidence of nerve injuries is unknown
- In USA account for 15% of postoperative litigation claims
- Most are due to careless positioning of the patient
- Commonest nerves affected are ulnar and common peroneal nerves and brachial plexus
- Predisposing factors include:
  - Medical conditions associated with a neuropathy (e.g. diabetes mellitus)
  - Nerve ischaemia due to hypotension
  - Local injections or direct nerve injury
  - The use of a tourniquets
- Most are due to a neurapraxia
- 90% undergo complete recovery
- 10% are left with residual weakness or sensory loss

#### *Ulnar nerve*

- Caused by arms along side patient in pronation
- Ulnar nerve compressed at elbow between table and medial epicondyle
- Prevented by positioning arms in supination



### **Brachial plexus**

- Caused by excessive arm abduction or external rotation
- Prevented by avoiding more than 60° abduction if possible
- Should avoid arm falling off side of table

### **Common peroneal nerve**

- Caused by direct pressure on the nerve with legs in lithotomy position
- Nerve compressed against neck of fibula
- Prevented by adequate padding of lithotomy poles

### **Radial nerve**

- Caused by tourniquet or misplaced injection in deltoid muscle
- Prevented by adequate padding of tourniquet

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## Haematological problems in surgery

### *Disorders of bleeding & coagulation*

#### Classification of bleeding disorders

- Bleeding disorders can arise from disorders of the:
  - Vessel wall
  - Platelets
  - Coagulation system

#### *Vessel wall*

- Hereditary haemorrhagic telangiectasia
- Ehlers-Danlos syndrome
- Drugs (e.g. steroids)
- Sepsis
- Trauma
- Vasculitis

#### *Platelets*

- Congenital platelet disorders
- Thrombocytopenia
- Myeloproliferative disorders
- Drugs (e.g. aspirin)

#### *Coagulation system*

- Haemophilia A, B
- Von Willebrand disease
- Factor IX, XIII deficiency
- Liver disease
- Anticoagulants
- Disseminated intravascular coagulation

#### Coagulation tests

##### *Prothrombin time (PT)*

- Tests extrinsic and common pathways
- Thromboplastin and calcium are added to patient plasma
- PT is expressed as ratio (International Normalised Ratio = INR)
- Prolonged in:
  - Warfarin treatment
  - Liver disease
  - Vitamin K deficiency
  - Disseminated intravascular coagulation

##### *Activated partial thromboplastin time (APPT, KCCT)*

- Tests intrinsic and common pathways
- Kaolin added to patient plasma
- Prolonged in:
  - Heparin treatment
  - Haemophilia and factor deficiencies
  - Liver disease





- Disseminated intravascular coagulation
- Massive transfusion
- Lupus anticoagulant

#### **Thrombin time (TT)**

- Tests common pathway
- Thrombin added to patient plasma
- Converts fibrinogen into fibrin
- Prolonged in:
  - Heparin treatment
  - Disseminated intravascular coagulation
  - Dysfibrinogenaemia

#### **Bleeding time (BT)**

- Measures capillary bleeding
- Prolonged in:
  - Platelet disorders
  - Vessel wall disorders

#### **Haemophilia**

- Haemophilia A is due to factor VIII deficiency
- Haemophilia B (Christmas disease) is due to factor IX deficiency

#### **Haemophilia A**

- Affects about 1 in 10,000 population
- It is a sex-linked clotting disorder
- One-third of patients have no family history
- Usually presents in childhood with:
  - Prolonged haemorrhage after dental extraction
  - Recurrent haemarthroses or muscle haematomas
  - Sub-periosteal haematomas can result in haemophilic pseudo-tumours
- Clinical severity depends on extent clotting factor deficiency
  - Less than 1% activity - severe disease with life-threatening bleeding
  - 1-5% activity - moderate disease with post-traumatic bleeding
  - 5-20% activity - mild disease

#### **Investigation**

- Activated partial thromboplastin time (APPT) is prolonged
- prothrombin time (PT) is normal
- Whole blood coagulation time is prolonged
- Factor VIII is reduced

#### **Treatment**

- Bleeding episodes are treated with factor VIII replacement
- Given as either factor VIII concentrate or cryoprecipitate
- Bleeding usually well controlled if factor VIII levels raised above 20% normal
- Desmopressin increases intrinsic factor VIII levels
- 5-10% develop antibodies to factor VIII
- Renders patients refractory to factor replacement therapy



### **Disseminated intravascular coagulation**

- Due to widespread intravascular activation of clotting cascade
- Causes a bleeding tendency due to consumption of clotting factors
- Presents with bruising or purpura
- Oozing from surgical wounds and venepuncture sites

#### **Causes**

- Severe (usually gram-negative or meningococcal) infection
- Widespread mucin-secreting metastatic adenocarcinoma
- Hypovolaemic shock
- Burns
- Transfusion reactions
- Eclampsia
- Amniotic fluid embolus
- Promyelocytic leukaemia

#### **Investigation**

- Increased APPT and PT
- Reduced serum fibrinogen levels (<1 mg / ml)
- Thrombocytopenia
- Increased fibrin degradation products
- Factor V and VIII activities are reduced

#### **Treatment**

- Fluid resuscitation
- Treat underlying cause
- Correct clotting abnormalities with:
  - Fresh frozen plasma
  - Cryoprecipitate
  - Platelet transfusion

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## Blood transfusion

### *Haemostasis*

- The haemostatic response has three elements:
  - Vasoconstriction
  - Platelet aggregation
  - Clotting cascade

### Vasoconstriction

- Occurs as a direct result of vessel injury
- Enhanced by vasoconstricting elements released from platelets
- Pain can also result in reflex sympathetic vasoconstriction

### Platelet aggregation

- Platelets are formed in bone marrow from megakaryocytes
- Contain the contractile proteins actin and myosin
- No nucleus but contain endoplasmic reticulum and Golgi apparatus that can produce proteins
- Contain mitochondria that can produce ATP and ADP
- Can also synthesis prostaglandins and thromboxane A<sub>2</sub>
- Have a half-life in the blood of 8-12 days
- In response to tissue damage platelets undergo a number of changes
- Platelet aggregation can result in a 'platelet plug' that can block a small hole
- Platelets adhere to damaged endothelium (via Von Willebrand factor)
- Aggregating platelets releases arachadonic acid which is converted to thromboxane A<sub>2</sub>
- Calcium mediated contraction of actin and myosin results in degranulation
- Releases ADP which can induces further aggregation and release in a positive feedback fashion

### Clotting cascade

- The clotting cascade has two semi-independent pathways
- The intrinsic pathway has all of its components within blood
- The extrinsic pathway is triggered by extravascular tissue damage
- This pathway is activated by exposure to a tissue factor
- Both pathways result in activation of prothrombin (factor II)
- The final common pathway converts fibrinogen to fibrin monomer
- Polymerisation of fibrin results in the formation of long fine strands held together by H-bonds
- These are then converted into covalent bonds with stabilisation of the fibrin polymer
- The intrinsic path ways is relatively slow (2-6 minutes)
- The extrinsic pathways is quite fast (15 seconds)

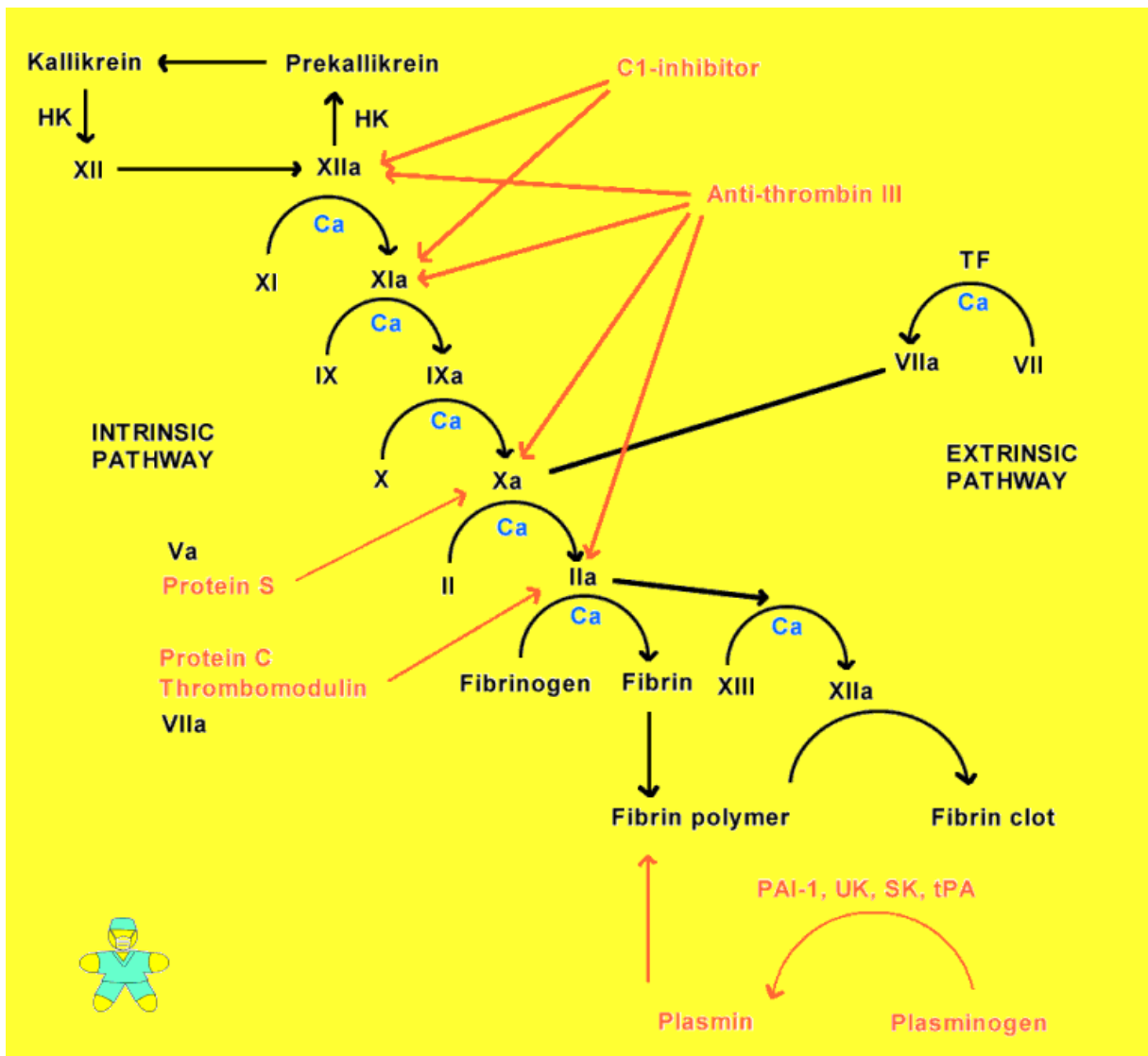


Figure 5 The clotting cascade

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## Blood groups

### ABO system

- Consists of three allelic genes - A, B and O
- A and B genes control synthesis of enzymes that add carbohydrate residues to cell surface glycoproteins
- The O gene is an amorph and does not transform the glycoprotein
- Six possible genotypes but only four phenotypes
- Naturally occurring antibodies are found in the serum of those lacking the corresponding antigen.

Table 8 ABO blood group system

Phenotype	Genotype	Antigens	Antibodies	Frequency (%)
O	OO	O	Anti-A & B	46
A	AA or AO	A	Anti-B	42
B	BB or BO	B	Anti-A	9
AB	AB	AB	None	3

- Blood group O is the universal donor
- Blood group AB is the universal recipient

### Rhesus system

- Rhesus antibodies are immune antibodies requiring exposure during transfusion or pregnancy
- 85% population are rhesus positive
- 90% of Rh-negative patients transfused with Rh-positive blood develop anti-D antibodies

### Cross matching

- Requires
  - Blood grouping  
Patients red cells grouped for ABO and Rhesus antigens  
Serum tested to confirm patients ABO group
  - Antibody screening  
Detects atypical red cell antibodies in recipients serum
  - Crossmatching  
Tests donor red cells against patients serum

### Blood products

- Whole blood
- Packed red cells
- Granulocyte concentrates
- Platelet concentrates
- Human plasma - fresh frozen plasma / freeze-dried plasma
- Plasma protein fraction
- Human albumin 25%
- Cryoprecipitate
- Clotting factors - Factor VIII / IX
- Immunoglobulins



## Transfusion reactions

Table 9 Complications of blood transfusion

Early	Late
Haemolytic reactions (immediate or delayed)	Infections - hepatitis or CMV
Bacterial infections from contamination	Iron overload
Allergic reactions to white cells or platelets	Immune sensitisation
Acute lung injury	
Pyogenic reactions	
Circulatory overload	
Air embolism	
Thrombophlebitis	
Citrate toxicity	
Hyperkalaemia	
Clotting abnormalities	

### Acute haemolytic or bacterial transfusion reactions

- Due to acute haemolysis or bacterial contamination
- Difficult to differentiate on clinical grounds
- May occur after infusion of small volume of incompatible or infected blood
- Associated with high morbidity and mortality
- In unconscious patient bleeding due to DIC may be only sign
- Most ABO mismatched transfusions are due to human error
- Usually occurs soon after start of transfusion
- Patient feels unwell and agitated
- Symptoms include back pain and pain at infusion site
- Associated with shortness of breath, rigors
- Examination will show hypotension, oliguria and bleeding from venepuncture sites
- Urinalysis will show haemoglobinuria

### Management

- Discontinue transfusion immediately and remove giving set
- Check unit of blood against patients identity
- Give intravenous crystalloid
- Consider transfer to the intensive care unit
- Take blood for FBC, plasma haemoglobin, clotting, blood cultures and repeat grouping
- Give broad spectrum antibiotics
- Monitor urine output and ECG

### Anaphylaxis

- Usually occurs soon after start of transfusion
- May be seen in IgA deficient patients reacting to transfused IgA
- Presents with circulatory collapse and bronchospasm

### Management

- Discontinue transfusion and remove giving set
- Maintain airway and give oxygen
- Administer adrenaline, chlorpheniramine, salbutamol



- If the patient is IgA deficient any further transfusion must be carefully planned

#### **Non haemolytic transfusion febrile reaction**

- Usually occurs more than 30 minutes after start of transfusion
- Patient feels generally well but may be shivering
- Temperature is usually less than 38.5 °C
- Blood pressure is usually normal

#### **Management**

- Stop transfusion and assess possibility that this may be a more significant reaction
- Restart transfusion at a slower rate
- Consider the use of paracetamol
- Hydrocortisone should not be routinely used during a transfusion

#### **Transfusion related acute lung injury**

- Occurs following administration of plasma-containing blood components
- Due to interaction of donor antibodies with recipient white cells
- The clinical picture is similar to ARDS
- Occurs 30 minutes to several days after transfusion
- Clinical features include fever, cough and shortness of breath
- Chest x-ray shows perihilar shadowing
- Treat as ARDS

#### **Delayed haemolytic transfusion reaction**

- Occurs 5-10 days after transfusion
- Clinical features are usually minimal
- Possibly unexplained pyrexia or jaundice
- Unexplained drop in haemoglobin
- Urinalysis shows urobilinogenuria

#### **Management**

- Check LFTs, clotting and red cell antibody screen

#### **Autologous transfusion**

- Is the use of the patient's own blood
- Particularly useful in elective surgery
- Accounts for 5% of transfusions in USA
- Reduces the need for allogeneic blood transfusion
- Reduces risk of postoperative complications (e.g. infection, tumour recurrence)
- Three main techniques are:
  - Predeposit transfusion
  - Intraoperative acute normovolaemic haemodilution
  - Intraoperative cell salvage

#### **Predeposit transfusion**

- Blood collection begins 3-5 weeks preoperatively
- Between 2 and 4 units are often stored
- Last unit collected more than 72 hours preoperatively
- Eliminates the risk of viral transmission
- Reduces the risk of immunological transfusion reactions



- Reduces risk of postoperative immunosuppression seen with allogeneic transfusion
- Collection is expensive and time-consuming
- Only suitable for elective surgery

#### ***Intraoperative acute normovolaemic haemodilution***

- Whole blood is removed at start of operative procedure
- Between 1.0 and 1.5 litres can be collected
- Replaced with crystalloid or colloid solution
- Few detrimental effects of acute anaemia have been demonstrated
- Blood is stored in theatre at room temperature
- Blood is re-infused during or immediately following surgery
- Cheaper than predeposit transfusion
- Little risk of administrative or clerical error
- Suitable for elective or emergency surgery at which considerable blood loss anticipated

#### ***Intraoperative cell salvage***

- Shed blood is collected from operative field
- Blood is anticoagulated with citrate or heparin and filtered to remove debris and clots
- Cells are then washed with saline and concentrated by centrifugation
- Concentrate is then reinfused
- Large volumes of blood can be salvaged
- Salvaged blood is not haemostatically intact
- Platelets and clotting factors are consumed
- Suitable in cardiac or trauma surgery
- Contraindicated in contaminated operative fields and in the presence of malignancy

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## Postoperative management and critical care

### Anaesthetic management

#### *Perioperative monitoring*

- General anaesthesia removes ability of patient to protect himself
- Safety and physiological control becomes the responsibility of the anaesthetist
- Anaesthetist needs to:
  - Maintain airway and oxygenation
  - Preserve circulation
  - Prevent hypothermia
  - Prevent injury
  - Monitor during anaesthesia

#### *Airway management*

- General anaesthesia removes muscle tone
- Without assistance airway will be compromised
- Methods of maintaining airway include:
  - Manual methods (e.g. Jaw thrust)
  - Guedel airway
  - Laryngeal mask
  - Endotracheal tube
  - Tracheostomy tube

#### *Complications of endotracheal intubation*

- Failure to intubate and loss of airway control
- Unrecognised oesophageal intubation
- Accidental intubation of a main bronchus
- Trauma to the larynx, trachea or teeth
- Pulmonary aspiration
- Disconnection or blockage of the tube
- Tracheal stenosis

#### *Hypothermia*

- Hypothermia develops rapidly during general anaesthesia
- Occurs due to:
  - Radiation of body heat
  - Vasodilatation
  - Infusion of cold fluids
  - Evaporation from open body cavities
- Hypothermia develops more rapidly in children
- Heat loss can be reduced by use of:
  - Warming blanket
  - Warm intravenous fluids
  - Warm fluid to irrigate body cavities

#### *Monitoring during anaesthesia*

- The continuous presence of an adequately trained anaesthetist is essential



- Accurate monitoring of vital signs is obligatory
- Facilities for cardiopulmonary resuscitation should be immediately available
- Monitoring of the following is considered essential for all patients:
  - Temperature
  - Heart rate
  - Blood pressure
  - ECG
  - Oxygen content of inspiratory gas mix
  - End-tidal carbon dioxide
  - Pulse oximetry
- Alarms should indicate
  - Oxygen supply failure
  - Ventilator disconnection
- The following may be considered for major surgery
  - Invasive blood pressure monitoring
  - Central venous pressure
  - Urine output

#### **Recovery from anaesthesia**

- Recovery from anaesthesia should be monitored by a suitable trained nurse
- Should occur in a properly equipped recovery area
- Anaesthetist should be immediately available
- Causes of failure to breath after general anaesthesia include:
  - Obstruction of airway
  - Central sedation due to opiates or anaesthetic agent
  - Hypoxia
  - Hypercarbia
  - Hypocarbia due to overventilation
  - Persistent neuromuscular blockade
  - Pneumothorax
  - Circulatory failure leading to respiratory arrest

#### **Postoperative nausea and vomiting**

##### ***Mechanisms of postoperative nausea and vomiting***

- Chemoreceptor trigger zone
  - Found in the area postrema of the 4th ventricle
  - Actions mediated via D2 receptors
  - Antagonists include domperidone, metoclopramide, prochlorperazine
- Vestibular apparatus
  - Actions mediated via muscarinic and H2 receptors
  - Antagonists include cyclizine, hyoscine
- Vagal sensory neural endings
  - Actions mediate via serotonin
  - Antagonists include serotonin (e.g. ondansetron)



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### **Postoperative pain control**

- Pain is defined as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage.'
- It is a complex process influenced by both physiological and psychological factors
- Management of postoperative pain has generally been shown to be inadequate

### **Effects of postoperative pain**

- Postoperative pain can affect all organ systems and includes:
  - Respiratory - reduced cough, atelectasis, sputum retention and hypoxaemia
  - Cardiovascular - increased myocardial oxygen consumption and ischaemia
  - Gastrointestinal - decreased gastric emptying, reduced gut motility and constipation
  - Genitourinary - urinary retention
  - Neuroendocrine - hyperglycaemia, protein catabolism and sodium retention
  - Musculoskeletal - reduced mobility, pressure sores and increased risk of DVT
  - Psychological - anxiety and fatigue

### **Assessment of pain**

- Pain is a subjective experience
- Observer assessment of patient behaviour is unreliable
- Pain should be assessed and recorded by:
  - Visual analogue scales
  - Verbal numerical reporting scale
  - Categorical rating scale

### **Non-pharmacological methods of pain relief**

- Preoperative explanation and education
- Relaxation therapy
- Hypnosis
- Cold or heat
- Splinting of wounds etc
- Transcutaneous electrical nerve stimulation (TENS)

### **Pharmacological methods of pain relief**

#### **Simple analgesia**

- Paracetamol is a weak anti-inflammatory agent
- Modulates prostaglandin production in the central nervous system
- Can be administered orally or rectally
- Best taken on a regular rather than 'as required' basis.
- Overdose results in hepatic necrosis
- Often combined with weak opiates (e.g. dihydrocodeine = Co-dydramol)

#### **Non-steroidal anti-inflammatory agents**

- Inhibit the enzyme cyclo-oxygenase
- Reduces prostaglandin, prostacyclin and thromboxane production
- Also have weak central analgesic effect
- Often used for their 'opiate sparing' effects



- Side effects include:
  - Gastric irritation and peptic ulceration
  - Precipitation of bronchospasm in asthmatics
  - Impairment of renal function
  - Platelet dysfunction and bleeding

### **Opiates**

- Most commonly used drugs are diamorphine, morphine and pethidine
- Diamorphine is a prodrug rapidly hydrolysed to morphine and 6-monoacetyl-morphine
- More lipid soluble than morphine with greater central effects
- Pethidine has only about 10% the analgesic potency of morphine
- All act on mu receptors in brain and spinal cord
- Mu 1 receptors are responsible for analgesia
- Mu 2 receptors are responsible for respiratory depression
- Side effects of opiates include:
  - Sedation
  - Nausea and vomiting
  - Vasodilatation and myocardial depression
  - Pruritus
  - Delayed gastric emptying
  - Constipation
  - Urinary retention

### **Routes of opiate administration**

- Oral - available for codeine, dihydrocodeine and oramorph
- Subcutaneous - useful for chronic pain relief
- Intramuscular - produces peaks and troughs in pain relief
- Intravenous - reliable but can produce sedation and respiratory depression

### **Patient-controlled analgesia (PCA)**

- Patient determines own analgesic requirement
- 'Lock-out' period prevents accidental overdose
- Safe as sedation occurs before respiratory depression

### **Epidural or spinal**

- Lipid soluble opiates (e.g. fentanyl) are normally used
- Produces good analgesia with reduced risk of side effects

### **Local anaesthetic agents and techniques**

- Can be used by:
  - Wound infiltration
  - Nerve or nerve plexus blockade
  - Epidural infiltration
  - Intrathecal (spinal) administration
- Lignocaine has rapid onset but short duration of action
- Bupivacaine has more prolonged onset but shorter duration of action
- Adrenaline and delay absorption and prolong duration of action
- Should not be used at sites of end-arteries (e.g. ear, fingers, penis)
- Act by reducing transmission along nerve fibres
- Work by blocking sodium channels in the nerve fibres
- Block pain-fibres first but can also result in
  - Neuromuscular blockade



- Hypotension due to sympathetic blockade

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## Metabolic & nutritional support

### Fluid & electrolyte management

#### Daily requirements

- For the 'average' 70 Kg man
- Total body water is 42 L (~60% of body weight)
- 28 L is in the intracellular and 14 L in the extracellular compartments
- The plasma volume is 3 L
- The extravascular volume is 11 L
- Total body Na<sup>+</sup> is 4200 mmol (50% in ECF)
- Total body K<sup>+</sup> is 3500 mmol (only about 50-60 mmol in ECF)
- Normal osmolality of ECF is 280 –295 mosmol/kg

#### Fluid replacement

- When calculating fluid replacement for a patients need to consider:

#### Maintenance requirements

- Daily maintenance fluid requirements vary between individuals
- 70 Kg Male = 2.5 - 3.0L H<sub>2</sub>O, 120 – 140 mmol Na<sup>+</sup> & 70 mmol K<sup>+</sup>
- 40 Kg Woman = 2.0L H<sub>2</sub>O, 70 – 90 mmol Na<sup>+</sup> & 40 mmol K<sup>+</sup>
- Daily maintenance fluid requirements for children
  - 0-10 kg is 100 ml/kg
  - 10-20 kg is 1000 ml + 50 ml/kg for each kg more than 10
  - More than 20 kg is 1500 ml + 25 ml/kg for each kg more than 20

Table 10 Composition of crystalloids

	Hartmann's	Normal Saline	Dextrose Saline
Sodium (mmol/l)	131	150	30
Chloride (mmol/l)	111	150	30
Potassium (mmol/l)	5	Nil	Nil
Bicarbonate (mmol/l)	29	Nil	Nil
Calcium (mmol/l)	2	Nil	Nil

Table 11 Composition of colloids

	Volume Effect (%)	MW (kDa)	Half life
Gelatins (Haemaccel)	80	35	2-3 hrs
4% Albumin	100	69	15 days
Dextran 70	120	41	2-12 hrs
6% Hydroxyethyl Starch	100	70	17 days

#### Replacement of losses

- Pre-operative or pre-admission
- Ongoing losses
- Nasogastric aspirate
- Vomit, diarrhoea



- Stoma, drains, fistula etc
- Most 'surgical' ongoing losses are rich in sodium and should be replaced with 0.9% saline

#### **Insensible losses**

- Faeces approximately 100 ml / day
- Lungs approximately 400 ml / day
- Skin approximately 600 ml / day
- 3L of Dextrose saline is **not** equivalent to 2L 5% Dextrose and 1L Normal saline
- 3L Dextrose Saline = 3L H<sub>2</sub>O and 90 mmol Na<sup>+</sup>
- 2L 5% Dextrose saline + 1L Normal saline = 3L H<sub>2</sub>O and 154 mmol Na<sup>+</sup>

#### **Colloids**

- Monodispersed = All molecules of similar molecular weight
- Polydispersed = Molecules have spread of molecular weights

#### **Albumin**

- Monodispersed
- Expensive
- Long half life
- Accounts for 60-80% of normal plasma oncotic pressure
- No adverse effect on coagulation

#### **Dextrans**

- Polysaccharides
- Polydispersed with MW 10-90 kDa
- Reduces plasma viscosity
- Reduces platelet aggregation
- 1-5% develop anaphylaxis

#### **Gelatins**

- Polypeptides
- Polydispersed with MW ~35 kDa
- Rapidly lost from vascular space

#### **Hydroxyethyl starch**

- Synthetic polysaccharide polymers derived from amylopectin
- Polydispersed with MW 50-450 kDa
- Large molecules engulfed by reticuloendothelial system
- Associated with bleeding diathesis

#### **Assessment of adequacy of resuscitation**

- Clinical history and observations – pulse, blood pressure, skin turgor
- Urine output – oliguria less than 0.5 ml/kg/hr
- CVP or pulmonary capillary wedge pressure
- Response of urine output or CVP to fluid challenge
- A fluid challenge should be regarded as a 200-250 ml bolus of colloid
- This should be administered as quickly as possible
- A response in the CVP or urine output should be seen within minutes
- The size and duration of the CVP response rather the actual values recorded is more important





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## **Techniques of venous access**

### **Indications**

- Peripheral venous access is required for:
- Administration of fluids
- Administration of drugs
- Central venous access is required for:
  - Parenteral nutrition
  - Monitoring of central venous pressure
  - Cardiac pacing
  - Difficult peripheral access

### **Techniques**

- Aseptic techniques should be used for all cannulations
- Local anaesthetic should be used for central catheters
- Success may be improved by using ultrasound guidance
- Techniques of gaining access include:
  - Catheter over needle
  - Catheter through needle
  - Seldinger technique
  - Surgical cutdown

### **Seldinger technique**

- There are four steps to the Seldinger technique
  - Venepuncture is performed with a introducer needle
  - A soft tipped guide wire is passed through the needle and the needle removed
  - A dilator is passed over the guide wire
  - Dilator is removed and catheter is passed over wire and wire is removed
- Chest x-ray should be performed to check position of catheter

### **Venous cutdown**

- Useful for gaining access in shocked hypovolaemic patient
- Commonest sites
  - Long saphenous vein at ankle - 2 cm anterior to medial malleolus
  - Basilic vein at elbow - 2.5 cm lateral to medial epicondyle
- At both sites vein is dissected and ligated distally
- Small transverse venotomy is made
- Cannula is passed through venotomy and secured

### **Anatomy of venous access**

#### **Internal jugular vein**

- Right sided access preferred
- Apical pleura does not rise as high on right and avoids thoracic duct
- Patient positioned head down
- In the low approach triangle formed by two heads of sternomastoid and clavicle identified
- Cannula aimed down and lateral towards ipsilateral nipple



### **Subclavian vein**

- Usually approached from below clavicle
- Patient positioned head down
- Needle inserted below junction of medial 2/3 and lateral 1/3 of the clavicle
- Needle aimed towards suprasternal notch
- Passes immediately behind clavicle
- Vein encountered after 4-5 cm

### **Early complications**

- Haemorrhage
- Air embolus
- Pneumothorax
- Cardiac arrhythmias
- Pericardial tamponade
- Failed cannulation

### **Late complications**

- Venous thrombosis
- Infection

### **Central line infection**

- 10% of central lines become colonised with bacteria
- 2% of patients in ITU develop catheter-related sepsis
- Usually due to coagulase-negative staphylococcus infection
- Occasionally due to *Candida* and *Staph. aureus*
- Infection can be prevented by aseptic techniques and adequate care of lines
- Closed systems should be used at all times
- Dedicated lines should be used for parenteral nutrition
- Antimicrobial coating of lines may reduce the risk of infection

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## ***Surgical nutrition***

- Malnutrition causes:
- Delayed wound healing
- Reduced ventilatory capacity
- Reduced immunity and increased risk of infection
- Does improving nutritional status influence outcome ?
- Currently the topic of intensive investigation

### **Nutritional assessment**

#### ***Clinical assessment***

- Weight loss
  - 10% =mild malnutrition
  - 30% = severe malnutrition
- Body mass index

#### ***Anthropometric assessment***

- Triceps skin fold thickness
- Mid arm circumference
- Hand grip strength

#### ***Blood indices***

- Reduced serum albumin, prealbumin or transferrin
- Lymphocyte count

#### ***'End-of-bedogram'***

- No index of nutritional assessment shown to be superior to clinical assessment

### **Methods of nutritional support**

- Use gastrointestinal tract if available
- Prolonged post-operative starvation is probably not required
- Early enteral nutrition reduced post-operative morbidity

### **Enteral feeding**

- Prevents intestinal mucosal atrophy
- Supports gut associated immunological shield
- Attenuates hypermetabolic response to injury and surgery
- Cheaper than TPN and has fewer complications

#### ***Polymeric liquid diet***

- Short peptides
- Medium chain triglycerides and polysaccharides
- Vitamins
- Trace elements

#### ***Elemental diet***

- L-amino acids
- Simple sugars



- Expensive and unpalatable
- High osmolarity can cause diarrhoea
- Enteral feed can be taken orally or by NGT
- Nasoenteral tube - usually fine bore
- Long term feeding can be by:
  - Surgical gastrostomy, jejunostomy
  - Percutaneous endoscopic gastrostomy
  - Needle catheter jejunostomy
- Rate of infusion – often started at low rate and increased
- Strength of initial feed – often diluted and strength gradually increased

#### **Complications of enteral feeding**

- Malposition and blockage of tube
- Gastrooesophageal reflux
- Feed intolerance

#### **Parenteral nutrition**

- Intestinal failure = 'A reduction in functioning gut mass below the minimal necessary for adequate digestion and absorption of nutrients'
- Useful concept for assessing need for TPN
- Can be given by either a peripheral or central line

#### **Indications for Total Parenteral Nutrition**

##### ***Absolute indications***

- Enterocutaneous fistulae

##### ***Relative indications***

- Moderate or severe malnutrition
- Acute pancreatitis
- Abdominal sepsis
- Prolonged ileus
- Major trauma and burns
- Severe inflammatory bowel disease

#### **Peripheral parenteral nutrition**

- Hyperosmotic solution
- Significant problem with thrombophlebitis
- Need to change cannulas every 24- 48 hours
- No evidence to support it as a clinically important therapy
- Composition - 12g nitrogen, 2000 Calories

#### **Central parenteral nutrition**

- Hyperosmolar, low pH and irritant to vessel walls
- Typical feed contains the following in 2.5L
  - 14g nitrogen as L amino acids
  - 250g glucose
  - 500 ml 20% lipid emulsion
  - 100 mmol sodium
  - 100 mmol potassium



- 150 mmol chloride
- 15 mmol magnesium
- 13 mmol calcium
- 30 mmol phosphate
- 0.4 mmol zinc
- Water and fat soluble vitamins
- Trace elements

#### **Complications of subclavian and jugular central venous lines**

- 10% of central lines develop significant complications

#### ***Problems of insertion***

- Failure to cannulate
- Pneumothorax
- Haemothorax
- Arterial puncture
- Brachial plexus injury
- Mediastinal haematoma
- Thoracic duct injury

#### ***Problems of care***

- Line and systemic sepsis
- Air embolus
- Thrombosis
- Catheter breakage

#### **Monitoring of parenteral nutrition**

- Feeding lines should only be used for that purpose
- Drugs and blood products should be given via separate peripheral line
- 5% patients on TPN develop metabolic derangement
- Nutrition should be monitored:
  - Clinically – Weight
  - Biochemically twice weekly
  - FBC, U+E, LFT
  - Magnesium, calcium, zinc, phosphate
  - Nitrogen balance
  - Blood cultures on any sign of sepsis

#### **Metabolic complications of parenteral nutrition**

- Hyponatraemia
- Hypokalaemia
- Hyperchloraemia
- Trace element and folate deficiency
- Deranged LFTs
- Linoleic acid deficiency



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## Postoperative complications

### *Postoperative pyrexia*

- Pyrexia is a common problem seen after surgery
- Underlying cause may be identified clinically depending on:
  - Time since operation
  - Type of surgery undertaken
  - Associated clinical features

### **Time since operation**

- Specific complications often occur at certain times after operation
- The following time scales should be regarded as a guide and not absolute rules

#### **First 24 hours**

- Systemic response trauma
- Pre-existing infection

#### **24 to 72 hours**

- Pulmonary atelectasis
- Chest infection

#### **3 to 7 days**

- Chest infection
- Wound infection
- Intraperitoneal sepsis
- Urinary tract infection
- Anastomotic leak

#### **7 to 10 days**

- Deep venous thrombosis
- Pulmonary embolus

### **Assessment of patient**

- Adequate assessment requires a full clinical examination
- Respiratory complications often associated with breathlessness, cough and chest pain
- Wound infections may show erythema, purulent discharge or dehiscence
- Abdominal pain, distension and ileus may suggest a collection
- Calf pain and tenderness may suggest a DVT
- Appropriate clinical signs may be present

### **Investigation**

- Useful investigations may include:
  - Chest x-ray
  - ECG
  - Arterial blood gases
  - Ventilation / perfusion scan
  - Abdominal ultrasound or CT scan





### **Wound dehiscence**

- Affects about 2% of mid-line laparotomy wounds
- Serious complication with a mortality of up to 30%
- Due to failure of wound closure technique
- Broken suture, slipped knots or inadequate muscle bites
- Usually occurs between 7 and 10 days post operatively
- Often heralded by serosanguinous discharge from wound
- Should be assumed that the defect involves the whole of the wound



Figure 6 Wound dehiscence

### **Management**

- Opiate analgesia
- Sterile dressing to wound
- Fluid resuscitation
- Early return to theatre
- Resuture under general anaesthesia
- Exact technique is variable
- Interrupted or mass closure with non-absorbable sutures often used
- The use of 'deep tension' sutures is controversial
- Believed by some to strangulate muscle and weaken the closure
- Also painful and associated with increased risk of infection

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## **Postoperative pulmonary complications**

### **Postoperative hypoxia**

- Lack of alveolar ventilation
  - Hypoventilation (airway obstruction, opiates)
  - Bronchospasm
  - Pneumothorax
  - Arteriovenous shunting (collapse, atelectasis)
- Lack of alveolar perfusion
  - Ventilation-perfusion mismatch (pulmonary embolism)
  - Impaired cardiac output
  - Decreased alveolar diffusion
  - Pneumonia
  - Pulmonary oedema

### **Atelectasis**

- Hypoxaemia is often seen during the first 48 hours after most major operations
- Due to a reduction in functional residual capacity
- Significant atelectasis is more often seen
- In those with pre-existing lung disease
- With upper rather than lower abdominal incisions
- Obese patients
- Cigarette smokers
- The basic mechanisms leading to atelectasis are:
  - Increased volume of bronchial secretions
  - Increased viscosity of secretions
  - Reduced tidal volume and ability to cough

### **Clinical features**

- Postoperative pyrexia - usually presenting at about 48 hours
- Often accompanied by tachycardia and tachypnoea
- Examination shows reduced air entry, dullness on percussion and reduced breath sounds
- X-ray shows consolidation and collapse

### **Treatment**

- Intensive chest physiotherapy
- Nebulised bronchodilators
- Antibiotics for associated infection

### **Pneumonia**

- Nosocomial pneumonia occurs in 1% of all patients admitted to hospital
- Occurs in 15-20% of unventilated ITU patients
- Occurs in 40-60% of ventilated ITU patients
- Organisms involved include:
  - Gram-negative bacteria (*Pseudomonas aeruginosa*, Enterobacter)
  - *Staph. aureus*
  - Anaerobes
  - *Haemophilus influenzae*
- No evidence that prophylactic antibiotics reduce the risk of pneumonia



### Aspiration pneumonitis

- Aspiration of gastric contents results in a chemical pneumonitis
- Most commonly seen in apical segments of right lower lobe
- If unrecognised or inadequately treated it can result in a secondary bacterial infection
- Secondary infection is usually with gram-negative and anaerobic organisms



Figure 7 Chest x-ray showing aspiration pneumonitis

### Treatment

- Tilt table head down and suck out pharynx
- Consider intubation and endotracheal suction
- Prophylactic antibiotics should be given
- No evidence that steroids reduce inflammatory response

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## **Perioperative cardiovascular complications**

### **Cardiovascular complications**

- Hypotension
- Hypovolaemia
- Ventricular failure
- Cardiogenic shock
- Arrhythmias
- Conduction defects
- Hypertension

### **Causes of perioperative arrhythmias**

- Physiological disturbances
  - Acidosis
  - Hypercapnoea
  - Hypoxaemia
- Electrolyte imbalance
- Vagal manoeuvres
- Hypovolaemia
- Pathological disturbances
  - Myocardial ischaemia or infarction
  - Pulmonary embolus
  - Pheochromocytoma
- Pharmacological causes
  - General anaesthesia
  - Local anaesthetic toxicity
  - Positive and negative inotropes

### **Causes of postoperative hypertension**

- Pain
- Pre-existing hypertension
- Hypoxaemia
- Hypercapnia
- Positive inotropic drugs
- Hyper-reninaemia

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## ***Other postoperative complications***

### **Causes of postoperative hepatic dysfunction**

#### ***Increased bilirubin load***

- Blood transfusion
- Haemolysis
- Haemolytic disorders
- Abnormalities of bilirubin metabolism

#### ***Hepatocellular damage***

- Pre-existing hepatic disease
- Viral hepatitis
- Sepsis
- Hypotension
- Hypoxaemia
- Drug-induced hepatitis
- Congestive cardiac failure
- General anaesthetic induced hepatic necrosis

#### ***Extra-hepatic biliary obstruction***

- Gallstones
- Ascending cholangitis
- Pancreatitis
- Common bile duct injury

### **Causes of postoperative renal failure**

#### ***Prerenal (hypoperfusion)***

- Shock (hypovolaemia, cardiogenic, septic)
- Renal artery disease

#### ***Renal (direct injury)***

- Acute tubular necrosis (following prerenal, drugs, myoglobin)
- Glomerulonephritis
- Interstitial nephritis

#### ***Postrenal (obstruction)***

- Bladder outflow obstruction
- Single ureter (calculus, tumour)
- Both ureters (bladder malignancy)

### **Urinary tract infections**

- 10% of patients admitted to hospital have a urinary catheter inserted
- Risk of catheter-related infection depends on:
  - Age and sex of patient
  - Duration of catheterisation
  - Indication for catheterisation
- Bacterial colonisation of catheters is common
- If catheter required for more than 2 weeks 90% patients will develop bacteriuria



- Commonest organisms are enterobacter and enterococci
- Does not require treatment unless patient is systemically unwell
- Infection can be prevented by:
  - Maintaining closed drainage system
  - High infection control standards
  - Preventing backflow from catheter bag

#### Postoperative confusion

- Occurs in 10% of postoperative patients
- Associated with increased morbidity and mortality
- Leads to increased duration of hospitalisation
- Clinical features include:
  - Reduced level of consciousness
  - Impaired thinking
  - Impaired memory
  - Perceptual abnormalities
  - Disturbed emotion
  - Psychomotor disturbance

#### Causes

- Hypoxia - respiratory disease, cardiac failure, arrhythmia
- Trauma - head injury
- Infection - intracranial, extracranial
- Neoplasia - primary and secondary cerebral tumours
- Vitamin deficiency - Thiamine (Wernicke's encephalopathy), B12 deficiency
- Endocrine - hypothyroidism, hyperthyroidism, Addison's disease
- Degenerative
- Vascular - CVA, TIAs
- Drugs
- Metabolic derangement

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## Principle of ICU

### Indications for admission to ITU

- Mechanical support of organ function
  - Respiratory - ventilation / CPAP
  - Renal - haemofiltration / haemodialysis
  - Cardiac - ECG and inotropic drugs
  - Hepatic - blood transfusion
  - Neurological - intracranial pressure monitoring
- Usually has 1:1 nursing care

### Indications for admission to HDU

- Close monitoring of unstable patient
  - Oxygenation - respiratory rate, oxygen saturation and arterial gases
  - Cardiac function - pulse, blood pressure, central venous pressure
  - Renal function - urine output
- Usually has at least 2 : 1 nursing care
- Usually does not have facilities for ventilation or haemodialysis

### Factors to be considered when assessing admission to ICU

- Diagnosis
- Severity of illness
- Age
- Coexisting disease
- Physiological reserve
- Prognosis
- Availability of suitable treatment
- Response of treatment to date
- Recent cardiopulmonary arrest
- Anticipated quality of life
- The patient's wishes

### Criteria for ICU assessment

- Threatened airway
- Respiratory arrest
- Respiratory rate more than 40 or less than 8 breaths / min
- Oxygen saturation less than 90% on more than 50% oxygen
- Cardiac arrest
- Pulse rate less than 40 or more than 140 beats / min
- Systolic blood pressure less than 90 mmHg
- Sudden fall in level of consciousness
- Repeated or prolonged seizures
- Rising arterial carbon dioxide tension with respiratory acidosis

### Outreach services

- Essential component of critical care services
- Has three essential objectives
  - To assess potential admissions
  - To enable discharges



- To share critical care skills
- Often use early warning scoring systems to identify sick patients
- Scoring systems based on assessment of physiological dysfunction

Table 12 Early warning system

	3	2	1	0	1	2	3
Heart rate		<40	41-50	51-100	101-110	111-130	>130
Mean BP	<70	71-80	81-100	101-199		>200	
Resp rate		<8		9-14	15-20	21-29	>30
Temperature		<35	35.1-36.5		36.6-37.4	>37.5	
Conscious level				Awake	Respond to voice	Respond to pain	No response

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## Respiratory support

### Oxygen saturation

- Oxygen delivery depends on:
  - Cardiac output
  - Haemoglobin concentration
  - Arterial oxygen saturation
  - Arterial oxygen saturation ( $S_aO_2$ ) depends on arterial oxygen tension ( $P_aO_2$ )

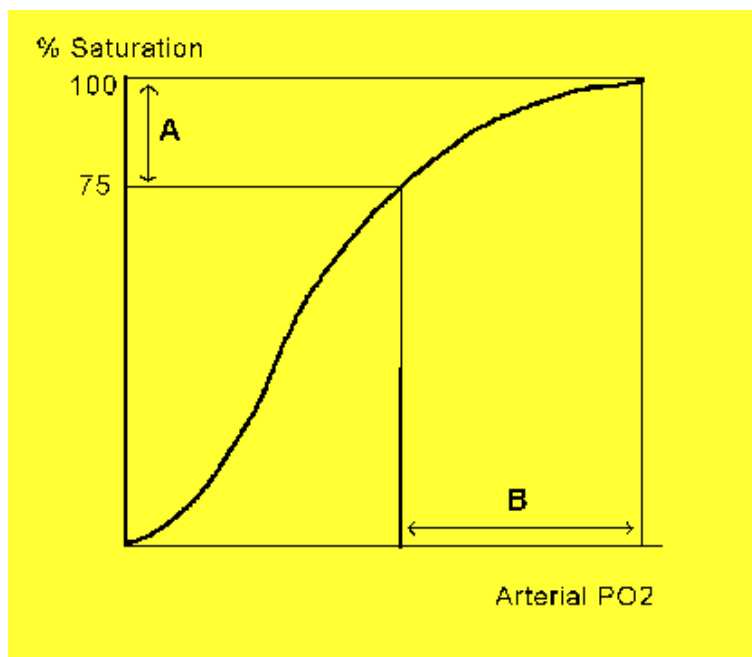


Figure 8 The oxygen dissociation curve

- A is the arterio-venous oxygen content difference
- Note that due to the non-linear nature of the curve B is greater than A

### Pulse oximetry

- Arterial oxygen saturation can be measured non-invasively using pulse oximetry
- Consists of two light emitting diodes of two different wavelengths
- Frequencies are in the red (660 nm) and infrared (940 nm) spectrum
- Monitor has one photodetector
- Absorption spectrum of haemoglobin at the two frequencies depends on degree of oxygenation
- Allows calculation of oxygen saturation
- Arterial component of circulation is targeted by restrict analysis to signal that is pulsatile
- Reading unreliable if:
  - Intense vasoconstriction
  - Jaundice
  - Methaemoglobinaemia



## Respiratory failure

- Hypoxaemic failure (type 1) = Reduced  $P_a\text{CO}_2$  + reduced  $P_a\text{O}_2$
- Ventilatory failure (type 2) = Increased  $P_a\text{CO}_2$  + reduced  $P_a\text{O}_2$

### Pathophysiology of respiratory failure

#### Failure of oxygenation (hypoxaemia, type I failure)

- Low inspired oxygen partial pressure
- Alveolar hypoventilation
- Diffusion impairment
- Ventilation to perfusion mismatch
- Right-to-left shunt

#### Failure of ventilation (hypercapnia, type II failure)

- Abnormalities of central respiratory drive
- Neuromuscular dysfunction
- Abnormalities of the chest wall
- Abnormalities of the airway
- Abnormalities of the lung

Table 13 Causes of respiratory failure

Ventilatory failure	Hypoxaemic failure
Deranged mechanics COPD Chest trauma	Collapse Consolidation Contusion
Respiratory depression Drugs Trauma Raised intracranial pressure	Pulmonary oedema Pulmonary embolus
Spinal cord lesions Cervical spine trauma Motor neurone disease	
Peripheral neuropathy	
Myasthenia gravis	
Muscle relaxants	

### Artificial ventilation

#### Indications for tracheal intubation

- Facilitation of mechanical ventilation
- Protection from aspiration
- Facilitation of tracheobronchial suction
- Relief of upper airway obstruction

#### Indications for mechanical ventilation

- Support in respiratory failure
- Coma (head injury, drug overdose)
- Control of intracranial pressure
- Reduction of metabolic demands



- Allow muscle relaxation and facilitate surgery
- Postoperative ventilation

#### **Benefits of ventilation**

- Eliminates carbon dioxide
- Improves oxygenation by:
  - Reducing respiratory work and oxygen consumption
  - Administering a higher inspired oxygen content ( $F_iO_2$ )
  - Preventing or reversing atelectasis

#### **Modes of ventilation**

- Most ventilators are volume/time-cycled with a pressure limit
- Deliver preset tidal volume irrespective of lung compliance
- Pressure limit reduces risk of over-inflation
- Possible modes in which they can be used are:
  - Controlled mechanical ventilation
  - Assisted controlled or triggered ventilation
  - Intermittent mandatory ventilation
  - Pressure support

#### **Ventilator variables**

- Variables on a ventilator that can be preset or altered include:
  - Tidal volume
  - Ventilation rate
  - Inspiratory to expiratory ratio
  - Flow waveform
  - Partial pressure of inspired oxygen
  - Pressure limit
  - Positive end expiratory pressure (PEEP)
  - Positive airway pressure (CPAP)

#### **Complications of ventilation**

- Problems associated with endotracheal tube
  - Trauma
  - Obstruction
  - Misplacement
- Disconnection
- Barotrauma
  - Pneumothorax
  - Surgical emphysema
- Impaired venous return
- Sodium and water retention
- Bronchopneumonia

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### Acid-base balance

- Blood pH is normally maintained at 7.36-7.44
- pH is a logarithmic scale
- A change in pH of 0.3 units is equivalent to a doubling of hydrogen ion concentration
- pH is maintained by biological buffering mechanisms involving:
  - Proteins
  - Bicarbonate
  - Haemoglobin
- The relationship between serum pH and bicarbonate concentration is simple
- Described by the Henderson-Hasselbach equation
- Compensatory mechanisms exist to compensate for changes in pH

### Blood gas analysis

- Blood gas analyser measures
  - Partial pressure oxygen
  - Partial pressure carbon dioxide
  - pH
- Other variables are derived using Henderson-Hasselbach equation

Table 14 Variables derived from a blood gas analyser

	Normal value
Temperature	37 degrees
pH	7.36 - 7.44
Partial pressure CO <sub>2</sub> (pCO <sub>2</sub> )	4.6 - 5.6 kPa
Partial pressure O <sub>2</sub> (pO <sub>2</sub> )	10.0 - 13.3 kPa
Bicarbonate	22 - 26 mmol/l
Total carbon dioxide	24 - 28 mmol/l
Standard bicarbonate (SBC)	22 - 26 mmol/l
Base excess (BE)	-2 to +2 mmol/l
Standard base excess (SBE)	-3 to +3 mmol/l
Oxygen saturation	>95%
Haemoglobin	11.5 - 16.5 g/dl

### Definitions

- Acidosis = a rise serum in hydrogen ion concentration or fall in pH
- Alkalosis = a reduction in hydrogen ion concentration or rise in pH
- Respiratory acidosis = a fall in pH due to a rise in partial pressure of carbon dioxide
- Respiratory alkalosis = a rise in pH due to a fall in partial pressure of carbon dioxide
- Metabolic acidosis = a fall in pH due to a metabolic cause
- Metabolic alkalosis = a rise in pH due to a metabolic cause

### Anion gap

- Is the sum of the positive and negative charges in the plasma
- Cations = sodium and potassium
- Anions = chloride, bicarbonate
- Difference between the two is the anion gap
- If metabolic acidosis is due to anion excess the anion gap is increased



- If metabolic acidosis is due to bicarbonate loss the anion gap is normal
- Lactic acidosis and renal failure are associated with an increased anion gap

#### Interpretation of results

- Interpret results with knowledge of the patients clinical condition
- Check for the consistency within the blood gas sample
- Look at the pH for the primary acid-base disorder
- Assess a respiratory component by looking at the partial pressure of carbon dioxide
- Assess the metabolic component by looking at the BE or SBE
- Calculate the anion gap

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## **Acute respiratory distress syndrome**

- Acute respiratory distress syndrome was first recognised in 1960s
- Initially termed adult respiratory distress syndrome
- Can occur in both children and adults
- Occurs following many different inflammatory insults to the lungs

### **Definition**

- Two conditions recognised
  - Acute lung injury (ALI)
  - Acute respiratory distress syndrome (ARDS)
- Both consist of an acute lung injury with:
  - Bilateral pulmonary infiltrates on chest x-ray
  - PCWP less than 18 mmHg
  - No evidence of left atrial hypertension
- In ALI -  $P_aO_2 / F_iO_2$  less than 200
- In ARDS -  $P_aO_2 / F_iO_2$  more than 300

### **Aetiology**

#### **Direct lung injury**

- Pneumonia
- Aspiration pneumonitis
- Pulmonary contusion
- Fat embolism
- Inhalational injury

#### **Indirect lung injury**

- Sepsis
- Trauma
- Cardiopulmonary bypass
- Acute pancreatitis

### **Pathology**

- Irrespective of aetiology the main pathological feature is diffuse alveolar damage
- Endothelial injury results in increased permeability
- Protein-rich exudate found in alveoli
- Neutrophils are important in inflammatory process
- Cytokines and enzymes may be responsible for many of the features
- Resolution of inflammation can occur
- Usually associated with some degree of pulmonary fibrosis

### **Clinical features**

- ARDS is usually a progressive clinical problem
- Presents with acute respiratory failure
- Hypoxaemia is often refractory to increasing respiratory support
- Bilateral infiltrates present on chest x-ray
- With time can progress to fibrosing alveolitis
- Lung compliance is reduced and hypoxaemia persists



- Pulmonary hypertension can progress to right heart failure
- Resolution can occur over 6-12 months
- Lung function can return to normal
- Overall mortality is approximately 50%

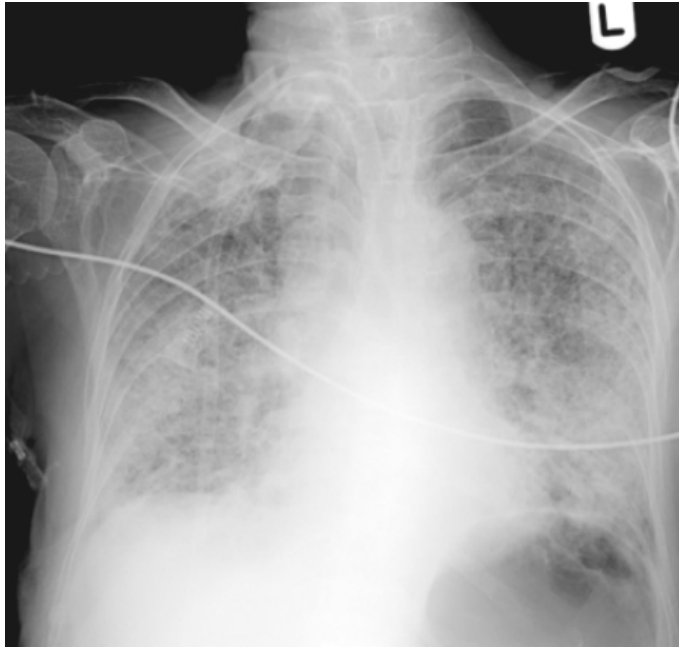


Figure 9 Adult respiratory distress syndrome

### Management

- Supportive intensive care therapy is important
- Sepsis should be treated with appropriate antibiotics
- Careful fluid balance is important
- Over hydration should be avoided
- Nutritional status should be addressed
- Mechanical ventilation is important but the exact strategy is controversial
- Generally believed that ventilation with low tidal volumes is beneficial
- High tidal volumes can exacerbate lung injury
- Role of positive end-expiratory pressure unclear
- Inhaled nitric oxide or surfactant are of no proven benefit
- Steroids may have some beneficial effect

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## **Multiple organ failure**

### **Circulatory failure**

#### **Criteria for diagnosis**

- Bradycardia (heart rate less than 50 bpm)
- Hypotension (mean arterial pressure less than 50 mmHg)
- Ventricular tachycardia or fibrillation
- Metabolic acidosis (pH less than 7.2)

#### **Management**

- Optimise cardiac preload
- Maximise cardiac contractility with inotropes
- Maximise perfusion pressures with vasopressors
- Correct anaemia
- Treat arrhythmia

### **Respiratory failure**

#### **Criteria for diagnosis**

- Respiratory rate <5 or >40 breaths per minute
- Hypercapnia ( $P_a\text{CO}_2 > 6.7$  kPa)
- Hypoxaemia

#### **Management**

- Oxygen
- Mechanical ventilation
- PEEP or CPAP
- Extra or extracorporeal gas exchange

### **Acute renal failure**

#### **Criteria for diagnosis**

- Urine output less than 400 ml per 24 hours
- Serum creatinine more than 150 mmol/l

#### **Management**

- Conservative measures
- Fluid and potassium restriction
- Drug dose adjustment
- Haemofiltration or dialysis

### **Haematological failure**

#### **Criteria for diagnosis**

- Leucopenia (WBC less than 1000 cell /  $\text{mm}^3$ )
- Thrombocytopenia (platelet less than 20,000 /  $\text{mm}^3$ )
- Evidence of disseminated intravascular coagulation





### **Management**

- Red cell and platelet transfusion
- Fresh frozen plasma
- Correct antithrombin III deficiency

### **Hepatic failure**

#### **Criteria for diagnosis**

- Coagulation defect
- Rising hepatic enzymes

#### **Management**

- Fresh frozen plasma
- Nutritional support
- Correct hypoalbuminaemia

### **Gastrointestinal failure**

#### **Criteria for diagnosis**

- Ileus
- Gastroparesis
- Haemorrhage

#### **Management**

- Parenteral nutrition
- Stress ulcer prophylaxis
- Selective gastrointestinal decontamination

### **Neurological failure**

#### **Criteria for diagnosis**

- Depressed level of consciousness (Glasgow coma score less than 6)
- Fits

#### **Management**

- Oxygenation
- Control seizures

### **Acute renal failure**

- Reduction in renal excretory or regulatory function
- Results in the retention of waste products normally excreted by the kidney
- Normal adult urine output = 0.5 ml/kg/hr
- Renal failure can be:
  - Anuric
  - Oliguric
  - Polyuric



Table 15 Causes of acute renal failure

Causes	
Pre-renal failure	Hypovolaemia secondary to acute blood or plasma loss
	Fluid and electrolyte depletion
	Hypotension secondary to cardiogenic shock
	Hypotension secondary to sepsis
Intrinsic renal failure	Acute tubular necrosis due to prolonged renal hypoperfusion
	Acute tubular necrosis secondary to pigment nephropathy
	Acute tubular necrosis due to contrast nephropathy
	Acute glomerulonephritis
	Drug induced nephrotoxic damage
	Atheroembolic disease
	Acute pyelonephritis
Renal outflow obstruction	Calculi
	Blood clot
	Ureteric damage and ligation
	Prostatic hypertrophy

#### Biochemical changes of acute renal failure

- Hyponatraemia
- Hyperkalaemia
- Hypocalcaemia
- Metabolic acidosis

#### Urinary biochemistry

##### *In pre-renal failure*

- Urine specific gravity more than 1.016
- Low urinary sodium less than 20 mmol/l
- High urinary urea more than 250 mmol/l
- High osmolality more than 500 mosm/kg

##### *In intrinsic renal failure*

- Urine specific gravity less than 1.010
- High urinary sodium more than 40 mmol/l
- Low urinary urea less than 185 mmol/l
- Isotonic urine - 300-350 mosm/kg

#### Management of renal failure

- Remove precipitating cause
- Most surgical patients are hypovolaemic
- Require volume resuscitation
- If inadequate perfusion pressure consider inotropic support
- Oxygen
- Consider bicarbonate if:
  - Base excess more than 10
  - Arterial pH less than 7



### Hyperkalaemia

- Requires urgent treatment if:
  - Symptomatic
  - ECG changes - increased pr interval, tented t waves, ventricular tachycardia
  - Serum potassium more than 6 mmol/l
- Treatment options are :
  - 10 ml 10% calcium chloride intravenously
  - 10u actrapid in 50 ml 50% dextrose
  - Salbutamol nebuliser
  - Calcium resonium 15-30 mg pr twice daily

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## Sepsis and SIRS

- Severe sepsis affects 500,000 annually in the United States
- Despite improvements in critical care mortality of 20-50% remains unchanged

Table 16 Definitions of SIRS, Sepsis and Septic shock

Definition	
Bacteraemia	The presence of viable bacteria in the bloodstream
SIRS	The systemic inflammatory response to a variety of clinical insult manifest by two or more of the following: <ul style="list-style-type: none"><li>• Temperature <math>&gt;38^{\circ}\text{C}</math> or <math>&lt;36^{\circ}</math></li><li>• Heart Rate <math>&gt; 90</math> bpm</li><li>• Respiratory Rate <math>&gt; 20</math> breaths per minute or <math>\text{PaCO}_2 &gt; 4.3</math> kPa</li><li>• White Cell Count <math>&gt; 12,000</math> or <math>&lt;4,000</math> per <math>\text{mm}^3</math></li></ul>
Sepsis	SIRS with documented infection
Severe SIRS	SIRS with documented infection and hypoperfusion, hypotension and organ dysfunction
Septic Shock	Sepsis with hypotension despite adequate fluid resuscitation

### Clinical features of sepsis and SIRS

#### Cardiorespiratory effects

- Increased cardiac output
- Decreased vascular resistance
- Increased oxygen consumption
- Fever or hypothermia
- Tachycardia
- Tachypnoea

#### Metabolic or haematological effects

- Respiratory alkalosis
- Deranged liver function
- Deranged renal function
- Altered white cell count and platelets
- Disseminated intravascular coagulation

### Aetiology of SIRS

- SIRS can arise from a number of aetiological triggers
  - Infection – bacterial, viral, fungal
  - Hypovolaemic shock
  - Trauma,
  - Burns
  - Tissue ischaemia
  - Pancreatitis
- Bacterial Infection is commonest cause
- 50% due to gram-negative organisms
- 40% due to gram-positive organisms



### ***Mechanisms in the pathology of SIRS***

- Over-production of inflammatory mediators
- Under-production of anti-inflammatory mediators
- Receptor abnormalities
- Decreased destruction of inflammatory mediators
- Abnormal leukocytes

### ***Major inflammatory mediators involved in SIRS***

- Platelet activating factor
- Tumour necrosis factor -alpha
- Interleukin-1
- Interleukin-6
- Interleukin-8
- Interleukin-10

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## ***Physiological Scoring systems***

- Patients admitted to intensive care form a heterogeneous population
- Differ in many respects including:
  - Age
  - Previous health status
  - Reason for admission
  - Severity of illness
- All factors influence the prognosis of the patient
- Scoring systems have been developed to quantify this case mix
- Scoring systems can be used for
  - Audit
  - Research
  - Clinical management
- Scoring systems can be generic or specific
- Limitations and errors associated with their use include:
  - Missing data
  - Observer error
  - Inter-observer variability
  - Lead time bias

### **APACHE II score**

- A general measure of disease severity based on
  - Current physiologic measurements
  - Age
  - Previous health condition
- Scores range from 0-71, with an increasing score associated with an increasing risk of hospital death.
- APACHE II score = (acute physiology score) + (age points) + (chronic health points)

### ***Acute Physiology Score***

- 1 = Rectal temp (C)
- 2 = Mean arterial pressure (mmHg)
- 3 = Heart rate (bpm)
- 4 = Respiratory rate (bpm),
- 5 = Oxygen delivery (ml/min)
- 6 = PO<sub>2</sub> (mmHg)
- 7 = arterial pH
- 8 = Serum sodium (mmol/l)
- 9 = Serum potassium (mmol/l)
- 10 = Serum creatinine (mg/dl)
- 11 = Haematocrit (5)
- 12 = White cell count (10<sup>3</sup>/ml)



	+4	+3	+2	+1	0	+1	+2	+3	+4
1	>41	39-40.9		38-38.9	36-38.4	34-35.9	32-33.9	30-31.9	<29.9
2	>160	130-159	110-129		70-109		50-69		<49
3	>180	140-179	110-139		70-109		55-69	40-54	<39
4	>50	35-49		25-34	12-24	10-11	6-9		<5
5	>500	350-499	200-349		< 200				
6					> 70	61-70		55-60	< 55
7	>7.7	7.6-7.69		7.5-7.59	7.3-7.49		7.25-7.3	7.15-7.2	< 7.15
8	>180	160-179	155-159	150-154	130-149		120-129	111-119	<110
9	>7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5
10	>3.5	2-3.4	1.5-1.9		0.6-1.4		< 0.6		
11	>60		50-59.9	46-49.9	30-45.9		20-29.9		< 20
12	>40		20-39.9	15-19.9	3-14.9		1-2.9		< 1

### Age Points

	Points
<44	0
45-54	2
55-64	3
65-74	5
>75	6

### Chronic Health Points

History of severe organ insufficiency	Points
Non-operative patients	5
Emergency postoperative patients	5
Elective postoperative patients	2

- Organ insufficiency or immunocompromised state must have preceded the current admission
- Immunocompromised if:
  - Receiving therapy reducing host defences (immunosuppression, chemotherapy, radiation therapy, long term steroid use, high dose steroid therapy), or
  - Has a disease interfering with immune function such as malignant lymphoma or leukaemia
- Hepatic insufficiency if:
  - Biopsy proven cirrhosis
  - Portal hypertension
  - Episodes of upper GI bleeding due to portal hypertension
  - Prior episodes of hepatic failure, coma or encephalopathy
- Cardiovascular insufficiency if:
  - New York Heart Association Class IV
- Respiratory insufficiency if:
  - Severe exercise restriction due to chronic restrictive, obstructive or vascular disease,
  - Documented chronic hypoxia, hypercapnia, secondary polycythaemia, severe pulmonary hypertension



- Respirator dependency
- Renal insufficiency if:
  - On chronic dialysis

### **POSSUM system**

- Outcome of surgery depends on several factors including:
- Physiological status of the patient
- Disease process that requires surgical intervention
  - Nature of operation
  - Pre and perioperative support
- Raw morbidity and mortality data can provide a biased picture
- POSSUM = Physiological and operative severity score for the enumeration of mortality and morbidity
- Allows risk-adjusted assessment of surgical quality
- Accurately predicts 30-day morbidity and mortality
- Two-part scoring system including:
  - Physiological assessment
  - Operative severity

### ***Physiological assessment***

- Provides exponential score on 12 variables
  - Age
  - Cardiac signs
  - Respiratory signs
  - Systolic blood pressure
  - Pulse
  - Coma score
  - Serum urea
  - Serum sodium
  - Serum potassium
  - Haemoglobin
  - White cell count
  - ECG

### ***Operative severity***

- Provides exponential score on 6 variables
  - Operative magnitude
  - Number of operations within 30 days
  - Blood loss
  - Peritoneal contamination
  - Presence of malignancy
  - Timing of operation





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## Surgical technique and technology

### Surgical wounds

#### *Pathophysiology of wound healing*

- Inflammation

#### *Vascular response*

- Initial vasoconstriction as a direct response to trauma
- Exposed subendothelial tissue activates coagulation and complement cascades
- Platelet adhesion and aggregation causes clot formation
- Degranulation of platelets releases growth factors and chemotactic factors
- Inflammatory response due to histamine and 5HT release produces:
  - Vasodilatation
  - Increased capillary permeability
  - Margination of neutrophils

#### *Cellular response*

- Migration of neutrophils, macrophages and lymphocytes
- Macrophages produce growth factors leading to migration of fibroblast and epithelial cells.
- This causes cellular proliferation with three components:
  - Epithelialisation
  - Contraction
  - Fibroplasia
- Epithelial barrier important to prevent infection and maintain fluid balance
- Achieved by both migration and proliferation of epithelial cells
- Migration require presence of granulation tissue
- When epithelial cover complete contact inhibition prevents further epithelial growth
- Contraction can account for up to 80% reduction in wound size
- Due to myofibroblasts in granulation tissue
- Usually more marked in animals than in man
- Fibroplasia due to procollagen production by fibroblasts
- Intra and intermolecular bonds form the Collagen fibres with triple helical quaternary structure
- Extracellular matrix contains Fibronectin and Glycosaminoaglycans
- Regulates collagen synthesis and cellular differentiation
- Accompanied by simultaneous angiogenesis
- Proliferation is followed by remodelling
- Maximum collagen production occurs at 20 days
- Maximum wound strength at 3 to 6 months
- Initial collagen production disorganised
- Remodelling lines it up with stresses in skin
- Reduced vascularity and cellularity



### **Important growth factors**

- Platelet Derived Growth Factors (PDGF)
- Insulin Like Growth Factor (IGF-1)
- Epidermal Growth Factor (EGF)
- Transforming Growth Factor (TGF $\beta$ )

### **Factors influencing wound healing**

#### **Systemic factors**

- Age and sex
- Nutrition
- Vitamin and trace element deficiencies - vitamin C, vitamin A, zinc
- Drugs – steroids, chemotherapy, Immunosuppression
- Systemic disease – diabetes, jaundice, malignancy
- Hypoxia

#### **Local Factors**

- Blood supply
- Infection
- Foreign bodies
- Surgical technique

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## **Scars and contractures**

### **Scar formation**

- Factors influencing scar formation
  - Individual genetic make up
  - Race
  - Anatomical site
  - Wound tension
  - Age
  - Placement of incision
  - Surgical technique
- To minimise the degree of postoperative scarring:
- Incisions should run along Langer's lines
- The finest suture possible should be used
- Tension should be avoided
- Sutures should be removed as soon as possible
- Traumatic wounds should be clean and edges excised
- Exposure to sunlight should be avoided in the early postoperative period

### **Problematic scars**

#### **Contractures**

- Result if scars shorten
- Particularly seen in badly aligned scars not corresponding to Langer's lines
- Can reduce joint mobility
- May require a z-plasty or skin graft

#### **Depressed scars**

- Result if skin becomes attached to deep tissue
- Can be treated by release of normal skin from margins of scar
- Scar is then de-epithelialised and skin edges closed over the top



Figure 10 Keloid scar



### **Keloid and hypertrophic scars**

- All scars become red and thickened during the normal healing process
- After several months maturation results in flattening of the wound
- In some scars collagen formation is excessive
- Results in elevated and red scar
- If confined to wound = hypertrophic scar
- If extends beyond wound into normal tissue = keloid scar
- Seen particularly in patients of Afro-Caribbean origin
- Particularly affects scars on the presternal and deltoid areas
- Treatment is often difficult
- Treatment options include:
  - Intra-lesional steroid injections (e.g. triamcinolone)
  - Compression dressings with elasticated compression garments
  - Silastic gel therapy
  - Excision and radiotherapy
  - Laser therapy



Figure 11 Keloid scar

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## **Surgical technique**

### ***Incisions and wound closure***

#### **Requirement for an incision**

- Allow access
- Can be extended if required
- Will be secure when closed
- Low complication rate
- Minimal pain
- Cosmetic appearance when healed

#### **Wound closure**

- Matter of personal preference influenced by experience

#### ***Midline abdominal incision***

- Mass closure using 0 or 1 non-absorbable monofilament suture
- Take 1 cm bite placed 1 cm apart
- 'Jenkins Rule' = Suture Length : Wound Length should be 4:1
- For safety avoid hand held needles
- No touch technique of the use of needles should be used
- Deep Tension Sutures – use controversial
- No extra security
- Painful and produce a cosmetically unacceptable scar

#### ***Other abdominal incisions***

- Layered closure
- Closure of peritoneum not essential

#### ***Skin***

- Fat stitch reduces dead space
- Adds no strength to wound repair
- No evidence that it reduces risk of wound infection
- Avoid silk sutures as increase risk of stitch abscesses
- No evidence that subcuticular sutures increase infection rate
- If you are worried about wound infection consider leaving the skin wound open

#### **Removal of sutures**

- Sutures should be removed:
- Head and face at 5 days
- Upper limb at 7 days
- Abdomen and lower limb at 10 days



## Suture materials & needles

### Suture materials

- The purpose of a suture is to hold a wound together in good apposition until such time as the natural healing process is sufficiently well established to make the support from the suture material unnecessary and redundant.

### Ideal suture material

- The ideal suture material should:
  - Have good handling characteristics
  - Not induce a significant tissue reaction
  - Allow secure knots
  - Have adequate tensile strength
  - Not cut through tissue
  - Be sterile
  - Be non-electrolytic
  - Be non-allergenic
  - Cheap and sterile

### Choice of a suture

- Choice of suture will depend on:
  - Properties of suture material
  - Absorption rate
  - Handling and knotting properties
  - Size of suture
  - Type of needle

Table 17. Suture properties

	Absorption	Examples
Natural	Absorbable	Catgut
	Non-absorbable	Silk
		Linen
		Stainless steel
Synthetic	Absorbable	Polyglycolic Acid (Dexon)
		Polyglactin (Vicryl)
		Polydioxone (PDS)
		Polyglyconate (Maxon)
	Non-absorbable	Polyamide (Nylon)
		Polyester (Dacron)
Polypropylene (Prolene)		

- Absorbable suture are broken down by either:
  - Proteolysis (e.g. Catgut)
  - Hydrolysis (e.g. Vicryl, Dexon)



### **Suture characteristics**

- Suture materials vary in their physical characteristics
- Monofilament sutures (e.g. polypropylene) are smooth
- They slide well in tissues but if handled inappropriately they can fracture
- Multifilament sutures (e.g. polyglactin) are braided
- They have a greater surface area
- They are easier to handle and knot well
- Some suture materials have a 'memory' (e.g. polypropylene)
- Return to former shape when tension is removed

### **Catgut**

- Made from the submucosa of sheep gastrointestinal tract
- Broken down within about a week
- Chromic acid delays hydrolysis
- Even so it is destroyed before many wounds have healed

### **Silk**

- Strong and handles well but induces strong tissue reaction
- Capillarity encourages infection causing suture sinuses and abscesses

### **Vicryl**

- Tensile strength
  - 65% @ 14 days
  - 40% @ 21 days
  - 10% @ 35 days
- Absorption complete by 70 days

### **PDS**

- Tensile strength
  - 70% @ 14 days
  - 50% @ 28 days
  - 14% @ 56 days
- Absorption complete by 180 days

### **Suture sizes**

- Sutures are sized by the USP (United States Pharmacopoeia) scale
- The available sizes and diameters are:
  - 6-0 = 0.07 mm
  - 5-0 = 0.10 mm
  - 4-0 = 0.15 mm
  - 3-0 = 0.20 mm
  - 2-0 = 0.30 mm
  - 0 = 0.35 mm
  - 1 = 0.40 mm
  - 2 = 0.5 mm





### Needle points

- Five types of needle points are in common use
  - Conventional cutting needle
  - Reverse cutting needle
  - Round-body taper-point needle
  - Taper cutting needle
  - Blunt point needle
- Needles vary
  - Diameter of the curve
  - Circumference of the curve
- Sutures can be attached to an needle by either an eye or a swage

### Common errors of suture use

- Too many throws. Increases foreign body size. Causes stitch abscesses
- Intra-cuticular rather than subcuticular sutures causing hypertrophic scars
- Holding monofilament sutures with instruments reduces tensile strength by over 50%
- Holding butt of needle causes needle and suture breakage

### Other techniques of wound closure

- Steristrips
  - Steristrips are self adhesive tapes
  - Useful if there is potential tension on a wound
  - Useful for superficial lacerations
  - Can cause skin blisters
- Tissue adhesive
  - Based on cyanoacrylate monomer
  - Wounds need to be clean and tension free

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## **Wound dressings**

- The 'Ideal Wound Dressing' should:
- Maintain a moist environment at wound interface
- Remove excess exudate without allowing 'strike through' to surface of dressing
- Provide thermal insulation and mechanical protection
- Act as a barrier to micro-organisms
- Allow gaseous exchange
- Be non-adherent and easily removed without trauma
- Leave no foreign particles in wound
- Be non-toxic, non-allergenic and non-sensitising
- No single dressing is appropriate for all wound types and all stages of healing

### **Hydrocolloids** e.g. *Granuflex*

- Matrix of cellulose and other gel forming agents - gelatin and pectin
- Occlusive dressing
- Avoid if infection particularly with anaerobic organisms
- Promotes autolysis and aids granulation
- Can remain in place for up to a week
- Over-granulation can occur

### **Alginates** e.g. *Kaltostat*

- Calcium and sodium salts of alginic acid obtained from seaweed
- Highly absorbent
- Useful in medium to heavily exudating wounds
- Secondary covering is required
- Forms a gel in contact with wound exudate

### **Foam dressings** e.g. *Lyof foam*

- Useful for moderately exudating wounds
- Prevents 'strike through' of exudate to wound surface
- Desloughs wounds by maintaining a moist environment

### **Hydrogels** e.g. *Intrasite Gel*

- High water content creates a moist wound surface
- Debrides wounds by hydration and promotion of autolysis
- Will absorb a light exudate
- Not appropriate for heavily exudating wounds

### **Debriding agents**

- Remove eschar and necrotic tissue
- Do not maintain moist environment.
- Need frequent changes
- Varidase = streptokinase
- Aserbine = malic, benzoic and salicylic acids in a cream base
- Damages granulation tissue and delays healing



### Negative pressure topical dressings

- Negative pressure topical dressings apply negative pressure via a foam dressing
- They remove wound exudate and reduce extravascular and interstitial fluid
- They improve blood supply during the phase of inflammation
- The mechanical effect stimulates cellular proliferation
- Shown to be effective in open wounds

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## Diathermy

- Diathermy is the use of high frequency electric current to produce heat
- Used to either cut or destroy tissue or to produce coagulation
- Main electricity is 50 Hz and produces intense muscle and nerve activation
- Electrical frequency used by diathermy is in the range of 300 kHz to 3 MHz
- Patients body forms part of the electrical circuit but has no effect on muscles

### Monopolar diathermy

- Electrical plate placed on patient to act as indifferent electrode
- Current passes between instrument and indifferent electrode
- As surface area of instrument is an order of magnitude less than that of the plate
- Localised heating is produced at tip of instrument
- Minimal heating effect produced at indifferent electrode

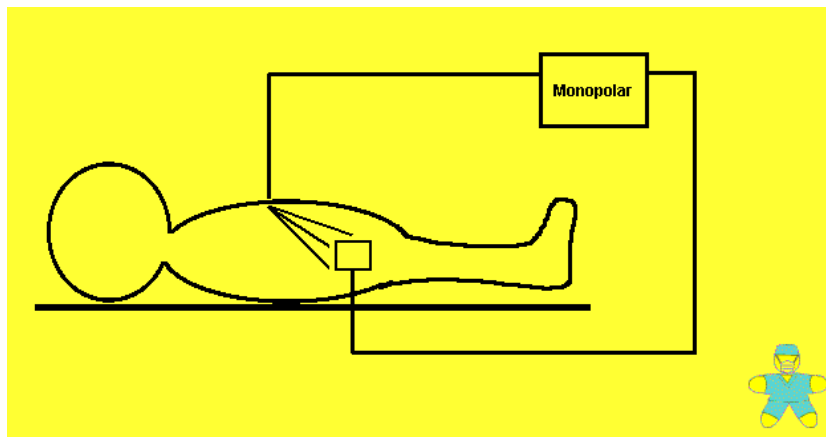


Figure 12 Monopolar diathermy

### Bipolar diathermy

- Two electrodes are combined in the instrument (e.g. forceps)
- Current passes between tips and not through patient

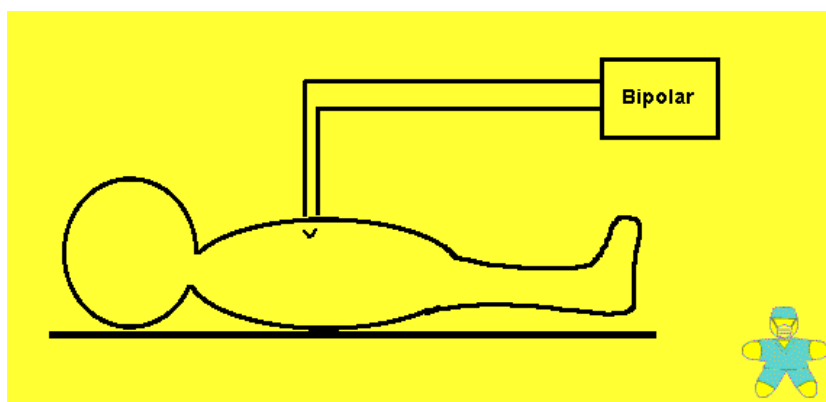


Figure 13 Bipolar diathermy



### Effects of diathermy

- The effects of diathermy depends on the current intensity and wave-form used

### Coagulation

- Produced by interrupted pulses of current (50-100 / second)
- Uses square wave-form

### Cutting

- Produced by continuous current
- Uses sinus wave-form

### Risk and complications

- Can interfere with pacemaker function
- Arcing can occur with metal instruments and implants
- Superficial burns if use spirit based skin preparation
- Diathermy burns under indifferent electrode if plate improperly applied
- Channelling effects if used on viscus with narrow pedicle (e.g. penis or testis)

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## Lasers

- Laser = Light Amplification by the Stimulated Emission of Radiation
- Laser emissions are:
  - Collimated - parallel output beam results in little energy loss
  - Coherent - waves are all in phase resulting in little loss of energy
  - Monochromic - all of the same wave length
- Effects of laser depends on photochemical, photomechanical and photothermal effects
- Tissue penetration increases with wavelength
- Pulsing of output can reduce thermal damage

Table 18 Characteristics and uses of different lasers

Laser	Wavelength (nm)	Pulse length	Uses
Carbon dioxide	10,600	continuous	tissue cutting
Neodymium-YAG	1064	continuous	coagulation
Neodymium-YAG	1064	10 ns	posterior capsulotomy
Ruby	694	100 $\mu$ s	tattoo removal
Argon	488-514	continuous	coagulation
Excimer	308	10 ns	photorefractive keratotomy

### Laser safety

- Lasers are classified according to the amount of damage they can cause
  - Class 1 - generally safe
  - Class 2 - safe within the time of the blink reflex
  - Class 3 - cause blindness after short exposure from mirrored surfaces
  - Class 4 - unsafe even with reflection from non-mirrored surfaces
- All medical lasers belong to class 4
- Both patients and operators require to wear goggles

### Risks associated with lasers

#### To patient

- Excessive burning
- Scar formation
- Visceral perforation

#### To the operator

- Accidental skin exposure
- Corneal or retinal burns

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## **Surgical procedures**

### ***Day care surgery***

- During recent years duration of hospital stay has been reduced
- Associated with an expansion in day case surgery
- Currently approximately 50% of elective operations are performed as day cases
- Potential benefits include:
  - Reduced disruption to patients normal lives
  - Psychological benefit of avoiding prolonged hospital stay
  - Reduced morbidity including nosocomial infections
  - Reduced in-patient waiting lists
  - Increased availability of in-patient beds
  - Reduced costs
- Safe day case surgery requires appropriate
  - Patient selection
  - Operative procedures
  - Anaesthetic techniques

### **Patient selection**

- Patients should fulfill the following criteria
  - Age less than 70 years
  - ASA Grade 1 or 2
  - BMI less than 30
  - Availability of a responsible adult
  - Access to a telephone
  - Live within an hours traveling time from the hospital
- Requires close co-operation between surgeon, anaesthetist and day unit
- Preoperative screening should be performed
- Can be carried by a questionnaire and/or a nurse-lead assessment clinic
- Patients requiring extensive investigation are not suitable for day case surgery

### **Operation selection**

- Operations for day case surgery vary between specialties
- Appropriateness may be expanded by the facility for an overnight stay
- Generally operations should be:
  - Short duration
  - Low incidence of postoperative complications
  - Not require blood transfusion
  - Not require major postoperative analgesia
- Laparoscopic surgery can now be performed, usually with an overnight stay
- Surgery should be performed by an experienced surgeon
- Access to in-patient beds should be available if required

### **Day case anaesthesia**

- Principles of anaesthesia are the same as for in-patient care
- Requires high quality induction, maintenance and recovery
- Recovery should be free from side effects
- Anaesthesia should be performed by an experienced anaesthetist
- Local anaesthetic techniques should be encouraged



### Discharge criteria

- Prior to discharge from the day case unit patients should
  - Have stable vital signs
  - Be alert and orientated
  - Be comfortable / pain free
  - Be able to walk
  - Be able to tolerate oral fluids
  - Have minimal nausea and vomiting
- Adequate follow-up arrangements should be made
- Patients should be provided with information sheets
- Should be provided with contact telephone numbers

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## ***Principles of anastomoses***

### **Gastrointestinal anastomoses**

- Anastomoses can be fashioned in various ways
  - End-to-end
  - End-to-side
  - Side-to-side
- Anastomoses heal in three phases

#### ***Lag phase (day 0-4)***

- Acute inflammatory responses occurs
- Anastomosis has no intrinsic strength

#### ***Fibroplasia phase (day 3-14)***

- Fibroblasts proliferate
- Immature collagen is laid down

#### ***Maturation phase (beyond 10 days)***

- Collagen is remodelled
- Strength of anastomosis is increased

### **Factors influencing anastomotic healing**

- Anastomotic technique is required to maintain apposition until collagen is laid down
- Anastomoses show serosal healing and require:
  - Maintenance of apposition
  - Good blood supply
  - Tension free
- Anastomotic leak or failure may occur if:
  - Distal obstruction
  - Peri-anastomotic sepsis
  - Peri-anastomotic haematoma
  - Hypotension
  - Hypoxia
  - Jaundice
  - Corticosteroids
  - Uraemia
- Any anastomotic technique should:
  - Promote primary healing by accurate alignment of the divided bowel
  - Cause minimal disruption of the local vasculature
  - Incorporate minimum amount of foreign material
  - Not implant malignant cells at the anastomosis
  - Not enhance the risk of metachronous tumours
- No evidence to suggest that hand-sewn are superior to stapled anastomoses

### **Anastomotic techniques**

- Conventional methods
  - Hand-sewn
  - Stapled
- Novel techniques
  - Compression rings



- Tissue glues

#### ***Two layered technique***

- Classic teaching of GI anastomoses
- Inner continuous all layer catgut suture.
- Outer seromuscular interrupted silk.
- Produced serosal apposition and mucosal inversion
- Inner layer believed to be haemostatic but also strangulates mucosa

#### ***Single layered technique***

- Modern teaching of GI anastomoses
- Interrupted seromuscular absorbable (e.g. 3/0 Vicryl on round bodied needle)
- Incorporates strong submucosal layer
- Minimal damage to submucosal vascular plexus

#### ***Stapled anastomoses***

- Side to side anastomosis with linear staplers (e.g. GIA 60)
- End to end anastomosis with circular devices (e.g. CEEA)
- Stapled anastomoses reduced radiologically detected anastomotic leaks
- Associated with increased rate of anastomotic strictures

#### ***Drainage of anastomosis***

- Drainage of anastomoses is controversial
- No evidence that the use of a drain reduced leak rate for anastomoses above pelvic brim
- Drain may increase risk of leak

#### ***Biliary and urological anastomoses***

- Always use absorbable sutures
- Nonabsorbable sutures risk stone formation

#### ***Vascular anastomoses***

- Always use nonabsorbable.
- Prolene most often used
- 2/0 on aorta
- 4/0 on femoral artery



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### **Endoscopic surgery and laparoscopy**

- Ideal minimal access surgery has:
- Reduced trauma associated with access
- No compromise of exposure of operative field
- Surgery can be performed using the following approaches
  - Laparoscopic
  - Thoracoscopic
  - Endoluminal
  - Intra-articular joint surgery
  - Combined approaches

### **Advantage of minimal access surgery**

- Less tissue trauma
- Less postoperative pain
- Faster recovery
- Fewer postoperative complications
- Better cosmesis

### **Disadvantages of minimal access surgery**

- Lack of tactile feedback
- Increased technical expertise required
- Possible longer duration of surgery
- Increased risk of iatrogenic injuries
- Difficult removal of bulky organs
- More expensive



Figure 14 ERCP showing a bile duct injury sustained during laparoscopic cholecystectomy



### **Established minimal access procedures**

- Laparoscopic cholecystectomy
- Diagnostic laparoscopy
- Laparoscopic appendicectomy
- Laparoscopic fundoplication
- Laparoscopic (or thoracoscopic) Heller's myotomy
- Laparoscopic adrenalectomy
- Laparoscopic splenectomy
- Thoracoscopic rectopexy

### **Minimal access procedures under evaluation**

- Laparoscopic hernia repair
- Laparoscopic colectomy
- Laparoscopic nephrectomy for living related donor
- Parathyroidectomy
- Laparoscopic surgery for perforated duodenal ulcer

### **Establishing pneumoperitoneum**

#### ***Veress needle***

- Blind procedure with potential for complications
- Major complication is visceral or vascular puncture
- Usually inserted at umbilicus
- Aimed towards the pelvis
- Intraperitoneal placement can be checked by:
  - Saline drop test
  - Saline instillation test
  - Low-flow gas insufflation
- Insufflate at least 3.5 litres of CO<sub>2</sub>
- Ensure maximum pressure is 10-12 mmHg
- Insert primary port through umbilicus
- Insert secondary ports under direct vision

#### ***Open (Hasson) technique***

- An attempt to reduce the rate of visceral injury
- Cannula inserted using a 'cut-down' technique
- Stay sutures inserted in linea alba as counter traction
- Finger inserted through peritoneum to ensure that there are no adhesions
- Primary port inserted under direct vision



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## Tourniquets in the operating theatre

- Commonly used in surgical practice
- When properly used they provide excellent haemostasis
- When incorrectly used they are dangerous
- Cuff failure can be disastrous with rapid systemic absorption of drugs (e.g. local anaesthetics)

### Safeguards

- Ensure correct placement and connection
- Use adequate padding
- Exsanguinate limb before inflation
- Use minimal pressure - usually 100 mmHg above systolic blood pressure
- Use for minimal duration - no longer than 90 minutes
- Avoid multiple inflations or deflations
- Be aware of relative contraindications to use
  - Previous DVT or pulmonary embolus
  - Arterial disease
  - Vasculitic disorders
  - Sickle cell anaemia

### Complications

- Nerve injury
- Vascular injury
- Postoperative embolic events
- Post-tourniquet syndrome
- Myoglobinuria
- Increased blood viscosity
- Increased postoperative pain
- Tourniquet burns

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## ***Surgical drains***

- Drains are inserted to:
  - Evacuate establish collections of pus, blood or other fluids (e.g. lymph)
  - Drain potential collections
- Their use is contentious
- Arguments for their use include:
  - Drainage of fluid removes potential sources of infection
  - Drains guard against further fluid collections
  - May allow the early detection of anastomotic leaks or haemorrhage
  - Leave a tract for potential collections to drain following removal
- Arguments against their use include:
  - Presence of a drain increases the risk of infection
  - Damage may be caused by mechanical pressure or suction
  - Drains may induce an anastomotic leak
  - Most drains abdominal drains infective within 24 hours

### ***Types of drains***

- Drains can be
  - Open or closed
  - Active or passive
- Drains are often made from inert silastic material
- They induce minimal tissue reaction
- Red rubber drains induce an intense tissue reaction allowing a tract to form
- In some situations this may be useful (e.g. biliary t-tube)

### ***Open drain***

- Include corrugated rubber or plastic sheets
- Drain fluid collects in gauze pad or stoma bag
- They increase the risk of infection

### ***Closed drains***

- Consist of tubes draining into a bag or bottle
- They include chest and abdominal drains
- The risk of infection is reduced

### ***Active drains***

- Active drains are maintained under suction
- They can be under low or high pressure

### ***Passive drains***

- Passive drains have no suction
- Function by the differential pressure between body cavities and the exterior

## ***Nasogastric tubes***

- Following abdominal surgery gastrointestinal motility is reduced for a variable period of time
- Gastrointestinal secretions accumulate in stoma and proximal small bowel
- May result in:
  - Postoperative distension and vomiting





- Aspiration pneumonia
- Little clinical evidence is available to support the routine use of nasogastric tubes
- May increase the risk of pulmonary complications
- Of proven value for gastrointestinal decompression in intestinal obstruction
- Tubes are usually left on free drainage
- Can be also aspirated maybe every 4 hours
- Can be removed when volume of nasogastric aspirate is reduced

### **Urinary catheters**

- A urinary catheter is a form of drain
- Commonly used to:
- Alleviate or prevent urinary retention
- Monitor urine output
- Can be inserted transurethraly or suprapubically
- Catheters vary by:
  - The material from which they are made (latex, plastic, silastic, teflon-coated)
  - The length of the catheter (38 cm 'male' or '22 cm 'female')
  - The diameter of the catheter (10 Fr to 24 Fr)
  - The number of channels (two or three)
  - The size of the balloon ( 5ml to 30 ml)
  - The shape of the tip
- Special catheters exist such as:
  - Gibbon catheters
  - Nelaton catheters
  - Tiemann catheters
  - Malecot catheters

### **Complications**

- Paraphimosis
- Blockage
- By-passing
- Infection
- Failure of balloon to deflate
- Urethral strictures

### **Do's and don'ts of urinary catheters**

- Choose an appropriate sized catheter
- Insert using an aseptic technique
- Never insert using force
- Do not inflate the balloon until urine has been seen coming from the catheter
- Record the residual volume
- Do not use a catheter introducer unless you have been trained in its use
- If difficulty is encountered inserting a urinary catheter consider a suprapubic
- Remove at the earliest possibility



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## Pharmacology

### Oral contraceptives and HRT

#### Combined OCPs

- Risk of DVT in non pill user = 5 / 100,000/ yr.
- Risk in 2<sup>nd</sup> generation OCP (containing levonorgesterel) user = 15 / 100,000 / yr.
- Risk in 3<sup>rd</sup> generation OCP (desogesterel or gestodene) user = 25 / 100,000 / yr.
- Combined OCPs increase the risk of DVT
- Increase serum procoagulant factors - factor VII, X and fibrinogen
- Reduce antithrombin III
- Little has been published on the size of the risk increase
- Probably increases risk by factor of between 2 and 4 times
- Progestogen-only pills do not increase risk of venous thrombosis

#### Peri-operative management

- Major surgery and surgery on legs (e.g. varicose veins)
- Stop combined OCP 4 weeks prior to surgery
- Restart 2 weeks post surgery when fully mobile
- Minor surgery - continue OCP
- Emergency surgery - Give full thromboprophylaxis including TED stockings and heparin

#### Hormone replacement therapy

- Increases risk of venous thrombosis by between 2 and 4 times
- Other risk factors for venous thrombosis in this age group
- No evidence that stopping HRT reduces risk
- HRT can be continued in peri-operative period

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## **Laxatives**

- Laxatives can be classified as:
- Bulk forming agents
- Stool softeners and lubricants
- Gastrointestinal stimulants
- Osmotic laxatives

### **Bulk forming agents**

- Hydrophilic agents that absorb H<sub>2</sub>O
- Increase stool bulk, stimulate rectal reflexes and induce defecation
- They require an adequate oral fluid intake
- Take several days for maximum effect
- Can induce intestinal obstruction if used inappropriately in patients with adhesions etc
- e.g. Bran, ispaghula husk (Fybogel<sup>®</sup>), methylcellulose, sterculia (Normacol<sup>®</sup>)

### **Stool softeners and lubricants**

- Act as lubricants or detergents
- Often produce rapid purgative effect
- e.g. Arachis oil enemas, glycerin suppositories, dioctyl sodium, sulphasuccinate

### **Gastrointestinal stimulants**

- Stimulate peristalsis and reduce H<sub>2</sub>O absorption
- Senna and bisacodyl act on colon and take 6-8 hours to produce an effect
- Castor oil acts on small intestine and works within 1-2 hours
- Sodium picosulphate (Picolax<sup>®</sup>) used in radiological and surgery bowel preparation
- Abuse of stimulant laxatives can induce hypokalaemia and colonic atony

### **Osmotic laxatives**

- Reduce H<sub>2</sub>O absorption and increase peristalsis
- Increase osmotic load delivered to large intestine
- e.g. Lactulose, magnesium hydroxide, sodium citrate (Microlax<sup>®</sup>)
- Lactulose is a disaccharide of galactose and fructose
- Hydrolysed by colonic bacteria into acetic and lactic acid which are osmotically active
- Takes several days to have maximum effect

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## Management and legal issues in surgery

### Evidence based surgical practice

#### Statistics

##### Types of data

- Before data analysis can be performed need to identify type of data presented
- Data can be quantitative or categorical
  - Quantitative and continuous - e.g. height, weight, blood pressure
  - Quantitative and discrete - e.g. number of children
  - Categorical and ordinal - e.g. Grade of tumour
  - Categorical and nominal - e.g. Male / female, blood group

##### Description of quantitative data

- Data can be described by a 'measure of location'
  - Median = mid point. 50% of variables above and 50% of variables below
  - Mode = most common variable
  - Mean = the average i.e. the sum of variable divided by the number
- Data can also be described by a 'measure of variation'
  - Range = distribution between maximum and minimum value
  - Interquartile range = distribution between first and third quartile
  - Standard deviation = distribution around mean in a 'normally' distributed population

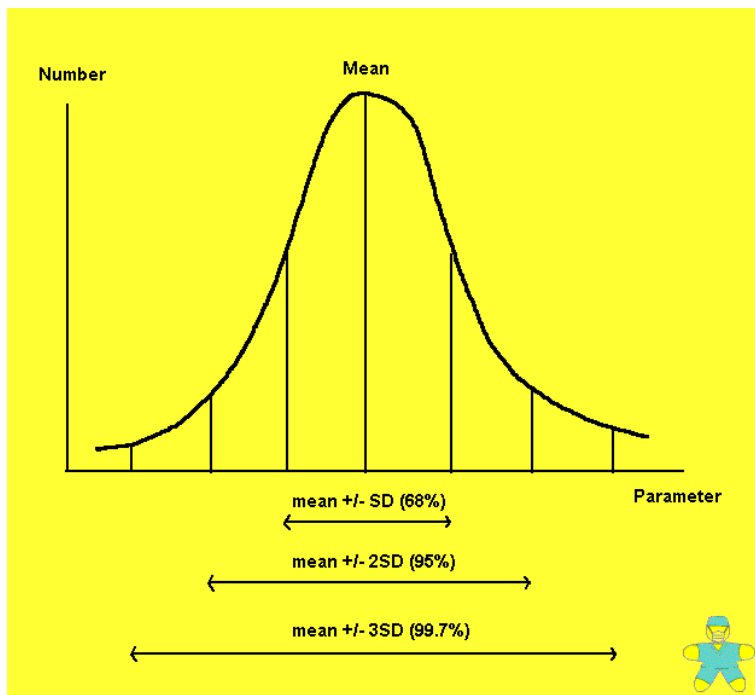


Figure 15 Normal distribution

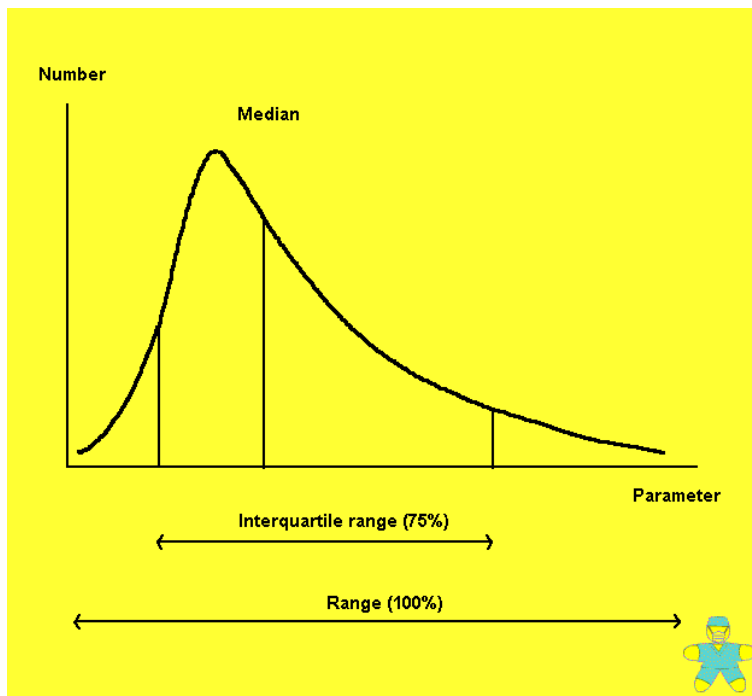


Figure 16 Skewed distribution

### Calculation of sample size

- Sample size needed to test a hypothesis depends on four factors
- Expected difference in means between the two groups
- Variability of the data
- Power of the study = probability that any difference is real (usually 90%)
- Level of significance accepted (usually 5%)

### Type I and Type II errors

- Type I error ( $\alpha$ ) = rejection of null hypothesis when it is in fact true
  - No difference is present between the samples
  - The statistical method used identified a difference
- Type II error ( $\beta$ ) = rejection of null hypothesis when difference between groups exists
  - A difference is present between the samples
  - The statistical method used failed to identify it

### Choice of statistical test

- Prior to analysing data need to define the hypothesis being tested
- If no hypothesis proposed then no statistical test can be selected
- Also need to decide whether matched, paired or independent
- Also need to define input and output variables
- Both variable can be categorical or quantitative



Table 19 Statistical tests for paired or matched observations

	Test
Nominal	McNemar
Ordinal	Wilcoxon
Quantitative (non-normal)	Wilcoxon
Quantitative (normal)	Paired t-test

Table 20 Choice of statistical test for independent observations and categorical outcome variables. Input variables are listed in first column.

	Nominal	Categorical	Ordinal
Nominal	Chi-squared or Fisher's	Chi-squared	Chi-squared or Mann Whitney
Categorical	Chi-squared	Chi-squared	Kruskal-Wallis
Ordinal	Mann-Whitney		Spearman rank
Quantitative - discrete	Logistic regression		
Quantitative - non-normal	Logistic regression		
Quantitative - normal	Logistic regression		

Table 21 Choice of statistical test for independent observations and quantitative outcome variables. Input variables are listed in first column.

	Quantitative - discrete	Quantitative - non-normal	Quantitative - normal
Nominal	Mann-Whitney	Mann-Whitney or log-rank	Student's t-test
Categorical	Kruskal-Wallis	Kruskal-Wallis	ANOVA
Ordinal	Spearman rank	Spearman rank	Spearman rank or linear regression
Quantitative - discrete	Spearman rank	Spearman rank	Spearman rank or linear regression
Quantitative - non-normal		Pearson or Spearman rank	Pearson or Spearman rank
Quantitative - normal		Linear regression	Linear regression



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## Principles of research & clinical trials

- Primary research includes:
  - Animal or volunteer experiments
  - Clinical trials
  - Surveys
- Secondary research includes:
  - Systematic review and meta-analyses
  - Guidelines
  - Decision analyses
  - Economic analyses

### Hierarchy of evidence

- The strength of a study depends on its design
- A hierarchy of evidence exists with decreasing strength as follows:
  - Systematic review and meta-analysis
  - Randomised controlled trials with definitive results
  - Randomised controlled trials with non-definitive results
  - Cohort studies
  - Case-control studies
  - Cross sectional surveys
  - Case reports

Table 22 Levels of Evidence

Description	
Ia	Evidence from a meta-analysis of randomised controlled trials
Ib	Evidence from at least one randomised controlled trial
IIa	Evidence from at least one well designed controlled study without randomisation
IIb	Evidence from at least one well designed quasi-experimental study
III	Evidence from well-designed non-experimental descriptive studies such as comparative studies, correlation studies or case studies
IV	Evidence from expert committee reports or opinions or clinical experiences of respected authorities

- Questions regarding:
- Drug treatment or medical interventions require a double-blind randomised controlled trial
- Prognosis require longitudinal cohort studies
- Causation require cohort or case-control studies



### **Purpose of clinical trials**

- Clinical trials conduct 'human experiments'
- Three fundamental principles apply
  - The trial must address a legitimate question
  - The patient must be informed and willing to participate
  - The patient may decline entry or withdraw at any stage
- There are 4 clinical trial structures

#### **Phase 1 study**

- Provides basic pharmacological and toxicology information
- Not a test of therapeutic efficacy
- Performed on either
  - Healthy volunteers
  - Patients whose disease has progressed on all available treatments

#### **Phase 2 study**

- Used to identify dose range of a particular drug
- Sample size is usually about 20 patients
- Patients usually have end-stage disease
- Not usually randomised and drug combinations may be tested

#### **Phase 3 study**

- Randomised trial designed to compare effects of different treatments
- One treatment option should be the best currently available
- Outcome measures usually include survival, disease-free survival, response and toxicity
- Usually involve large numbers of patients
- May involve different institutions in several countries

#### **Phase 4 study**

- Less commonly used
- Aimed to evaluate the long-term outcome of established therapies
- Often regarded as a post-marketing study

### **Randomised controlled trials**

- In RCT participants are randomly allocated to one intervention or another
- Both groups are followed up for a specified period
- Groups analysed in terms of outcome defined at the outset
- If groups similar at outset any difference should be due to intervention

#### **Advantages of RCTs**

- Allows rigorous evaluation of a single variable in a defined patient group
- Potentially eradicates bias by comparing two (or more) identical groups
- Allows for meta-analysis

#### **Disadvantages of RCTs**

- Expensive and time consuming
- Often have too few patients or too short a follow-up period
- Surrogate endpoints are often used in preference to clinical outcome measures
- Often imperfect randomisation
- Often not all eligible patients are randomised



- Failure to blind assessors to randomisation status of patients

#### **Cohort studies**

- Cohort studies compare groups exposed to different factors
- Followed up to see whether there is a difference in outcome
- Usually used to study disease aetiology
- Also used to assess disease prognosis

#### **Case-control studies**

- Case-control studies match patients with a disease to controls
- Data then collected retrospectively to find a difference between the groups

#### **Why are papers rejected for publication?**

- The study does not address an important scientific issue
- The study was not original - it had been done before
- The study did not address the authors hypothesis
- A different type of study should have been done
- The sample size was too small
- The study was uncontrolled
- The statistical analysis was inappropriate or incorrect
- The authors drew unjustified conclusions from their data
- The papers was poorly written and incomprehensible

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## **Quality of life**

- Diseases and their treatment have an impact on patient well-being
- Quality of life (QoL) is a measure of an illness, disease and its treatment on patient welfare
- Has dimensions beyond physical measures of patients progress
- No universal definition of QoL exists
- It has three fundamental characteristics
- Multidimensional
  - Physical - patients perceived ability to carryout daily activities
  - Social - ability to interact with family and friends
  - Psychological - degrees of depression, anxiety, fear etc
- Subjective
- Dynamic

## **Quality of life assessment**

- QoL assessment is used to
- Assess progress of individual patient
- In clinical trials to compare treatment options
- Determine cost-effectiveness of treatment
- Instrument used must be
  - Valid - measure what it is supposed to measure
  - Reliable - produce consistent results
  - Responsive - be able to detect changes with time
- Can be either self-administered or by interview
- Can be repeated on several occasions

## **Measures of quality of life**

- Data is usually collected using a structured questionnaire
- Different items tap various dimensions of QoL
- QoL instruments can be either generic or specific

## **Generic instruments**

- Assess many dimensions
- Produce a global concept of QoL
- Two types of generic questionnaires exist
  - Health profiles (e.g. SF-36)
  - Health indices (e.g. Quality adjusted life years)

## **Specific instruments**

- Used for specified disease or condition
- Several types exist:
  - Domain specific (e.g. Hospital anxiety and depression scales)
  - Disease specific (e.g. EORTC QLQ-C30 for cancer patients)
  - Population specific (e.g. children or elderly)
  - Symptom specific (e.g. McGill pain questionnaire)



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## Management aspects of surgical practice

### *Clinical governance*

- '...a framework through which NHS organisations are accountable for continuously improving the quality of their services and safeguarding high standards by creating an environment in which excellence in clinical care will flourish.'
- Purpose of clinical governance is to ensure that patients receive the highest quality of care
- Covers organisational systems and processes for monitoring and improving services including:
  - Consultation and patient involvement
  - Clinical risk management
  - Clinical audit
  - Research and effectiveness
  - Staffing and staff management
  - Education, training and continuing professional development
  - The use of information about experience, outcome and processes
- Effective clinical governance should ensure:
  - Continuous improvement of patient services and care
  - A patient-centred approach to care
  - A commitment to quality
  - The prevention of clinical errors

### *Clinical audit*

- 'The systematic, critical analysis of the quality of medical care, including the procedures used for diagnosis and treatment, to help to provide reassurance that the best quality of service is being achieved, having regard to the available resources'
- Medical audit = Assessment by peer review of medical care
- Clinical audit = Assessment of total care

### *Medical audit*

- Involves a systematic approach
- Highlights opportunities for improvement
- Provides mechanism for change
- Is different from case presentation, morbidity & mortality meetings
- Clinical audit can assess
  - Structure - type of resources
  - Process - what is done to patients
  - Outcome - the result of clinical interventions

### *Audit cycle*

- The audit cycle involves:
  - Observation of existing practice
  - The setting of standards
  - Comparison between observed and set standards
  - Implementation of change
  - Re-audit of clinical practice

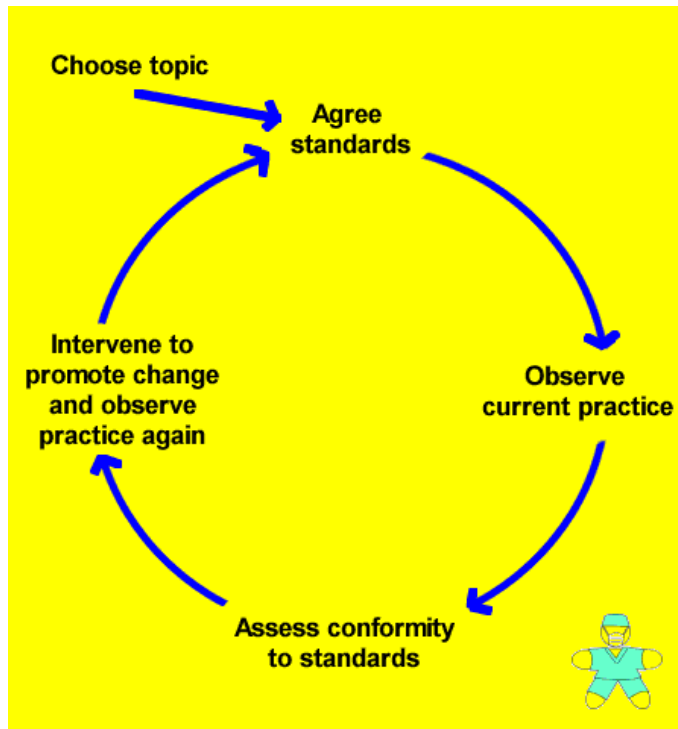


Figure 17 The audit loop

### Audit techniques

- Basic clinical audit - throughput, morbidity, mortality
- Incident review - critical incident reporting
- Clinical record review
- Criterion audit - retrospective analysis judged against chosen criteria
- Adverse occurrence screening
- Focused audit studies - specific outcome
- Global audit - comparison between units
- National studies - e.g. NCEPOD

### Essential features of comparative audit

- High quality data collection
- Relevant and valid measure of outcome
- Appropriate and valid measures of case mix
- A representative population
- Appropriate statistical analysis



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## Ethics and the law

### *Duties of a doctor (GMC)*

- Make the care of your patient your first concern
- Treat every patient politely and considerately
- Respect patients' dignity and privacy
- Listen to patients and respect their views
- Give patients information in a way that they can understand
- Respect the rights of patients to be fully involved in decisions about their care
- Keep your professional knowledge and skills up to date
- Recognise the limits of your own professional confidence
- Be honest and trustworthy
- Respect and protect confidential information
- Make sure that your personal beliefs do not prejudice your patients care
- Act quickly to protect patients from risk if you have good concerns to believe that you or a colleague may not be fit to practice
- Avoid abusing your position as a doctor
- Work with colleagues in the ways that best serve patients interests

### *The Coroner*

- There are approximately 600,000 deaths per year in England and Wales
- Cause of death is certified by the attending doctor in 75% cases
- Of 150,000 deaths referred to the coroner
  - 60% are referred by doctors
  - 38% by the police
  - 2% by the registrar of births, marriages and deaths
- Initial investigations are conducted by Coroner's Officers
- They are plain-clothed policemen
- Death certificate may be issued after discussion with a Coroner's Officers
- Coroners hold inquest for about 10% of deaths that they certify

### *Referral to the coroner*

- A death should be referred to the coroner if:
- The cause of death is unknown
- The deceased was not seen by the certifying doctor either after death or within 14 days of death
- The death was violent, unnatural or suspicious
- The death may be due to an accident (whenever it occurred)
- The death may be due to self-neglect or neglect by others
- The death may be due to an industrial disease or related to the deceased employment
- The death may be due to an abortion
- The death occurred during an operation or before recovery from the effects of an anaesthetic
- The death may be due to suicide
- The death occurred during or shortly after detention in police or prison custody



### Role of the coroner

- Coroner's Act 1988 defines when an inquest should be held
- Inquests are held in public and may involve a jury
- Purpose of the inquest is to determine
  - Who is the deceased
  - How, when and where he died
  - Details of the cause of death
- The coroner is not concerned with civil or criminal liability
- Coroner may record the cause of death as
  - Natural causes
  - Accident / misadventure
  - Industrial disease
  - Sentence of death
  - Dependence on drugs or non-dependent abuse of drugs
  - Lawful killing
  - Open verdict
  - Want of attention at birth
  - Unlawful killing
  - Suicide
  - Still birth
  - Attempted or self-induced abortion

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## Clinical microbiology

### Surgical microbiology

#### ***Drainage of superficial and deep abscesses***

- An abscess is collection of pus within soft tissues
- Occurs when hosts response to infection is inadequate
- Predisposing factors include:
  - Foreign bodies
  - Haematoma formation
  - Poor blood supply

#### **Pathology**

- An abscess contains bacteria, acute inflammatory cells, protein exudate and necrotic tissue
- It is surrounded by granulation tissue (the 'pyogenic membrane')
- The organisms usually involved are:
- In superficial abscesses
  - *Staph. Aureus*
  - *Strep. pyogenes*
- In deep abscesses
  - Gram negative species (e.g. *E. coli*)
  - Anaerobes (e.g. *Bacteroides*)

#### **Clinical features**

- Superficial abscesses include infected sebaceous cysts, breast and pilonidal abscesses
- Show cardinal features of inflammation - calor, rubor, dolor, tumor
  - Heat
  - Redness
  - Pain
  - Swelling
- After a few days superficial abscess usually 'point' and are fluctuant
- Deep abscesses include diverticular, subphrenic and anastomotic leaks
- Patients shows signs of inflammation
  - Swinging pyrexia
  - Tachycardia
  - Tachypnoea
- Physical signs are otherwise difficult to demonstrate
- Site of abscess may not be clinically apparent
- Radiological imaging often required to make the diagnosis

#### **Treatment**

- All abscesses require adequate drainage
- Should be performed under general anaesthesia
- Antibiotics have little to offer as tissue penetration is usually poor
- Prolonged antibiotic treatment can result in a chronic inflammatory mass (an 'antibioma')
- Superficial abscesses are usually suitable for open drainage
- For deep abscesses closed drainage may be attempted



### Open technique

- Superficial abscesses can usually be drained through a cruciate incision
- Position of incision may allow depended drainage
- Pus should be sent for microbiology
- Loculi should be broken down and necrotic tissue excised
- A dressing should be inserted into the wound
- Packing is not required - it is painful

### Closed techniques

- Deep abscess can be treated by ultrasound or CT guided aspiration
- Success can not always be guaranteed
- Multiloculated abscesses may not drain adequately
- Percutaneous access may be difficult because of the position of adjacent organs

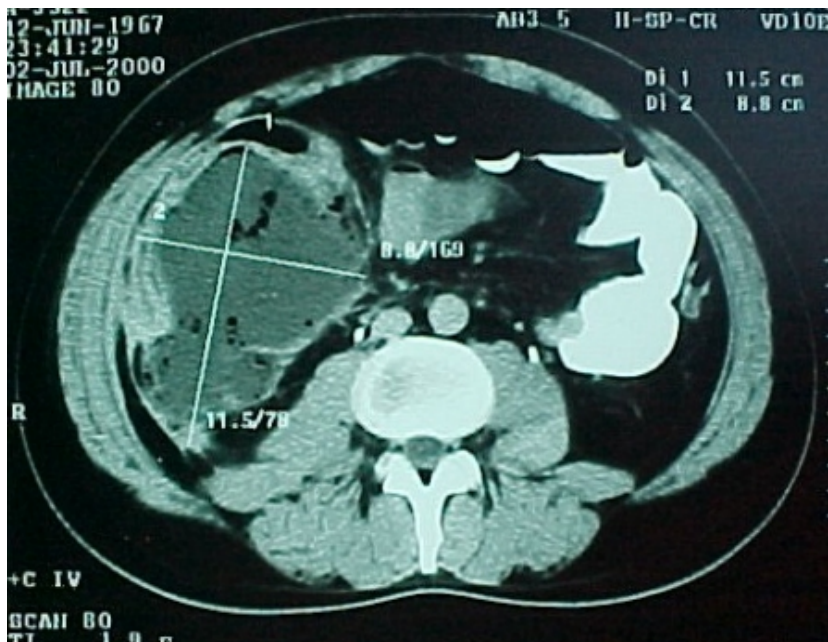


Figure 18 CT appearance of an appendix abscess

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## Cellulitis and necrotising soft tissue infections

### Cellulitis

- Cellulitis is a spreading infection in the subcutaneous tissue
- Often occurs after skin abrasion or other similar trauma
- Usually due to infection with  $\beta$  haemolytic *streptococcus* or *Staph. aureus*
- Both produce enzymes that degrade tissue and allow spread of infection

### Clinical features

- Cellulitis usually presents with a well demarcated area of inflammation
- Usually associated with malaise, fever and a raised white cell count
- If not rapidly treated it can progress to lymphangitis and lymphadenitis
- Localised areas of skin necrosis may occur
- Predisposing factors include:
  - Lymphoedema
  - Venous stasis
  - Diabetes mellitus
  - Surgical wounds



Figure 19 Cellulitis

### Management

- Rest and elevation of the affected limb
- Antibiotics
- May initially be given orally
- Intravenous administration if no rapid improvement
- Benzylpenicillin and flucloxacillin are usually antibiotics of choice

### Necrotising soft tissue infections

- Are the result of skin and subcutaneous infections with virulent bacteria
- Toxins can cause widespread skin and fascial necrosis



### Melaney's synergistic gangrene

- This results from synergistic infection affecting principally the skin
- Usually occurs around surgical wounds, stomas and cutaneous fistulae
- Due to infection with both *Staph. aureus* and anaerobic *streptococci*
- Often initially indistinguishable from cellulitis
- Spreads slowly and often results in skin ulceration
- Lacks the severe systemic toxicity seen with necrotising fasciitis

### Management

- Antibiotics including benzylpenicillin
- Surgical debridement of the affected area

### Necrotising fasciitis

- Occurs in immunocompromised patients
- Often diabetic, alcoholics or intravenous drug abusers
- Occurs at several characteristic sites
- Limbs after cuts, abrasions or bites
- Around postoperative abdominal surgical wounds
- In the perineum secondary to anorectal sepsis
- In the male genitalia (Fournier's gangrene)
- Polymicrobial infection involving the following:
  - Facultative aerobes
  - *Streptococcal* species or *E. coli*
  - Anaerobes
- Exotoxins produce severe systemic toxicity



Figure 20 Fournier's gangrene



### **Clinical features**

- Often presents similar to cellulitis
- Warning features include
- Severe pain - out of proportion to the clinical signs
  - Severe systemic toxicity
  - Cutaneous gangrene
  - Haemorrhagic fluid leaking from a wound
- Untreated it progresses to multiple organ failure
- Overall has about a 30% mortality
- X-ray may show gas in the subcutaneous tissue

### **Management**

- Requires high clinical suspicion and early diagnosis
- Patients should be managed in high dependency unit
- Need fluid resuscitation and organ support
- Early surgical debridement is essential
- Requires excision well into apparently normal tissue
- Amputation or fasciotomies may be required
- Defunctioning colostomy may be required for perineal sepsis
- Antibiotic cover should include benzylpenicillin, metronidazole and gentamycin
- Hyperbaric oxygen therapy may be of benefit

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## **Wound infection**

### **Sources of surgical infection**

- 75% of nosocomial infections occur in surgical patients
- Most postoperative infections arise from patients own flora
- Commonest sites of infection are:
  - Urinary tract (40%)
  - Respiratory tract (15%)
  - Bacteraemia ( 5%)

### **Normal body flora**

- Skin - staphylococci, streptococci
- Oral cavity - staphylococci, streptococci and anaerobes
- Nasopharynx - staphylococci, streptococci, haemophilus and anaerobes
- Large bowel - gram-negative rods, enterococci and anaerobes
- Urinary tract - normally sterile

### **Sources of wound contamination**

#### **Direct inoculation**

- Patients residual flora or skin contamination
- Surgeon's hands
- Contaminated instruments or dressings
- Contaminated procedure
- Drains, catheters or intravenous lines

#### **Airborne contamination**

- Skin and clothing of staff and patients
- Air flow in operating theatre or ward

#### **Haematogenous spread**

- Intravenous lines
- Sepsis at other anatomical sites

### **Definition of wound infection**

- 1992 US Centre for Disease Control
- Defined the following:
  - Surgical site infections
  - Superficial incisional infection
  - Deep incisional infections
  - Organ space infections



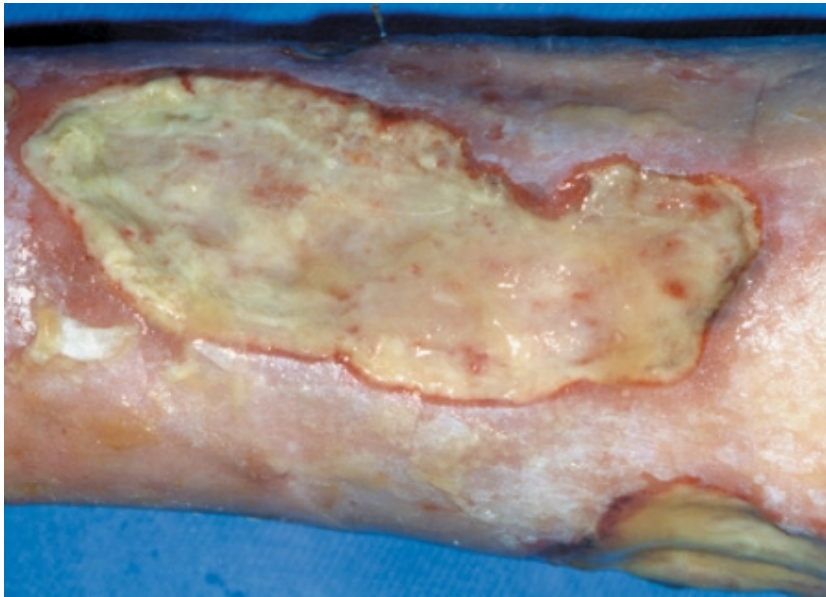


Figure 21 Infected wound

- Surgical site infections must fulfil the following criteria
  - Infection must occur within 30 days of surgery
  - Infection must involve only the skin and subcutaneous tissue
- There must be at least one of the following
  - Purulent discharge from a superficial infection
  - Organisms isolated from aseptically obtained wound culture
- Must be at least one of the following signs of infection
  - Pain or tenderness
  - Localised swelling
  - Redness or heat

#### **Aerobic pathogens in wound infections**

- *Staphylococcus aureus* (17%)
- Enterococci (13%)
- Coagulase-negative staphylococci (12%)
- *Escherichia coli* (10%)
- *Pseudomonas aeruginosa* (8%)
- *Enterobacter species* (8%)
- *Proteus mirabilis* (4%)
- *Klebsiella pneumoniae* (3%)
- *Candida species* (2%)

#### **Predisposing factors**

##### **General factors**

- Age, obesity, malnutrition
- Endocrine and metabolic disorders
- Hypoxia, anaemia
- Malignant disease
- Immunosuppression



### **Local factors**

- Necrotic tissue
- Foreign bodies
- Tissue ischaemia
- Haematoma formation
- Poor surgical technique

### **Microbiological contamination**

- Type and virulence of organism
- Size of bacteriological dose
- Antibiotic resistance

### **Prevention of wound infection**

#### **Exogenous**

- Sterilisation of instruments, sutures etc
- Positive pressure ventilation of operating theatres
- Laminar air flow in high risk areas
- Exclusion of staff with infections

#### **Endogenous**

- Skin preparation
- Mechanical bowel preparation
- Antibiotic prophylaxis
- Good surgical technique

### **Wound infection rates**

- Risk of wound infection varies with type of surgery
- USA National Research Council has classified wound by risk of infection
- Four categories have been defined

#### **Clean surgery**

- An incision through uninfamed tissue
- Elective surgery and the wound is primarily closed
- Only closed drainage systems are used
- No breach in aseptic technique
- No viscus opened
- Examples include mastectomy and hernia repair
- Infection rate typically 1-2%

#### **Clean-contaminated**

- Wound (that is otherwise clean) created at emergency surgery
- Reoperation via a clean incision with 7 days
- Viscus opened but no spillage of gut contents
- Minor break in aseptic technique
- Examples include right hemicolectomy and cholecystectomy
- Infection rate usually <10%

#### **Contaminated**

- Wounds left open
- Penetrating trauma less than 4 hours old



- Viscus opened with inflammation or spillage of contents
- Major break in sterile technique
- Examples include appendicectomy and stab wound
- Infection rate 15-20%

#### **Dirty**

- Presence of pus
- Intraperitoneal abscess formation or visceral perforation
- Penetrating trauma more than 4 hours old
- Examples include all perforated abdominal viscera
- Infection rate 40%

#### **Antibiotic prophylaxis**

- Infection rate can be reduced with antibiotic prophylaxis
  - Prophylaxis is the use of antibiotics to prevent infection
  - Treatment is their use to eradicate established sepsis.
- Prophylaxis important in:
  - Surgery with a high incidence of post-operative infection (e.g. colonic surgery)
  - Surgery where infection would be hazardous (e.g. prosthetic valves)
- Need to consider:
- The use of an appropriate antibiotic based on likely bacteria and tissue penetration
  - Cefuroxime & metronidazole for colonic surgery
  - Benzylpenicillin for peripheral vascular surgery
- Timing and duration of administration
  - Intravenous administration at induction
  - Number of doses - usually no more than three doses

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## Tetanus

- Less than 100 cases per year reported each year in the UK
- Seen following deep or penetrating wound in relatively avascular areas
- More prevalent in developing countries
- Seen in neonate (tetanus neonatorum) following the use of cow dung on the umbilicus

## Microbiology

- Due to *Clostridium tetani*
- Gram-positive spore forming rod
- Typical 'drum-stick' appearance with terminal spore
- Widely found in the environment and soil
- A strict anaerobe that produces a powerful exotoxins
- Exotoxin is resistant to autoclaving
- Exotoxin is not antigenic and repeat infection can occur
- Infection produces few signs of local inflammation



Figure 22 Gram-positive spore forming rods of *Clostridium tetani*

## Pathogenesis

- Germination of spores releases the exotoxin
- Toxin affects nervous system and reaches CNS via the peripheral nerves
- Acts on presynaptic terminals of inhibitor nerves
- Reduces the release of inhibitory neurotransmitters (e.g. glycine)
- Excess activity of motor neurones produces muscle spasm

## Clinical features

- Facial muscle spasm produces trismus
- Typical facial appearance = 'risus sardonicus'
- Back muscle spasm produces opisthotomous
- Eventually exhaustion and respiratory failure leads to death
- The diagnosis is essentially clinical
- Differentiating between contamination and infection on wound swabs is difficult



## **Treatment**

### **Prevention**

- Tetanus can be prevented by:
  - Active immunisation with tetanus toxoid with booster every 5-10 years
  - Adequate wound toilet of contaminated wounds
  - Consider passive immunisation with hyperimmune immunoglobulin

### **Treatment**

- In suspected cases:
  - Passive immunisation with anti-tetanus immunoglobulin
  - Adequate wound debridement
  - Intravenous benzylpenicillin
  - Intensive care support
  - Despite the use of ITU mortality is about 50%

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Hollander J E, Singer A J. Laceration management. *Ann Emerg Med* 1999; 34: 356-367.



## Gas gangrene

- Clostridial spores are widely distributed in the environment
- May enter traumatic or surgical wounds
- Contamination may also occur from patients own faecal flora

### Microbiology

- Gas gangrene results from the following clostridial species:
  - *Clostridium welchii*
  - *Clostridium oedematiens*
  - *Clostridium septicum*
- Microscopy of wound exudate shows gram-positive bacilli
- Rectangular shape without spore formation
- Anaerobic culture on blood agar show haemolytic colonies (*Clostridium welchii*)
- 'Stormy' clot reaction with litmus milk
- *Clostridium welchii* also shows positive Nagler reaction
- Due to lecithinase reaction of alpha exotoxin

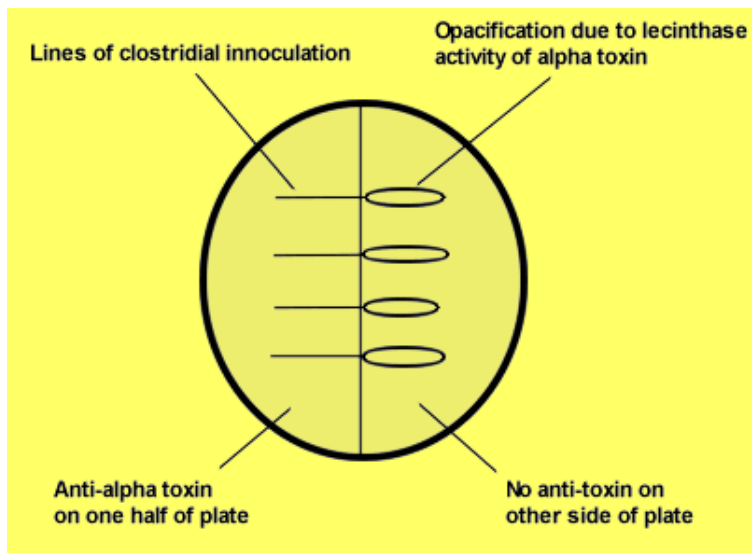


Figure 23 The Nagler reaction

### Clinical features

- Patients are generally toxic and unwell
- Often have features of shock, jaundice, haemolysis or acute renal failure
- Local signs of gas gangrene include:
  - Myositis or myonecrosis
  - Gas formation with palpable crepitus
  - Mottled discolouration of the overlying skin
- Plain X-ray often shows gas in the subcutaneous tissue and fascial plains



### Treatment

- Failure of recognition often results in rapid deterioration
- Patients require adequate resuscitation
- Debridement or amputation should be considered to remove affected tissue or limb
- Organisms are usually sensitive to penicillin
- Hyperbaric oxygen may be helpful

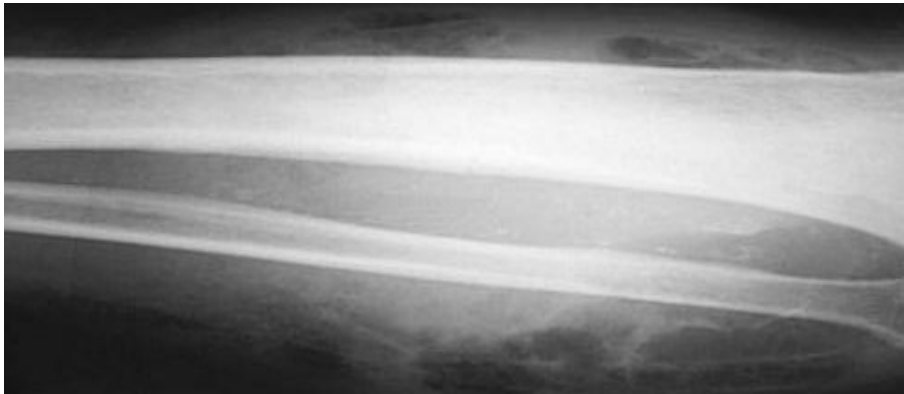


Figure 24 Plain x-ray showing gas in the fascial planes characteristic of gas gangrene

### Prevention

- Benzylpenicillin antibiotic prophylaxis in those with:
  - Contaminated wounds
  - Diabetic undergoing elective peripheral vascular surgery

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### ***Pseudomembranous colitis***

- Pseudomembranous colitis is due infection by *Clostridium difficile*
- A gram-positive anaerobic bacillus
- Not identified until 1953 because it was 'difficult' to culture
- Spores are commonly found in the hospital environment

### **Pathophysiology**

- Normal stool contains >500 different bacteria at a concentration of  $10^{12}$  per gram
- Antibiotic therapy can change the faecal flora
- Broad-spectrum antibiotics are main culprits
- Particular problem with lincomycin and clindomycin - but rarely used
- Allows colonisation by *C. difficile* transmitted by the faecal-oral route
- Exotoxins (Toxin A & B) produced by bacteria are cytotoxic
- Act via cell membrane receptors
- Produces mucosal inflammation and cell damage
- If severe epithelial necrosis a pseudo-membrane is formed
- Consists of mucin, fibrin, leucocytes and cellular debris



Figure 25 Endoscopic appearance of pseudomembranous colitis

### **Clinical features**

- 50% of neonates are transient healthy carriers of *C. difficile*
- Only 1% of adults are also asymptomatic carriers
- 10% patients on antibiotics develop diarrhoea
- Only 1% develop pseudomembranous colitis





- The spectrum of symptomatic disease includes:
  - Mild diarrhoea
  - Colitis without pseudo-membrane formation
  - Pseudomembranous colitis
  - Fulminant colitis
- Diagnosis is confirmed by the detection of toxin in the stool by ELISA

### Treatment

- Asymptomatic carriers require no active treatment
- Those with mild diarrhoea should have their antibiotics stopped
- If colitis present need active treatment with oral antibiotics:
  - Metronidazole - first line therapy
  - Vancomycin - second line therapy
- Symptoms usually improve within 72 hours
- May take 10 days for diarrhoea to stop
- Pseudomembranous colitis requires aggressive resuscitation and treatment
- If fulminant colitis with toxic megacolon or perforation surgery may be necessary
- 10% patients relapse after initial treatment
- Due to either failure of eradication or re-infection

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## **Tuberculosis**

- Tuberculosis is common throughout the world
- Causes significant morbidity and mortality particularly in Africa and Asia
- Over 10,000 cases per year occur in United Kingdom
- Accounts for 1,000 deaths mainly in immigrant Asian population
- Usually due to *Mycobacterium tuberculosis* or *Mycobacterium bovis* infection

### **Primary tuberculosis**

- Usually a respiratory infection that occurs in childhood
- Infection results in sub-pleural Ghon focus and mediastinal lymphadenopathy
- Regarded as the primary complex
- Symptoms are often few
- Resolution of infection usually occurs
- Complications include:
  - Haematogenous spread causing miliary TB affecting lungs, bones, joints, meninges
  - Direct pulmonary spread resulting in TB bronchopneumonia

### **Post-primary tuberculosis**

- Occurs in adolescence or adult life
- Due to reactivation of infection or repeat exposure
- Results in more significant symptoms
- Reactivation may be associated with immunosuppression (e.g. drugs or HIV infection)
- Pulmonary infection accounts for 70% of cases of post-primary TB
- Usually affects apices of upper or lower lobes
- Cavitation of infection into the bronchial tree results in 'open' TB
- Clinical features include cough, haemoptysis, malaise, weight loss and night sweats
- Infection of lymph glands results in discrete, firm and painless lymphadenopathy
- Confluence of infected glands can result in a 'cold' abscess
- Infection of the urinary tract can cause haematuria and 'sterile pyuria'

### **Investigations**

- Large volume specimens should be collected preferably in the early morning
- Repeated samples may be required

### **Microscopy**

- If Mycobacteria infection suspected samples should be submitted to a Ziehl-Neelsen stain
- Mycobacteria appear as red acid-alcohol fast organisms
- Organisms also fluoresce with auramine staining
- Negative microscopy does not exclude tuberculosis
- Need supporting histological examination and microbiological culture

### **Culture**

- Mycobacteria can be difficult to culture
- Need to:
  - Collect adequate and relevant specimens (e.g. early morning urine x3)
  - Concentration of specimen (e.g. centrifugation)
  - Decontamination to remove other organisms (e.g. Petroff method)



- Culture on Lowenstein-Jensen method at 35-37° for at least 6 weeks
- Confirm that any Mycobacteria cultures are pathological

### **Histology**

- Histological examination shows evidence of a delayed hypersensitivity reaction
- Classical appearance is of caseating necrosis
- Tuberculous follicle consists of central caseous necrosis
- Surrounded by lymphocytes, multi-nucleate giant cells and epithelioid macrophages
- Organisms may be identified within the macrophages

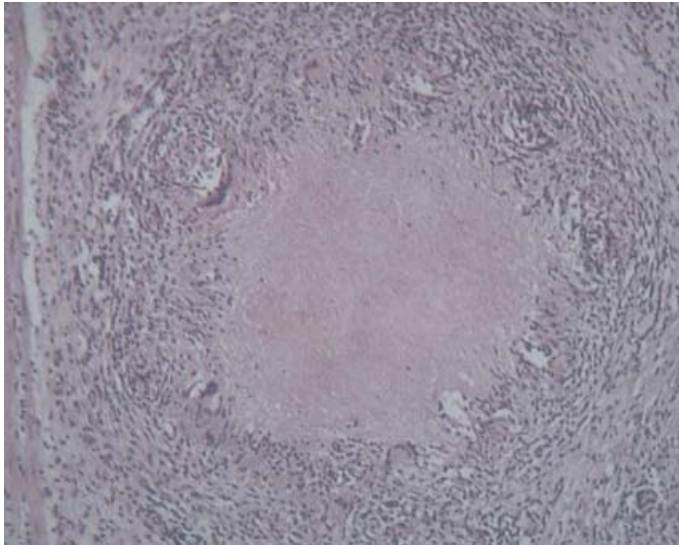


Figure 26 Caseating granuloma due to *Mycobacterium tuberculosis*

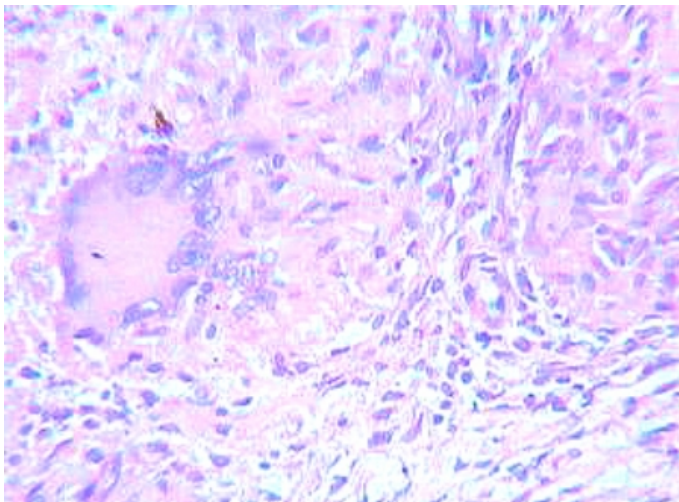


Figure 27 Multinucleated (Langhan's) giant cell

### **Skin tests**

- Delayed hypersensitivity reaction used to diagnose tuberculosis
- The two commonest tests are the Mantoux and Heaf test
- In the Mantoux test 0.1 ml of purified protein derivative is injected intradermally



- Positive reaction is a papule of more than 5 mm diameter at 72 hours
- In the Heaf test purified protein derivative is placed on the skin
- A gun is used to produce multiple punctures
- Positive reaction is more than 4 papules at puncture sites at 72 hours
- Positive skin test are indicative of active infection or previous BCG vaccination

#### **Treatment**

- First line chemotherapeutic agents are rifampicin, isoniazid and ethambutol
- Given as 'triple therapy' for first 2 months until sensitivities available
- Rifampicin and isoniazid are the usually continued for further 7 months
- Less than 5% of organisms are resistant to first-line agents
- Second line treatment includes pyrazinamide

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## **Staphylococcal and streptococcal infections**

### **Staphylococcal infections**

- More than 30 staphylococcal species exist
- All are part of normal skin and mucous membrane flora
- They are either coagulase-positive or negative
- The most important coagulase-positive species is *Staph. aureus*

### **Staph. aureus**

- 30% adults carry *Staph. aureus* in their anterior nares
- Carriers transfer the organism to skin allowing a portal of entry
- The organism has several putative determinant of pathogenicity including:
  - Cell wall constituents
  - Cell surface proteins
  - Toxins (e.g. haemolysins and leukocidins)
  - Enzymes (e.g. coagulase, protease, hyaluronidase)
- The organism is both aerobic and anaerobic on blood agar
- Microscopically it is gram-positive
- Forms clusters on solid media
- There is increasing spread of clones resistant to beta-lactam antibiotics (e.g. MRSA)
  
- Clinically it produces skin and soft tissue infections including
  - Impetigo
  - Folliculitis
  - Cellulitis
- Deeper infections may occur after trauma or surgery
- Metastatic infection may result in
  - Endocarditis
  - Pericarditis
  - Osteomyelitis
  - Lung abscesses
- Treatment is with antistaphylococcal antibiotics (e.g. flucloxacillin)
- In MRSA, vancomycin is the treatment of choice

### **Coagulase-negative staphylococci**

- *Staph. epidermidis* and *Staph. saprophyticus* are the commonest human pathogens
- *Staph. epidermidis* is a common cause of nosocomial bacteraemia
- Often associated with indwelling catheters and prosthetic materials
- Is a common cause of prosthetic valve endocarditis
- Its is often multiply antibiotic resistant
- Treatment may require removal of line or prosthesis

### **Streptococcal infections**

- Streptococci are gram-positive cocci
- More than 30 species have been identified
- On solid media they grow in pairs or chains
- They are catalase negative
- Beta-haemolytic streptococci are classified according to their Lancefield group
- The following are human pathogens
  - *Strep. pyogenes* (group A *Streptococcus*)



- Group C and G streptococci
- *Strep. pneumoniae* (pneumococcus)
- Group B *Streptococcus*
- viridans group streptococci
- *Enterococcus*

### ***Strep. pyogenes***

- Important human pathogen
- Causes various cutaneous and systemic infections including:
  - Streptococcal pharyngitis
  - Scarlet fever
  - Rheumatic fever
  - Post-streptococcal glomerulonephritis
- The bacteria is sensitive to penicillin

### ***Strep. pneumoniae***

- Common bacterial pathogen
- Found in the nasopharynx of 20% of adults
- On a Gram-stain it appears as a diplococcus
- It is alpha-haemolytic on blood agar
- Common cause of localised and systemic infections including
  - Otitis media
  - Sinusitis
  - Meningitis
  - Pneumonia
  - Endocarditis
  - Osteomyelitis
- Infection can be prevented by the pneumococcal vaccine
- Resistance to penicillin is increasing worldwide

### ***Viridans group streptococci***

- The viridans group of streptococci are a diverse group of organisms
- They are respiratory, gastrointestinal and oral cavity commensals
- Infection usually occurs in immunocompromised hosts
- Principal virulence trait is to adhere to cardiac valves and cause endocarditis
- Account for 30 - 40% of cases of endocarditis
- Most occur in patients with valvular heart disease
- Other risk factors include:
  - Prosthetic heart valves
  - Intravenous drug abuse
- Most are viridans streptococcal species are sensitive to penicillin



### ***Enterococcus spp.***

- Enterococci are facultative anaerobes
- They are common commensal of the gastrointestinal tract
- They are significant cause of nosocomial infection including:
  - Urinary tract infections
  - Endocarditis
  - Intra-abdominal infection
  - Risk factors for infection include
  - Severe underlying disease
  - Previous surgery
  - Previous antibiotic therapy
  - Renal failure
  - The presence of vascular or urinary catheters
- Mortality from enterococcal infection is high
- Intrinsically resistant to beta-lactams and aminoglycosides
- They can also acquire resistance to vancomycin
- Management of vancomycin-resistant enterococcus (VRE) is difficult

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### **Methicillin resistant staphylococcus aureus (MRSA)**

- MRSA is a major nosocomial pathogen
- Causes severe morbidity and mortality worldwide
- Endemic in many European and American hospitals
- 40% of nosocomial *Staph. aureus* infections are methicillin resistant
- Many in-patients are colonised or infected
- 25% hospital personnel may be carriers
- Found on inguinal, perineal, or axillary skin and anterior nares
- Spread by hand, usually of health care workers

### **Microbiology**

- *Staph aureus* is a gram-positive coccus
- Forms clusters on culture medium
- Methicillin resistance is mediated by the *mecA* gene
- Encodes a single additional penicillin binding protein PBP2a
- Expression of *mecA* can be either constitutive or inducible

### **Risk factors for MRSA colonisation**

- Advanced age
- Male gender
- Previous hospitalisation
- Length of hospitalisation
- Stay in ICU
- Chronic medical illness
- Prior and prolonged antibiotic therapy
- Presence and size of a wound
- Exposure to colonised or infected patient
- Presence of invasive indwelling device

### **Clinical presentations**

- Pneumonia
- Surgical site infections
- Line sepsis
- Intra-abdominal infections
- Osteomyelitis
- Toxic shock syndrome

### **Infection control**

- Screening of patients and staff
- Hand washing
- Use of gowns and gloves
- Topical antimicrobials
- Isolation of patients
- Environmental cleaning





### Management

- Vancomycin is the antibiotic of choice
- Teicoplanin may be used if the isolate is resistant to vancomycin
- Linezolid is new class of antimicrobial agent
- Active against MRSA and VRE
- Quinupristin / dalfopristin are newer alternative

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## Prevention of infection

### *Principles of asepsis and antisepsis*

#### History

- 1847 - Semmelweis identifies surgeons hands as route of spread of puerperal infection
- 1865 - Lister introduces hand and wound asepsis with the use of carbolic acid
- 1880 - von Bergmann invents the autoclave

#### Definitions

- Asepsis is procedure to reduce the risk of bacterial contamination
- Usually involves
  - The use of sterile instruments
  - The use of a gloved no touch technique
- Antisepsis is the removal of transient microorganisms from the skin and a reduction in the resident flora

#### Preoperative skin preparation

##### *Skin shaving*

- Aesthetic and makes surgery, suture and dressing removal easier
- Wound infection rate lowest when performed immediately prior to surgery
- Infection rate increased from 1% to 5% if performed more than 12 hours prior to surgery
- Abrasions can cause colonisation which can lead to wound infection
- Clippers or depilatory creams reduce infection rates to less than 1%.

##### Skin preparation

###### *70% Isopropyl alcohol*

- Acts by denaturing proteins
- Is bactericidal but short acting
- Effective against gram-positive and gram-negative organisms
- Also fungicidal and virucidal

###### *0.5% Chlorhexidine*

- Quaternary ammonium compound
- Acts by disrupting the bacterial cell wall
- Bactericidal but does not kill spore forming organisms
- It is persistent and has a long duration of action (up to 6 hours)
- More effective against gram-positive organisms

###### *70% Povidone - iodine*

- Acts by oxidation / substitution of free iodine
- Bactericidal and active against spore forming organisms
- Effective against both gram-positive and gram-negative organisms
- Rapidly inactivated by organic material such as blood
- Patient skin sensitivity is occasionally a problem
- No evidence that one is superior to any other



### ***Occlusive adhesive drapes***

- No evidence that they reduce infection rate
- May actually increase skin bacterial count during surgery

### **Bibliography**



## ***Sterilisation and disinfection***

### ***Sterilisation***

- Removal of viable microorganisms including spores and viruses
- Can be achieved by:
  - Autoclaves
  - Hot air ovens
  - Ethylene oxide
  - Low-temperature steam and formaldehyde
  - Sporicidal chemicals
  - Irradiation
  - Gas plasma

### ***Autoclaves***

- Steam under pressure has a higher temperature than 100 °C
- To be effective against viruses and spore forming bacteria need to
- Have steam in direct contact with material
- Vacuum has to be created
- Need to autoclave for 3 min at 134 °C or 15 min at 121 °C
- Check performance by colour changes on indicator tape
- Autoclaves are highly effective and inexpensive
- Unsuitable for heat-sensitive objects

### ***Hot ovens***

- Inefficient compared to autoclaves
- Require temperatures of 160 °C for 2 hours or 180 °C for 30 min

### ***Ethylene oxide***

- Highly-penetrative and active against bacteria, spores and viruses
- Also flammable, toxic and expensive
- Leaves toxic residue on sterilised items
- Instruments therefore need to be stored for prolonged period before use
- Suitable for heat-sensitive items

### ***Sporicidal chemicals***

- Often used as disinfectants but can also sterilise instruments if used for prolonged period
- Inexpensive and suitable for heat-sensitive items
- Toxic and irritants
- 2% Gluteraldehyde is most widely used liquid sporicidal chemical
- Most bacteria and viruses killed within 10 minutes
- Spores can survive several hours

### ***Irradiation***

- Gamma rays and accelerated electrons are excellent at sterilisation
- Used as an industrial rather than hospital based method



## Disinfection

- Disinfection is a reduction in the number of viable organisms
- Can be achieved by:
  - Low-temperature steam
  - Boiling water
  - Chemical disinfectants

### *Low-temperature steam*

- Most bacteria and viruses are killed by exposure to moist heat
- Usually achieved with dry saturated steam at 73 °C for greater than 10 minutes
- Effective and reliable and suitable for instrument with a lumen
- Unsuitable for heat-sensitive items

### *Chemical disinfectants*

- Destroys microorganisms by chemical or physicochemical means
- Different organisms vary in their sensitivity
  - Gram-positive - highly sensitive
  - Gram-negative - relatively resistant
  - Clostridial and mycobacterial species - very resistant
  - Slow viruses - highly resistant
- Disinfectants are suitable for heat-sensitive items
- Less effective than heat
- Chemicals used include:
  - Clear soluble phenolics
  - Hypochlorites
  - Alcohols
  - Quaternary ammonium compounds

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## Surgery in hepatitis and HIV carriers

### Hepatitis B

- The Hepatitis B virus is a single stranded DNA virus
- Consists of 42 nm Dane particle (Hb<sub>s</sub>Ag) and 22 nm core (Hb<sub>c</sub>Ag)
  - HbsAg - Hepatitis B surface antigen = Australia antigen
  - HbcAg - Hepatitis B core antigen
  - HbsAb - Hepatitis B surface antibody
  - HbeAg - Hepatitis B 'e' antigen
- In UK prevalence of Hb<sub>s</sub>Ag positivity is 1-2%
- Seen particularly in drug addicts, homosexuals, dialysis patients and occasionally medical staff
- In Asia, Middle East and South America prevalence between 20-30%
- Transmitted by vertical transmission, inoculation, oral and sexual contact
- Incubation period between 6 weeks and 6 months
- Period of infectivity is from 6 weeks before onset of symptoms and possibly indefinitely after
- 10% of infected patients become chronic carriers
- Risk of chronic infection varies with age at which infection is acquired
  - Less than one year = 90%
  - 1-5 years = 30%
  - Greater than 5 years and adult = 2%

### Clinical pictures

- Acute hepatitis with clinical recovery
- Acute fulminating hepatitis leading to death
- Chronic active hepatitis with risk of cirrhosis and hepatocellular carcinoma

### Serological results

#### Hb<sub>s</sub>Ag positive

- The first indicator of infection and seen throughout course of disease
- Persistence is marker of failure to clear infection

#### Hb<sub>s</sub>Ab positive

- Marker of protection due to either previous infection or immunisation

#### Hb<sub>e</sub>Ag positive

- Closely associated with infectivity of patient

### Treatment

- Two modes of treatment
  - Immunomodulation = interferon
  - Viral suppression = nucleoside analogues

### Prevention of infection

- Avoid contact with virus
- Care with needles, body fluids etc
- After needle stick injury from high risk patient
- Hyperimmune anti-Hepatitis B IgG



- Ideally given with 24 - 48 hours after exposure
- Repeated at one month

#### **Immunisation**

- All paramedical staff should be immunised
- Energix B<sup>®</sup> given and repeated at one and 6 months
- Hb<sub>s</sub>Ab levels >1000 u/l = adequate response
- Confers protection for up to 5 years

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## **HIV infection**

- Acquired immunodeficiency syndrome (AIDS) was first recognised in the USA in the 1970s
- Human immunodeficiency virus (HIV) was isolated in 1983
- In 1984 a serological test for antibodies to the virus became available
- In 1996 WHO estimated worldwide that there were:
  - 3.1 million new cases of HIV infections
  - 29 million people were infected with HIV
- In UK to date 58,000 have been HIV positive and 18,000 have developed AIDS
- 30-50% of HIV positive patients are unaware of their infection
- HIV is a treatable disease
- Where therapy is available infected individuals have the same rate of death as age-matched uninfected controls

## **Immunology**

- HIV is a double-stranded RNA retrovirus
- Attaches to human immune cells through the CD4 molecule
- It produces DNA by the use of the enzyme reverse transcriptase
- DNA is incorporated into host cells
- The incorporated viral DNA produces new viral components which are spliced and assembled using a viral protease
- HIV infection results in widespread immunological dysfunction
- It results in a fall in CD4 lymphocytes, monocytes and antigen-presenting cells
- Immunological dysfunction results in opportunistic infections and increases risk of malignancy
- The virus is transmitted in bodily fluids by:
  - Heterosexual intercourse - Africa and Asia
  - Homosexual intercourse - UK and North America
  - Blood transfusions
  - Intravenous drug abuse
  - Perinatal transmission

## **Natural history**

- Up to three months there is often an asymptomatic viraemia
- Patients are infective during this period
- ELISA test for HIV antibodies are negative
- At seroconversion an acute seroconversion illness (ASI) can occur
- May be followed by persistent generalised lymphadenopathy (PGL)
- Progression to symptomatic disease occurs within several years
- AIDS develops within 5 to 10 years
- AIDS diagnosed by the presence of an AIDS indicator disease with a positive HIV test
- Median survival with AIDS is 2 years
- 5% of HIV positive patients have remained well without therapy for more than 20 years

## **AIDS indicator diseases**

- Multiple recurrent bacterial infections
- Tracheal or bronchial candidiasis
- Invasive cervical carcinoma
- Extrapulmonary or disseminated coccidioidomycosis





- Cryptosporidiosis
- Cytomegalovirus retinitis
- HIV encephalopathy
- Disseminated or extrapulmonary histoplasmosis
- Kaposi's sarcoma
- Lymphoma
- Disseminated mycobacteriosis
- *Pneumocystis carinii* pneumonia
- Progressive multifocal leukoencephalopathy
- Cerebral toxoplasmosis

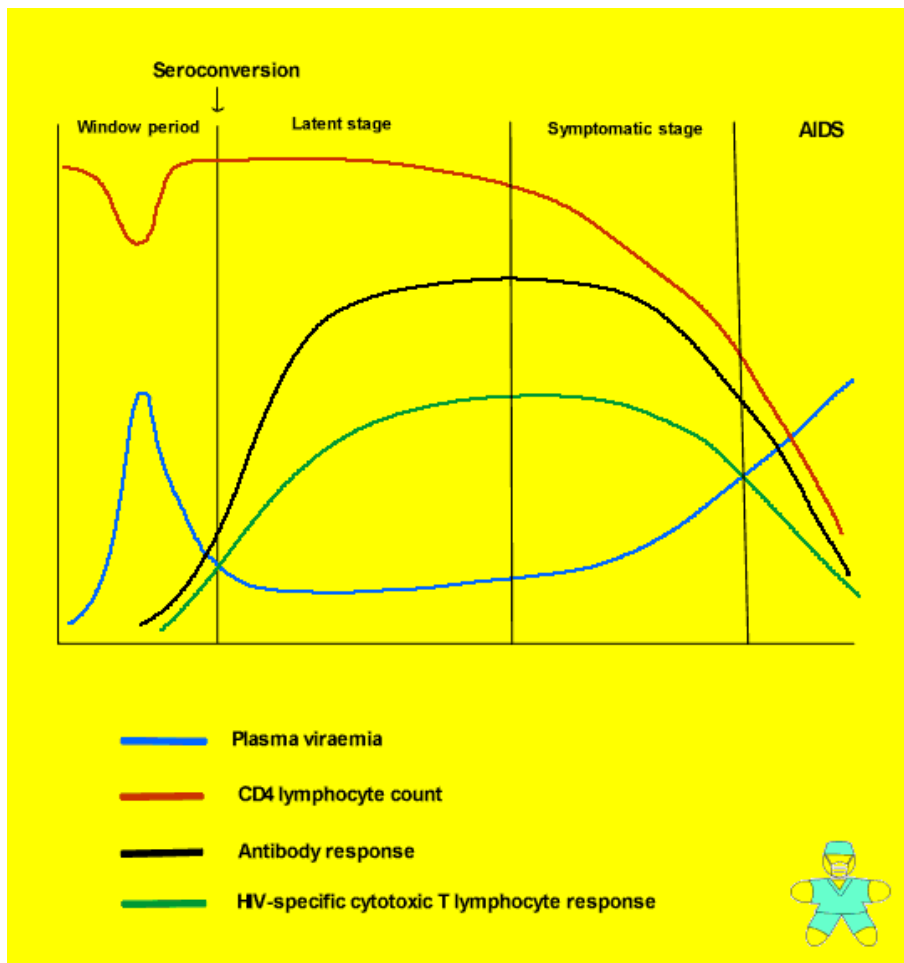


Figure 28 Virological and serological response to HIV infection

#### Sites of pyogenic infections in AIDS

- Thoracic empyema
- Anorectal abscesses
- Skin boils, carbuncles and cellulitis
- Necrotising fasciitis
- Pyomyositis
- Osteomyelitis
- Septic arthritis
- Epididymo-orchitis



- Pelvic inflammatory disease
- Appendicitis

#### **Treatment**

- HIV therapies are available that:
  - Prevent virus entry into cells
  - Inhibit viral reverse transcriptase
  - Inhibit viral protease
- Combination therapy with anti-HIV drugs:
  - Inhibits viral replication
  - Reduces viraemia to undetectable levels
  - Leads to reconstitution of immune dysfunction
  - Prevents opportunistic disease

Stopping therapy leads to re-emergence of viraemia

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## Emergency medicine and the management of trauma

### Pathophysiology of trauma

#### *Metabolic response to injury*

- Similar responses seen to trauma, burns, sepsis and surgery
- Involves both local and systemic reactions
- Extent of response proportional to severity of insult
- An appropriate response maintains homeostasis and allows wound healing
- An excessive response can produce a systemic response
- This can cause the systemic inflammatory response syndrome (SIRS)
- Multiple organs dysfunction syndrome (MODS) can result from SIRS

#### Initiation of response

- Several factors can initiate the physiological response to trauma
- Multiple simultaneous factors can have a synergistic effect
- Important factors are:
  - Tissue injury
  - Infection
  - Hypovolaemia
  - Hypoxia or hypercarbia

#### Control of response

- Four systems control the response to trauma
  - Sympathetic nervous system
  - Acute phase response
  - Endocrine response
  - Vascular endothelium

#### *Sympathetic nervous system*

- Has direct actions via the release of noradrenaline from sympathetic nerves
- Has indirect action via the release of adrenaline from the adrenal medulla
- Produces cardiovascular, visceral and metabolic actions
- Blood diverted from skin and visceral organs
- Heart rate and myocardial contractility are increased
- Bronchodilation occurs and gastrointestinal motility is reduced
- Insulin production is reduced and glucagons production increased
- Increased glycogenolysis increases blood sugar levels

#### *Acute phase response*

- Tissue injury results in cytokine release
- Important cytokines include:
  - TNF- $\alpha$
  - IL-1, IL-2, IL-6
  - Interferon
  - Prostaglandins
- Cytokines have mainly paracrine actions



- Important in regulating the inflammatory response
- Overflow of cytokines into systemic circulation is important factor in SIRS
- Cytokines stimulate the production of acute phase proteins such as:
  - C-reactive protein
  - Fibrinogen
  - Complement C3
  - Haptoglobin

#### **Endocrine response**

- The hypothalamus, pituitary, adrenal axis is important
- Trauma increases ACTH and cortisol production
- Steroids have a permissive action in many metabolic responses
- Catabolic action increases protein breakdown
- Insulin antagonism increases blood sugar levels
- Anti-inflammatory actions reduce vascular permeability
- Aldosterone increases sodium reabsorption
- Vasopressin increases water reabsorption and produces vasoconstriction
- Histamine increases vascular permeability
- Total T4, total and free T3 levels are reduced

#### **Vascular endothelium**

- Nitric oxide produces vasodilatation
- Platelet activating factor augments the cytokine response
- Prostaglandins produce vasodilatation and induce platelet aggregation

#### **Outcome or response**

- Inflammatory response produces clinically apparent local and systemic effects
- The local response is usually the cardinal signs of inflammation
- The systemic response includes:
  - Increased ECF volume and hypovolaemia
  - Increased vascular permeability and oedema
  - Early reduced urine output and increased urine osmolality
  - Reduced 'free' water clearance
  - Late diuresis and increased sodium loss
  - Pyrexia in the absence of infection
  - Early reduction in metabolic rate
  - Late increased metabolism, negative nitrogen balance and weight loss
  - Lipolysis and ketosis
  - Gluconeogenesis via amino acid breakdown
  - Reduced serum albumin
  - Hyponatraemia due to impaired sodium pump action
  - Acid-base disturbance – usually a metabolic alkalosis or acidosis
  - Immunosuppression
  - Hypoxia and coagulopathy

#### **Limitation of response**

- Inflammatory response can be limited by:
  - Reducing degree of trauma with appropriate and careful surgery
  - Reducing infection with wound care and antibiotics
  - Maintaining enteral nutrition
  - Controlling pain
  - Correcting hypovolaemia



- Correcting acid-base disturbance
- Correcting hypoxia

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## Initial assessment of the trauma patient

### *Prehospital trauma care*

#### Epidemiology of trauma

- Trauma is the commonest cause of death in young adults
- Road traffic accidents each year in UK result in:
  - 320,000 injuries
  - 40,000 serious injuries
  - 3,400 death
- Up to 30% of prehospital deaths may be preventable
- Prehospital care is important and is the start of the 'trauma chain'
- Philosophy of prehospital care varies between countries
- In USA basic resuscitation is performed at the scene
- This has been described as 'scoop and run'
- In France, mobile intensive care units often attend the scene of an accident
- This has been described as 'stay and play'

#### Initial action

- Potential problems at scene of accident
  - Hostility of environment
  - Lack of familiarity with surroundings
  - Intrusive onlookers
- Assess safety of yourself and any casualties
- Make the accident site as safe as possible before assessing any casualties
- Determine the nature of accident and likely mechanism of injuries
- At road traffic accidents
  - Determine number, direction and types of vehicles involved
  - Degree of intrusion of damages vehicles
  - Whether occupants were wearing seatbelts



Figure 29 Accident scene



### Indications of potential significant trauma

- Penetrating injury to chest and abdomen
- Two or more proximal long bone fractures
- Burns involving more than 15% of body surface area
- Burns to face and airway
- Evidence of high-energy impact
  - Fall more than 6m
  - Crash speed greater than 20 mph
  - Inward deformity of car of more than 0.6 m
  - Rearward displacement of front axle
  - Ejection of passenger from vehicle
  - Rollover of vehicle
  - Death of another car occupant
  - Pedestrian hit at great than 20 mph
  - Abnormal physiological variables

### Prehospital resuscitation

- Should follow same principles as that in hospital
- Will need to be adapted to circumstances
- Airway management can be difficult
- Can often be maintained with basic measures
- Intubation without anaesthesia and rapid sequence induction is ill advised
- Can induce vomiting and raised intracranial pressure
- The cervical spine should be immobilized with a hard collar
- Oxygen should be given
- Haemorrhage should be controlled with direct pressure
- If casualty is entrapped ensure good venous access before releasing from vehicle
- Fluid resuscitation should be give to a systolic blood pressure of 90 mmHg
- If venous access difficult consider 'scoop and run' rather than delay transfer
- Analgesia can be achieved with Entonox or ketamine
- Entonox is contraindicated if possibility of:
  - Pneumothorax
  - Basal skull fracture
- Extrication requires close co-ordination between medical and fire services
- Casualty should be 'packaged for transport'
- This will require hard collar, head blocks, limb splints, scoop stretcher or vacuum mattress



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### Major incident triage

- If faced with large number of casualties need to prioritise management
- Aim is to 'do the most for the most'
- Triage is the sorting of casualties by priority of treatment
- Performed by a 'Triage officer' who assesses casualties without giving treatment
- Divides patients into categories
- Casualties may be given coloured triage label

Table 23 Triage categories

	Definition	Colour	Treatment	Example
P1	Life-threatening	Red	Immediate	Tension pneumothorax
P2	Urgent	Yellow	Urgent	Fractured femur
P3	Minor	Green	Delayed	Sprained ankle
P4	Dead	White		

### Method of triage

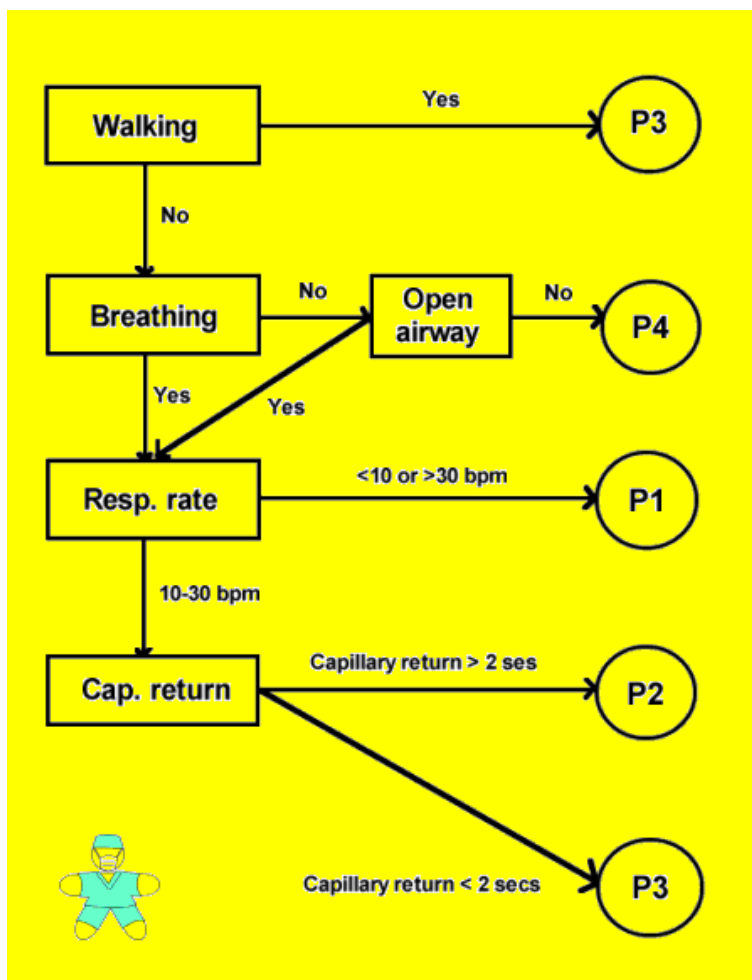


Figure 30 Triage methods



- Triage can be performed rapidly by assessing:
  - Ability to walk
  - Airway
  - Respiratory rate
  - Pulse rate or capillary return

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## ***Clinical assessment and resuscitation***

- Trauma deaths have a trimodal distribution

### ***First peak***

- Within minutes of injury
- Due to major neurological or vascular injury
- Medical treatment can rarely improve outcome

### ***Second peak***

- Occurs during the 'golden hour'
- Due to intracranial haematoma, major thoracic or abdominal injury
- Primary focus of intervention for the Advanced Trauma Life Support (ATLS) methodology

### ***Third peak***

- Occurs after days or weeks
- Due to sepsis and multiple organ failure

## **ATLS Methodology**

- Primary survey and resuscitation
  - A = Airway and cervical spine
  - B = Breathing
  - C = Circulation and haemorrhage control
  - D = Dysfunction of the central nervous system
  - E = Exposure
- Secondary survey
- Definitive treatment

## **Primary survey and resuscitation**

### ***Airway and cervical spine***

- Always assume that patient has cervical spine injury
- Place in hard collar and keep on until cervical spine has been 'cleared'
- If patient can talk then he is able to maintain own airway
- If airway compromised initially attempt a chin lift and clear airway of foreign bodies
- If gag reflex present insert nasopharyngeal airway
- If no gag reflex patient will need endotracheal intubation
- If unable to intubate will require a cricothyroidotomy
- Give 100% oxygen through a Hudson mask

### ***Breathing***

- Check position of trachea, respiratory rate and air entry
- If clinical evidence of tension pneumothorax place venous cannula through second intercostal space in the mid-clavicular line
- If open chest wound seal with occlusive dressing

### ***Circulation and haemorrhage control***

- Assess pulse, capillary return and state of neck veins
- Identify exsanguinating haemorrhage and apply direct pressure
- Place two large calibre intravenous cannulas



- Take venous blood for FBC, U+E, and Cross match
- Take sample for arterial blood gasses
- Give intravenous fluids ? crystalloid ? colloid
- Attach patient to ECG monitor
- Insert urinary catheter

#### **Dysfunction**

- Assess level of consciousness using AVPU method
  - A = alert
  - V = responding to voice
  - P = responding to pain
  - U = unresponsive
- Assess pupil size, equality and responsiveness

#### **Exposure**

- Fully undress patients
- Avoid hypothermia

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### ***Airway and ventilation***

- The airway should be secured as the initial action in trauma resuscitation
- A cervical spine injury should be assumed until proven otherwise
- Oxygen should be delivered at high concentration
- Hypercarbia should be prevented

### ***Airway assessment***

- The patient should be asked a simple question
- If he responds appropriately
  - The airway is patent
  - Ventilation is intact
  - The brain is being adequately perfused
- Agitation is often a sign of hypoxia

### ***Airway management***

- The aims of airway management are:
  - To secure an intact airway
  - To protect a jeopardised airway
  - To provide an airway when none is available
- These can be achieved with basic, advanced and surgical techniques

### ***Basic life support***

- Foreign bodies should be removed from the mouth and oropharynx
- Secretions and blood should be removed with suction
- Airway can usually be secured with a chin lift or jaw thrust
- An oropharyngeal or nasopharyngeal airway may be required
- Oxygen should be delivered at a rate of 10-12 l/min
- Should be administered via a tight fitting mask with reservoir (e.g. Hudson mask)
- An  $F_iO_2$  of 85% should be achievable

### ***Advanced measures***

- If absent gag reflex, endotracheal intubation is required
- If no cervical spine fracture orotracheal intubation is preferred
- If cervical spine injury can not be excluded consider nasotracheal intubation
- The position of the tube should be checked
- Complications include:
  - Oesophageal intubation
  - Intubation of right main bronchus
  - Failure of intubation
  - Aspiration

### ***Surgical airways***

- If unable to intubate the trachea a surgical airway is required
- There are few indications for an emergency tracheostomy
- Surgical airway can be achieved with a needle or surgical cricothyroidotomy

### ***Needle cricothyroidotomy***

- Cricothyroid membrane is punctured with a 12 or 14 Fr cannula
- Connected to oxygen supply via a Y connector
- Oxygen supplied at a rate of 15 l/min



- Jet insufflation achieved by occlusion of Y connection
- Insufflation provided one second on and four seconds off
- Jet insufflation can result in significant hypercarbia
- Should only be used for 30 - 40 minutes

#### ***Surgical cricothyroidotomy***

- Small incision made over cricothyroid membrane
- 5 mm incision made in membrane
- Small tracheostomy tube inserted
- Complications of surgical airways include:
  - Aspiration
  - Haemorrhage / haematoma
  - Cellulitis
  - False passage
  - Subglottic stenosis
  - Mediastinal emphysema

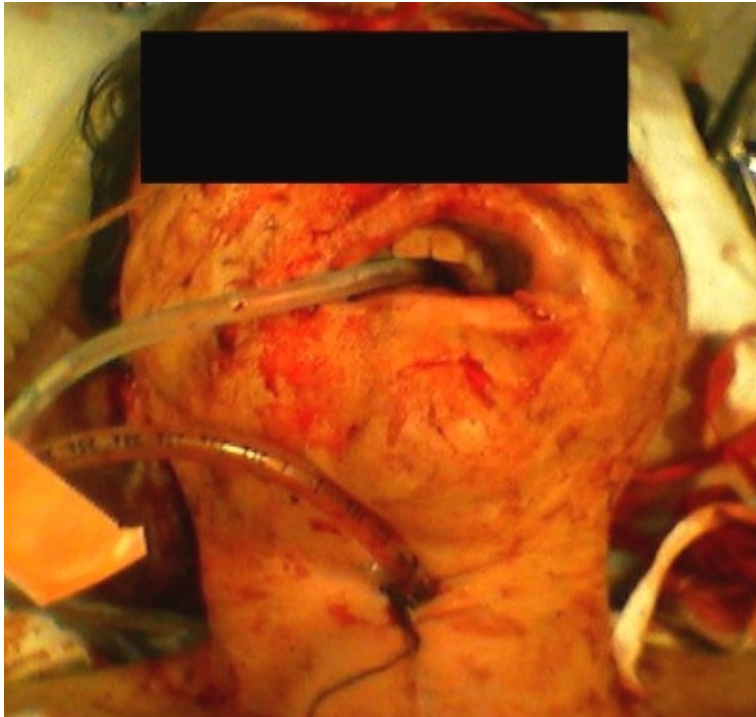


Figure 31 Surgical crichthyroidotomy



### Ventilation

- In the non-intubated patient ventilation can be achieved with either:
  - Mouth to face-mask
  - Bag-valve-face-mask
- The later is more efficient if performed with a two person technique
- One maintains face seal - other ventilates patient
- If endotracheal intubation required
- Should be performed with cricoid pressure
- If rib fractures present need to insert chest drain on side of injury to prevent pneumothorax

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## ***Hypovolaemic shock***

### **Grades of hypovolaemic shock**

#### ***Grade 1***

- 15% blood volume (~750 ml)
- Produces a mild resting tachycardia

#### ***Grade 2***

- 15 - 30% blood volume (750 - 1500 ml)
- Produces moderate tachycardia, fall in pulse pressure, delayed capillary return

#### ***Grade 3***

- 30 - 40% blood volume (1500 - 2000 ml)
- Causes hypotension, tachycardia, low urine output

#### ***Grade 4***

- 40-50% blood volume (2000 -2500 ml)
- As above but with profound hypotension

### **Fluid resuscitation**

- Early volume intravascular volume replacement in trauma patients is essential
- The ideal resuscitation fluid is uncertain
- Timing and end-points of resuscitation unclear

#### ***Packed red blood cells***

- Provide best volume expansion and oxygen carrying capacity
- Needs cross-matching and not immediately available
- Dilutional coagulopathy occurs with massive transfusion

#### ***Crystalloid versus colloid resuscitation***

- More than 40 randomised controlled trials of crystalloid vs. colloid resuscitation published
- None has shown either type of fluid to be associated with a reduction in mortality
- No single type of colloid has been shown to be superior
- Albumin solution may be associated with slight increase in mortality
- Colloids can more rapidly correct hypovolaemia
- Also maintain intravascular oncotic pressure
- Crystalloids require large volume but are equally effective
- Cheaper and have fewer adverse side effects

#### ***Hypertonic solutions***

- Subjected to recent intensive investigation
- Can resuscitate patient rapidly with a reduced volume of fluid
- May reduce cerebral oedema in patients with severe head injuries

#### ***Oxygen therapeutic agents***

- Currently being extensively investigated in clinical trials
- Not widely used at present outside of clinical trials





- Potential advantages over blood include:
- Free potential viral contamination
- Longer shelf life
- Universal ABO compatibility
- Similar oxygen carrying capacity to blood
- Agents being studied include:
  - Perfluorocarbons
  - Human haemoglobin solutions
  - Polymerised bovine haemoglobin

### **Intraosseous infusion**

- Venous access can be difficult in the hypovolaemic child
- If difficulty experienced then intraosseous route can be used as an alternative
- Medullary canal in a child has a good blood supply
- Drugs and fluids are absorbed into venous sinusoids of red marrow
- Red marrow replaced by yellow marrow after 5 years of age
- Less effective in older children
- Systemic drug levels are similar to those achieved via the intravenous route
- Technique is generally safe with few complications

### **Indications**

- Major trauma
- Extensive burns
- Cardiopulmonary arrest
- Septic shock

### **Contraindications**

- Ipsilateral lower limb fracture
- Vascular injury

### **Technique**

- Intraosseous access achieved with specially designed needles
- Short shaft allows accurate placement within the medullary canal
- Handle allows controlled pressure during introduction
- Usually inserted into antero-medial border of tibia, 3 cm below tibial tubercle
- Correct placement checked by aspiration of bone marrow
- Both fluids and drugs can be administered
- Fluid often needs to be administered under pressure
- Once venous access achieved intraosseous needle can be removed

### **Complications**

- Complications are rare
- Needles are incorrectly placed or displaced in about 10% patients
- Complications include:
  - Tibial fracture
  - Compartment syndrome
  - Fat embolism
  - Skin necrosis
  - Osteomyelitis



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## Shock

- Shock = Acute circulatory failure with inadequate or inappropriately distributed tissue perfusion resulting in generalised cellular hypoxia

### Cardiogenic shock

- Pump failure often due to myocardial infarction

### Obstructive shock

- Mechanical impedance to ventricular outflow - pulmonary embolus, cardiac tamponade

### Hypovolaemic shock

- Loss of circulating blood volume - blood loss, burns, pancreatitis etc.

### Distributive shock

- Abnormalities of peripheral circulation - sepsis or anaphylaxis

### Acute blood loss

- Haemoglobin and PCV remain normal for first 3-4 hours
- Plasma volume then expands and Hb and PCV fall
- Associated with increase in neutrophils and platelets
- Reticulocyte count increases on day 2 or 3
- Reaches maximum of 10-15% by day 8 to 10
- Without treatment haemoglobin begins to rise by day 7

Table 24 Properties of commonly used inotropic and vasopressor agents

	$\beta_1$	$\beta_2$	$\alpha_1$	$\alpha_2$	DA <sub>1</sub>	DA <sub>2</sub>
Adrenaline						
Low dose	+	+	+	+	NA	NA
High dose	+++	+++	++++	+++	NA	NA
Noradrenaline	++	0	+++	+++	NA	NA
Isoprenaline	+++	+++	0	0	NA	NA
Dopamine						
Low dose	+	0	+	+	++	+
High dose	+++	++	++	+	+++	+
Dopexamine	+	+++	0	0	++	+
Dobutamine	++	+	+	?	0	0

### Cardiovascular support

- Need to achieve adequate cardiac output and tissue perfusion
- Aim for a mean arterial pressure of at least 80 mmHg
- For this to be achieved it requires:
  - Preload optimisation with volume replacement
  - Inotropic support
- Some patients require inotropes and vasopressors
- Others require inodilators to redistribute blood flow
- Choice of inotrope depends on actions on relative actions on sympathetic nervous system



## **Inotropic support of shock states**

### ***Cardiogenic shock***

- Patients have low cardiac output with high filling pressure and vascular resistance
- Dobutamine is an inotrope that reduces vascular resistance
- Inodilators such as dopexamine are also useful
- Pure vasodilators such as nitrates or nitroprusside may also be useful

### ***Obstructive shock***

- Inotropes may be useful to support myocardium until definitive treatment available

### ***High output states***

- In severe cases vasodilatation is resistant to vasoconstrictors
- Perfusion pressure can be restored with noradrenaline
- Dobutamine can be added to increase cardiac output
- Adrenaline aggravates splanchnic ischaemia

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### **Cardiac arrest and resuscitation**

- Heart rhythms associated with cardiac arrest can be divided into two groups
  - Ventricular fibrillation (VF) and ventricular tachycardia (VT)
  - Other rhythms including asystole and electromechanical dissociation (EMD)
- Principal difference in management is attempted defibrillation in VF and VT
- Subsequent action includes:
  - Chest compression
  - Airway management
  - Ventilation
  - Venous access
  - Administration of adrenaline
  - Correction of contributing factors

### **Ventricular fibrillation**

- Commonest rhythm seen at cardiac arrest
- Requires prompt defibrillation
- Chance of success decreases by 10% for each minute of persisting VF
- If arrest witnessed, single precordial thump may be useful
- Three shocks should be given as follows:
  - 200 J
  - 200 J
  - 360 J
- Can be repeated after one minute of CPR
- Chest compression should be initiated
- Airway and ventilation should be secured
- Amiodarone can be considered in refractory VF or VT
- Lignocaine is an alternative to amiodarone
- Consider 50 mmol bicarbonate if pH fall below 7.1



Figure 32 Ventricular fibrillation



Figure 33 Ventricular tachycardia



### Asystole

- Its is essential that a correct diagnosis is made and VF is not missed
- Asystole can be confirmed by:
  - Checking absence of a pulse
  - Checking leads are correctly attached
  - Checking the gain on the monitor
  - Viewing the rhythm in different leads
- Chest compression should be initiated for 3 minutes
- Airway should be secured
- Venous access should be obtained
- Adrenaline 1 mg iv or 2-3 mg via the endotracheal tube should be given
- Atropine 3 mg iv or 6 mg via endotracheal tube should be administered
- If rhythm changes to VF then treat as VF and shock

### Resuscitation Council (UK) Guidelines and Algorithms (2005)

- Resuscitation Council Guidelines have recently been updated
- Both the Guidelines and Algorithms can be downloaded from the Resuscitation Council website ([www.resus.org.uk](http://www.resus.org.uk))

### Guidelines

- Introduction
- Adult Basic Life Support
- Automated external defibrillators
- In-hospital resuscitation
- Adult Advanced Life Support
- Paediatric Basic Life Support
- Paediatric Advanced Life Support

### Algorithms

- Adult Basic Life Support
- Automated external defibrillator
- In-hospital resuscitation
- Adult Advanced Life Support
- Bradycardia algorithm
- Tachycardia algorithm
- Paediatric Basic Life Support
- Paediatric Advanced Life Support

### Correctable causes of cardiac arrest

- Hypoxia
- Hypovolaemia
- Hypothermia
- Hyperkalaemia
  
- Tension pneumothorax
- Tamponade
- Toxic therapeutic disorders
- Thromboembolic events



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## Trauma scoring systems

- To evaluate trauma management and outcome one needs to assess

### Input

- Anatomical scoring systems
- Abbreviated injury score
- Injury severity score
- Physiological scoring systems
- Glasgow coma scale
- Trauma score
- Revised trauma score
- TRISS methodology

### Treatment

- Individual patient
- System of patient care

### Outcome

- Morbidity
- Mortality

### Injury severity score

- Used to assess patients involved in traffic accidents
- Makes use of the Abbreviated Injury Scale (AIS)
- Its value correlates with the risk of mortality
- Patients with immediately or rapidly fatal injuries are excluded.
- Injuries are assigned to five body regions
- General, head & neck, chest, abdominal, extremities & pelvis
- Each type of injury encountered is assigned a value from 1 to 5, with:
  - 1 = minor injury
  - 2 = moderate injury
  - 3 = severe but not life-threatening injury
  - 4 = life-threatening but survival likely
  - 5 = critical with uncertain survival

Table 25 Examples of AIS scores

System	Severity	Example
General	1	1 <sup>st</sup> degree burns
General	3	50% 3 <sup>rd</sup> degree burns
Chest	3	Haemothorax
Chest	4	Pericardial injury
Abdomen	5	Ruptured liver

- Highest score, indicating the most severe injury, for each region is selected.
- Ranked from the highest to lowest value.
- Three highest values are then used to calculate the injury severity score.





Injury severity score =  
= (highest region score)<sup>2</sup> +  
(second highest region score)<sup>2</sup> +  
(third highest region score)<sup>2</sup>

- Minimum score: 0 Maximum score: 75
- Mortality rate increases with score and age

Table 26 Mortality (%) according to ISS and age

	mortality (%) <49	mortality (%) 50-69	mortality (%) >70
5	0	3	13
10	2	4	15
15	3	5	16
20	6	16	31
25	9	26	44
30	21	42	65
35	31	56	82
40	47	62	92
45	61	67	100
50	75	83	100
55	89	100	100

#### Revised trauma score

- Used to rapidly assess patients at the scene of an accident.

Table 27 Revised trauma score

	Finding	Points
Respiratory rate	10-29 per minute	4
	> 29 per minute	3
	6-9 per minute	2
	1-5 per minute	1
	0	0
Systolic blood pressure	>89 mm Hg	4
	76-89 mm Hg	3
	50-75 mm Hg	2
	1-49 mm Hg	1
	0	0
Glasgow Coma Score	13-15	4
	9-12	3
	6-8	2
	4-5	1
	3	0

Revised trauma score =  
(points for respiratory rate) +  
(points for systolic blood pressure) +  
(points for Glasgow coma score)



- Maximum score (indicating least affected) = 12
- Minimum score (indicating most affected) = 0

#### **TRISS methodology**

- Trauma and Injury Severity Score (TRISS) was designed to evaluate trauma care
- Calculates expected survival based on patient characteristics.
- Intended to be used to compare outcomes from different treatment centers.

#### **Components**

- Weighted Revised Trauma Score (RTS)
- Injury Severity Score (ISS)
- Score for patient's age
- Coefficients based on blunt versus penetrating trauma

#### **Limitations**

- Some researchers have found problems with the accuracy of the TRISS method.
- May be necessary to develop different coefficients for different populations of patients

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## Traumatic wounds

### *Gunshot and blast wounds*

- Gunshot and blast wounds are increasingly seen in civilian practice
- Military and civilian wounds however differ in several key respects
- Military wounds are often heavily contaminated with delays in treatment
- The same principals apply to their treatment

### **Physical properties**

- Penetrating missiles include both munition fragments and bullets
- Often divided into 'high' and 'low' velocity
- Velocity *per se* is not important
- The amount of kinetic energy transferred to tissues is they key factor
- Kinetic energy transfer depends on:
  - Velocity
  - Presenting area of fragment
  - Mechanical properties of tissue

### *Fragment injuries*

- Fragments are usually small and numerous
- Are of low velocity (100 - 500 m/s) and low energy (10-100 J)
- They have poor tissue penetration
- Injuries often numerous but are usually limited to fragment track

### *Bullet wounds*

- Hand gun bullets are of low velocity (<250 m/s) and low energy (200-300 J)
- Rifle bullets are high velocity (750-1000 m/s) and high energy (2-3 kJ)
- Physiological effects depend on degree of energy transfer
- High velocity bullets can result in low energy transfer wounds

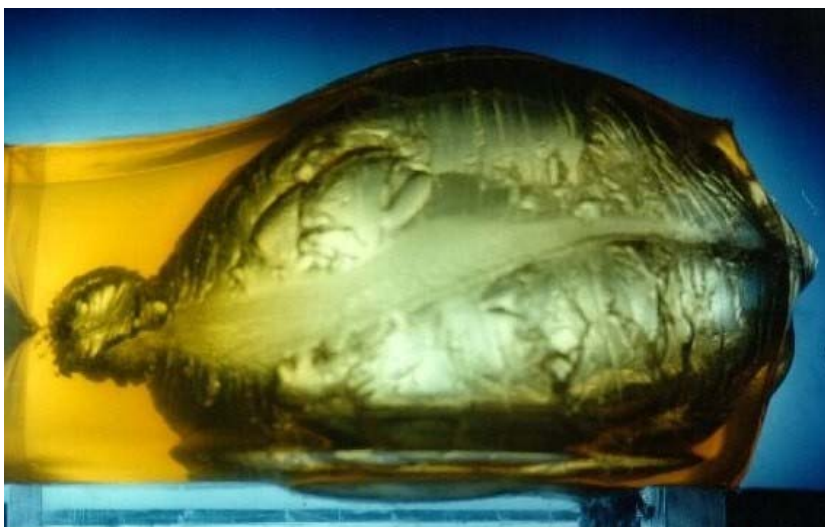


Figure 34 Effect of a high-velocity bullet passing through a gel block



### Pathophysiology

- The effects of bullets can result from both direct and indirect effects
- In low energy transfer wounds injury results from direct effects along bullet track
- In high energy transfer wounds indirect effects are more important
- Radial forces perpendicular to tract result in cavitation
- Generates contusions and lacerations away from tract
- Negative pressure within cavity can suck in environmental contaminants
- Rifle bullets also tumble (yaw) within the wound
- Increases presenting area and increases energy transfer
- Can result in small entry and exit wounds but large wound cavity
- Radial energy transfer can cause indirect fractures
- Bullet and bone fragmentation can cause secondary tracts and further unpredictable damage

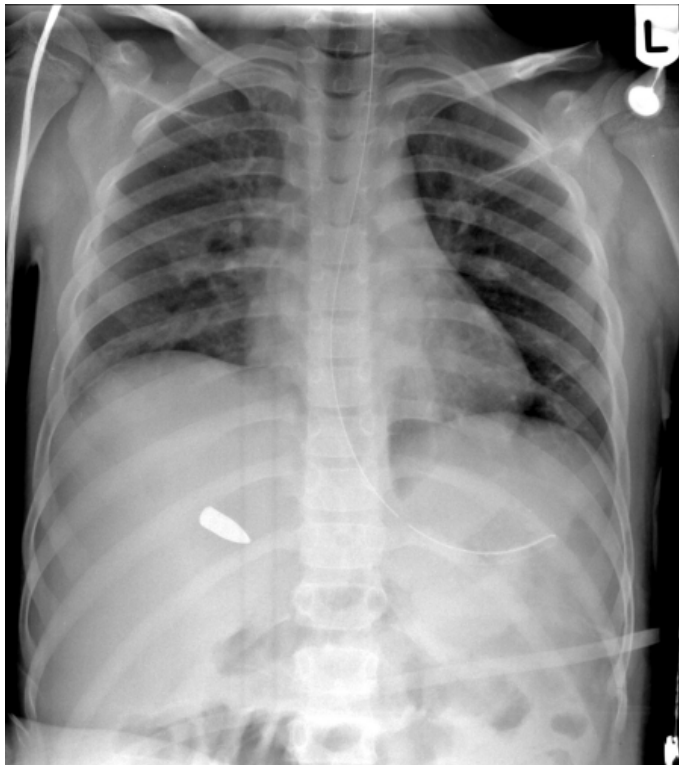


Figure 35 High velocity round within the liver

### Treatment

- In military environment the standard treatment of gunshot wounds has involved:
  - Wound debridement
  - Wound excision
  - Antibiotic prophylaxis
  - Dressing change and delayed primary suture at 5 days
- Similar wound management protocols have been advocated by the Red Cross
- Approach may be modified in civilian environment



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## Traumatic oedema and compartment syndromes

### Compartment syndromes

- The deep fascia envelops the limbs
- Other fascial planes divide the limbs into compartments
- The forearm has two compartments
- The thigh has three compartments
- The lower limb therefore has four fascial compartments

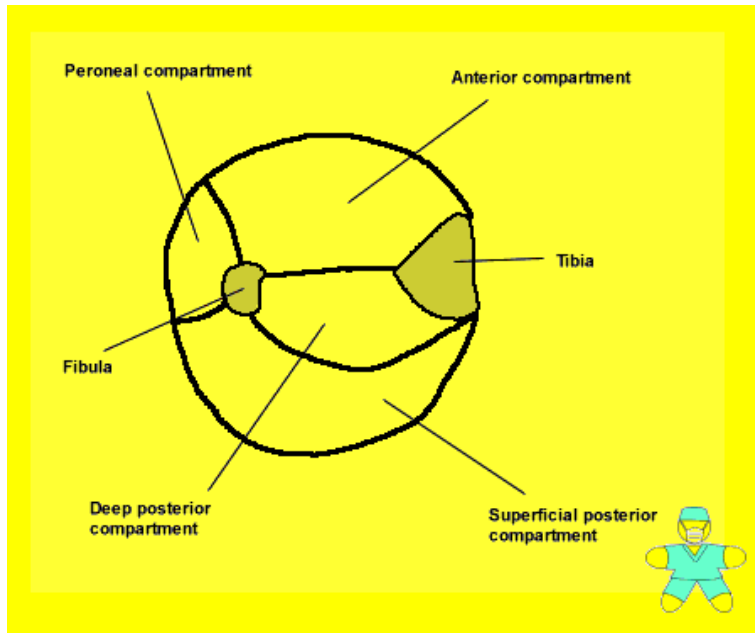


Figure 36 Lower limb muscular compartments

### Pathophysiology

- The normal lower limb venous pressure is a few mmHg
- Normal intracompartmental pressures are in the range 0 - 10 mmHg
- Compartmental pressure does not normally interfere with blood flow
- Swelling within a fascial compartment results in increased intracompartmental pressure
- Initial venous compromise may progress to reduced capillary flow
- This exacerbates the ischaemic insult and further increases pressure
- A vicious cycle of increasing pressures can be initiated
- Arterial inflow is rarely reduced unless the pressure exceed systolic blood pressure

### Aetiology

- Orthopaedic
  - Tibial fractures (especially comminuted fractures)
  - Forearm fractures
- Vascular
  - Ischaemia-reperfusion injury
  - Haemorrhage
  - Phlegmasia caerulea dolens
- Iatrogenic
- Vascular puncture in anticoagulated patients



- Intravenous or intra-arterial drug injection
- Soft-tissue injury
  - Prolonged limb compression
  - Crush injury
- Burns

#### **Clinical features**

- Compartment syndromes are normally seen within 48 hours of injury
- Clinical features include:
  - Increasing pain despite immobilisation of fracture
  - Altered sensation in the distribution of nerves passing through the compartment
  - Muscle swelling and tenderness
  - Excessive pain on passive movement
  - Peripheral pulses may still be present

#### **Pressure monitoring**

- Intracompartmental pressure (ICP) can be measured by several means including:
  - Wick catheter
  - Simple needle manometry
  - Infusion techniques
  - Pressure transducers
  - Side-ported needles
- Critical pressure for diagnosing compartment syndrome unclear
- Different authors consider surgical intervention if:
  - Absolute ICP greater than 30 mmHg
  - Difference between diastolic pressure and ICP greater than 30 mmHg
  - Difference between mean arterial pressure and ICP greater than 40 mmHg

#### **Treatment**

- Remove constricting casts, splints etc
- If no improvement prompt fasciotomies are required
- Need to divide skin and deep fascia for the whole length of the compartment
- Wounds should be left open
- May require delayed closure or skin grafting



Figure 37 Forearm fasciotomy



### Outcome

- Timely surgery produces a good functional outcome
- Delay results in muscle ischaemia and necrosis
- Muscle fibrosis produces the typical Volkmann's ischaemic contracture



Figure 38 Lower limb fasciotomies

### Fat embolism

- Due to fat entering torn venous channels at fracture site
- Chylomicrons may also aggregate due to lipase release
- Presents with pyrexia, tachycardia, tachypnoea, reduced consciousness
- May develop petechial rash
- Clotting may be deranged with features of DIC
- Arterial gases show hypoxia and hypercapnia
- Patients may require ventilation
- Mortality can be as high as 15%

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## Miscellaneous

### *The eye – trauma and common infections*

#### Trauma

- The eye is well protected by bony orbit and reflex closure of the eye lid
- Corneal trauma is common
- More major injuries are rare

#### *Corneal foreign body*

- Due to fragments hitting cornea at high speed
- Often as a result of hammering or drilling
- Usually causes pain, photophobia and profuse lacrimation
- Local anaesthesia may be required in order to examine the eye
- Foreign body is often readily seen
- If present for more than a few hours is often results in a 'rust ring'
- Object can often be removed with sterile needle under local anaesthesia
- Antibiotic ointment and cycloplegic drops should be instilled into the eye
- A pad should be applied

#### *Subtarsal foreign body*

- Foreign bodies occasionally become embedded in subtarsal conjunctiva of upper lid
- Cause pain and lacrimation
- Examination may show fine, vertical linear corneal abrasions
- Eversion of the upper eyelid with a cotton bud will show the foreign body
- Can be removed with a needle
- Foreign body sensation may persist for a while

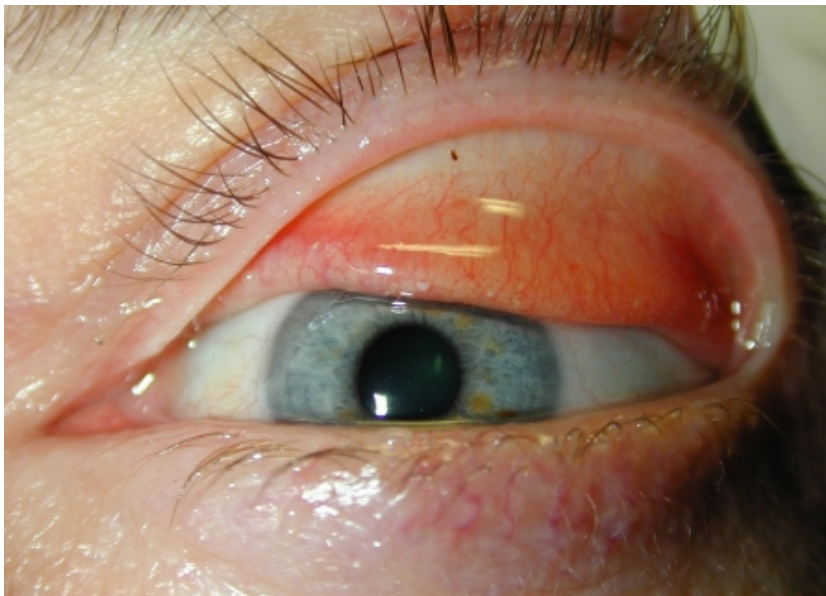


Figure 39 Subtarsal foreign body

#### *Corneal abrasion*

- Often causes by twigs, fingernails and the edges of pieces of paper



- Causes intense pain and lacrimation
- Abrasion can be confirmed with the aid of fluorescein
- Antibiotic ointment and cycloplegic drops should be instilled into the eye
- A pad should be applied
- Most abrasions heal within 48 hours

### **Blunt trauma**

- Blunt ophthalmic trauma can result in:
  - Black eye
  - Subconjunctival haemorrhage
  - Corneal abrasion
  - Traumatic mydriasis
  - Hyphaema
  - Iridodialysis
  - Concussion cataract
  - Lens subluxation
  - Retinal tear
  - Vitreous haemorrhage
  - Commotio retinae
  - Choroidal rupture
  - Blow-out orbital fracture

### **Hyphaema**

- Bleed into the anterior chamber of the eye
- Due to rupture of the iris blood vessels
- Presents with a reduction in visual acuity
- Red reflex is lost
- Within short period of time the blood settles and produces a fluid level
- Most settle with conservative treatment
- Surgical treatment may be required if anterior chamber is full of blood ('eight-ball' hyphaema)
- Can result in glaucoma or blood-staining of the cornea

### **Blow-out fracture**

- Posterior displacement of globe raises orbital pressure
- Orbit then fractures at its weakest point
- Usually occurs at the orbital floor
- Soft tissues herniates into the maxillary sinus
- Clinical features include:
  - Enophthalmos
  - Restriction of eye movement - especially on upward gaze
  - Loss of sensation over region supplied by infra-orbital nerve
- Sinus x-ray shows clouding of the affected sinus
- May be able to identify herniated tissue on x-ray
- Surgical correction is often required

### **Penetrating injuries**

- Penetrating injuries can result in:
  - Corneoscleral lacerations
  - Intraocular foreign bodies
  - Sympathetic ophthalmitis



### **Chalazion**

- Due to inflammation of the meibomian gland
- Presents as painless, hard lump close to margin of eye lid
- More common in the upper lid
- Increases in size over days or weeks
- Small lesions require no treatment
- Large symptomatic lesions can be incised and curetted
- Performed via conjunctival incision

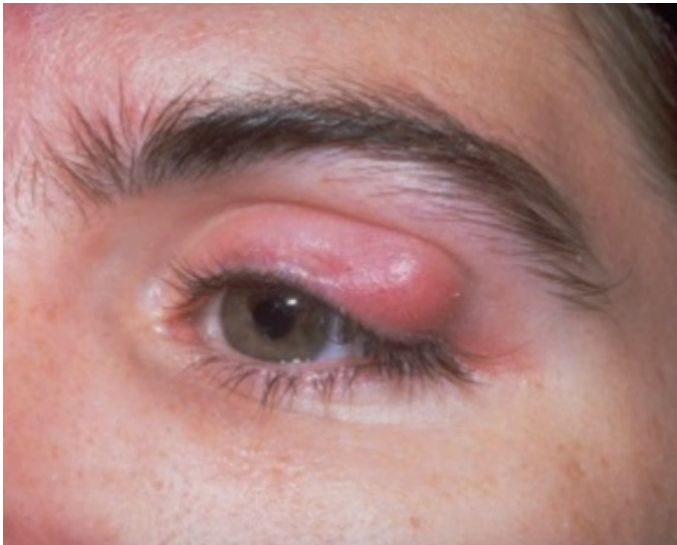


Figure 40 A chalazion

### **Intraocular foreign body**

- Usually caused by metal fragment hitting eye at high speed
- Patient is usually aware of something having struck the eye
- In early stages there is no significant visual loss
- Signs may be easily missed
- X-ray of the orbit is essential
- Foreign body may also be identified on CT or ultrasound
- Retained iron and copper foreign bodies can give rise to serious chemical reactions
- Siderosis from iron causes staining of the iris, cataract formation and retinal atrophy
- Chalcosis from copper deposition causes endophthalmitis and rapid visual loss
- Ferrous foreign bodies can be removed with a powerful electromagnet
- Non-magnetic foreign bodies should be mechanically removed

### **Acute red eye**

- Common causes of an acute red eye include:
  - Conjunctivitis
  - Keratitis
  - Iritis
  - Acute glaucoma
  - Episcleritis
  - Scleritis

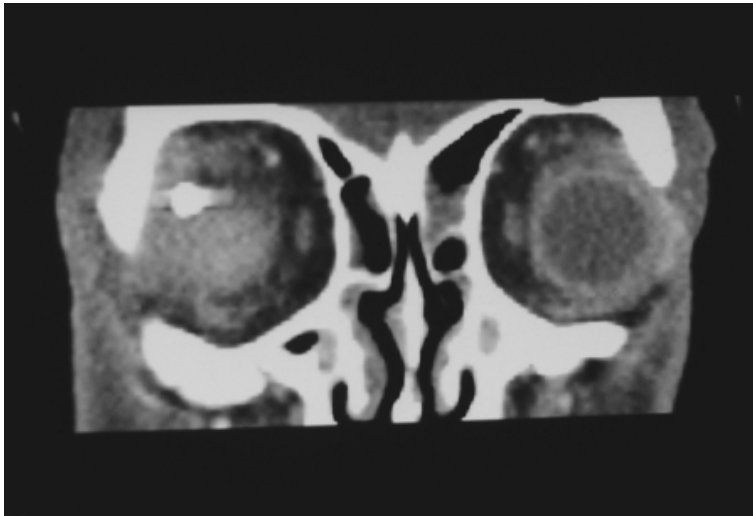


Figure 41 Intraocular metallic foreign body on CT scanning

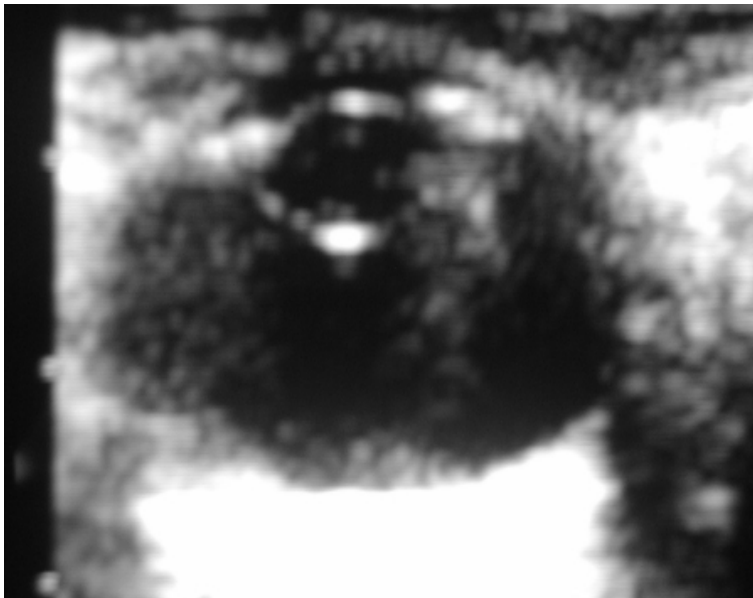


Figure 42 Intraocular foreign body on ultrasound scan

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## Principles of surgical oncology

### Principles of carcinogenesis

#### *Pathological terms*

##### *Atrophy*

- A reduction in organ size due to a reduction in size of individual cells
- e.g. Due to immobility or nutritional deficiency

##### *Hyperplasia*

- An increase in organ size due to cell proliferation
- e.g. Breast enlargement during pregnancy

##### *Hypertrophy*

- An increase in organ size due to increase in size of individual cells
- e.g. Ventricular hypertrophy due to aortic stenosis

##### *Metaplasia*

- A change from one differentiated cell type to another
- e.g. Bronchial squamous metaplasia in response to smoking
- Barrett's oesophagus - intestinal metaplasia at the gastro-oesophageal junction

##### *Dysplasia*

- Disordered cellular development - usually pre-malignant
- e.g. Cervical intraepithelial neoplasia

#### **Tumour markers**

- The ideal tumour marker would
  - Be present in the blood
  - Be undetectable in health
  - Be produced only by malignant tissue
  - Be organ specific
  - Would have circulating levels proportional to tumour mass
- The ideal does not exist
- Tumour markers can be used for:
  - Screening for primary disease
  - Diagnosis of primary disease
  - Monitoring response to treatment
  - Establishing prognosis
  - Detection of recurrence

#### **Specific tumour markers**

- CA-125 - ovary
- CEA - colon, pancreas, stomach
- PSA - prostate
- Alpha-fetoprotein – teratoma, hepatoma
- Beta-hCG - seminoma, choriocarcinoma
- CA19.9 - pancreas



- CA15.3 - breast
- CA 27.29 – breast

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## Molecular biology of cancer

### Cancer genetics

- Several germline mutations have been shown to increase cancer risk
- More than 50 genetic abnormalities have been identified
- Most are inherited in autosomal dominant fashion
- Cancer genetics are important as:
  - Genes involved are important in normal growth and development
  - Improve our knowledge of cancer biology
  - Allow identification of high-risk patients who will benefit from preventative therapies
- Most genetic abnormalities involve tumour suppressor genes
- Code for proteins that are important in normal growth and development
- Hereditary cancer syndromes result from germline mutation in one copy of the suppressor gene
- Somatic mutation in the second copy of the gene results in the development of cancer

### Breast cancer genetics

- 12% women will develop breast cancer in their life-time
- 5% breast and ovarian cancers due to germ-line mutation

### BRCA1 and BRCA2 genes

- BRCA1 and BRCA 2 are tumour suppressor genes
- Commonest abnormality is in BRCA 1 gene found on long arm of chromosome 17
- Mutation seen in 50% of families with 4 or more affected members less than 60 years
- More than 100 BRCA mutations described
- Highest carrier rate is in Ashkenazi Jews
- If a patient is BRCA 1 positive she has:
  - 50% risk of developing breast cancer by 50 years
  - 85% risk of developing breast cancer by 70 years
  - 70% risk of developing contralateral breast cancer
  - 50% life time risk of developing ovarian cancer

### Treatment

- How should BRCA1 and BRCA2 positive patients be managed ?
- Possible options include:
  - Intensive screening with annual mammography from an early age
  - Chemoprophylaxis with tamoxifen
  - Prophylactic mastectomy
- Reduces but does not completely abolish risk of breast cancer
- Risk of ipsilateral and contralateral recurrence is higher in BRCA1 and BRCA2 carriers



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## Epidemiology of common cancer

### Common cancers

- Cancer is a major cause of morbidity in the UK
- 250,000 people are diagnosed each year
- Overall, 1:3 people will develop some form of cancer during their life
- There are more than 200 different types of cancer
- Breast, lung, colorectal and prostate cancer account for over 50% of new cases
- Breast cancer is the most common cancer in the UK despite being rare in men

Table 28 Common cancer (2000)

	Males	Female	Total	% Total
Breast	240	40 467	40 707	15
Lung	23 245	15 165	38 410	14
Bowel	18 956	16 344	35 300	13
Prostate	27 149	Nil	27 149	10
Bladder	7 876	3 205	11 081	4
Stomach	6 088	3 572	9 660	4

### Age

- Cancer occurs predominantly in older people
- 65% cases are diagnosed over the age of 65 years
- Less than 1% occur in children
- Breast cancer accounts for 50% of all cancers diagnosed 40-60 years

### Men

- Prostate cancer has overtaken lung cancer as the commonest cancer diagnosed in men
- Incidence of prostate cancer is rising due to the widespread use of PSA
- Lung cancer is the second most common cancer
- Incidence of lung cancer is falling

### Women

- Breast cancer is the commonest cancer in women
- Accounts for 30% of all female cancer
- The second commonest cancer in women is colorectal cancer

### Bibliography



## Cancer screening programmes

### *Breast cancer screening*

#### Criteria for an effective screening programme

- The disease screened for must be an important problem.
- The natural history of the disease should be well understood with a recognisable early stage.
- A specific and sensitive test for the early detection of the disease must be available.
- There should be good evidence that the screening test can result in reduced mortality and morbidity in the targeted population.
- The test must be acceptable producing a high participation rate.
- There should be suitable facilities for diagnosis and treatment of detected abnormalities.
- There should be appropriate treatment options.
- The benefits of screening should outweigh any adverse effects.
- The benefit must be of an acceptable financial cost.
- The results of the implementation require audit to ensure they meet the above criteria.

#### Sensitivity and specificity

- A screening test can give a positive or negative result
- Does not imply that the patient has or does not have the disease
- The test results can be:
  - True positive (TP) = A positive test result in the presence of the disease
  - True negative (TN) = A negative test result in the absence of the disease
  - False positive (FP) = A positive test result in the absence of the disease
  - False negative (FN) = A negative test result in the presence of the disease

#### *Sensitivity*

- The ability of the test to identify the disease in those who have it
- Equals  $TP / (TP + FN)$

#### *Specificity*

- The ability of the test to exclude the disease in the absence of the disease
- Equals  $TN / (TN + FP)$

#### *Ductal carcinoma in-situ*

- DCIS is non-invasive breast carcinoma
- Malignant cells remain within the basement membrane
- True DCIS does not cause lymph node metastases
- Not all cases progress to invasive cancer
- Usually asymptomatic
- Was rarely identified prior to the establishment of breast screening
- Usually presents as malignant microcalcification on screening mammography
- Often multifocal disease process
- Management depends on:
  - Extent of lesion
  - Nuclear grade

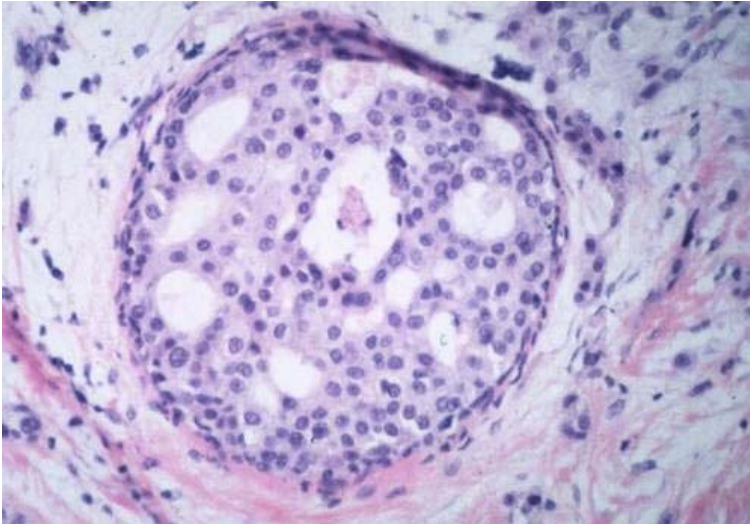


Figure 43 Ductal carcinoma *in-situ*

### Is breast cancer screening worthwhile ?

#### **An important problem**

- Single leading cause of cancer death
- Lifetime incidence is approximately 1:12

#### **The natural history**

- Does DCIS always proceed to invasive cancer ?
- At what stage does invasive cancer cease to be localised to the breast?
- At what interval does screening need to be repeated?

#### **A suitable test**

- Single view mammography is 90% sensitive and 95-99% specific
- Breast examination adds nothing to value of mammographic screening

#### **Screening is effective**

- Primary aim of screening is the reduction of breast cancer mortality
- Best evidence comes from randomised control trials

#### **Avoid screening biases:**

- Selection Bias - patients select themselves into one group by attending
- Lead Time Bias - Early detection appears to improve survival by increasing time from diagnosis to death yet mortality is unchanged. The patient is simply aware that they have the disease for longer
- Length Bias - Slower growing better prognosis tumours are more likely to be detected by screening

#### **An acceptable test**

- If screening acceptable compliance increased and mortality is reduced
- Compliance of more than 70% will impact on mortality
- Compliance decreases with age



### ***Facilities for diagnosis and treatment***

- Need facilities for radiology, clinical assessment, cytology, surgery, pathology etc.

### ***Appropriate treatment options***

- Treatment must impact on natural course of disease
- Must have tolerable and minimal side effects

### ***Adverse effects and cost-benefit analysis***

- Principal adverse effects of mammographic screening:
  - Resources required
  - Exposure of women to ionising radiation
  - False positive results with unnecessary biopsies
  - Unnecessary treatment of lesions that may never have caused problems

### **History of breast screening**

#### ***HIP Study***

- Began in 1963,
- Health Insurance Plan of New York
- Randomised control trial of 60,000 women
- 67% accepted invitation for two view mammography and clinical examination
- Followed up with yearly mammography and examination
- Controls received routine medical care
- Mammography alone detected 30% of breast cancers
- Clinical examination detected a further 45%
- At 10 years mortality from cancer detected in first 5 years was reduced by 30%
- Largest effect in women > 50 years

#### ***Breast Cancer Detection Demonstration Project (BCDDP)***

- Began in 1973
- Designed to test conduct of rather than efficacy of screening
- 280,000 women between 35 & 74 years enrolled
- 5 yearly mammography and clinical examination
- No control group. Compared with HIP data
- Screening effective for women > 40 years
- Effect particularly good for cancers detected by screening only

#### ***Swedish two county trial***

- Began in 1977
- Randomised control trial of mass screening
- 135,000 women between 40 & 74 years
- Two areas compared. Kopparberg and Ostergotland
- Single mediolateral oblique view mammography
- High compliance 89% at prevalence round 83% at incidence round
- 13% of control group underwent mammography as part of normal medical care
- By 1984 31% reduction in breast cancer mortality in screened group
- Effect greatest >50 years

#### ***Netherlands case control studies***

- Two case control studies
- Cases = Deaths from breast cancer after first screening round



- Controls = Random sample of age matched women alive at time of case death
- Odds ratio for breast cancer deaths calculated
- Women self selected into screened and non-screened group
- Selection bias possible
- Non screened population of Arnhem used to provide control breast cancer rates and to estimate effect of selection bias in Nijmegen population

#### ***Nijmegen Project***

- Began in 1975
- Single view mammography every 2 years
- 23 000 women between 35 & 65 invited for screening
- 52% reduction in breast cancer mortality in screened group

#### ***DOM Project***

- Began in 1974
- Clinical examination and mammography at 12, 18 and 24 months
- 20,500 women between 50 & 64 years

#### **Conclusions from initial breast screening trials**

- Every major trial shows that breast cancer screening reduces risk of death from breast cancer in women > 50 years
- Effect begins 5-7 years after screening has commenced
- In all studies mortality curves were diverging at time of analysis and likely to increase in significance with time
- For women < 50 years no trial has shown a reduction in mortality from screening

#### **National Health Service Breast Screening Programme**

- Introduced in 1988 with 95 screening programmes
- Followed Forest Report 1986
- All women 50-64 years invited for 3 yearly single view mammography
- Upper age limit soon to be extended to 70 years
- If abnormality seen on mammogram women are recalled for:
  - Clinical examination
  - Further imaging - mammography or ultrasound
  - Fine needle aspiration cytology or core biopsy
- 70% of screen detected abnormalities shown to be unimportant following triple assessment

#### **Current controversies in breast screening**

##### ***Number of mammographic views***

- UKCCR multicentre randomised control trial of one and two view mammography
- Two view mammography detects 24% more cancers and leads to recall of 15% fewer women
- Most centres now perform 2 view mammography at first screening
- Two views will soon be performed at all screening rounds

##### ***Frequency of screening***

- Concern that 3 yearly screening interval too long
- Most European countries screen every 2 years
- Interval cancers = cancers occurring between screening episodes



- Rates in 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> year after screening 24%, 59% and 79% expected incidence in the absence of screening
- Currently no evidence to suggest that more frequent screening reduces breast cancer mortality

#### **Screening under 50 years of age**

- Only 20% breast cancers occur in women less than 50 years
- Meta-analysis of all available trial results suggest non significant reduction in mortality
- Sensitivity of mammography reduced in the young breast

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## **Other screening programmes**

### **Cervical screening**

- In the United Kingdom 1500 women die each year from cervical cancer
- Cervical screening has been estimated to save 1000 lives per year
- Cervical screening has been practised since 1967
- NHS Cervical screening programme was established in 1988
- 4 million women are screened each year
- Women are screened between 25 and 64 years
  - 25 - 49 every three years
  - 50 - 64 every five years
- Cervical cells obtained by either a smear or brush
- Brush samples are analysed by liquid based cytology
- 1:10 smear tests are abnormal
- Non-neoplastic causes of an abnormal smear include
  - Infection
  - Presence of blood or mucus
  - Inadequate specimen
  - Poorly preserved specimen
- Abnormal smears are reported as:
  - CIN 1 = Mild dyskariosis
  - CIN 2 = Moderate dyskariosis
  - CIN 3 = Severe dyskariosis

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## Clinicopathological staging of cancer

- Staging is the clinical or pathological assessment of the extent of tumour spread
- Clinical staging is a preoperative assessment
- It is based on clinical, radiological and operative information
- Used to determine treatment offered to the patient
- Pathological staging is a postoperative assessment
- Provides useful prognostic information
- Allows decisions to be made regarding adjuvant therapy
- Allows comparison of treatment outcomes between different centres

### Staging systems

- The ideal staging system should be:
- Easy to use and remember
- Reproducible - not subject to inter or intra-observer variation
- Based on prognostically important pathological factors

### TNM system

- Based on anatomical extent of spread
  - T refers to the extent of primary tumour
  - N refers to the extent of nodal metastases
  - M refers to the presence or absence of distant metastases
- Two classifications are described for each site
  - Clinical classification (TNM)
  - Pathological classification (pTNM)

#### T - primary tumour

- T<sub>x</sub> = primary tumour can not be assessed
- T<sub>0</sub> = no evidence of primary tumour
- T<sub>is</sub> = carcinoma *in-situ*
- T<sub>1-4</sub> = increasing size and local extent of primary tumour

#### N - regional lymph nodes

- N<sub>x</sub> = regional lymph nodes can not be assessed
- N<sub>0</sub> = no regional lymph node metastases
- N<sub>1-3</sub> = Increasing involvement of regional lymph nodes

#### M - distant metastases

- M<sub>x</sub> = distant metastases can not be assessed
- M<sub>0</sub> = no distant metastases
- M<sub>1</sub> = distant metastases present
  
- The TNM system is generally accepted
- Does not recorded all factors (e.g. grade, contiguous organ involvement) that is prognostically important





## Pathological staging

### Dukes staging of colorectal cancer

- First published in 1932 for rectal cancers
- Now used for all rectal and colonic cancers
  - Duke's A - spread into submucosa but not through muscle
  - Duke's B - spread through muscle but nodes negative
  - Duke's C - lymph node metastases present
- Often divided into C<sub>1</sub> and C<sub>2</sub> dependent on the involvement of the highest lymph node

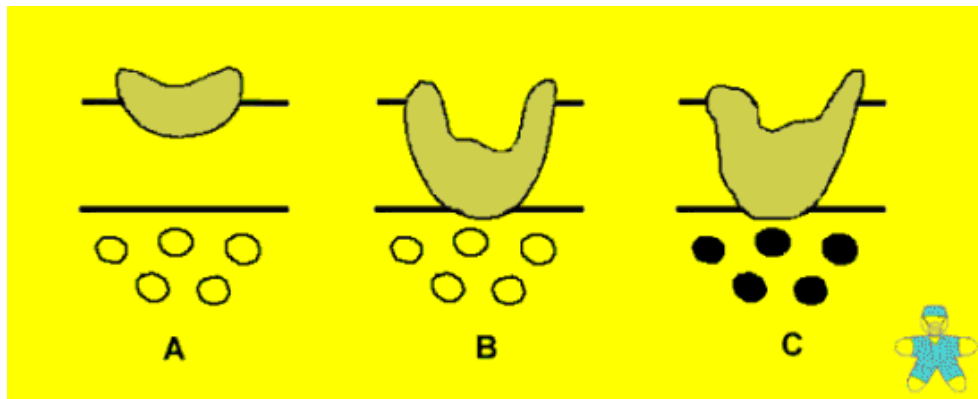


Figure 44 Duke's classification of colorectal carcinoma

- Advantages of the Dukes classification are that it:
  - Is simple and reproducible
  - Accurately reflects prognosis
  - Accepted nationally and internationally

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## Principles of cancer treatment

### Radiotherapy

- Radiotherapy is the use of ionising radiation to treat malignancy
- Attempts to deliver a measured radiation dose to defined tumour volume
- Need to limit dose to surrounding normal tissue
- Radiotherapy may be:
  - Curative or radical
  - Palliative
  - Adjuvant
- Brachytherapy is the use of intracavity irradiation

### Physics

- Radiation may be electromagnetic or particulate
- Linear accelerators used to generate high energy x-rays (electromagnetic)
- Generated by electrons hitting a fixed target
- Depth of penetration depends on x-ray voltage
- 10-125 KeV x-rays absorbed by superficial tissues
- 4-24 MV x-rays absorbed in deeper tissues
- Use of MV x-rays avoids significant skin toxicity
- High energy electrons may be used instead of x-rays (particulate)
- Electrons have limited tissue penetration
- CT planning reduces dose delivered to normal tissue

### Biology

- Radiation damages DNA
- Either causes direct damage to DNA or acts via the production of free radicals
- Double-stranded DNA breaks prevent cell replication and induce cell death
- Tissue response depends on degree of cellular differentiation
- Terminally differentiated cells (e.g. muscle and nerves) are resistant to damage
- Most significant effects seen in rapidly dividing cells (e.g. gut, bone marrow)

### Toxicity

- Acute toxicity
  - Occurs within days
  - Depends on overall treatment time
  - Includes mucositis, bone marrow suppression, skin reactions
- Late toxicity
  - Occurs after weeks or months
  - Depends on total dose and fractionation
  - Includes tissue necrosis or fibrosis

### Fractionation

- Higher total dose of radiation can be given if smaller repeated doses administered
- Allows a degree of repair of normal tissues
- High total dose increases the probability of tumour control
- Hypofractionation = small number of large doses
- Accelerated fractionation = standard dose over short interval
- Hyperfractionation = large number of small doses



### ***Curative as sole treatment***

- Head and neck cancers
- Carcinoma of the cervix
- Seminomas
- Hodgkin's and non-Hodgkin's lymphomas
- Bladder cancer
- Early prostate cancer
- Early lung cancer
- Anal and skin cancer
- Medulloblastoma and other brain tumours
- Thyroid cancer

### ***Component of multimodality therapy***

- Breast cancer
- Rectal cancer
- Soft tissue sarcomas
- Advanced head and neck cancers
- Whole body DXT before bone marrow transplantation

### ***Palliative radiotherapy***

- Pain - especially bone metastases
- Spinal cord compression
- Cerebral metastases
- Venous or lymphatic obstruction

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## Chemotherapy

- Aims of chemotherapy are to selectively destroy tumour cells
- Achieved by specific growth characteristics of most tumours

## Cell cycle

- A cells synthesising DNA go through a regular cycle with different phases

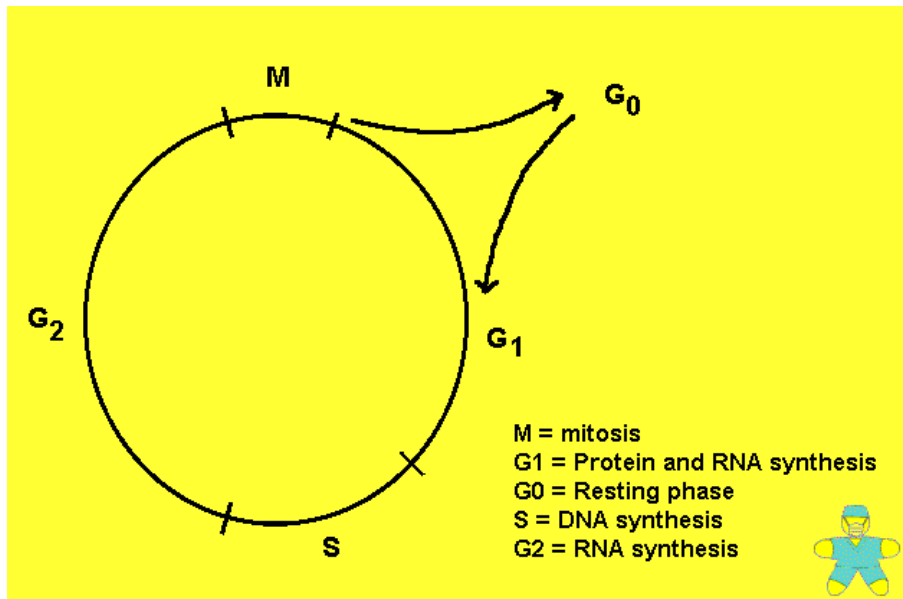


Figure 45 The cell cycle

- G<sub>0</sub> is a resting phase outside the cell cycle
- Cells in G<sub>0</sub> are resistant to the effects of cytotoxic drugs

## Mechanism of action

- The faster cells are growing the more likely that cytotoxic drugs are to 'catch' them
- Also accounts for toxicity on rapidly growing normal tissues (e.g. GI mucosa, bone marrow)
- Large tumours are relatively unresponsive to chemotherapy
- More cells are in G<sub>0</sub> and drug penetration is less reliable
- Most drugs kill a fixed proportion of cells rather than fixed number
- Different drugs act at different phases of the cell cycle
- As a result, combinations of drugs are more likely to be effective
- Modes of action include:
  - Bleomycin - inhibits DNA polymerase causing breakage of single stranded DNA
  - Doxorubicin - Inhibits RNA synthesis by intercalating between DNA base pairs
  - Cisplatin - inhibits DNA synthesis by cross-linking DNA strands
  - Methotrexate - inhibits dihydrofolate reductase
  - Vinca alkaloids - binds to tubulin and inhibits the metaphase of mitosis



### **Non-phase dependent drugs**

- Kill cells exponentially with increasing dose
- Equally toxic for cell within the cell cycle or G<sub>0</sub> phase
- Examples include:
  - Alkylating agents - cyclophosphamide, cisplatin
  - 5 Flurouracil
  - Anthracyclines - doxorubicin

### **Phase dependent drugs**

- Kill cells at a lower dose
- Act within a specific phase of the cell cycle
- Examples include:
  - Methotrexate
  - Vinca alkaloids - vincristine, vinblastine

### **General side effects**

- Some side effects occur with many cytotoxic agents
- These include:
  - Nausea and vomiting
  - Bone marrow toxicity
  - Gastrointestinal toxicity
  - Alopecia
  - Gonadal effects
  - Hyperuricaemia

### **Specific side effects**

- Some side effects are specific to certain agents
- These include:
  - Pulmonary fibrosis - bleomycin
  - Haemorrhagic cystitis - cyclophosphamide
  - Cardiomyopathy - doxorubicin
  - Hepatic damage - methotrexate
  - Skin pigmentation - 5-flurouracil

### **Tumours potentially curable with chemotherapy**

- Acute lymphoblastic leukaemia
- Germ cell tumours
- Choriocarcinoma
- Hodgkin's disease
- Wilm's tumour

### **Tumours with a significant response to chemotherapy**

- Breast carcinoma
- Ovarian carcinoma
- Lymphoma
- Osteosarcoma

### **Tumours poorly responsive to chemotherapy**

- Pancreatic carcinoma
- Melanoma



- Soft tissue sarcomas
- Colorectal carcinoma
- Gastric carcinoma

### **Bibliography**



### **Hormonal treatment**

- Hormonal treatment used in several cancers
- Usually works by reducing steroid production

### **Breast cancer**

- Aim of hormonal treatment is to reduce oestrogenic growth stimulation of cancer cells
- Effective in women with oestrogen and / or progesterone receptor-positive tumours
- 50-60% of breast cancer are ER or PR positive
- 70% of receptor-positive tumours will respond to hormonal manipulation
- Only 5% of receptor-negative tumours will respond

### **Types of hormonal treatment**

- Ovarian ablation
  - Surgical
  - Radiotherapy
  - LH-RH analogues
- Selective oestrogen receptor modulators
  - Tamoxifen
  - Raloxifene
  - Fulvestrant
- Aromatase inhibitors
  - Non-steroidal - anastrozole, letrozole
  - Steroidal - exemestane
- Progestogens
  - Megestrol acetate
  - Medroxyprogesterone acetate

### **Uses of hormonal treatment**

- Can be used as adjuvant treatment or in metastatic disease
- In adjuvant setting tamoxifen or an aromatase inhibitor is given for 5 years
- Both have been shown to:
  - Reduce risk of recurrence
  - Increase survival
  - Reduce risk of contralateral breast cancer
- In patients with metastatic disease use of hormonal therapy depends on:
  - ER / PR status of the tumour
  - Duration of disease-free interval
  - Location of metastases
  - Previous therapy
  - Patient's performance status

### **Prostate cancer**

- Aim of treatment is to ablate androgen production
- 80% of prostate cancers respond to medical or surgical androgen ablation
- Surgical ablation by orchidectomy produces a rapid reduction in testosterone levels
- Medical ablation is reversible and the effect may take several weeks
- Side effects of androgen ablation include:
  - Impotence
  - Loss of libido
  - Osteoporosis



- Gynaecomastia
- Hot flushes

#### **Types and site of hormonal treatment**

- Pituitary gland
  - LH-RH analogues
  - Stilbeostrol
  - Prednisolone
  - Cyproterone acetate
- Adrenal gland
  - Ketoconazole
  - Aminoglutethamide
- Prostate
  - Flutamide
  - Cyproterone acetate
- Testis
  - Orchiectomy

#### **Uses of hormonal treatment**

- Androgen ablation is used in both the neoadjuvant setting and in metastatic disease
- In neoadjuvant setting is used in combination with external beam radiotherapy
- LH-RH analogues are commonly used in metastatic disease
- Median duration of response is about 18 months
- 20% patients achieve response that may last several years
- Response can be measure by a fall in PSA level
- LH-RH analogues are give by monthly injection
- The first injection my induce LH-RH release, a rise in PSA and worsening of symptoms
- Cyproterone acetate should be give for first 2 weeks of treatment to reduce this effect

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## Palliative care

### *Pain and other symptoms*

- Pain is the commonest and most feared symptom associated with cancer
- Chronic pain can be controlled in more than 80% of patients
- WHO analgesia guidelines form the most common template for pain control
- Consists of a three-stepped ladder

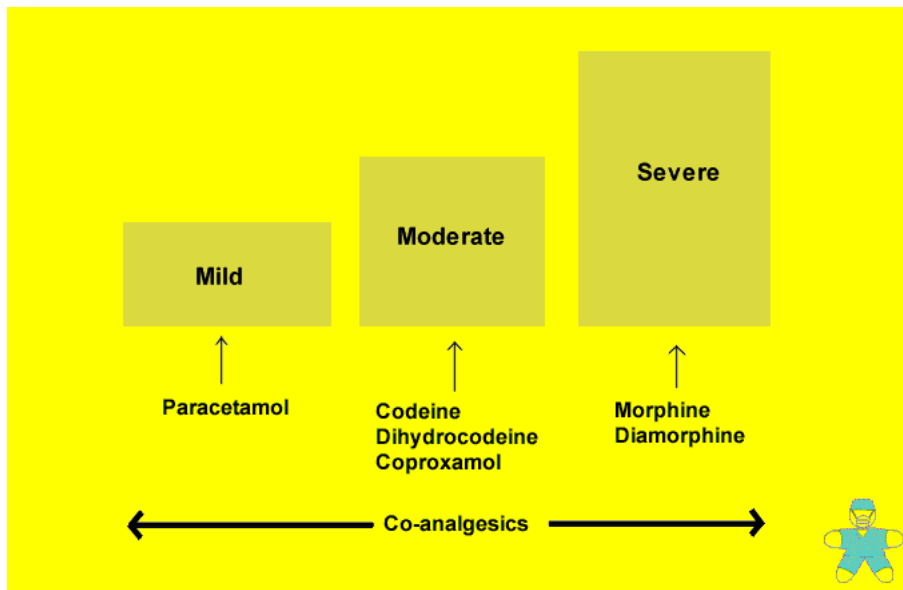


Figure 46 WHO analgesia ladder

- With increasing pain increasing strength of analgesia is required
- On each step of the ladder the maximum dose and frequency should be used
- Drugs should be prescribed on a regular basis not 'as required'
- Co-analgesic agents often have a synergistic effect
- May increase efficacy of a particular analgesic agent

### **Morphine**

- Most commonly used strong analgesic in palliative care
- Should initially be prescribed as an immediate release preparation (e.g. oramorph)
- Can be given as 5-10 mg every four hours
- Dose can be increased every 24 hours until pain is adequately controlled
- Once pain controlled total daily dose can be calculated
- Immediate release can then be substituted for delayed release preparations
- Most commonly used are MST given twice daily or MXL given once daily
- Immediate release preparations can still be given for breakthrough pain
- No ceiling exists for the maximum permissible dose of morphine
- Laxative should be prescribed to prevent constipation
- Patients may also require antiemetic
- Complications include itch, hallucinations, dry mouth
- Respiratory depression is rarely a problem
- Physical dependence may occur
- Psychological dependence and addiction are not a problem in the palliative care setting
- If oral route unavailable consider subcutaneous diamorphine or fentanyl patches



### **Co-analgesia**

- Co-analgesics have little intrinsic analgesic activity
- Have additive effects to analgesic agents
- NSAIDs useful in bone pain
- Anticonvulsants and antidepressants useful in neuropathic pain
- Steroids increase well being
- Benzodiazepines reduce muscle spasm

### **Other symptoms**

#### **Bone pain**

- Often well controlled with single fraction of radiotherapy
- NSAID may have useful co-analgesic effect
- Bisphosphonates reduce osteoclastic activity and reduce bone pain

#### **Neuropathic pain**

- Often resistant to treatment
- Anticonvulsants and antidepressants may have useful effect
- Neurolytic blocks may be considered if fails to respond to pharmacological agents

#### **Liver capsule pain**

- NSAID often have excellent additive effect in this situation
- Steroids can reduce swelling, inflammation and pain
- Dexamethasone is usually the drug of choice

#### **Dyspnoea**

- Not always due to underlying malignancy
- Consider treatment of any underlying infection, cardiac failure etc.
- Causes of breathlessness related to malignancy include:
  - Pleural effusion
  - Lymphangitis carcinomatosa
  - Intrapulmonary metastases
  - Constricting chest wall disease
- Aspiration of a pleural effusion often produces symptomatic improvement
- Pleurodesis with talc or bleomycin only effective if drained to dryness
- A pleuro-peritoneal shunt may produce symptomatic improvement
- Steroids produce symptomatic improvement in those with lymphangitis and intrapulmonary metastases
- The respiratory depressant effect of morphine will also reduce dyspnoea

#### **Nausea and vomiting**

- Nausea and vomiting is usually multifactorial in origin
- Causes include:
  - Hypercalcaemia
  - Liver metastases
  - Constipation
  - Drug side effects
  - Intestinal obstruction
- Metoclopramide, domperidone and cyclizine useful if gastric stasis or intestinal obstruction
- 5-HT<sub>3</sub> blockers (e.g. ondansetron) useful for chemotherapy induced nausea



- Haloperidol useful in morphine-induced nausea
- Can be administered as a continuous subcutaneous infusion

### **Constipation**

- Treatment should be continuous and anticipatory
- Often a side effect of opiate analgesia
- Can be worsened by inactivity, dehydration and hypercalcaemia
- Opiate-induced constipation best treated with compound preparations
- Contain both a stool softener and stimulant (e.g. co-danthrusate)

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## Cardiothoracic surgery

### Cardiac surgery

#### Cardiopulmonary bypass

- In early 1950s first open heart procedures were performed under:
- Cooling an circulatory arrest
- Cross circulation between parent and child
- Cardiopulmonary bypass with pump and oxygenator

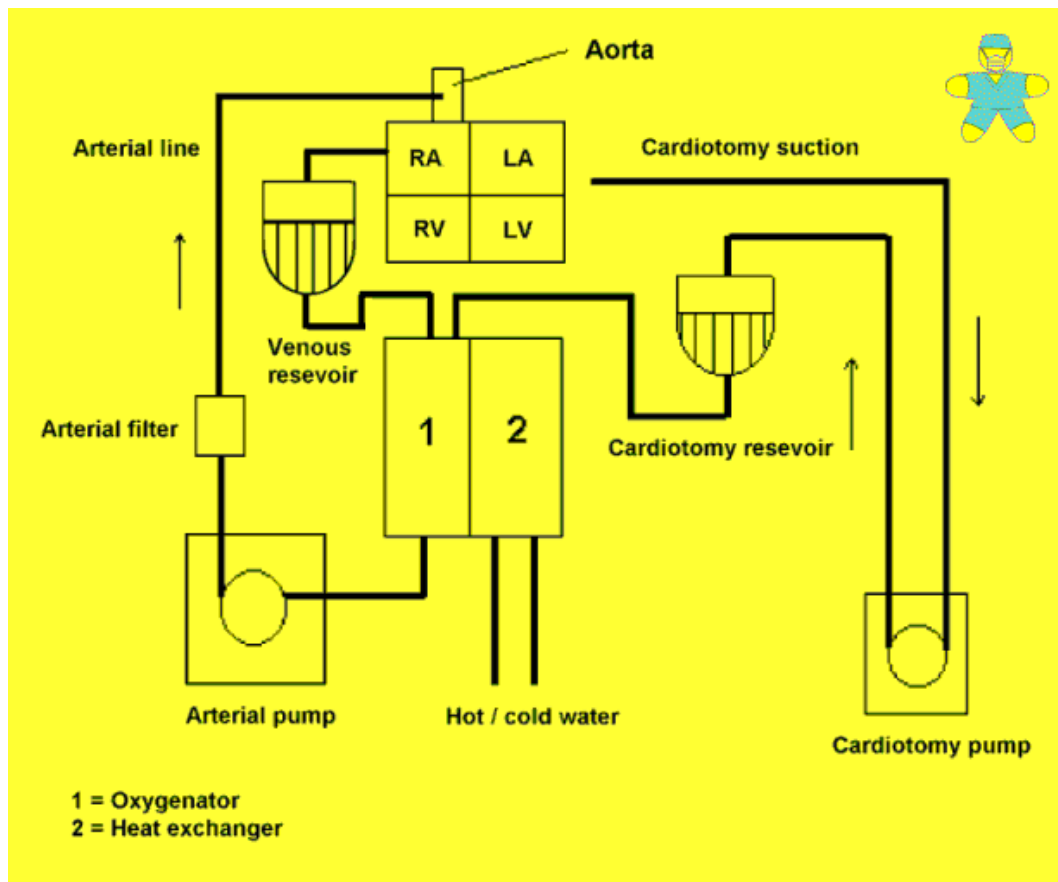


Figure 47 Components of cardiopulmonary bypass circuit

- Cannula is inserted into right atrium to drain venous return
- Venous blood passes into venous reservoir under gravity
- Oxygenated (and CO<sub>2</sub>) removed usually by membrane oxygenator
- Heat exchanger control blood temperature
- Surgery often performed with 5-10 °C of hypothermia
- A 40 µm filter removes air bubbles
- Pump returns blood into aorta distal to a cross clamp
- Suction used to remove blood from operative field
- Returned to patient via cardiomy reservoir



### **Complications of bypass**

- Prolonged bypass induces cytokine activation and an inflammatory response
- Results in:
  - Red cell damage and haemoglobinuria
  - Thrombocytopenia
  - Clotting abnormalities
  - Reduced pulmonary gas exchange
  - Cerebrovascular accidents

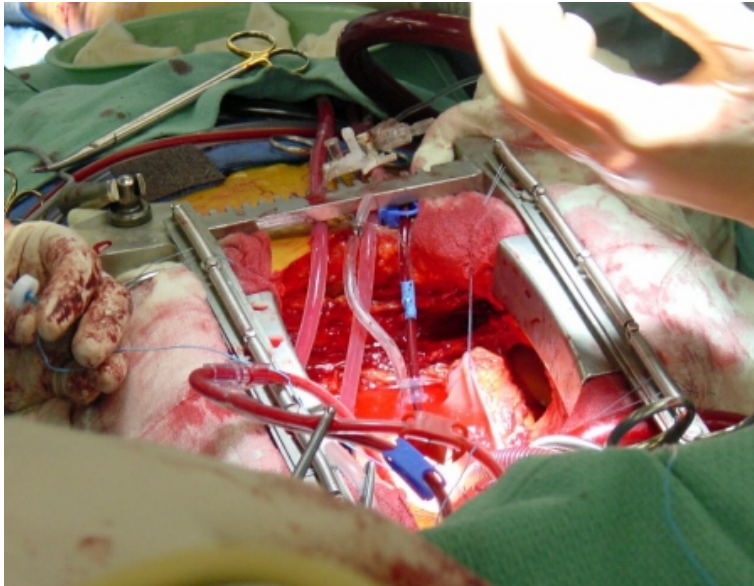


Figure 48. Cardiopulmonary bypass

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## **Valvular heart disease**

### **Aetiology**

- Principal causes vary between Western and developing countries
- Common causes are:
  - Congenital valvular abnormalities (e.g. bicuspid aortic valve)
  - Infective endocarditis
  - Rheumatic fever
  - Degenerative valve disease
  - Ischaemic heart disease

### **Pathology**

- Rheumatic fever results from immune-mediated inflammation of heart valve
- Results from cross reaction between Group A  $\beta$  haemolytic strep and cardiac proteins
- Valve disease results in either stenosis or incompetence
- Stenosis causes pressure load on proximal chamber
- Incompetence causes volume load proximal chamber
- Thrombus may form in dilated left atrium resulting in peripheral embolisation

### **Clinical features**

#### **Aortic stenosis**

- Angina pectoris
- Syncopal episodes
- Left ventricular failure
- Slow upstroke to arterial pulse
- Ejection systolic murmur in 2<sup>nd</sup> right intercostal space

#### **Aortic regurgitation**

- Congestive cardiac failure
- Increased pulse pressure
- Water-hammer pulse
- Early diastolic murmur at left sternal edge

#### **Mitral stenosis**

- Pulmonary hypertension
- Paroxysmal nocturnal dyspnoea
- Atrial fibrillation
- Loud first heart sound
- Mid diastolic murmur at apex

#### **Mitral regurgitation**

- Pulmonary oedema
- Apex beat displace laterally
- Apical pansystolic murmur

#### **Tricuspid stenosis**

- Fatigue and peripheral oedema
- Hepatomegaly and ascites
- Increased JVP with prominent a waves



- Diastolic murmur at left sternal edge

#### ***Tricuspid regurgitation***

- Pulsatile hepatomegaly and ascites
- Right ventricular heave
- Prominent JVP with large v waves
- Pansystolic murmur at left sternal edge

#### **New York Heart Association classification**

- Dyspnoea can be classified by severity of symptoms
- NYHA I - Capable of ordinary physical activity
- NYHA II - Ordinary activity induces dyspnoea
- NYHA III - Limitation of physical activity
- NYHA IV - Symptoms at rest

#### **Investigation**

- Investigation of valvular heart disease will require:
  - Electrocardiogram
  - Chest x-ray
  - Echocardiography
  - Cardiac catheterisation with measurement of transvalvular gradient

#### **Medical Management**

- Few patients with symptomatic aortic stenosis survive 5 years
- Approximately 20% of symptomatic patients will suffer sudden death
- Asymptomatic mitral stenosis is well tolerated with greater than 50% 10-year survival
- Medical management consists of:
  - Treatment of cardiac failure
  - Digitalisation if in atrial fibrillation
  - Anticoagulation if evidence of peripheral embolisation

#### **Surgical management**

- Approximately 7,000 patients per year undergo valve replacement
- Aortic valve is commonest to be replaced (75% of operations)

#### **Indications for surgery**

- Aortic valve replacement
  - Symptomatic aortic stenosis
  - Asymptomatic aortic stenosis with pressure gradient > 50 mmHg
  - Symptomatic aortic regurgitation
- Mitral valve replacement
  - Symptomatic mitral stenosis especially if peripheral emboli
  - Mitral valve area less than 1 cm<sup>2</sup>

- Surgery usually performed through a median sternotomy
- On cardiopulmonary bypass with systemic hypothermia
- Heart is arrested and protected with cardioplegic solution
- Valve can be either repaired or replaced
- Valve repair results in better haemodynamics
- Does not require long-term anticoagulation



### ***Prosthetic heart valves***

- Principal types
- Heterografts – stented or unstented (e.g. pig)
- Homografts
- Ball and cage (e.g. Starr-Edwards)
- Tilting disc (e.g. Bjork-Shiley)

### ***Mechanical valves***

- Readily available
- Good durability
- Require life-long anticoagulation
- Risk of endocarditis

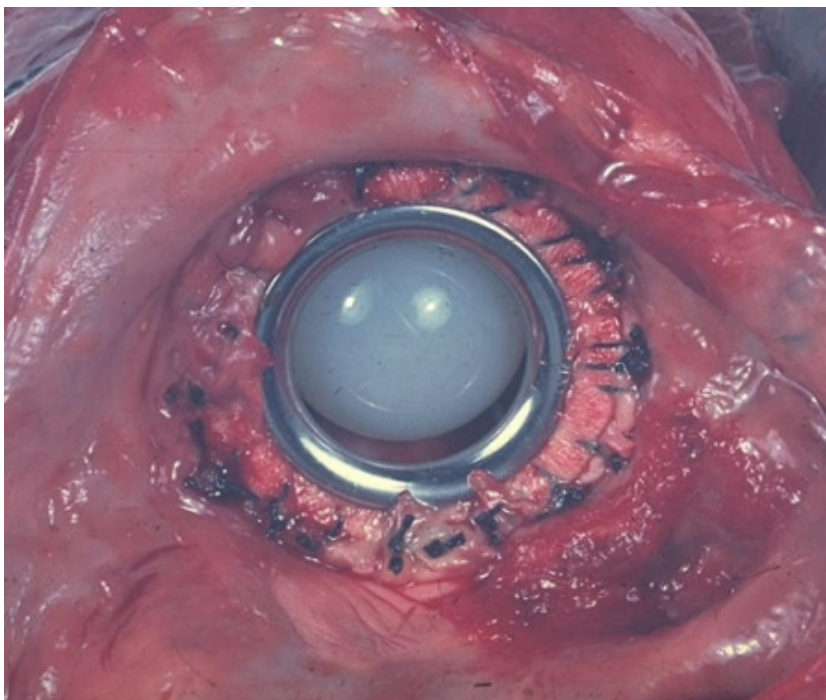


Figure 49 Starr Edwards prosthetic heart valve

### ***Heterografts***

- Readily available
- Limited lifespan (aortic valves ~ 15 years, mitral valve ~8 years)
- Limited duration of anticoagulation

### ***Homografts***

- Not readily available
- Do not require anticoagulation
- Long-term outcome uncertain





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### **Infected endocarditis**

- Results from bacterial infection of the endothelial surface of the heart
- Produces characteristic vegetations
- Vegetations consist of platelets, fibrin and bacteria

### **Predisposing factors**

- Rheumatic valve disease
- Degenerative heart disease
- Mitral valve prolapse
- Congenital heart disease
- Hypertrophic cardiomyopathy
- Intravenous drug abuse
- Prosthetic valve

### **Microbiology**

- Relative proportions of infecting organisms depends on underlying valve disease
- Native-valve endocarditis usually caused by:
  - viridans streptococci
  - *Streptococcus bovis*
  - *Staphylococcus aureus*
  - enterococci
  - Gram-negative coccobacilli (HACEK group)
  - Nosocomial native-valve endocarditis
- Often occurs as a complication central venous catheter infection
- Usually caused by:
  - *Staphylococcus aureus*
  - enterococci
  - coagulase-negative staphylococci
- Prosthetic-valve endocarditis accounts for 10% cases of infective endocarditis
- Greatest risk is during the first 6 months after surgery
- MRSA responsible for most cases seen in the first year

### **Diagnosis**

- Clinical presentation can be varied
- At one extreme acute systemic toxicity with rapid progression to cardiac complications
- At other extreme indolent low-grade febrile illness with minimal cardiac dysfunction
- 90% patients have a fever
- 85% patients have murmur, usually that of underlying cardiac lesion
- 10-40% have a changing murmur
- Peripheral signs are rare
- 95% patients have positive blood cultures
- Echocardiography allows:
  - Visualisation of vegetations
  - Detection of cardiac complications
- Transthoracic echocardiography has a low sensitivity but high specificity
- Transoesophageal echocardiography has a higher sensitivity

**Duke clinical criteria**

- Requires the presence of :
  - Two major criteria or
  - One major and three minor criteria or
  - Five minor criteria

**Major criteria**

- Positive blood cultures
- Evidence of endocardial involvement

**Minor criteria**

- Predisposing heart condition or intravenous drug abuse
- Fever (more than 38.0 deg C)
- Vascular phenomenon
- Major arterial emboli
- Septic pulmonary infarcts
- Mycotic aneurysm
- Intracranial haemorrhage
- Conjunctival haemorrhages
- Immunological phenomenon
- Glomerulonephritis
- Osler's nodes
- Roth spots
- Microbiological evidence (but less than major criteria)
- Echocardiographic findings (but not meeting major criteria)

**Management**

- Recommended antibiotic therapy depends on infecting organism
- Parenteral therapy required to ensure bactericidal concentration
- When empirical treatment is necessary need to consider
- Risk factors for certain organisms
- Local bacterial resistance patterns
- Need to determine
  - Antibiotic sensitivities
  - Minimum inhibitory concentrations

**Indications for surgical intervention**

- Moderate-to-severe heart failure as a result of valvular dysfunction
- Partial dehiscence of a prosthetic valve
- Persistent bacteraemia despite optimal antimicrobial therapy
- Absence of effective bactericidal treatment
- Fungal infective endocarditis
- Relapse of prosthetic-valve endocarditis
- *Staphylococcus aureus* prosthetic-valve endocarditis



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## Aortic dissection

- Commonest aortic emergency
- Incidence is twice that of ruptured abdominal aortic aneurysm
- Rare less than 40 years of age
- Most commonly seen between 50 and 70 years
- Male: female ratio is equal
- Associated with hypertension, Marfan's syndrome, bicuspid aortic valve

## Pathology

- Intimal tear results in blood splitting the aortic media
- Produces a false lumen that can progress in an antegrade or retrograde direction
- Rupture can occur back into the lumen or externally in to pericardium or mediastinum
- External rupture often results in fatal pericardial tamponade
- Commonest site of intimal tear is within 2-3 cm of aortic valve
- Also seen in descending aorta distal to left subclavian artery
- Dissection can result in occlusion of aortic branches
- Most commonly involved are renal, spinal, coronary or iliacs

## Classification

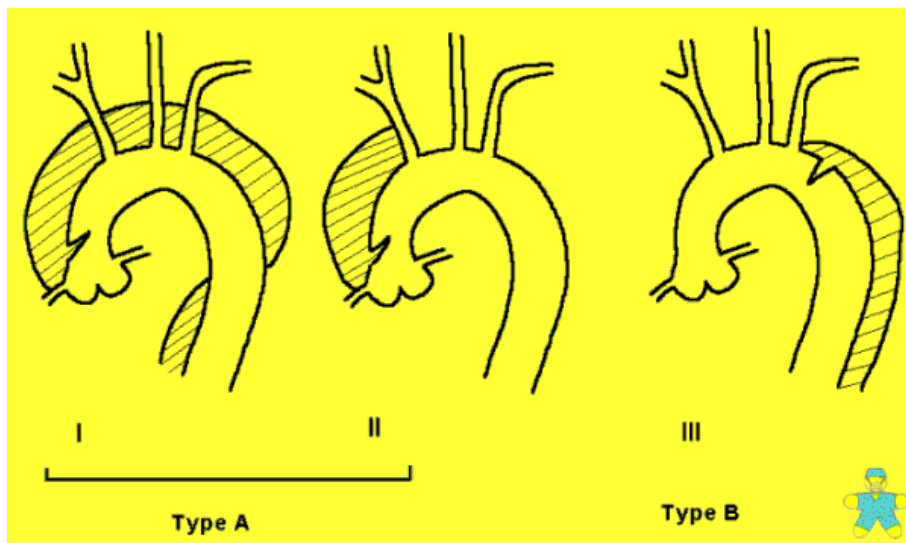


Figure 50 Classification of aortic dissection

- Two classifications in common use:
  - Stanford - Type A and B depending on whether ascending or descending aorta involved
  - DeBakey - Divided into Types I, II and III as above

## Clinical features

- Usually presents with tearing chest pain radiating to the back
- Often associated with an episode of collapse
- Examination may show
  - Reduced or absent peripheral pulses
  - Soft early diastolic murmur
- Chest x-ray usually shows a widened mediastinum



- Diagnosis can be confirmed by echocardiogram or CT scanning
- If aortic branches occluded there may clinical evidence of:
  - Acute renal failure
  - Paraplegia
  - Acute limb ischaemia
  - Cerebrovascular accident
- Inferior myocardial infarction



Figure 51 Thoracic CT scan showing a Type A aortic dissection

### Management

- All patients require urgent management of associated hypertension
- Type A dissections usually require surgical intervention
- Surgery performed via a median sternotomy and on cardiopulmonary bypass
- Dissection excised and aorta replaced with graft
- Aortic valve is preserved if possible
- An evolving CVA or established renal failure are contraindications to surgery
- Type B dissections may be treated without surgery
- Requires fastidious blood pressure control
- Surgery should be considered if evidence of aortic expansion
- Surgery for Type B dissections is associated with significant risk of paraplegia
- Without operation the prognosis for Type A dissections is poor
- 40% die within 24 hours and 80% die within 2 weeks
- Operative mortality is approximately 25%



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## **Thoracic trauma**

### **Primary survey chest injuries**

- Airway obstruction
- Tension pneumothorax
- Open pneumothorax
- Massive haemothorax
- Flail chest
- Cardiac tamponade

### **Secondary survey chest injuries**

- Pulmonary contusion
- Myocardial contusion
- Aortic disruption
- Traumatic diaphragmatic hernia
- Tracheobronchial disruption
- Oesophageal disruption

### **Management of the unstable patient**

#### **Indications for emergency room thoracotomy**

- Acute pericardial tamponade unresponsive to cardiac massage
- Exsanguinating intra-thoracic haemorrhage
- Intra-abdominal haemorrhage requiring aortic cross clamping
- Need for internal cardiac massage

#### **Indications for urgent thoracotomy**

- Chest drainage >1500 ml or >200 ml per hour
- Large unevacuated clotted haemothorax
- Developing cardiac tamponade
- Chest wall defect
- Massive air leak despite adequate drainage
- Proven great vessel injury on angiography
- Proven oesophageal injury
- Proven diaphragmatic laceration
- Traumatic septal or valvular injury of the heart

### **Haemothorax**

- Common after both penetrating and blunt trauma
- Pleural cavity can hold up to 3 litres of blood
- One litre may accumulate before apparent on chest x-ray
- 90% due to injury to internal mammary or intercostal vessels
- 10% from pulmonary vasculature
- Bleeding usually stops when lung re-expanded
- Most require no more than simple chest drainage



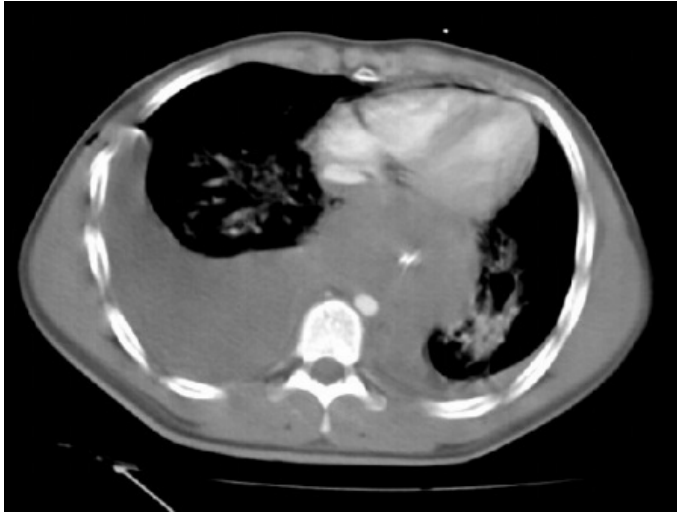


Figure 52 CT scan showing right haemothorax due to aortic rupture.



Figure 53 Chest x-ray showing traumatic left diaphragmatic rupture

### Pericardial tamponade

- Major complication of penetrating chest trauma
- Haemopericardium prevents diastolic filling of the heart
- Classic signs are Beck's triad
  - Hypotension
  - Venous distension
  - Muffled heart sounds
- May be associated with pulsus paradoxus
- Chest x-ray shows a globular heart
- Unstable patient requires urgent thoracotomy



- In stable patient diagnosis can be confirmed by echocardiography or pericardiocentesis
- Subxiphoid pericardiotomy is both a diagnostic and therapeutic procedure

### Cardiac stab wounds

- Right side of the heart is more commonly injured
- Patients with right ventricular wound is more like to survive than with left sided injury
- Atria, inflow and outflow tracts may also be damaged
- Patients usually presents with pericardial tamponade
- Treatment consists of resuscitation and pericardiocentesis
- Stab wounds can be accessed via a median sternotomy
- Can be directly repaired without cardiopulmonary bypass
- Teflon-pledgeted prolene sutures are generally used

### Injuries to the great vessels

- Suspect possibility of injury from the mechanism or site of penetrating injury
- Usually present with shock or pericardial tamponade
- Chest x-ray may show:
  - Widening of the mediastinum to greater than 8 cm
  - Depression of the left main bronchus to greater than 140 degrees
  - Haematoma in the left apical area
  - Massive left haemothorax
  - Deviation of oesophagus ton the right
  - Loss of aortic knob contour
  - Loss of paraspinal pleural stripe
- Requires emergency thoracotomy or sternotomy
- Injuries to descending thoracic aorta require left anterior thoracotomy
- Injuries to proximal aorta and proximal carotid arteries require median sternotomy

### Flail chest

- Flail chest is associated with multiple rib fractures on the same side
- Flail segment does not have continuity with remainder of thoracic cage
- Results in paradoxical chest wall movement with respiration
- Often associated with underlying pulmonary contusion
- Paradoxical movement results in impaired ventilation
- The work of breathing is increased
- Ventilation perfusion mismatch and arterio-venous shunting occurs
- Chest x-ray will show:
  - Multiple rib fractures
  - Underlying lung contusion
  - Haemopneumothorax
  - Other associated injuries
- Treatment requires:
  - Adequate ventilation
  - Humidified oxygen
  - Adequate analgesia
- Consider intubation and ventilation if:
  - Significant other injuries (ISS >50)
  - Respiratory rate more than 35 per min
  - Partial pressure oxygen less than 8.0 kPa
  - Partial pressure carbon dioxide greater than 6.6 kPa
  - Vital capacity less than 12 ml / kg



- Right to left shunt of more than 15%
- Operative fixation is not normally required

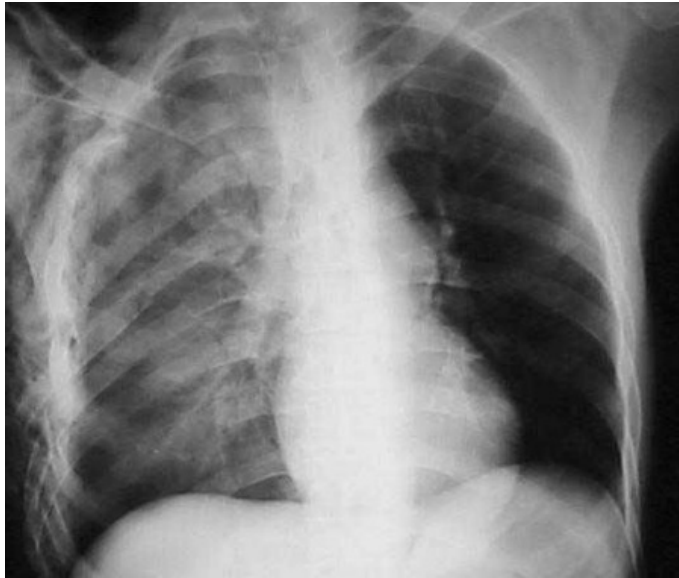


Figure 54 Chest x-ray showing a flail right chest due to multiple rib fractures

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## Thoracotomy & chest drainage

### **Chest drains**

- Chest drain is a conduit to remove air or fluid from the pleural cavity
- The fluid can be blood, pus or a pleural effusion
- Allows re-expansion of the underlying lung
- Must prevent entry of air or drained fluid back into the chest
- A chest drain must therefore have three components
- An unobstructed chest drain
- A collecting container below chest level
- A one-way mechanism such as water seal or Heimlich valve

### **Indications for chest drain insertion**

- Pneumothorax
  - In any ventilated patient
  - Tension pneumothorax after initial needle insertion
  - Persistent pneumothorax after simple aspiration
  - Large spontaneous pneumothorax in patients over 50 years
- Malignant pleural effusion
- Empyema and complicated parapneumonic pleural effusion
- Traumatic haemopneumothorax
- Post thoracotomy, oesophagectomy and cardiac surgery

### **Mechanism of action**

- Drainage occurs during expiration when pleural pressure is positive
- Fluid within pleural cavity drains into water seal
- Air bubbles through water seal to outside world
- The length of drain below fluid level is important
- If greater than 2-3 cms increases resistance to air drainage

### **Insertion**

- Unless emergency situation then pre-procedure chest x-ray should be performed
- Drain usually inserted under local anaesthesia using aseptic technique
- Inserted in 5<sup>th</sup> intercostal space in mid-axillary line
- Inserted over upper border of rib to avoid intercostal vessels and nerves
- Blunt dissection and insertion of finger should ensure that pleural cavity is entered
- Used to be taught that:
  - To drain fluid it should be inserted to base of pleural cavity
  - To drain air it should be inserted towards apex of lung
- Probably does not matter provided there is no loculation of fluid within pleural cavity
- A large drain (28 Fr or above) should be used to drain blood or pus
- Drain should be anchored and purse-string or Z-stitch inserted in anticipation of removal

### **Does and don'ts of chest drains**

- Avoid clamping of drain as it can result in a tension pneumothorax
- Drain should only be clamped when changing the bottle
- Always keep drain below the level of the patient
- If lifted above chest level contents of drain can siphon back into chest
- If disconnection occurs reconnect and ask patient to cough



- If persistent air leak consider low pressure suction
- Observe for post-expansion pulmonary oedema

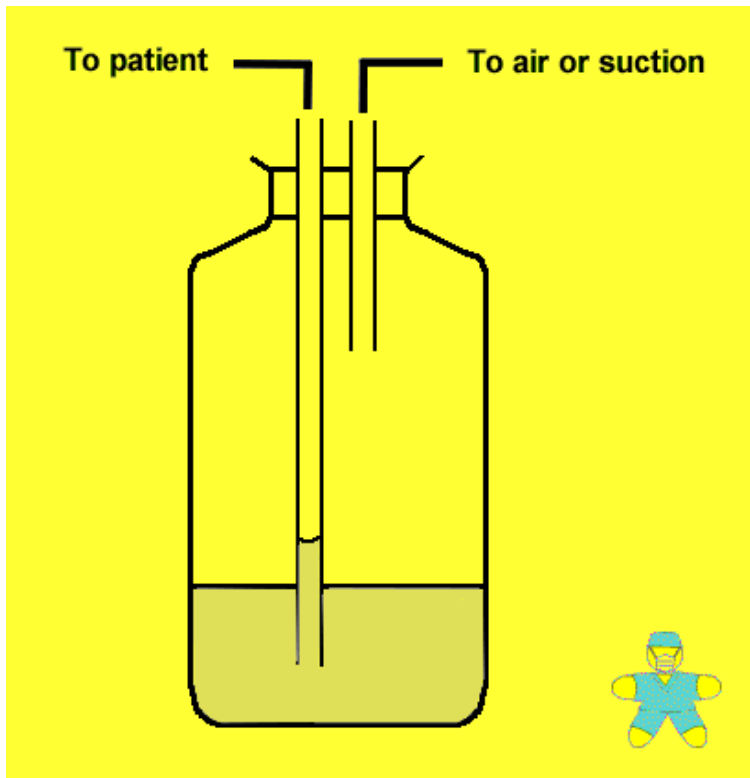


Figure 55 Principles of a chest drain



Figure 56 Left chest drain



## Removal

- Remove drain as soon as it has served its purpose
- For a simple pneumothorax it can often be removed within 24 hours
- To remove drain ask patient to perform a Valsalva manoeuvre
- Remove drain at the height of expiration
- Tie to pre-inserted purse-string or Z-stitch
- Perform a post-procedure chest x-ray to exclude a pneumothorax

## Complications

- "There is no organ in the thoracic or abdominal cavity that has not been pierced by a chest drain."

### *Early complications*

- Haemothorax
- Lung laceration
- Diaphragm and abdominal cavity penetration
- Bowel injury in the presence of unrecognised diaphragmatic hernia
- Tube placed subcutaneously
- Tube inserted too far
- Tube displaced

### *Late complications*

- Blocked drain
- Retained haemothorax
- Empyema
- Pneumothorax after removal

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## **Thoractomy**

- A surgical incision into the chest
- Used to gain access to thoracic organs
- Approach depends on procedure planned

### **Anterior incision**

- Principle option is anterior thoracotomy
- Used for:
  - Access to right middle lobe
  - Partial pericardectomy
- Provides poor access for pulmonary and oesophageal resections

### **Lateral incisions**

- Options include:
  - Axillary thoracotomy
  - Lateral (muscle-sparing) thoracotomy
  - The 'French' incision
- Used for access to mediastinum

### **Posterior thoracotomy**

- Option include:
  - Posterolateral thoracotomy
  - Posterior thoracotomy
- Used for:
  - Pneumonectomy
  - Oesophageal surgery
  - Tracheal surgery

## **Bibliography**



## **Surgical disorders of the Lung**

### ***Lung cancer***

#### **Epidemiology**

- Leading cause of cancer-related deaths in western world
- Affects 1.2 million people annually worldwide
- 40,000 cases diagnosed in the UK each year
- Results in 29,000 deaths
- Commonest malignancy in men
- Second commonest malignancy in women
- Male : female ratio = 3:2
- Overall, 5-year survival is about 6%

#### **Aetiology**

- Smoking is primary risk factor
- Responsible for 85% cases in UK
- The incidence of lung cancer is related to the number of cigarettes smoked
- Other risk factors include
  - Passive smoking
  - Environmental and occupational hazards
  - Diet
  - Genetic factors

#### **Pathology**

##### ***Adenocarcinoma***

- Accounts for 45% of all cases
- 75% cases are peripheral
- Lymph node metastases are common

##### ***Squamous cell carcinoma***

- Accounts for 30% of all cases
- 70% are centrally located near the hilum or major bronchi
- Often locally invasive

##### ***Large cell tumours***

- Account for 5-10% of tumours
- Usually peripherally located
- Poorly differentiated tumours may cavitate
- Early spread to distant sites

##### ***Small cell tumours***

- Accounts for 20% of tumours
- 80% centrally located
- Can produce neuroendocrine hormones
- May result in paraneoplastic syndromes
- Tendency to disseminate early





### Management of suspected lung cancer

- The aims of evaluating a patient with suspected lung cancer are to determine
  - Cell type of the tumour
  - Anatomical extent of the disease
  - Functional status of the patient

### Investigation of potential lung cancer

- Imaging
  - Chest x-ray
  - CT of chest
  - Positron emission tomography
  - Magnetic resonance imaging

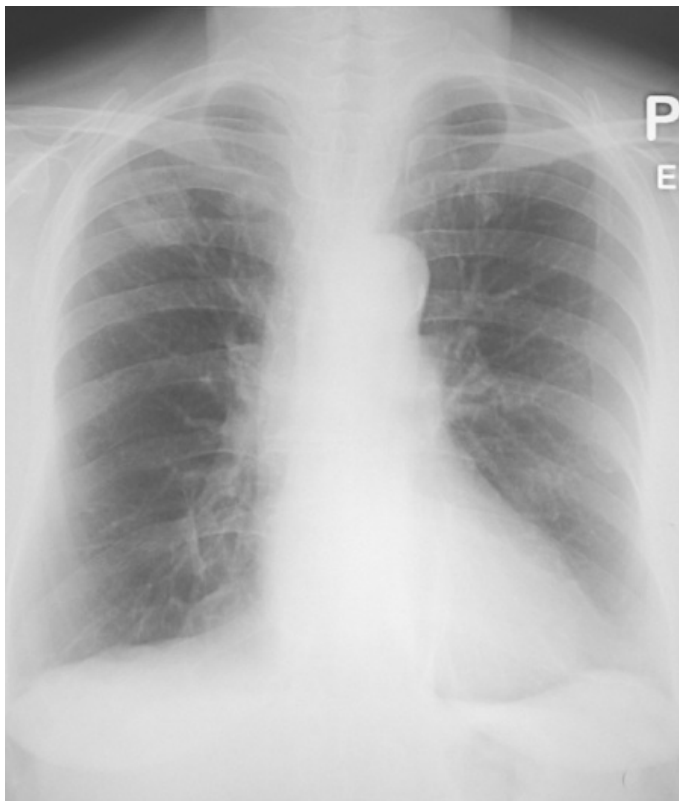


Figure 57 Chest x-ray of a bronchial carcinoma

- Invasive
  - Bronchoscopy
  - CT-guided percutaneous needle biopsy
  - Mediastinoscopy
  - Left anterior mediastinoscopy

### Surgical management

- Only surgery can cure non-small cell lung cancer
- Only 25% patients have resectable disease at presentation

### Preoperative assessment

- Patients require assessment of



- Pulmonary function
- Cardiac status
- Nutritional and performance status
- Pulmonary complications are commonest cause of postoperative morbidity and mortality
- Assessment of respiratory function is important
- Pulmonary function test are essential before surgery
- Full respiratory assessment includes:
  - FVC and FEV1
  - Estimation of transfer factor
  - Postoperative lung function prediction using anatomical equations
  - Quantitative isotope perfusions scans
- FEV1 and transfer factor less than 40% places patient in high risk group

### **Surgery**

- Lung resection is best treatment for Stage 1 and 2 disease
- Most patients with small-cell cancer are not suitable for surgery
- Five year survival decreases with extent of disease
- Aims of surgery are complete resection and intrapulmonary lymphatics
- Can be achieved with
  - Pulmonary lobectomy
  - Pneumonectomy
  - Sublobar resections
  - Bronchoplastic resections
- Mortality from lobectomy is 2-4%
- Mortality from pneumonectomy is 6-8%

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## Complications of thoracic operations

### Thoracotomy

- Thoracotomy allows access to the chest cavity
- Position of incision depends on intended operation or procedure
- Two different approaches exist
  - Lateral thoracotomy
  - Median sternotomy
- Lateral thoracotomy can be carried out in three different positions
  - Posterolateral
  - Anterolateral
  - Lateral or axillary
- Median sternotomy allows access to the anterior and superior mediastinum
- Sternum is divided with oscillating or Gigli saw or Lebske knife
- Ooze from the bone marrow may be stopped with bone wax
- Sternum is usually closed with steel wire

### Intrathoracic bleeding

- Usually occurs from lung parenchyma or bronchial vessels
- May present with clinical features of hypovolaemia
- Usually detectable from mediastinal or pleural drains
- Drains may however block and haemothorax may be detected on chest x-ray
- Can often be treated conservatively with transfusion
- Reoperation required if:
  - Rapid blood loss via chest drain
  - Significant intrapleural collection on chest x-ray
  - Persistent hypovolaemia despite transfusion
  - Hypoxia due to compression of underlying lung

### Sputum retention and atelectasis

- Failure to clear bronchial secretions can result in:
  - Bronchial obstruction
  - Atelectasis
  - Lobar collapse
  - Secondary pulmonary infection
- Presents as tachypnoea and hypoxia
- Examination usually shows reduced bilateral basal air entry
- Prevention is preferred to treatment
- Risk of sputum retention can be reduced by:
  - Preoperative cessation of smoking
  - Adequate postoperative pain relief
  - Chest physiotherapy
  - Humidification of inspired oxygen
  - Bronchodilator therapy
  - Early mobilisation after surgery
- Treatment required formal chest physiotherapy
- Mini-tracheostomy and suction may be required
- Antibiotics should be reserved for those with proven pneumonia



### Air leak

- Following lung resection residual lung tissue expands to fill pleural cavity
- Raw area can result in an air leak into the pleural cavity
- Presents as persist air leak or bubbling of chest drain
- Usually settles spontaneously over 2-3 days
- May require suction on pleural drains
- Apposition of lung to parietal pleura encourages efficient healing

### Bronchopleural fistula

- Results from major air leak from pneumonectomy bronchial stump
- Seen in 2% of patients undergoing pneumonectomy
- Airway thus directly communicates with pleural space
- Usually occurs as a result from a leak from a suture line
- Occurs particularly in those with factors impairing wound healing
- Most commonly occurs 7-10 days after surgery
- Presents with sudden breathlessness and expectoration of bloodstained fluid
- Fluid is that which normally fills the postpneumonectomy space
- Emergency treatment consists of lying patient with operated side downwards
- Providing oxygen and draining the pleural space
- Thoracotomy and repair of fistula may be required
- Repair may be reinforced with omental or intercostals muscle patch
- Thoracoplasty may be required to obliterate the postpneumonectomy space

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## **Pneumothorax & empyema thoracis**

### ***Pneumothorax***

- Pneumothorax is the presence of air within the pleural space
- Due to disruption of parietal, visceral or mediastinal pleura
- May also occur from spontaneous rupture of subpleural bleb
- A tension pneumothorax occurs when pleura form a one-way flap valve
- Tension pneumothorax is a medical emergency

### **Classification**

#### ***Spontaneous pneumothorax***

- Primary - no identifiable pathology
- Secondary - underlying pulmonary disorder
- Catamenial

#### ***Traumatic***

- Blunt or penetrating thoracic trauma
- Iatrogenic
- Postoperative
- Mechanical ventilation
- Thoracocentesis
- Central venous cannulation

#### **Primary spontaneous pneumothorax**

- Usually occurs in young healthy adult men
- 85% patients are less than 40 years old
- Male : female ratio is 6:1
- Bilateral in 10% of cases
- Occurs as result of rupture of an acquired subpleural bleb
- Blebs have no epithelial lining and arise from rupture of the alveolar wall
- Apical blebs found in 85% of patients undergoing thoracotomy
- Frequency of spontaneous pneumothorax increases after each episode
- Most recurrences occur within 2 years of the initial episode

#### **Secondary spontaneous pneumothorax**

- Accounts for 10-20% of spontaneous pneumothoraces
- Can be due to:
  - Chronic obstructive pulmonary disease with bulla formation
  - Interstitial lung disease
  - Primary and metastatic neoplasms
  - Ehlers-Danlos syndrome
  - Marfan's syndrome

#### **Traumatic pneumothorax**

- Can result from either blunt or penetrating trauma
- Tracheobronchial and oesophageal injuries can cause both mediastinal emphysema and pneumothorax
- Iatrogenic pneumothorax is common



- Occurs after:
- Pneumonectomy
- Thoracocentesis
- High-pressure mechanical ventilation
- Subclavian venous cannulation

### Clinical features

- Predominant symptom is acute pleuritic chest pain
- Dyspnoea results from pulmonary compression
- Symptoms are proportional to the size of the pneumothorax
- Also depend on the degree of pulmonary reserve
- Physical signs include:
  - Tachypnoea
  - Increased resonance
  - Absent breath sounds
- In a tension pneumothorax
  - The patient may be hypotensive with acute respiratory distress
  - The trachea may be shifted away from the affected side
  - Neck veins may be engorged
- Diagnosis can be confirmed with a chest x-ray

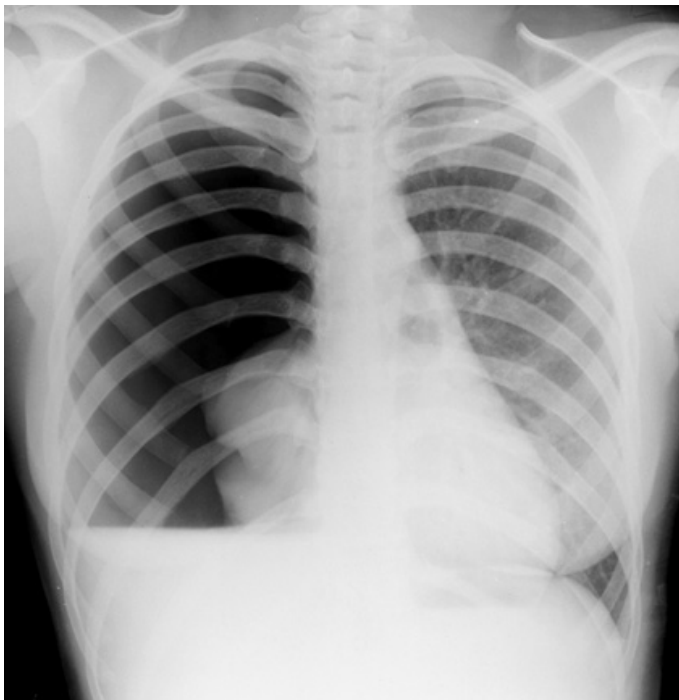


Figure 58 Chest x-ray showing a large right pneumothorax

### Management

#### *Spontaneous pneumothorax*

- Depends symptoms and the radiological size of the pneumothorax
- Small asymptomatic pneumothoraces (<20%) may simply be followed with serial chest x-rays



- If drainage required a chest drain should be inserted
- Through the 5th intercostal space
- Just above the upper border of the rib
- Blunt insertion (rather than using the trocar) should be used
- Position should be checked with a chest x-ray
- Should be connected to an underwater seal placed below the level of the patient

### **Tension pneumothorax**

- Prophylactic chest drains should be inserted in patients with rib fractures prior to ventilation
- Tension pneumothorax requires immediate needle aspiration
- Inserted anteriorly through the 2nd intercostal space
- Chest drain can then be inserted

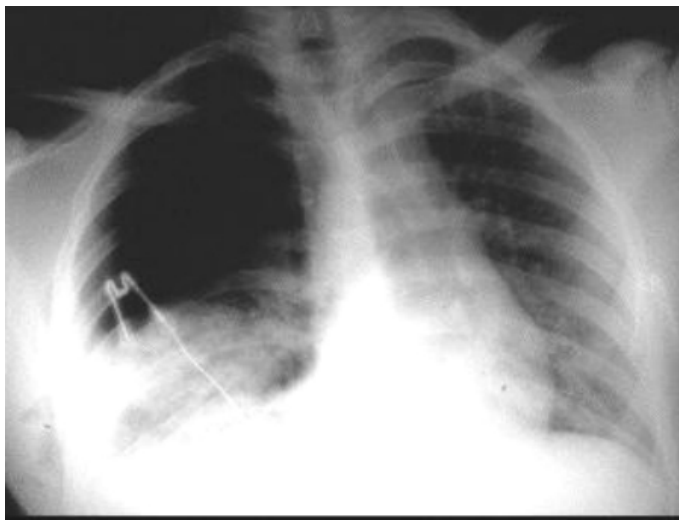


Figure 59 Tension pneumothorax

### **Surgery**

- Surgery is required for:
  - Air leak persisting for more than 10 days
  - Failure of lung re-expansion
  - Recurrent spontaneous pneumothorax
- Surgical options include:
  - Partial pleurectomy
  - Operative abrasion of pleural lining
  - Resection of pulmonary bullae
- Poor-risk patients may benefit from chemical pleurodesis with tetracycline

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## ***Pneumonia, lung abscess and empyema***

### **Lung abscess**

- Some patients with pneumonia develop focal necrosis and a lung abscess
- Particularly occurs in patients with malignancy and malnutrition
- Can also occur following aspiration or inhalation of a foreign body
- Diagnosis can be difficult

### **Clinical features**

- Usually clinical features of pneumonia that fails to improve with antibiotics
- Patient develops pleuritic chest pain and haemoptysis
- Volume of sputum produced may increase
- Patients usually systemically unwell with swinging pyrexia
- Examination usually shows signs of pneumonia
- Commonest complication is an empyema
- Differential diagnosis includes:
  - Primary lung neoplasm
  - Tuberculosis
  - Aspergillosis
  - Lung cyst

### **Investigations**

- Chest x-ray may show cavity with air / fluid level
- CT scanning will confirm diagnosis of chest x-ray inconclusive
- Bronchoscopy should be considered to exclude foreign body

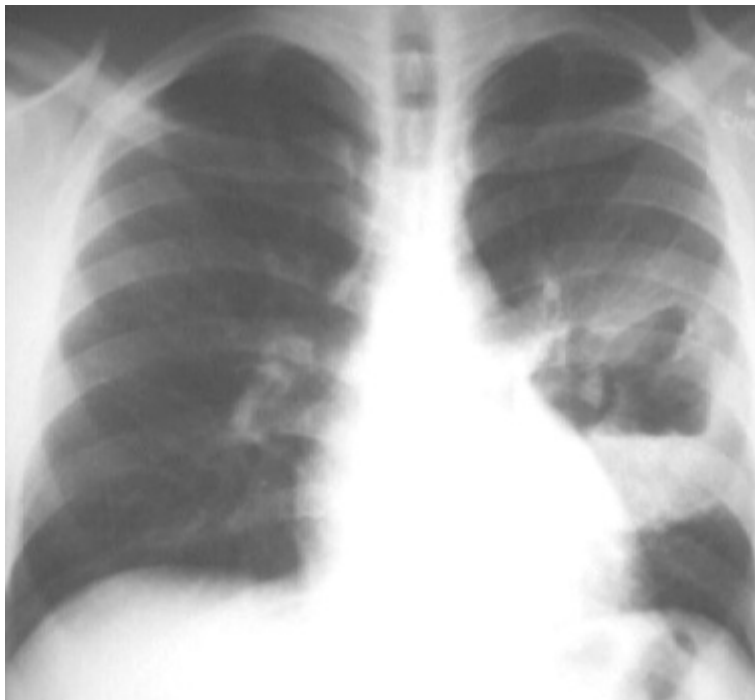


Figure 60. Chest x-ray of lung abscess





### **Management**

- Appropriate antibiotic therapy based on sputum culture result
- Percutaneous aspiration if fails to improve with antibiotics
- For abscesses greater than 5 cm diameter open drainage may be required
- Thoracotomy and lung resection should be considered

### **Empyema**

- Empyema is pus within a body cavity
- Lung empyema usually occurs secondary to pneumonia
- Collection is often multiloculated
- If diagnosis is delayed it will also have a thick, fibrous wall
- Also seen following:
  - Oesophageal perforation or rupture
  - Blunt or penetrating thoracic trauma
  - Nasopharyngeal sepsis that has spread to chest
  - Thoracic surgical procedures

### **Clinical features**

- Usually clinical features of pneumonia that fails to improve with antibiotics
- Pleuritic chest pain and breathlessness
- Examination may show clinical features of pleural fluid
- Chest x-ray will show fluid within the pleural cavity
- CT scanning will confirm diagnosis
- Percutaneous aspiration will provide microbiological sample for culture

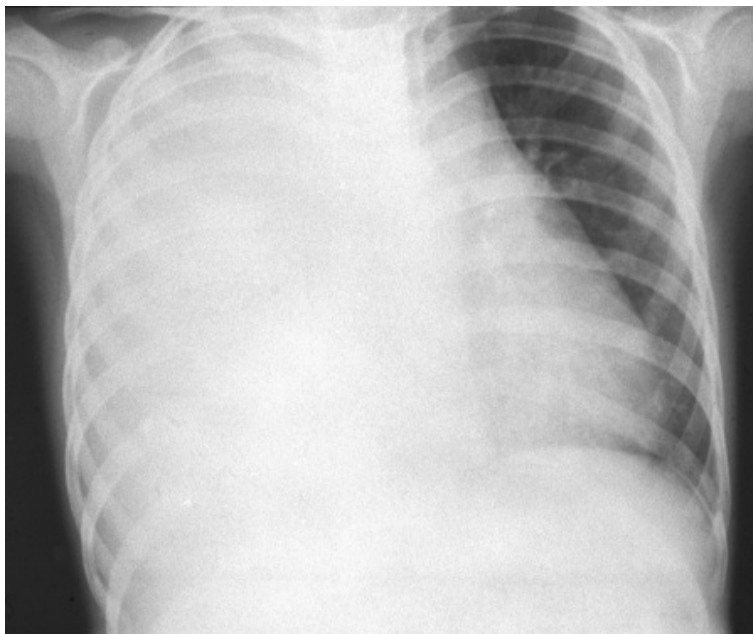


Figure 61. Chest x-ray of empyema

### **Management**

- Appropriate antibiotic therapy based on sputum culture result
- If fails to resolve will require drainage
- Pleural drainage should be with adequate (28Fr) chest drain



- Thoracoscopy may be required to break down loculi
- Decortication of visceral and parietal pleura may be required to allow lung expansion
- Post-operative adequate drainage is required
- Pneumothorax is not a risk due to resulting pleural scarring

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## General surgery

### Abdominal trauma

#### *Assessment and management*

##### Assessment of abdominal trauma

- Assessment of patients with abdominal trauma can be difficult due to:
  - Altered sensorium (head injury, alcohol)
  - Altered sensation (spinal cord injury)
  - Injury to adjacent structures (pelvis, chest)
- Pattern of injury will be different between penetrating and blunt trauma

##### Indications for laparotomy

- Unexplained shock
- Rigid silent abdomen
- Evisceration
- Radiological evidence of intraperitoneal gas
- Radiological evidence of ruptured diaphragm
- Gunshot wounds
- Positive result on peritoneal lavage

##### Imaging

- Either CT or ultrasound can be used for the assessment of abdominal trauma
- CT scanning is preferred method but requires patient to be cardiovascularly stable
- Ultrasound has high specificity but low sensitivity for the detection of free fluid or visceral damage

##### **FAST**

- Focused assessment for the sonographic assessment of trauma
- Is the use of ultrasound to rapidly assess for intraperitoneal fluid
- Probe is placed on the:
  - Right upper quadrant
  - Left upper quadrant
  - Suprapubic region
- Fluid in subphrenic, subhepatic spaces or Pouch of Douglas in hypotensive patient
- Confirms likely need for emergency laparotomy

##### Peritoneal lavage

###### *Indications*

- Equivocal clinical examination
- Difficulty in assessing patient - alcohol, drugs, head injury etc
- Persistent hypotension despite adequate fluid resuscitation
- Multiple injuries
- Stab wounds where the peritoneum is breached



### **Method**

- Ensure that catheter and NGT are in place
- Under LA make vertical sub-umbilical incision dividing linea alba
- Incise peritoneum and insert peritoneal dialysis catheter
- Aspirate any free blood or enteric contents
- If no blood aspirated infuse 1L of normal saline and allow 3 min to equilibrate
- Place drainage bag on floor and allow to drain
- Send 20 ml to laboratory for measurement of RBC, WCC and microbiological examination

### **Positive result**

- Red cell count > 100 000 / mm<sup>3</sup>
- White cell count > 500 / mm<sup>3</sup>
- Presence of bile, bacteria or faecal material

### **Damage Control Surgery**

- Following multiple trauma poor outcome is seen in those with:
  - Hypothermia
  - Coagulopathy
  - Severe acidosis
- Prolonged surgery can exacerbate these factors
- As a result the concept of 'damage control' surgery has been developed
- Damage control surgery should be considered if a patient with multiple trauma has
  - Injury severity score greater than 25
  - Core temperature less than 34 degree
  - Arterial gas pH less than 7.1

### **Initial operation**

- Early management of major abdominal trauma surgery should aim to:
- Control haemorrhage with ligation of vessels and packing
- Remove dead tissue
- Control contamination with clamps and stapling devices
- Lavage the abdominal cavity
- Close the abdomen without tension
- A plastic sheet or 'Bogata bag' may be useful

### **Intensive care unit**

- Early surgery should be followed by a period of stabilisation on the intensive care unit
- During this period the following should be addressed:
  - Rewarming
  - Ventilation
  - Restoration of perfusion
  - Correction of deranged biochemistry
  - Commence enteral or parenteral nutrition

### **'Second look laparotomy'**

- Planned re-laparotomy at 24 - 48 hours allows:
  - Removal of packs
  - Removal of dead tissue
  - Definitive treatment of injuries
- Restoration of intestinal continuity



- Closure of musculofacial layers of abdominal wall
- This approach has been shown to be associated with a reduced mortality



Figure 62 Laparostomy managed with a 'Bogota bag'

### Gastrointestinal injury

- Small bowel perforations can invariably be primarily closed
- The management of colonic perforations is more controversial
- Used to common practice to excise damaged segment
- Proximal stoma was then fashioned
- Perforation could also be exteriorised as a stoma
- Increasingly recognised that primary repair of colonic injuries is safe
- Now recommended method, especially in the absence of significant contamination

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### **Splenic injury**

- Splenic injury can be either accidental or iatrogenic
- Most commonly associated with blunt trauma
- Often occurs in the presence of lower rib fractures
- May be common clinically apparent either early or delayed
- Delayed injury is usually due to rupture of subcapsular haematoma
- 20% of splenic injuries occur inadvertently during other abdominal operations
- In some patients spontaneous rupture can occur following trivial trauma
- Spleen is invariably abnormal due to, for example, malaria or infectious mononucleosis

### **Clinical feature**

- Clinical features depend on extent of blood loss and presence of associated injuries
- Clinical features range from left upper quadrant pain to shock and peritonitis
- 30 to 60% of patients have other associated intraperitoneal injuries

### **Grading**

- Grade 1 – Minor subcapsular tear or haematoma
- Grade 2 – Parenchymal injury not extending to the hilum
- Grade 3 – Major parenchymal injury involving vessels and hilum
- Grade 4 – Shattered spleen



Figure 63 CT scan of Grade 2 splenic injury

### **Management**

- If cardiovascularly unstable requires resuscitation and early surgery
- If cardiovascularly stable consider either ultrasound or CT scan
- If isolated Grade 1 or 2 splenic injury may be suitable for conservative management

### **Surgical options**

- Surgical management can involve either splenectomy or splenic repair



- Main benefit of retaining the spleen is the prevention of overwhelming postsplenectomy infection (OPSI)
- If splenic conservation attempted need to preserve more than 20% of tissue

### **Conservative management**

- Overall 20-40% of patients are suitable for conservative management
- Children can often be managed conservatively as they have
  - More low grade injuries
  - Fewer multiple injuries
- Should be monitored in high dependency unit
- Require cardiovascular and haematological monitoring
- If successful patients should remain on:
  - Bed rest for 72 hours
  - Limited physical activity for 6 weeks
  - No contact sports for 6 months
- Surgery needed if clinically hypovolaemic or they have a falling haematocrit
- Approximately 30% of patients fail conservative management
- Usually occurs within the first 72 hours of injury
- Failed conservative management often results in splenectomy
- Overall more spleens can often be conserved by early surgery

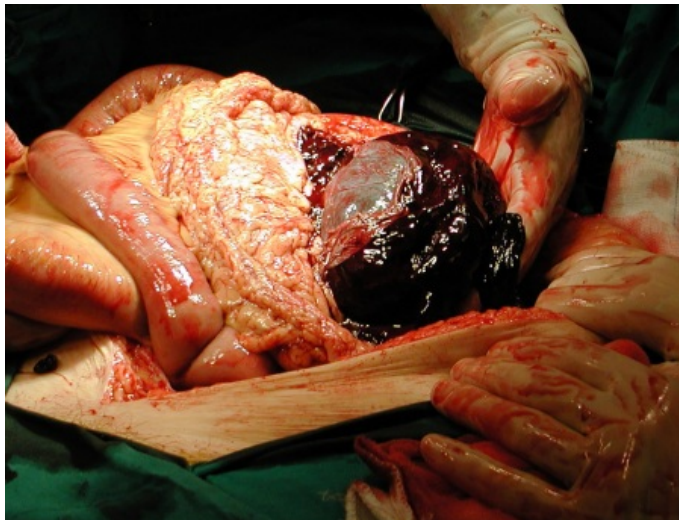


Figure 64 Intraoperative appearance of ruptured subcapsular haematoma

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## Common abdominal problems

### Investigation of abdominal masses

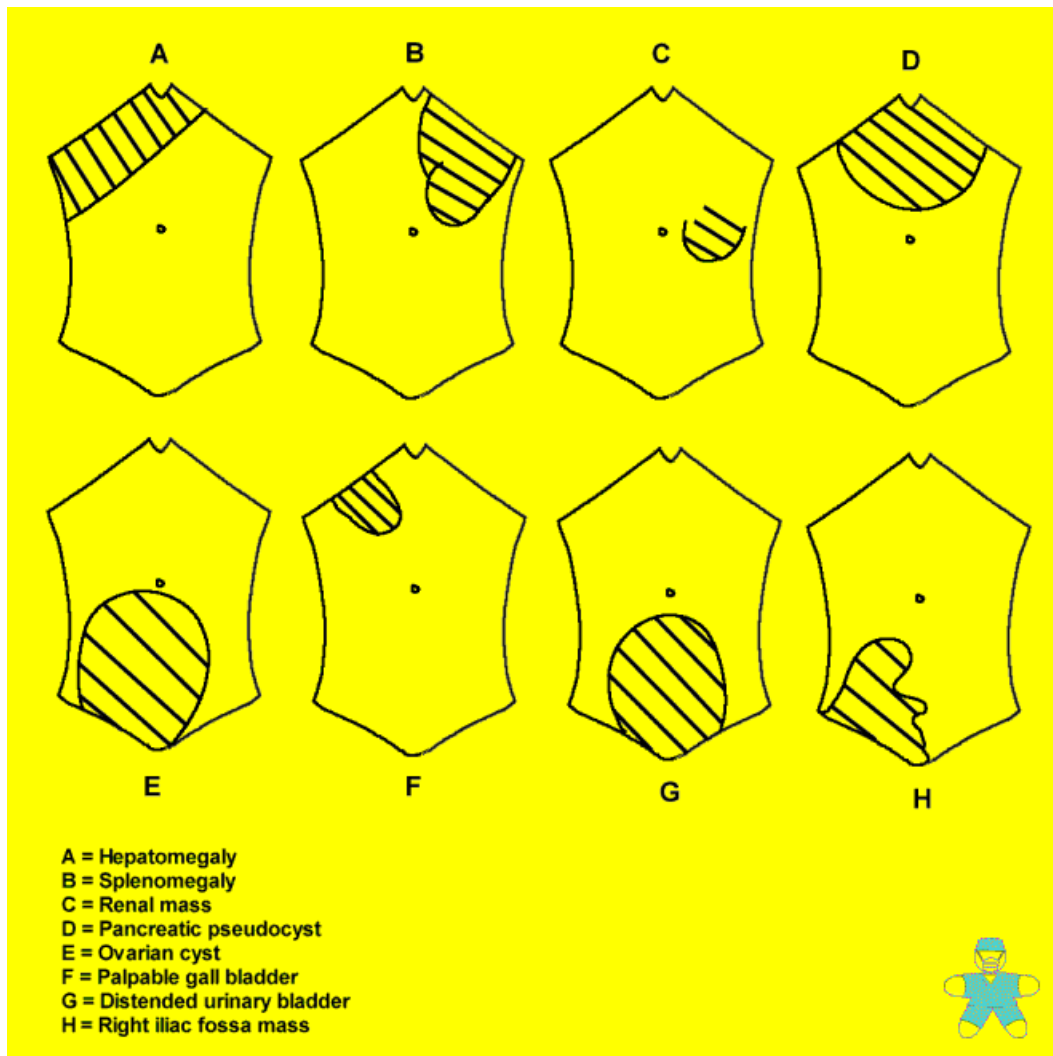


Figure 65 Clinical signs of abdominal masses

### Physical signs of abdominal masses

#### Signs of hepatomegaly

- Mass descending below right costal margin and costal angle
- Moves with respiration and can not get above it
- Dullness to percussion up to the level of the 8<sup>th</sup> rib in the mid-axillary line

#### Signs of splenomegaly

- Mass descending below the left 10<sup>th</sup> rib and enlarging in a line towards the umbilicus
- Often has a palpable notch on the medial border
- Moves with respiration and can not get above it
- Dullness to percussion
- Can be brought forward by lifting the lower ribs but can not be felt bimanually or balloted





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**Signs of a renal mass**

- Mass lies in paracolic gutter
- Moves with respiration but usually only lower border is palpable
- Can be felt bimanually or balloted
- Not dull to percussion

**Signs of an enlarged gallbladder**

- Mass arising from below the tip of the right 9<sup>th</sup> rib
- Smooth and hemi-ovoid in shape
- Moves with respiration
- Dull to percussion
- Can not feel space between mass and liver

**Signs of an enlarged urinary bladder**

- Hemi-ovoid smooth mass arising from the pelvis
- Can extend above umbilicus
- Non-mobile and dull to percussion
- Does not bulge into the pelvis
- Can not be felt on rectal examination

**Signs of an ovarian cyst**

- Smooth mass arising from the pelvis
- Mobile from side-to-side but not up and down
- Dull to percussion
- Palpable fluid thrill
- Lower extremity can be felt on pelvic examination

**Causes of hepatomegaly****Smooth generalised enlargement**

- Congestion due to cardiac failure
- Micronodular cirrhosis
- Reticuloses
- Hepatic vein obstruction (Budd-Chiari syndrome)
- Infective hepatitis
- Cholangitis
- Portal pyaemia
- Amyloidosis

**Knobbly generalised enlargement**

- Secondary carcinoma
- Macronodular cirrhosis
- Polycystic disease

**Localised swelling**

- Riedel's lobe
- Hydatid cyst
- Liver abscess
- Hepatocellular carcinoma



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## **Causes of splenomegaly**

### ***Infection***

- Bacterial - typhoid, typhus, TB
- Viral - glandular fever
- Protozoal - malaria, kala-azar

### ***Cellular proliferation***

- Myeloid and lymphatic leukaemia
- Pernicious anaemia
- Polycythaemia rubra vera
- Spherocytosis
- Thrombocytopenia purpura
- Myelosclerosis

### ***Congestion***

- Portal hypertension
- Hepatic vein obstruction
- Congestive heart failure

### ***Others***

- Amyloidosis
- Gaucher's disease
- Felty's syndrome
- Angioma
- Lymphosarcoma

## **Causes of a renal mass**

- Hydronephrosis
- Pyonephrosis
- Perinephric abscess
- Hypernephroma
- Nephroblastoma
- Solitary cyst
- Polycystic disease

## **Causes of a palpable gall bladder**

### ***Obstruction of the cystic duct***

- Stone in Hartmann's pouch
- Cholangiocarcinoma

### ***Obstruction of the common bile duct***

- Stone in common bile duct
- Carcinoma of the head of the pancreas

### ***Courvoisier's law***

- 'If in the presence of jaundice the gallbladder is palpable, the obstruction of the bile duct causing the jaundice is unlikely to be due to a stone.'
- Stones causes a thickened non-distensible gall bladder



### **Causes of a right iliac fossa mass**

- Appendicitis
- Tuberculosis
- Carcinoma of the caecum
- Crohn's disease
- Iliac lymphadenopathy
- Psoas abscess



## Abdominal emergencies

### Investigation of abdominal pain

- Emergency admissions account for 50% of general surgical work load
- 50% of emergency admissions are for abdominal pain

Table 29 Conditions presenting with acute abdominal pain

Condition	Percentage
Non-specific abdominal pain	35
Acute appendicitis	17
Intestinal obstruction	15
Urological causes	6
Gallstone disease	5
Colonic diverticular disease	4
Abdominal trauma	3
Abdominal malignancy	3
Perforated peptic ulcer	3
Pancreatitis	2
Ruptured AAA	<1
Inflammatory bowel disease	<1
Gastroenteritis	<1
Mesenteric ischaemia	<1

### Causes of non-specific abdominal pain

- Viral infections
- Bacterial gastroenteritis
- Worm infestations
- Irritable bowel syndrome
- Gynaecological causes
- Psychosomatic pain
- Abdominal wall pain
- Iatrogenic peripheral nerve injuries
- Hernia
- Myofascial pain syndrome
- Rib tip syndrome
- Nerve root pain
- Rectus sheath haematoma

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## Peritonitis

- Intra-abdominal infections results in two major clinical manifestations
- Early or diffuse infection results in localised or generalised peritonitis
- Late and localised infections produces an intra-abdominal abscess
- Pathophysiology depend on competing factors of bacterial virulence and host defences
- Bacterial peritonitis is classified as primary or secondary

### Primary peritonitis

- Diffuse bacterial infection without loss of integrity of GI tract
- Often occurs in adolescent girls
- *Streptococcus pneumonia* commonest organism involved

### Secondary peritonitis

- Acute peritoneal infection resulting from GI perforation, anastomotic dehiscence or infected pancreatic necrosis
- Often involves multiple organisms - both aerobes and anaerobes
- Commonest organisms are *E. coli* and *Bacteroides fragilis*

### Surgical management

- The management of secondary peritonitis involves
  - Elimination of the source of infection
  - Reduction of bacterial contamination of the peritoneal cavity
  - Prevention of persistent or recurrent intra-abdominal infections
- Could be combined with fluid resuscitation, antibiotics and ITU / HDU management
- Source control achieved by closure or exteriorisation of perforation
- Bacterial contamination reduced by aspiration of faecal matter and pus
- Recurrent infection prevented by the used of:
  - Drains
  - Planned re-operations
  - Leaving the wound open / laparostomies

### Peritoneal Lavage

- Peritoneal lavage often used but benefit is unproven
- Simple swabbing of pus from peritoneal cavity may be of same value
- Has been suggested that lavage may spread infection or damage peritoneal surface
- No benefit of adding antibiotics to lavage fluid
- No benefit of adding Chlorhexidine or Betadine to lavage fluid
- If used, lavage with large volume of crystalloid solution probably has best outcome

### Intra-abdominal abscesses

- An intra-abdominal abscess may arise following:
  - Localisation of peritonitis
  - Gastrointestinal perforation
  - Anastomotic leak
  - Haematogenous spread
- They develop in sites of gravitational drainage
  - Pelvis
  - Subhepatic spaces
  - Subphrenic spaces
  - Paracolic gutters



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### **Clinical features**

- Postoperative abscesses usually present at between 5 and 10 days after surgery
- Suspect if unexplained persistent or swinging pyrexia
- May also cause abdominal pain and diarrhoea
- A mass may be present with overlying erythema and tenderness
- A pelvic abscess may be palpable only on rectal examination

### **Management**

- Ultrasound scanning may reveal the diagnosis
- Contrast-enhanced CT is probably the investigation of choice
- May delineate a gastrointestinal or anastomotic leak
- Identifies collection and often allows percutaneous drainage
- Operative drainage may be required if:
  - Multi-locular abscess
  - No safe route for per cutaneous drainage
  - Recollection after percutaneous drainage
  - Patients should receive antibiotic therapy guided by organism sensitivities

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### Acute appendicitis

- Acute abdominal pain is defined as undiagnosed pain of less than 72 hours duration
- Accounts for about 2% of hospital admissions
- In only 50% of patients is the preoperative diagnosis correct
- Right iliac fossa pain accounts for about half of all cases of acute abdominal pain

### Causes of right iliac fossa pain

- Appendicitis
- Urinary tract infection
- Non-specific abdominal pain
- Pelvic inflammatory disease
- Renal colic
- Ectopic pregnancy
- Constipation

### Causes of right iliac fossa mass

- Appendix mass
- Crohn's disease
- Caecal carcinoma
- Mucocele of the gallbladder
- Psoas abscess
- Pelvic kidney
- Ovarian cyst

### Appendicitis

- About 10% of the population will develop acute appendicitis
- The incidence is falling
- 70,000 appendicectomies are performed each year in the UK
- Appendicitis is more common in men
- Appendectomy is performed more often in women
- At 10-20% appendicectomies a normal appendix is removed

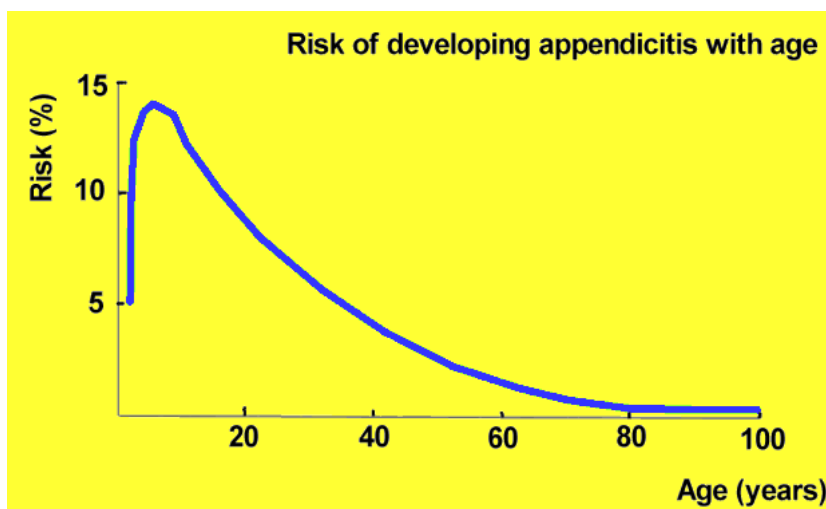


Figure 66 Risk of developing appendicitis with age



- The risk of perforation is:
- Less than 10 years old = 50%
- 10-50 years old = 10%
- Over 50 years old = 30%
- A women is more likely to have a normal appendix removed

#### Clinical features of appendicitis

- Central abdominal pain moving to right iliac fossa
- Nausea, vomiting, anorexia
- Low-grade pyrexia
- Localised tenderness in right iliac fossa
- Right iliac fossa peritonism
- Percussion tenderness is a kinder sign of peritonism than rebound
- Rovsing's sign = pain in RIF with palpation in LIF

#### Investigations

- Appendicitis is essentially a clinical diagnosis
- The following may be useful:
  - Urinalysis may exclude urinary tract infection
  - Pregnancy test to exclude ectopic pregnancy
  - Abdominal Xray is of little value
  - A normal white cell count does not exclude appendicitis
  - Ultrasound may be helpful in the assessment of an appendix mass or abscess
  - Scoring systems and computer-aided diagnosis may be helpful
- Meta-analysis suggest the following to be useful predictors of appendicitis in patients with abdominal pain
  - Raised inflammatory markers
  - Clinical signs of peritoneal irritation
  - Migration of abdominal pain



Figure 67 Features of appendicitis on ultrasound





### Management of acute RIF pain

- In cases of diagnostic doubt a period of 'active observation' is useful
- Active observation reduces negative appendectomy rate without increased risk of perforation
- Intravenous fluids and analgesia should be given
- Opiate analgesia does not mask the signs of peritonism
- Antibiotics should not be given until a decision to operate has been made
- Diagnostic laparoscopy should be considered particularly in young women
- Whether a 'normal' appendix should be removed following laparoscopy is unclear

### Appendectomy

- Early appendectomy for non-perforated appendicitis was first performed in 1880s
- Open appendectomy is usually performed via a Lanz incision and muscle splitting approach
- No evidence that burying the stump reduces the infection rate
- Consider a midline incision in elderly patients



Figure 68 Acute appendicitis

- Laparoscopic appendectomy may be associated with:
  - Reduced hospital stay
  - Rapid return to normal activity
- Overall benefits of laparoscopic approach not as great as for cholecystectomy

### Appendix mass

- Usually presents with a several day history
- Inflammation localised to RIF by the omentum
- Patient is usually pyrexial with a palpable mass
- Initial treatment should be conservative
- Fluids, analgesia and antibiotics
- Observe the patient and mass
- Continue conservative whilst there is clinical improvement



Figure 69 Laparoscopic appendicectomy

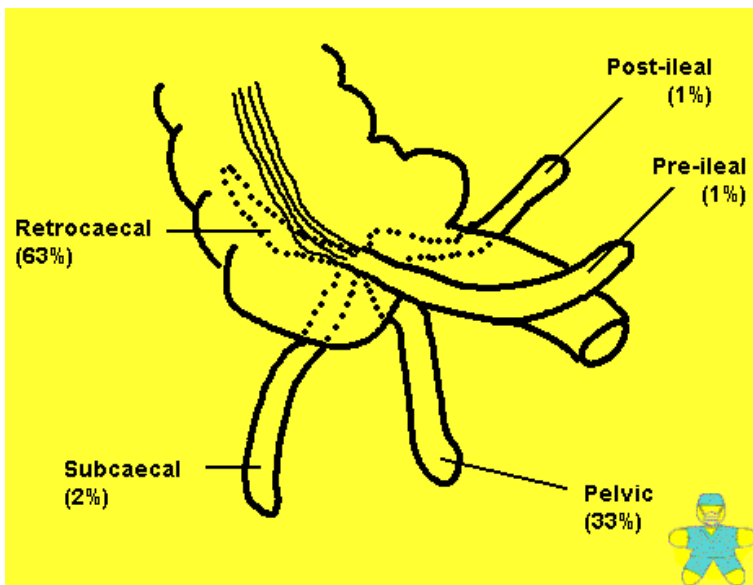


Figure 70 Relative position of appendix

### Appendix abscess

- Results from localised perforation
- Abscess should be surgically or percutaneously drained
- Appendicectomy at initial operation can be difficult
- Need for appendicectomy after abscess drainage is unclear

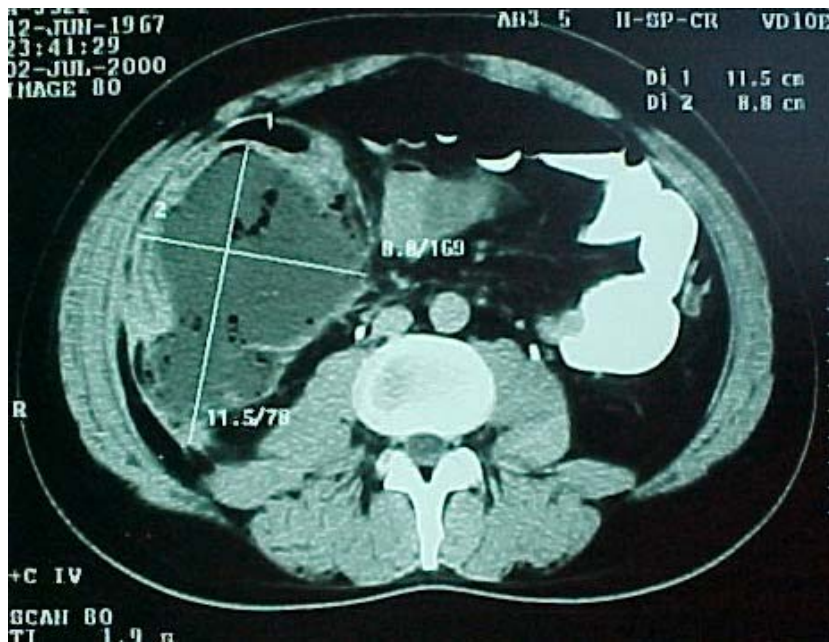


Figure 71 Appendix abscess on CT scan

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### **Perforated peptic ulcer**

- 50 years ago perforated peptic ulcer was a disease of young men
- Today it is a problem seen mainly in elderly women
- Overall incidence for admission with peptic ulceration is falling
- The number of perforated ulcers remains unchanged
- Sustained incidence possibly due to increased NSAID in elderly
- 80% of perforated duodenal ulcers are *H. pylori* positive

### **Clinical Features**

- Most occur in patients with pre-existing dyspepsia
- 10% have no previous symptoms
- Classic presentation is with:
  - Sudden onset epigastric pain
  - Rapid generalisation of pain
  - Examination shows peritonitis with absent bowel sounds
- 10% have an associated episode of melaena
- 10% have no demonstrable gas on an erect CXR
- If diagnostic doubt then water soluble contrast enema may confirm perforation
- Can be associated with elevated serum amylase but not to same level as in pancreatitis

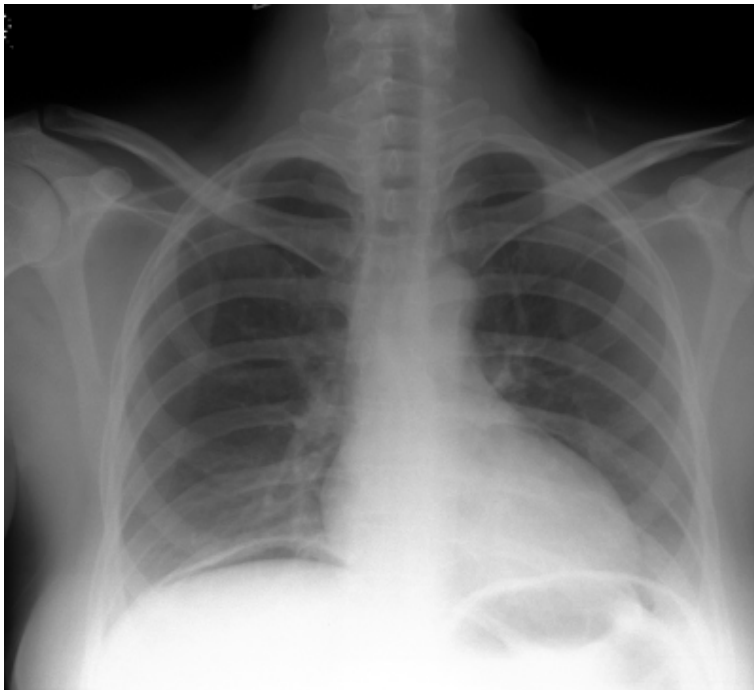


Figure 72 Free gas under the diaphragm

### **Management**

- Most patients require surgery after appropriate resuscitation
- Conservative management may be considered if significant co-morbidity
- More likely to fail if perforation is of a gastric ulcer
- Laparoscopic techniques have recently been described



### Preoperative preparation

- Fluid resuscitation with CVP or Swan Ganz monitoring
- Analgesia
- Antibiotics
- Nasogastric intubation

### Operation

- Oversew first performed by Dean in 1894
- Upper midline incision
- Oversew perforation with omental patch
- Use 2/0 synthetic absorbable.
- Take 1 cm bites either side of ulcer
- Thorough wash out and irrigation with 0.9% saline
- If unable to find perforation open the lesser sac
- Remember that multiple perforations can occur
- If closure secure and adequate toilet then a drain is not required
- Prepyloric ulcer behave as duodenal ulcers
- All gastric ulcers require biopsy to exclude malignancy
- Definitive ulcer surgery probably not required
- 50% patients develop no ulcer recurrence
- Postoperatively patients should receive *H. pylori* eradication therapy
- Surgery increasingly performed laparoscopically
- Associated with no increased morbidity and reduced hospital stay

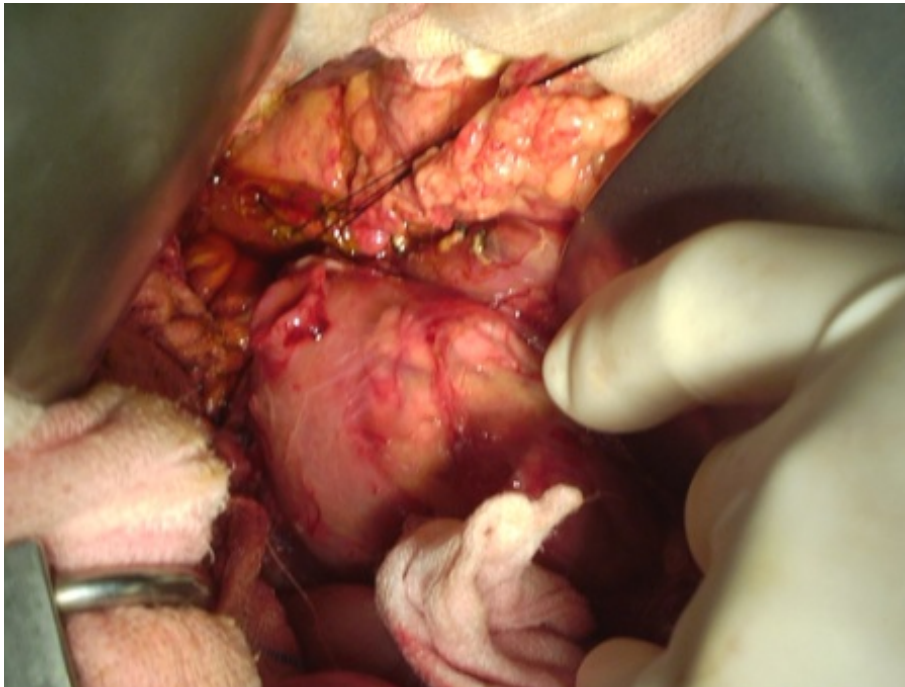


Figure 73 Perforated duodenal ulcer



### Outcome

- Operative mortality depends on four major risk factors
  - Long period from perforation to admission
  - Increasing age
  - Coexisting medical disease
  - Hypovolaemia on admission

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### **Acute mesenteric ischaemia**

- First described by Virchow in 1852
- Occurs as result of either superior mesenteric arterial or venous occlusion
- Affects bowel from 2<sup>nd</sup> part of duodenum to transverse colon
  - 50% embolic arterial occlusion
  - 25% atheromatous arterial occlusion
  - 10% venous occlusion
- Whatever the underlining aetiology reduced capillary flow causes intestinal necrosis
- Overall mortality is approximately 90%

### **Clinical features**

- No single clinical feature provided conclusive evidence of the diagnosis
- As a result the diagnosis is difficult and often delayed
- Early diagnosis requires a high index of suspicion
- Severe central abdominal pain is a common presentation
- Often is out of proportion to the apparent clinical signs
- Vomiting and rectal bleeding may also occur
- Features of chronic mesenteric ischaemia may also be present
- May also be evidence of an embolic source (e.g., recent MI, cardiac arrhythmia)
- May also be other features of atherosclerotic disease
  - 75% have ischaemic heart disease
  - 25% have cerebrovascular disease
  - 10% have peripheral vascular disease

### **Investigations**

- No single investigation provides pathognomic evidence
- Serum white cell count is often raised
- Arterial blood gases may show a metabolic acidosis
- Serum amylase is raised in 50% of patients
- Abdominal x-ray may be normal early in the disease process
- Late features include dilated small bowel and 'thumb printing' due to mucosal oedema
- Mesenteric angiography may confirm the diagnosis

### **Management**

- Papaverine infusion into the SMA may be beneficial
- If fails to rapidly improve symptoms then laparotomy may be indicated
- Laparotomy allows:
  - Confirmation of diagnosis and assessment of extent of ischaemia
  - Opportunity to revascularise SMA
  - Resect necrotic small intestine
- Revascularisation may be achieved by embolectomy, bypass or endarterectomy
- Resection and primary anastomosis may be possible
- If doubt over bowel viability then a 'second-look' laparotomy may be considered
- If extensive necrosis in elderly patient then palliative care may be preferred option



Figure 74 Acute mesenteric ischaemia

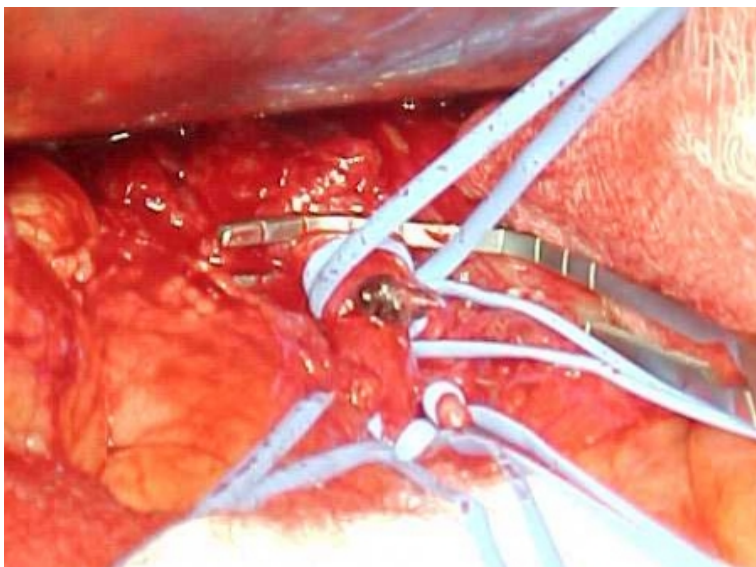


Figure 75 Superior mesenteric artery embolectomy

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## ***Upper gastrointestinal haemorrhage***

### **Causes of upper gastrointestinal haemorrhage**

- Peptic ulcer (50%)
- Gastric erosions
- Oesophageal or gastric varices
- Mallory-Weiss tear
- Angiodysplasia
- Dieulafoy malformation
- Gastric neoplasia

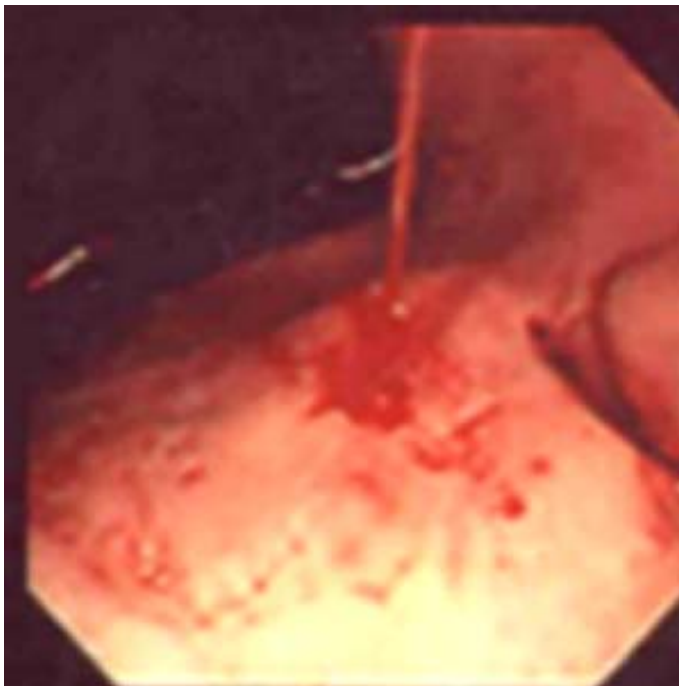


Figure 76 Dieulafoy abnormality

### **Management of upper GI haemorrhage**

- Patients should be managed according to agreed multidisciplinary protocols
- Close collaboration between physicians and surgeons is vital
- Aggressive fluid resuscitation is important
- Circulating blood volume should be restored with colloid or crystalloid
- Cross-matched blood should be given when available
- All patients require closed monitoring
- Possibly in an HDU or ITU environment with central and arterial pressure monitoring

### **Bleeding peptic ulcer**

- Management requires close liaison between physicians and surgeons
- 80% bleeding stops spontaneously
- 25% require intervention for recurrent bleeding within 48 hours
- It is difficult to predict those that will continue to bleed



- All patients require early endoscopy ( $\pm$  intervention) to determine:
  - Site of bleeding
  - Continued bleeding
- Features of recent bleed
  - Ooze from ulcer base
  - Clot covering ulcer base
  - Black spot in ulcer base
  - Visible vessel
- Recently shown that proton pump inhibitors may improve outcome in acute non-variceal upper GI haemorrhage

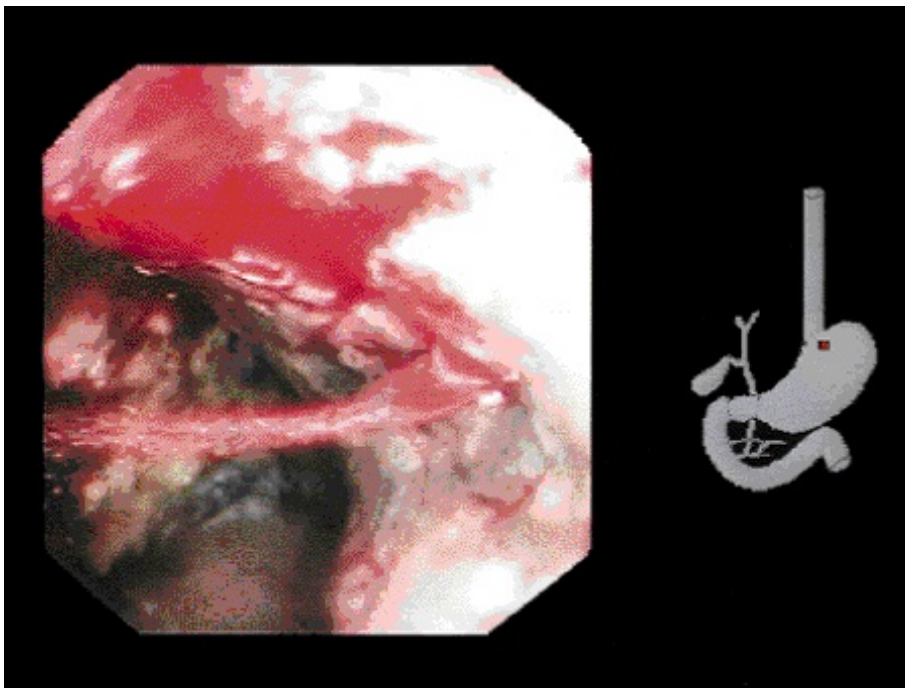


Figure 77 Bleeding gastric ulcer

#### ***Endoscopic therapy***

- Laser photocoagulation using the Nd-YAG laser
- Bipolar diathermy
- Heat probes
- Adrenaline or sclerosant injection
- No technique is superior
- Comparative trials of different techniques are inconclusive

#### ***Indications for surgery***

- Continued bleeding that fails to respond to endoscopic measures
- Recurrent bleeding
- Patients more than 60 years
- Gastric ulcer bleeding
- Cardiovascular disease with predictive poor response to hypotension



### **Surgery for bleeding peptic ulcer**

- For duodenal ulcer
- Create gastroduodenotomy between stay sutures
- Bleeding usually from gastroduodenal artery
- Underun vessels with 2/0 nonabsorbable suture on round body needle
- Avoid picking up common bile duct
- Close gastroduodenotomy as a pyloroplasty
- Consider truncal vagotomy and pyloroplasty
- All patients should be given *H. pylori* eradication therapy post operatively
- If a pyloroplasty will be difficult because of large ulcer consider Polya gastrectomy
- For gastric ulcer consider either local resection of ulcer or partial gastrectomy

### **Variceal upper gastrointestinal haemorrhage**

- 90% patients with portal hypertension have varices
- 30% patients with varices will have an upper gastrointestinal bleed
- 80% of GI bleed in patients with portal hypertension comes from varices
- The mortality of a variceal bleed is approximately 50%
- 70% patients will have a rebleed
- Survival is dependent on the degree of hepatic impairment

#### **Primary prevention**

- Bleeding from varices more likely if poor hepatic function or large varices
- Primary prevention of bleeding is possible with  $\beta$  blockers
- Reduces risk of haemorrhage by 40-50%
- Band ligation may also be considered
- Sclerotherapy or shunting is ineffective

#### **Active bleeding**

- Resuscitation should be as for other causes of upper GI haemorrhage
- Endoscopy should be performed to confirm site of haemorrhage
- Vasopressin and octreotide decrease splanchnic blood flow and portal pressure
- Lactulose may be used to decrease GI transit and reduce ammonia absorption
- Metronidazole and neomycin may be used to reduce gut flora
- Temporary tamponade can be achieved with Sengstaken-Blackmore tube
- Should be considered as a salvage procedure
- A Sengstaken-Blackmore tube has three channels
  - One to inflate the gastric balloon
  - One to inflate the oesophageal balloon
  - One to aspirate the stomach
- Tamponade is 90% successful at stopping haemorrhage
- Unfortunately 50% patients rebleed within 24 hours of removal of tamponade
- Emergency endoscopic therapy includes:
  - Endoscopic banding of varices
  - Intravariceal or paravariceal sclerotherapy
- Sclerosants include ethanolamine and sodium tetradecyl sulphate
- If endoscopic methods fail need to consider
  - Transection or devascularisation
  - Porto-caval or mesenterico-caval shunting
- Emergency shunting associated with 20% operative mortality and 50% encephalopathy



- Shunting can also be performed non-surgically by transjugular intrahepatic portosystemic shunting (TIPSS)
- Reduces risk of rebleeding but increases risk of encephalopathy
- Mortality of the procedure ~1%

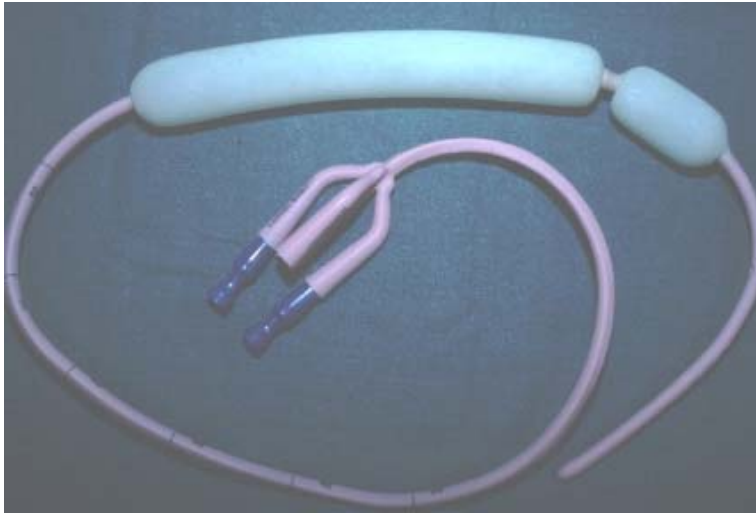


Figure 78 A Senstaken-Blackmore tube

#### ***Secondary prevention***

- 70% of patients with an variceal haemorrhage will rebleed
- The following have been shown to be effective in the prevention of rebleeding
  - Beta-blockers possibly combined with isosorbide mononitrate
  - Endoscopic ligation
  - Sclerotherapy
  - TIPSS
  - Surgical shunting



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### **Lower gastrointestinal haemorrhage**

- Accounts for 20% cases of acute gastrointestinal haemorrhage
- Most patients are elderly
- Most cases settle spontaneously without the need for emergency surgery
- Following investigation often a cause is not found

### **Causes of lower gastrointestinal haemorrhage**

- Diverticular disease
- Angiodysplasia
- Inflammatory bowel disease
- Ischaemic colitis
- Infective colitis
- Colorectal carcinoma

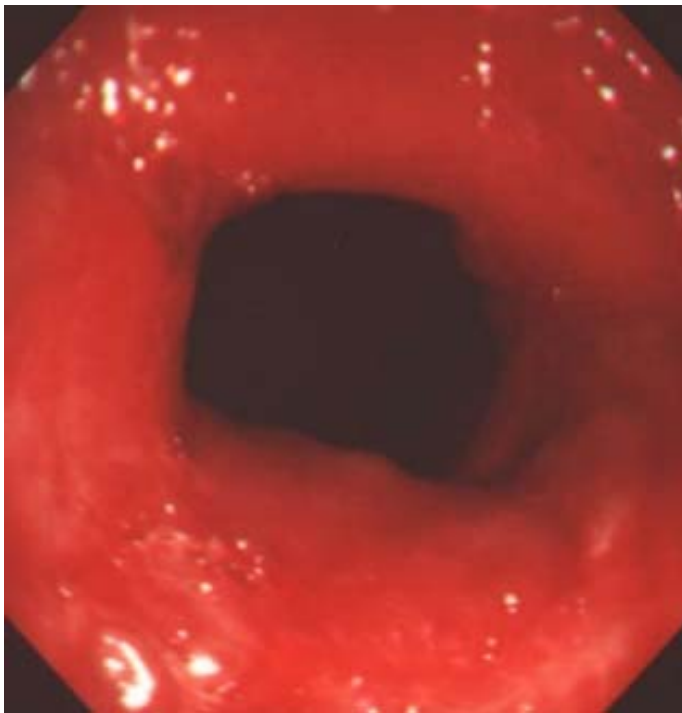


Figure 79 Endoscopic appearance of acute colitis

### **Angiodysplasia**

- Acquired malformation of intestinal blood vessels
- 80% lesions occur in the right side of the colon
- Often associated with cardiac valvular disease
- Dilated vessels or 'cherry red' areas may be seen at colonoscopy
- Early filling of vessels seen at angiography
- Bleeding may be visible during capillary phase of angiogram
- Angiodysplasia is an incidental finding during 5% of colonoscopies
- Seen in up to 25% of asymptomatic patients over the age of 75 years

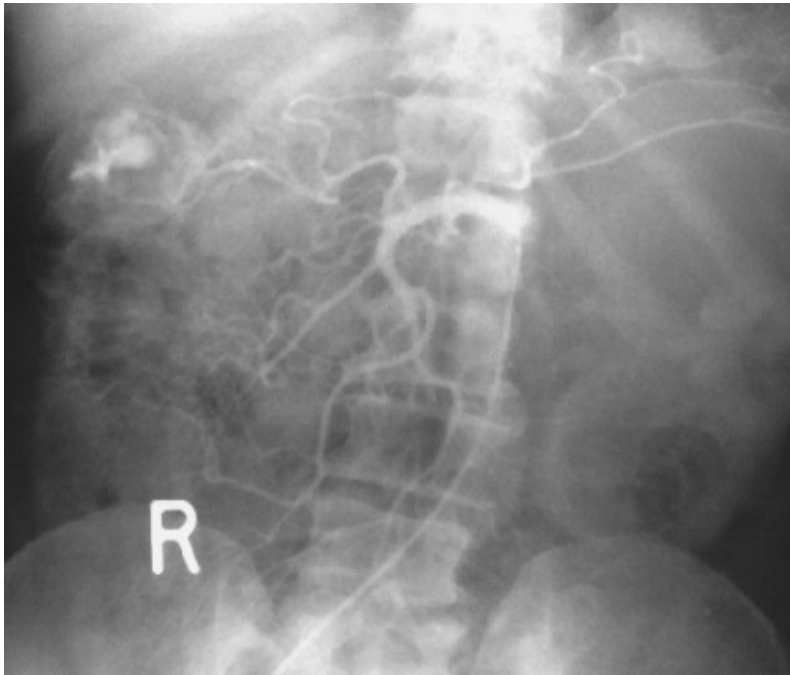


Figure 80 Angiodysplasia as seen on mesenteric angiography

#### Investigation of lower GI haemorrhage

- Most patients are stable and can be investigated once bleeding has stopped
- In the actively bleeding patient consider
  - Colonoscopy - can be difficult
  - Selective mesenteric angiography
    - Requires continued bleeding of  $>1$  ml/minute
    - May show angiodysplastic lesions even once bleeding has ceased
  - Radionuclide scanning
    - Uses technetium-99m labelled red blood cells

Table 30 Rate of bleeding required for the detection of lower GI haemorrhage

Investigation	Rate of bleeding (ml/min)
Radiolabel red cell scan	0.1
Mesenteric angiography	1.0
Non-selective aortic angiography	6.0
Colonoscopy	Any
Intraoperative endoscopy	Any

#### Management of lower GI haemorrhage

- Acute bleeding tends to be self limiting
- Consider selective mesenteric embolisation if life threatening haemorrhage
- If bleeding persists perform endoscopy to exclude upper GI cause
- Proceed to laparotomy and consider on-table lavage and panendoscopy
- If right-sided angiodysplasia perform a right hemicolectomy
- If bleeding diverticular disease perform a sigmoid colectomy
- If source of colonic bleeding unclear perform a subtotal colectomy and end-ileostomy



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## ***Small bowel obstruction***

### **Mechanical obstruction**

#### ***Aetiology***

- Small bowel obstruction accounts for 5% of acute surgical admissions
- In UK the commonest causes are
  - Adhesions (60%)
  - Strangulated hernia (20%)
  - Malignancy (5%)
  - Volvulus (5%)

#### ***Pathophysiology***

- Proximal dilatation occurs above obstructing lesion
- This results in the accumulation of gas and fluid and reduced reabsorption
- Dilatation of the gut wall produced mucosal oedema
- This impairs venous and then arterial blood flow
- Intestinal ischaemia eventually results in infarction and perforation of that segment of bowel
- Ischaemia also results in bacterial and endotoxin translocation
- The overall effect is progressive dehydration, electrolyte imbalance and systemic toxicity

#### ***Clinical feature***

- Colicky central abdominal pain
- Vomiting - early in high obstruction
- Abdominal distension - extent depends on level of obstruction
- Absolute constipation - late feature of small bowel obstruction
- Dehydration associated with tachycardia, hypotension and oliguria
- Features of peritonism indicate strangulation or perforation

#### ***Investigation***

- Supine abdominal X-ray shows dilated small bowel
- May be normal if no air fluid interface
- Valvulae conniventes differentiate small from large intestine
- Erect abdominal film rarely provided additional information

#### ***Management***

- Adequate resuscitation prior to surgery is vital
- May require more than 5 litres of intravenous crystalloid
- Adequacy of resuscitation should be judged by urine output or central venous pressure
- Surgery in under resuscitated patient is associated with increased mortality
- If obstruction presumed to be due to adhesions and there are no features of peritonism
- Conservative management for up to 48 hours is often safe
- Requires regular clinical review
- If features of peritonism or systemic toxicity present
- Need to consider early operation
- Exact procedure will depend on underlying cause



Figure 81 Radiological appearances of small bowel obstruction

### **Indications for surgery**

#### ***Absolute***

- Generalised peritonitis
- Localised peritonitis
- Visceral perforation
- Irreducible hernia

#### ***Relative***

- Palpable mass lesion
- 'Virgin' abdomen
- Failure to improve

#### ***Trial of conservatism***

- Incomplete obstruction
- Previous surgery
- Advanced malignancy
- Diagnostic doubt - possible ileus



### Paralytic ileus

- Functional obstruction most commonly seen after abdominal surgery
- Also associated with trauma, intestinal ischaemia, sepsis
- Small bowel is distended throughout its length
- Absorption of fluid, electrolytes and nutrients is impaired
- Significant amounts of fluid may be lost from the extracellular compartment

### Clinical features

- Usually history of recent operation or trauma
- Abdominal distension is often apparent
- Pain is often not a prominent feature
- If no nasogastric tube in-situ vomiting may occur
- Large volume aspirates may occur via nasogastric tube
- Flatus will not be passed until resolution of the ileus
- Auscultation will reveal absence of bowel sounds

### Investigation

- Plain abdominal x-ray may show dilated loops of small bowel
- Gas may be present in the colon
- If doubt as to whether there is a mechanical or functional obstruction
- Water soluble contrast study may be helpful

### Management

- Prevention is better than cure
- Bowel should be handled as little as possible
- Fluid and electrolyte derangements should be corrected
- Sources of sepsis should be eradicated
- For an established ileus the following will be required:
  - Nasogastric tube
  - Fluid and electrolyte replacement
- No drugs are available to reverse the condition
- Usually resolves spontaneously after 4 or 5 days

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## **Large bowel obstruction**

### **Malignant obstruction**

- 15% colorectal cancers present with obstruction
- Most patients are over 70 years old
- Risk of obstruction greatest with left sided lesions
- Usually present at a more advanced stage
- 25% have distant metastases at presentation
- Perforation can occur at site of tumour or in a dilated caecum

### **Clinical presentation**

- Caecal tumours present with small bowel obstruction
  - Colicky central abdominal pain
  - Early vomiting
  - Late absolute constipation
  - Variable extent of distension
- Left sided tumours present with large bowel obstruction
  - Change in bowel habit
  - Absolute constipation
  - Abdominal distension
  - Late vomiting

### **Investigation**

- Plain supine abdominal x-ray will show dilated large bowel
- Small bowel may also be dilated depending on competence of ileocaecal valve
- Added value of erect film debatable
- If doubt over diagnosis or site of obstruction consider a water soluble contrast enema

### **Management**

- All patients require
- Adequate resuscitation
- Prophylactic antibiotics
- Consenting and marking for potential stoma formation
- At operation
- Full laparotomy should be performed
- Liver should be palpated for metastases
- Colon should be inspected for synchronous tumours
- Appropriate operations include
  - Right sided lesions – right hemicolectomy
  - Transverse colonic lesion – extended right hemicolectomy
  - Left sided lesions – various options



Figure 82 Radiological appearance of large bowel obstruction

#### ***Three staged procedure***

- Defunctioning colostomy
- Resection and anastomosis
- Closure of colostomy

#### ***Two stage procedure***

- Hartmann's procedure
- Closure of colostomy

#### ***One stage procedure***

- Resection, On table lavage and primary anastomosis
- Three stage procedure will involve 3 operations!
- Associated with prolonged total hospital stay
- Transverse loop colostomy can be difficult to manage
- With two-staged procedure only 60% of stomas are ever reversed
- With one-stage procedure stoma is avoided
- Anastomotic leak rate of less than 4% have been reported
- Irrespective of option total perioperative mortality is about 20%



Table 31 The prognosis of colorectal carcinomas

	Obstructing Lesion	Non-Obstructing Lesion
Operative mortality	40%	12%
5 year survival	23%	42%

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### ***Sigmoid and caecal volvulus***

- Volvulus = Rotation of the gut on its own mesenteric axis
- Produces partial or complete intestinal obstruction
- Blood supply compromised resulting in intestinal ischaemia
- Venous congestion leading to infarction can occur
- Arterial supply rarely compromised
- Long narrow based mesentery predisposes to volvulus

#### **Sigmoid volvulus**

- Sigmoid is commonest site of colonic volvulus
- Accounts for 5% of large bowel obstruction in UK
- Usually seen in elderly or those with psychiatric disorders
- Commonest cause of obstruction in Africa / Asia
- Incidence is 10 times higher than in Europe or USA

#### **Clinical features**

- Obstruction – pain, constipation and vomiting
- Disproportionate abdominal distension
- 50% patients have had a previous episode
- Severe pain and tenderness suggests ischaemia
- Plain x-ray may show large 'bean' shaped loop of large bowel arising from pelvis
- If diagnostic doubt consider a water soluble contrast enema
- Will demonstrate site of obstruction



Figure 83 Radiological appearance of a sigmoid volvulus



### Management

- Resuscitation with intravenous fluids is essential
- Conservative management can be attempted if so clinical features of ischaemia
- Sigmoidoscopy can be diagnostic and therapeutic
- Obstruction at ~15 cm which when advanced passed produces release of flatus
- Flatus tube can be inserted for 2-3 days
- 80% of patients will settle with conservative management
- If decompression occurs no emergency treatment required
- 50% further episode of volvulus within 2 years
- If decompression fails or features of peritonitis
- Options are:
  - Sigmoid colectomy and primary anastomosis
  - Hartmann's procedure
  - Paul Mickulicz Colostomy
  - Sigmoidopexy best avoided



Figure 84 Operative appearance of a sigmoid volvulus

### Caecal volvulus

- Incidence is less than that of sigmoid volvulus
- Accounts for about 25% cases of colonic volvulus
- Incomplete midgut rotation is a predisposing factor
- Results in inadequate fixation of caecum to posterior abdominal wall
- Volvulus usually occurs clockwise around ileocolic vessels
- Usually also involves terminal ileum and ascending colon





### **Clinical features**

- Presents with clinical features of proximal large bowel obstruction
- Colicky abdominal pain and vomiting are common
- Abdominal distension may occur
- Plain abdominal x-ray shows a comma shaped caecal shadow in mid abdomen
- Small bowel loops may lie to the right of the Caecum
- If diagnostic doubt consider a water soluble contrast enema
- Will show beaked appearance in ascending colon

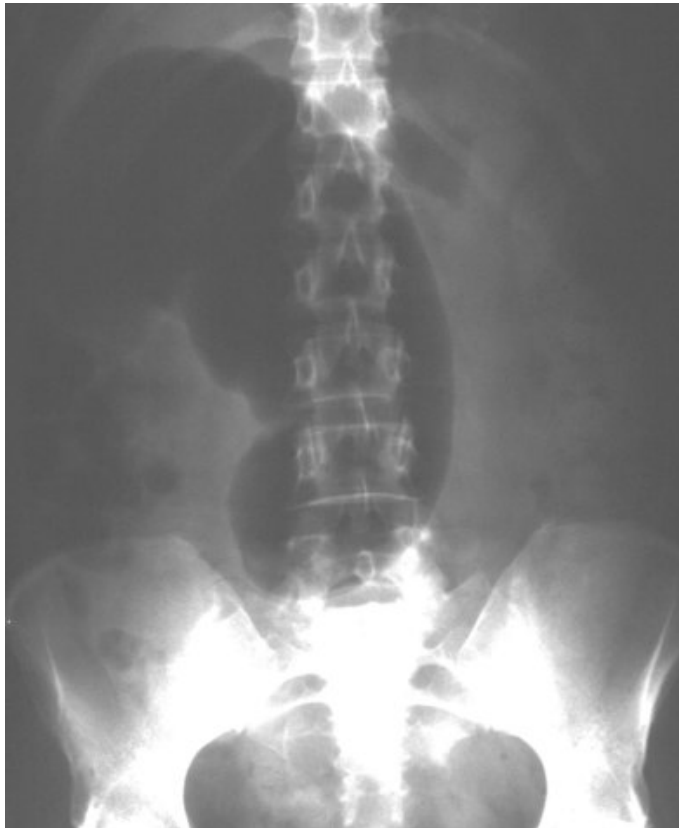


Figure 85 Radiological appearance of a sigmoid volvulus

### **Management**

- Colonoscopic decompression may be appropriate if patient unfit for surgery
- Laparotomy is normally required
- If colon is ischaemic then right hemicolectomy should be performed
- Primary anastomosis may be inappropriate
- Exteriorisation of both ends of the bowel might be the safest option
- If the caecum is viable and the volvulus reduced the following can be considered:
- Reduction alone is associated with high recurrence rate
  - Right hemicolectomy
  - Caecostomy
  - Caecopexy

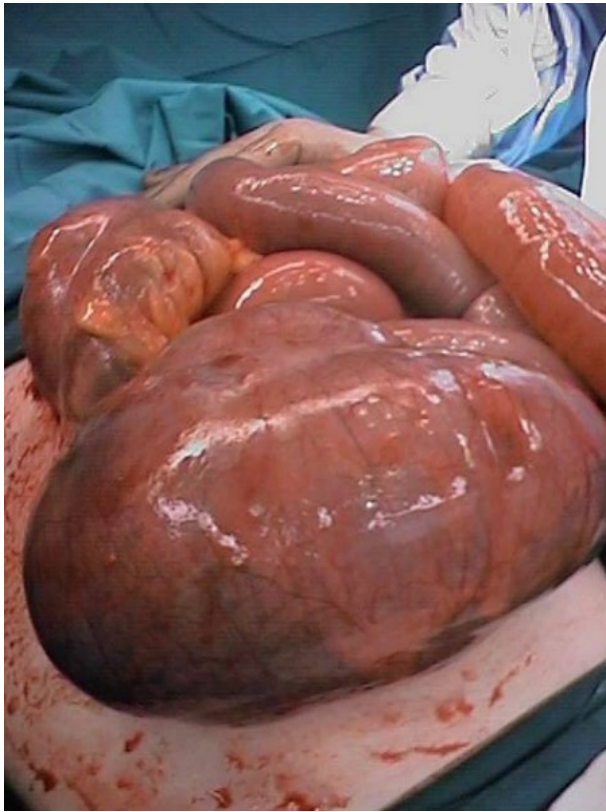


Figure 86 Operative appearance of a caecal volvulus

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### **Colonic pseudo-obstruction**

- Often referred to as Olgilvie's syndrome
- A condition characterised by reduced colonic mobility and dilatation
- Presents with symptoms and signs of large bowel obstruction
- Diagnosis is confirmed by single contrast enema
- Excludes obstructing lesion
- Often precipitated by other medical or surgical conditions including:
  - Chest infection
  - Myocardial infarction
  - Cerebrovascular accident
  - Renal failure
  - Puerperium
  - Abdominal malignancy
  - Orthopaedic trauma
  - Myxoedema
  - Electrolyte disturbances

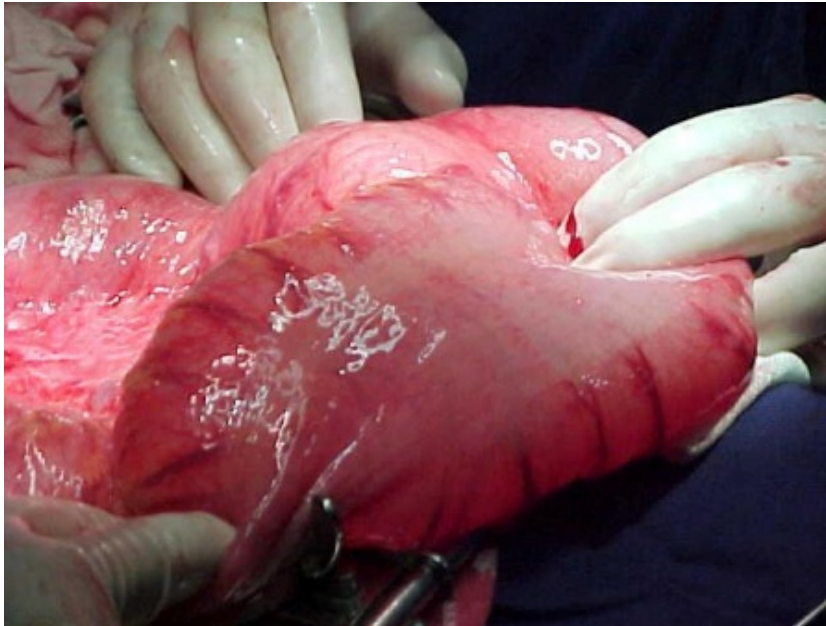


Figure 87 Colonic pseudo-obstruction

### **Management**

- Remove precipitating causes
  - Stop anticholinergics drugs
  - Reduce the use of opiates
  - Correct electrolyte disturbances
- Decompress colon with
  - Flexible sigmoidoscopy or flatus tube
  - The cautious use of enemas
  - Intravenous neostigmine
- Consider surgery if failure of conservative management



- Surgical options include:
  - Tube caecostomy
  - Resection with end ileostomy and mucus fistula

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## Abdominal wall

### *Incisions and laparoscopic access*

- Abdominal incisions are based on anatomical principles
- They must allow adequate access to the abdomen
- They should be capable of being extended if required
- Ideally muscle fibres should be split rather than cut
- Nerves should not be divided
- The rectus muscle has a segmental nerve supply
- It can be cut transversely without weakening a denervated segment
- Above the umbilicus tendinous intersections prevent retraction of the muscles

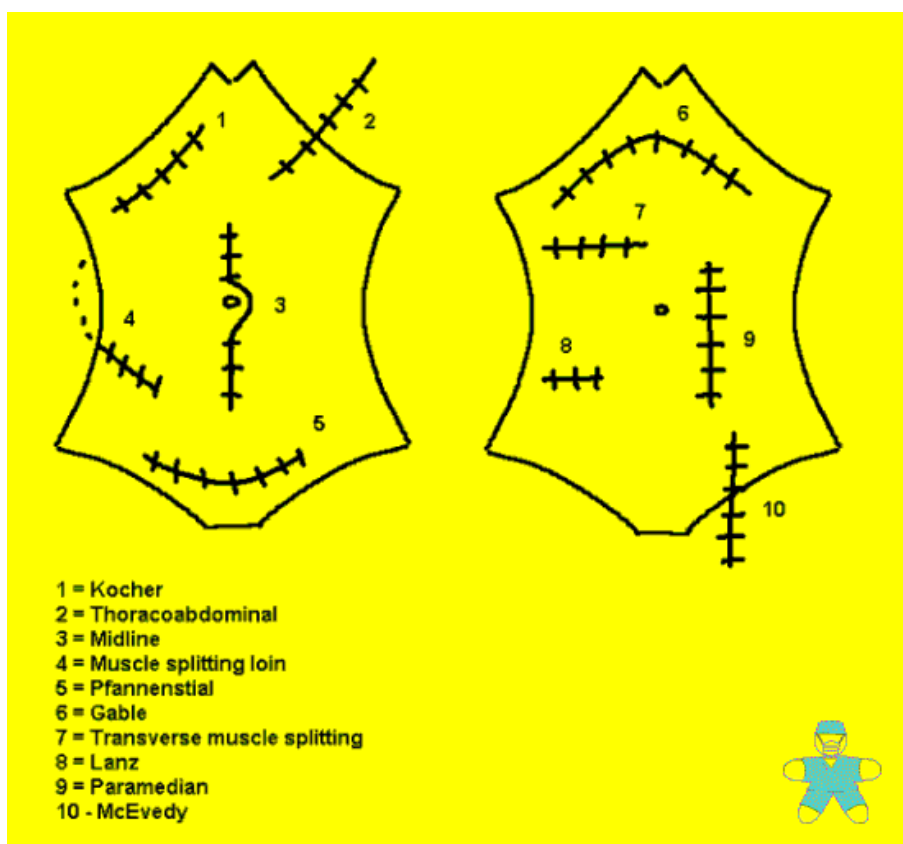


Figure 88 Abdominal incisions

### **Midline incisions**

- Midline incisions are the commonest approach to the abdomen
- The following structures are divided:
  - Skin
  - Linea alba
  - Transversalis fascia
  - Extraperitoneal fat
  - Peritoneum
- The incision can be extended by cutting through or around the umbilicus
- Above the umbilicus the Falciform ligament should be avoided



- The bladder can be accessed via an extraperitoneal approach through the space of Retzius
- The wound can be closed using a mass closure technique
- The most popular sutures are either non-absorbable or absorbable monofilaments
- At least 1 cm bits should be taken 1 cm apart
- Requires the use of one or more sutures four times the wound length

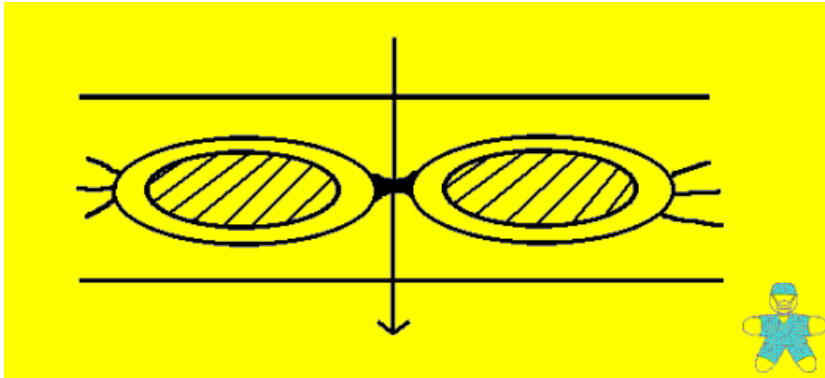


Figure 89 Midline incision

#### Paramedian incision

- A paramedian incision is made parallel to and approximately 3 cm from the midline
- The incision transverse:
  - Skin
  - Anterior rectus sheath
  - Rectus - retracted laterally
  - Posterior rectus sheath - above the arcuate line
  - Transversalis fascia
  - Extraperitoneal fat
  - Peritoneum
- The potential advantages of this incision are:
- The rectus muscle is not divided
- The incisions in the anterior and posterior rectus sheath are separated by muscle
- The incision is closed in layers
- Takes longer to make and close (when sutures were not so good)
- Had a lower incidence of incisional hernia

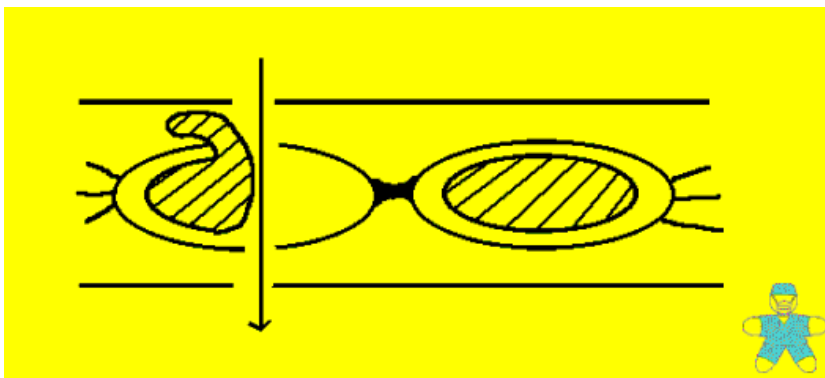


Figure 90 Paramedian incision



## Abdominal hernias

### *Inguinal & femoral hernias*

#### Definition

- A hernia is a protrusion of an organ through the wall that normally contains it
- The wall can be the abdominal wall, muscle fascia, diaphragm or foramen magnum
- Hernias can be congenital or acquired
- Abdominal wall hernias are common
- Account for approximately 10% of general surgical workload
- The two main aetiological factors for acquired hernias are:
  - Increased intra-abdominal pressure (e.g. straining or lifting)
  - Abdominal weakness (e.g. advancing age or malnutrition)
- A hernia consists of:
  - A sac
  - Its coverings
  - Its contents
- Hernias can be:
  - Reducible
  - Irreducible
  - Obstructed or incarcerated
  - Strangulated
- Irreducible hernias have either a narrow neck or the contents adhere to the sac wall
- Obstructed hernias contain obstructed but viable intestine
- Strangulated hernias when the venous drainage from the sac contents is compromised

#### Clinical features

- Hernia usually present with a lump at an appropriate anatomical site
- The hernia often increases in size on coughing or straining
- It reduces in size or disappears when relaxed or supine
- Examination may show it to have a cough impulse and to be reducible
- Irreducible but non-obstructed hernias may cause little pain
- If the hernia causes obstruction colicky abdominal pain, distension and vomiting may occur
- The hernia will be tense tender and irreducible
- If strangulation occurs the lump will become red and tender
- Diagnosis is usually based on clinical features
- Herniography may be useful in the investigation of chronic groin pain
- Ultrasound or CT may be useful if a clinically occult hernia is suspected

Table 32 Mortality of elective hernia repair

Age	Mortality
Less than 60 years	0.1%
60 - 70 yrs	0.2%
70 - 79 yrs	1.6%
More than 80 yrs	3.3%



### Mortality of elective hernia repair

- The mortality of elective hernia repair increases with age

### Mortality of strangulated hernia repair

- 10% patients with strangulation give no previous history of a hernia
- The peak incidence of hernia strangulation is approximately 80 years
- In those with acute onset of a hernia the greatest risk is in the first 3 months
- Risk of strangulation depends on type of hernia
  - Femoral is approximately 40%
  - Direct inguinal is approximately 2-3%
- The mortality of surgery for strangulated hernias has changed little over the past 50 years
- Operative mortality remains at approximately 10%
- Is ten times greater than that following an elective repair
- Risk of death is dependent on age
- Presence of necrotic bowel requiring resection

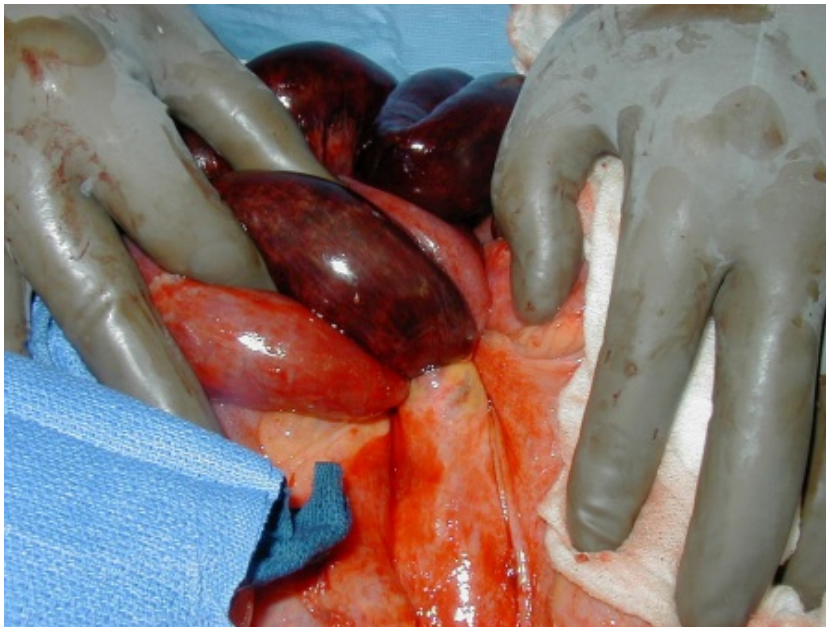


Figure 91 Necrotic small intestine in a strangulated hernia

### Inguinal hernias

- 80,000 operations per year in UK
- 3% adults will require operation for inguinal hernia
- Male : female ratio is 12:1
- Elective : emergency operation 12:1
- Peak incidence is in the 6th decade
- 65% inguinal hernias are indirect
- In females inguinal hernias are as common as femoral hernias





## Anatomy

- Inguinal canal lies between the superficial and deep inguinal rings
- Deep ring lies deep to the mid-inguinal point
- Mid-inguinal point is half way between symphysis pubis and anterior superior iliac spine
- Not the midpoint of the inguinal ligament
- In men it contains vas deferens and testicular artery and veins
- In women it contains the round ligament
- Anterior border is the external oblique aponeurosis
- Posterior border is the transversalis fascia
- Inferior border is the inguinal ligament
- Superior border is the conjoint tendon - the lower fibres of internal oblique and transversus abdominis
- Indirect hernias arise lateral to the inferior epigastric vessels
- Direct hernias arise medial to the inferior epigastric vessels

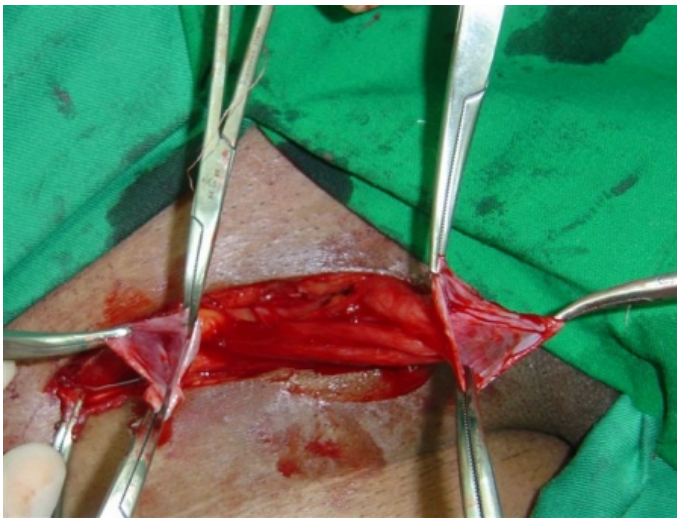


Figure 92 Indirect inguinal hernia sac

Table 33 Classification of inguinal hernias (Nyhus)

Type	Features
Type 1	Indirect hernia. Normal internal ring
Type 2	Indirect hernia. Dilated internal ring. Posterior wall intact
Type 3	Posterior wall defect
	A. Direct inguinal hernia
	B. Indirect inguinal hernia. Internal ring dilated. Posterior wall defective
	C. Femoral hernia
Type 4	Recurrent hernia

## Techniques of hernia repair

- Herniotomy involves removal of the sac and closure of the neck
- Herniorrhaphy involves a form of reconstruction to:
  - Restore the disturbed anatomy



- Increase the strength of the abdominal wall
- Construct a barrier to recurrence

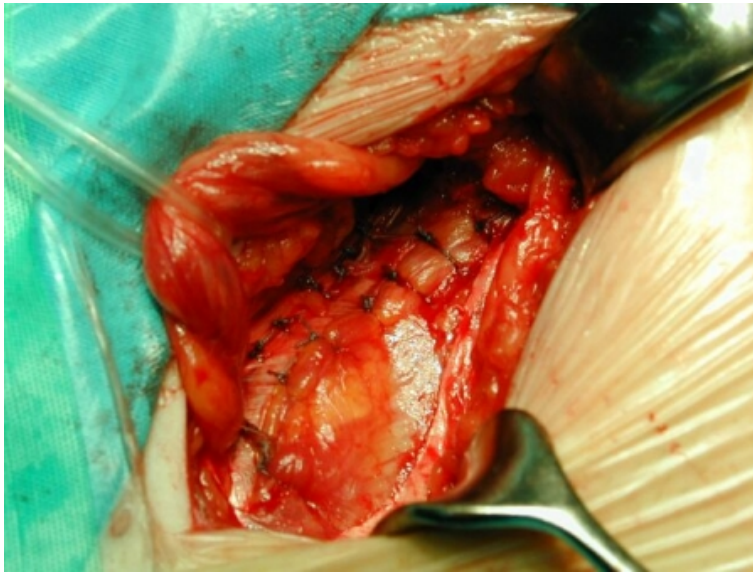


Figure 93 Open hernia repair

- Herniorrhaphy can be achieved with following techniques
  - Bassini +/- Tanner Slide
  - Nylon darn
  - Shouldice
  - Lichtenstein
  - Other Mesh - Stoppa
  - Laparoscopic
- Shouldice or Lichtenstein now regarded as 'gold standard' as judged by low risk of recurrence
- Laparoscopic hernia repair should be reserved for bilateral or recurrent hernia

#### **Complications of hernia repairs**

- Urinary retention
- Scrotal haematoma
- Damage to the ilioinguinal nerve
- Ischaemic orchitis
- Recurrent hernia

#### **Trusses**

- 40,000 sold annually in UK
- 20% purchased prior to seeing a doctor
- 45% have no instruction on fitting
- 75% fit whilst standing up!

#### **Recurrent inguinal hernia**

- Recurrence rate varies with herniorrhaphy technique and duration of follow up
- With Bassini and darn repairs may be as high as 20%
- With Shouldice and Lichtenstein repairs recurrence rates <1% have been reported
- Factor involved in recurrence include:



- Inadequate preoperative selection
- Type of hernia
- Type of operation
- Postoperative wound infection
- Recurrent hernias should be repaired using a mesh technique
- Can be performed as either an open or a laparoscopic procedure
- Patients should be consented for a possible orchidectomy



Figure 94 Bilateral femoral hernias

#### Femoral hernias

- Account for 7% of all abdominal wall hernia
- Female : male ratio is 4:1
- Commonest in middle aged and elderly women
- Rare in children
- More common in parous
- Less common than inguinal hernias but as common as inguinal hernias in older women

Table 34 Differentiation between inguinal and femoral hernias

Inguinal hernia	Femoral hernia
Femoral hernia	Inguinal hernia
Vaginal hydrocele	Lymphadenopathy
Hydrocele of cord	Saphena varix
Undescended testis	Ectopic testis
Lipoma of cord	Psoas abscess
	Psoas bursa
	Lipoma

#### Anatomy of the femoral canal

- Anterior border is the inguinal ligament
- Posterior border is the pectineal ligament
- Medial border is the lacunar ligament
- Lateral border is the femoral vein

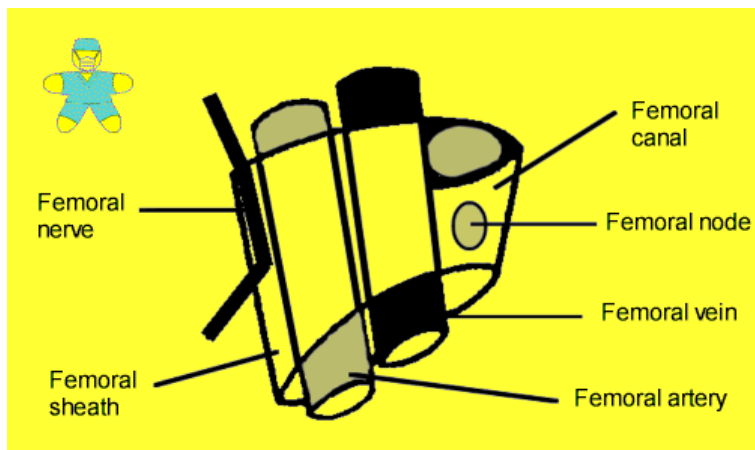


Figure 95 Anatomy of femoral sheath

### Management of femoral hernia

- All uncomplicated femoral hernias should be repaired as an urgent elective procedure
- Three classical approaches to the femoral canal have been described
  - Low (Lockwood)
  - Transinguinal (Lotheissen)
  - High (McEvedy)
- Irrespective of approach used the following will be achieved by
  - Dissection of the sac
  - Reduction / inspection of the contents
  - Ligation of the sac
  - Approximation of the inguinal and pectineal ligaments

Table 35 Special types of hernia

Hernia	Features
Richter's Hernia	Partial Enterocele
	Strangulation + obstruction
Maydl's Hernia	W loop strangulation
	Strangulated bowel within abdominal cavity
Littre's' Hernia	Strangulated Meckel's diverticulum
	Can cause small bowel fistula



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## ***Other abdominal wall hernias***

### **Umbilical hernias**

- Two types of umbilical hernia occur in adults
- True umbilical hernias are rare
- Occur with abdominal distension (e.g. ascites)
- Para-umbilical hernias are more common
- Occurs through the superior aspect of the umbilical scar
- Female : male ratio is 5:1
- Usually contain omentum
- Neck is often tight and the hernias are often irreducible



Figure 96 Umbilical hernia

### ***Differential diagnosis***

- Cyst of the vitello-intestinal duct
- Urachal cyst
- Metastatic tumour deposit (Sister Joseph's nodule)

### ***Management***

- Management of true and para-umbilical hernias is similar
- Surgery is usually performed through an infra-umbilical incision
- Occasionally the umbilicus needs to be excised
- Contents of the hernia are reduced
- Defect in linea alba can be repaired with:
  - An overlapping Mayo repair
  - A mesh repair



### Epigastric hernia

- Arises through a congenital weakness of the linea alba
- Hernia usually consists of extra-peritoneal fat from near to falciform ligament
- Male : female ratio is 3:1
- Many are asymptomatic
- Produce local symptoms
- Strangulation is rare
- Can be repaired with either sutures or a mesh

### Incisional hernia

- Occurs through the scar from a previous operation
- 1% of all transperitoneal abdominal incisions result in a hernia
- Account for 10% of all abdominal wall hernias
- Partial dehiscence of all deep fascial layers occurs
- Skin remains intact
- Most develop within a year of surgery
- Symptoms are often minimal with cosmetic appearance the main concern
- Most are wide necked but strangulation can occur



Figure 97 Incisional hernia

### *Aetiological factors*

#### *Preoperative*

- Increasing age
- Malnutrition
- Sepsis
- Uraemia
- Jaundice
- Obesity



- Diabetes
- Steroids

#### **Operative**

- Type of incision
- Technique and materials used
- Type of operations
- Use of abdominal drains

#### **Postoperative**

- Wound infection
- Abdominal distension
- Chest infection or cough

#### **Management**

- CT or ultrasound may clarify muscular defect and hernial sac content
- The elderly or infirm may be helped by an abdominal wall support
- If surgery is required the following should be considered:
- Fascial closure or mayo-type repair using sutures
  - A 'keel repair' using sutures
  - A mesh repair using polypropylene or PTFE
  - Mesh can be placed as a sublay, onlay or inlay
  - Laparoscopic mesh repair may be considered
- The results of surgery for incisional hernias are variable
- Re-recurrence rate of 20% have been reported
- The results with mesh are superior to suture repairs
- Composite meshes may offer reduced risk of complications
- A sublay mesh repair may have the lowest recurrence rate

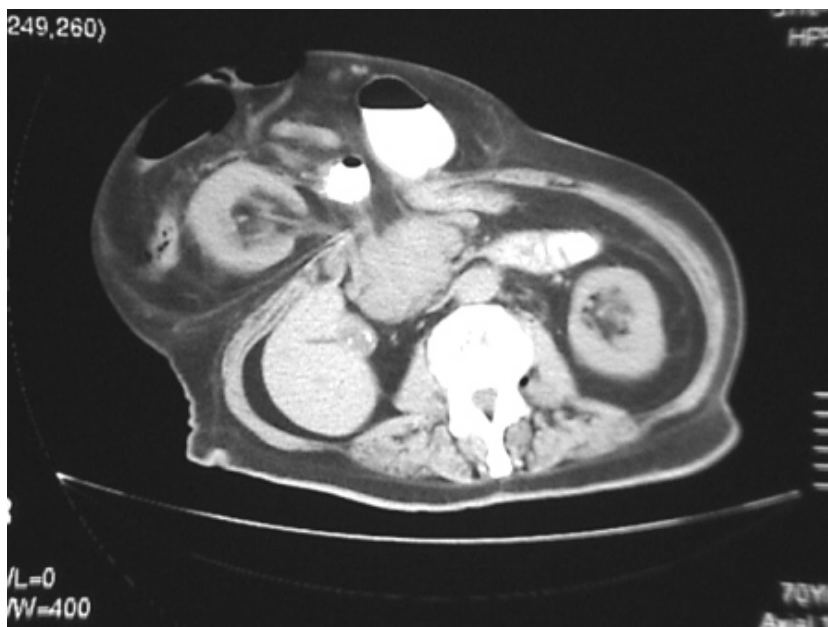


Figure 98 CT scan of an incisional hernia



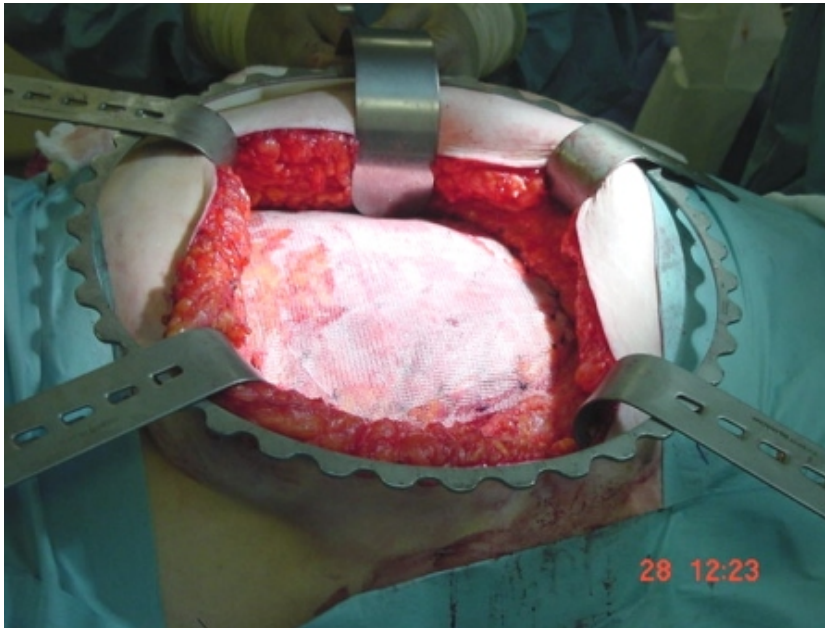


Figure 99 Mesh repair of an incisional hernia

### Spigelian hernia

- Occurs at the lateral edge of the rectus sheath
- Interparietal hernia in the line of the linea semilunaris
- Usually occurs at the level of the arcuate line

### Obturator hernia

- Occurs in the obturator canal
- Usually asymptomatic until strangulation occurs
- May complain of pain on the medial aspect of the thigh
- Vaginal examination may allow identification of a lump in the region of the obturator foramen

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## Intestinal fistulas

### *Enterocutaneous fistulae*

- A fistula is an abnormal connection between hollow viscus and adjacent organ or skin
- Simple fistula = direct communication between gut and skin
- Complex fistula = fistula with associated abscess cavity



Figure 100 Enterocutaneous fistula from a strangulated hernia

- Fistulae, particularly if high output (>500 ml / day) results in:
  - Dehydration
  - Electrolyte and acid-base imbalance
  - Malnutrition
  - Sepsis

### **Aetiology**

- Anastomotic leaks
- Trauma - often iatrogenic post surgery
- Inflammatory bowel disease
- Malignancy
- Radiotherapy

### **Imaging**

- Important to determine anatomy of fistula
- Fistulography will define tract
- Small bowel or barium enema will define state of intestine or distal obstruction
- US and CT will define abscess cavities



## Management

- Usually conservative management - at least initially - consisting of:

### **Skin protection**

- Upper GI contents are very corrosive

### **Correction of fluid and electrolyte loss**

- Require careful fluid balance
- Restoration of blood volume
- Correction of acid-base imbalance
- H<sub>2</sub> Antagonist, proton pump inhibitor to reduce gastric secretions
- Somatostatin analogues (e.g. Octreotide) to reduce GI and pancreatic secretions

### **Nutritional support**

- Restrict oral intake and possibly an nasogastric tube
- Malnutrition corrected with either parenteral or enteral nutrition
- Total parenteral nutrition given via Dacron-cuffed tunnelled feeding line
- Radiological screening to ensure tube in correct site
- Enteral nutrition can be given distal to fistula

### **Control of sepsis**

- Abscess cavities should be drained
- Antibiotics to be avoided

### **Surgery**

- Enterocutaneous fistulas will not close if:
  - There is total discontinuity of bowel ends
  - There is distal obstruction
  - Chronic abscess cavity exists around the site of the leak
  - Mucocutaenous continuity has occurred
- Fistulas are less likely to close if
  - They arise from disease intestine (e.g. Crohn's Disease)
  - They are end fistulae
  - The patient is malnourished
  - They are internal fistulas
- 60% will close in one month once sepsis has been controlled with conservative treatment
- Mortality associated with fistula is still at least 10%
- Surgery should be considered if fistula does not close by 30-40 days

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## Gastrointestinal stomas

### *Abdominal stomas*

- A stoma is a surgically created communication between a hollow viscus and the skin
- Types of stomas includes a:
  - Colostomy
  - Ileostomy
  - Urostomy
  - Caecostomy
  - Jejunostomy
  - Gastrostomy
- Functionally they can be end, loop or continent stoma



Figure 101 Transverse loop colostomy

### **Positioning of stomas**

- Away from umbilicus, scars, costal margin and anterior superior iliac spine
- Ensure compatible with the clothing worn by the patient

### **Complications of stomas**

#### *Structural complications*

- Necrosis
- Detachment
- Recession
- Stenosis
- Prolapse
- Ulceration
- Parastomal herniation
  - Due to opening in abdominal wall being too large
  - Herniation between external oblique and superficial fascia
- Fistula formation



Figure 102 Necrotic stoma



Figure 103 Retracted stoma

***Functional disorders***

- Excess action
- Distal colostomy should produce solid faeces
- Ileostomy will produce 500-700 ml/day of liquid effluent
- If excess output consider
  - Inflammatory bowel disease



- Para-intestinal sepsis
- Subacute obstruction
- Reduced action
- Consider simple constipation or obstruction



Figure 104 Prolapsed stoma



Figure 105 Parastomal hernia

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## Upper gastrointestinal surgery

### ***Gastro-oesophageal reflux disease (GORD)***

- Affects 40% of the adult population
- Due to acid or bile reflux
- Delayed oesophageal clearance also important
- Gastric hypersecretion rarely implicated
- Poor correlation between symptoms and endoscopic evidence of oesophagitis
- 20% patients with oesophagitis are symptom free
- Most gain symptomatic relief with conservative treatment
- 30% of patients with symptoms have no endoscopic evidence of mucosal injury

### **Natural barriers to gastro-oesophageal reflux**

- Lower oesophageal sphincter
  - Basal tone
  - Adaptive pressure changes
  - Transient lower oesophageal sphincter relaxation
- External mechanical factors
  - Flap valve mechanism
  - Cardio-oesophageal angle
  - Diaphragmatic pinchcock
  - Mucosal rosette
  - Distal oesophageal compression
  - Phreno-oesophageal ligament
  - Transmitted abdominal pressure

### **Investigation**

- Endoscopy - provides histological confirmation and grading



Figure 106 Endoscopic appearance of oesophagitis



- Savary Miller grading of oesophagitis
  - Grade 1 – Erythema
  - Grade 2 – Linear erosions
  - Grade 3 – Confluence of erosions
  - Grade 4 – Strictures
- 24-hour pH monitoring - probe placed 5 cm above lower oesophageal sphincter (LOS)
- Oesophageal manometry

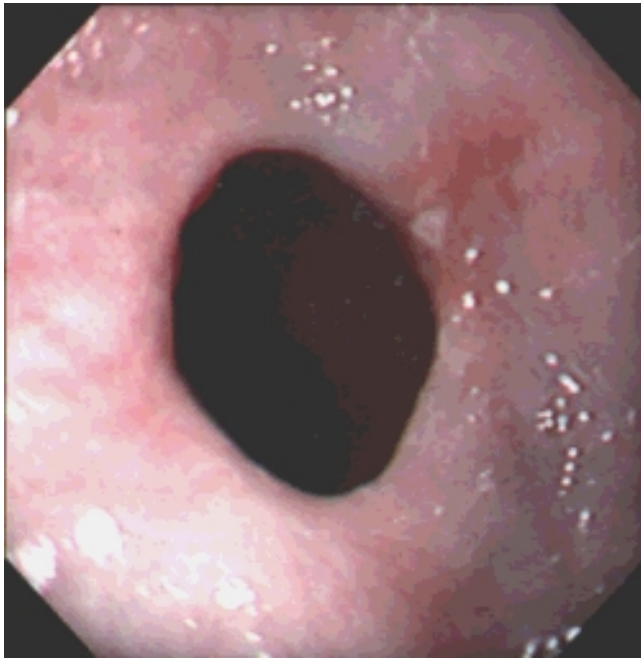


Figure 107 Endoscopic appearance of an oesophageal stricture

### **Conservative treatment**

#### ***Lifestyle modification***

- Stop smoking
- Avoid alcohol
- Loose weight
- Raise head of bed

#### ***Drug treatment***

- H<sub>2</sub> antagonists
  - Provide symptomatic relief in 60% at 6 weeks
  - Endoscopic evidence of healing seen in only 40%
- Proton pump inhibitors
  - 80% healing at 8 weeks in H<sub>2</sub> antagonist resistant disease
  - More than 20% relapse despite maintenance therapy
- Life-long therapy often required

#### ***Surgical options***

- Indications:
- Recurrent symptomatic relapse
- Bile reflux





- Documented evidence of deficient LOS
- Fundoplication is operation of choice - performed as open or laparoscopic procedure
- Important features are:
- Mobilisation of gastric fundus
- A tension free wrap possibly around 50 Fr oesophageal bougie
- A wrap suture line of less than 3 cm

### Complications

- 3% develop dysphagia
- 11% develop gastric bloat

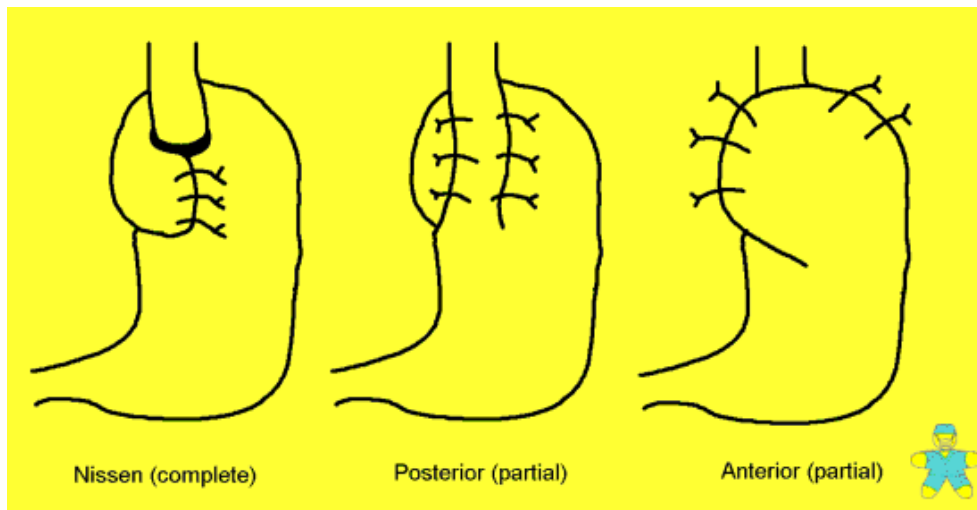


Figure 108 Types of fundoplication

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## **Oesophageal carcinoma**

### **Barrett's oesophagus**

- First described by Norman Barrett in 1950
- Consists of columnar-lined distal oesophagus
- Due intestinal metaplasia of distal oesophageal mucosa
- Can progress to dysplasia and adenocarcinoma
- Its is an acquired condition due to gastro-oesophageal reflux
- Bile reflux appears to be an important aetiological factor
- 10% of patients with GORD develop Barrett's oesophagus
- Approximately 1% of patients with Barrett's oesophagus per year progress to carcinoma
- Barrett's oesophagus increase the risk of cancer by x30

### **Clinical features**

- Barrett's per se is usually asymptomatic
- Usually recognised as an incidental finding at endoscopy
- Appears as 'velvety' epithelium extending more than 3 cm above gastro-oesophageal junction
- The significance of 'short segment' Barrett's (<3 cm long) is unclear

### **Management**

- If recognised at endoscopy most patients are started on life-long acid suppression
- Little evidence exists that it causes regression of metaplasia
- Anti-reflux surgery may reduce progression to dysplasia and cancer
- Recent interest has been shown in endoscopic mucosal ablation
- Usually achieved with photosensitisers and laser therapy
- The role of endoscopic surveillance of Barrett's oesophagus is controversial
- Aim of surveillance is to detect dysplasia before progression to carcinoma
- 40% patients with dysplasia have focus of adenocarcinoma
- Oesophagectomy for dysplasia has an 80% 5-year survival

### **Oesophageal carcinoma**

- 90% are squamous cell carcinomas
- Occur in the upper or middle third of the oesophagus
- 8% are adenocarcinomas
- Occur in the lower third of the oesophagus
- Overall 5 year survival is very poor and is at best 20%
- Less than 50% patients are suitable for potentially curative treatment
- Of those undergoing 'curative' treatment less than 40% survive one year

### **Risk factors**

#### **Squamous cell carcinoma**

- Alcohol / tobacco
- Diet high in nitrosamines
- Aflatoxins
- Trace element deficiency - molybdenum
- Vitamin deficiencies - vitamins A & C
- Achalasia



- Coeliac Disease
- Genetic - Tylosis
- High incidence in Transkei, Areas of Northern China and the Caspian littoral region

### **Adenocarcinoma**

- 15% associated with Barrett's Oesophagus

### **Clinical features**

- Progressive dysphagia
- Respiratory symptoms due to overspill or occasionally a trachea-oesophageal fistula
- Weight loss

### **Assessment**

- Diagnosis confirmed by:
  - Endoscopy plus biopsy / cytology
  - Ba Swallow
- Resectability and fitness for surgery assessed by:
  - Chest x-ray
  - Lung function tests (FEV1 > 1L)
  - Liver ultrasound
  - Endoscopic ultrasound
  - Bronchoscopy
  - Laparoscopy
  - Thoracic CT

### **Management**

- Adenocarcinomas are not radiosensitive and surgery is mainstay of treatment
- Squamous cell carcinomas can be treated with either surgery or radiotherapy

### **Radiotherapy**

- 19% 5 year survival with radiotherapy
- Improved survival compared to surgery
- Similar results not seen in other centres

### **Surgery**

- Only 40% tumours are resectable
- Operative mortality now less than 10%
- Treatment should be in centres who perform operation regularly
- No place for the occasional operator
- Preoperative chemotherapy may improve survival

### **Operative approaches**

- Need 10 cm proximal clearance to avoid submucosal spread.
- Total gastrectomy via thoracoabdominal approach ( Adenocarcinoma)
- Subtotal two-stage oesophagectomy (Ivor-Lewis)
- Subtotal three-stage oesophagectomy (McKeown)
- Transhiatal oesophagectomy



### Palliative treatment of oesophageal cancer

- Aim to relieve obstruction / dysphagia with minimal morbidity

#### *Oesophageal intubation*

- Open surgical intubation (Celestin or Mousseau-Barbin tubes) now obsolete
- Endoscopic or radiological placement now most commonly practised
- Atkinson tube is the most commonly placed endoscopically
- Requires dilatation with risk of oesophageal perforation
- Recent increased use of self-expanding stents that require no pre-dilatation

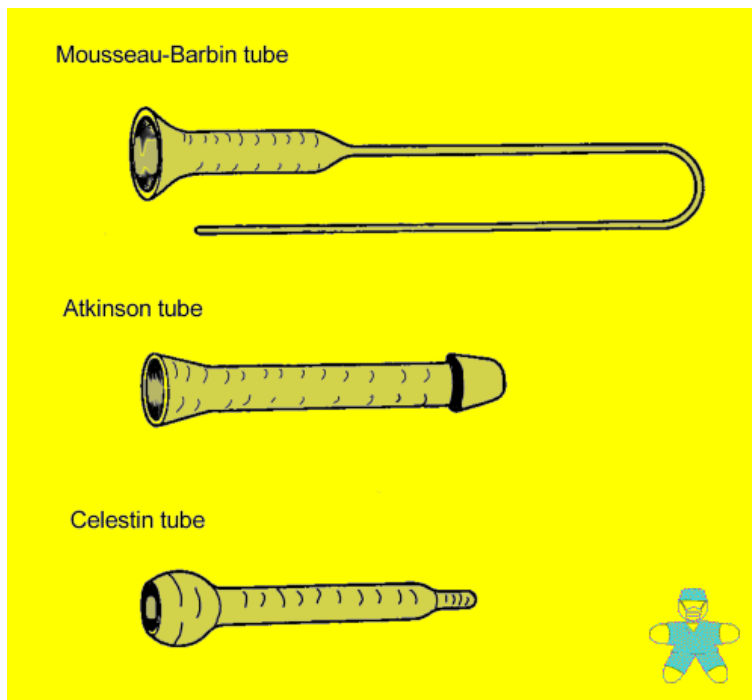


Figure 109 Design of oesophageal tubes

- Complications of stents and tubes
  - Oesophageal perforation
  - Tube displacement or migration
  - Tube blockage due to ingrowth or overgrowth

#### *Laser therapy*

- Produces good palliation in over 60% of cases
- May need to be repeated every 4 to 6 weeks
- Associated with oesophageal perforation in about 5% cases

#### *Other modalities*

- External beam radiotherapy
- Brachytherapy
- Diathermy
- Alcohol injection



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## ***Oesophageal perforation***

- Management and outcome depends on time from injury to diagnosis
- 'Early' injuries are identified within 24 hours
- 'Late' injuries are identified later than 24 hours

### **Aetiology**

- Endoscopic intubation
  - OGD
  - Bouginage
  - Pneumatic dilatation
- Sclerotherapy of oesophageal varices
- Endoscopic prostheses
- Traumatic intubation
- Perioesophageal surgery
- Trauma
  - Penetrating
  - Foreign body
- Caustic ingestion
- Barotrauma
- Tumours
- Infections

### ***Boerhaave's Syndrome***

- Post-emetic rupture of the oesophagus
- First described by Herman Boerhaave in 1723
- His patient was Baron Jan von Wassenaer, Grand Admiral of the Dutch Fleet
- Vomited after a meal and developed left-sided chest pain
- Died 18 hours later
  - At post mortem the following were found:
  - A tear of the left posterior wall of the oesophagus
  - 5 cm above the diaphragm
  - Surgical emphysema
  - Food in the left pleural space

### **Clinical features**

- Oesophageal rupture occurs
  - After 0.1% of standard endoscopies
  - After 2% of oesophageal dilatation
- Diagnosis requires high index of suspicion
- Typical symptoms include chest pain, and dysphagia
- Signs include pyrexia, tachycardia, hypotension, tachypnoea
- Subcutaneous emphysema may be present
- Undiagnosed systemic sepsis rapidly develops
- Death often occurs with 48 hours
- Chest x-ray may show pleural air / fluid level and mediastinal emphysema
- Diagnosis can be confirmed by water-soluble contrast swallow



Figure 110 Chest x-ray showing a pneumomediastinum



Figure 111 CT scan showing an oesophageal perforation and bilateral pleural effusions

## Management

### *Conservative management*

- Conservative management may be appropriate for:
- Small perforations without systemic upset
- Small contained thoracic leaks
- Requires:
  - Nil by mouth
  - Antibiotics
  - Intravenous hydration
- Failure of conservative management will need surgery

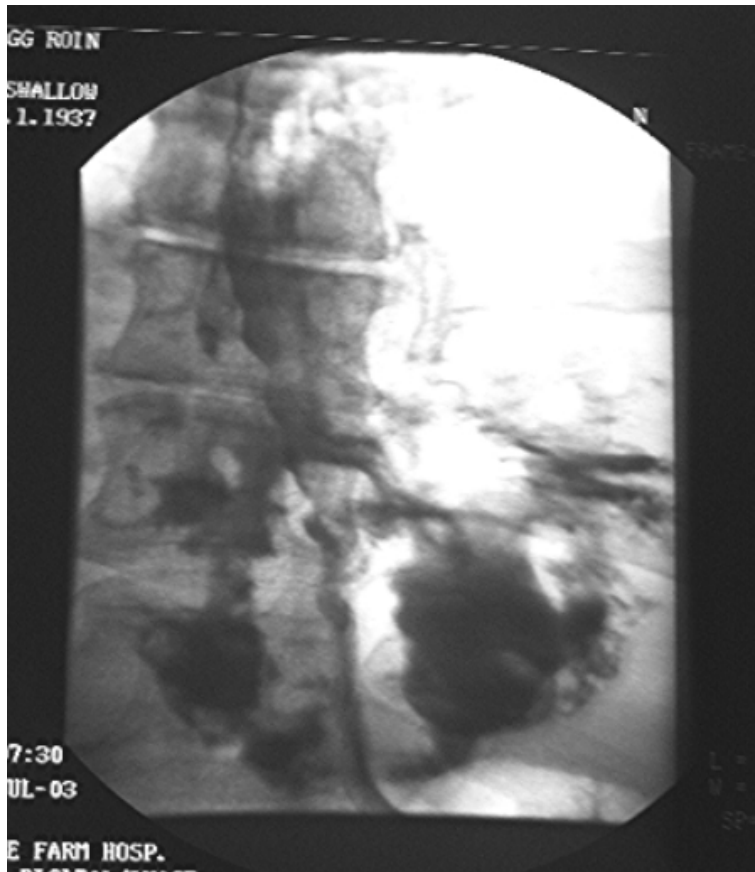


Figure 112 Oesophageal perforation confirmed on barium swallow

### ***Operative management***

- Management principals for thoracic perforations include:
- Control oesophageal leak
  - Eradicate mediastinal / pleural sepsis
  - Re-expand lung
  - Prevent gastric reflux
  - Nutritional and pulmonary support
  - Antibiotics
  - Post-operative drainage of residual septic foci
- Methods of treatment include:
  - Primary closure with buttress or patch
  - Exclusion and diversion
  - T-tube fistula
  - Thoracic drainage an irrigation
  - Resection
  - Decompression gastrostomy and feeding jejunostomy
- If operated on within 24 hours mortality is 5-10%
- If operation delayed more than 48 hours mortality is more than 50%





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## **Dysphagia and achalasia**

### **Causes of dysphagia**

#### **Extrinsic mechanical**

- Carcinoma of the bronchus
- Thoracic aortic aneurysm
- Goitre

#### **Intrinsic mechanical**

- Benign stricture
- Oesophageal carcinoma
- Bolus obstruction

#### **Primary neuromuscular**

- Achalasia
- Diffuse oesophageal spasm
- Nutcracker oesophagus

#### **Secondary neuromuscular**

- Multiple sclerosis
- Systemic sclerosis
- Chagas' disease
- Autonomic neuropathy

### **Achalasia**

- Due to reduced number of ganglion cells in myenteric plexus
- Vagi show axonal degeneration of the dorsal motor nucleus and nucleus ambiguus
- Aetiology unknown but a neurotropic virus may be important
- Similar to Chagas' Disease due to *Trypanosoma Cruzi*

#### **Clinical features**

- Commonest in patients between 40 - 70 years
- Male : female ratio 1:1
- Symptoms include dysphagia, weight loss, regurgitation, chest pain
- 5% of patients develop squamous carcinoma

#### **Investigations**

- CXR - widening of mediastinum, air / fluid level and absence of gastric fundus gas bubble
- Ba Swallow - dilatation & residue, small tertiary contractions and 'rat tail' of distal oesophagus
- Manometry - absent primary peristaltic wave and non-propulsive tertiary contractions
- Endoscopy - essential to exclude 'pseudoachalasia' due to submucosal carcinoma
- Tight LOS which relaxes with gentle pressure usually seen
- Isotope transit studies



### Differential diagnosis

- Diffuse oesophageal spasm
- Infiltrating carcinoma
- Hypertrophic lower oesophageal sphincter
- Scleroderma
- Chagas' disease

### Treatment options

- Two treatment options are commonly available
- Treatment selected should be based in individual patient needs

### Balloon Dilatation

- Rider Moeller Balloon
- Inflated to 300 mmHg for 3 minutes
- 3% perforation rate
- 60% dysphagia free at 5 years
- May be repeated if necessary

### Cardiomyotomy

- Described by Heller (1914) & Grenveldt (1918)
- May be performed laparoscopically
- 85% dysphagia free
- 10% develop oesophageal reflux
- 3% peptic stricture
- Some combine cardiomyotomy with an antireflux operation

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## Gastric carcinoma

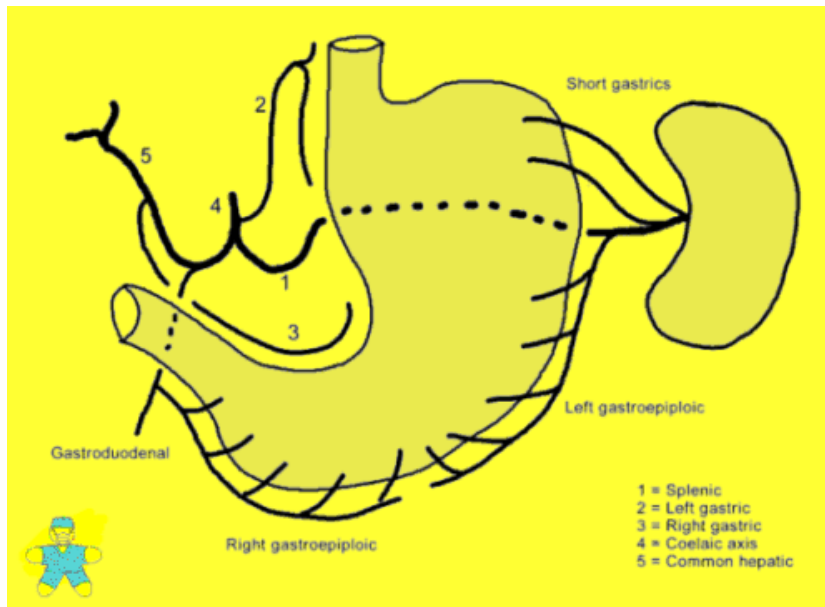


Figure 113 Arterial supply to the stomach - lymphatic drainage follows blood supply

- Gastric carcinoma is the second commonest cause of cancer deaths world wide
- Accounts for 7000 deaths per year in the UK

**Risk factors**

- Diet low in Vitamin C
- Blood group A
- Pernicious anaemia
- Hypogammaglobulinaemia
- Post gastrectomy

**Precursor states**

- *Helicobacter pylori* infection
- Atrophic gastritis
- Intestinal metaplasia
- Gastric dysplasia
- Gastric polyps

**Clinical presentation**

- Most present late and are not amenable to radical surgery
- Upper GI endoscopy should be considered in patients with dyspeptic symptoms over 40 years

**Staging of gastric carcinoma**

- Requires a combination of preoperative investigations and intraoperative assessment
- OGD confirms diagnosis, site and extent of tumour
- Endoscopic ultrasound may allow assessment of intramural tumour penetration
- CT will assess nodal spread and extent of metastatic disease
- Laparoscopy will identify peritoneal seedlings



- Peritoneal lavage will allow detection of free tumour cells

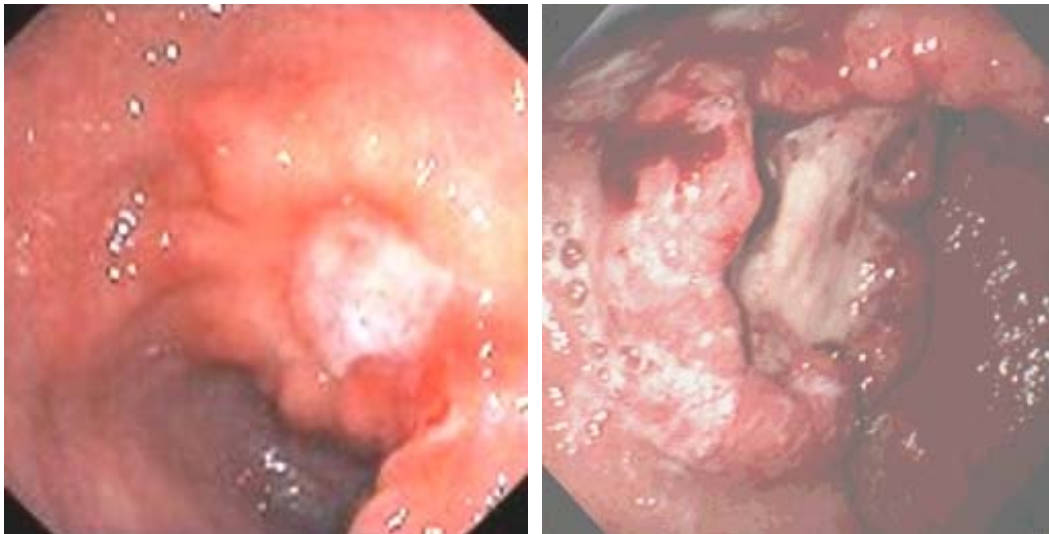


Figure 114 Endoscopic appearance of gastric carcinoma

#### **Birmingham Staging System**

- Clinicopathological system
- Does not require detailed lymph node status
  - Stage 1 - Disease confined to muscularis propria
  - Stage 2 - Muscularis and serosal involvement
  - Stage 3 - Gastric and nodal involvement
  - Stage 4a - Residual disease
  - Stage 4b - Metastatic disease

#### **Survival**

- Prognosis is generally very poor
- Overall 5 year survival is approximately 5%
- Survival is 70%, 32%, 10% and 3% for Stages 1,2,3 and 4 respectively

#### **Management of gastric carcinoma**

- Surgery is the only prospective of cure
- Antral tumours may be suitable for a partial gastrectomy usually with Polya reconstruction
- Other tumours will need a total gastrectomy with oesophagojejunal anastomosis and Roux-en-Y biliary diversion
- A tumour is considered resectable if confined to stomach or N<sub>1</sub> or N<sub>2</sub> nodes involved
  - Nodes less than 3 cm from tumour = N<sub>1</sub> nodes
  - Nodes greater than 3 cm from tumour = N<sub>2</sub> nodes
  - If tumour and N<sub>1</sub> nodes resected = D<sub>1</sub> gastrectomy
  - If tumour and N<sub>2</sub> nodes resected = D<sub>2</sub> gastrectomy
- Evidence to support the use of D<sub>2</sub> gastrectomy is incomplete
- D<sub>2</sub> gastrectomy associated with increased post-operative mortality
- May be associated with improved long-term survival
- Even in patients with incurable disease surgery may palliate symptoms
- Results from adjuvant chemotherapy post surgery are disappointing
- Chemoradiotherapy may reduce relapse and improve survival

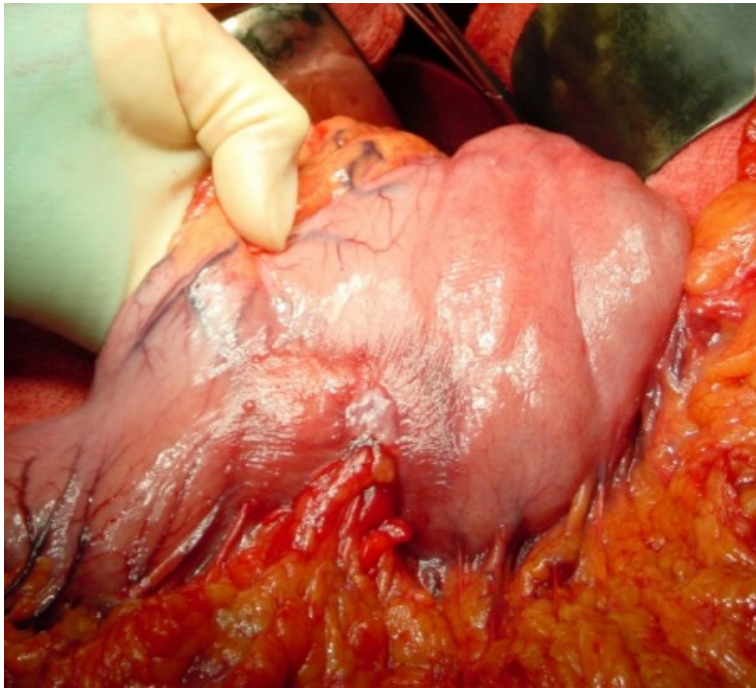


Figure 115 Intraoperative appearance of a gastric cancer



Figure 116 Linitis plastica



## Other gastric tumours

### *Leiomyosarcoma*

- Accounts for 2-3% of all gastric tumours
- Arises from the smooth muscle of the stomach wall
- Lymphatic spread is rare
- 75% present with an upper gastrointestinal bleed
- 60% have palpable abdominal mass
- Diagnosis can be confirmed by endoscopy and CT scanning
- Partial gastrectomy may allow adequate resection
- 5-year survival is approximately 50%



Figure 117 Gastric leiomyoma

### *Gastric lymphoma*

- Stomach is the commonest extranodal primary site for non-Hodgkin's lymphoma
- Accounts for approximately 1% of gastric malignancies
- Clinically presents similar to gastric carcinoma
- 70% of tumours are resectable
- 5-year survival is approximately 25%
- Both adjuvant radiotherapy and chemotherapy may be useful

### *Sister Mary Joseph Nodule*

- Sister Mary Joseph was Head Nurse to William Mayo
- Was first to notice that a 'nodule' in the umbilicus was often associated with advanced malignancy
- Presents as firm, red, non-tender nodule
- Results from spread of tumour within the falciform ligament
- 90% of tumours are adenocarcinomas
- Commonest primaries are stomach and ovary
- Primary tumour is almost invariably inoperable



Figure 118 Sister Mary Joseph nodule

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### Peptic ulcer disease

- Number of admissions for uncomplicated disease is falling
- Incidence of complications related to NSAID use is increasing

### Helicobacter pylori

- *H. pylori* is gram-negative spiral flagellated bacterium
- Produces urease
- Important in the aetiology of peptic ulcers and gastric cancer
- Found in:
  - 90% patients with duodenal ulceration
  - 70% patients with gastric ulceration
  - 60% patients with gastric cancer

### Investigation

- The organism can be detected by :
  - Microscopy – silver or Giemsa staining of antral biopsies
  - Culture – difficult and requires special culture techniques
  - Rapid urease test – colour changes due to change in pH
  - <sup>13</sup>C or <sup>14</sup>C breath test – ingested radioactive urea is broken down to carbon dioxide
  - Serology – detected immunologically using an ELISA

Table 36 Sensitivity and specificity of *H. pylori* diagnostic tests

Test	Sensitivity (%)	Specificity (%)
Rapid urease	90	90-95
Culture	80	100
Microscopy	90	90
Carbon breath test	95	95
Serology	98	100

### Medical management of peptic ulcer disease

#### H<sub>2</sub> Antagonists

- 65% healing at one month
- 85% healing at two months
- If stop treatment - 90% recurrence at 2 years
- If maintenance therapy - 20% recurrence at 5 years

#### Proton Pump inhibitors

- 90 - 100% healing at 2 months
- Low recurrence on long term maintenance

#### H. Pylori eradication

- 80% cured with dual or triple therapy
- Two weeks amoxicillin, metronidazole and omeprazole
- Short term recurrence rates are low
- Long term recurrence rates are at present unknown
- Drugs have changed the need for ulcer surgery over last 20 years
- Admissions for elective surgery have significantly reduced
- The number of complications however remain unchanged



- May be increasing due to increased NSAID use in elderly
- Bleeding and perforation still have mortality of >10%

### History of peptic ulcer surgery

- Harberer (1882) - First gastric resection for benign ulcer
- Billroth (1885) - Billroth II Gastrectomy
- Von Fiselberg (1889) - 'Valve' to prevent bile reflux through gastroenterostomy
- Hofmeister (1896) & Polya (1911) - Retrocolic anastomosis
- Dragstedt (1943) - Truncal vagotomy
- Visick (1948) - Truncal Vagotomy and drainage
- Johnson & Wilkinson (1970) - Highly Selective Vagotomy

### Billroth I gastrectomy

- Originally described for the resection of distal gastric cancers
- Still used in gastric cancers if radical gastrectomy is inappropriate
- Later applied in the treatment of benign gastric ulcers
- Useful if ulcer situated high on the lesser curve or bleeding ulcer that requires resection
- Less effective than Polya Gastrectomy for duodenal ulcers

### Billroth II / Polya gastrectomy

- Initially described for duodenal ulceration but rarely performed today
- Some form of vagotomy is the surgical treatment of choice for uncomplicated DU
- Occasionally used below a high gastric ulcer
- Ulcer invariably heals after surgery
- Useful in recurrent ulceration following previous vagotomy
- When constructing the anastomosis need to consider:
  - Antecolic vs. retrocolic anastomosis
  - Hofmeister valve so as direct bile in to the efferent loop
  - Anastomosis can be either isoperistaltic or anteperistaltic

### Current surgical options

- Indications for surgical treatment of duodenal ulceration are:
  - Intractability
  - Haemorrhage
  - Perforation
  - Obstruction
- Aims of surgery is cure the ulcer diathesis with the lowest risk of recurrence and complications

### Surgical options for duodenal ulceration

- Operations for DU reduce acid production by the stomach
- Cephalic phase reduced by vagotomy
- Antral phase reduced by antrectomy
- May require gastric drainage procedure to overcome effects of vagotomy on gastric drainage

### Open surgical procedures

- Truncal vagotomy and pyloroplasty
- Truncal vagotomy and gastrojejunostomy
- Truncal vagotomy and antrectomy
- Highly selective vagotomy



- Anterior seromyotomy and posterior truncal vagotomy

#### **Laparoscopic peptic ulcer operations**

- Thoracoscopic truncal vagotomy and pyloric stretch
- Truncal vagotomy and pyloric stretch
- Highly selective vagotomy
- Posterior truncal vagotomy and selective anterior vagotomy
- Posterior truncal vagotomy and anterior seromyotomy

#### **Post gastrectomy complications**

- Recurrent Ulceration (2%)
- Diarrhoea (16%)
- Dumping (14%)
- Bilious Vomiting (10%)
- Iron Deficient anaemia (12%)
- B<sub>12</sub> Deficiency (14%)
- Folate Deficiency (32%)

#### **Post vagotomy complications**

- Diarrhoea (2%)
- Dumping (2%)
- Bilious Vomiting (<2%)

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## Hepatobiliary and pancreatic surgery

### *Obstructive jaundice*

#### Aetiology of obstructive jaundice

##### *Common*

- Common bile duct stones
- Carcinoma of the head of pancreas
- Malignant porta hepatis lymph nodes

##### *Infrequent*

- Ampullary carcinoma
- Pancreatitis
- Liver secondaries

##### *Rare*

- Benign strictures - iatrogenic, trauma
- Recurrent cholangitis
- Mirrizi's syndrome
- Sclerosing cholangitis
- Cholangiocarcinoma
- Biliary atresia
- Choledochal cysts

#### Investigation of obstructive jaundice

- Investigation will differentiate hepatocellular and obstructive jaundice in 90% cases

##### *Blood results*

- Conjugated bilirubin more than 35 mmol/l
- Increase in ALP / GGT more than AST / ALT
- Albumin may be reduced
- Prolonged PTT

Table 37 Urinalysis findings in jaundice

	<b>Haemolysis</b>	<b>Obstruction</b>	<b>Hepatocellular</b>
Conjugated bilirubin	normal	increased	normal
Urobilinogen	increased	nil	normal

##### *Ultrasound*

- Normal CBD less than 8 mm diameter
- CBD diameter increase with age and after previous biliary surgery
- For obstructive jaundice ultrasound has a sensitivity 70 - 95% and specificity 80 - 100%
- In future endoscopic ultrasound may become more widely available

##### *CT Scanning*

- Sensitivity and specificity similar to good quality ultrasound
- Useful in obese or excessive bowel gas



- Better at imaging lower end of common bile duct
- Stages and assesses operability of tumours

#### **Radionuclide scanning**

- <sup>99</sup> technetium iminodiacetic acid (HIDA)
- Taken up by hepatocytes and actively excreted into bile
- Allows imaging of biliary tree
- Failure to fill gallbladder = acute cholecystitis
- Delay of flow into duodenum = biliary obstruction

#### **ERCP**

- Allows biopsy or brush cytology
- Stone extraction or stenting

#### **PTC**

- Rarely required today
- Performed with 22G Chiba Needle
- Also allows biliary drainage and stenting

#### **Complications of obstructive jaundice**

##### **Ascending cholangitis**

- Charcot's triad is classical clinical picture
- Intermittent pain, jaundice and fever
- Cholangitis can lead to hepatic abscesses
- Need parenteral antibiotics and biliary decompression
- Operative mortality in elderly of up to 20%

##### **Clotting disorders**

- Vitamin K required for gamma-carboxylation of Factors II, VII, IX, XI
- Vitamin K is fat soluble. No absorbed.
- Needs to be given parenterally
- Urgent correction will need Fresh Frozen Plasma
- Also endotoxin activation of complement system

##### **Hepato-renal syndrome**

- Poorly understood
- Renal failure post intervention
- Due to gram negative endotoxaemia from gut
- Preoperative lactulose may improve outcome
- Improves altered systemic and renal haemodynamics

##### **Drug Metabolism**

- Half life of some drugs prolonged. e.g. morphine

##### **Impaired wound healing**

#### **Perioperative management of obstructive jaundice**

- Preoperative biliary decompression improves postoperative morbidity
- Broad spectrum antibiotic prophylaxis
- Parenteral vitamin K +/- fresh frozen plasma
- IVI and catheter



- Pre operative fluid expansion
- Need careful post operative fluid balance to correct depleted ECF compartment
- Consider 250 ml 10% mannitol. No proven benefit in RCT

### Common bile duct stones

- Accurate prediction of the presence of common bile duct stones can be difficult
- If elevated bilirubin, ALP and CBD > 12 mm risk of CBD stones is 90%
- If normal bilirubin, ALP and CBD diameter risk of CBD stones 0.2%
- ERCP and endoscopic sphincterotomy is investigation of choice
  - Stones extracted with balloons or Dormia basket
  - 90% successful
  - Complication rate approximately 8%
  - Mortality less than 1%
- If fails to clear stones will require:
  - Open cholecystectomy + exploration of CBD
  - Laparoscopic exploration of CBD
  - Mechanical lithotripsy  
80% successful after failure of ERCP
  - Extra-corporeal shockwave lithotripsy
  - Chemical dissolution with cholesterol solvents  
Methyl tertbutyl ether or mono-octanoin  
Administered via T Tube or nasobiliary catheter  
25% complete response and 30% partial response
- If retained stones after CBD exploration need to consider:
  - Early ERCP
  - Exploration via T tube tract at 6 weeks

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## ***Acute pancreatitis***

### **Aetiology of pancreatitis**

- Idiopathic
- Obstruction – choledocholithiasis, pancreatic tumours
- Pancreatic structural anomalies
- Toxins – alcohol, drugs (e.g. salicylates, azathioprine, cimetidine)
- Trauma – accidental, iatrogenic
- Metabolic abnormalities
- Infection
- Vascular anomalies

### **Diagnosis of pancreatitis**

- Serum amylase has low sensitivity and specificity
- 20% cases of pancreatitis have normal serum amylase (particularly alcoholic aetiology)
- Serum lipase more sensitive



Figure 119 Cullen's sign

### ***Causes of hyperamylasaemia***

- Perforated peptic ulcer
- Cholecystitis
- Generalised peritonitis
- Intestinal obstruction
- Mesenteric infarction
- Ruptured abdominal aortic aneurysm
- Ruptured ectopic pregnancy



Figure 120 Grey Turner's sign

#### Prognostic factors

- 80% of patients have mild pancreatitis with good recovery
- Mild disease accounts for less than 5% of the mortality from pancreatitis
- Mortality from pancreatitis due to:
  - Early multiple organ failure
  - Late infected pancreatic necrosis
  - Haemorrhage
  - Associated co-morbidity
- Aim of prognostic scores is to identify patients with severe pancreatitis
- Need to have high sensitivity and specificity
- Ideally should be applicable on admission

#### Ranson's criteria

- On admission
  - Age > 55 yrs
  - WCC > 16,000
  - LDH > 600 U/l
  - AST > 120 U/l
  - Glucose > 10 mmol/l
- Within 48 hours
  - Haematocrit fall > 10%
  - Urea rise > 0.9 mmol/l
  - Calcium < 2 mmol
  - pO<sub>2</sub> < 60 mmHg
  - Base deficit > 4
  - Fluid sequestration > 6L
- Can not be applied fully for 48 hours
- Also poor predictor later in the disease
- 'Single snapshot in a whole feature length film'





### APACHE II

- Multivariate scoring system
- Measure objective parameter - vital signs and biochemical analysis
- Account for premorbid state and age
- Can be used throughout course of illness

Table 38 Contrast-enhanced CT grading system

Grade	Criteria
A	Normal
B	Focal or diffuse glandular enlargement Small intra-pancreatic fluid collection
C	Any of the above Peripancreatic inflammatory changes Less than 25% gland necrosis
D	Any of the above Single extrapancreatic fluid collection 25-50% gland necrosis
E	Any of the above Extensive extrapancreatic fluid collection Pancreatic abscess More than 50% gland necrosis

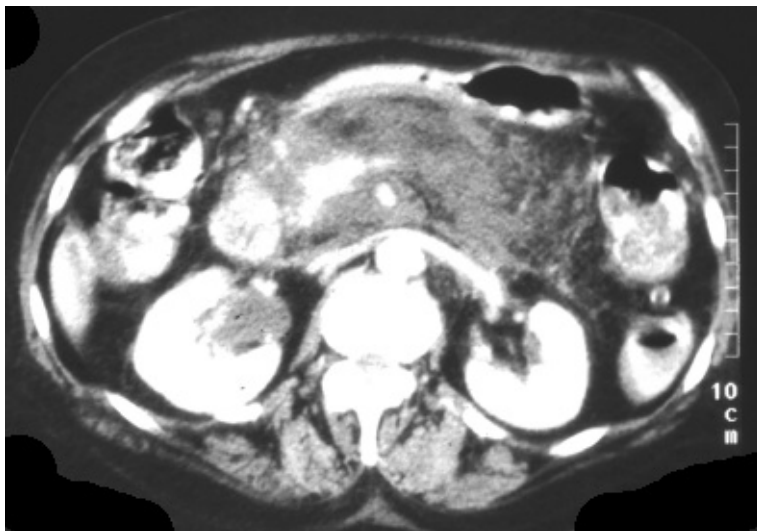


Figure 121 CT appearances of acute pancreatitis

### Early treatment of pancreatitis

- Aims of treatment are to :
  - To halt progression of local disease
  - Prevent remote organ failure
- Requires full supportive therapy – often on ITU or HDU
- Urinary catheter, CVP line and possibly arterial line
- Regular assessment of U+E, Ca, blood sugar, LFTs
- Patients require:
  - Fluid resuscitation with both colloid and crystalloid



- Correction of hypoxia with an increased  $F_iO_2$  or ventilation
- Adequate analgesia - opiate or epidural
- Increasing evidence that antibiotic prophylaxis useful in severe pancreatitis

#### **Nutritional support**

- Pancreatitis is associated with a catabolic state
- The benefit of pancreatic 'rest' by limiting oral intake is unproven
- Evidence that early enteral nutrition is safe
- Nasojejunal feeding limits pancreatic secretion
- Preferable to oral or nasogastric feeding

#### **Complications of acute pancreatitis**

##### **Local**

- Necrosis possibly with infection
- Pancreatic fluid collections
- Colonic necrosis
- Gastrointestinal haemorrhage
- Splenic rupture

##### **Systemic**

- Hypovolaemia and shock
- Coagulopathy
- Respiratory failure
- Renal Failure
- Hyperglycaemia
- Hypocalcaemia

#### **Pseudocysts**

- Fibrous walled peri-pancreatic fluid collection
- Present for more than one month
- No epithelial lining. Fluid has high amylase content
- Acute fluid collections are **not** pseudocysts
- 35% patients with pancreatitis develop peri-pancreatic fluid collections
- More than 50% resolve spontaneously over a 3 month period
- Complication rate increases after 6 weeks
- Diagnosis may be suggested by persistent elevation of serum amylase
- Planned intervention at 6 weeks

#### **Classification of pseudocysts**

- Type 1 - Normal duct anatomy. No fistula between duct and cyst
- Type 2 - Abnormal duct anatomy - No fistula
- Type 3 - Abnormal duct anatomy and fistula

#### **Investigation of pseudocysts**

- Ultrasound will allow assessment of changes in the size of the cyst
- Endoscopic ultrasound increasingly used
- CT to define relationship to adjacent organs
- ERCP to define duct anatomy

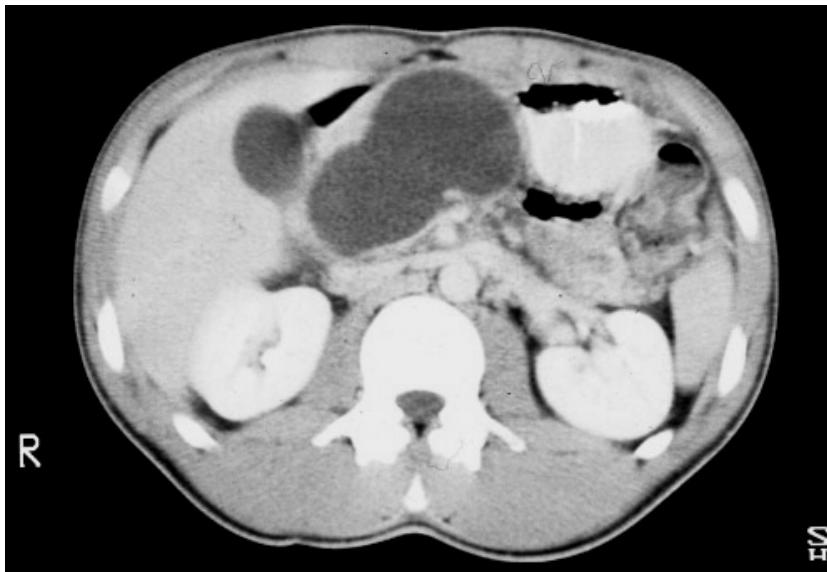


Figure 122 CT appearance of a pseudocyst

### Treatment options

#### *Percutaneous drainage*

- US or CT guided
- 80% successful in type 1 cyst
- Less successful if fistula to duct present
- Occasionally associated with pancreatic abscess or fistula

#### *Endoscopic drainage + insertion of pigtail catheter*

- Transpapillary or transmural

#### *Surgical drainage*

- Cystogastrostomy
- Roux Loop Cystojejunostomy
- Allows adequate internal drainage
- Biopsy cyst wall to exclude cystadenocarcinoma
- Mortality similar to percutaneous drainage (~5%)
- Lower recurrence rate (~5 vs. 20%)

### Timing of intervention in pancreatitis

- All patients should undergo US within 24 hours of admission
- If confirms gallstones and severe pancreatitis consider ERCP within 48 hrs
- RCT confirm reduction in morbidity and mortality with early duct clearance
- If patient fails to settle during first week of admission
- Contrast enhanced CT to assess pancreatic necrosis
- If suspicion of infection - CT guided aspiration
- Consider pancreatic necrosectomy if:
  - Clinical deterioration
  - Bacteriological proof on infection
- Operative mortality more than 40%

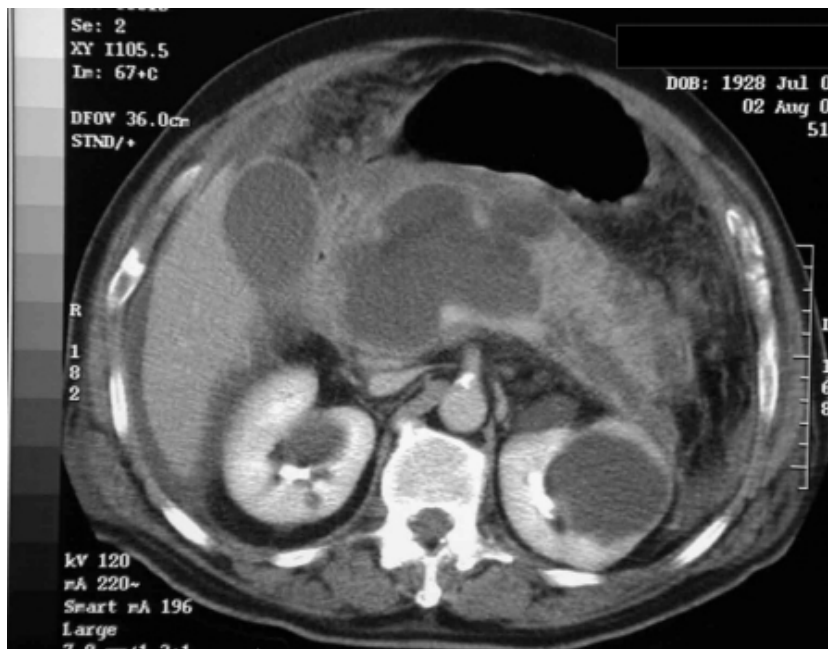


Figure 123 CT appearance of pancreatic necrosis

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### **Pyogenic liver abscess**

- Usually seen in elderly patients
- Can be multiple or solitary
- Arise as a result of biliary sepsis
- Mortality is high as diagnosis is often delayed
- Commonest organisms involved
  - *E. coli*
  - Klebsiella
  - Proteus
  - Bacteroides species

### **Aetiology**

- Portal pylophlebitis - appendicitis, diverticulitis or pelvic infections
- Biliary disease - cholecystitis, ascending cholangitis or pancreatitis
- Trauma - blunt or penetrating
- Direct extension - empyema of the gall bladder, subphrenic or perinephric abscess
- Septicaemia
- Infected liver cysts or tumours

### **Clinical features**

- Patients are generally systemically unwell
- Severe abdominal pain usually localised to right hypochondrium
- Swinging pyrexia, rigors and weight loss
- 25% present with jaundice
- Examination shows an hypochondrial or epigastric mass
- 30% have a pleural effusion

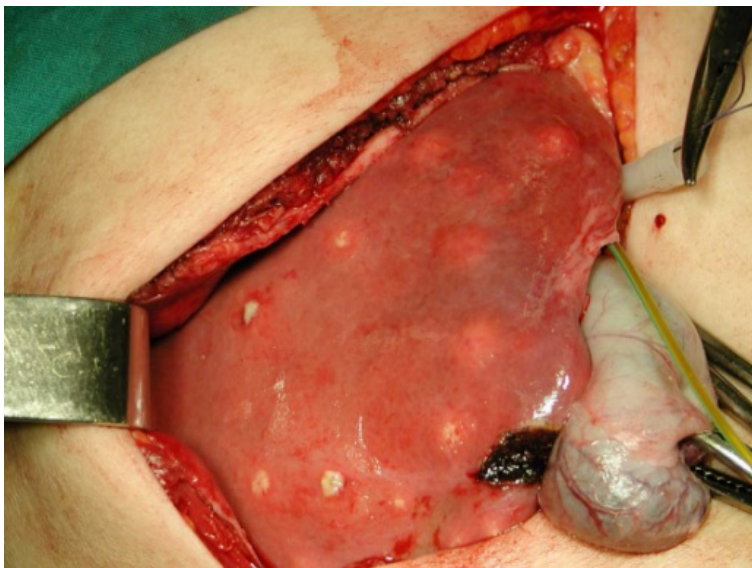


Figure 124 Pyogenic liver abscess



### Investigation

- Serology shows a raised WCC, increased ESR and deranged LFTs
- Chest x-ray often shows a raised right hemidiaphragm and pleural effusion
- Ultrasound will localise the abscess and will guide drainage
- CT useful if diagnosis in doubt or if there are multiple abscesses

### Management

- Patients should be started on appropriate antibiotics (cephalosporin and metronidazole)
- Percutaneous drainage under ultrasound guidance is the initial treatment of choice
- If biliary obstruction will need to consider decompression
- Surgery may be required if:
  - Failure of resolution with percutaneous drainage
  - Intraperitoneal rupture
- Both situations are associated with a high mortality (more than 30%)
- Laparoscopic drainage may succeed after failure of percutaneous route

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### **Amoebic liver abscess**

- Due to infection with the protozoan parasite *Entamoeba histolytica*
- Found in the stool of carriers in the cystic or trophozoite form
- Transmitted by the faecal-oral route
- The liver is the commonest extraintestinal site of infection
- 10% of affected patients develop liver abscesses
- Liver abscesses can be solitary or multiple
- 80% of abscess develop in right lobe of the liver
- Can present several years after intestinal infection

### **Clinical features**

- Presents with malaise pyrexia and weight loss
- Right hypochondrial pain is often mild
- Less than 20% of patients present with diarrhoea
- Jaundice is uncommon
- Complications can arise as a result of abscess rupture or extension of infection
- Complications occur in 5% patients and include:
  - Amoebic empyema
  - Hepato-bronchial fistula
  - Lung abscess
  - Pericarditis
  - Peritonitis

### **Investigations**

- Serology shows raised WCC and ESR
- Latex agglutination assay positive in more than 90%
- Sigmoidoscopy, stool microscopy and rectal biopsy may identify the organism
- Chest x-ray may show a raised right hemidiaphragm, atelectasis or abscess
- The abscess can often be identified on ultrasound
- Aspiration produces a typical 'anchovy sauce' appearing pus
- Pus is odourless and sterile on routine culture

### **Management**

- Metronidazole is the antibiotic of choice
- If ineffective chloroquine and dihydrometine may be considered
- Ultrasound guided aspiration may be useful
- Surgery is only rarely required
- Prognosis in uncomplicated cases is good (<1%)
- If pulmonary complications occur mortality can be as high as 20%

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### Hydatid disease

- Due to infection with the helminth *Ecchinococcus granulosus*
- Adult worm is found normally in the dog and sheep intestine
- Man is an accidental intermediate host
- Infection seen in Mediterranean areas, Australia and South America
- Liver is the commonest organ involved
- Cysts are unilocular, can be up to 20 cm in diameter and may be multiple
- Daughter cysts may develop
- 70% develop in the right lobe of the liver
- Lung, brain and bone can also be infected
- Pathologically hydatid liver cyst has three distinct layers:
  - Ectocyst - fibrous adventitial layer due to host response
  - Middle layer - laminated membrane of proteinaceous material
  - Endocyst - inner germinal layer from which the scolices may be detached

### Clinical features

- Clinical presentation is often non-specific and may be asymptomatic
- 60% have right hypochondrial pain
- Only 15% become jaundiced
- Other features include skin rashes, pruritus and allergic reactions
- Cysts can rupture resulting in bronchobiliary fistula

### Investigation

- 30% of patients have an eosinophilia
- Diagnosis can be confirmed by indirect haemagglutinin assay
- Plain abdominal x-ray may show calcification in cyst wall
- Cyst can be imaged with ultrasound or CT
- Aspiration should not be performed if hydatid disease is suspected
- Associated with risk of dissemination of infection or anaphylaxis



Figure 125 Hepatic hydatid cyst





Figure 126 Hepatic hydatid cysts

### Management

- Pharmacological treatment is not curative
- Used as an adjunct to surgery to kill spilled scolices
- The drugs of choice are albendazole, mebendazole and praziquantel
- If surgery is required a laparotomy is performed to exclude other cysts
- The liver is packed off with hypertonic saline-soaked swabs
- Cysts are then decompressed with trocar and cannula
- Scolicidal agent (e.g. hypertonic saline or 0.5% silver nitrate) can be injected into cyst cavity
- Cavity is filled with saline and a suction drain inserted
- Alternatively liver cysts can be excised
- Hepatic resection may be required for recurrent cysts
- Recurrence rate is approximately 5% at 5 years

### Complications

- Operative mortality is less than 2%
- Complications include:
  - Subphrenic abscess
  - Prolonged cyst drainage



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## Gallstones

- Gallstones are found in 12% men and 24% women
- Prevalence increases with advancing age
- 10-20% become symptomatic
- Over 10% of those with stones in the gallbladder have stones in the common bile duct
- 40,000 cholecystectomies are performed annually in UK
- More than 4,000 common bile ducts are cleared of stones

## Pathophysiology

- Three types of stones are recognised
  - Cholesterol stones (15%)
  - Mixed stones (80%)
  - Pigment stones (5%)



Figure 127 Pigment gallstones

- Mixed stones are probably a variant of cholesterol stones
- 10% of gallstones are radio-opaque
- Cholesterol stones result from a change in solubility of bile constituents
- Bile acids act as a detergent keeping cholesterol in solution
- Bile acids, lecithin and cholesterol result in the formation of micelles
- Bile is often supersaturated with cholesterol
- This favours the formation of cholesterol microcrystals
- Biliary infection, stasis and changes in gallbladder function can precipitate stone formation
- Bile is infected in 30% of patients with gallstones
- Gram-negative organisms are the most common isolated

## Clinical presentations

- Acute cholecystitis
- Empyema of the gallbladder
- Mucocele of the gallbladder
- Biliary colic
- 'Flatulent dyspepsia'
- Mirrizi's syndrome



- Obstructive jaundice
- Pancreatitis
- Acute cholangitis



Figure 128 Acute cholecystitis

#### Acute cholecystitis

- 90% cases result from obstruction to the cystic duct by a stone
- Increased pressure within the gallbladder results in an acute inflammatory response
- Secondary bacterial infections occurs in 20% of cases of acute cholecystitis
- Most common organisms are *E. coli*, *Klebsiella* and *strep. faecalis*

#### Clinical features

- Constant pain (usually greater than 12 hours duration) in right upper quadrant
- Fever, tachycardia
- Tenderness in right upper quadrant
- Murphy's sign - guarding in right upper quadrant on deep inspiration

#### Investigation

- Ultrasound is the initial investigation of choice
- Diagnostic features on ultrasound include:
  - Presence of gallstones
  - Distended thick-walled gallbladder
  - Pericholecystic fluid
  - Murphy's sign demonstrated with ultrasound probe
  - If diagnostic doubt a HIDA scan may be useful
  - Will show failure of isotope (hydroxyiminodiacetic acid) uptake by gallbladder

#### Complications of acute cholecystitis

- Gangrenous cholecystitis
- Gallbladder perforation
- Cholecystoenteric fistula
- Gallstone ileus

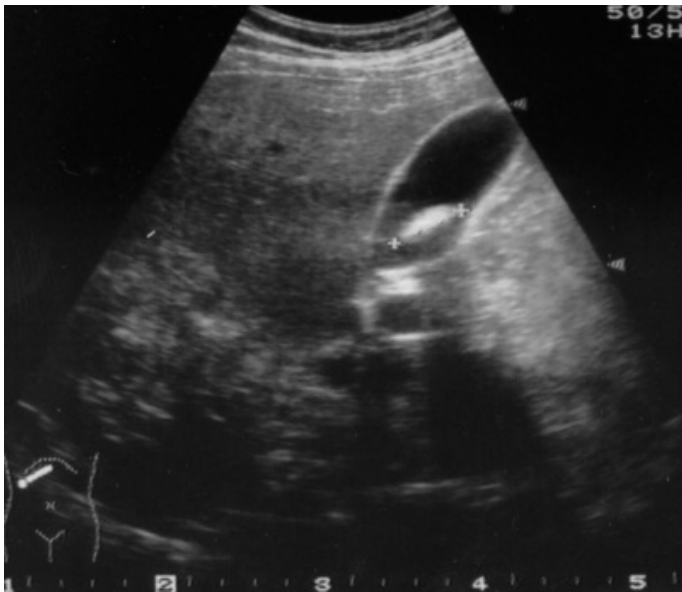


Figure 129 Gallstones on ultrasound

### **Management**

- Initial management is usually conservative
- Patient is fasted, given intravenous fluids and opiate analgesia
- Intravenous antibiotics (e.g. second generation cephalosporin) should be given to prevent secondary infection
- 80% patients improve with conservative treatment
- If fit, should be considered for a laparoscopic cholecystectomy
- Timing of surgery is controversial
- Evidence now suggests that early surgery (<72 hours) is safe
- It has a lower conversion rate
- It avoids the complications of conservative treatment failure
- If patient unfit for surgery, percutaneous cholecystotomy may be beneficial
- Particularly useful in acalculous cholecystitis



Figure 130 Gallstone ileus



### Treatment of gallbladder stones

- 1882 the first open cholecystectomy was performed by Langenbuch in Berlin
- Throughout the 20<sup>th</sup> century open cholecystectomy was performed
- It was associated with significant complications
- Today mortality is approximately 0.5%
- Morbidity includes:
- Specific complications
  - Bile duct damage
  - Retained stones
  - Bile leak
- General complications
  - Wound dehiscence
  - Pulmonary atelectasis
- Lead to the development of 'mini' cholecystectomy through a 5 cm transverse incision
- Laparoscopic cholecystectomy was introduced in 1988

### Other modalities

- Dissolution therapies
  - High complication rate
  - Poor long-term results
- Extra-corporeal shock wave lithotripsy
  - Poor stone clearance

### Laparoscopic Cholecystectomy

- Shown to be equally as effective as open cholecystectomy in controlled trials
- Pre-operative ERCP indicated if:
  - Recent jaundice
  - Abnormal liver function tests
  - Significantly dilated common bile duct
  - Ultrasonic suspicion of bile duct stones

### Technique

- Routine use of nasogastric tubes and catheter controversial
- CO<sub>2</sub> pneumo-peritoneum induced using either Veress needle or open technique
- Open (Hasson) technique is believed to be safer
- Over half of bowel injuries are caused by Veress needles or trocars
- Abdominal pressure set to 12-15 mm Hg
- High intra-abdominal pressure can:
  - Reduce pulmonary compliance
  - Decrease venous return
  - Higher end-tidal CO<sub>2</sub> levels
- Surgery usually performed using four standard ports (2 x 10 mm & 2 x 5 mm)
- Patient positioned with head up tilt and rolled to the left
- Calot's triangle dissected using a retrograde technique
- Cystic duct and artery identified
- Ligated with clips or endo-loops
- About 50% surgeons routinely use intra-operative cholangiography
- Cholangiography allows:
  - Definition of biliary anatomy
  - Identification of unsuspected CBD stones (~10% patients)

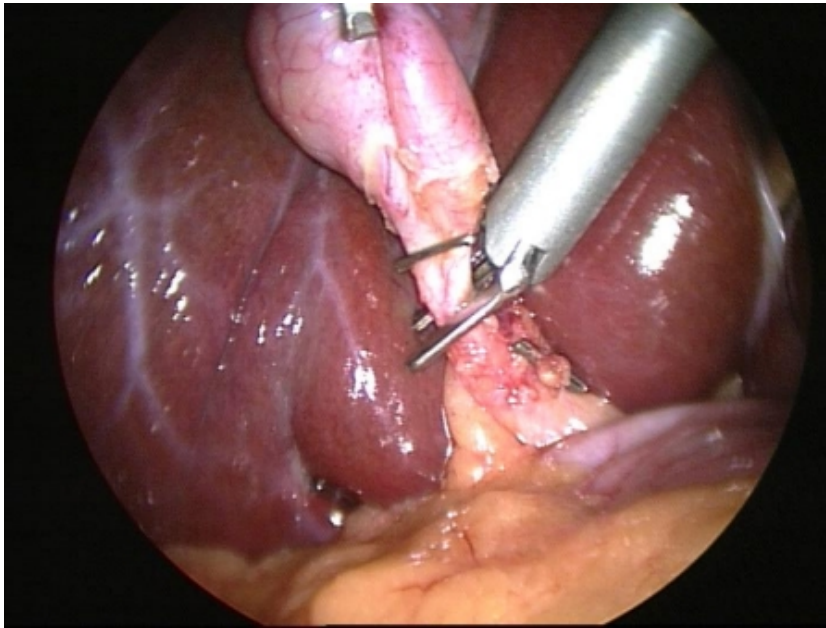


Figure 131 Laparoscopic cholecystectomy



Figure 132 Post laparoscopic cholecystectomy bile duct stricture

**Outcome**

- Conversion rates typically about 5%
- Laparoscopic cholecystectomy associated with:
- Reduced analgesic requirements
- Reduced postoperative stay



- Faster return to normal activity

#### **Bile duct injury**

- Occurs in between 0.1% and 0.5% of patients
- Risk related to surgical inexperience and problems identifying biliary anatomy
- Outcome improved if recognised at time of initial surgery
- For most injuries hepaticojejunostomy is the treatment of choice
- If recognition of injury is delayed then associated with higher morbidity and mortality
- Management then requires drainage of collections and control of sepsis
- Long-term risk include stricture formation and cirrhosis

#### **Laparoscopic surgery in acute cholecystitis**

- In those with acute cholecystitis operation has usually been deferred 6-8 weeks
- Recently shown that early laparoscopic cholecystectomy is:
  - Safe
  - Associated with reduced conversion rate
  - Trend towards early surgery during first admission

#### **Potential future improvements**

- Gasless pneumoperitoneum using mechanical abdominal wall retractors
- Narrower ports and instruments

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## Hepatocellular carcinoma

- Hepatocellular carcinoma (HCC) is a primary malignant disease of the liver
- Uncommon in northern Europe where hepatic secondaries are 30 times more common
- Highest incidence seen in East Africa and South-east Asia
- In these countries it is one of the commonest malignant tumours
- Male : female ratio = 4:1
- In Europe peak age at presentation is 80 years
- In Africa and Asia peak presentation is 40 years

### Aetiology

- Incidence of HCC parallels the world-wide prevalence of hepatitis B
- Aetiological factors are:
  - Cirrhosis
  - Viral hepatitis - particularly Hepatitis B and C
  - Mycotoxins - e.g. aflatoxin produced by *Aspergillus flavus*
  - Alcohol
  - Anabolic steroids
  - Primary liver diseases - e.g. primary biliary cirrhosis, haemochromatosis

### Clinical presentation

- Suspect in any patient with cirrhosis who shows evidence of clinical deterioration
- Often present with right hypochondrial pain and possible mass
- Malaise, weight loss and low grade pyrexia are often present
- Jaundice is a late feature
- Haemobilia or haemoperitoneum are often the immediate cause of death
- Median survival in those with irresectable disease is 6 months
- As most tumours cause symptoms late screening of high risk patients has been advocated
- Can be imaged by:
  - Ultrasound - transabdominal or laparoscopic
  - CT scanning - Conventional or lipiodal enhanced
  - CT portography
- Assessment of serum alpha-fetoprotein ( $\alpha$ FP) may also be useful

### Alpha-fetoprotein

- $\alpha$ FP is a normal fetal serum protein produced by the yolk sac and liver
- Progress increases in serum levels are seen in 70-90% of patients with HCC
- Slightly increased and often fluctuating serum levels also seen in hepatitis and cirrhosis
- In HCC serum levels correlate with tumour size
- Rate of increase in serum levels correlate with growth of tumour
- Tumour resection results in a fall in serum concentrations
- Serial assessment useful in measuring response to treatment

### Surgery for HCC

- Only about 25% patients are suitable for surgery
- The two surgical options are:
  - Surgical resection
  - Liver transplantation



Figure 133 CT appearances of a hepatocellular carcinoma

### Surgical resection

- Surgical resection involves either hemi-hepatectomy or segmental resection
- Most tumours are irresectable to :
  - Large size
  - Involvement of major vessels
  - Associated advanced cirrhosis
  - Metastatic disease or extra-hepatic spread
- The presence of cirrhosis increases the operative mortality (from ~5 to >20%)
- After resection, 5 year survival is typically 30-60%
- Only a small proportion of patients are cured
- The 5 year recurrence rate is over 80%

### Liver transplantation

- Useful for irresectable disease confined to the liver
- Operative mortality is often 10-20%
- Metastases after transplantation occur in 30-40% of patients
- After transplantation, 5 year survival is less than 20%

### Palliative therapy

- Possible palliative interventions include:
  - Devascularisation procedures
  - Chemotherapy
  - Cryotherapy
  - Chemo-embolisation
  - Thermotherapy
- Chemoembolisation improves survival compared to conservative treatment

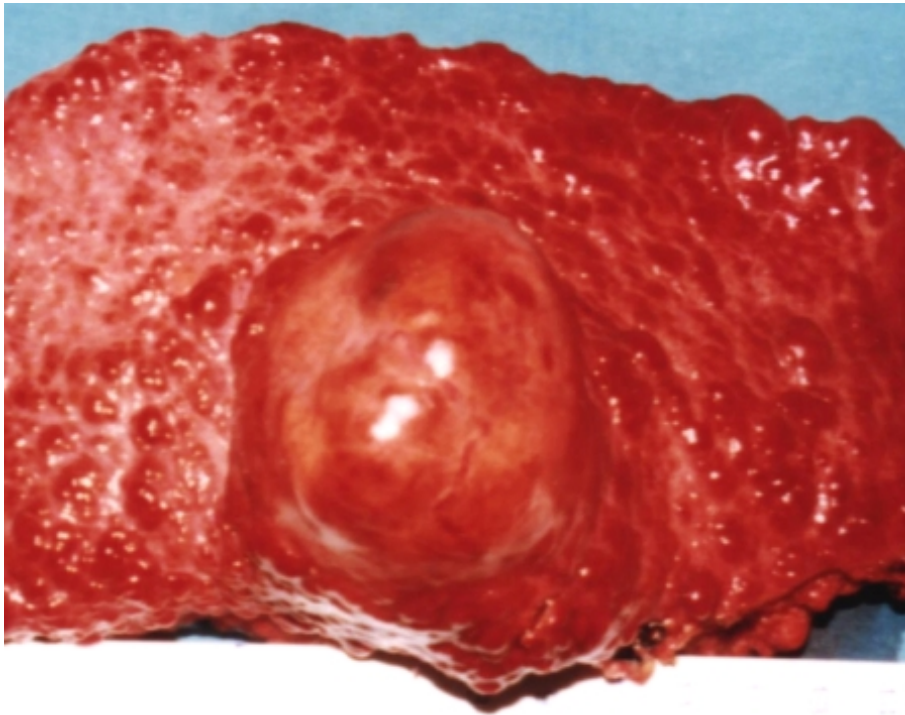


Figure 134 Hepatocellular carcinoma in a cirrhotic liver

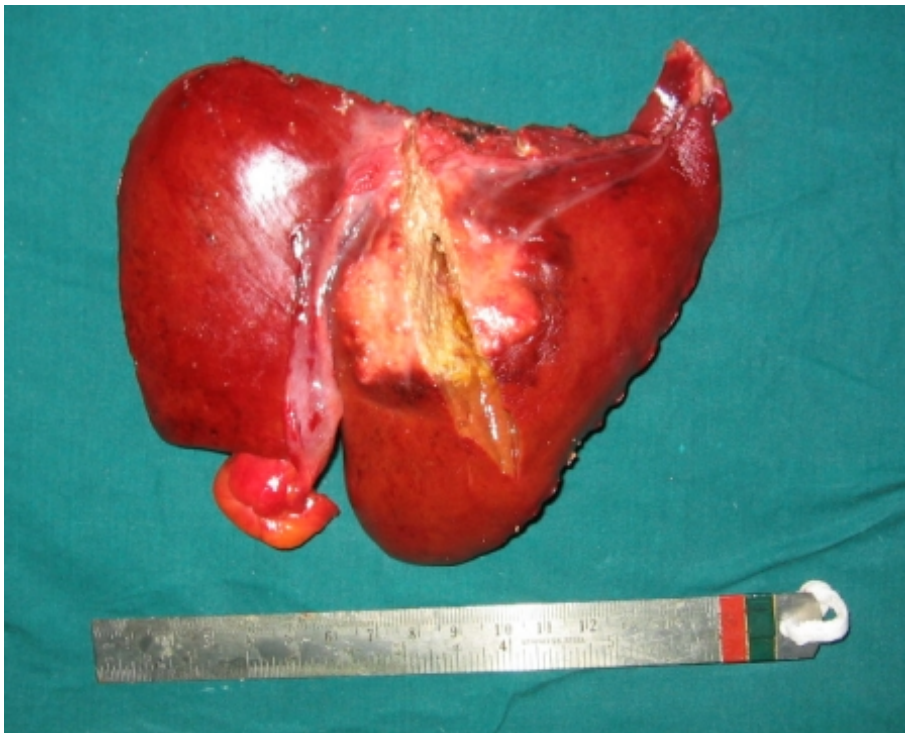


Figure 135 Gross pathological appearance of a hepatocellular carcinoma



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### **Pancreatic carcinoma**

- Pancreatic carcinoma is the second commonest tumour of the digestive system
- The incidence is increasing in the Western world
- It is uncommon less than 45 years of age
- More than 80% of cases occur between 60 and 80 years of age
- Male : female ratio is 2 : 1
- Most tumours are adenocarcinomas
- More than 80% occur in the head of the pancreas
- Overall 5-year survival less than 5%
- Prognosis of ampullary tumours is much better

### **Clinical features**

- 30% present with obstructive jaundice
- Classically described as 'painless jaundice'
- Most develop pain at some stage - 50% present with epigastric pain
- 90% develop anorexia and weight loss
- 75% have metastases at presentation

### **Pancreatic imaging**

#### **Ultrasound**

- Abdominal ultrasound has sensitivity of about 80% for the detection of pancreatic cancer
- Detects level of biliary obstruction, excludes gallstones and may identify pancreatic mass
- Doppler ultrasound allows assessment of vascular invasion

#### **Computerised tomography**

- Spiral CT has improved on resolution of conventional CT
- Contrast-enhanced triple-phase imaging is modality of choice
- Has sensitivity of greater than 95% for detection of pancreatic tumours
- Probably the most useful of staging investigations
- Both US and CT often fail to detect small (< 2 cms) hepatic metastases

#### **Laparoscopy**

- Laparoscopy will identify liver or peritoneal metastases in 25% of patients deemed resectable after conventional imaging
- Laparoscopic ultrasound has improved predictability of resection
- Mesenteric angiography is now considered obsolete

### **Resectional surgery**

- Resection is the only hope of cure
- Only 15% tumours are deemed resectable
- Resectability assessed by:
  - Tumour size (<4 cm)
  - Invasion of SMA or portal vein
  - Presence of ascites, nodal, peritoneal or liver metastases
- Pre-operative biliary drainage of unproven benefit
- Has not been shown to reduce post-operative morbidity or mortality



### **Whipple's operation**

- Involves a pancreatico-duodenal resection
- Initial assessment of resectability by dissection and Kocherisation of the duodenum
- Head of pancreas and duodenum excised followed by:
  - End to side pancreaticojejunostomy
  - End to side hepaticojejunostomy
  - Duodenojejunostomy
- Octreotide given for one week to reduce pancreatic secretion
- Operative mortality in experienced centres less than 5%
- In those suitable for resectional surgery 5-year survival still only 30%
- Post-operative morbidity 30-50%
- 10% of patients develop diabetes
- 30% of patients require post-operative exocrine supplements
- Postoperative adjuvant chemotherapy may improve survival

### **Complications**

- Delayed gastric emptying
- Gastrointestinal haemorrhage
- Operative site haemorrhage
- Intra-abdominal abscess
- Pancreatic fistula

### **Pylorus-preserving proximal pancreaticoduodenectomy**

- Preserves gastric antrum and pylorus
- Compared with Whipple's procedure it is associated with:
  - Reduced morbidity
  - Fewer post gastrectomy symptoms
  - Less entero-gastric reflux
  - Improved postoperative nutrition
  - No difference in mortality
- May be associated with increased risk of local recurrence

### **Palliation of pancreatic cancer**

- 85% of patients are not suitable for curative resection
- Palliation of symptoms can be achieved either surgically or endoscopically
- Surgical palliation has initially higher complication rate
- Produces better long-term symptom control.
- Palliative treatment should achieve:
  - Relief of jaundice by either endoscopic stenting or surgery
  - Prevention of duodenal obstruction by gastrojejunostomy
  - Relief of pain possibly by coeliac plexus block
- External biliary drainage now rarely required
- Palliative chemotherapy (e.g. gemcitabine) controversial

### **Endoscopic stenting**

- Achievable in over 95% of patients
- Complications include bleeding, perforation, pancreatitis
- Mortality less than 3%
- 20% develop duodenal obstruction
- Patency of plastic stents often only 3 to 4 months
- Can be improved with the use of self-expanding wall stents



### **Palliative surgery**

- Biliary drainage can be achieved by choledocho- or cholecystojejunostomy
- 10% will develop duodenal obstruction
- A 'triple bypass' involves a choledochojejunostomy, gastrojejunostomy and entero-enterostomy
- Removes risk of duodenal obstruction and often avoid recurrent jaundice

### **Analgesia**

- Pain occurs in over 80% with advanced malignancy
- Can be palliated with:
  - Slow release morphine
  - Coeliac nerve block
  - Thoracoscopic section of splanchnic nerves

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### Chronic pancreatitis

- Chronic inflammatory disease of the pancreas
- Results in irreversible destruction of both the endocrine and exocrine pancreatic tissue
- Early stages of the disease may be characterised by episodes of acute pancreatitis
- Pancreas may appear macroscopically normal
- Late stage of disease is characterised by pancreatic fibrosis and calcification
- Pancreatic duct dilatation and stricture formation occurs
- Cysts form within the pancreatic tissue
- Aetiological factors include:
  - Alcohol
  - Tobacco
  - Pancreatic duct strictures
  - Pancreatic trauma
  - Hereditary pancreatitis
  - Tropical pancreatitis
- Male to female ratio is approximately 4:1
- Mean age of onset is approximately 40 years
- The incidence is increasing
- Chronic pancreatitis increases the risk of pancreatic carcinoma

### Clinical features

- Pain is the principal symptom in most patients
- Usually epigastric, sub-costal and radiating to the back
- Pain may be continuous or episodic
- Often interferes with life and may lead to opiate abuse
- Weight lost may occur
- Loss of exocrine function produces malabsorption and steatorrhoea
- Loss of endocrine function results in diabetes



Figure 136 CT appearances of chronic pancreatitis





## Investigation

- Serum amylase is often normal
- Plain abdominal x-ray may show pancreatic calcification
- CT or MRI is the most useful investigation for imaging the pancreas
- May confirm pancreatic enlargement, fibrosis and calcification
- ERCP has a high sensitivity for detecting chronic pancreatitis
- MR pancreaticogram will outline the state of the pancreatic duct
- Pancreatic function test rarely provide useful information
  - Direct tests - e.g. secretin-pancreozymin test, Lundh test
  - Indirect tests - e.g. serum trypsin, faecal fat analysis
- On imaging criteria it can be difficult to differentiate chronic pancreatitis from carcinoma

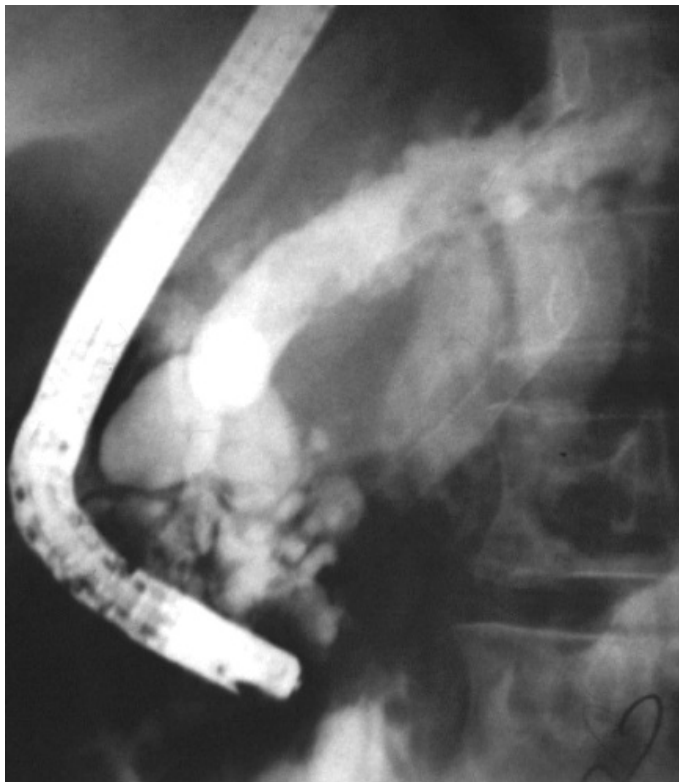


Figure 137 Pancreatic calcification and pancreatic duct dilation at ERCP

## Treatment

### Conservative

- Low fat diet and alcohol abstinence is essential
- Opiate analgesia should be avoided if possible
- Pancreatic enzyme supplements may:
  - Reduce steatorrhoea
  - Reduce frequency of painful crises



### **Surgery**

- Surgery is associated with significant morbidity and mortality
- Does not arrest loss of endocrine and exocrine function
- If performed is aimed at:
  - Removing any mass lesion
  - Relieving pancreatic duct obstruction
- Mass lesion can be removed by pancreaticoduodenectomy or a Beger procedure
- Duct obstruction can be relieved by pancreaticojejunostomy or Frey procedure
- Disease confined to pancreatic tail may require distal pancreatectomy
- Surgery relieves symptoms in 75% of patients

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## Portal hypertension

- Normal portal pressure is 5 - 10 mmHg
- Portal hypertension is defined as a pressure more than 12 mmHg

Table 39 Aetiology of portal hypertension

Prehepatic	Intrahepatic	Posthepatic
Portal vein thrombosis	Presinusoidal	Caval abnormality
Splenic vein thrombosis	Schistosomiasis	Constrictive pericarditis
Tropical splenomegaly	Primary biliary cirrhosis	
Arterio-venous fistula	Chronic active hepatitis	
	Sarcoidosis	
	Sinusoidal	
	Cirrhosis - post hepatic, alcohol, cryptogenic, metabolic (e.g. Wilson's, haemochromocytosis)	
	Non-cirrhotic - cytotoxic drugs, Vitamin A intoxication	
	Postsinusoidal	
	Budd-Chiari syndrome	
	Veno-occlusive disease	

## Pathophysiology

- Increased portal pressure reduces portal venous flow
- Encourages development of porto-systemic anastomoses
- Develop at site of connections between portal and systemic circulation at:
  - Gastro-oesophageal junction
  - Lower rectum
  - Peri-umbilical veins
  - Retroperitoneal veins of Retzius
  - Peri-hepatic veins of Sappey

## Clinical features

- Cirrhosis is commonest cause of portal hypertension in the UK
- Cirrhosis produces features of
  - Hepatocellular failure
  - Portal hypertension
  - Variceal bleeding
  - Ascites
- 90% patients with cirrhosis will develop oesophageal varices
- Bleeding will occur in 30% of these patients

## Severity of Cirrhosis

- Severity can be assessed using Child-Pugh classification
  - Score 5-6 = Class A
  - Score 7-9 = Class B
  - Score more than 10 = Class C



Table 40 Child-Pugh classification of the severity of cirrhosis

Variable	Score		
	1 point	2 points	3 points
Encephalopathy	Absent	Mild / moderate	Severe or coma
Bilirubin ( $\mu$ mol/l)	Less than 34	34-51	More than 51
Albumin (g/l)	More than 3.5	2.8-3.5	Less than 2.8
Prothrombin time (sec above normal)	1-4	4-6	More than 6

### Management

- In patients with known varices bleeding can be prevented by  $\beta$  blockers
- Sclerotherapy does not prevent bleeding
- The role of TIPS in primary prevention is at present unknown

### Surgical shunts

- Portocaval shunts were commonly performed until the mid 1980s
- Aims were to reduce portal pressure
- Their use has decreased due to:
  - The introduction of TIPS
  - Liver transplantation in end stage liver disease
- Shunts can be total, partial or selective
- Role of shunts is to:
  - Emergency control of variceal bleeding when no access to TIPS
  - Reduce portal hypertension in patients awaiting transplantation
  - Relieve intractable ascites
  - Reduce bleeding from rectal, colonic or stomal varices

### Total shunts

- Have wide diameter and decompress all of portal circulation
- There is no portal vein flow to the liver
- Over 90% long-term patency can be achieved
- 30-40% of patients will develop encephalopathy
- Examples of total shunts are:
  - End-to-side portocaval shunt
  - Side-to-side portocaval shunt
  - Mesocaval C-graft
  - Central splenorenal shunt

### Partial shunts

- Have narrow diameter and partially decompress portal circulation
- Some portal vein flow is maintained
- Lesser procedure than total shunt
- 20% will either stenose or occlude
- 10% of patients will develop encephalopathy
- Examples of partial shunts is the small bore portocaval H-graft



### **Selective shunts**

- Decompress part of portal circulation
- Portal vein flow is maintained
- Examples of selective shunts are:
  - Distal splenorenal shunt
  - Distal splenocaval shunt

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## Ascites

- Ascites is free fluid within the abdominal cavity
- Over 70% cases due to liver disease.

### Aetiology of ascites

- Hepatic - cirrhosis, veno-occlusive disease
- Cardiac - right ventricular failure, constrictive pericarditis
- Renal - nephrotic syndrome, renal failure
- Malignancy - ovarian, gastric, colorectal carcinoma
- Infection - tuberculosis
- Pancreatitis
- Lymphatic - congenital anomaly, trauma
- Malnutrition
- Myxoedema

### Investigation of ascites

- A diagnostic peritoneal tap allows peritoneal fluid to be sent for:
- Protein estimation
  - Cytology
  - Bacteriology
  - Biochemistry - amylase, CEA
- A transudate has a total protein less than 30 g/l
  - Causes include cirrhosis and heart failure
- An exudate has a total protein more than 30 g/l
  - Causes include carcinomatosis and infection

### Pathophysiology of ascites

- The normal peritoneal cavity contains approximately 100 ml of fluid
- It is a transudate and has a 50% turnover per hour
- It is produced by visceral capillaries
- It is drained via diaphragmatic lymphatics
- In cirrhotic ascites pathophysiology is complex
- Portal hypertension results in splanchnic vasodilatation
- Results in sodium retention due to:
  - Altered systemic haemodynamics
  - Altered neurohumeral control
  - Altered renal function
- Impaired free-water excretion results in dilutional hyponatraemia
- Renal vasoconstriction results in hepatorenal syndrome

### Complications

- Spontaneous bacterial peritonitis
- Hepatorenal syndrome
- Hepatic hydrothorax



### **Treatment of ascites in cirrhosis**

- Effective treatment is difficult
- Medical measures include sodium restriction and diuretics
- Spironolactone is usually drug of choice
- In those with ascites refractory to medical therapy options include:
  - Repeated large-volume paracentesis
  - Peritoneovenous shunting
  - Portocaval shunting
  - Transjugular intrahepatic portosystemic shunting
  - Liver transplantation

### ***Transjugular intrahepatic portosystemic shunting***

- Involves the creation of an intrahepatic portosystemic shunt
- Hepatic vein is cannulated via the internal jugular vein
- Intrahepatic portal vein punctured percutaneously
- Guide wire passed from portal to hepatic vein
- Stent is then passed along guide wire
- Complications include encephalopathy and liver failure
- Has improved survival compared with other techniques

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## Colorectal surgery

### *Benign colonic polyps*

- A polyp is a pedunculated lesion
- Not all polyps are tumours
- Not all polypoid tumours are benign
- Not all benign tumours are polypoid

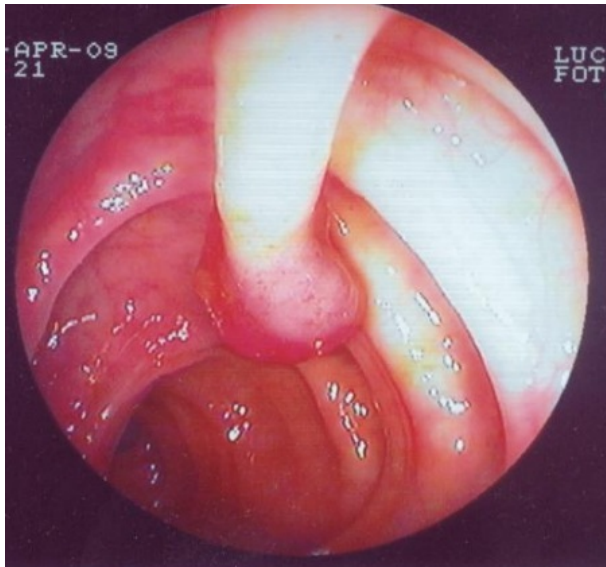


Figure 138 Adenomatous colonic polyp

### Classification of large bowel polyps

#### *Epithelial*

- Adenomas - tubular, villous, tubulovillous
- Metaplastic polyps

#### *Mesodermal*

- Lipoma
- Leiomyoma
- Haemangioma

#### *Hamartoma*

- Juvenile polyps
- Peutz-Jeghers syndrome

#### *Juvenile polyps*

- Commonest form of polyp in children
- Can occur throughout large bowel but are most common in the rectum
- Usually present before 12 years
- Present with Prolapsing lump or rectal bleeding
- Not pre-malignant
- Treated by local endoscopic resection





### Peutz-Jeghers syndrome

- Rare familial disorder
- Circumoral pigmentation and intestinal polyps
- Polyps found throughout gut but most common in the small intestine
- Present in childhood with bleeding, anaemia or intussusception
- Polyps can become malignant



Figure 139 Circumoral cutaneous features of Peutz-jeghers syndrome

### Metaplastic polyps

- Small plaques approximately 2 mm in diameter
- Pathogenesis unknown
- Not pre-malignant

### Adenomas

- benign epithelial neoplasm
- They are pre-malignant
- Risk of malignancy increases with size
- Malignancy more common in villous rather than tubular lesions
- Most adenomas are asymptomatic
- 10% of population over 45 years have adenomatous polyps
- If do become symptomatic usually present with bleeding, mucous discharge or prolapse
- Villous adenomas may produce hypokalaemia but this is rare
- Diagnosis is often by sigmoidoscopy or colonoscopy
- Full colonoscopy essential to exclude other lesions
- Treatment is by transanal excision or colonoscopic snaring
- Patients require regular colonoscopic surveillance



Figure 140 Histological appearance of an adenomatous polyp

#### **Familial adenomatous polyposis**

- Accounts for 1% of colorectal cancers
- Its is an autosomal dominant
- Due to mutation on long arm of chromosome 5
- Mutation induces proliferation of mucosa throughout GI tract
- Develop colonic polyps in teens or early 20's
- Untreated progress to cancer by 30's
- Screening can be by either rigid or flexible sigmoidoscopy
- Safe alternative to colonoscopy as rectal sparing rarely seen
- Start late teens and continue until 40 yrs and polyp free.

#### **Extra-colonic manifestations**

- Osteomas. epidermoid cysts = Gardner's Syndrome
- Gastroduodenal polyps
- Desmoid tumours
- Congenital hypertrophy of retinal pigmented epithelium

#### **Surgical options**

- Panproctocolectomy and ileostomy
- Restorative panproctocolectomy
- Subtotal colectomy and ileorectal anastomosis
- Third option will require surveillance of rectal stump



Figure 141 Familial adenomatous polyposis

#### **Hereditary non-polyposis colorectal cancer syndrome**

- Accounts for 5-10% of colorectal cancers
- Results in mainly right sided cancers
- Increased risk of other gastrointestinal, urological and gynaecological malignancy
- Diagnosed by having 3 affected relatives, in 2 generations and one patient <50 years
- Recommend to start colonoscopic screening starting 5 years before youngest affected relative.

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## Colorectal cancer

- Colorectal cancer is second commonest cancer causing death in the UK
- 20,000 new cases per year in UK
- 40% are rectal and 60% are colonic tumours
- 3% patients present with more than one tumour (synchronous tumours)
- A previous colonic neoplasm increases the risk of a second tumour (metachronous tumour)
- Some cases are hereditary
- Most related to environmental factors

### Risk factors

- Sporadic colorectal cancer (85%)
  - Older age
  - Male sex
  - Cholecystectomy
  - Ureterocolic anastomosis
  - Diet rich in meat and fat
  - Obesity
  - Smoking
  - History of colorectal polyps
  - History of colorectal cancer
  - History of small bowel, endometrial, breast and ovarian cancer
  - Familial colorectal cancer (20%)
    - First or second degree relatives with cancer but criteria for HNPCC not fulfilled
    - On first-degree relative increases risk by 2.3
    - Two or more first degree relatives increases risk by 4.3
    - Index case <45 years increases risk by 3.9
    - Family history of colorectal adenoma increases risk by 2.0
- Colorectal cancer in inflammatory bowel disease (1-2%)
  - Ulcerative colitis
  - Crohn's disease
- Hereditary colorectal cancer (5-10%)
  - Polyposis syndromes - FAP
  - Hereditary non-polyposis colorectal cancer (HNPCC)
  - Hamartomatous polyposis syndromes

### Adenoma - carcinoma sequence

- Of all adenomas
  - 70% tubular
  - 10% villous
  - 2% tubulovillous
- Most cancers believed to arise within pre-existing adenomas
- Risk of cancer greatest in villous adenoma
- Series of mutations results in epithelial changes from normality, through dysplasia to invasion
- Important genes - APC, DCC, k-ras, p53.



### Clinical presentation

- Right-sided lesions
  - Iron deficiency anaemia due occult GI Blood loss
  - Weight loss
  - Right iliac fossa mass
- Left-sided lesions
  - Abdominal pain
  - Alteration in bowel habit
  - Rectal bleeding
- 40% of cancers present as a surgical emergency with either obstruction or perforation
- Emergency surgery is associated with a poorer outcome

### Investigation

- In elective cases diagnosis can be confirmed by a combination of:
  - Rigid sigmoidoscopy
  - Flexible sigmoidoscopy
  - Colonoscopy
  - Double contrast barium enema
- In patients presenting with large bowel obstruction single contrast enema (after rigid sigmoidoscopy) is the investigation of choice

### Surgical options

- Any surgical resection requires 5 cm proximal and 2 cm distal clearance for colonic lesions
- 1 cm distal clearance of rectal lesions adequate if mesorectum resected
- Radial margin should be histopathologically free of tumour if possible
- Lymph node resection should be performed to the origin of the feeding vessel
- En Bloc resection of adherent tumours should be performed
- The value of a 'no-touch' techniques remains unproven
- Depending on site of lesion surgical options are:
- Caecum, ascending colon, hepatic flexure – Right hemicolectomy
  - Transverse colon – Extended right hemicolectomy
  - Splenic flexure, descending colon – Left hemicolectomy
  - Sigmoid colon – High anterior resection
  - Upper rectum – Anterior resection
  - Consider defunctioning loop ileostomy is anastomosis <12 cm from anal margin
  - Lower rectum – Abdomino-perineal resection
- Transanal microsurgery for small lower rectal cancers
- Laparoscopic surgery is unproven
- Early studies raised concerns about port site recurrence
- Recent studies suggest equivalent overall and disease-free survival

### *Surgery for upper rectal cancers*

- Risk of local recurrence reduced by performing Total Mesorectal Excision
- Pelvic peritoneum and lateral ligaments divides
- Plane between visceral (rectum, mesorectum) and somatic structures dissected

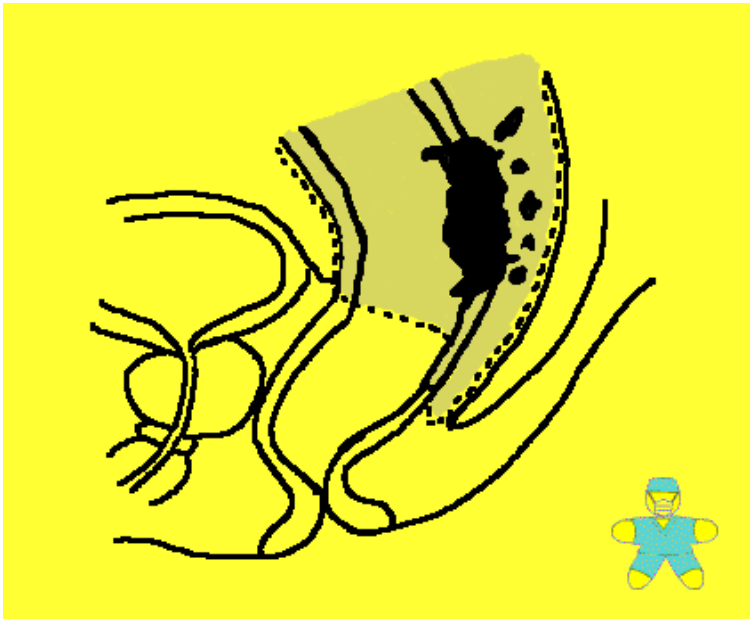


Figure 142 Anatomy of the mesorectum

- Middle rectal vessels divided laterally
- Rectal stump washed out with cytotoxic fluid (water, Betadine) from below
- Anastomosis can be either hand-sown or stapled
- It can be either a straight anastomosis or a colonic pouch can be fashioned
- This is often a J-pouch and provides a better functional outcome



Figure 143 Total mesorectal excision specimen

### Dukes Classification

- Developed by Cuthbert Duke in 1932 for rectal cancers
  - Stage A - Tumour confined to the mucosa
  - Stage B - Tumour infiltrating through muscle
  - Stage C - Lymph node metastases present
- Five year survival - 90%, 70% and 30% for Stages A, B and C respectively

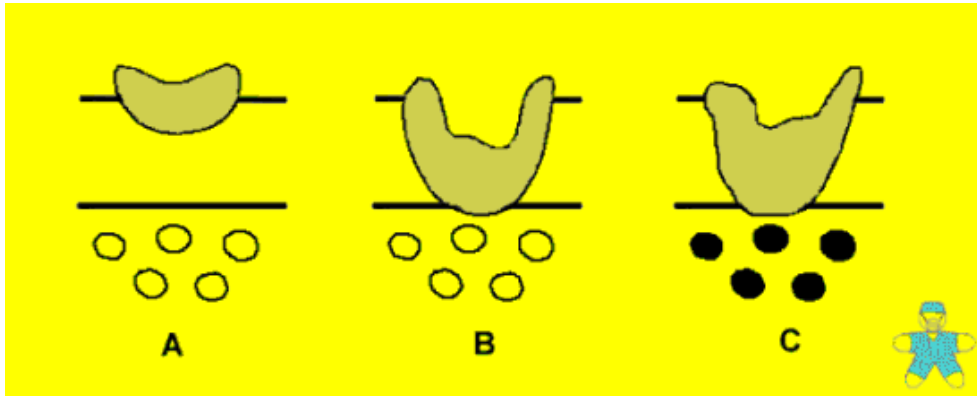


Figure 144 Dukes staging of colorectal cancer

### Adjuvant radiotherapy

- In patients with rectal cancer 50% undergoing curative resection develop local recurrence
- Median survival with local recurrence is less than one year
- Risk factors for local recurrence include:
  - Local extent of tumour
  - Nodal involvement
  - Circumferential margin status
- Risk of local recurrence can be reduced by radiotherapy
- Can be given either preoperatively or postoperatively
- Preoperative radiotherapy given as short course immediately prior to surgery
  - Reduces local recurrence
  - Increases time to recurrence
  - Increases 5-year survival
- Combination chemotherapy and radiotherapy may produce better outcome

### Adjuvant chemotherapy

- Improves survival in Duke's C tumours
- Not required in Duke's A tumours which already have a good prognosis
- Role in Duke's B tumours remains to be defined
- Currently being investigated in the QUASAR (Quick and Simple and Reliable) trial
- Results of QUASAR study to date have shown:
  - 5FU and Folinic acid is effective as adjuvant therapy
  - High dose folinic acid rescue confers no additional benefit
  - The use of levamisole confers no additional benefit

### Colorectal cancer screening

- The role of screening is currently being investigated by either:
  - Faecal occult blood testing
  - Colonoscopy
- Nottingham study has recruited over 150,000 patients
- 75,250 underwent biennial FOB testing
- Resulted in 1774 colonoscopies
- Seven complications occurred requiring operations in 6 patients



- No difference identified in stage of presentation in screened group
- Survival in screened group was significantly improved

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### **Liver metastases**

- 50% patients with colorectal cancer develop liver metastases
- 20% have metastases at time of initial surgery
- 25% develop metastases within 5 years of a 'curative' resection
- Median survival with metastases is about one year

### **Detection of metastases**

- Value of intensive follow-up after curative resection of colorectal cancer is controversial
- Ultrasound will detect lesion more than 0.5 cm in diameter
- CT allows assessment of resectability
- Intra-operative ultrasound superior to extra-corporeal scanning
- Elevated tumour marker - CEA, CA 19.9, CA 242

### **Liver resection for metastatic disease**

- Resectional surgery is only chance of cure for patients with liver metastases
- Only 10% of patients with metastases suitable for 'curative' hepatic resection
- Aim is to resect tumour with more than 1 cm margin by segmentectomy, lobectomy or hepatectomy
- 5 year survival 35% and 10 year survival 20%

### **Relative indications for surgical resection**

- Single lobe involvement
- Less than three lesions without evidence of satellite lesions
- No invasion of inferior vena cava
- More than 20% of liver can be spared

### **Relative contra-indications for surgical resection**

- Hilar and coeliac nodal involvement
- Distant metastases
- Poor cardiovascular reserve
- Pre-operative portal vein embolisation - atrophy of segments to be excised
- Neoadjuvant chemotherapy

### **Palliation of liver metastases**

- Cryotherapy
- Hepatic artery infusion therapy
- Laser photo-coagulation

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### **Anal carcinoma**

- Anal carcinoma is relatively uncommon tumour
- The incidence appears to be increasing
- There are 250 - 300 cases per year in England and Wales
- They account for 4% of anorectal malignancies

### **Pathology**

- 80% are squamous cell carcinomas
- Other tumour types include melanoma, lymphoma and adenocarcinoma
- Tumour behaviour depends on its anatomical site
- Anal margin tumours are usually well differentiated, keratinising lesions
- They are more common in men and have a good prognosis
- Anal canal tumours arise above the dentate line
- They are usually poorly differentiated and non-keratinising lesions
- They are more common in women and have a worse prognosis
- Tumours above the dentate line spread to the pelvic lymph nodes
- Tumours below the dentate line spread to the inguinal nodes

### **Aetiology**

- Anal carcinoma is more common in homosexuals
- It is also increasingly seen in those with genital warts
- Patients with genital warts often develop intraepithelial neoplasia
- Intraepithelial neoplasia appears to be premalignant
- The natural history of this premalignant state is however unknown
- Human papilloma virus (types 16,18,31 and 33) is an important aetiological factor
- 50% of tumours contain viral DNA



Figure 145 Anal warts



### **Clinical features**

- 75% of tumours are initially misdiagnosed as benign lesions
- 50% present with perianal pain and bleeding
- Only 25% patients have identified a palpable lesion



Figure 146 Anal carcinoma

- 70% of patients have sphincter involvement at presentation
- This can cause faecal incontinence
- Neglected tumours can cause a rectovaginal fistula
- Only 50% of patients with palpable inguinal nodes have metastatic disease

### **Investigation**

- Rectal EUA and biopsy is the most useful 'staging' investigation
- Endoanal ultrasound is often impossible due to pain
- CT or MRI can be used to assess pelvic spread

### **Management**

- The management of anal carcinoma has changed over the last 15 years
- Was considered a 'surgical' disease requiring radical abdominoperineal resection
- Now most patients are managed with radiotherapy
- The role of chemotherapy is currently undergoing investigation
- Radiotherapy is given to tumour and inguinal nodes
- 50% of patients respond to treatment
- Over 5 year survival is 50%
- Surgery is required for:
  - Tumours that fail to respond to radiotherapy
  - Large tumours causing gastrointestinal obstruction
  - Small anal margin tumours without sphincter involvement

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## **Diverticular disease**

- Colonic diverticulae are outpouchings of colonic wall
- Usually result from herniation of mucosa through muscular wall
- Occur at sites where mesenteric vessels penetrate the bowel wall
- Most common in sigmoid colon
- Increased prevalence with age
- Affects 10% population at 40 yrs and 60% population at 80 years
- More common in developed countries

### **Aetiology**

- Due to lack of dietary fibre in Western diets
- Low dietary fibre results in low stool bulk
- Induces increased segmentation of colonic musculature resulting in hypertrophy
- Increased intraluminal pressure results in herniation
- Complications of diverticular disease include
  - Diverticulitis
  - Pericolic abscess
  - Purulent peritonitis - due to rupture of pericolic abscess
  - Faecal peritonitis - due to free perforation of diverticulum
  - Fistula - to vagina, bladder, skin
  - Colonic stricture



Figure 147 Perforated sigmoid diverticulum

### **Investigation**

- Plain X-rays with positive diagnostic features (e.g. free gas, gas in bladder) are useful
- Normal X-rays can not exclude complications of diverticular disease
- Double contrast barium enema - allows diagnosis, assessment of extent and complications
- CT +/- intravenous and rectal contrast - useful for imaging abscesses, fistulae



Figure 148 Perforated sigmoid diverticulum

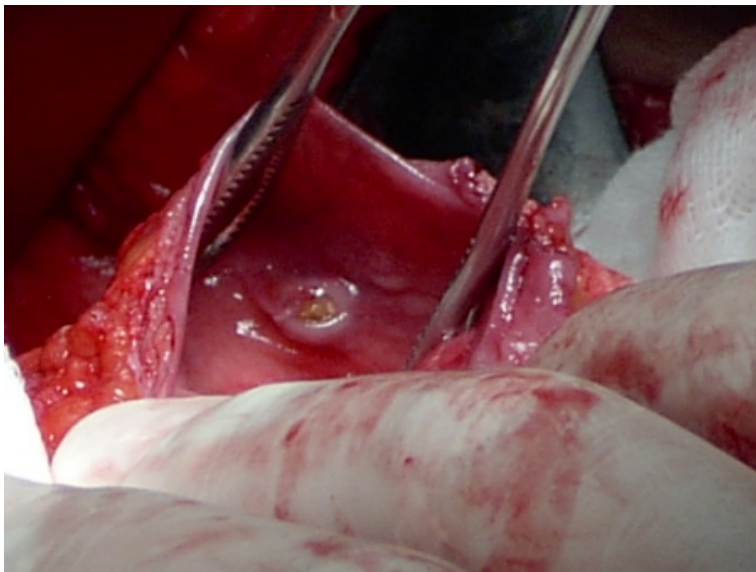


Figure 149 Intraoperative appearance of colonic diverticulum

#### Treatment of acute diverticulitis

- Bowel rest by restricting oral intake and intravenous fluids
- Intravenous antibiotics - 2<sup>nd</sup> generation cephalosporin (e.g. cefuroxime) and metronidazole
- Active observation for the development of complications
- If abscess formation - percutaneous drainage under radiological guidance usually possible
- Subsequent elective resection and primary anastomosis often required



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## **Inflammatory bowel disease**

### **Causes of colonic inflammation**

- Infection - bacteria, viruses, parasites
- Ulcerative colitis
- Crohn's' disease
- Radiation enteritis
- Ischaemic colitis
- Microscopic colitis
- Drug-induced colitis

### **Ulcerative colitis**

- Prevalence 80-90/100,000 population
- Peak age of onset 20 - 35 yrs
- Characteristic feature - acute mucosal inflammation with crypt abscesses

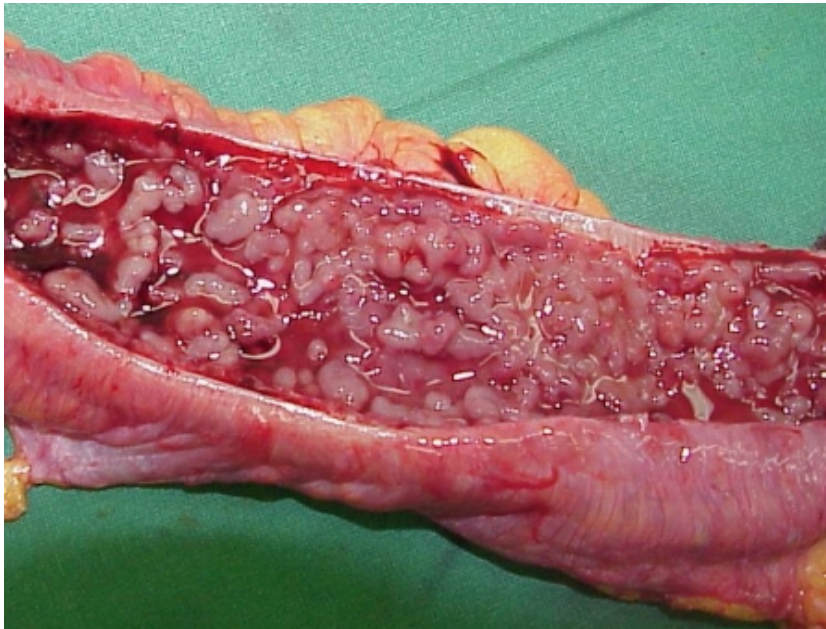


Figure 150 Ulcerative colitis

### **Crohn's disease**

- Prevalence 40/100,000 population
- Incidence is increasing possibly due to increased recognition
- Characteristic feature - patchy transmural inflammation with non-caesating granulomas



Table 41 Pathological features

Ulcerative colitis	Crohn's disease
Lesions continuous - superficial	Lesions patchy - penetrating
Rectum always involved	Rectum normal in 50%
Terminal ileum involved in 10%	Terminal ileum involved in 30%
Granulated ulcerated mucosa No fissuring	Discretely ulcerated mucosa Cobblestone appearance with fissuring
Normal serosa	Serositis common
Muscular shortening of colon Fibrous strictures rare	Fibrous shortening Strictures common
Fistulae rare	Enterocutaenous or intestinal fistulae in 10%
Anal lesions in <20%	Anal lesions in 75% Anal fistulae and chronic fissures
Malignant change well recognised	Possible malignant change



Figure 151 Crohn's disease of the terminal ileum

### Pathophysiology

- Both Crohn's disease and ulcerative colitis have some pathophysiological features in common
- Both result from inappropriate activation of the mucosal immune system
- This process is driven by the normal luminal flora
- May result from defective barrier function of the intestinal epithelium
- Genetic factors contribute to susceptibility as demonstrated by:
  - Variable prevalence in different populations
  - Increased incidence in first degree relatives
  - Increased concordance in monozygotic twins
  - Concordance in site and type of disease in affected families
- Possible environmental factors include:
  - Smoking – increases risk of Crohn's disease





- Use of NSAIDs
- Luminal flora

### **Clinical features of inflammatory bowel disease**

#### ***Ulcerative colitis***

- 30% disease confined to rectum
- 15% develop more extensive disease over 10 years
- 20% total colonic involvement from onset
- Patients generally fall into following categories:
  - Severe acute colitis
  - Intermittent relapsing colitis
  - Chronic persistent colitis
  - Asymptomatic disease
- Assessment of disease severity
- Mild = More than 4 stools per day. Systemically well
- Moderate = Less than 4 stools per day. Systemically well
- Severe = More than 6 stools per day. Systemically unwell
- Systemic features include tachycardia, fever, anaemia, hypoalbuminaemia
- Endoscopic grading of ulcerative colitis
  - 0 = normal
  - 1 = loss of vascular pattern or granularity
  - 2 = Granular mucosa with contact bleeding
  - 3 = Spontaneous bleeding
  - 4 = Ulceration

#### ***Crohn's disease***

- Clinical features depend on site of disease
- 50% have ileocaecal disease
- 25% present with colitis
- Systemic features are more common than in ulcerative colitis

### **Extraintestinal manifestations**

#### ***Associated with disease activity***

- Skin
  - Erythema Nodosum
  - Pyoderma Gangrenosum
- Joints
  - Asymmetrical non-deforming arthropathy
- Eyes
  - Anterior uveitis
  - Episcleritis
  - Conjunctivitis
- Hepatobiliary conditions
  - Acute fatty liver
- Thromboembolic disease



### **Unrelated to disease activity**

- Joints
  - Sacroilitis
  - Ankylosing spondylitis
- Hepatobiliary conditions
  - Primary sclerosing cholangitis
  - Cholangiocarcinoma
  - Chronic active hepatitis
  - Gallstones
- Amyloid
- Nephrolithiasis

### **Medical management of inflammatory bowel disease**

- Treatment depends on:
  - Type of disease
  - Site of disease
  - Disease severity
- Different drugs may be used for active disease and those in remission

### **5-Aminosalicylic acid**

- Used in mild / moderate ulcerative colitis and Crohn's disease
- 5-ASA block production of prostaglandins and leukotrienes
- Sulfasalazine was first agent described
- Now compounds available to release 5-ASA at site of disease activity
- Mesalazine is conjugated to prevent absorption in small intestine
- Topical preparation may be used in those with left-sided colonic disease
- Maintenance therapy of proven benefit in those with ulcerative colitis
- Of unproven benefit in those with Crohn's disease

### **Corticosteroids**

- Often used in those in whom 5-ASA therapy is inadequate
- Also used in those presenting with acute severe disease
- Can be given orally, topically or parenterally
- Use should be limited to acute exacerbations of disease
- Of no proven value as maintenance therapy in either ulcerative colitis or Crohn's disease
- Use must be balanced against side effects

### **Immunosuppressive and immunomodulatory agents**

- Often used in those in whom steroids can not be tapered or discontinued
- Agents used include:
  - Azathioprine -effective in both ulcerative colitis and Crohn's disease
  - Methotrexate - effective in Crohn's disease
  - Cyclosporin
  - Infliximab - anti-TNF-alpha therapy



## Surgery for inflammatory bowel disease

### Indications for surgery - Ulcerative colitis

- 20% of patients with ulcerative colitis require surgery at some time
- 30% of those with total colitis require colectomy within 5 years

### *Emergency*

- Toxic megacolon
- Perforation
- Haemorrhage
- Severe colitis failing to respond to medical treatment

### *Elective*

- Chronic symptoms despite medical therapy
- Carcinoma or high grade dysplasia

## Surgical options

### *Emergency*

- Total colectomy with ileostomy and mucus fistula

### *Elective*

- Panproctocolectomy and Brooke ileostomy
- Panproctocolectomy and Kock continent ileostomy
- Total colectomy and ileorectal anastomosis
  - Maintains continence but proctitis persists
- Restorative proctocolectomy with ileal pouch
  - Need adequate anal musculature
  - Need for mucosectomy uncertain
  - Need for defunctioning ileostomy unresolved



Figure 152 Ileoanal pouch

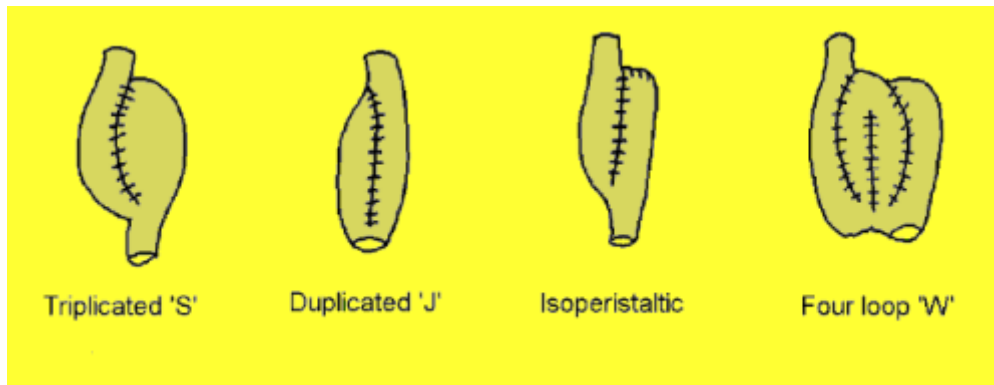


Figure 153 Ileoanal pouch design

#### **Functional results**

- Mean stool frequency is six times per day
- Perfect continence achieved during day in 90% and at night in 60%
- Gross incontinence occurs in 5%

#### **Morbidity**

- 50% develop significant complications
  - Small bowel obstruction (20%)
  - Pouchitis (15%)
  - Genitourinary dysfunction (6%)
  - Pelvic sepsis (5%)
  - Fistula (5%)
  - Pouch failure (6%)
  - Anal stenosis (5%)
- Larger capacity pouches reduce stool frequency

#### **Indications for surgery - Crohn's disease**

##### **Absolute**

- Perforation with generalised peritonitis
- Massive haemorrhage
- Carcinoma
- Fulminant or unresponsive acute severe colitis

##### **Elective**

- Chronic obstructive symptoms
- Chronic ill health or debilitating diarrhoea
- Intra-abdominal abscess or fistula
- Complications of perianal disease
- Surgery should be as conservative as possible
- No evidence that increased resection margins reduce recurrence rate
- If possible improve preoperative nutritional state

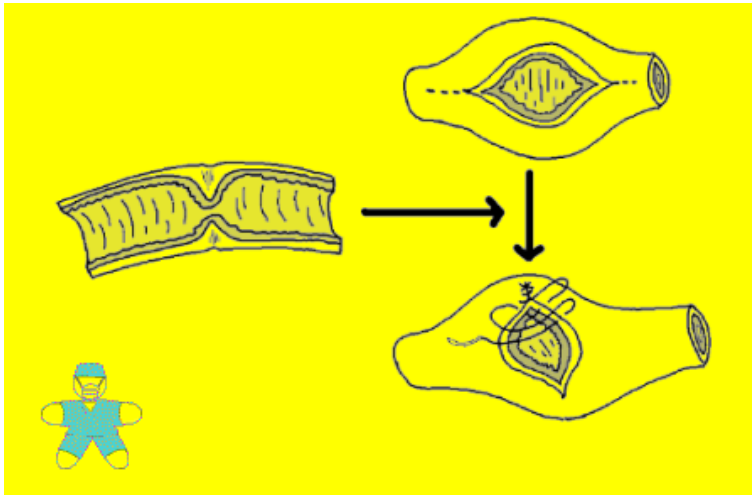


Figure 154 Strictureplasty technique

### **Surgical Options**

- Limited resections
- 30% undergoing ileocaecal resection require further surgery
- Strictureplasty often successful
- Bypass procedures rarely required

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## Perianal disease

- Internal sphincter is smooth muscle
- External sphincter is striated muscle
- Mucosa of upper third of anal canal has no somatic sensation
- Mucosa of lower two thirds of anal canal has somatic innervation from inferior rectal nerves
- Anal glands occur in intersphincteric plane and open at level of dentate line

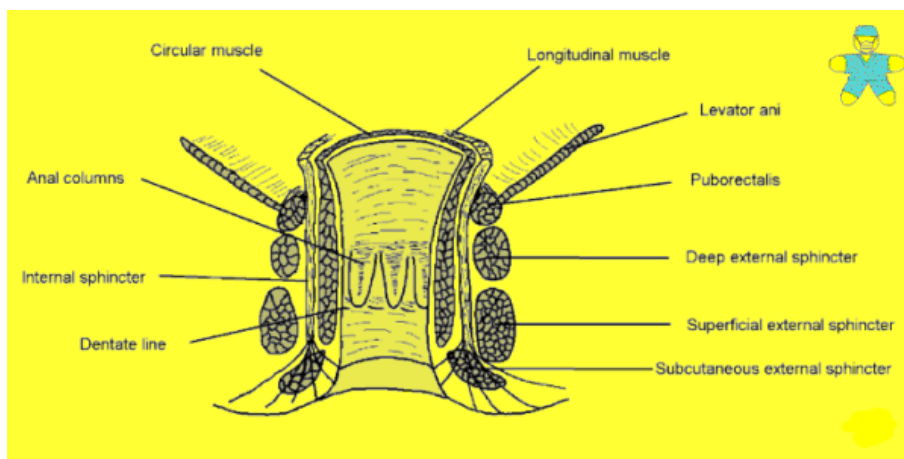


Figure 155 Anatomy of the Anal Canal

## Anorectal abscesses and fistulae

- Aetiology - Intersphincteric sepsis (Cryptoglandular Hypothesis)
- Abscesses classified as:
  - Perianal
  - Ischiorectal
  - Intersphincteric
  - Supralevator

### Perianal & ischiorectal abscess

- Initial surgery should simply be incision and drainage
- Avoid looking for fistula at initial surgery
- Rectal EUA at approximately 5 days
- Especially if gut related organisms on culture
- 80% recurrent abscesses associated with a fistula

### Fistula-in-Ano

- Goodsall's Rule = An external opening situated behind the transverse anal line will open into the anal canal in the midline posteriorly. An anterior opening is usually associated with a radial tract.



- Fistulae can be classified as:
  - Intersphincteric (70%)
  - Transsphincteric (25%)
  - Suprasphincteric (5%)
  - Extrasphincteric (less than 1%)
- Extrasphincteric fistulae not associated with intersphincteric sepsis
- Consider inflammatory bowel disease or neoplasia

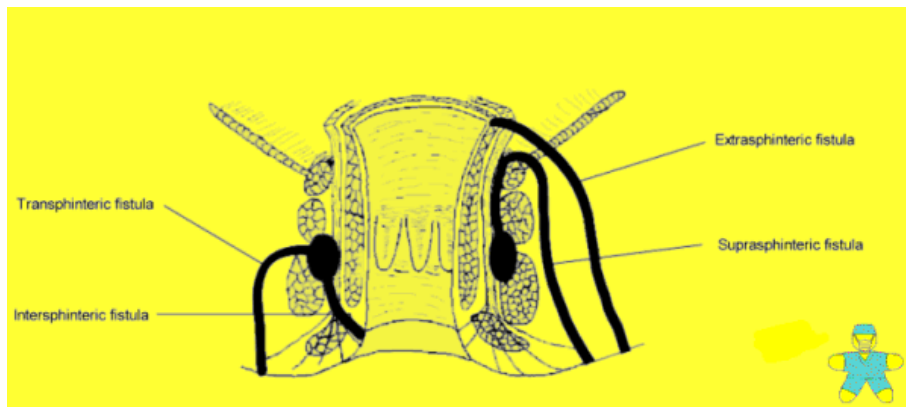


Figure 156 Anatomy of perianal fistulae

### **Investigation**

- Clinical assessment
- MRI
- Ultrasound

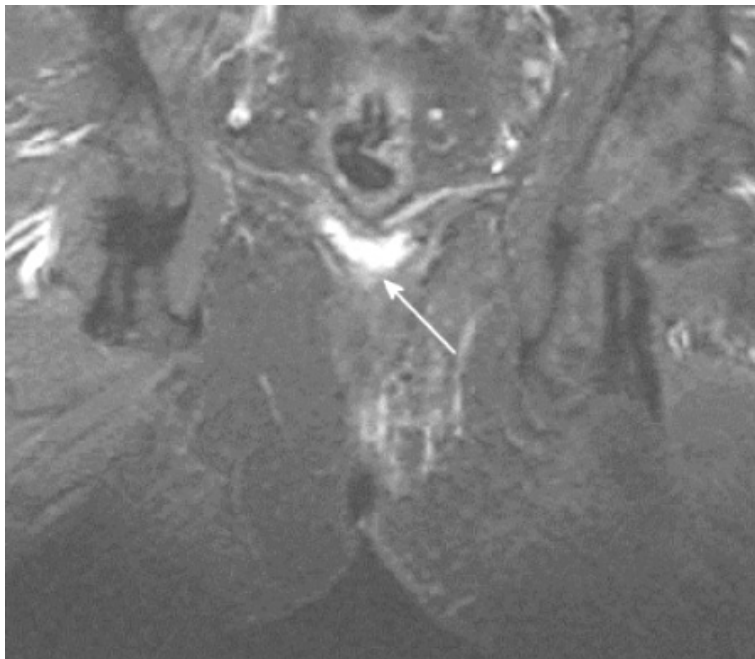


Figure 157 MRI of fistula-in-ano



### **Treatment**

- Puborectalis is the key to future continence
  - Low fistulas - lay open with either fistulotomy or fistulectomy
  - High fistulas - requires two stage surgery
- Setons - loose or tight
- Anorectal advancement flap may be considered



Figure 158 Fistulotomy for a high fistula-in-ano

### **Pruritus Ani**

#### **Causes**

- Idiopathic (50%)
- Anorectal (25%)
  - Fissures
  - Fistulas
  - Papilloma
  - Skin Tags
  - Haemorrhoids
- Dermatological (25%)
  - Psoriasis
  - Lichen Planus
  - Candidiasis
  - Threadworms

#### **Treatment**

- Keep perianal skin clean and dry
- Avoid rubbing and scratching
- Avoid perfumed medications, ointments and creams
- Keep bowels regular





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## **Haemorrhoids**

- Affect 50% of population over the age of 50 years
- Usually presents with:
  - Painless bright red rectal bleeding
  - Prolapsing perianal lump
  - Acute pain due to thrombosis
  - Faecal soiling or pruritus ani

### **Pathogenesis**

- The following factors appear important
  - Dilatation of venous plexus
  - Distension of AV anastomoses
  - Displacement of anal cushions
- 80% of patients have high resting anal pressure

### **Classification**

- Haemorrhoids are often classified as internal or external
- Internal haemorrhoids arise above the dentate line and can be sub-classified as:
  - First degree - bleeding only
  - Second degree - prolapse, reduce spontaneously
  - Third degree - prolapse, pushed back
  - Fourth degree - permanently prolapsed



Figure 159 Third-degree haemorrhoids



Figure 160 Thrombosed haemorrhoids

#### Treatment options

- All should have high residue diet
- Local preparations rarely produced long-term clinical benefit

#### Outpatient

- Treatment options for first and second degree haemorrhoids include:
- Injection with 5% phenol in arachis or almond oil
- Rubber band ligation (RBL)
- Randomised trial of RBL and sclerotherapy have shown
  - 90% success with RBL
  - 70% success with sclerotherapy

#### Inpatient

- Treatment options include:
  - Dilatation and banding
  - Haemorrhoidectomy
  - Haemorrhoidectomy is usually performed as an open procedure (Milligan-Morgan)
- Haemorrhoidectomy is the treatment of choice for 3<sup>rd</sup> degree haemorrhoids
- Secondary infection and postoperative pain may be reduced with oral metronidazole
- Botulinum toxin injection may also reduce postoperative pain
- Complications include:
  - Bleeding (3%)
  - Urinary retention (10%)
  - Anal stenosis may develop if adequate skin bridges are not maintained



- Other haemorrhoidectomy techniques include closed or stapled procedures
- The recently described stapled technique is associated with:
  - Reduced operating time
  - Less postoperative pain
  - Shortened hospital stay
  - More rapid return to normal activity



Figure 161 Stapled haemorrhoidectomy

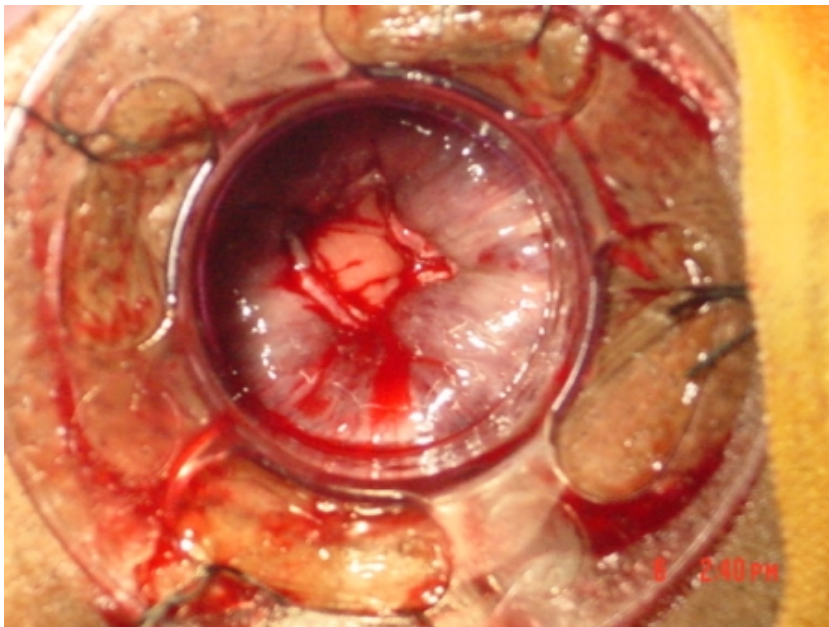


Figure 162 Result of stapled haemorrhoidectomy



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## **Anal fissures**

- Most acute fissure heal spontaneously
- Chronic fissures ( more than 6 weeks) duration associated with increased intra-anal pressure
- Treatment aimed at reducing anal sphincter pressure

## **Aetiology**

- Probably due to mucosal ischaemia secondary to muscle spasm
- Probably not a 'tear' due to the passage of a hard stool (Pecten band theory)
- 5% associated with chronic intersphincteric abscess
- Usually seen between 30 and 50 years
  - 90% posterior midline
  - 10% anterior midline
- Anterior fissure more common in women especially post partum
- If multiple fissures or at unusual site consider
  - Crohn's Disease
  - Syphilis
  - Tuberculosis

## **Clinical features**

- Present with pain on defecation, bright red bleeding and pruritus ani
- Fissure often visible on parting of buttocks and or a 'sentinel pile'
- Features of chronicity include:
  - Symptoms for more than 6 weeks
  - Papilla
  - Undermined edges
  - Visible internal sphincter

## **Treatment**

- Bulking agent and topical local anaesthesia produces symptomatic improvement
- 50% of acute fissures heal with this treatment
- Recent interest in the use of 0.2% GTN ointment for treatment of chronic fissures
- GTN is a nitric oxide donor that relaxes the internal anal sphincter
- Induces a 'reversible chemical sphincterotomy'
- Reduces anal resting pressure by 30 – 40 %
- Heals more than 70% fissures by 6 weeks with about a 10% risk of early recurrence
- Most common side effect is headache
- Similar results to GTN achieved with diltiazem
- Botulinum toxin also produces a chemical sphincterotomy

## **Surgery**

- 95% achieve prolonged symptomatic improvement
- 20% some degree of incontinence (faecal soiling or incontinent of flatus)
- Anal dilatation or internal sphincterotomy are the two most common procedures
- Sphincterotomy more effective and has a reduced risk of incontinence
- Lateral sphincterotomy preferred
- Posterior sphincterotomy or fissurectomy should be avoided



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### ***Pilonidal sinus***

- A pilonidal sinus is a subcutaneous sinus containing hair
- Lined by granulation tissue rather than epithelium
- Usually occur in the natal cleft
- Also seen in interdigital clefts, face and axilla
- Usually seen in young adults.
- Rare after the age of 40 years
- Male : female ratio is 4:1



Figure 163 Pilonidal sinus and operative specimen

### ***Aetiology***

- It is generally believed to be an acquired condition
- Inflamed hair follicles in the cleft result in abscess or sinus formation
- Hair becomes trapped in cleft and enters sinuses
- Results in a foreign body reaction and perpetuates sinus formation
- 80% present with recurrent pain
- 80% present with a purulent discharge

### ***Treatment***

- Consider methylene blue injection to identify all of the tracts
- Antibiotic prophylaxis may be of benefit
- Options available included:

#### ***Excision and healing by secondary intention***

- Requires regular wound dressing and shaving
- Produces 70 - 90% healing at 70 days
- 5-15% recurrences rate

#### ***Excision and primary closure***

- Produces 70% healing at 2 weeks
- 20% develop wound infection





### Lord's procedures

- Involves excision of pits, removal of hair and brushing of tracts
- Produces 80-90% healing

### Phenol injections

- Produces 60 - 70% healing

### Skin flap procedures (e.g. Karydakis procedure)

- Aim to flatten natal cleft and keep scar from midline
- In expert hands produces good results
- Failure rates as low as 5% have been reported

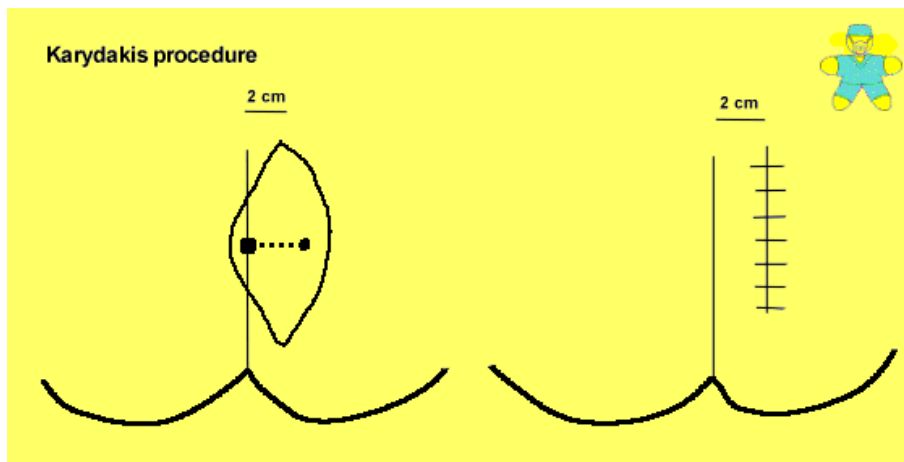


Figure 164 Karydakis procedure for a pilonidal sinus

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## **Rectal prolapse**

### **Complete prolapse**

- Full thickness prolapse of rectum through anus
- Contains two layer of rectal wall
- Has intervening peritoneal sac
- Occurs in older adults
- Female to male ratio is approximately 6:1
- Associated with weak pelvic and anal musculature
- Sigmoid and rectum often floppy and redundant

### **Incomplete or mucosal prolapse**

- Prolapse limited to mucosa
- Occurs in both children and adults
- Often associated with excessive straining ,constipation and haemorrhoids
- In children occasionally seen in cystic fibrosis

### **Concealed prolapse**

- Internal intussusception of upper into lower rectum
- Prolapse does not emerge through anus

### **Clinical features**

- Rectal prolapse occurs in the extremes of life
- Prolapse in children usually noted by parents
- Needs to be differentiated from:
  - Colonic intussusception
  - Juvenile rectal polyp
- In adults usually presents with prolapsing anal mass



Figure 165 Rectal prolapse

- Usually occurs after defaecation



- May reduce spontaneously or be reduced manually
- Bleeding, mucus discharge or incontinence may be troublesome
- Examination usually shows poor anal tone
- Prolapse may be visible on straining
- Most prolapses that are longer than 5 cm are complete
- Differential diagnosis in adult
  - Large haemorrhoids
  - Prolapsing rectal tumours
  - Prolapsing anal polyp
  - Abnormal perineal descent

## Management

### Complete prolapse

- Many patients too frail for surgery
- Should be given bulk laxatives and carers taught how to reduce the prolapse
- Urgent treatment required if prolapse is irreducible or ischaemic
- If fit for surgery can be performed via perineal or abdominal approach
- Perineal options include:
  - Perineal sutures (Thiersh procedure)
  - Delorme's procedure
  - Perineal rectopexy
- Abdominal or sacral options include:
  - Abdominal rectopexy
  - Anterior resection rectopexy
- Abdominal procedures may be performed laparoscopically

### Incomplete prolapse

- In children improvement often seen with dietary advice and treatment of constipation
- Surgery is rarely required
- In adults management similar to that of haemorrhoids
- Includes injection sclerotherapy, mucosal banding or formal haemorrhoidectomy
- Occasionally anal sphincter repair is required

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## Breast disease

### Symptoms that may indicate breast cancer

- Breast lump
- Breast pain
- Change in the size or shape of the breast
- Swelling of the arm (lymphoedema)
- Dimpling of the breast skin
- Involution or inversion of the nipple
- Axillary lymphadenopathy
- Nipple discharge or bleeding
- Ulceration of the breast skin
- Bone or abdominal pain / jaundice

### Symptoms requiring specialist referral

#### *Lumps*

- All new discrete breast lumps
- A new lump in pre-existing nodularity
- Asymmetrical nodularity persisting after menstruation
- Breast abscess
- Persistently refilling or recurrent cysts
- Axillary lymphadenopathy

#### *Breast pain*

- Pain associated with a lump
- Persistent unilateral pain in a postmenopausal woman

#### *Nipple discharge*

- All women aged over 50 years
- Women aged below 50 years with:
  - Bilateral discharge sufficient to stain clothes
  - Blood-stained nipple discharge
  - Persistent discharge from a single duct

#### *Family history*

### Triple assessment

- Triple assessment comprises of:
  - Clinical examination
  - A radiological assessment – mammography or ultrasound
  - A pathological assessment – cytology or biopsy



### **Breast imaging**

- The breast can be imaged with mammography, ultrasound or MRI
- Mammography is the most sensitive of breast imaging modalities
- Sensitivity is reduced in young women due to the presence of increased glandular tissue
- For symptomatic patients, imaging always be performed as part of triple assessment

### **Mammography**

- Abnormalities detected on mammography are classified as:
  - Spiculated masses
  - Stellate lesions
  - Circumscribed masses
  - Microcalcification

### **Spiculated masses**

- Soft tissue mass with spicules extending into surrounding tissue
- 95% of spiculated masses are due to invasive cancer
- Other causes of spiculated masses include:
  - Ductal carcinoma in-situ (DCIS)
  - Radial scar / complex sclerosing lesion
  - Fat necrosis
  - Fibromatosis
  - Granular cell myoblastoma

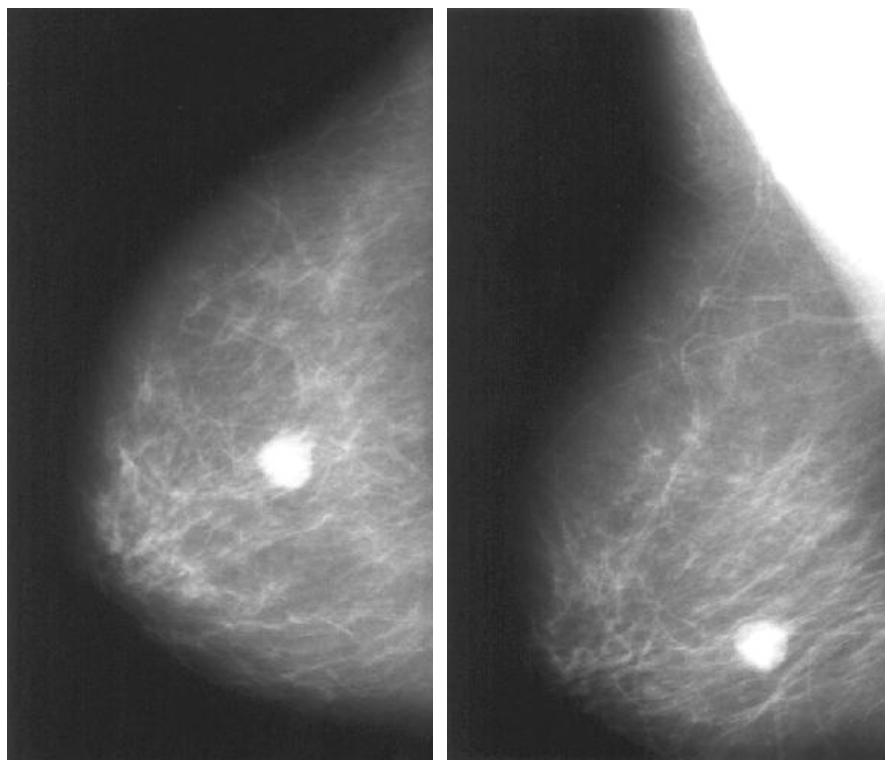


Figure 166 Mammogram of a spiculate mass



### **Stellate lesions**

- Localised distortion of the breast parenchyma with no perceptible mass lesion
- Differential diagnosis of stellate lesions includes:
  - Radial scar
  - Invasive cancer
  - DCIS
  - Surgical scar

### **Circumscribed masses**

- Circumscribed masses should be analysed according to density, outline and size
- Differential diagnosis of circumscribed masses includes:
  - Fibroadenoma
  - Cyst
  - Mucinous or medullary carcinoma
  - Lipoma
  - Abscess

### **Microcalcification**

- Microcalcification is due to debris within the duct wall or lumen
- Sole feature of 33% of screen-detected cancers
- Malignant microcalcification is usually linear or branching
- Benign microcalcification is usually rounded and punctate
- Differential diagnosis of microcalcification includes:
  - DCIS
  - Invasive cancer
  - Papilloma
  - Fibroadenoma
  - Fat necrosis

### **Breast ultrasound**

- Ultrasound is useful in the assessment of breast lumps
- Complements mammography and is able to differentiate solid and cystic lesions
- Also able to guide fine needle aspiration and core biopsies
- Can be used to assess tumour size and response to therapy
- In the diagnosis of malignancy it has a sensitivity and specificity of 75% and 97% respectively
- Cysts and solid lesions have typical appearances

### **Cysts**

- On ultrasound examination cysts have:
  - Smooth walls
  - Sharp anterior and posterior borders
  - Black hypoechoic centres without internal echoes

### **Solid lesions**

- Solid lesions have internal echoes
- Malignant tumours have:
  - Hypoechoic areas interspersed between brighter echoes
  - Irregular edges
  - Cast hypoechoic shadows
- Benign tumours have:
  - Isoechoic or hypoechoic patterns



- Smooth well defined borders
- Cast no hypoechoic shadows

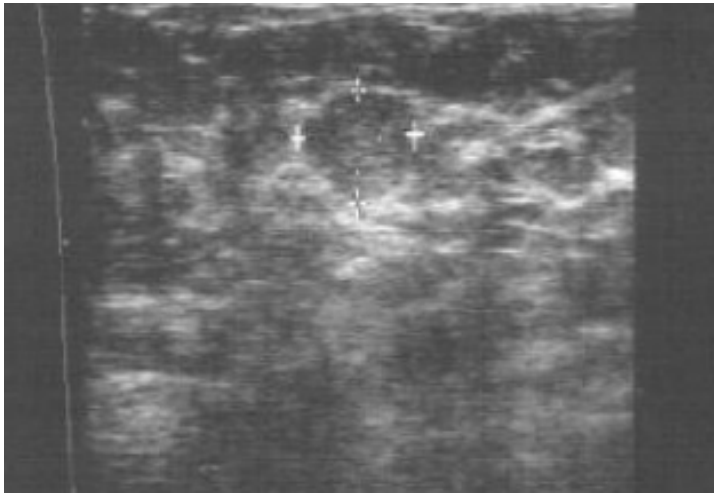


Figure 167 Ultrasound scan of circumscribed breast lesion

#### Breast MRI

- Breast MRI is a recently developed technique
- Uses are currently being defined
- Has high sensitivity for multifocal carcinoma
- Likely uses include:
  - Imaging of breast for occult disease in presence of axillary metastases
  - Differentiating between scar tissue and recurrence
  - Assessment if breast implants

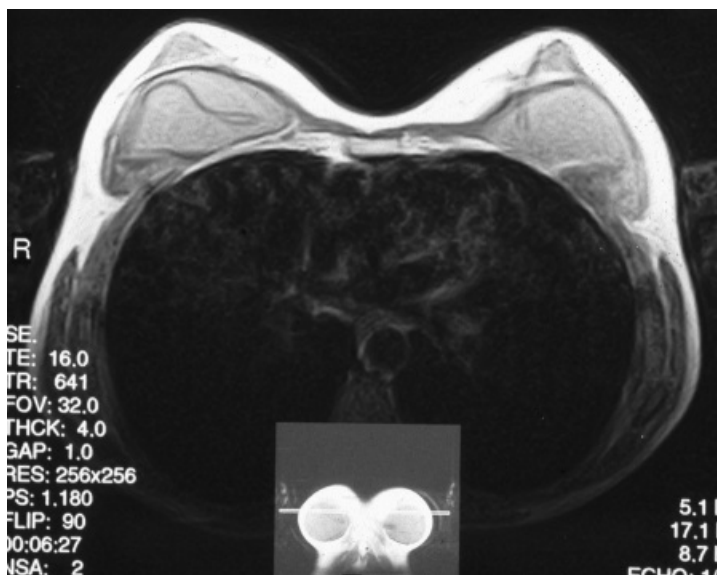


Figure 168 Ruptured right breast implant on magnetic resonance imaging



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## Benign breast disease

### Breast anatomy

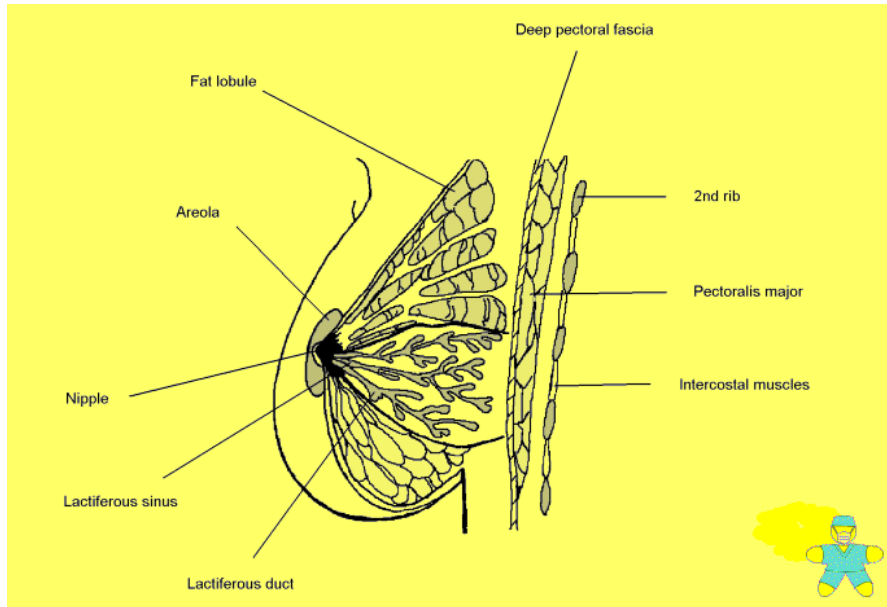


Figure 169 Breast anatomy

Table 42 Classification of benign breast disease

	Normal	Benign Disorder	Benign Disease
Development	Duct development Lobular development Stromal development	Nipple inversion Fibroadenoma Adolescent hypertrophy	Mammary fistula Giant fibroadenoma
Cyclical change	Hormonal activity	Mastalgia and nodularity	
Epithelial activity			Benign papilloma
Pregnancy and lactation	Epithelial hyperplasia	Bloodstained discharge	Galactocele
Involution	Ductal involution	Duct ectasia nipple retraction	Periductal mastitis
Lobular involution	Cysts Sclerosing adenosis Involutional epithelial hyperplasia	Hyperplasia Micropapillomatosis	Lobular and ductal hyperplasia with atypia



## Relationship between benign and malignant breast disease

### **No increased risk**

- Sclerosing adenosis
- Apocrine change
- Duct ectasia
- Mild hyperplasia
- Fibroadenoma
- Cysts
- Apocrine metaplasia

### **Slight increased risk (1.5 - 2x)**

- Moderate or florid hyperplasia
- Papilloma with fibrovascular core

### **Moderate increased risk (4 - 5x)**

- Atypical ductal hyperplasia
- Atypical lobular hyperplasia

### **High risk (8 - 10x)**

- Ductal carcinoma *in-situ* (DCIS)
- Lobular carcinoma *in-situ* (LCIS)



Figure 170 A galactocele

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## **Breast pain**

- Commonest reason for referral to breast clinics
- Accounts for 50% of all referrals
- Only 7% of patients with breast cancer report breast pain
- Assessment requires the keeping of a breast pain chart
- Divided into cyclical and non-cyclical mastalgia

### **Cyclical mastalgia**

- Usually bilateral, affects upper outer quadrant
- Mostly minor and accepted by many women as 'part of normal life'
- Average age of onset is 24 years
- No consistent hormonal abnormality
- Prolactin levels may be increased
- Essential fatty acid profiles may be abnormal
- No evidence of psychopathology
- In those with no palpable mass no imaging is required

### **Treatment**

- 80% require no treatment other than reassurance
- Treatment should be considered if symptoms >6 months for >7 days per cycle

### **Evening primrose oil (EPO)**

- Require treatment for at least 4 months
- 50% response rate
- 1% complications - nausea

### **Danazol**

- 80% response rate
- 25% complications - acne, weight gain, hirsutism
- Requires mechanical contraception

### **Bromocriptine**

- 50% response rate
- 20% complications - postural hypotension
- Tamoxifen effective but not licensed for use in mastalgia
- Diuretics or progestogens are not advised

### **Non-cyclical mastalgia**

- Usually affects older women
- Average age = 45 yrs
- Usually unilateral, often localised

### **Aetiology**

- True non-cyclical mastalgia
- Often has a musculoskeletal cause
- Rarely cancer

### **Treatment**

- Support bra & NSAID



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## **Fibroadenomas**

- Fibroadenomas are derived from the breast lobule
- They have both epithelial and connective tissue elements
- Their pathogenesis is unclear
- They are not true neoplasms being polyclonal rather than monoclonal
- Should be considered as an 'Aberration of Normal Development and Involution'

### **Simple fibroadenoma**

- Most are smooth or slightly lobulated
- Usually 2-3 cm in diameter
- Usually present between 16 and 24 yrs age
- Decrease incidence approaching the menopause
- May present has 'hard' calcified mass in the elderly
- Approximately 10% of fibroadenomas are multiple
- Diagnosed by triple assessment
  - Clinical assessment
  - FNA Cytology or core biopsy
  - Ultrasound

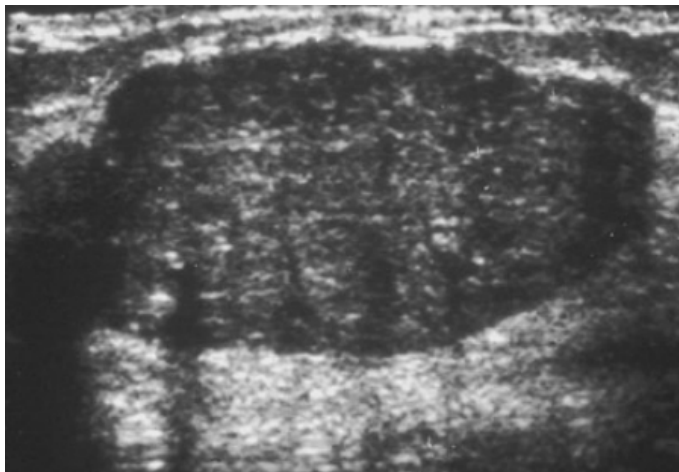


Figure 171 Ultrasound appearances of a fibroadenoma

- Recent improved understanding of natural history
- Over 5 year period
  - 50% increase in size
  - 25% remain stable
  - 25% decrease in size
- Risk of malignant transformation is approximately 1 in 1,000
- Resulting carcinoma is often a lobular carcinoma

### **Treatment**

- Less than 25 years - observe
- 25 - 35 years - offer conservative treatment
- More than 35 years - excision biopsy
- Excise at any age if patient requests

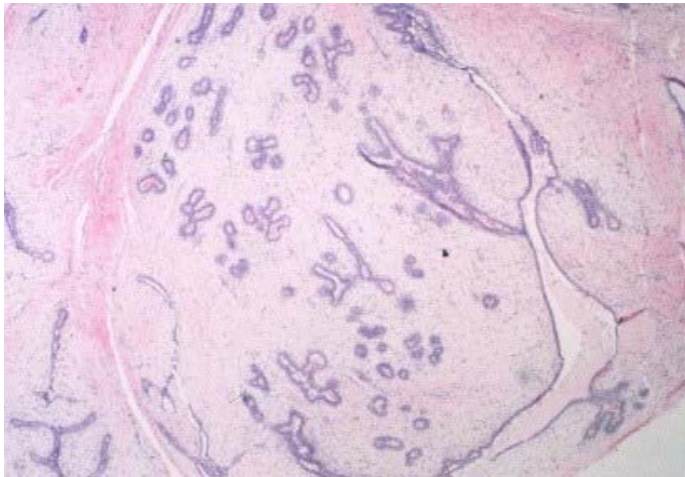


Figure 172 Histology of a fibroadenoma

### ***Giant fibroadenoma***

- Bimodal age presentation - teens & premenopausal
- More common in black / Orientals
- Rapidly grow to a large size
- Present with pain, breast enlargement, nipple displacement
- Characteristic shiny skin changes with dilated veins
- Enuceate through cosmetically sited scar
- Resulting breast distortion is usually self correcting
- No evidence that these tumours recur

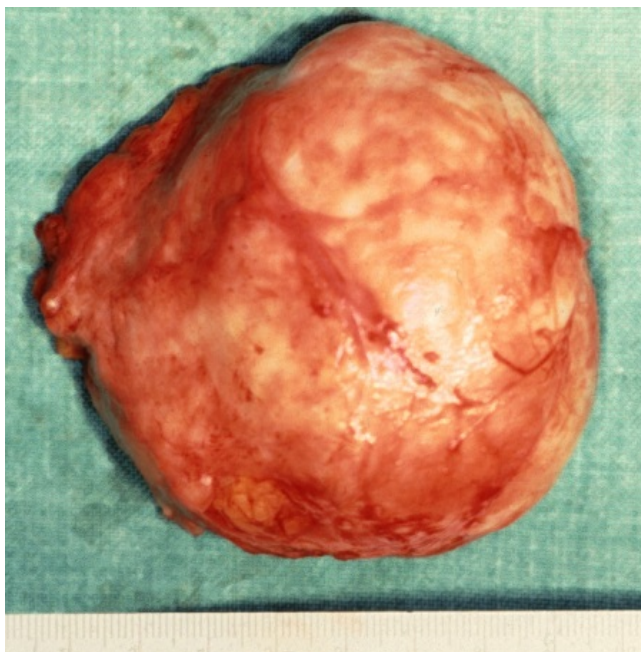


Figure 173 Giant fibroadenoma

### ***Phyllodes tumour***

- Occur in premenopausal women



- Wide spectrum of activity
- Vary from benign to locally aggressive
- Have cellular fibrous element
- Excise with 1 cm margin of normal tissue
- Re-excision or mastectomy for local recurrence



Figure 174 Histology of a phyllodes tumour



Figure 175 Phyllodes tumour



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## Breast cysts

- 7% of women will develop a clinically palpable cyst
- Usually occurs in peri-menopausal women
- Highest prevalence is between 45 and 55 years
- Cysts are often singular
- May appear suddenly and are frequently painful
- Require triple assessment
- Initial treatment is by simple aspiration



Figure 176 Typical breast cyst fluid

- Cytology should be performed if blood-stained aspirate
- Consider excision if
- Cyst recurs rapidly or repeatedly
- Residual lump after aspiration

Table 43 Breast cyst pathology

	Simple	Apocrine
Lining Epithelium	Simple cuboidal	Apocrine
Na / K ratio	Less than 3	More than 3
pH	Less than 7.4	More than 7.4
Tendency to recur	Low	Moderate
Association with cancer	Not proven	Possible

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## Breast Infections

### Lactational breast abscess

- Usually due to *Staph. aureus*
- Usually peripherally situated
- Surgery may be pre-empted by early diagnosis
- Attempt aspiration
- If no pus - antibiotics
- If pus consider repeated aspiration or incision and drainage
- Consider biopsy of cavity wall
- Continue breast feeding from opposite breast
- No need to suppress lactation

### Non-lactational breast abscess

- Occur in periareolar tissue
- Culture yield - Bacteroides, anaerobic strep, enterococci
- Usually manifestation of duct ectasia / periductal mastitis
- Occur 30- 60 years
- More common in smokers
- Often give history of recurrent breast sepsis
- Repeated aspiration is the treatment of choice
- Metronidazole and flucloxacillin
- Drain through small incision if non-resolving
- Definitive treatment when quiescent with antibiotic prophylaxis
- Usually a major duct excision = Adair's operation
- Spontaneous discharge or surgical excision can result in mammary fistula



Figure 177 Nonlactational breast abscess



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### **Nipple discharge**

- Nipple discharge is the efflux of fluid from the nipple
- Accounts for about 5% of referrals to a breast clinic
- Discharge can be elicited in approximately 20% of women by squeezing
- Nipple discharge can be regarded as physiological in the following:
  - Neonatal period
  - Lactation
  - Pregnancy
  - Post lactation
  - Following mechanical stimulation
  - Hyperprolactinaemia
- If can also represent duct pathology
  - Duct ectasia
  - Duct papilloma
  - Breast cancer

### **Description of nipple discharge**

- Unilateral or bilateral
- Single or multiple ducts
- Colour and nature
- Blood-stained
- Spontaneous or expressed

### **Galactorrhoea**

- Galactorrhoea is milk secretion unrelated to breast feeding
- Bilateral, multi-duct, milky discharge
- Often copious volumes and can occur spontaneously

### **Causes of Galactorrhoea**

- Physiological
  - Mechanical stimulation
  - Extremes of reproductive life
  - Post lactation
  - Stress
- Drugs
  - Associated with hyperprolactinaemia
  - Dopamine receptor-blocking agents (e.g. phenothiazines, haloperidol)
  - Dopamine-depleting agents (e.g. Methyldopa)
- Others
  - Oestrogens
  - Opiates
- Pathological
  - Hypothalamic and pituitary stalk lesion
  - Pituitary tumours
  - Ectopic prolactin secretion
  - Hypothyroidism
  - Chronic renal failure



### Coloured, opalescent discharge

- Usually bilateral, multi-duct, creamy or green in colour
- Usually occurs in late reproductive life
- Symptoms may be intermittent
- Commonest cause is duct ectasia

### Blood-stained and serosanguinous discharge

- Serous or blood-stained discharges are more worrying
- Often due to hyperplastic epithelial lesions
- Risk of malignancy increases with age
- 12% of breast cancers present with nipple discharge
- 70% of cases of blood-stained discharge have either a duct papilloma or breast cancer



Figure 178 Blood-stained nipple discharge

### Management

- A detailed history will often indicate the underlying cause
- Breast examination is often normal
- Haemostix can be used to test for the presence of blood
- Nipple smear cytology is rarely useful
- Mammography should be performed in all women over 35 years
- Ultrasound may identify retroareolar lesions
- If a lump is present, investigation should be by triple assessment
- If suggestion of galactorrhoea the serum prolactin should be measured
- Other investigations that have been described include:
  - Galactography
  - Fibreoptic ductography
- Most women with multi-duct, creamy discharge can be reassured after appropriate investigation
- Surgery is only required if:
  - The discharge is profuse and embarrassing
  - Malignancy can not be excluded



- In women with single-duct blood-stained discharge consider
- Young women - microdochectomy
- Older women - total duct excision

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## Gynaecomastia



Figure 179 Gynaecomastia

- Commonest condition affecting male breast
- Due to enlargement of both ductal and stromal tissue
- It is benign and often reversible
- Most cases are idiopathic
- Physiological causes are due to relative oestrogen excess
- Usually presents as unilateral non-tender breast enlargement

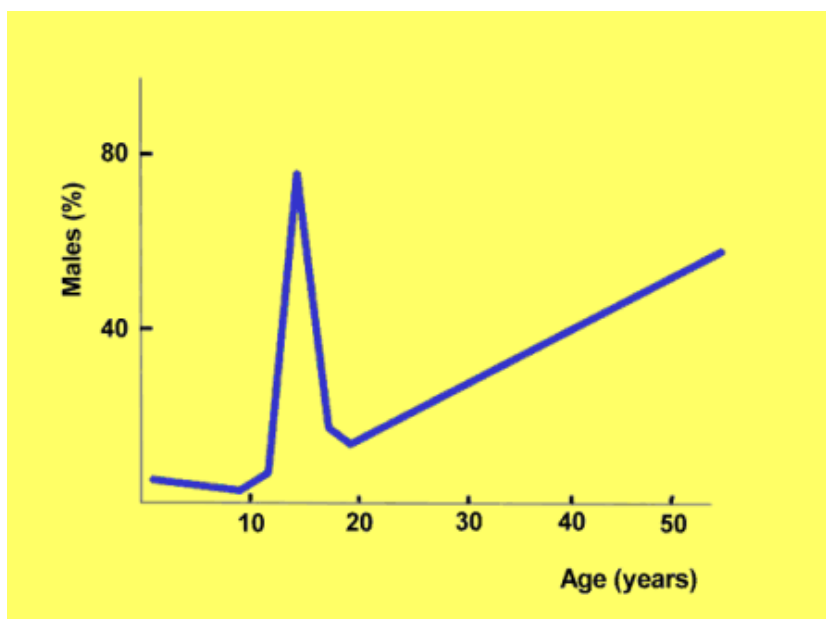


Figure 180 Prevalence of gynaecomastia with age



## **Aetiology**

### ***Physiological causes***

- Neonatal
- Puberty
- Senile

### ***Pathological causes***

#### ***Primary Testicular Failure***

- Anorchia
- Klinefelter's Syndrome
- Bilateral cryptorchidism

#### ***Acquired Testicular Failure***

- Mumps
- Irradiation

#### ***Secondary Testicular Failure***

- Generalised hypopituitarism
- Isolated gonadotrophin deficiency

#### ***Endocrine Tumours***

- Testicular
- Adrenal
- Pituitary

#### ***Non-Endocrine Tumours***

- Bronchial carcinoma
- Lymphoma
- Hypernephroma

#### ***Hepatic Disease***

- Cirrhosis
- Haemochromatosis

#### ***Drugs***

- Oestrogens and oestrogen agonists - digoxin, spironolactone
- Hyperprolactinaemia - methyldopa, phenothiazines
- Gonadotrophins
- Testosterone target cell inhibitors - cimetidine, cyproterone acetate

## **Treatment**

- Reassurance that it is a benign and self-limiting condition
- Treatment of any underlying cause
- If painful or embarrassing consider subcutaneous mastectomy
- Performed through circumareolar incision





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## **Breast cancer**

- Breast cancer affects 1:12 women
- In United Kingdom there are 24,000 new cases and 15,000 deaths annually
- It is the commonest cause of cancer death in women
- It accounts for 6% of all female deaths
- Britain has highest breast cancer mortality in the world

## **WHO Classification**

### **Epithelial**

- Non-invasive
  - Ductal carcinoma in situ (DCIS)
  - Lobular carcinoma in situ (LCIS)
- Invasive
  - Ductal (85%)
  - Lobular (1%)
  - Mucinous (5%)
  - Papillary (<5%)
  - Medullary (<5%)

### **Mixed Connective tissue and Epithelial**



Figure 181 Clinical photograph of breast carcinoma



### Diagnosis and assessment

- Most symptomatic cancers present as a painless lump
- Breast pain is an uncommon presentation of breast cancer
- Diagnosis is by Triple Assessment
  - Clinical Evaluation – Lump and regional nodes
  - Imaging (ultrasound <35 years old or mammography >35 years old)
  - Cytology or Histology
- Cytology is reported as:
  - C1 = Inadequate sample
  - C2 = Definitely benign
  - C3 = Probably benign
  - C4 = Suspicious of malignancy
  - C5 = Definitely malignant

### Aims of breast cancer surgery

- To achieve cure if excised before metastatic spread has occurred
- To prevent unpleasant sequelae of local recurrence

### Surgical options for the breast

- Breast Conserving Surgery (BCS) + radiotherapy
- Simple mastectomy
- Mastectomy + reconstruction (immediate or delayed)
- Radical mastectomy is now obsolete

### Tumours suitable for breast conservation

- Small single tumours in a large breast
- Peripheral location
- No local advancement or extensive nodal involvement
- For tumours that are suitable for breast conservation there is no difference in local recurrence or overall survival when BCS + radiotherapy is compared to mastectomy

### Aims of axillary surgery

- 30-40% of patients with early breast cancer have nodal involvement
- The aims of axillary surgery is to:
  - To eradicate local disease
  - To determine prognosis to guide adjuvant therapy
- Clinical evaluation of the axilla is unreliable (30% false positive, 30% false negative)
- No reliable imaging techniques available
- Surgical evaluation important and should be considered for all patients with invasive cancer
- Levels of axillary clearance are assessed relative to pectoralis minor
  - Level 1 - below pectoralis minor
  - Level 2 - up to upper border of pectoralis minor
  - Level 3 - to the outer border of the 1<sup>st</sup> rib
- Axillary samplings removes at least four nodes
- Pre-operative axillary ultrasound and biopsy may allow a tailored approach to the axilla

### Arguments for axillary clearance

- Axillary clearance both stages and treats the axilla
- Sampling potentially misses nodes and under stages the axilla



- Surgical clearance possibly gains better local control
- Avoids complications of axillary radiotherapy
- Avoids morbidity of axillary recurrence

#### **Arguments for axillary sampling**

- Only stages the axilla
- Must be followed by axillary radiotherapy
- The 60% of patients with node negative disease have unnecessary surgery
- Radical lymphadenectomy in other cancers (e.g. melanoma) produces disappointing results
- Avoids morbidity of axillary surgery
- The combination of axillary clearance and radiotherapy is to be avoided
- Produces unacceptable rate of lymphoedema



Figure 182 Post-mastectomy lymphoedema

#### **Sentinel node biopsy**

- Currently under investigation and should still be regarded as experimental
- Aims to accurately stage the axilla without the morbidity of axillary clearance
- Technique used to identify the first nodes that tumour drains to
- Can be located following the injection of either:
  - Radioisotope
  - Blue dye
  - Combination of isotope and blue dye
- Can be injected in peritumoural, subdermal or subareolar site
- Allows more detailed examination of nodes removed
- Significance of micrometastatic deposits identified in sentinel nodes is unclear

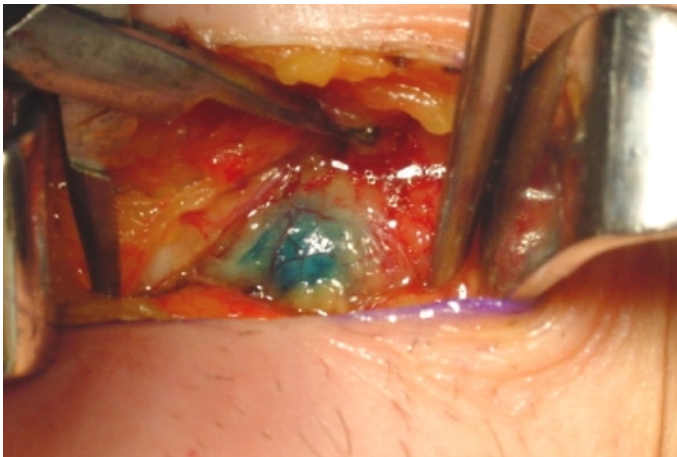


Figure 183 Blue sentinel lymph node

### Prognostic factors in early breast cancer

- 50% women with operable breast cancer who receive locoregional treatment alone will die from metastatic disease.
- Prognostic factors have three main uses:
  - To select appropriate adjuvant therapy according to prognosis
  - To allow comparison of treatment between similar groups of patient at risk of recurrence or death
  - To improve the understanding of the disease
- Prognostic factors can be:
  - Chronological
    - Indication of how long the disease has been present
    - Relate to stage of disease at presentation
  - Biological
    - Relate to intrinsic behaviour of tumour

### Chronological prognostic factors

#### Age

- Younger women have poorer prognosis of equivalent stage

#### Tumour size

- Diameter of tumour correlates directly with survival

#### Lymph node status

- Single best prognostic factor
- Direct correlation between number and level of nodes involved and survival

#### Metastases

- Distant metastases worsen survival

### Biological prognostic factors

#### Histological type

- Some histological types associated with improved prognosis:



- Tubular
- Cribriform
- Mucinous
- Papillary
- Micro-invasive

#### ***Histological grade***

- Three characteristics allow scoring of grade into grades one, two or three depending on:
  - Tubule formation
  - Nuclear pleomorphism
  - Mitotic frequency

#### ***Lymphatic / vascular invasion***

- 25% operable breast cancers have lympho-vascular invasion
- Double risk of local relapse
- Higher risk of short term systemic relapse

#### **Biochemical measurements**

##### ***Hormone and growth factor receptors***

- ER positivity predicts for response to endocrine manipulation
- EGF receptors are negatively correlated with ER and poorer prognosis

##### ***Oncogenes***

- Tumours that express C-erb-B2 oncogene likely to be:
  - Resistant to CMF chemotherapy
  - Resistant to hormonal therapy
  - Respond to anthracycline
  - Respond to taxols

##### ***Proteases***

- Urokinase and cathepsin D found in breast cancer
- Presence confers a poorer prognosis

#### **Prognostic indices**

- Although individual prognostic factors are useful combining independent prognostic variables in the form of an index allows identification of patients with different prognoses

##### ***Nottingham Prognostic Index (NPI)***

- Incorporates three factors:
  - Tumour size
  - Nodal status
  - Histological grade



Table 44 The Nottingham Prognostic Index

Factor		
Involved Nodes	Tumour Grade	Score per factor
0	1	1
1-3	2	2
>3	3	3

- $NPI = 0.2 \times \text{size(cm)} + \text{Lymph node stage} + \text{Tumour grade}$

#### Chemotherapy in breast cancer

- Can be given as
  - Primary systemic therapy prior to locoregional treatment
  - Adjuvant therapy following locoregional treatment

#### Post-operative adjuvant chemotherapy

- Depends primarily on:
  - Age / menopausal status
  - Nodal status
  - Tumour grade
- Combination chemotherapy more effective than single drug
- Most commonly used regimen = CMF (Cyclophosphamide, Methotrexate, 5 Fluorouracil)
- Given as six cycles at monthly intervals
- No evidence that more than 6 months treatment is of benefit
- Greatest benefit seen in premenopausal women
- High -dose chemotherapy with stem cell rescue produces no overall survival benefit

Table 45 Chemotherapeutic options in breast cancer

	Nodal state	Treatment
Premenopausal	Node positive	Combination chemotherapy
	Node negative	Adjuvant therapy is not generally recommended; for high risk patients chemotherapy should be considered
Postmenopausal	Node positive	ER positive - Tamoxifen
		ER negative - Combination chemotherapy should be considered
	Node negative	No indication for routine adjuvant therapy: for high risk patients chemotherapy should be considered

#### Primary (neoadjuvant) chemotherapy

- Chemotherapy prior to surgery for large or locally advanced tumours
- Shrinks tumour often allowing breast conserving surgery rather than mastectomy
- 70% tumours show a clinical response
- In 20–30% this is response is complete
- Surgery required even in those with complete clinical response
- 80% of these patients still have histological evidence of tumour
- Primary systemic therapy has not to date been shown to improve survival



### Endocrine therapy in breast cancer

- It is just over 100 years since Beatson described response to oophorectomy in women with advanced breast cancer

#### *Tamoxifen*

- Tamoxifen is an oral anti-oestrogen
- Effective in both the adjuvant setting and in advanced disease
- 20 mg per day is as effective as higher doses
- 5 years treatment is better than 2 years
- Value of treatment beyond 5 years is unknown
- Risk of contralateral breast cancer reduced by 40%
- Greater benefit seen in oestrogen receptor rich tumours
- Benefit still seen in oestrogen receptor negative tumours
- Benefit observed in both pre and post menopausal women

#### *Aromatase inhibitors*

- Several new endocrine therapies are available
- Reduced the peripheral conversion of androgens to oestrogens
- Only effective in post menopausal women
- May be superior to tamoxifen
- To date have not been shown to have survival benefit compared with tamoxifen

### Locally advanced breast cancer



Figure 184 Locally advanced breast carcinoma

- Regarded as a tumour that is not surgically resectable
- Clinical features include:
  - Skin ulceration
  - Dermal infiltration
  - Erythema over the tumour
  - Satellite nodules





- Peau d'orange
- Fixation to chest wall, serratus anterior or intercostal muscles
- Fixed axillary nodes

### **Management**

- If oestrogen receptor-positive usually treated with primary hormonal
- If oestrogen receptor-negative chemotherapy may be useful
- Radiotherapy may be useful in local control of disease
- If adequate response a salvage mastectomy can be consider

### **Recurrent breast cancer**

- Most local recurrences are symptomatic
- Often associated with the development of metastatic disease
- Restaging is therefore essential
- Commonest sites for ductal carcinoma are liver, bone and lung
- Lobular carcinoma less predictable often spreading to bowel, retroperitoneum etc



Figure 185 Locally recurrent breast carcinoma

### **Management**

- Recurrence whilst on adjuvant tamoxifen consider:
- Further surgery for :
  - Isolated 'spot' recurrence after mastectomy
  - Local recurrence in the conserved breast
- Radiotherapy if not previously given
- Change of hormonal agent to anastrozole or other aromatase inhibitor

### **Male breast cancer**

- 1% of all breast cancers occur in men
- Pathologically, the disease is similar to that which occurs in women
- The principles of treatment are the same
- The proportion of men undergoing mastectomy is higher
- Adjuvant therapy is the same as for women



Figure 186 Male breast cancer

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### **Breast reconstruction**

- Breast reconstruction is increasing in popularity
- Can be performed as immediate or delayed procedure
- Breast reconstruction is oncologically safe
- Does not delay adjuvant therapy
- Does not delay the detection of recurrent disease
- There are no absolute contraindications
- Relative contraindications are old age, diabetes, smoker, collagen diseases
- Preoperative counselling is essential

### **Reconstructive options**

- There are three types of breast reconstruction
  - Tissue expanders
  - Pedicled myocutaneous flaps
  - Free tissue transfer
- Each has specific uses and complications
- The contralateral breast may require surgery to produce symmetry

### **Tissue expanders**

- A simple and reliable technique
- When used alone often produce a poor cosmetic result
- Capsular contracture can result in firmness and discomfort
- Capsulectomy and replacement of the implant may be required
- Radiotherapy may increase the risk of capsular contracture
- Textured implants reduce the risk of capsule formation

### **Pedicled myocutaneous flaps**

- The two commonest flaps are:
  - The latissimus dorsi flap based on the thoracodorsal vessels
  - The pedicled transverse rectus abdominis based on the superior epigastric vessels
- Either can be performed as an immediate or delayed procedure
- Pedicled flaps produce a better cosmetic result
- Use of an LD flap is often combined with tissue expander or prosthesis
- TRAM flaps often provide enough autologous tissue to avoid the need for a tissue expander
- General complications associated with flaps include necrosis and flap loss
- The LD flap leaves a scar on the back and some shoulder weakness
- TRAM flaps can result in abdominal donor site hernia and weakness
- Abdominal free flaps (e.g. DIEP flap) produce similar cosmetic results
- Risk of abdominal wall complications is reduced



### ***Nipple reconstruction***

- Nipples can be reconstructed by:
  - Nipple sharing
  - Skate flaps
  - Labial grafts
  - Nipple tattooing
  - Prosthetic nipples



Figure 187 Skin sparing mastectomy and immediate LD reconstruction



Figure 188 Bilateral delayed LD reconstructions

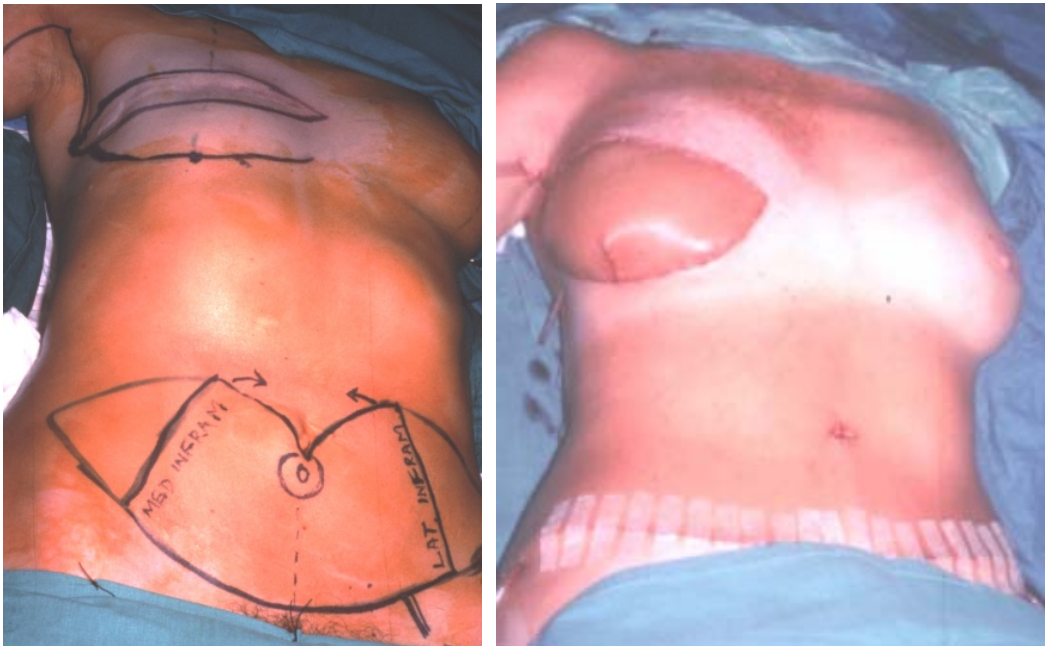


Figure 189 Pedicle TRAM flap breast reconstruction

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## Thyroid and parathyroid disease

### Thyroglossal cysts

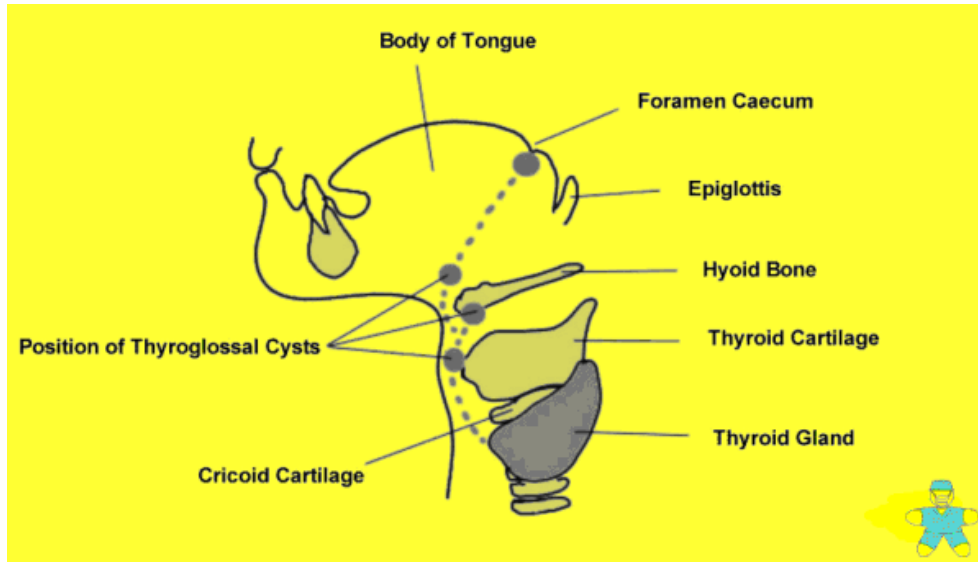


Figure 190 Embryology of the thyroid gland

- The thyroglossal tract arises from foramen caecum at junction of anterior 2/3 and posterior 1/3 of the tongue
- Any part of the tract can persist causing a sinus, fistulae or cyst
- Most fistulae are acquired following rupture or incision of infected thyroglossal cyst
- Thyroglossal cysts are usually found in subhyoid portion of tract
- 75% present as midline swellings



Figure 191 Two examples of thyroglossal cysts

- Remainder can be found as far lateral as lateral tip of hyoid bone
- Elevated on protrusion of the tongue
- Male : female ratio is approximately equal
- 40% present less than 10 years of age



- 65% present less than 35 years of age
- Often present as an infected cyst due lymphoid tissue in the cyst wall
- If infected aspirate cyst rather than incise
- Prevents formation of thyroglossal fistula

#### **Treatment**

- Sistrunk Operation is surgery of choice
- Transverse skin crease incision
- Platysma flaps raised. Cyst dissected
- Middle 1/3 of hyoid and any suprahyoid tract extending into the tongue dissected

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### **Thyrotoxicosis**

- Affects 2% women and 0.2% of men
- Commonest causes:
  - Graves disease
  - Toxic nodular goitre
  - Toxic solitary nodule
  - Thyroiditis
- Diagnosis confirmed by measurement of TSH level
- A normal TSH excludes the diagnosis (except in rare case of TSH secreting pituitary tumours)
- Serum free T<sub>4</sub> is normally increased
- Serum total T<sub>4</sub> can be variable due to changes in thyroid binding globulin
- Occasionally free T<sub>3</sub> is increased in T<sub>3</sub>-toxicosis

### **Clinical features of thyrotoxicosis**

- Palpitation, tachycardia, cardiac arrhythmias, cardiac failure
- Sweating, tremor
- Hyperkinetic movements
- Nervousness
- Myopathy
- Tiredness and lethargy
- Weight loss
- Heat intolerance
- Diarrhoea and vomiting
- Irritability
- Emotional disturbance
- Behavioural abnormalities
- Ophthalmic signs
- Irregular menstruation and amenorrhoea
- Pretibial myxoedema
- Thyroid acropachy
- Vitiligo
- Alopecia

### **Pretibial myxoedema**

- Occurs in 1-2% patients with Graves' disease
- Painless thickening of the skin in nodules or plaques
- Usually occurs on shins or dorsum of foot
- Strongly associated with ophthalmopathy

### **Thyroid acropachy**

- Occurs in less than 1% patients with thyrotoxicosis
- Closely resembles finger clubbing
- Almost all patients also have ophthalmopathy or pretibial myxoedema

### **Graves disease**

- Usually occurs in women between 20 and 40 years
- Immunological disorder due to release production of thyroid stimulating IgG antibodies
- Bind to TSH receptor stimulating thyroid hormone production



- Produces a diffuse goitre
- Clinically patients have features of thyrotoxicosis often with eye signs:
  - Exophthalmos and proptosis - usually bilateral
  - Diplopia due to weakness of external ocular muscles
  - Chemosis and corneal ulceration

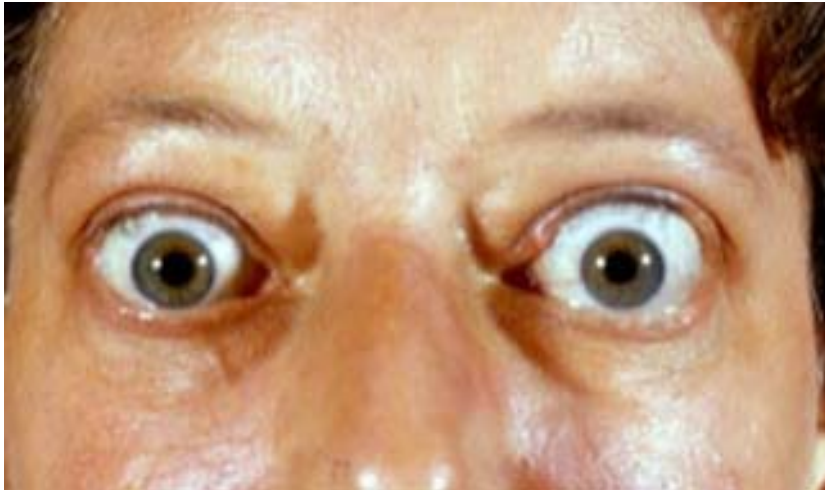


Figure 192 Exophthalmos due to Grave's disease

#### Treatment of thyrotoxicosis

- Rapid symptomatic relief can be achieved with  $\beta$ -blockers
- Thyroid function can be reduced by:
  - Anti-thyroid drugs
  - Radioactive iodine
  - Surgery

#### Anti-thyroid drugs

- Inhibit synthesis of thyroxine by reducing incorporation of iodine into tyrosine residues
- Most commonly used drugs are carbimazole and propylthiouracil
- Used short-term (3-4 months) prior to definitive treatment (radioiodine or surgery)
- Used long-term (12-24 months) induce remission in Grave's disease
- 40% of patients with Grave's disease respond to carbimazole
- Side effects - agranulocytosis, aplastic anaemia, hepatitis
- Patients need to be warned to seek medical attention if develop sore throat etc.
- Advantage
  - No surgery or the use of radioactive materials
- Disadvantages:
  - Treatment is prolonged
  - Failure rate after 2 years treatment is approximately 50%
  - Impossible to predict which patients will remain in remission
  - Some goitres enlarge during treatment

#### Radioactive iodine

- $^{131}\text{I}$  is commonest isotope used
- 400 MBq renders 50% patients hypothyroid but about 20% remain hyperthyroid
- Contraindicated in children, pregnancy and breast feeding
- Pregnancy should be avoided for 4 months after treatment



- Advantage
  - No surgery or prolonged drug therapy
- Disadvantages
  - Isotope facilities must be available
  - 80% hypothyroid at 10 years
  - Indefinite follow up required

### **Surgery**

- Indications for surgery in Grave's disease are
- Relapse after adequate course of anti-thyroid drugs
- Large goitre
- High T<sub>4</sub> levels at diagnosis (>75 pmol/l)
- Subtotal thyroidectomy is treatment of choice
- Preserves about 4g (10%) of thyroid tissue
- Patients must be euthyroid prior to operation
- Advantages
  - Goitre is removed and cure rate is high
- Disadvantages
  - 5% develop recurrent thyrotoxicosis
  - 20% develop postoperative hypothyroidism
  - 0.5% develop parathyroid insufficiency

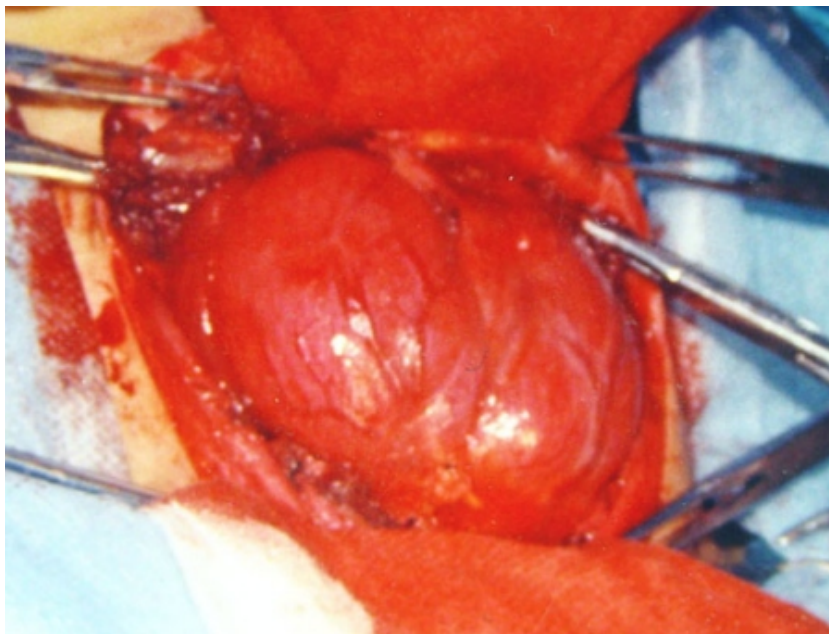


Figure 193 Thyroidectomy for Grave's disease



### **Thyroid storm**

- Uncommon life-threatening exacerbation of thyrotoxicosis
- Has a mortality of 50%

#### ***Precipitating factors***

- Thyroid surgery
- Radioiodine
- Withdrawal of antithyroid drugs
- Iodinated contrast agents
- Acute illness (e.g. stroke, infection, trauma)

#### ***Clinical features***

- Severe thyrotoxicosis
- Fever
- Delirium
- Seizure or coma
- Jaundice

#### ***Treatment***

- Propylthiouracil 600mg loading dose
- Lugol's iodine at least one hour later
- Beta-blocker
- Supportive measures
- Treatment of precipitating cause

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## **Goitre**

- Goitre is a non-specific term describing enlargement of the thyroid gland
- Does not imply the presence of any specific pathology
- Goitres can be either diffuse or multi-nodular



Figure 194 Multinodular goitre

### **Causes of diffuse goitres**

#### **Simple goitre**

- Patient euthyroid
- Due to compensatory hypertrophy resulting from
- Iodine deficient diet
- Congenital enzyme defect in thyroxine synthesis
- Increased physiological demands

#### **Smooth toxic goitre**

- Patient hyperthyroid (Graves disease)

#### **Other smooth goitres**

- Thyroiditis
- Lymphoma
- Thyroid amyloidosis

### **Causes of multinodular goitres**

- Usually a simple goitre that has progressed to nodularity



Table 46 Thyroid examination and functional assessment

Thyroid Examination	Thyroid Function	Causes
Diffuse goitre	Euthyroid	Physiological goitre Autoimmune thyroiditis
Diffuse goitre	Hyperthyroid	Primary hyperthyroidism
Multinodular goitre	Euthyroid	Multinodular goitre
Multinodular goitre	Hyperthyroid	Toxic nodular goitre (rare)
Solitary nodule	Euthyroid	Thyroid cyst Thyroid adenoma Thyroid carcinoma
Solitary nodule	Hyperthyroid	Functioning adenoma



Figure 195 Multinodular goitre

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### **Evaluation of solitary thyroid nodules**

- 5% of population have a palpable solitary thyroid nodule
- 50% of population have solitary nodule identifiable at autopsy
- If all nodules were removed less than 10% would prove to be malignant
- Thyroid surgery is not without complications
- Need selective surgical excision policy for thyroid nodules
- Conservative management is appropriate if malignancy can be reasonably excluded

### **Indications for excision of thyroid nodule**

- Proven or suspected cancer
- Obstructive symptoms
- Patient anxiety
- Hyperfunctioning nodules resulting in hyperthyroidism
- Cosmesis

### **Assessment of thyroid nodules**

#### **History**

- Rapid painless growth suggests malignancy
- Sudden painful growth suggests haemorrhage into degenerating colloid nodule
- Family history - 20% medullary carcinomas are familial associated with MEN 2 Syndrome
- History of radiation exposure
  - In 1940s to 60s large numbers of children exposed in USA to low dose irradiation
  - Used in treatment of tonsillar hypertrophy, acne, thymic enlargement
  - Increased incidence of thyroid malignancy - usually papillary
  - Most occult (less than 1.5 cm diameter) and multifocal
  - Usually good prognosis

#### **Examination**

- 80% solitary thyroid nodules occur in women
- The risk of malignancy is increased three fold in men
- Malignancy more common in children and more than 60 years
- Assess whether true solitary or dominant nodule within goitre
- True solitary nodule have 10% risk of malignancy
- Dominant nodule in multinodular goitre has 2-5% risk of malignancy
- Evidence of fixation or nodal involvement suggests malignancy
- Most patients will be clinically and biochemically euthyroid
- Obstructive signs - stridor, tracheal deviation, neck vein engorgement
- Hoarseness and vocal cord paralysis suggests recurrent laryngeal nerve palsy
- 50% solitary thyroid nodules in children are cancers
- 70% will have cervical and 15% pulmonary metastases on presentation
- Childhood tumours have good prognosis with greater than 80% 10 year survival



## Investigations

### *Biochemical assessment*

- Thyroid functional status - Free T<sub>4</sub> and TSH
- Thyroid antibodies - anti-thyroglobulin and anti-microsomal
- If positive family history an possibility of medullary carcinoma - calcitonin
- If suspicion of MEN2 Syndrome will need 24 hr urinary catecholamine estimations to exclude phaeochromocytoma prior to surgery

### *Standard radiography*

- Chest radiography and thoracic inlet views if obstructive symptoms

### *Isotope scanning*

- <sup>131</sup>I, <sup>123</sup>I or <sup>99m</sup>Tc scanning provides functional assessment of thyroid
- Nodules classified as cold, warm or hot
- Unable to differentiate benign and malignant nodules
- Most solitary thyroid nodules are cold
- Most cancers arise in cold nodules
- Risk of cancer in a cold nodule is 10-15%
- Risk of tumour in a hot nodule is negligible
- Scintigraphy of minimal use in evaluation of solitary thyroid nodules
- Useful in recurrent thyroid swellings and retrosternal goitres

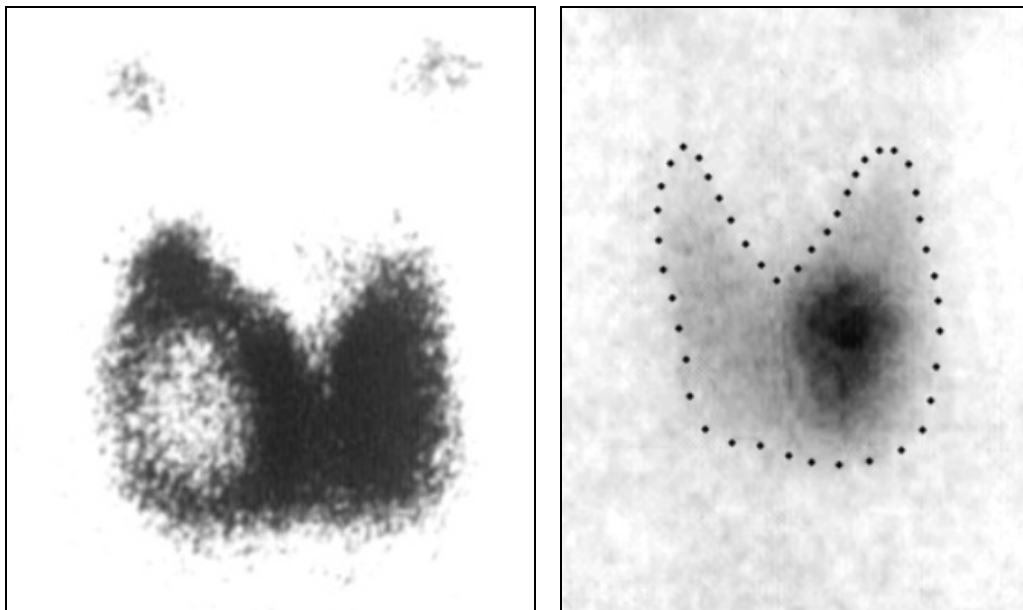


Figure 196 Cold (left) and hot (right) thyroid nodule on isotope scanning

### *Ultrasound*

- Will define solitary and dominant nodules
- Will distinguish solid and cystic lesions
- Most sonographically solid lesions are benign
- Cancer can occur in the wall of a cystic lesion





- No reliable criteria to distinguish benign and malignant lesions
- However, features that might suggest malignancy are:
  - Hypoechogenicity
  - Microcalcification
  - Irregular margins
  - Increased nodular flow on Doppler
  - Regional lymphadenopathy

#### ***Fine needle aspiration cytology***

- Should be first line investigation of the solitary thyroid nodule
- With experienced cytologist diagnostic accuracy can be >95%
- Accuracy improved if performed under ultrasound guidance
- Possible cytopathological diagnoses are:
  - Benign
  - Malignant
  - Indeterminate
  - Inadequate
- Can distinguish benign and malignant tumours except follicular neoplasms
- Diagnosis of follicular carcinoma depends on the visualisation capsular
- If follicular neoplasm on FNA lesion will require surgical excision
- False negative rate less than 5% in most institutions
- Definitive FNA cytology allows:
  - Non-operative treatment with benign disease
  - Appropriate surgical treatment of thyroid cancers at initial operation
  - Surgery can be avoided in anaplastic tumours and lymphomas
  - Reduces total number of thyroid lobectomies
  - Increases yield of thyroid cancers

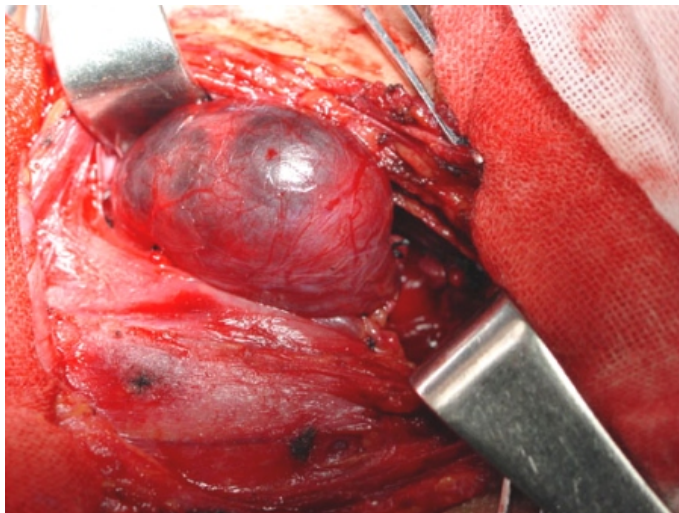


Figure 197 Intraoperative appearance of a thyroid adenoma

#### **Indications for surgery after FNA cytology**

- All proven malignant nodules
- All cytologically diagnosed follicular neoplasms
- All lesions exhibiting an atypical but non-diagnostic cellular pattern on cytology
- Cystic nodules which recur after aspiration



- When on clinical grounds the index of suspicion of malignancy is high even if the cytology report suggests it is benign

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## Thyroid neoplasms

Table 47 Classification of thyroid tumours

Benign Tumours	Malignant Tumours
Follicular adenoma	Papillary carcinoma
Teratoma	Follicular carcinoma
	Mixed papillary-follicular carcinoma
	Medullary carcinoma
	Lymphoma
	Miscellaneous - e.g. squamous, sarcoma
	Metastatic

### Benign thyroid tumours

- Most are follicular adenomas
- Papillary adenomas are rare.
- All papillary tumours should be considered malignant

#### Follicular adenoma

- Of all follicular lesions - 80% benign and 20% malignant
- They are smooth and discrete lesions with glandular or acinar pattern
- They are encapsulated and usually 2-4 cm in diameter
- Adenomas can not be differentiated from carcinoma on FNA cytology
- Requires histological assessment of capsular invasion
- Various histological types
  - Embryonal - rudimentary acini. No Colloid
  - Fetal
  - Simple
  - Colloid - Well formed acini. Much colloid
  - Macrofollicular
  - Microfollicular

#### Toxic adenoma

- Account for 5% of cases of thyrotoxicosis
- Female : Male ratio is approximately 9:1
- Presentation
  - 54% with a nodule
  - 37% with thyrotoxicosis
  - 95% of toxic adenomas are benign
- Thyrotoxicosis not usually associated with eye signs
- A hot nodule on scintigraphy with suppression of normal thyroid uptake
- Treatment is by thyroid lobectomy
- Require post operative thyroxine until suppressed gland returns to normal

### Malignant thyroid tumours

- Differentiated thyroid cancer accounts for 80% of thyroid neoplasms
- Female : male ratio is approximately 4:1
- Usually presents as solitary thyroid nodule in young or middle age adult
- Nodule more likely to be malignant in man or child
- Papillary and follicular tumours are biologically very different



Table 48 Comparison of papillary and follicular tumours

Papillary tumours	Follicular tumours
Multifocal	Solitary
Unencapsulated	Encapsulated
Lymphatic spread	Haematogenous spread
Metastases to regional nodes	Metastases to lung, bone and brain



Figure 198 Large goitre due to a anaplastic thyroid carcinoma

### **Papillary and mixed tumours**

- 50% tumours are less than 2 cm diameter at presentation
- Tumours < 1 cm diameter regarded as minimal or micropapillary lesions
- Psammoma bodies and 'orphan Annie' nuclei are characteristic histological features
- 30 - 50% are multicentric with simultaneous tumour in contralateral lobe
- Early spread occurs to regional lymph nodes
- 'Lateral aberrant thyroid' almost always metastatic papillary carcinoma
- Thyroid lobectomy adequate for minimal lesions
- Total thyroidectomy is otherwise surgery of choice
- Many tumours are TSH dependent
- TSH suppression with post-operative thyroxine appropriate
- Thyroxine reduces recurrence and improves survival
- 80% nodes have microscopic involvement
- The role of prophylactic lymph node dissection at time of initial surgery is unclear
- Lymph node dissection does not improve survival
- Alternative is to sample the lymph nodes.
- If no evidence of nodal metastases - no further surgery
- If nodal metastases present - modified neck dissection



### ***Follicular tumours***

- Can not differentiate follicular adenoma and carcinoma on FNA cytology
- Treatment of all follicular neoplasms is thyroid lobectomy with frozen section
- If frozen section confirms carcinoma - Total thyroidectomy
- If frozen section confirms adenoma - No further surgery required
- Total thyroidectomy allow detection of metastases using  $^{123}\text{I}$  Scanning during follow up
- All patients require suppressive thyroxine therapy

### ***Follow up of thyroid carcinoma***

- Annual  $^{123}\text{I}$  scanning to detect asymptomatic recurrence
- Treatment of such recurrence can still be curative
- Need to be off  $\text{T}_4$  for at least one month with conversion to  $\text{T}_3$
- Serum Thyroglobulin - increasing levels often first sign of recurrence
- May allow detection of recurrence without inconvenience of scintigraphy

### **Total thyroidectomy vs.. thyroid lobectomy for differentiated tumours**

#### ***Arguments for total thyroidectomy***

- Multifocal disease occurs in opposite lobe in 50% cases
- Total thyroidectomy reduces risk of local recurrence
- Ablation with radioiodine is facilitated
- Serum thyroglobulin can be used as a tumour marker for progression or recurrence
- In experienced hands, morbidity of total thyroidectomy is low

#### ***Arguments for thyroid lobectomy***

- Many patients do not require radioiodine
- Progression to undifferentiated carcinoma is rare
- Significance of micro-foci in contralateral lobe is uncertain
- No evidence that more extensive procedure is associated with better prognosis
- Higher incidence of hypoparathyroidism after total thyroidectomy

### **Anaplastic carcinoma**

- Accounts for less than 5% thyroid malignancies
- Occurs in elderly and is usually an aggressive tumour
- Local infiltration causes dyspnoea, hoarseness and dysphagia
- Thyroidectomy seldom feasible
- Incision biopsy should be avoided as it often causes uncontrollable local spread
- Radiotherapy and chemotherapy important modes of treatment
- Death usually occurs within 6 months

### **Thyroid lymphoma**

- Accounts for 2% of thyroid malignancies
- Often arises with Hashimoto's thyroiditis or non-Hodgkin's B-cell lymphoma
- Presents as a goitre in association with generalised lymphoma
- Diagnosis can often be made by FNA cytology
- Radiotherapy is treatment of choice
- Prognosis is good - often >85% 5 year survival



### **Medullary carcinoma of the thyroid**

- Accounts for 8% of thyroid neoplasms
- Arises from para-follicular C-cells
- 20% of cases are familial
- Autosomal dominant inheritance with almost complete penetrance
- Can occur as part of MEN IIa and MEN IIb syndromes
- 80% of cases are sporadic
- Sporadic cases usually unilateral
- 50% have lymph nodes at presentation
- Familial cases often multifocal and bilateral
- Tumours metastasise to nodes and via blood to bone, liver and lung
- They produce calcitonin, calcitonin gene related peptide and CEA
- Total thyroidectomy is treatment of choice
- Calcitonin can be used in follow up for the presence of metastatic disease

### **Complications of thyroidectomy**

- Haemorrhage
- Wound Complications
  - Sepsis
  - Hypertrophic scarring
- Respiratory Obstruction
  - Laryngeal mucosal oedema
  - Clot deep to strap muscles
  - Bilateral incomplete recurrent laryngeal nerve palsies
  - Tracheomalacia
- Nerve Damage
  - Recurrent laryngeal nerve palsy
  - Incomplete - Cord moves to midline
  - Complete - Cord in cadaveric position
  - Preoperative cord inspection is essential
  - 3% population have asymptomatic recurrent laryngeal nerve palsy
- Hypocalcaemia
- Pneumothorax
- Air Embolism
- Recurrent hyperthyroidism
- Hypothyroidism

### **Thyroid Crisis**

- Fulminating hyperthyroidism
- Hyperpyrexia
- Arrhythmia
- Cardiac Failure

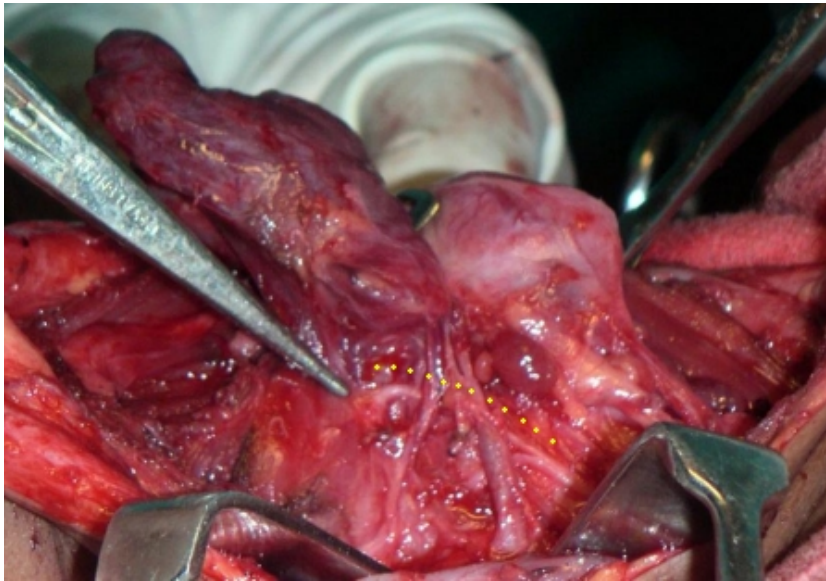


Figure 199 Course of recurrent laryngeal nerve

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## Thyroiditis

### de Quervain's thyroiditis

- Also known as granulomatous or subacute thyroiditis
- Due to viral infection
- Often follows a upper respiratory tract infection

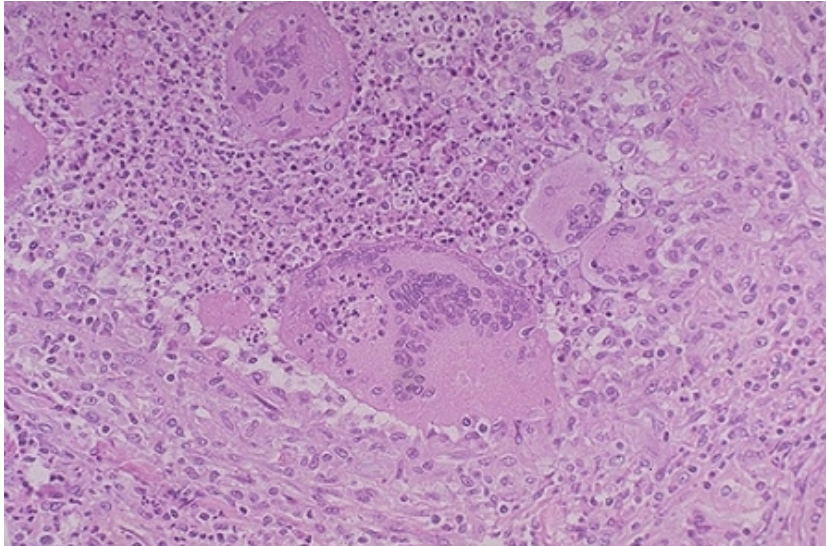


Figure 200 de Quervains thyroiditis

- Presents with painful swelling of one or both thyroid lobes
- Usually associated with malaise and fever
- Patients often have clinical features of mild hyperthyroidism
- Free T<sub>4</sub> and ESR is usually raised
- Usually a self-limiting illness with spontaneous recovery
- A few patients develop mild hypothyroidism
- Symptomatic improvement can occur with the use of NSAID
- Steroids may speed resolution in those with severe symptoms

### Hashimoto's thyroiditis

- Also known as lymphomatous thyroiditis
- Due to autoimmune disease
- Produces diffuse swelling of thyroid gland
- Histological thyroid is infiltrated with lymphocytes and plasma cells
- May progress to secondary lymphoid nodule formation and stromal fibrosis
- Serum anti-thyroglobulin and anti-microsomal antibodies are raised
- Patients eventually become hypothyroid
- Thyroxine replacement therapy suppresses TSH and reduces size of gland
- Surgery is rarely required
- Long-term the risk of thyroid lymphoma is increased



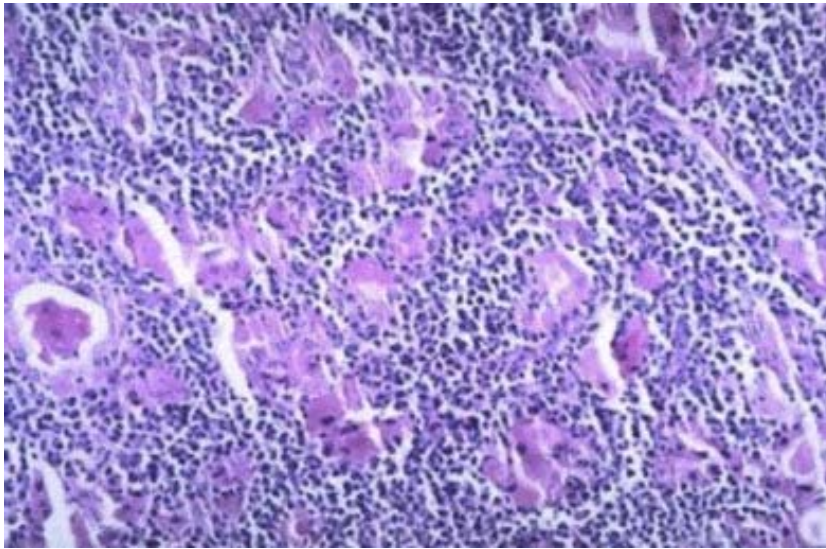


Figure 201 Histological appearances of Hashimoto's thyroiditis

#### Riedel's thyroiditis

- Also known as acute fibrous thyroiditis
- Rare but important as it often clinically mimics malignancy
- Produces a diffuse inflammatory infiltrate throughout the thyroid gland
- May extend beyond capsule into adjacent structures
- Clinically is associated with sclerosing cholangitis, retroperitoneal and mediastinal fibrosis
- Surgery is rarely required
- May require division of isthmus to decompress trachea

#### Acute suppurative thyroiditis

- Bacterial or fungal infection
- Produces acutely inflamed thyroid gland
- Diagnosis is confirmed by fine-needle aspiration cytology
- Treatment is by parenteral antibiotics

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## Parathyroid disease

### Parathyroid embryology

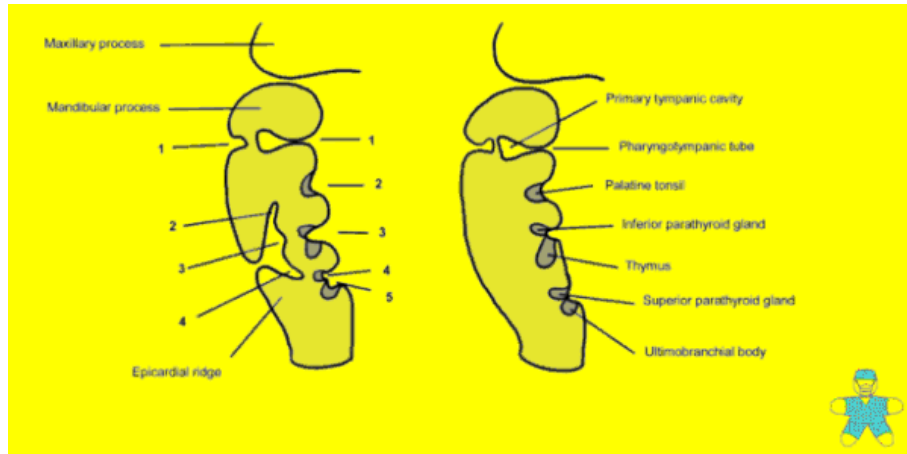


Figure 202 Parathyroid embryology

- The parathyroid glands are derived from pharyngeal pouches
  - Pouch III - Inferior parathyroid glands
  - Pouch IV - Superior parathyroid glands
- Abnormalities of position and number of glands common
- 5% of population have less than four glands
- 25% have supernumerary glands often in aberrant positions (e.g. thymus)

### Parathyroid physiology

- Parathyroid hormone = 84 amino acid protein (MW = 9500)
- Has half life measured in minutes
- Broken down to C and N terminal fragments which remain biologically active
- Acts on cell membrane receptors increasing cAMP
  - In bone - increases turnover and Ca release
  - In kidney - increases production of 1,25 dihydroxy -Vitamin D3
  - In gut - increases Ca absorption

### Causes of hypercalcaemia

- Primary Hyperparathyroidism
- Malignancy
- Granulomatous disease - sarcoidosis, tuberculosis
- Drugs - thiazide diuretics, vitamin D toxicity, lithium, milk alkali syndrome
- Familial hypercalciuric hypercalcaemia
- Endocrine – thyrotoxicosis, adrenal crisis
- Immobilisation
- Renal Failure
- Aluminium intoxication



### Hyperparathyroidism

- Prevalence of hyperparathyroidism is 1; 1000 population
- Affects one in 500 women over 45 years of age
- Most asymptomatic.
- Most detected on testing for other conditions

#### *Primary hyperparathyroidism*

- Elevated PTH.
- Normal or increased serum Ca due to:
  - Parathyroid adenoma (85%)
  - Parathyroid hyperplasia (15%)
  - Parathyroid carcinoma (<1%)



Figure 203 Intraoperative appearance of a thyroid adenoma

#### *Secondary hyperparathyroidism*

- Elevated PTH. Low serum Ca due to:
- Chronic renal failure
- Malabsorption

#### *Tertiary hyperparathyroidism*

- Elevated PTH following correction of cause of secondary hyperparathyroidism

#### **Clinical Features of hyperparathyroidism**

- General - polydipsia, weight loss
- Renal - colic, haematuria, back pain, polyuria
- Cardiovascular - hypertension, heart block
- Musculoskeletal - non-specific aches and pains, bone pain, pathological fractures
- Gastrointestina - anorexia, nausea, dyspepsia, constipation
- Neurological - depression, lethargy, apathy, weakness, psychosis



Figure 204 Osteitis fibrosa cystica due to hyperparathyroidism

#### **Incidence of clinical presentations of hyperparathyroidism**

- Asymptomatic hypercalcaemia (50%)
- Renal stones (28%)
- Polyuria, Polydipsia (5%)
- Peptic ulcer (4%)
- Hypertension (4%)
- Bone disease (3%)
- MEN 1 Syndrome (1%)

#### **Biochemical investigation**

- Primary hyperparathyroidism
- Increased corrected calcium
- Increased PTH - mid region and C terminal assays most sensitive
- 75% hypercalciuria
- 50% hypophosphataemia
- Mild hyperchloraemic acidosis

#### **Familial hypocalciuric hypercalcaemia**

- Autosomal dominant with high penetrance
- Accounts for less than 1% cases of hypercalcaemia
- Due to increased renal tubule absorption of calcium
- Urine Ca more than 2.5 nmol/day
- PTH normal
- It is a benign condition - parathyroid surgery not required



- Suspect if hypercalcaemia in several generations of a family
- Especially if member has had unsuccessful parathyroid surgery

#### Normocalcaemic hypercalciuria

- Due to increased absorption of Ca from gut or primary renal tubular leak
- No benefit from parathyroid surgery

#### Preoperative parathyroid localisation

- Opinion divided on preoperative localisation for primary surgery
- Some will undertake primary surgery without investigation

#### Ultrasound

- Operator dependent with variable accuracy
- Will not usually detect normal parathyroids
- Sensitivity up to 85% for abnormal glands
- Able to identify intra-thyroid parathyroid glands
- May miss deep or intra-thoracic glands

#### Computed tomography

- Equally as accurate as ultrasound
- Useful for identifying ectopic glands

#### Magnetic resonance imaging

- Role still being defined. Potentially most useful investigation
- T<sub>2</sub> sequences weighted images produce best resolution between adenoma and normal tissue
- Improve resolution with neck surface coils
- 85% lesions less than 0.5 cm detected

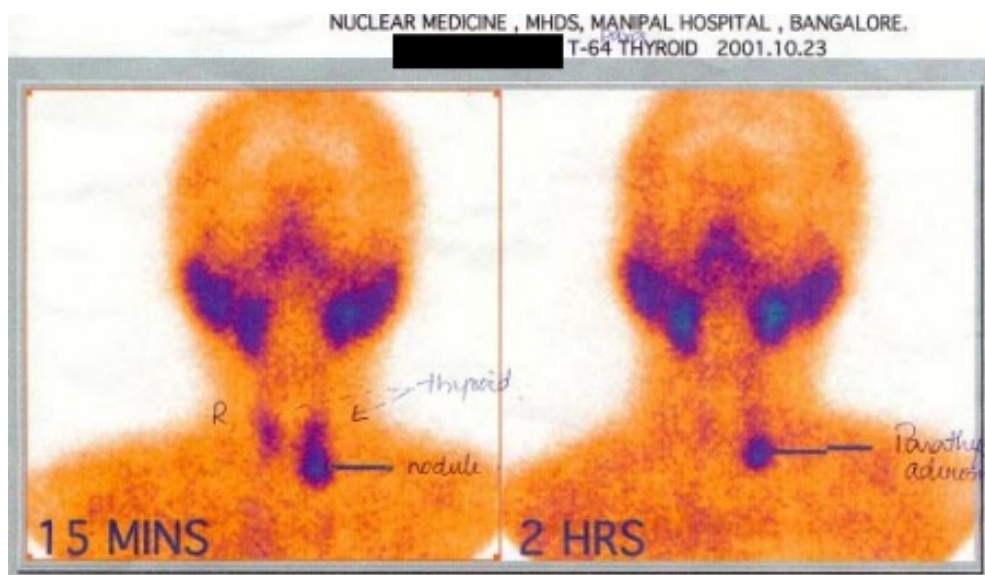


Figure 205 Thallium subtraction scintigraphic localisation of a parathyroid adenoma



### **Scintigraphy**

- Combined  $^{99}\text{Tc}$  (pertechnetate) and  $^{201}\text{Th}$  (thallium chloride) subtraction technique
- Thyroid gland take up  $^{99}\text{Tc}$  and  $^{201}\text{Th}$
- Parathyroids take up  $^{201}\text{Th}$
- Images subtracted leaving only parathyroid image
- Best single preoperative localisation technique
- Localises 85% of abnormal glands
- Specificity adversely affected by  $^{201}\text{Th}$  uptake in thyroid abnormalities (e.g. multinodular goitres, thyroid adenomas)

### **Preoperative methylene blue**

- 3.5 mg/kg body weight dissolved in 500 ml dextrose
- Infused over 1 hour preoperatively
- Selectively stains parathyroid glands
- Normal glands stain pale green
- Pathological glands stain dark blue or black

### **Selective venous catheterisation**

- Invasive procedure. Multiple samples from neck and mediastinal sites
- PTH double that of peripheral venous sample considered significant
- Lateralising rather than localising procedure
  - Adenoma - unilateral elevation
  - Hyperplasia - bilateral elevation
- Most use prior to re-exploration for recurrent disease

## **Surgical management of hyperparathyroidism**

### **Indications for surgery**

- Significant symptoms
- Corrected Ca more than 2.8 mmol/l
- Complications of hypercalcaemia
- The management of mild hypercalcaemia or asymptomatic patients is controversial

### **Operative procedure**

- Experienced parathyroid surgeon who can recognise normal gland, hyperplasia and adenoma
- Frozen section may be useful
- If adenoma and one normal gland - No further action
- If hyperplasia - Remove all 4 glands and transplant one into marked forearm site

## **Persistent or recurrent hyperparathyroidism**

### **Persistent hyperparathyroidism**

- Hypercalcaemia within 6 months of initial surgery
- Usually due to missed adenoma

### **Recurrent hyperparathyroidism**

- Hypercalcaemia more than 6 months after initial surgery with a intervening period of normocalcaemia
- Usually inadequate surgery for hyperplasia
- Consider MEN syndromes



- Review histology and recheck serum Ca
- Offer surgery if Ca > 3 mmol/l
- Preoperative localisation essential
- Recurrent parathyroid surgery has a
  - Higher morbidity
  - Greater chance of failure

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## Adrenal disorders

### Adrenal incidentalomas

- Adrenal masses discovered during imaging for non-adrenal related causes
- Commonest adrenal 'disorder'
- Found during 1-5% of abdominal CT scans
- 5-10% patients have non-functioning adrenal masses found at postmortem examination
- Male to female ratio is equal
- Most incidentalomas are benign and hormonally inactive
- Few patients require adrenalectomy
- Diagnostic assessment needs to evaluate:
  - Is the lesion hormonally active?
  - Is the lesion malignant?

Table 49 Differential diagnosis in absence of prior malignancy

Diagnosis	Percentage
Non-functioning cortical adenoma	55
Cortisol producing adenoma	8
Aldosteronoma	2
Adrenal carcinoma	5
Phaeochromocytoma	5
Metastases	20
Other (e.g. cyst, myelolipoma)	5

### Adrenal metastases

- Adrenal gland is a common site for metastases
- Common primary sites are breast, lung, renal, melanoma, lymphoma
- Often bilateral
- If prior history of carcinoma then 10-40% of adrenal masses will be metastases
- Risk of malignancy increases with size
- Most malignant adrenal lesions are greater than 5 cm in diameter

### Assessment of adrenal incidentalomas

- Assessment of function requires:
  - Plasma dihydroepiandrosterone
  - 24 hour urinary catecholamines and metanephrines
  - Low dose dexamethasone suppression test
  - Serum ACTH
- If hypertension and hypokalaemia - standing serum aldosterone to renin ratio
- Assessment of risk of malignancy requires:
  - CT or MRI scanning
  - On CT malignant lesions are irregular non-homogeneous and have high attenuation
  - On MRI malignant lesions have bright intensity on T2 weighed images
- CT guided cytology may be useful
- Need to exclude phaeochromocytoma prior to this procedure





### Management of adrenal incidentalomas

- If lesion is functioning patient requires adrenalectomy
- Can be performed as either an open or laparoscopic procedure
- Malignant lesions are best managed by open surgery
- If non-functioning treatment depends on:
  - Size
  - Risk of malignancy
- If > 5 cm or imaging suggests malignancy consider surgery
- If < 5 cm or benign repeat CT at 3-6 months

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## **Cushing's syndrome**

- Cushing's syndrome results from cortisol excess
- Commonest cause is iatrogenic from the use of exogenous steroid medication
- Cushing's disease has an incidence of 1 per 100,000 per year
- Female : male ratio is 5:1
- Peak incidence 30 to 50 years

### **Aetiology**

#### **Primary adrenal disease (20%)**

- Adrenal adenoma
- Adrenal carcinoma
- Adrenal cortical hyperplasia

#### **Secondary adrenal disease**

- Cushing's disease = Due to ACTH secreting pituitary microadenoma (70%)
- Ectopic ACTH production from a malignancy (10%)
  - Small cell carcinoma of the lung
  - Carcinoid tumours
  - Medullary carcinoma of the thyroid

#### **Pseudo-Cushing's syndrome**

- Major depressive illness
- Alcohol excess



Figure 206 Facial features of Cushing's syndrome



Table 50 Clinical features of Cushing's syndrome

Symptoms	Signs
Weight gain	Truncal obesity
Menstrual irregularity	Plethora
Hirsutism in women	'Moon' face
Headache	Hypertension
Thirst	Bruising
Back pain	Striae
Muscle weakness	Buffalo hump
Abdominal pain	Acne
Lethargy / depression	Osteoporosis

### Investigation

- The clinical picture often does not identify cause of Cushing's syndrome
- Investigations are aimed at:
  - A biochemical confirmation of the diagnosis of Cushing's syndrome
  - Identifying the site of the pathological lesion - adrenal, pituitary, ectopic production
  - Identifying the nature of the pathology

### Diagnosis can be confirmed by:

- Increased 24 hour urinary free cortisol
- Loss of diurnal rhythm of serum cortisol
- Failure of suppression of serum cortisol with low dose (0.5 mg) dexamethasone
- Increased salivary cortisol

### Anatomical site of lesion identified by:

- Serum ACTH
  - Low in adrenal disease
  - High in pituitary and ectopic production
- CRH test
  - Increased ACTH following CRH in pituitary disease
  - No increase in ACTH following CRH in ectopic production
- High-dose dexamethasone suppression test (2 mg qds for 2 days)
- Reduced serum cortisol in pituitary disease
- Suppression of urinary free cortisol to less than 10% baseline

### Identifying the pathological lesion

- Pituitary CT has a sensitivity of ~50% for identifying microadenomas
- MRI has increased sensitivity but is not 100% predictive
- If diagnostic doubt need bilateral inferior petrosal sinus sampling for ACTH
- Abdominal CT will allow identification of adrenal pathology
- Somatostatin scintigraphy may identify sites of ectopic hormone production

### Management

- Cushing's disease is best managed by transphenoidal microadenectomy
- Success rate is approximately 90%
- Large tumours occasional require open surgery via the anterior fossa
- Post-operative radiotherapy occasionally required
- If pituitary surgery fails need to consider bilateral adrenalectomy



- Requires postoperative mineralocorticoid and glucocorticoid replacement
- Approximately 25% patients undergoing bilateral adrenalectomy develop Nelson's syndrome
- Adrenal adenomas require adrenalectomy
- Performed either laparoscopically or via open surgery
- Open surgery can be performed via a transabdominal or retroperitoneal approach

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## Conn's syndrome

- Aldosteronism - excess secretion of aldosterone - can be:
  - Primary - due to primary pathology of the adrenal gland
  - Secondary - due to reduced plasma volume and increased angiotensin production
- Due to cirrhosis, nephrotic syndrome or cardiac failure
- Conn's syndrome is primary hyperaldosteronism
- Due to:
  - Aldosterone producing adenoma (50%)
  - Bilateral idiopathic hyperplasia - idiopathic hyperaldosteronism (40%)
  - Aldosterone secreting carcinoma

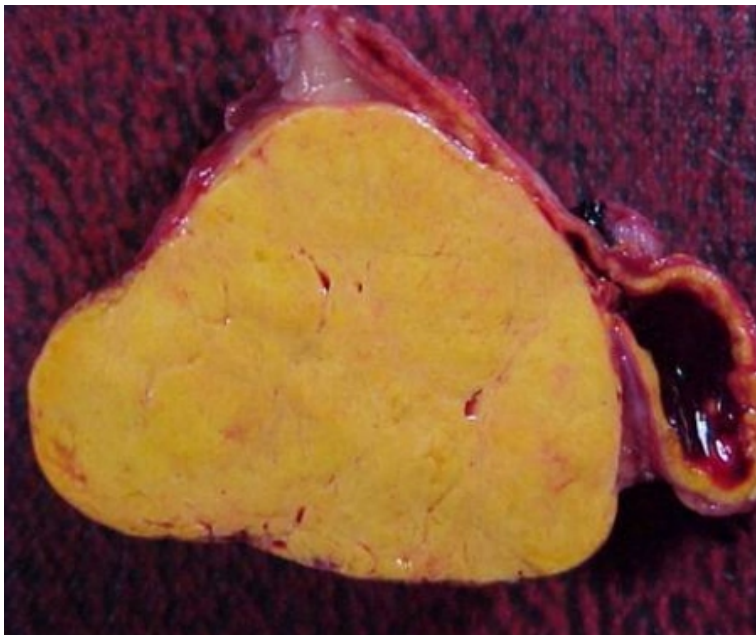


Figure 207 Adrenal adenoma

### Pathophysiology

- Aldosterone is produced by the zona glomerulosa of the adrenal cortex
- Acts on distal convoluted tubule to increase sodium reabsorption
- Sodium reabsorption occurs at the expense of potassium and hydrogen ion loss

### Clinical presentation

- Usually occurs between 30 and 60 years
- Conn's syndrome accounts for 1% of cases of hypertension
- Hypertension often responds poorly to treatment
- Biochemically there is usually a hypokalaemic alkalosis
- It should be noted that serum potassium may be normal



### Investigation

- Investigations need to:
  - Confirm primary hyperaldosteronism
  - Localise pathology
- If there is an adrenal mass is producing aldosterone
- Diagnosis depend on demonstration of
  - Reduced serum potassium
  - Increased urinary potassium excretion
  - Increased plasma aldosterone
- CT is able to demonstrate 80% of adrenal adenomas
- MRI has a similar sensitivity
- Assessment of function may require isotope (NP59) scanning or renal vein sampling for aldosterone

### Treatment

- If adrenal adenoma demonstrated - adrenalectomy is treatment of choice
- Requires preoperative spironolactone to increase serum potassium
- Blood pressure returns to normal in 70% of patients
- Hypertension associated with bilateral idiopathic hyperplasia is difficult to control
- Spironolactone alone or with an ACE inhibitor is often useful

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## Phaeochromocytomas

- Phaeochromocytomas are neuroendocrine tumours of the adrenal medulla
  - 10% multiple
  - 10% extra-adrenal
  - 10% malignant
- Extra-adrenal tumours are called paraganglionomas
- Most secrete adrenaline
- Some secrete noradrenaline and dopamine
- Clinical effects are due catecholamine excess

### Clinical features

- Phaeochromocytomas account for 0.1% cases of hypertension
- Symptoms are often sporadic and paroxysmal
- Attacks may last minutes or hours and occur at variable intervals
- Include hypertension, palpitations, tachycardia and sweating
- 50% of patients develop chest pain
- Chronic effects include hypovolaemia and cardiomyopathy
- Phaeochromocytomas can be associated with
  - Multiple endocrine neoplasia syndrome (Type 2)
  - Neurofibromatosis
  - Von Hippel Lindau syndrome

### Investigations

- To confirm diagnosis need to demonstrate catecholamine excess with
  - 24-hour urinary vanillyl mandelic acid (VMA)
  - 24-hour urinary total catecholamines
  - Serum adrenaline or noradrenaline
- Tumour can be localised with:
  - Abdominal CT
  - MIBG (meta-iodobenzylguanidine) scanning

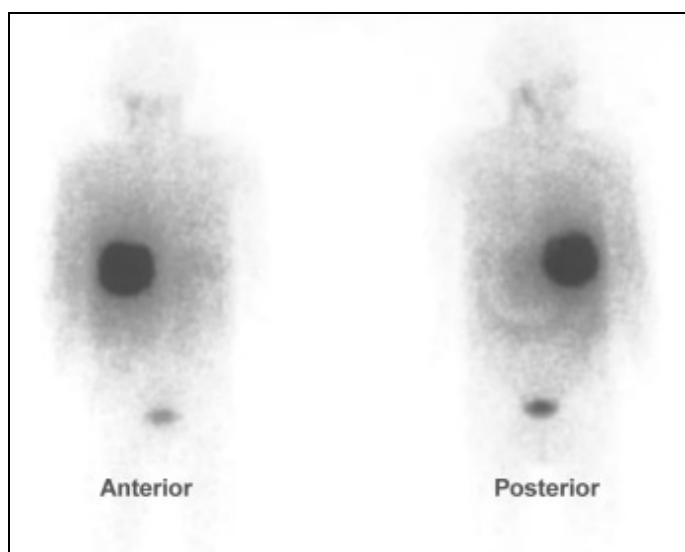


Figure 208 Phaeochromocytoma demonstrated on MIBG scanning



Figure 209 Paraganglionoma demonstrated on MRI scan

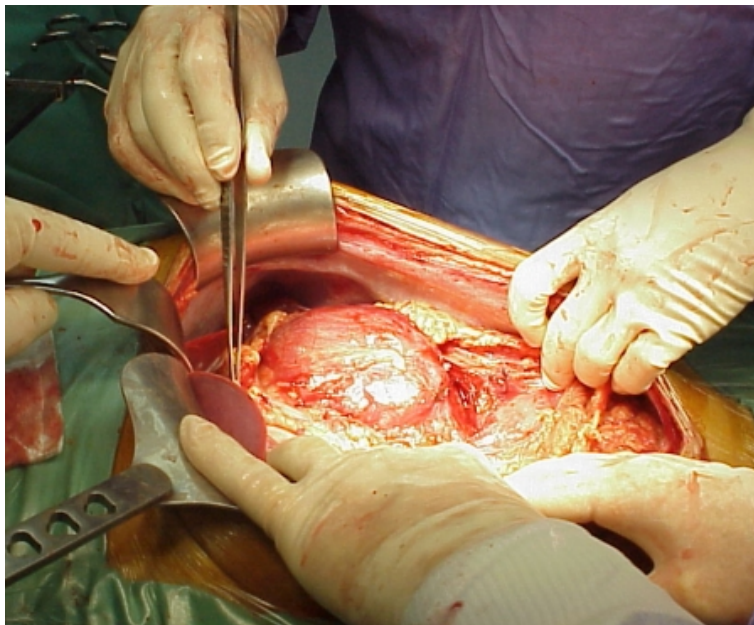


Figure 210 Intraoperative appearance of a paraganglionoma





### Management

- Clinical features can not be controlled pharmacologically
- Need adrenalectomy after appropriate preoperative preparation
- Requires close cooperation between surgeon and anaesthetist
- Preoperative preparation requires:
  - $\alpha$ -blockade with phenoxybenzamine for at least 2 weeks preoperatively
  - Volume expansion with intravenous fluids
  - May need  $\beta$ -blockade after  $\alpha$ -blockade
  - $\beta$ -blockade without  $\alpha$ -blockade can cause a hypertensive crisis
- Intraoperative problems include:
  - Hypertension associated with handling of the tumour
  - Hypotension following devascularisation of the tumour
  - Intraoperative blood pressure control achieved with fluids, nitroprusside and dopamine infusions

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## **Multiple endocrine neoplasia syndromes**

### **MEN 1 Syndrome (Wermer's Syndrome)**

- Hyperparathyroidism (90%)
- Pancreatic islet cell tumours (60%)
  - Gastrinoma (60%)
  - Insulinoma(10%)
  - Vipoma
  - PPoma
  - Glucagonoma
- Pituitary tumours (5%)
  - Prolactinoma
  - GH, ACTH, TSH secreting tumours
- Thyroid adenoma
- Adrenal adenoma
- Carcinoid tumours

### **MEN 2a Syndrome (Sipple's Syndrome)**

- Medullary thyroid carcinoma (100%)
- Pheochromocytoma (50%)
- Hyperparathyroidism (10%)

### **MEN 2b Syndrome**

- Medullary thyroid carcinoma (100%)
- Pheochromocytoma (50%)
- Multiple mucosal neuromas (100%)
- Ganglioneuromatosis of the gut (100%)
- Marfanoid appearance (100%)

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## ***Carcinoid tumours***

- Carcinoid tumours are rare neuroendocrine lesions
- Arise from amine precursor uptake and decarboxylation (APUD) cells
- Approximately 1,000 are identified in the United Kingdom each year
- Most primary tumours arise from the gastrointestinal tract
- Commonest sites of primary tumours are appendix (30%), small bowel (20%)
- Foregut tumours produce little 5HIAA - often produce other hormones (e.g. gastrin)
- Midgut and hindgut tumours produce increased amounts of 5HIAA
- When metastasis to liver these tumours produce the carcinoid syndrome

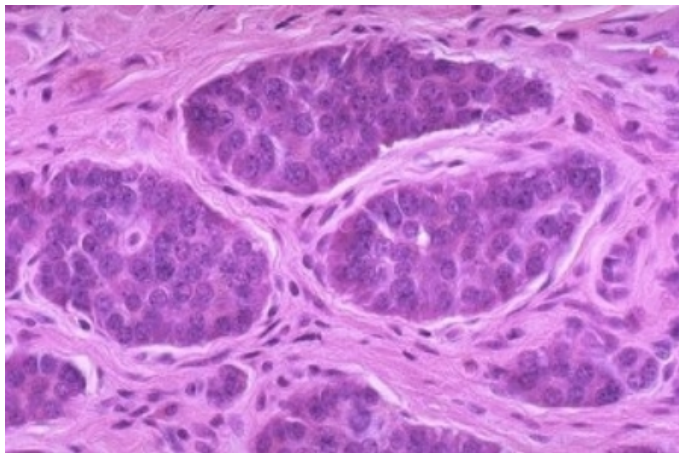


Figure 211 Carcinoid tumour

## ***Clinical features***

- Carcinoid tumours produce vague right-sided abdominal discomfort
- Symptoms have often been present for a number of years prior to diagnosis
- Previous investigations have often been normal
- Diagnosis is often only made after urgent surgery - usually due to obstruction

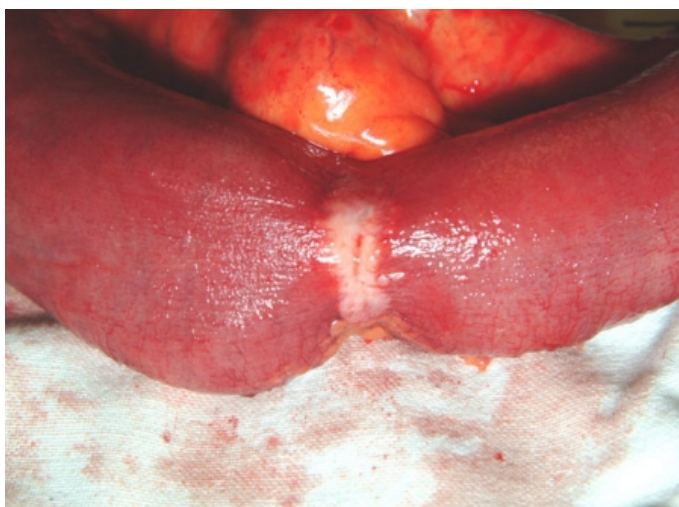


Figure 212 Small bowel carcinoid tumour



- In those with carcinoid syndrome symptoms include diarrhoea and flushing
- Flushing affects face and neck lasting only several minutes
- Often precipitated by alcohol or chocolate
- May be associated with palpitations or hypotension
- Examination is often normal
- A right-sided abdominal mass or hepatomegaly may be present
- Other features include telangiectasia, pellagra, tricuspid regurgitation.
- Sclerotic bone secondaries occasionally occur



Figure 213 Facial flushing associated with carcinoid syndrome



Figure 214 Appendiceal carcinoid tumour

### ***Investigation***

- Diagnosis confirmed by increased 24-hour urinary 5HIAA excretion
- Plasma chromogranin A may be increased
- Radiological investigations are rarely helpful



- Ultrasound may demonstrate an abdominal mass or liver secondaries
- <sup>111</sup>In - octreotide scintigraphy may identify primary or secondary tumour

#### **Treatment**

- Diagnosis is often made after resection of primary tumour
- Symptomatic carcinoid syndrome can often be palliated by:
- Somatostatin analogues (e.g. octreotide)
- Embolisation of hepatic metastases

#### **Prognosis**

- Prognosis is better than for adenocarcinomas at similar sites
- For surgically resectable tumours 10-year survival rates of >60% have been reported

#### **Appendiceal carcinoid tumours**

- Most common tumour of the appendix
- Found in 0.5% of appendectomy specimens
- Accounts for 85% of all appendiceal tumours
- Usually an incidental finding found during appendectomy
- 75% occur at the tip, 15% in the middle and 10% at the base of the appendix
- 80% are less than 1 cm in diameter
- Only 5% are greater than 2 cm in diameter
- Locoregional spread or metastases are rare especially if tumour is less than 2cm
- Appendectomy is adequate if tumour less than 1 cm
- Right hemicolectomy needed if tumour greater than 1 cm
- Prognosis is good with 5-year survival of 90-100%

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## Secondary hypertension

- Hypertension affects 10 - 20% of adult population
- Defined as
  - Diastolic blood pressure greater than 95 mmHg
  - Systolic blood pressure greater than 160 mmHg
- Associated with increased risk of:
- Ischaemic heart disease
  - Stroke
  - Peripheral vascular disease
  - Renal dysfunction
- In 90% cases not cause is found (essential hypertension)
- In 10% cases an underlying abnormality is identified (secondary hypertension)

### Causes of secondary hypertension

- Renal disease
  - Renal artery stenosis
  - Glomerulonephritis
  - Pyelonephritis
  - Interstitial nephritis
  - Obstructive nephropathy
  - Polycystic disease
  - Obstructive uropathy
- Adrenal disease
  - Primary aldosteronism
  - Cushing's syndrome
  - Pheochromocytoma
- Drug induced
  - Oral contraceptives
  - Corticosteroids
  - Sympathomimetics
- Other causes
  - Coarctation of the aorta
  - Pre-eclampsia
  - Raised intracranial pressure

### Renal artery stenosis

- 70% cases are due to atherosclerosis
- 20% cases due to fibromuscular dysplasia
- Accounts for about 2% of all cases of hypertension
- Suspect renovascular cause of hypertension if:
  - Severe hypertension (diastolic pressure greater than 125 mmHg)
  - Patients with pulmonary oedema
  - Patients with generalised atherosclerosis
  - The elderly
  - The very young
- Diagnosis can be confirmed by:
  - Duplex ultrasound
  - Digital subtraction angiography
  - Increased serum renin levels



- Renal isotope scan

### Management

- Initial management should be pharmacological
- If blood pressure is well controlled with drugs no further intervention is required
- In young patient or those with poorly controlled blood pressure consider:
  - Percutaneous transluminal angioplasty
  - Renal stenting
  - Renal artery endarterectomy
  - Aortorenal bypass graft
- Best results seen in those with fibromuscular dysplasia

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## Arterial diseases

### *Assessment of arterial disease*

#### Clinical Assessment

##### *Claudication*

- Calf or thigh pain precipitated by exercise
- Usually occurs after predictable distance
- Described as 'cramp' or 'tightness'
- Relieved by rest
- Progression of symptoms is important - worsening or improvement
- Impact on social function should be identified
- Need to differentiate from spinal stenosis
- Also cause exercise induced leg pain
- Usually associated with neurological symptoms and relieved by spinal flexion
- Peripheral pulses can be present in patients with intermittent claudication

##### *Critical limb ischaemia*

- Characterised by rest pain
- Occurs when foot is elevated (e.g. in bed)
- Improved with foot dependent
- May be associated with ulceration or gangrene
- Foot pulses are invariably absent

#### Non-invasive testing of arterial patency

- Arterial investigations are used to:
- Confirm the clinical impression of arterial disease
- Assess disease severity
- Preoperative planning of surgical or radiological interventions

##### *Hand-held doppler*

- Reflection of an ultrasound wave off a stationary object does not change its frequency
- Reflection off a moving object results in a change of frequency
- The change in frequency is proportional to velocity or blood flow
- Hand held 8 MHz doppler probe is used to assess arterial system
- Can be used to measure arterial pressures
- Measurements can be made at rest and after exercise
- In normal individual lower limb pressures are greater than upper limb
- Ankle-brachial pressure index (ratio of best foot systolic to brachial systolic pressure)
  - Normal >1.0
  - Claudication 0.4 -0.7
  - Critical Ischaemia 0.1-0.4
- In normal individuals pressures do not fall following exercise
- In claudicants the ABPI falls and recovery is delayed
- In diabetic lower limb pressures are falsely elevated due to calcification in the vessel wall



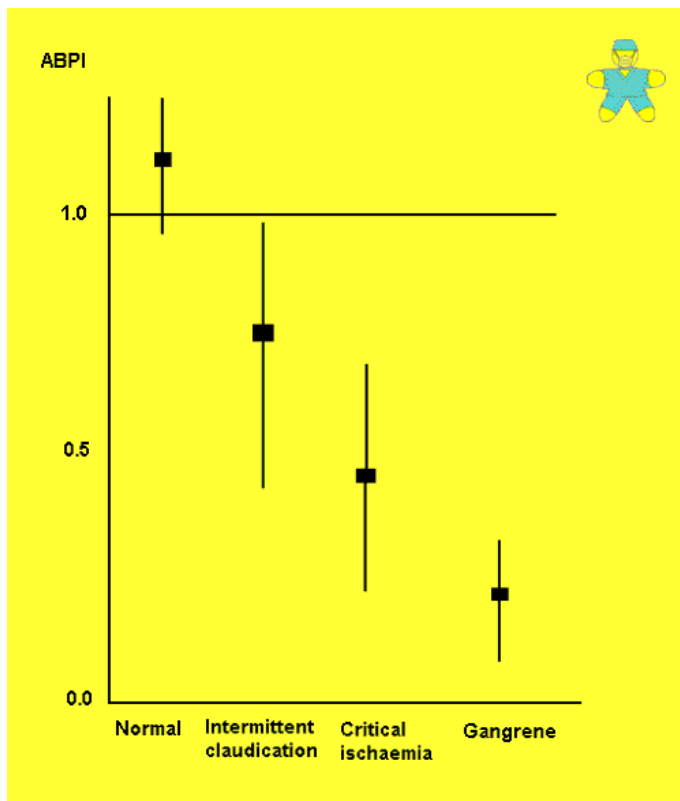


Figure 215 Relationship of clinical features to the ABPI

### **Toe pressures**

- Provides accurate assessment of distal circulation
- Not influenced by calcification in pedal vessels
- Medical calcification particularly seen in diabetics
- Normal toe pressures are 90-100 mmHg
- Toe pressure less than 30 mmHg suggests critical limb ischaemia

### **Duplex ultrasound**

- Combined pulsed doppler and real time B mode ultrasound
- Allows imaging of vessels and any stenotic lesion
- Flow and pressure wave form can be also be assessed
- In normal individuals a 'triphasic' wave is obtained
- Rapid antegrade flow during systole
- Transient reverse flow in early diastole
- Slow antegrade flow in late diastole
- An arterial stenosis results in the following distal to the lesion:
- Decreased rate of rise of the antegrade flow
- A reduced amplitude of the forward velocity
- Loss of reverse flow (i.e. a 'biphasic' wave form)
- At the stenosis velocity is increased
- Severe stenosis results in a monophasic wave form
- Duplex ultrasound has sensitivity of 80% and specificity of 90% for stenotic lesions in the femoral and popliteal segments

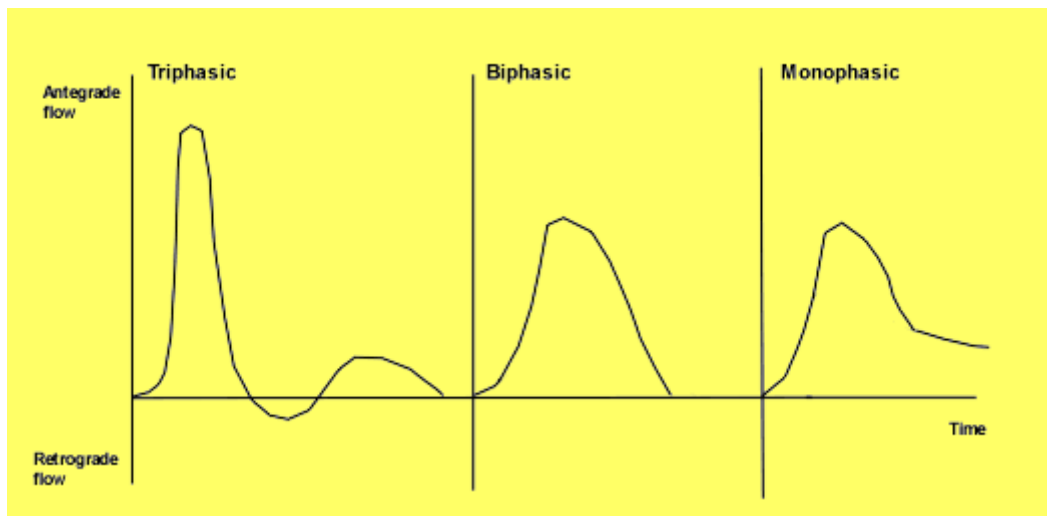


Figure 216 Doppler wave forms from normal and diseased arteries

#### ***Pulse generated run off***

- Proximal occlusion often causes poor filling of distal vessels on arteriography
- Rapid cycling of a proximal cuff generates arterial pulse wave
- PGR allows functional testing of distal arterial patency

#### ***Magnetic resonance angiography***

- Time of flight sequences
- No contrast required

#### ***Invasive vascular assessment***

##### ***Angiography***

- Usually performed using digital subtraction techniques
- Catheter inserted using Seldinger technique
- Femoral artery is commonest site of venous access
- Generally safe procedure performed under local anaesthetic
- Potential complications include:
  - Contrast-related
    - Anaphylactic reaction
    - Toxic reactions
    - Deterioration in renal function
  - Technique-related
    - Haematoma
    - Arterial spasm
    - Sub-intimal dissection
    - False aneurysm
    - Arteriovenous fistula
    - Embolisation
    - Infection



### **CT angiography**

- Required intravenous contrast and ionising radiation
- Spiral CT and reconstruction can provide detailed images
- Particularly useful for the assessment of aneurysmal disease

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## **Peripheral vascular disease**

### **Intermittent claudication**

#### **Epidemiology of claudication**

- 5% of males older than 50 years have intermittent claudication
- 5% of claudicants progress to critical ischaemia each year
- 75% of patients remain stable or show clinical improvement
- Peripheral vascular disease is an independent risk factor for cardiovascular disease
- At 5 years of follow-up
  - 10% claudicants and 50% of those with critical ischaemia have had an amputation
  - 20% claudicants and 50% have died usually from ischaemic heart disease

#### **Assessment of claudication**

- History to assess disability associated with symptoms
- Exclude rest pain or tissue loss
- Doppler studies to measure pressures and assess wave forms

#### **Management of claudication**

- Risk factor reduction
- Stop smoking - arrests disease progression
- Lipid-lowering drugs
- Anti-platelet medication
- Good diabetic control if appropriate
- Regular exercise - as part of supervised exercise program
- Lose weight

### **Critical limb ischaemia**

#### **European Working Group on Critical Leg Ischaemia (1991)**

- ' Persistently recurring ischaemic rest pain requiring regular adequate analgesia for more than 2 weeks, or ulceration or gangrene of the foot or toes, with an ankle pressure of <50 mmHg or toe pressures of <30 mmHg '

#### **Indications for operative intervention in peripheral vascular disease**

- Disabling claudication or critical limb ischaemia
- Arteriography is essentially a preoperative investigation
- Arteriography is not required in the routine assessment of claudication
- Two options are:
  - Percutaneous angioplasty
  - Bypass surgery

#### **Percutaneous transluminal angioplasty**

- Angioplasty of the aorto-iliac segment has a 90% 5 year patency
- Angioplasty of the infra-inguinal vessels has a 70% 5 year patency
- Best results seen with short segment stenoses less than 2 cm long



- Complications occur in less than 2% of patients and include:
  - Wound haematoma
  - Acute thrombosis
  - Distal embolisation
  - Arterial wall rupture

### **Bypass surgery**

- Types of bypass graft include

#### **Biological grafts**

- Autografts
- Long saphenous vein - insitu or reversed
- Internal mammary artery
- Allografts
- Dacron coated umbilical vein

#### **Synthetic grafts**

- Dacron
- Woven or knitted +/- albumin coated
- Woven grafts
- Smaller pores. No preclotting required
- Velour
- Polyfluorotetraethylene (PTFE)

#### **Choice of graft material**

- Determined by long term patency rates
- Autologous vein is best graft material but not always available
- Interposition of vein between PTFE graft and artery at distal anastomosis can improve long term patency
- Vein often fashioned as either Miller cuff or Taylor patch

Table 51 Comparative three year patency of vein and synthetic grafts

	<b>Vein Graft</b>	<b>PTFE</b>
Above Knee Anastomosis	85-90%	75-80%
Below Knee Anastomosis	70-75%	<50%

- Reasons for graft failure
  - Less than 30 days - technical failure
  - 30 days to 1 years - neointimal hyperplasia at distal anastomosis
  - More than 1 years - progression of distal disease



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### **Acute limb ischaemia**

- Effects of sudden arterial occlusion depends on state of collateral supply
- Collateral supply in leg usually inadequate unless pre-existing occlusive disease

### **Aetiology of acute limb ischaemia**

#### **Embolism**

- Left atrium in patients in atrial fibrillation
- Mural thrombus after myocardial infarct
- Prosthetic and diseased heart valves
- Aneurysm or atheromatous stenosis
- Tumour, foreign body, paradoxical

#### **Thrombosis**

#### **Other**

- Trauma
- Dissecting aneurysm
- Raynaud's Syndrome



Figure 217 Acute ischaemia due to intra-arterial temazepam injection

### **Clinical features of limb ischaemia**

- Clinical diagnosis depends on the 6 'p's
  - Pain
  - Paraesthesia
  - Pallor
  - Pulselessness
  - Paralysis
  - Perishing with cold



- Fixed staining is a late sign
- Objective sensory loss requires urgent treatment
- Need to differentiate embolism from thrombosis
- Important clinical features include:
  - Rapidity of onset of symptoms
  - Features of pre-existing chronic arterial disease
  - Potential source of embolus
  - State of pedal pulses in contralateral leg

### Management of acute ischaemia

#### Initial

- Heparinise & analgesia
- Treat associated cardiac disease
- Treatment options are:
  - Embolic disease - embolectomy or intra-arterial thrombolysis
  - Thrombotic disease - intra-arterial thrombolysis / angioplasty or bypass surgery

#### Emergency embolectomy

- Can be performed under either general or local anaesthesia
- Display and control arteries with slings
- Transverse arteriotomy performed over common femoral artery
- Fogarty balloon embolectomy catheters used to retrieve thrombus
- If embolectomy fails - on-table angiogram and consider
- Bypass graft or intraoperative thrombolysis



Figure 218 Thrombectomy specimen





### ***Intra-arterial thrombolysis***

- Arteriogram and catheter advanced into thrombus
- Streptokinase 5000u/hr + heparin 250u/hr
- Alternative thrombolytic agents include Urokinase or tissue plasminogen activator (tPA)
- Repeat arteriogram at 6 -12 hours
- Advance catheter and continue thrombolysis for 48 hours or until clot lysis
- Angioplasty of chronic arterial stenosis may be necessary
- Success 60-70% but needs careful case selection
- Not suitable if severe neuro-sensory deficit
- Thrombolysis can be accelerated by
  - Pulse spray through multiple side hole catheter
  - Aspiration thrombectomy - debulking thrombus aspiration
  - High dose over shorter time

### ***Complications of Thrombolysis***

- Mortality of 1-2%
- Bleeding - CVA, retroperitoneal

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### Diabetic foot

- Foot problems are common in type-1 and type-2 diabetics
- 20-40% of diabetics have peripheral neuropathy
- Many also have features of peripheral vascular disease
- 15% of diabetics develop foot ulceration
- Diabetes is the leading cause of non-traumatic lower limb amputation



Figure 219 A diabetic foot

### Pathophysiology

- The diabetic foot results from a combination of neuropathy and ischaemia
- Neuropathy has sensory, motor and autonomic components
- Sensory loss results in loss of protective sensation and unnoticed foot injuries
- Loss of motor control to the small muscles of the feet results in a claw foot deformity
- Autonomic neuropathy leads to vasomotor denervation and arteriovenous shunting
- This compromises the ability to direct blood flow to the capillary beds
- Ischaemia can affect both the large and small vessels
- Large vessels disease results in atheroma of the femoral, popliteal and tibial vessels
- Small vessel disease affects the microcirculation
- Other contributing factors include:
  - Poor vision
  - Limited joint mobility
  - Cerebrovascular disease
  - Peripheral oedema
- In patients with foot ulceration healing is impaired
- This results from:
  - Impaired fibroblast function
  - Deficiency in growth factors
  - Abnormalities of the extracellular matrix

### Management

- Prevention of complications is preferable to the need for active management
- Patients should be monitored and self-care encouraged



- They should be educated about:
  - Washing
  - Care of cores and calluses
  - Toenail cutting
  - Suitable footwear
- In those with ulceration assessment should be made of:
  - Infection
  - Vascular insufficiency

#### **Management of infection**

- Wound swabs often show both gram-negative, gram-positive and anaerobic bacteria
- Osteomyelitis if usually due to Staph. aureus
- Plain radiography or MRI may demonstrate the extent of the infection
- The threshold for antibiotic use should be low
- The antibiotics used should be based on culture sensitivities
- Surgery may be required if progression despite antibiotic treatment

#### **Management of vascular insufficiency**

- All patients with diabetic ulceration should undergo non-invasive vascular assessment
- The ABPI should be calculated
- This may be falsely elevated due to arterial calcification
- Normal values may still be recorded in diabetics with significant major vascular disease
- Revascularisation should be considered if arterial insufficiency is present
- Diabetics have a predisposition for disease in medium-sized vessels especially at the popliteal trifurcation
- The distal pedal vessels are often spared
- Femoro-distal bypass grafting may be required

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### **Abdominal aortic aneurysms**

- An AAA is an increase in aortic diameter by greater than 50% of normal
- Usually regarded as aortic diameter of greater than 3 cm diameter
- More prevalent in elderly men
- Male : female ratio is 4:1

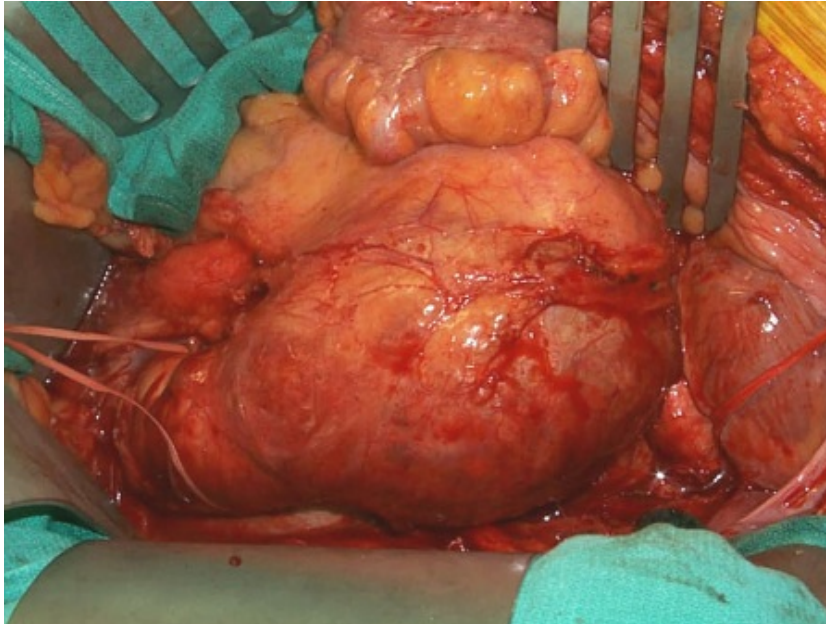


Figure 220 Abdominal aortic aneurysm

- Risk factors
  - Hypertension
  - Peripheral vascular disease
  - Family history
- Accounts for 2% male deaths above the age of 55 years
- 3000 elective and 1,500 emergency operations in UK each year
- Mortality of emergency operation is greater than 50%
- Mortality of elective surgery is less than 5%
- Selection of patients for operation depends on risk of operation vs. risk of rupture

#### **Natural history**

- AAA diameter expands exponentially at approximately 10% per year
- Risk of rupture increases as aneurysm expands
- 5 year risk of rupture:
  - 5.0 to 5.9 cm is 25%
  - 6.0 to 6.9 cm is 35%
  - More than 7 cm is 75%
- Overall only 15% aneurysms ever rupture
- 85% of patients with a AAA die from an unrelated cause

#### **Screening**

- Suitable for screening as elective operation of asymptomatic aneurysms can reduce mortality associated with rupture



- Who should be screened?
- Probably males over 65 years - especially hypertensives
- Single US at 65 years reduces death from ruptured AAA by 70% in screened population
- Patients with small aneurysms should undergo regular surveillance
- Repeated ultrasound every 6 months

#### Clinical features

- 75% are asymptomatic
- Possible symptoms include:
  - Epigastric pain
  - Back pain
  - Malaise and weight loss (with inflammatory aneurysms)
- Rupture presents with
  - Sudden onset abdominal pain
  - Hypovolaemic shock
  - Pulsatile epigastric mass
- Rare presentations include
  - Distal embolic features
  - Aorto-caval fistula
  - Primary aorto-intestinal fistula

#### Indication for operation

- Rupture
- Symptomatic aneurysm
- Rapid expansion
- Asymptomatic more than 6 cm – exact lower limit controversial

#### *UK Small Aneurysm Trial*

- Randomised 1090 small aneurysms (4.0-5.5 cm) to operation or surveillance
- Showed no improvement in overall mortality for those offered early surgery
- Similar results obtained in US Aneurysm Detection and Management Study

#### Pre-operative investigation

- Need to determine
  - Extent of aneurysm
  - Fitness for operation
- Ultrasound, conventional CT and more recently spiral CT
- Imaging determines:
  - Aneurysm size
  - Relation to renal arteries
  - Involvement of iliac vessels
- Most significant post op morbidity and mortality related to cardiac disease
- If pre-operative symptoms of cardiac disease need cardiological opinion
- Thallium scan may be required
- Cardiac catheterisation with a view to revascularisation required in up to 10% patients

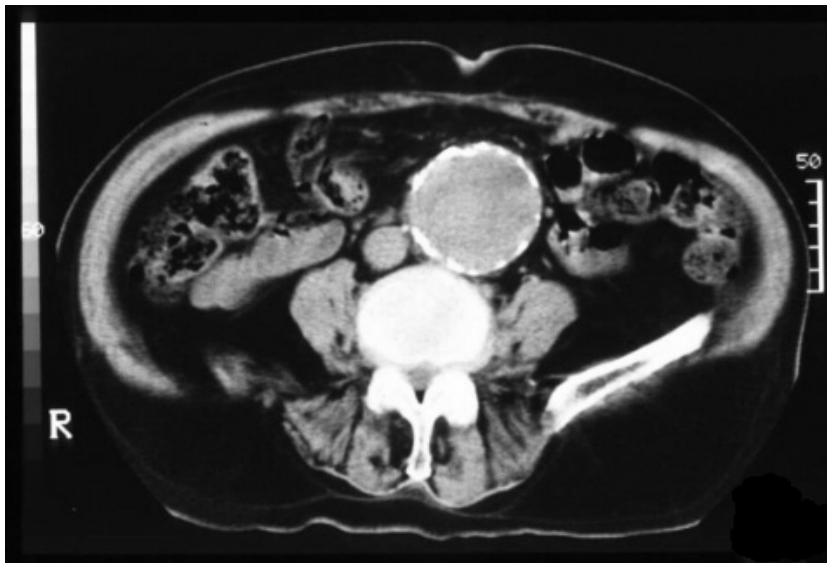


Figure 221 CT scan showing infrarenal abdominal aortic aneurysm

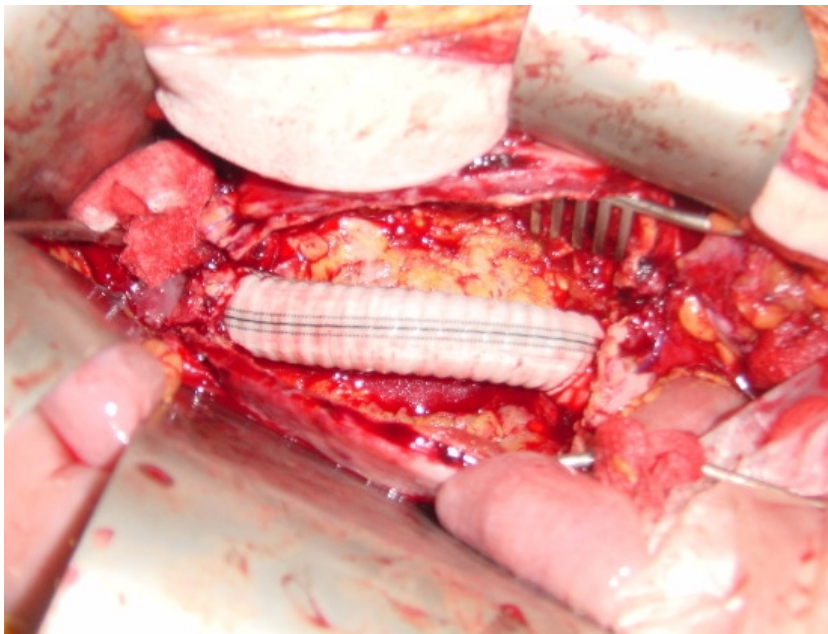


Figure 222 Straight Dacron aortic graft in-situ

### Endovascular aneurysm repair

- Introduced into clinical practice with few clinical trials over the past 10 years
- Exact role unclear and medium and late-complications only recently recognised
- Morbidity of conventional open aneurysm surgery related to:
  - Exposure of infra-renal aorta
  - Cross clamping of aorta
- Endovascular repair may be associated with:
  - Reduced physiological stress
  - Reduced morbidity
  - Reduced mortality



### Technique

- Endovascular repair achieved by transfemoral or transiliac placement of prosthetic graft
- Proximal and distal cuffs / stents anchor graft
- Exclude aneurysm from circulation
- Three main types of graft:
  - Aorto-aortic
  - Bifurcated aorto-iliac
  - Aorto-uniliac graft with femoro-femoral crossover and contralateral iliac occlusion
- Use of technique depends on aneurysm morphology
- Aneurysm morphology is best assessed with spiral CT
- Only about 40% of aneurysms suitable for this type of repair
- Aorto-aortic grafts less frequently used due to high complication rate
- Successful stenting associated with reduced aneurysm expansion
- Still has 1% per year risk of aneurysm rupture

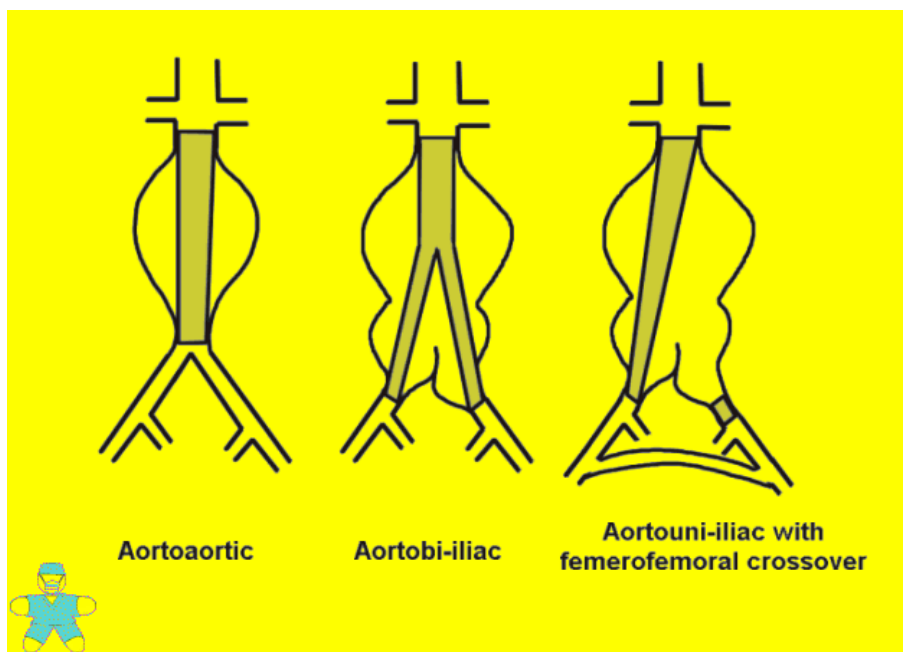


Figure 223 Endovascular aneurysm repair

### Complications

- Graft migration
- Endovascular leak
- Graft kinking
- Graft occlusion

### Popliteal artery aneurysms

- Defined as a popliteal artery diameter greater than 2 cm
- Account for 80% of all peripheral aneurysms
- 50% are bilateral
- 50% are associated with an abdominal aortic aneurysm
- 50% are asymptomatic



- Symptomatic aneurysms present with features of:
  - Compression of adjacent structures (veins or nerves)
  - Rupture
  - Limb ischaemia due to emboli or acute thrombosis
- Treatment is by proximal and distal ligation
- Revascularisation of the leg with a femoropopliteal bypass
- With a symptomatic popliteal aneurysm 20% patients will undergo an amputation



Figure 224 Angiogram of a popliteal aneurysm





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### **Carotid artery disease**

- Atherosclerosis is most common at the bifurcation of the common carotid artery
- Stenosis of the internal carotid artery is a potentially treatable cause of:
  - Ischaemic stroke
  - Transient ischaemic attack
  - Retinal infarction
- A patient with an asymptomatic 50% carotid stenosis has 1-2% per year risk of a stroke
- The risk of stroke increases with the degree of stenosis
- Once stenosis has become symptomatic the risk of a stroke is further increased
- Once an ischaemic stroke has occurred the risk of further stroke is ~10% in the first year and ~5% in subsequent years

### **Assessment of stenosis**

- Carotid bruits are an unreliable guide to severity of stenosis
- May be absent in patients with severe stenosis

### **Duplex ultrasound**

- Doppler recordings allow assessment of flow at stenosis
- Ultrasound allows imaging of arterial anatomy

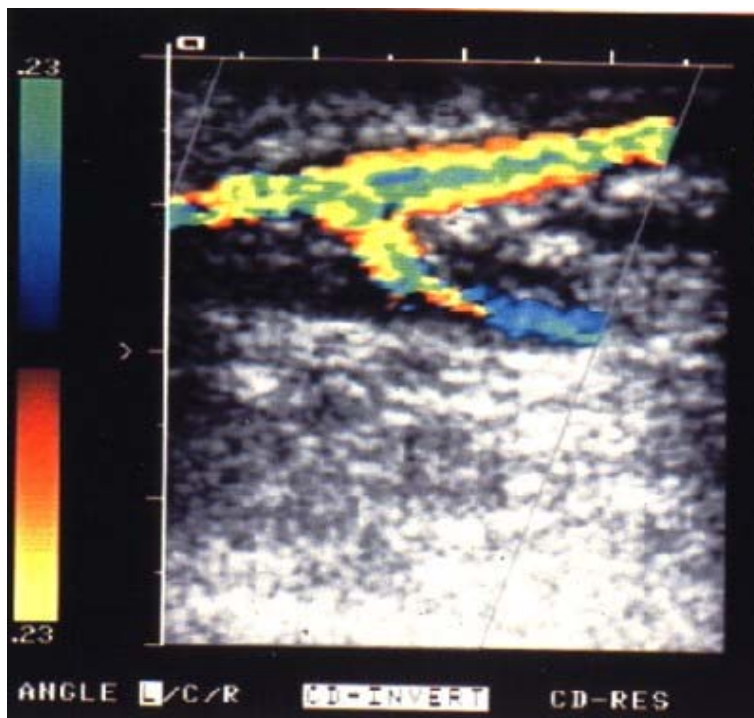


Figure 225 Colour flow doppler of carotid bifurcation

### **Carotid angiography**

- Intra-arterial angiography is the traditional method of assessing degree of stenosis
- 4% risk of inducing further neurological event
- 1% risk of permanent stroke



Figure 226 Carotid angiography showing left internal carotid stenosis

#### **Magnetic resonance angiography**

- An increasingly used non-invasive technique
- Some surgeons will operate on the basis of non-invasive assessments

#### **Medical management**

- Stop smoking
- Pharmacological treatment of hypertension and diabetes
- Prophylactic aspirin
  - Aspirin prevents 40 'vascular events' per 1000 patients treated for 3 years
  - It should be started at 175-150 mg daily once ischaemic stroke confirmed by CT
  - It should also be given to those with asymptomatic stenoses
  - The combination of aspirin and dipyridamole is no more effective than aspirin alone.

#### **Carotid endarterectomy**

#### **Surgery for asymptomatic stenosis**

#### **Asymptomatic Carotid Atherosclerosis Study**

- 1662 patients with more than 60% reduction in luminal diameter
- Randomised to either:
  - Endarterectomy + medical treatment (aspirin 300 mg)
  - Medical treatment alone
- Risk of ipsilateral stroke over 5 year period was reduced (5% vs. 11%) in surgery group
- 2.3% in surgery group had stroke within 30 days of surgery
- 0.4% in medical group had stroke in same time period
- Overall, benefit for those with asymptomatic stenosis but only the presence of a low perioperative complication rate.



### ***Asymptomatic Carotid Surgery Trial***

- 3120 patients with more than 60% reduction in luminal diameter
- Randomised to either immediate or deferred carotid surgery
- Risk of stroke within 30 days of surgery was 3.1%
- Risk of stroke over 5 year period was reduced (3.8% vs. 11%) in surgery group
- Results were similar to ACAS study

### ***Surgery for symptomatic stenosis***

- Two large trials have been published

### ***North American Symptomatic Carotid Endarterectomy Trial (NASCET)***

- Compared endarterectomy plus medical treatment in those patients with
- Non-disabling stroke in 4-6 months prior to surgery
- Severe (70-99%) ipsilateral stenosis
- The risk of stroke or death over 2 years was reduced (9% vs. 26%) in surgery group
- 5.8% randomised to surgery had stroke within 30 days
- Benefit also seen in those with >50% stenosis but not to same degree

### ***European Carotid Surgery Trial (ECST)***

- ECST risk of stroke or death over 3 years was reduced (12% vs. 22%) in surgery group
- 7.5% randomised to surgery had stroke or died within 30 days of operation
- In those with mild (0-30%) and moderate (30-60%) symptomatic stenoses there was benefit from surgery
- Overall, In those with symptomatic stenoses
- Best results are seen in those with more severe stenoses
- Benefit only seen in institutions with low perioperative stroke and death rate
- Surgery indicated in those with severe stenosis ( more than70%) that have recently become symptomatic
- Operation should be performed by experienced surgeon
- Centres should audit their results and have a perioperative stroke rate of less than 7%
- Angina and hypertension should be well controlled pre-operatively
- If patient selection poor or complication rate greater then there will be no overall benefit from surgery.

### ***Carotid angioplasty***

- Angioplasty and stenting is being increasingly used to dilate stenoses
- Without stenting re-stenosis often occurs
- The risk of distal embolisation can be reduced with embolisation reducing devices
- To date there have been no published randomised trials
- There are early encouraging results in high-risk patients



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## **Vascular trauma**

- Vascular trauma can result from either blunt or penetrating injury
- Penetrating injury is more common in the USA than Europe
- Pattern of injury differs according to the mechanism of injury
- Blunt vascular trauma is associated with an increased amputation rate
- Results from blunt injury being associated with significant fractures and tissue loss
- The diagnosis of blunt vascular trauma is often delayed

### **Types of vascular injury**

- Contusion
- Puncture
- Laceration
- Transection

### **Clinical features**

- Depends on site, mechanism and extent of injury
- Signs classically divided into 'hard' and 'soft' sign

#### **Hard signs of vascular injury**

- Absent pulses
- Bruit or palpable thrill
- Active haemorrhage
- Expanding haematoma
- Distal ischaemia

#### **Soft signs of vascular injury**

- Haematoma
- History of haemorrhage at scene of accident
- Unexplained hypotension
- Peripheral nerve deficit

### **Investigation**

- Hard signs often require urgent surgical exploration without prior investigation
- Arteriography should be considered:
- To confirm extent of injury in stable patient with equivocal signs
- To exclude injury in patient without hard signs but strong suspicion of vascular injury
- The role of doppler ultrasound in vascular trauma remains to be defined

### **Management**

- Often requires a multidisciplinary approach with orthopaedic and plastic surgeons
- Aims of surgery are to:
  - Control life-threatening haemorrhage
  - Prevent limb ischaemia
- If surgery is delayed more than 6 hours revascularisation is unlikely to be successful
- The use of arterial shunts is controversial
- May reduce ischaemic time and allow early fixation of fractures



### ***Vascular repair***

- Usually performed after gaining proximal control and wound debridement
- Options include :
  - Simple suture of puncture hole or laceration
  - Vein patch
  - Resection and end-to-end anastomosis
  - Interpositional graft
- Contralateral saphenous vein is the ideal Interpositional graft
- Prosthetic graft material may be used if poor vein or bilateral limb trauma

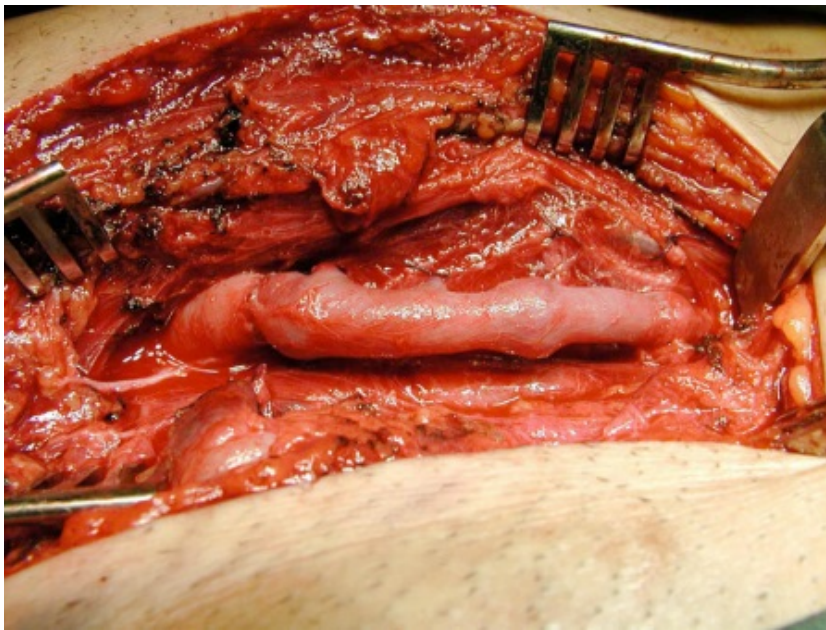


Figure 227 Interpositional vein graft

### ***Primary amputation***

- Usually considered in two situations
- Severe injury with significant risk of reperfusion injury
- The limb is likely to be painful and useless

### ***Complications of vascular injury***

#### ***False aneurysm***

- Most commonly occurs following catheterisation of femoral artery
- Often presents with pain, bruising and a pulsatile swelling
- Diagnosis can be confirmed by doppler ultrasound
- May respond to ultrasound guided compression therapy
- Suturing of puncture site may be required
- Vein patching may be required

#### ***Arteriovenous fistula***

- Often presents several weeks after the injury
- Patient complains of a swollen limb with dilated superficial veins
- Machinery type bruit often present throughout cardiac cycle



- Diagnosis can be confirmed by angiography
- Fistula can be divided and both the vein and artery sutured
- Flap of fascia can be interposed between vessels to reduce risk of recurrence

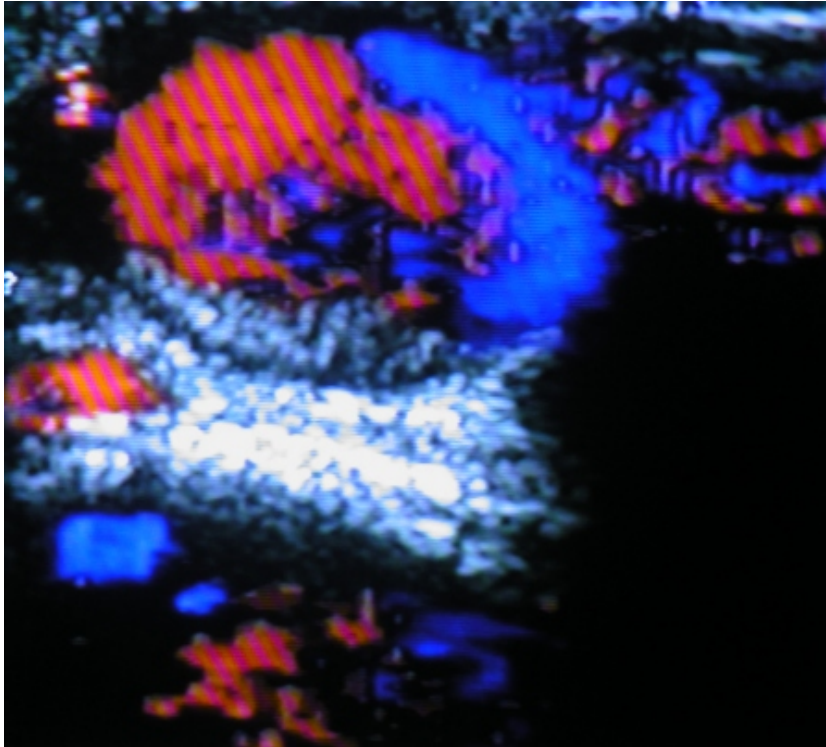


Figure 228 Colour dopple of femoral false aneuysm

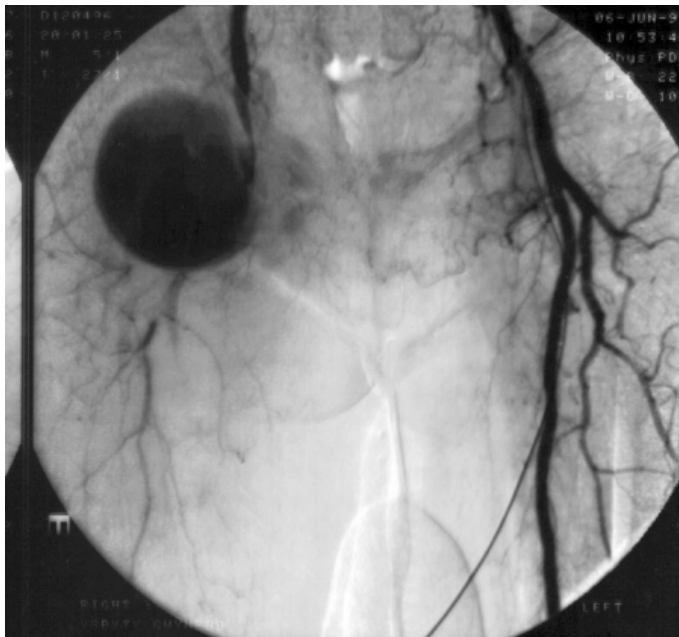


Figure 229 Angiogram of a femoral false aneuysm





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## **Amputations**

- Approximately 5,500 performed per year in UK
- 75% patients are older than 65 years
- 65% patients are men
- 70% of amputees having surgery for ischaemia are dead within 3 years

### **Indications**

- Peripheral vascular disease (85%)
- Trauma (10%)
- Tumours (3%)
- Infection (<1%)

### **Level of amputation**

- Influenced by:
  - Cosmetic appearance
  - Functional requirement
  - Comfort
  - Viability of soft tissues

### **Sites of election**

#### **Lower limb amputations**

- Toe
- Transmetatarsal
- Syme's
- Below knee
- Through knee / Gritti-Stokes
- Above knee
- Hindquarter

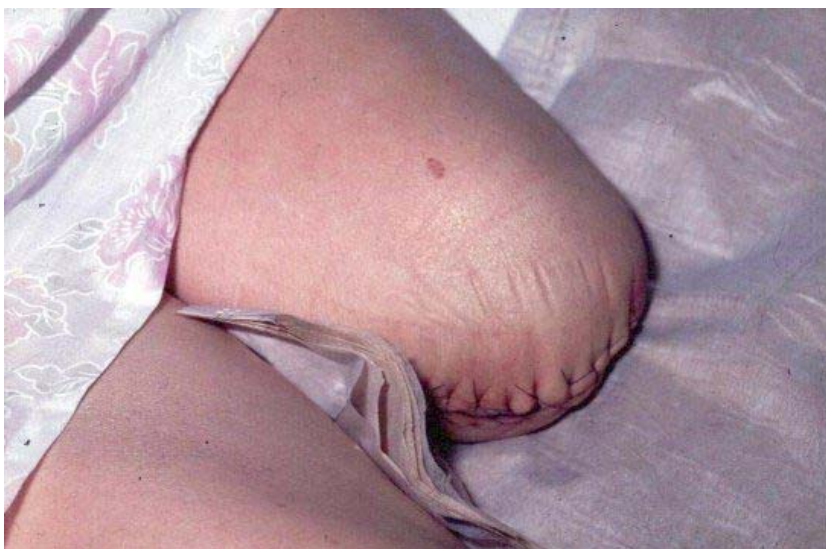


Figure 230 Above knee amputation



Figure 231 Below knee amputation

#### **Upper limb amputations**

- Digital
- Forearm
- Through elbow
- Above elbow
- Forequarter
  
- Level of amputation will influence post-operative mobility
- Approximately 80% of below knee amputees will walk
- Only 40% of above knee amputees walk

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## Venous diseases

### Varicose veins

- Varicose veins affect
- 20-25% of adult females
- 10-15% of adult males
- 75,000 operations are performed annually in United Kingdom
- 20% of operations are for recurrent disease

### Assessment of varicose veins

#### History

- Poor correlation exists between symptoms and signs
- Cough, tap and thrill tests are inaccurate
- Important to identify those with history of DVT or lower limb fracture
- If history of DVT need preoperative investigation with duplex scanning

#### Examination

- Identify distribution of varicose veins – long saphenous (LSV) vs short saphenous (SSV)
- Confirm with tourniquet testing and hand held-doppler probe (5 MHz)
- Recurrent varicose veins need duplex ultrasound



Figure 232 Varicose veins

### Indications for duplex scanning

- Suspected short saphenous incompetence
- Recurrent varicose veins
- Complicated varicose veins (e.g. ulceration, lipodermatosclerosis)
- History of deep venous thrombosis



### Indications for varicose vein surgery

- Most surgery is cosmetic or for minor symptoms
- Absolute indications for surgery :
  - Lipodermatosclerosis leading to venous ulceration
  - Recurrent superficial thrombophlebitis
  - Bleeding from ruptured varix

### LSV surgery

- Trendelenberg position with 20 - 30° head down
- Legs should be abducted 10 -15°
- Saphenofemoral junction (SFJ) found 2 cm below and lateral to pubic tubercle
- Essential to identify SFJ before performing flush ligation of the LSV
- Individually divide and ligate all tributaries of the LSV
  - Superficial circumflex iliac vein
  - Superficial inferior epigastric vein
  - Superficial and deep external pudendal vein
- Check that femoral vein clear of direct branches for 1 cm above and below SFJ
- Stripping of LSV reduces risk of recurrence
- Only strip to upper calf.
- Stripping to ankle is associated with increased risk of saphenous neuralgia
- Post operative care:
  - Elevate foot of bed for 12 hours
  - Class 2 varix stocking should be worn for at least 2 weeks

### SSV surgery

- Patient prone with 20-30° head down
- Saphenopopliteal junction(SPJ) has very variable position
- Preoperative localisation with duplex ultrasound is recommended
- Identify and preserve the sural nerve
- Need to identify the SPJ
- Stripping associated with risk fo sural nerve damage
- Subfascial ligation inadequate

### Perforator surgery

- Significance of perforator disease is unclear
- Perforator disease may be improved by superficial vein surgery
- Perforator surgery (e.g. Cockett's and Todd's procedure) associated with high morbidity
- Subfascial endoscopic perforator surgery (SEPS) recently described
- Not indicated for uncomplicated primary varicose veins
- May have a role in addition to saphenous surgery in those with venous ulceration



### **Sclerotherapy**

- Only suitable for below knee varicose veins
- Need to exclude SFJ or SPJ incompetence
- Main use in persistent or recurrent varicose veins after adequate saphenous surgery

### **Sclerosants**

- 5% Ethanolamine oleate
- 0.5% Sodium tetradecyl sulphate
- Different to sclerosants used for haemorrhoids
- Needle placed in vein when full with patient standing
- Empty vein prior to injection
- Apply immediate compression and maintain for 6 weeks
- Do not exceed maximum volume - Allow injection about 5 sites

### **Complications of sclerotherapy**

- Extravasation causing pigmentation or ulceration
- Deep venous thrombosis

### **Recurrent varicose veins**

- 15 - 25 % of varicose vein surgery is for recurrence
- Outcome of recurrent varicose veins surgery is less successful
- Can be avoided with adequate primary surgery

### **Reasons for recurrence**

#### ***Inaccurate clinical assessment***

- Confusion as to whether varicosities are in LSV or SSV distribution
- Can be avoided with use of hand held doppler

#### ***Inadequate primary surgery***

- 10% cases SFJ not correctly identified
- 20% cases tributaries mistaken for LSV
- Failure to strip LSV

#### ***Injudicious use of sclerotherapy***

- 70% of those with SF incompetence treated with sclerotherapy alone will develop recurrence

### **Neovascularisation**

- With recurrent varicose vein need to image with duplex or varicography



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### ***Venous hypertension and leg ulceration***

- Leg ulceration is common
- Most are due to venous hypertension
- 40% of venous ulcers are due to superficial venous disease
- Rare causes include:
  - Rheumatoid arthritis
  - Malignancy
  - Syphilis
- Surgical correction of superficial venous disease often results in healing

### ***Assessment***

- Clinical assessment should
- Identify previous DVT
- Assess arterial disease
- Identify varicose veins and underlying valvular incompetencies
- Assessment requires
  - Clinical examination
  - Hand held doppler assessment
  - Possible duplex scanning



Figure 233 Ischaemic ulceration due to peripheral vascular disease

### ***Venous hypertension***

- Affects 1-2% of population
- Due to chronic venous insufficiency and distal vein hypertension
- Usually due to post thrombotic syndrome
- Can be due to primary valvular incompetence





## Causes of chronic venous insufficiency

### *Gravitational reflux*

- Venous insufficiency classified as primary or secondary
- Primary insufficiency has no obvious cause of valvular dysfunction
- Insufficiency results in early refilling of venous pool after muscle contraction
- Causes progressive and sustained increase in calf vein pressure
- = Ambulatory venous hypertension
- Results in capillary dilatation and leakage of plasma proteins

### *Compartmental pressures*

- Incompetent perforating veins exposes superficial veins to high pressures during muscle contraction
- = Hydraulic ram effect
- Produces localised venous hypertension and filtration oedema
- Continues until tissue pressures rise to restore equilibrium

### *Leucocyte trapping*

- Accumulation of leucocytes occurs in dependent limbs of those with venous hypertension
- Trapping of WC associated with activation
- Hypoxic endothelial cells stimulate adherence of WC
- Activate WC release O<sub>2</sub> radicals, collagenases and elastases which injure surrounding tissue



Figure 234 Lipodermatosclerosis and venous ulceration



### **Evaluation of venous insufficiency**

- History of chronic venous insufficiency
- Exclude other causes of leg ulceration
- Signs of venous hypertension
  - Perimalleolar oedema
  - Pigmentation
  - Lipodermatosclerosis
  - Eczema
  - Ulceration

### **Doppler ultrasonography**

- Used to assess presence of venous reflux
- LSV, SSV and perforators should be assessed
- Patency of femoral and popliteal veins should be checked
- Flow augmented by compression of calf, deep inspiration or Valsalva manoeuvre

### **Duplex ultrasonography**

- Allow anatomical and functional assessment
- Flow rate and anatomy can be measured

### **Treatment of venous ulceration**

#### **Compression**

- Elastic compression stockings
  - Provide graduated compression
  - Produce local alteration of microvascular haemodynamics
  - Minimal effect on deep vein dynamics
  - Do not cure hypertension - Protect skin from the effects
- Occlusive arterial disease is a relative contraindication
- Gel paste gauze boots
- CirAid
- External pneumatic compression

#### **Drug treatment**

- Systemic agents - minimally effective
  - Zinc
  - Fibrinolytic agents
  - Pentoxifylline
- Topical agents - not recommended
  - Antibiotics
  - Free radical scavengers
  - Hydrocolloid dressings

#### **Surgery**

- Aims
  - Cure venous hypertension
  - Heal the ulcer
- Combination of superficial venous surgery and compression may be beneficial
- Possible useful techniques include:
  - Skin grafting
  - Free flap grafting



- Superficial vein stripping
- Perforating vein interruption
- Valve plasty
- Thrombolysis, dilation, stenting

### Marjolin's ulceration

- First described by Jean Nicholas Marjolin in 1828
- Marjolin's ulceration is a squamous cell carcinoma arising at sites of chronic inflammation
- Recognised underlying causes include:
  - Chronic venous ulceration
  - Burns
  - Osteomyelitis sinuses
- Usually a long-period between injury and malignant transformation
- This period may be 10-25 years
- 40% occur on lower limb
- Malignant change is usually painless
- Nodal involvement is uncommon
- Diagnosis is confirmed by biopsy of the edge of the ulcer
- Management involves adequate excision and skin-grafting or amputation



Figure 235 Marjolin's ulcer associated with chronic venous ulceration



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## Venous thrombosis and thromboprophylaxis

- Venous thrombosis is significant cause of morbidity and mortality
- Pulmonary embolus accounts for 10 - 25 % of hospital deaths
- At least 20% patients with a DVT develop a post-thrombotic limb
- Most calf DVTs are clinically silent
- 80% of calf DVTs lyse spontaneously without treatment
- 20% of calf DVTs propagate to the thigh and have increased risk of PE

### Pathophysiology

- Thrombus formation and propagation depends on the presence of Virchow's triad
  - Venous stasis
  - Hypercoagulable state
  - Endothelial damage
- Immobility contributes to venous stasis
- Endothelial damage can result from external compression
- A hypercoagulable state can be due to drugs or malignancy

Table 52 Risk factors for venous thrombosis

Patient Factors	Disease or Surgical Procedure
Age	Trauma or surgery topelvis, hip, lower limb
Obesity	Malignancy
Varicose veins	Heart Failure
Immobility	Recent myocardial infarction
Pregnancy	Lower limb paralysis
Puerperium	Infection
High-dose oestrogen therapy	Inflammatory bowel disease
Previous DVT or PE	Nephrotic syndrome
Thrombophilia	Polycythaemia
Deficiency of Antithrombin III	Paraproteinaemia
Protein C	Paroxysmal nocturnal haemoglobinuria
Protein S	Behcets disease
Antiphospholipid antibody	Homocystinuria
Lupus anticoagulant	

- It is estimated that about 1:250 of the population have a congenital thrombophilia
- Potential for venous thrombosis can be investigated by a thrombophilia screen
  - FBC and blood film
  - Clotting studies - APPT / PT / TT
  - Reptilase test
  - Protein C & S and Antithrombin III assay
  - Lupus anticoagulant



Table 53 Epidemiology of DVT and pulmonary embolus

	Calf DVT	Proximal DVT	Fatal PE
Low Risk Group	<10%	<1%	0.01%
Moderate Risk Group	10-40%	1-10%	0.1-1%
High Risk Group	40-80%	10-30%	1-10%

### Risk of venous thrombosis during surgery

#### Low risk

- Minor surgery (less than 30 min) + no risk factors other than age
- Major surgery (more than 30 min), age less than 40 yrs + no other risk factors
- Minor trauma or medical illness

#### Moderate risk

- Major general, urological, gynaecological, cardiothoracic, vascular or neurological surgery + age >40 yrs or other risk factor
- Major medical illness or malignancy
- Major trauma or burn
- Minor surgery, trauma or illness in patients with previous DVT, PE or thrombophilia

#### High risk

- Fracture or major orthopaedic surgery of pelvis, hip or lower limb
- Major pelvic or abdominal surgery for cancer
- Major surgery, trauma or illness in patient with previous DVT, PE or thrombophilia
- Major lower limb amputation

### Prevention of thromboembolism

#### Prevention of stasis

- Early mobilisation
- Graduated compression stockings
- Intermittent pneumatic compression (e.g. Flowtron boots)

#### Pharmacologically reduce hypercoagulable state

##### Heparin

- Acidic mucopolysaccharide
- Unfractionated heparin (MW = 15 kDa)
- Low Molecular Weight Heparin (MW = 5 kDa)
- Both potentiate Antithrombin III by inactivating activated clotting factors
- Unfractionated heparin anti-Xa activity = anti IIa activity
- Low Molecular Weight Heparin anti-Xa activity 4x > than anti IIa activity
- Does not have significant effect on APPT
- Side effects of unfractionated Heparin
  - Osteoporosis
  - Idiosyncratic thrombocytopenia



### **Warfarin**

- Coumarin derivative & vitamin K antagonist
- Inhibits vitamin K dependent post translational carboxylation of factors II, VII, IX & X
- Graduated compression stockings reduce incidence of DVT by 50%
- No proven benefit of thigh-length compared to calf-length stockings
- Unfractionated and low molecular weight heparin are equally effective
- Reduce DVTs by 70% and PEs by 50%
- Unfractionated Heparin usually given 5000u 3x daily
- Low Molecular Weight Heparin - Enoxaparin 20 or 40 mg daily

### **New drugs**

- New drugs useful in DVT prophylaxis include
  - Thrombin inhibitors (e.g. hirudin)
  - Specific factor Xa inhibitors (e.g. fondaparinux)
- Factor Xa inhibitors may be more effective than LMWH

### **THRIFT recommendations**

- Current recommendations for DVT prophylaxis

### **All hospital inpatients**

- Should be assessed for clinical risk factors and overall risk of thromboembolism
- Should receive prophylaxis according to degree of risk
- Prophylaxis should continue until discharge

### **Low risk patients**

- Should be mobilised early

### **Moderate risk patients**

- Should receive specific prophylaxis
- Should be mobilised early

### **Clinical features of DVT**

- Clinical presentation of a DVT can be very non-specific
- Many are asymptomatic
- Clinical features depends on site of venous occlusion
- Classical clinical features of a calf DVT are:
  - Calf pain and tenderness
  - Pyrexia
  - Persistent tachycardia
- Homan's sign = pain on passive dorsiflexion of the ankle is a non-specific sign
- Occlusion of the iliofemoral vein can result in venous gangrene (phlegmasia cerulea dolens)



Figure 236 Phlegmasia cerulea dolens

#### Investigation of suspected DVT

- Less than 50% of those suspected of having DVT have clot identified on imaging

#### *D-dimers*

- A fibrin degradation product that can be assayed in plasma
- Levels raised in the presence of recent thrombus
- A negative result almost excludes the presence of venous thrombosis
- Decision to proceed to venography or ultrasound often based on D-dimer result

#### *Venography*

- Regarded as gold standard investigation for the diagnosis of DVT
- Will identify both calf vein and proximal vein thrombus
- Painful and time consuming investigation.
- 2-3% of patients develop contrast reaction

#### *Ultrasound*

- Technique has three components - all operator dependent.
- Venous compressibility
- Detection of doppler flow
- Visualisation of clot
- In femoro-popliteal segment
  - Sensitivity = 94%
  - Secificity = 100%
- In calf veins
  - Sensitivity = 73%
  - Specificity = 86%
- Able to exclude femoro-popliteal or major calf DVT in symptomatic patients





### Treatment of venous thrombosis

- Aims of treatment:
  - Prevention of pulmonary embolus
  - Restore venous and valvular function to prevent the post thrombotic limb
- Few aspects of treatment submitted to RCTs

### Anticoagulation

- Main component of treatment
- Initially with unfractionated or low molecular weight heparin
- Followed by oral anticoagulation
- LMWHs have improved bioavailability and linear kinetics
- The treatment of isolated calf DVTs is of unproven benefit
- Optimal duration of treatment unknown
- No proof that treatment beyond 3-6 months is required

### Surgical thrombectomy

- Considered in massive ileo-femoral thrombosis associated with phlegmasia cerulea dolens
- Good early results with 62% complete and 38% partial clearance of ileo-femoral segment
- Unfortunately re-occlusion common

### Thrombolysis

- Of unproven benefit

### Pulmonary embolism

- Accounts for 3% of hospital inpatients deaths
- Untreated has a mortality of 30%
- Treated mortality reduced to about 2%
- Only 10% have clinical signs of a DVT

Table 54 Clinical presentation of pulmonary embolus

Symptoms	Signs
Dyspnoea	Low grade pyrexia
Pleuritic chest pain	Central cyanosis
Haemoptysis	Tachycardia
	Tachypnoea
	Hypotension
	Neck vein distension
	Pleural rub
	Increased pulmonary second sound

### Investigations of possible pulmonary embolus

- Arterial blood gases - hypoxia, hypocarbia but may be normal
- ECG - Signs of right heart strain - classically S<sub>1</sub>Q<sub>3</sub>T<sub>3</sub>
- CXR - Show oligoemia and central pulmonary markings and excludes other pathologies
- Ventilation / Perfusion scanning - May confirm or refute diagnosis
- Pulmonary angiography and echocardiography useful if haemodynamic instability
- Spiral CT may replace pulmonary angiography



- Lower limb investigations for DVT as above

### Management of pulmonary embolus

- Depends on degree of suspicion and haemodynamic stability
- If high degree of suspicion but stable:
  - Anti-coagulate with heparin or LMWH
  - Oxygen, analgesia, colloid to increase CVP
  - Warfarinise for at least 3 months
- If haemodynamically unstable:
  - Consider pulmonary thrombolysis via pulmonary artery catheter
  - If thrombolysis contraindicated consider pulmonary embolectomy

### Inferior vena caval filters

- Inserted percutaneously usually via femoral vein
- Present a physical barrier to emboli
- Indicated if:
  - Recurrent pulmonary emboli despite adequate anti-coagulation
  - Extensive proximal venous thrombosis and anticoagulation is contraindicated

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## Lymphatics and spleen

### Causes of limb swelling

#### *Bilateral pitting oedema*

- Heart failure
- Renal disease
- Proteinuria
- Cirrhosis
- Carcinomatosis
- Nutritional

#### *Painful unilateral pitting oedema*

- Deep venous thrombosis
- Superficial thrombophlebitis
- Cellulitis
- Trauma
- Ischaemia

#### *Painless unilateral oedema*

- Post-phlebitic limb
- Extrinsic compression of the deep veins
- Deep venous incompetence
- Lymphoedema
- Immobility

### *Lymphoedema*

- Lymphoedema presents with gradual limb swelling
- Due to progressive failure of lymphatic system

#### *Primary lymphoedema*

- Congenital (age < 1 year) - familial or non-familial
- Praecox (age < 35 years) - familial or non-familial
- Tarda (age > 35 years)

#### *Secondary lymphoedema*

- Malignant disease
- Surgery - axillary surgery or groin dissection
- Radiotherapy
- Infection - parasitic (e.g. filariasis)



Figure 237 Bilateral lymphoedema



Figure 238 Filariasis

### Pathology

- Primary lymphoedema is the result of a spectrum of lymphatic disorders
- Can be due to aplasia, hypoplasia or hyperplasia of lymphatics
- In 80% obliteration of distal lymphatics occurs
- A proportion of patients have a family history (Milroy's disease)
- In 10% proximal occlusion of lymphatics in abdomen and pelvis is seen
- In 10% lymphatic valvular incompetence develops



- Chronic lymphoedema results in subcutaneous fibrosis
- Fibrosis can be worsened by secondary infection

### **Clinical features**

- The initial presentation is usually with peripheral oedema worse on standing
- Begins distally and progresses proximally
- Limb usually feels heavy
- Can be unilateral or bilateral
- Primary lymphoedema is more common in women and is usually bilateral
- With secondary lymphoedema the underlying cause is often apparent
- Examination shows non-pitting oedema
- The skin often has hyperkeratosis, fissuring and secondary infection
- Ulceration is rare

### **Investigations**

- Chronic venous insufficiency should be excluded with doppler ultrasound
- Lymphoedema and its cause can be confirmed with:
  - Lymphoscintigraphy
  - CT or MRI scanning
  - Lymphangiography
- Lymphoscintigraphy is usually the investigation of choice
- Has a sensitivity > 90% and specificity of 100%
- Normal lymphoscintigraphy excludes a diagnosis of lymphoedema
- Lymphangiography is painful and rarely required

### **Management**

- The aims of treatment are to:
  - Reduce limb swelling
  - Improve limb function
  - Reduce the risk of infection

### **Conservative treatment**

- General skin care will reduce risk of infection
- Swelling can be reduced by elevation
- Physiotherapy and manual lymph drainage may help
- External pneumatic compression will also reduce swelling
- Once swelling is reduced compression stockings should be applied
- Antibiotics should be given at the first sign of infection
- Drugs (e.g. diuretics) are of no proven benefit



Figure 239 Pre and post operative appearances of a patient with filariasis under going a Charles' procedure

### Surgery

- Surgery consists of two approaches
  - Debulking operations
  - Bypass procedures
- Debulking operations include:
  - Homan's operation - excision of skin and subcutaneous tissue with primary closure
  - Charles' operation - radical excision of skin and subcutaneous tissue with skin grafts
- Both produce good functional results
- Cosmesis is often poor
- Bypass operations include:
  - Skin and muscle flaps
  - Omental bridges
  - Enteromesenteric bridges
  - Lymphaticolymphatic anastomosis
  - Lymphaticovenous anastomosis

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## **The spleen**

- Normal spleen weighs 150g
- Lies within the anterior leaf of the dorsal mesogastrum parallel to 9-11 ribs
- Closely related to:
  - Tail of pancreas
  - Greater curvature of stomach
  - Left kidney / lienorenal ligament
  - Greater omentum
- Blood supply - splenic artery and short gastric arteries
- Divides in hilum to 4 or 5 end arteries

## **Splenic function**

- Important component of lympho-reticular system
- Site of haemopoiesis in foetus and patients with bone marrow pathology
- Site of maturation and destruction of RBCs
- Important component of humoral and cell mediated immune system
- Antigen trapped and IgM produced in germinal centres
- Produces opsonins (tuftsin and properdin) for the phagocytosis of encapsulated bacteria

## **Causes of splenomegaly**

### **Massive**

- Chronic myeloid leukaemia
- Myelofibrosis

### **Moderate**

- Portal hypertension
- Lymphoma
- Leukaemia
- Thalassaemia
- Glycogen storage diseases

### **Small**

- Polycythaemia rubra vera
- Haemolytic anaemias
- Infections - infectious mononucleosis, malaria
- Connective tissue disorders
- Infiltrations - amyloid, sarcoid

## **Indications for splenectomy**

### **Trauma**

- Commonest organ injured in blunt abdominal trauma
- Associated with lower rib fractures
- 25% injuries are iatrogenic
- Delayed rupture of splenic haematoma uncommon



### **Spontaneous rupture**

- Usually seen in those with massive splenomegaly (e.g. infectious mononucleosis)
- Often precipitated by minor trauma

### **Hypersplenism**

- Hereditary spherocytosis or elliptocytosis
- Idiopathic thrombocytopenic purpura



Figure 240 Splenectomy specimen from a patient with idiopathic thrombocytopenic purpura

### **Neoplasia**

- Lymphoma or leukaemic infiltration
- Splenectomy not usually required for diagnosis
- Only required if hypersplenism resistant to treatment

### **With other viscera**

- Total gastrectomy
- Distal pancreatectomy

### **Other indications**

- Splenic cysts
- Hydatid cysts
- Splenic abscesses

### **Physiological effects of splenectomy**

- Raised white cell and platelet count - peaks at about 7 days
- Increased abnormal red cells in circulation
- Reduced IgM and raised IgA
- Reduced ability to opsonize encapsulated bacteria





### Ruptured spleen

- Suspect in any patient with abdominal trauma and shock
- Especially if shoulder tip pain, lower rib fractures and left upper quadrant bruising
- Require prompt resuscitation
- CXR may show:
  - Rib fractures
  - Pleural effusion
  - Displaced gastric air bubble
- Ultrasound / CT will confirm diagnosis and identify other pathology

### Non-operative management

- Acceptable if isolated injury and patient is stable
- Monitor closely
- Must stay in hospital for 10-14 days

### Surgery

- Required if cardiovascularly unstable
- Long midline incision and full laparotomy
- Spleen drawn medially and left leaf of lienorenal ligament divided
- Mobilised spleen displaced in to the wound
- Vascular control can be obtained by compression on vascular pedicle
- Consider repair if possible
- If total splenectomy required
- Divide short gastric arteries - Avoid damage to stomach
- Divide splenic artery and then vein - Avoid damage to tail of pancreas

### Alternatives to total splenectomy

- Topical Applications
- Digital pressure
- Gelatin sponge
- Microfibrillar collagen
- Cyanoacrylate adhesive
- Diathermy
- Packing
- Splenorrhaphy
- Suture using Teflon buttresses, omentum or absorbable mesh
- Splenic artery ligation
- Partial splenectomy
- Autotransplantation

### Elective splenectomy

- As above
- If splenomegaly consider early ligation of splenic artery through lesser sac
- Inject 1 ml 1:10,000 adrenaline prior to splenic artery ligation
- facilitates removal and generates an autotransfusion

### Overwhelming Post Splenectomy Infection (OPSI)

- Infection due to encapsulated bacteria
- 50% due to *strep. Pneumoniae*
- Other organisms include:



- *Haemophilus influenzae*
- *Neisseria meningitidis*
- Occurs post splenectomy in 4% patients without prophylaxis
- Mortality of OPSI is approximately 50%
- Greatest risk in first 2 years post op

### **Prevention of OPSI**

#### ***Antibiotic prophylaxis***

- Penicillin or amoxicillin
- Little consensus exists over duration of prophylaxis
- Certainly in children up to 16 years

#### ***Immunisation***

- Pneumococcal and Haemophilus
- Perform 2 weeks prior to planned operation
- Immediately post op for emergency cases
- Repeat every 5 - 10 years

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## **Lymphadenopathy**

- Lymphadenopathy can result from neoplastic or inflammatory processes
- In the western adult population 50% of cases are neoplastic and 50% are inflammatory
- In children only 20% of cases are due to neoplasia



Figure 241 Burkett's lymphoma

## **Causes of lymphadenopathy**

### **Neoplastic**

- Solid tumours - melanoma, breast, head and neck cancers
- Haematological - lymphoma, leukaemia, myeloproliferative diseases

### **Inflammatory**

- Infection –bacterial, viral, fungal, tuberculosis
- Autoimmune – rheumatoid arthritis, systemic lupus erythematosus, tuberculosis
- Miscellaneous – angiofollicular hyperplasia, dermatopathic lymphadenitis

## **Clinical Assessment**

- Clinical assessment should include:
  - Duration of symptoms
  - Distribution of lymphadenopathy
  - Presence of pain
  - Associated symptoms – fever, malaise, weight loss
  - Examination – firm or rubbery, discrete or matted
  - Presence of hepatosplenomegaly

## **Investigation**

- Fine needle aspiration cytology may be useful for solid tumours
- Excision or incision biopsy required if suspect haematological disorder



- Risks of node biopsy (e.g. damage to accessory nerve) should be appreciated
- Specimens should be sent 'dry' to laboratory
- Will allow samples for imprint cytology or microbiological culture



Figure 242 Caseous necrosis of lymph node due to tuberculosis

### Sentinel node biopsy

- Lymph node surgery may be used as both a diagnostic and staging procedure
- Staging may be achieved by a full regional lymph node dissection
- Provides useful prognostic information but does not increase survival
- Also associated with significant complications (e.g. lymphoedema, sensory disturbances)
- Many patients have no evidence of metastatic spread
- Therefore, node dissection can be associated with unnecessary morbidity
- The sentinel lymph node is the first draining node from a tumour
- Can be identified by the use of dye or radioisotope injected next to a tumour
- Agents often used include:
  - Patent blue dye
  - <sup>99</sup>Tc Technetium nanocolloid
  - Blue dye and isotope in combination
- At time of surgery blue node will be seen and 'hot' node identified using a gamma probe
- Has been shown in melanoma and breast surgery to be accurate predictor of nodal status
- Associated with few complications
- Sparse node-negative patients the need for a lymph node dissection



Figure 243 Sentinel lymph node biopsy

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## Lymphomas

### Hodgkin's disease

- First described by Sir Thomas Hodgkin in 1832
- The disease can present at any age
- Most commonly seen in young adults
- Male : Female ratio 2:1
- Usually presents as painless lymphadenopathy in superficial lymph nodes
  - Cervical nodes (60-70%)
  - Axillary nodes (10-15%)
  - Inguinal node (6-12%)



Figure 244 Cervical lymphadenopathy due to Hodgkins lymphoma

- Splenomegaly occurs in 50% patients
- Cutaneous involvement occurs as a late complication in 10%
- Constitutional symptoms include:
  - Fever (Pel-Ebstein)
  - Pruritus
  - Alcohol-induced pain
- Symptoms occurs in those with widespread disease
- Diagnosis confirmed by histological examination of involved node
- Reed-Sternberg cells are diagnostic of the disease

### Histological type

- Lymphocyte predominant (7%)
- Nodular sclerosing (64%)
- Mixed cellularity (25%)
- Lymphocyte depleted (4%)

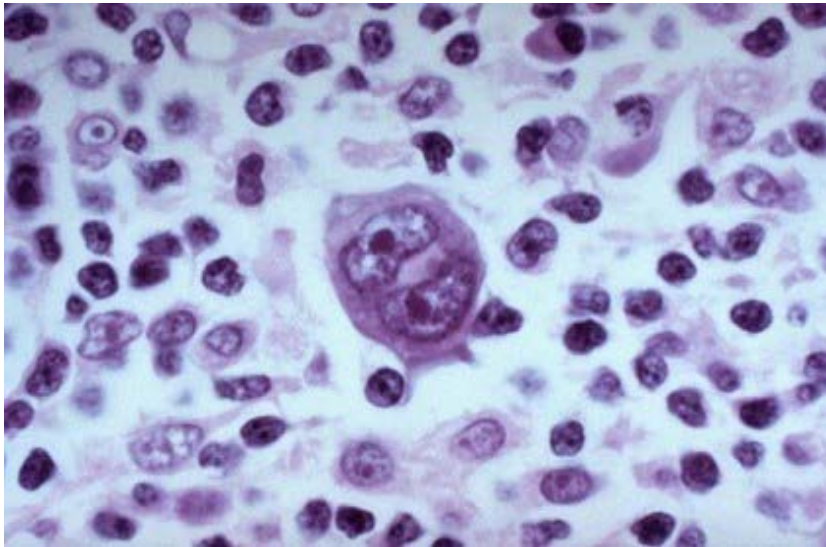


Figure 245 Reed-Sternberg cell

### **Staging investigations**

- Chest X-ray
- Bone marrow trephine biopsy
- Abdominal and chest CT scan
- Staging laparotomy - often not required

### **Staging of Hodgkin's disease**

- Stage I - Confined to one lymph node region
- Stage II - Disease confined to 2 or more nodal regions on one side of diaphragm
- Stage III - Disease involving node on both sides of diaphragm
- Stage IV - Extra-nodal disease - usually liver or bone marrow
- A = Absence of constitutional symptoms
- B = Presence of constitutional symptoms
  - Unexplained fever above 38 °C
  - Night sweats
  - Loss of >10% body weight in 6 months

### **Treatment**

- Stage I & II = Radiotherapy
- Stage III & IV = Chemotherapy and DXT

### **Survival**

- Stage I is 90% at 5 years
- Stage IV is 60% at 5 years

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## Raynaud's disease

- Raynaud's phenomenon refers to the symptoms of digital ischaemia
- 80% of patients are women
- Commonest before the age of 35 years
- Population prevalence may be as high as 5%
- Most patients have primary disease
- Primary Raynaud's disease occurs in patients with normal arteries
- Symptoms are due to an abnormal reversible physiological response
- Secondary Raynaud's disease occurs in patients with underlying systemic disorder

### Primary Raynaud's disease

- Due to excessive vasoconstriction of digital arteries
- Vessels are normal between episodes
- Cooling of the hands results in intense vasoconstriction
- Flow in the digital arteries ceases at the critical closing temperature
- Reopening of blood vessels requires a rise in perfusion pressure
- Possible pathophysiological mechanisms include:
  - Increased sympathetic activity
  - Increased sensitivity to adrenergic stimuli
  - Increased number of alpha-receptors in the vessel wall

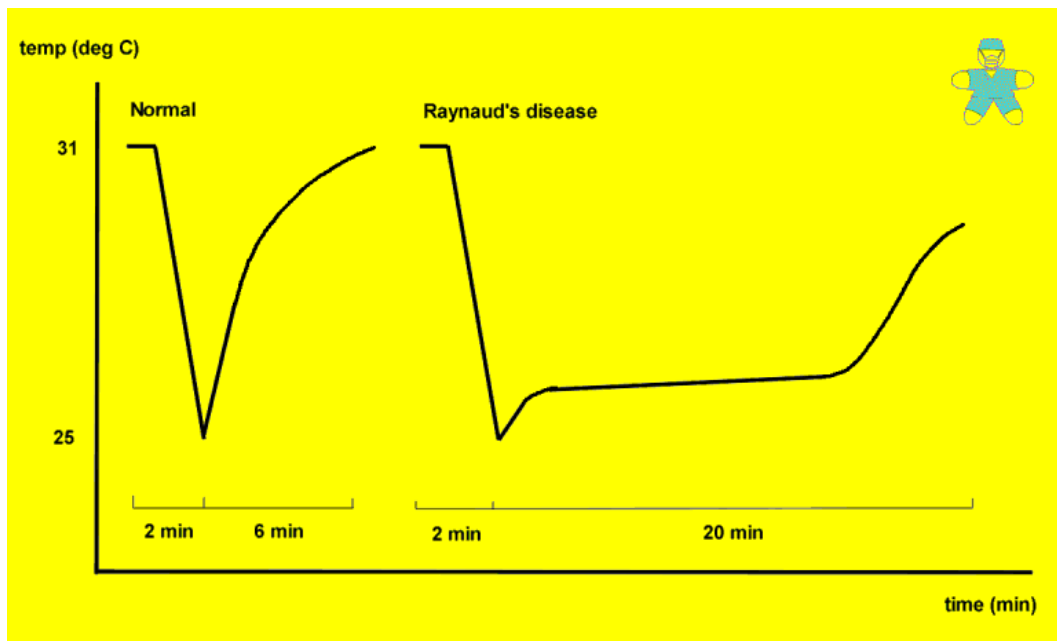


Figure 246 Result of a cold provocation test in a normal individual and patients with Raynaud's disease

### Conditions associated with secondary Raynaud's disease

- Due to conditions associated with
  - Abnormal vessel walls
  - Increased blood viscosity





### **Connective tissue disease**

- Scleroderma
- Systemic lupus erythematosus
- Rheumatoid arthritis
- Dermatomyositis
- Polyarteritis nodosa

### **Haematological**

- Cryoglobulinaemia
- Cold haemagglutinaemia
- Paraproteinaemia
- Thromboembolic disease

### **Arterial**

- Buerger's disease
- Atherosclerosis
- Arteritis

### **Neurovascular**

- Thoracic outlet syndrome
- Carpal tunnel syndrome
- Crutch pressure

### **Drugs**

- Nicotine
- Beta-blockers
- Ergot derivatives
- Sympathomimetics

### **Miscellaneous**

- Vibration white finger
- Neoplasms
- Poliomyelitis
- Hypothyroidism
- Chronic renal failure

### **Clinical features**

- Diagnosis can usually be made from clinical history
- Consists of a triphasic response provoked by exposure to cold
  - Phase 1 - pallor due to intense vasoconstriction
  - Phase 2 - cyanosis due to desaturation of haemoglobin
  - Phase 3 - erythema due to hyperaemia and restoration of circulation
- Primary disease is usually bilateral, symmetrical and involves all fingers
- Secondary disease is usually patchy and asymmetrical
- Symptoms are often milder in primary disease
- Examination often shows peripheral pulses to be normal
- Features of thoracic outlet syndrome or connective tissue disorders may be present



- Raynaud's phenomena is seen in
  - 90% patients with scleroderma
  - 30% patients with rheumatoid arthritis
  - 30% patients with primary Sjogren's syndrome
  - 10% patients with rheumatoid arthritis



Figure 247 Hand signs of scleroderma

### Investigations

- Should be guided by clinical features
- Serology should include - FBC, ESR, anti-nuclear antibodies
- Electrophoresis, cold agglutinins and fibrinogen levels may identify hyperviscosity states
- Chest x-ray and thoracic outlet views may show cervical rib
- Duplex ultrasound or arteriography may be indicated in suspicion of arterial disease
- No reliable method of provoking Raynaud's phenomenon exists

### Treatment options

#### Prevention

- Clothing - wearing of thermal fabrics
- The use of hand warmers or electric gloves
- Stop smoking
- Change job if vibration induces
- Avoid sympathetic stimulants

#### Topical agents

- GTN paste
- Prostaglandin analogues

#### Oral agents

- Sympatholytic agents - reserpine, guanethidine
- Alpha-blockers - phenoxybenzamine, prazosin



- Beta-stimulants - terbutaline
- Vasodilators - nifedipine, diltiazem
- Fibrinolytic agents - pentoxifylline
- Serotonin antagonists - ketanserin

#### ***Invasive***

- Intraarterial reserpine
- Intravenous iloprost

#### ***Surgery***

- Thoracic outlet surgery
- Embolectomy
- Sympathectomy

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## Renal failure and transplantation

### Chronic renal failure

Table 55 Stages of renal dysfunction

Stage	Description	Creat clearance (ml/min/1.73m <sup>2</sup> )	Metabolic consequences
1	Normal	>90	
2	Early renal insufficiency	60-89	Inc. serum PTH
3	Chronic renal failure	30-59	Inc. Ca absorption, anaemia
4	Pre-end stage failure	15-29	Inc. TGs, PO <sub>4</sub> , K <sup>+</sup> . acidosis
5	End stage renal failure	<15	Uraemia

- Chronic renal failure = GFR < 60 ml / min

#### Causes of chronic renal failures

- Chronic glomerulonephritis
- Chronic pyelonephritis
- Diabetic nephropathy
- Chronic interstitial nephritis
- Chronic obstructive uropathy
- Hypertensive nephrosclerosis
- Polycystic disease
- Amyloid
- Myeloma

#### Treatment of chronic renal failure

- Three basic stages in treatment
  - Preserve remaining nephrons
  - Conservative treatment of uraemic syndrome
  - Renal dialysis and transplantation

#### *Preserve remaining nephron function*

- Control of hypertension and heart failure
- Treatment of superimposed urinary tract infection
- Correction of salt and water depletion
- Careful prescribing of drugs that are potentially nephrotoxic
- Dietary protein restriction

#### *Conservative management of uraemic syndrome*

- Reduce protein intake
- Aluminium hydroxide to reduce intestinal phosphate absorption
- Vitamin D and calcium supplements to increase serum calcium
- Allopurinol to reduce serum uric acid
- Erythropoietin to correct anaemia



## **Renal dialysis**

### **Indications**

- Patient aged 5-70 years without significant systemic disease or neoplasia
- Clinical deterioration despite good conservative management
- Uraemic pericarditis
- Severe renal bone disease
- Peripheral neuropathy
- Creatinine > 1,200  $\mu\text{mol/l}$
- Glomerular filtration rate < 5 ml/min

### **Principals**

- Dialysis depends on
  - Diffusion
    - Passage of solute through membrane down concentration gradient
  - Ultrafiltration
    - Passage of solvent through membrane due hydrostatic or osmotic pressure

### **Peritoneal dialysis**



Figure 248 Continuous ambulatory peritoneal dialysis catheter



- Dialysis membrane = peritoneum
- Dialysis fluid low in urea and creatinine
- Also hypertonic solution due to high glucose concentration
- Dialysis occurs as a result of diffusion and ultrafiltration
- Tenckhoff catheter usually inserted below umbilicus
- Cuffs on catheter prevent leaks and infection
- Dialysis performed on either intermittent or continuous basis
- In continuous ambulatory peritoneal dialysis fluid is changed 4 times per day
- Peritonitis is main complication
- Inefficient compared to haemodialysis

### **Haemodialysis**

- Dialysis membrane = artificial membrane
- Pumps move blood on either side of membrane in countercurrent directions
- Solutes move across membrane by diffusion
- Vascular access obtained by:
  - Arteriovenous shunt with prosthetic graft
  - Arteriovenous fistula between artery and vein
  - Vascular catheters in large central veins
- AV fistulas take 4-6 weeks to mature
- Can cause heart failure and steal syndrome
- Complications include aneurysm formation and haemorrhage



Figure 249 Arterio-venous fistula



### **Haemofiltration**

- Dialysis membrane = artificial membrane
- Used in ITU mainly for acute renal failure
- Pressure difference across membrane causes ultrafiltration
- Inefficient compared to haemodialysis

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### **Renal transplantation**

- 1,500 renal transplants per year are performed in the United Kingdom
- 50% of patients on dialysis are on transplant waiting list
- 5000 patients waiting for transplant

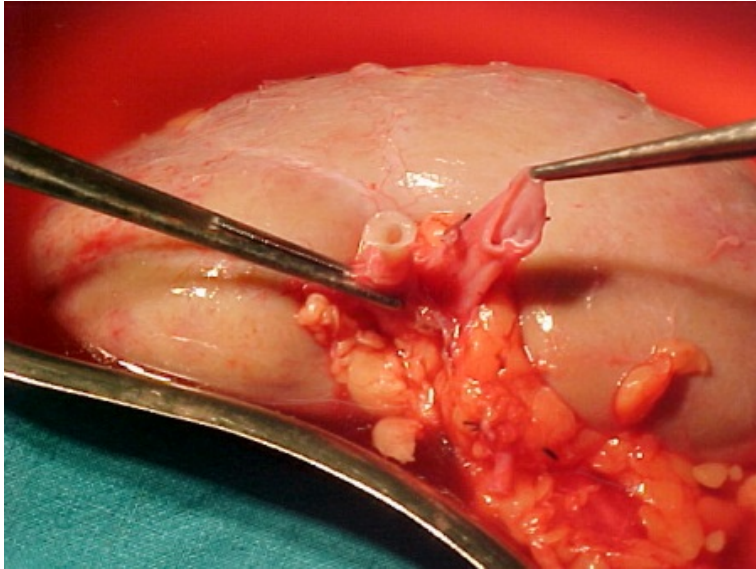


Figure 250 A prepared cadaver kidney

### **Donor kidneys**

- 80% are from beating-heart organ retrievals
- 10% are from non-beating heart donors
- 10% are from live donors

### **Transplant recipients**

- Age less than 75 years
- No history of recent neoplasia
- No major infections (e.g. tuberculosis)
- Good cardiovascular status

### **Potential donors**

- Aged 5-75 years
- No significant renal disease
- No major infections
- Hepatitis B / C and HIV negative
- No history of malignancy

### **Outcome**

- Outcome from renal transplantation is improving
- 95% patients are alive at one year
- 87% patients are alive at five year





## Graft survival

Table 56 Renal graft survival

	One year (%)	10 years (%)
Cadaver donor	85	60
Live donor	95	70

## Complications

- Vascular
  - Haemorrhage
  - Renal artery thrombosis
  - Renal vein thrombosis
- Urological
  - Bladder leak
  - Ureteric stenosis
- Lymphocele
- Infection
  - Cytomegalovirus
  - Herpes simplex
  - Pneumocystis
- Post transplant neoplasia
  - Lymphoma
  - Kaposi sarcoma

## Immunosuppression

- Classically achieved with a combination of:
  - Cyclosporin A
  - Azathioprine
  - Prednisolone
- Newer drugs include:
  - Tacrolimus
  - Mycophenolate mofetil
  - Basiliximab
  - Daclizumab
  - Sirolimus
- Basiliximab and daclizumab are anti-interleukin-2 receptor antibodies
- Newer drugs are associated with fewer side effects
- Incidence of hypertension and hyperuricaemia are reduced
- Rate of adverse lipid profiles is lessened
- Newer drugs may have a reduced incidence of chronic allograft nephropathy

## Rejection

- 1-2% of patients develop acute rejection
- Acute rejection is characterised by
  - Pyrexia
  - Graft tenderness
  - Increasing creatinine
- Diagnosis can be confirmed by renal biopsy
- Treated with:
  - High dose steroids - methylprednisolone 500 mg/day



- OKT3 = anti-T cell monoclonal antibody

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## Otorhinolaryngology, head & neck surgery

### Ear, nose and throat disorders

#### *Inflammatory condition of the ear, nose and throat*

##### Otitis externa

- Inflammatory disorders of the external ear are common
- Can be either an acute or chronic disorder
- Often associated with generalised skin disorders
- Common pathogens include staphylococcal species and pseudomonas aeruginosa
- Fungi, candida and aspergillus may also be involved
- The condition is often bilateral
- Treatment is with topical antibiotics and steroids
- Debris should be suctioned under direct vision
- Systemic antibiotics are rarely required

##### Acute suppurative otitis media

- Common in childhood
- Due to infection of the middle ear
- Commonest pathogens are Streptococci pneumoniae and Haemophilus influenzae
- Presents with severe ear ache
- Child is usually systemically unwell
- Tympanic membrane is often red and bulging
- Pain may be relieved by rupture of the tympanic membrane
- Child requires oral antibiotics for 10 days

##### Complications

- Chronic suppurative otitis media
- Adhesive otitis media
- Tympanosclerosis
- Ossicular destruction
- Acute mastoiditis
- Intracranial complications

##### Chronic suppurative otitis media

- Classified into two types
  - Tubotympanic associated with perforation of the pars tensa
  - Atticoantral associated with a retraction pocket of the pars flaccida

##### Tubotympanic CSOM

- Usually follows acute otitis media or trauma
- Results in chronic perforation of the tympanic membrane
- Presents with an intermittently discharging ear
- Associated with conductive hearing loss
- Treatment is with antibiotics, steroids and suction
- If conservative treatment fails a myringoplasty may be needed



- Temporalis fascia is usually used as the graft material

#### **Atticoantral CSOM**

- More dangerous condition than tubotympanic CSOM
- Associated with cholesteatoma formation
- Squamous epithelium proliferates in the attic of the middle ear
- Expanding ball of skin causes a low-grade osteomyelitis
- Presents with purulent aural discharge and conductive hearing loss
- Complications include:
  - Vestibular symptoms
  - Facial nerve palsy
  - Meningitis
  - Intracranial abscess
- Treatment is surgical and requires either:
  - Atticotomy
  - Modified radical mastoidectomy

#### **Acute tonsillitis**

- Common condition
- Approximately 60% cases are bacterial
- Often due to Group A streptococci
- Characterised by sore throat, fever, malaise
- Cervical lymphadenopathy usually occurs
- Tonsils are usually enlarged and coated with pus
- Treatment is with simple analgesia and penicillin

#### **Quinsy**

- A quinsy is a peritonsillar abscess
- Causes severe tonsillar pain and trismus
- Examination shows swelling of the soft palate above the involved tonsil
- The uvula is usually displaced
- Treatment is with intravenous antibiotics
- Abscess can be aspirated or drained under local anaesthetic
- Consider elective tonsillectomy

#### **Indications for tonsillectomy**

- Absolute
  - Sleep apnoea
  - Suspected tonsillar malignancy
- Relative
  - Recurrent tonsillitis
  - Chronic tonsillitis
  - Peritonsillar abscess (Quincy)
  - Diphtheria carriers
  - Systemic disease due to beta-haemolytic streptococcus

#### **Acute paediatric stridor**

- Congenital
  - Laryngomalacia
  - Laryngeal web
  - Subglottic stenosis



- Acquired
  - Angioneurotic oedema
  - Impacted foreign body
  - Epiglottitis
  - Laryngotracheobronchitis
  - Vocal cord palsy
  - Benign laryngeal papillomatosis

### Acute epiglottitis

- Occurs in both adults and children
- In children it is a life-threatening disease
- In young children symptoms can progress rapidly
- Due to haemophilus influenzae infection
- Presents with stridor and drooling
- Patient may require intubation or tracheostomy
- Insertion of spatula may precipitate complete airway obstruction
- Also require humidified oxygen and antibiotics

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## **Tracheostomy**



Figure 251 Tracheostomy tube

### **To relieve upper airway obstruction**

- Foreign body
- Trauma
- Acute infection - Acute epiglottitis, Diphtheria
- Glottic oedema
- Bilateral abductor paralysis of the vocal cords
- Tumours of the larynx
- Congenital web or atresia

### **To improve respiratory function**

- Fulminating bronchopneumonia
- Chronic bronchitis and emphysema
- Chest injury +/- flail chest

### **Respiratory paralysis**

- Unconscious head injury
- Bulbar poliomyelitis
- Tetanus

### **Tracheostomy technique**

- Patient positioned supine with sandbag between scapulae
- Transverse cervical skin incision 1 cm above sternal notch
- Incision should extend to the sternomastoid muscles
- Dissect through fascial planes and retract anterior jugular veins
- Retract the strap muscles
- Divide thyroid isthmus and oversew to prevent bleeding
- Place cricoid hook on 2<sup>nd</sup> tracheal ring
- Stoma fashioned between 3<sup>rd</sup> and 4<sup>th</sup> tracheal rings
- Anterior portion of tracheal ring removed
- No advantage in creating a tracheal flap
- Endo-tracheal tube withdrawn to sub-glottis



- Tracheostomy tube inserted using obturator
- When confirmed that in correct position the ET tube removed
- Tube secured with tapes

### **Complications of tracheostomy**

#### ***Immediate***

- Haemorrhage
- Surgical trauma - oesophagus, recurrent laryngeal nerve
- Pneumothorax

#### ***Intermediate***

- Tracheal erosion
- Tube displacement
- Tube obstruction
- Subcutaneous emphysema
- Aspiration & lung abscess

#### ***Late***

- Persistent tracheo-cutaneous fistula
- Laryngeal and tracheal stenosis
- Tracheomalacia
- Tracheo-oesophageal fistula

### **Post-operative tracheostomy care**

#### ***Maintain patent airway***

- Frequent atraumatic suction
- Humidification of inspired air and oxygen
- Mucolytic agents
- Coughing and physiotherapy
- Occasional bronchial lavage

#### ***Prevent infection and complications***

- Aseptic tube suction, handling and tube changing
- The use of antibiotic prophylaxis is controversial
- Deflate cuff for 5 minutes every hours
- Avoid tube impinging on posterior tracheal wall

### **Percutaneous tracheostomy**

- Usually performed at the bedside in an ITU
- Performed using a guide-wire and dilators
- Bronchoscopic guidance may reduce the complication rate
- May be associated with a reduced risk of bleeding and infection



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### **Foreign bodies in the aerodigestive tract**

- Children ingest foreign bodies whilst playing
- Adults ingest foreign bodies either when intoxicated or for perceived gain
- Most foreign bodies are innocuous and may require no active treatment
- Other may warrant urgent removal

### **Oesophagus**

- Objects that stick in the oesophagus do so at sites of anatomical narrowings
- Commonest sites are cricopharyngeus, aortic indentation and diaphragm
- Usually present with acute dysphagia and drooling
- Diagnosis may be confirmed with a plain x-ray
- If object radiolucent and diagnostic uncertainty consider a water-soluble contrast study
- Foreign bodies can usually be removed by rigid oesophagoscopy
- Occasionally difficult with sharp objects (e.g. open safety pins)
- If removal difficult then advancement into stomach is a safer option
- Neglected objects can result in oesophageal perforation and mediastinitis
- Can also result in fatal haemorrhage from an aorto-oesophageal fistula

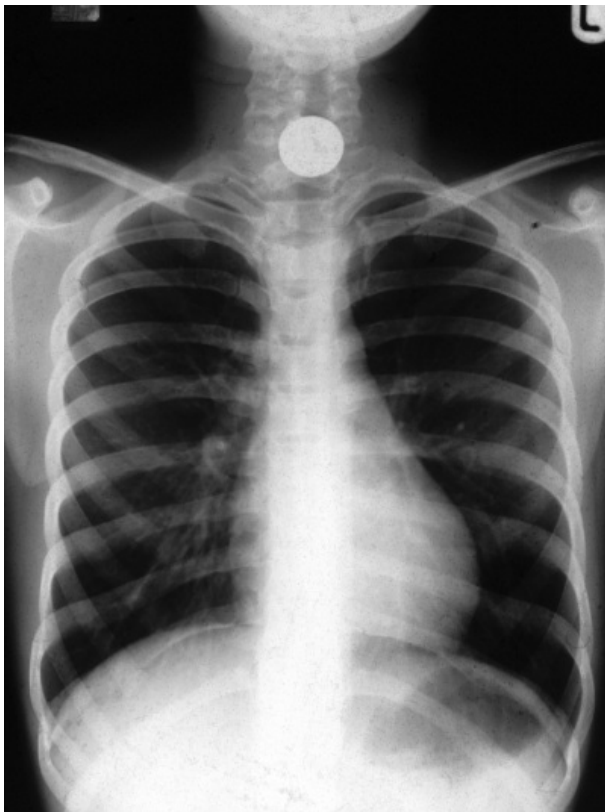


Figure 252 A coin the upper oesophagus

### **Stomach**

- If a foreign body reaches the stomach it will usually pass spontaneously
- Sharp objects may result in GI perforation often in the 3<sup>rd</sup> or 4<sup>th</sup> part of the duodenum



- The only objects that require urgent retrieval are button batteries
- Contain silver oxide, lithium and sodium hydroxide
- If they leak they can cause major caustic injuries
- Foreign bodies do not require the prescription of emetic or cathartic agents



Figure 253 A coin the stomach

### Pharynx

- Sharp objects (e.g. fish bones) can stick in the pharynx
- Commonest sites are tonsil, pyriform fossa, and post-cricoid region
- Objects often result in a 'scratch'
- Symptoms can persist after object has passed
- Diagnosis can often be confirmed by indirect laryngoscopy
- Fish bones may be seen on a soft-tissue x-ray of the neck
- May require removal under general anaesthetic
- Often removed by the anaesthetist!

### Bronchus and lung

- Inhaled foreign bodies usually pass down the right main bronchus
- Radio-opaque objects seen on chest x-ray
- Radio-lucent objects (e.g. peanuts) are more dangerous and more difficult to diagnose
- Organic material produces an inflammatory reaction
- If neglected results can be bronchiectasis and a lung abscess



Figure 254 Foreign body in the rectum

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## **Epistaxis**

- Main blood supply to nose is the sphenopalatine artery
- Terminal branch of the external carotid artery
- Incidence of epistaxis has a bimodal distribution
- Commonest in childhood and old age
- Causes are different in the two age groups
- Epistaxis may be classified as either anterior or posterior
- 80% of cases are anterior and arise on lower part of nasal septum (Little's area)
- 80% of cases are idiopathic

## **Aetiology**

### **Idiopathic**

- Local causes
  - Minor trauma
  - Nasal fractures
- Inflammatory
  - Infective rhinitis
  - Atrophic rhinitis
  - Sinusitis
- Neoplastic
  - Squamous carcinoma
  - Juvenile angiofibroma

### **General causes**

- Systemic hypertension
- Haematological abnormalities
- Anticoagulation

## **Management of epistaxis**

- Commonest local cause - spontaneous haemorrhage (Anterior nasal haemorrhage)
- Commonest general cause – hypertension (Posterior nasal haemorrhage)
- After initial clinical assessment will need
  - Blood count, clotting screen and possibly cross match
  - Volume resuscitation may be required
  - Exclude hypertension

### **Anterior nasal haemorrhage**

- Pressure
- 1: 1000 adrenaline applied to Little's area
- Consider cautery to retrocolumellar veins
- Can usually be achieved with a silver nitrate stick
- Electrocautery may be attempted
- Anterior nasal packing should be considered if bleeding persists
- Can be carried out with a nasal tampon or formal nasal pack
- Prophylactic antibiotics should be used if pack in place for more than 48 hours



### **Posterior nasal haemorrhage**

- Layered BIPP ribbon gauze pack
- Possibly postnasal pack or balloon
- Performed with layered BIPP ribbon gauze pack
- If fails to control bleeding need to consider surgery
- Endoscopic electrocautery can be attempted
- May require ligation of maxillary and anterior ethmoidal artery

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## **Facial nerve palsy**

### **Anatomy**

- Facial nerve arises at junction of pons and medulla
- Traverses the following structures:
  - Posterior cranial fossa
  - Internal auditory meatus
  - Temporal bone in the facial canal
  - Stylomastoid foramen
  - Parotid gland
- The terminal motor branches are:
  - Temporal
  - Zygomatic
  - Buccal
  - Marginal mandibular
  - Cervical

### **Function**

- Motor to the muscles of facial expression
- Parasympathetic secretomotor to the lacrimal gland
  - via the greater petrosal nerve
- Parasympathetic secretomotor to the submandibular and sublingual salivary glands
  - via the Chorda tympani
- Taste to the anterior two-thirds of the tongue
  - via the Chorda tympani and lingual nerve
- Somatic sensory to an area of skin around the external auditory meatus
  - via fibres from the geniculate ganglion

### **Facial nerve and Bell's palsy**

- Lower motor neurone affects whole of one side of face
- Upper motor neurone spares the forehead
- Bell's palsy accounts for 40% of facial nerve palsies
- Idiopathic and usually self-limiting
- May result from viral infection

### **Causes**

#### **Intracranial**

- Brainstem lesions
- Cerebrovascular accident
- Multiple sclerosis
- Acoustic neuroma
- Cholesteatoma

#### **Intratemporal**

- Otitis media
- Ramsay Hunt syndrome - herpes zoster oticus
- Trauma - temporal bone fracture
- Iatrogenic



### **Infratemporal**

- Parotid tumours
- Trauma
- Surgery

### **Management**

- Protection of eye
- Tarsorrhaphy may be required if palsy persists
- Surgery
- Bell's palsy - steroids may be beneficial
- Ramsey Hunt syndrome - acyclovir

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## Salivary gland disorders

### *Neoplastic salivary gland disease*

#### Pathological classification

- 75% of tumours occur in parotid gland - 15% are malignant
- 10% of tumours occur in submandibular gland - 30% are malignant
- 15% of tumours occur in minor salivary glands - 50% are malignant

#### *Benign*

- Pleomorphic adenoma (mixed parotid tumour)
- Adenolymphoma (Warthin's tumours)
- Haemangioma in children
- Lymphangioma in children

#### *Intermediate*

- Mucoepidermoid tumours
- Acinic cell carcinoma
- Oncocytoma

#### *Malignant*

- Adenoid cystic carcinoma
- Adenocarcinoma
- Squamous cell carcinoma

#### Clinical features

- Usually present as lump in the parotid region
- Most are slow-growing even if malignant
- Pain is suggestive of malignancy but is not a reliable symptom
- Facial nerve palsy is highly suspicious of a malignant tumour
- Extent of lesion can often be confirmed by CT or MRI scanning
- Open biopsy is contraindicated
- Fine needle aspiration cytology may confirm diagnosis
- Has a poor sensitivity but a high specificity

#### Pleomorphic adenoma

- Accounts for 75% of parotid and 50% submandibular tumours
- Initially described as a 'mixed' tumour
- Believed to have both epithelial and mesothelial elements
- Now appears to arise from ductal myoepithelial cells
- Male : female ratio approximately equal
- May undergo malignant change but risk is small
- Requires excision with 5-10 mm margin as local implantation of cells can lead to recurrence



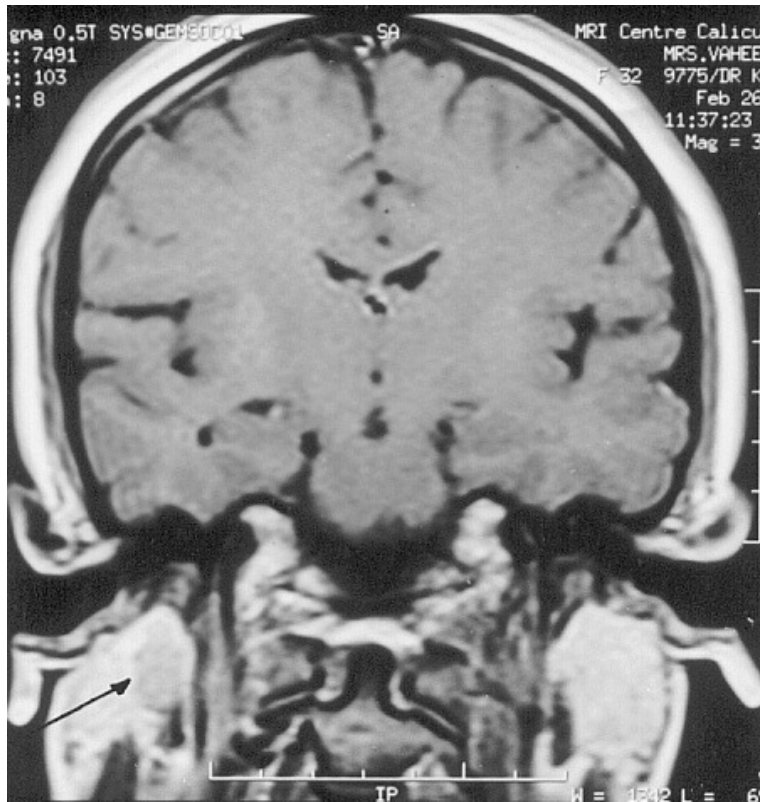


Figure 255 Coronal MRI scan of parotid tumour

#### Warthin's tumour

- Also known as an adenolymphoma
- Usually occurs in elderly patients
- Male: female ratio is approximately 4 : 1
- Accounts for 15% of parotid tumours
- 10% of tumours are bilateral
- Rare in other salivary glands
- Do not undergo malignant change

#### Intermediate salivary tumours

- Acinic cell and mucoepidermoid carcinomas account for 5% of all tumours
- Have low malignant potential
- Do not require radical therapy
- Can be treated similar to benign tumours

#### Malignant salivary tumours

- Adenoid cystic, adenocarcinomas and squamous cell tumours are rare
- All are usually high grade tumours
- Prognosis is often poor regardless of treatment
- Adenoid cystic tumours have tendency for perineural spread into the brain
- Also develop distant metastases to the lung
- Cannon-ball metastases may be present for years without symptoms
- Overall 5-year survival is approximately 50%



### Management of salivary tumours

- All tumours require partial or complete excision of the affected gland
- Enucleation of benign tumours often results in local recurrence
- In the parotid this involves either superficial or total parotidectomy
- In both procedures the facial nerve is preserved
- For malignant salivary tumours consideration should be given to:
  - Postoperative radiotherapy
  - Neck dissection if evidence of nodal involvement

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### **Non-neoplastic salivary gland enlargement**

- Acute sialadenitis - viral (mumps, CMV), bacterial
- Recurrent acute sialadenitis
- Chronic sialadenitis - tuberculosis, actinomycosis
- Calculi
- Cysts - mucous retention, ranula
- Systemic disease - pancreatitis, diabetes, acromegaly
- Sjogren's syndrome
- Sarcoidosis
- Mickulicz's syndrome
- Drug induced - phenothiazines
- Allergic

### **Acute sialadenitis**

#### **Mumps**

- Commonest cause of acute painful swelling of the parotid gland in children
- Due to paromyxovirus infection
- Flu-like illness is followed by acute bilateral painful parotid swelling
- Resolves spontaneously over 5 -10 days
- Occasionally parotid swelling may be unilateral
- Occasionally may affect submandibular glands
- Similar clinical picture may occur with Coxsackie A or B or parainfluenza virus infection

#### **Bacterial sialadenitis**

- Acute ascending bacterial sialadenitis usually affects the parotid glands
- Due to *staphylococcus aureus* or *streptococcus viridans* infection
- Incidence of this condition is decreasing
- Used to be seen in dehydrated post-operative patients with poor oral hygiene
- Presents with painful tender swelling of the parotid gland
- Pus can often be expressed from the parotid duct
- Sialogram is contraindicated
- Treatment is with parenteral broad-spectrum antibiotics
- Late presentation can cause a parotid abscess to develop

#### **Sialolithiasis**

- Of all salivary stones:
  - 80% occur in the submandibular gland
  - 10% occur in the parotid gland
  - 7% occur in the sublingual gland
- 80% of submandibular stones are radio opaque
- Most parotid stones are radiolucent
- Presentation of a submandibular stone is pain and swelling prior to or during meal
- This does however requires almost complete obstruction of the submandibular duct
- In partial obstruction swelling may be mild with chronic painful enlargement of the gland
- If diagnostic doubt then stone can be demonstrated by sialogram
- Treatment is by either removal of stone from duct or excision of the gland
- The stone should be removed if palpable with no evidence of chronic infection
- The gland should be excised if the stone posterior or gland is chronically inflamed



Figure 256 Radio-opaque parotid duct calculi



Figure 257 Submandibular sialogram



Figure 258 Submandibular calculua



### Sjogren's syndrome

- First described by Henrich Sjogren in 1933
- Autoimmune condition affecting the salivary and lacrimal glands
- Female : male is approximately 10:1
- Patients present with:
  - Dry eyes - keratoconjunctivitis sicca
  - Dry mouth - xerostomia
  - Bilateral parotid enlargement
- Often associated with connective tissue disorders
- Primary Sjogren's Syndrome - no connective tissue disorder
- Secondary Sjogren's Syndrome - associated with connective tissue disorders
- 15% patients with rheumatoid arthritis and 30% patients with SLE develop Sjogren's Syndrome
- Associated with increased risk of B-cell lymphoma
- Sialogram shows a characteristic sialectasis and parenchymal destruction
- Diagnosis can be confirmed by labial gland biopsy
- Treatment is symptomatic
- No treatment will reverse the keratoconjunctivitis and xerostomia

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## Common neck swellings

### Pharyngeal pouch

- Is posteromedial pulsion diverticulum through Killian's dehiscence
- Occurs between thyropharyngeus and cricopharyngeus muscles
- Both form the inferior constrictor of the pharynx
- Male : female ratio is approximately 5:1
- Usually only seen in the elderly
- Aetiology is unknown but upper oesophageal sphincter dysfunction may be important

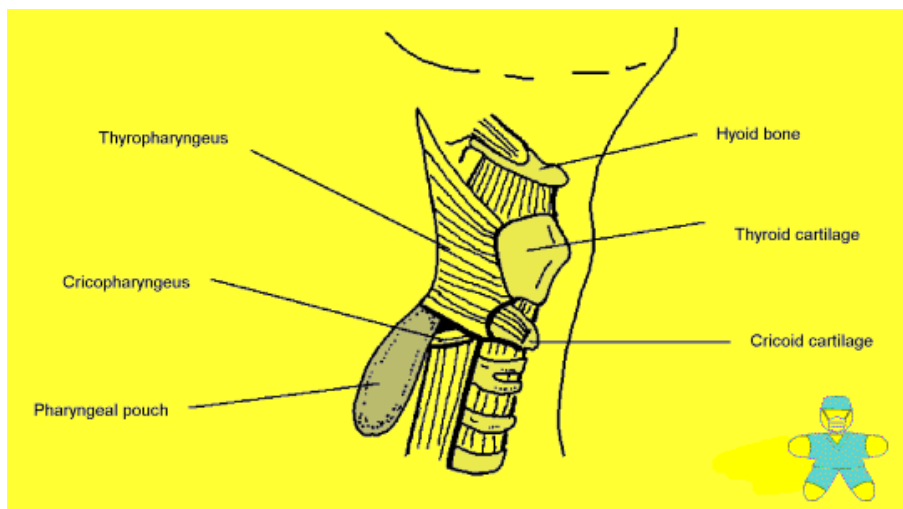


Figure 259 Anatomy of a pharyngeal pouch

### Clinical features

- Commonest symptoms are:
  - Dysphagia
  - Regurgitation of undigested food
  - Cough
- Recurrent aspiration can result in pulmonary complications
- A carcinoma can develop within the pouch
- Clinical signs are often absent
- A cervical lump may be present that gurgles on palpation

### Investigation

- Barium swallow show residual pool of contrast within the pouch
- Indirect laryngoscopy may show a pooling of saliva within the pyriform fossa

### Treatment

- Depends on size of pouch and age of patient
- Options include:
  - Diverticulectomy
  - Dohlman's procedure

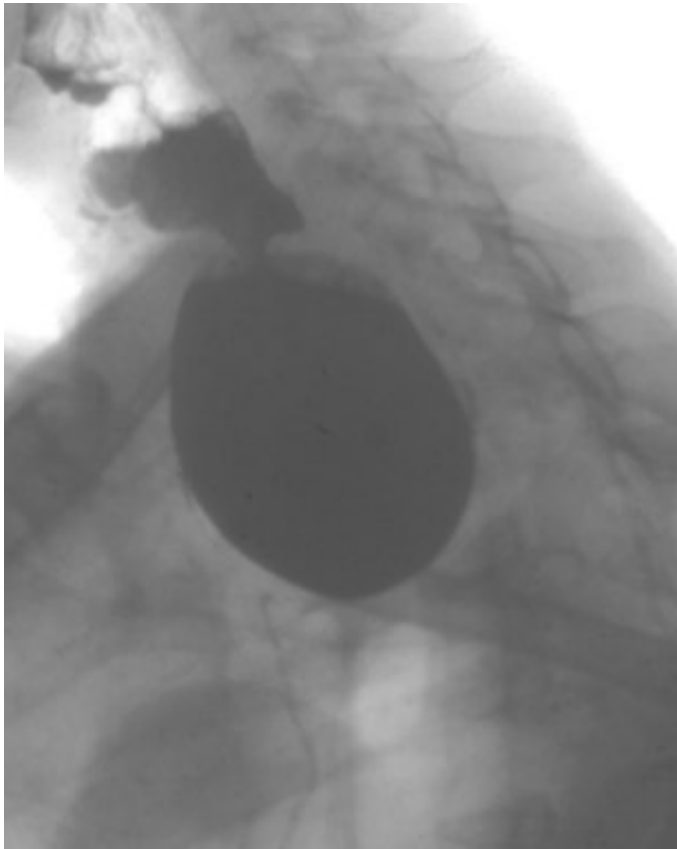


Figure 260 Barium swallow demonstrating a pharyngeal pouch

#### ***Diverticulectomy***

- Following rigid endoscopy the pouch is packed with gauze
- A 32 Fr bougie is placed with in the oesophagus
- Collar incision made at level of cricoid cartilage
- Fascia at anterior border of sternomastoid is divided
- Pouch is identified anterior to prevertebral fascia
- Pouch is then excised an defect closed
- Cricopharyngeal myotomy is performed to prevent recurrence
- Patient should be feed via a nasogastric tube for a week postoperatively
- Complications include:
  - Recurrent laryngeal nerve palsy
  - Cervical emphysema
  - Mediastinitis
  - Cutaneous fistula

#### ***Dohlman's procedure***

- Is an endoscopic procedure
- A double-lipped oesophagoscope is used
- Wall between the diverticulum and oesophageal wall is exposed
- Hypopharyngeal bar divided with diathermy or laser



- Minimally invasive techniques allow:
  - Shorter duration of anaesthesia
  - More rapid resumption of oral intake
  - Shorter hospital stay
  - Quicker recovery

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## Oral and maxillo-facial surgery

### Maxillo-facial trauma

#### *Facial and orbital injuries*

- Usually seen following sporting accidents, interpersonal violence and RTAs
- May be associated with multisystem trauma

#### **Assessment**

- Assessment should follow ATLS principals

#### *Primary survey*

- Airway compromise from a fracture or haemorrhage should be identified
- Bilateral anterior mandibular fractures may allow tongue to fall back
- Orotracheal intubation may be required
- Haemorrhage should be reduced with mouth props and epistaxis balloons
- Anterior and posterior nasal packing may be required

#### *Secondary survey*

- Palpate of orbital rims, zygomatic arches and mandible to identify fractures
- Examine eyes carefully
- Reduced eye movement may suggest orbital fracture
- Subconjunctival haemorrhage may suggest skull fracture
- Proptosis and ophthalmoplegia may suggest retrobulbar haemorrhage
- Assess sensation in maxillary branch of trigeminal nerve
- Intercanthal distance should be 30 - 35 mm
- Intercanthal distance greater than 35 mm suggests a nasoethmoid fracture
- Interpupillary distance should be 55 mm
- Intraoral examination is essential
- Allows assessment of occlusion and intraoral haematomas

#### *Radiology*

- May be difficult to obtain films in the acute setting
- Useful radiographs include:
  - Occipitomeatal views (15° and 30°) for orbital and zygomatic fractures
  - Postero-anterior views of facial bones
  - Submentovertex view for zygomatic arch fractures
  - Orthopantomogram (OPG) for mandibular fractures
  - Reverse Townes view for condyle neck fractures
  - Occlusal films for dento-alveolar fractures
- CT scanning allows complete assessment of fractures
- 3-D reconstruction is useful
- Allows production of a stereolithograph and a 1:1 resin model from the digital image



### **Classification**

- Fractures usually classified as
  - Upper third - frontal bones
  - Middle third - zygoma, nasal bones, and maxilla
  - Lower third - mandible and teeth

### **Le Fort fractures**

- Fractures of mid portion of face have been classified as
  - Le Fort 1 - Fracture detaching palate and maxillary alveolus
  - Le Fort 2 - Pyramidal fracture through sinus wall laterally and nasal bones medially
  - Le Fort 3 - Fracture through frontozygomatic sutures and orbits detaching facial skeleton from base of skull

### **Principals of treatment**

- Primary repair produces the best cosmetic results
- May be delayed for 2 or 3 days if multidisciplinary approach required
- Open reduction and internal fixation is treatment of choice allowing:
  - Anatomical reduction of fractures
  - Stable internal fixation
  - Early jaw mobilisation

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## Conditions of the face & mouth

### *Cancrum oris*

#### Epidemiology

- First described by Tourdes in 1848
- Also called noma and gangrenous stomatitis
- Occurs almost exclusively in children
- 80% patients are less than 10 years old
- Virtually unknown in Europe and North America
- Still seen in developing countries
- Often associated with immunosuppression

#### Clinical features

- Aetiology unclear but it may be a sequelae of acute necrotising gingivitis
- Results in spontaneous necrosis of the mucous membrane of the oral cavity
- Spreads into adjacent structures including cheek, nose, palate
- Early clinical features include:
  - Excessive salivation
  - Marked fetid odour
  - Grey discolouration of the affected area
- Child often has features of chronic malnutrition
- Poor oral hygiene is invariably present
- Also occurs in association with:
  - Measles
  - Typhoid
  - Bacillary dysentery
  - Tuberculosis
  - Whooping Cough
  - Leukaemia
  - Clinical course can be variable



Figure 261 Cancrum oris



### Investigation

- *Borrelia vincenti* and fusiform bacilli can be cultured in most cases
- Anaerobic bacteria may be present in rapidly progressing cases
- Facial x-rays and CT will determine degree of bone involvement

### Management

- Requires a multidisciplinary team approach
- In the early stages child will need:
  - Dehydration
  - Enteral nutrition
  - Antibiotics
  - Wound debridement
- Late treatment includes:
  - Facial reconstruction with myocutaneous and osteomyocutaneous flaps
  - Temporomandibular joint arthroplasty
- Mortality rate is now less than 10%

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## Paediatric surgery

### Principles of neonatal physiology & paediatric surgery

#### *Neonatal physiology*

##### Thermoregulation

- A full-term infant is homeothermic
- Has limited ability to regulate body temperature compared with older child

##### *Mechanisms of heat loss*

- Evaporation
- Radiation
- Conduction
- Convection

##### *Mechanisms to conserve heat*

- Peripheral vasoconstriction
- Increased heat production by increase metabolic rate and muscle activity
- Non-shivering thermogenesis

##### *Why is neonate prone to loose heat ?*

- Increased surface area to body ration
- Limited ability to shiver
- Reduced subcutaneous fat
- Relative deficiency of brown fat and glycogen

##### Hypoglycaemia

- Commonest neonatal metabolic disorder
- Often has a non-specific presentation
- Clinical features include respiratory distress, tachycardia, tachypnoea, irritability

##### *Predisposing factors*

- Diabetic mother
- Prematurity / small for gestational age
- Hydrops foetalis
- Birth asphyxia
- Sepsis
- Hypothermia

##### Neonatal Jaundice

- Physiological jaundice - normal elevation of unconjugated bilirubin in healthy neonate
- Erythroblastosis foetalis - results from materno-foetal Rhesus D Antigen incompatibility
- Kernicterus - deposition of bilirubin in basal ganglia, thalamus and hippocampus

##### *Causes of hyperbilirubinaemia*

- Haemolysis - rhesus or blood group incompatibility
- Enzyme defect - G6PD deficiency, pyruvate kinase deficiency



- Red cell structural defect - hereditary spherocytosis or elliptocytosis
- Increased red cell mass - polycythaemia
- Increased red cell sequestration - haematoma
- Reduced hepatic uptake - Gilbert's syndrome
- Reduced hepatic conjugation - Crigler-Najjar syndrome

#### ***Investigation***

- ABO group and rhesus status
- Coomb's test
- Blood film and reticulocyte count
- Total and direct bilirubin

#### ***Treatment***

- Phototherapy causes photo-oxidation of bilirubin
- Increases water solubility and increases urinary excretion
- Exchange blood transfusion may be required

#### ***Bibliography***



## **Paediatric trauma**

- Trauma is the commonest cause of death in childhood
- Road traffic accidents and falls account for 80% of injuries
- Thoracic and abdominal injuries usually result from blunt trauma
- Penetrating injuries are uncommon
- Significant injuries can occur without overlying fractures

### **Assessment**

- Assessment should follow same principles as adult
- Important to know weight of child to calculate fluid volumes and drug doses
- Weight can be estimated from age or head-to-toe length

### **Airway and breathing**

- Airway management in a child can be difficult due to
- Large head relative to size of body
- Small oral cavity with large tongue
- Large angle of the jaw
- Larynx is cephalad
- Trachea is short
- Infants less than 6 months are obligate nose breathers
- Uncuffed endotracheal tubes should be used in children before puberty

### **Circulation**

- Normal values for pulse and blood pressure vary with age
- Less than one year, pulse = 120 to 140 and systolic BP is 70-90 mmHg
- Between 2 and 5 years, pulse is 100-120 and systolic BP is 80-90 mmHg
- Between 5 and 12 years, pulse is 80-100 and systolic BP is 90-110 mmHg
- Venous access in a child can be difficult
- Femoral or external jugular access may be required
- If percutaneous cannulation fails need to consider:
  - Medial cephalic venous cut down
  - Long saphenous venous cut down
  - Intraosseous infusion
- Initial resuscitation should be with a 20 ml/kg crystalloid bolus

### **Occult chest injuries in children**

- Pulmonary contusion
- Pulmonary laceration
- Intrapulmonary haemorrhage
- Tracheobronchial tear
- Myocardial contusion
- Diaphragmatic rupture
- Partial aortic or other great vessel disruption
- Oesophageal tears



## Burns

- Relative %BSA of different regions varies between children and adult

Table 57 Relative %BSA for adults and children

Region	Adult (%)	Child (%)
Head	9	19
Body	18	18
Upper limb	9	9
Lower limb	18	13
Perineum	1	1

## Diagnostic criteria for non-accidental injury

- Delay in seeking medical advice
- Vague or inconsistent account of the accident
- Discrepancy between the history and degree of injury
- Abnormal parental behaviour or lack of concern for the child
- Interaction between child and parents is abnormal
- Finger tip bruising over upper arm, trunk, face or neck
- Bizarre injuries - bites, cigarette burns or rope marks
- Sharply demarcated burns in unusual site
- Perioral injuries - torn frenulum
- Retinal haemorrhages
- Ruptured internal organs without a history of major trauma
- Perianal or genital injury
- Long bone fractures in children less than 3 years
- Injuries of differing ages

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## Correctable congenital abnormalities

### *Congenital abnormalities – malformation and deformations*

- Approximately 2% of live births have major congenital abnormality
- Incidence is increased in pre-term and small for gestational age infants
- Malformation = disturbance of growth during embryogenesis
- Deformation = late change in previously normal structure due to intrauterine factors

### Causes of deformations

- Primigravidity
- Oligohydramnios
- Abnormal presentation
- Multiple pregnancy
- Uterine abnormality

### Malformations

Table 58 Causes of malformations

Cause	Percentage
Mendelian genetic aberration	20
Chromosomal	10
Teratogens	10
Multiple factors	30
Unknown	30

Table 59 Anatomical systems involved

Malformation	Rate per 10,000 birth
All	165
Heart	35
Genital organs	25
Urinary system	20
Central nervous system	15
Limbs	15

### Teratogenesis

- Teratogen = drug, chemical or virus that can cause foetal malformation
- Act during critical period of foetal development
- Critical period varies between organs
  - Brain 15-25 days
  - Eye 25-40 days
  - Heart 20-40 days
  - Limb 24-36 days

### Drugs as teratogens

- Hormones – progestogens, diethyl stilbestrol, male sex hormones
- Antipsychotics – lithium, haloperidol, thalidomide
- Anticonvulsants – sodium valproate, carbamazepine, phenobarbitone



- Antimicrobials – tetracycline, chloramphenicol, amphotericin B
- Antineoplastics – alkylating agents, folic acid antagonists
- Anticoagulants – warfarin
- Antithyroid agents – carbimazole, propylthiouracil
- Others – toluene, alcohol, marijuana, narcotics

#### **Microbial agents as teratogens**

- Rubella
- Toxoplasmosis
- Syphilis
- Cytomegalovirus
- Coxsackie B virus

#### **Bibliography**



## Cleft lip and palate

- Commonest congenital abnormalities of the orofacial structure
- Cleft lip / palate occurs in 1:600 live births
- Isolated cleft palate occurs in 1:1000 live births
- Often occur as isolated deformities
- Can be associated with other anomalies (e.g. congenital heart disease)
- Cleft lips and palates are a diverse and variable congenital abnormality
- Cleft lip / palate predominates in males
- Isolated cleft palate is more common in female

## Aetiology

- Cleft lip and palate is believed to have both a genetic and environmental component
- Cleft palate may be inherited as an autosomal dominant condition with variable penetrance
- Family history in a first-degree relative increases the risk by a factor of 20
- Environmental factors include:
  - Maternal epilepsy
  - Drugs - steroids, diazepam, phenytoin
  - ? Folic acid deficiency
- Cleft lip and palate also occurs as part of over 100 syndromes
  - Pierre Robin Syndrome - cleft palate, retrognathia, posteriorly displaced tongue
  - Stickler Syndrome
  - Down's Syndrome
  - Treacher Collins' Syndrome

## Embryology

- Cleft lip deformity is established in first 6 weeks of life
- Possibly due to failure of fusion of maxillary and medial nasal processes
- May be due to incomplete mesodermal ingrowth into the processes
- Extent of deficiency determines the extent of the cleft
- Palatal clefts result from failure of fusion of the palatal shelves of the maxillary processes

## Clinical features

- Typical distribution of cleft types is :
  - Cleft lip alone (15%)
  - Cleft lip and palate (45%)
  - Isolated cleft palate (40%)
- Cleft lips are more common on the left

## Primary management of cleft lip and palate

- Antenatal diagnosis of cleft lip may be possible
- Feeding is rarely a difficulty
- Breast feeding may be achieved or modified teats for bottle feeding may be required
- Major respiratory obstruction is uncommon



- The aims of surgery are:
  - To achieve a normal appearance of the lip, nose and face
  - To allow normal facial growth
  - To allow normal speech



Figure 262 Cleft lip and palate

### **Surgery**

- Many different techniques have been advocated
- Cleft lip repair is usually performed between 3 and 6 months of age
- Cleft palate repair is usually performed between 6 and 18 months
- Two or more operations may be required

### **Secondary management of cleft lip and palate**

- A multidisciplinary team approach is essential
- Other aspects that need to be addressed included:
  - Hearing
  - Speech therapy
  - Dental
  - Orthodontics

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### **Exomphalos and gastroschisis**

- Exomphalos and gastroschisis are two different congenital anomalies
- Differ markedly in their clinical appearance
- Overall incidence is approximately 1: 3000 live births
- Usually diagnosed prenatally on ultrasound
- Exomphalos and gastroschisis can usually be differentiated prenatally
- Do not inevitably require delivery by caesarian section

### **Exomphalos (omphalocele)**

- An omphalocele always has a sac
- The sac may be intact or ruptured
- It has three layers - peritoneum, Wharton's jelly and amnion
- Umbilical cord arises from apex of sac
- Sac contains intestinal loops, liver, spleen and bladder
- Often associated with other major congenital anomalies
- Prognosis depends on these associated anomalies
- Mortality is approximately 40%



Figure 263 Two examples of an omphalocele



### Treatment

- No consensus exists on the optimal management of large unruptured omphaloceles
- Treatment depends on the size of the lesion
- Aims of treatment are to reduce contents into small abdominal cavity
- If bowel is covered there is no urgency to do this
- Treatment options are both surgical or conservative and include:
  - Biological dressings
  - Polymer films
  - Direct surgical closure
  - Skin flap closure
- Small defects can usually be closed surgically
- Surgical closure of large defects may require staged procedures
- Overzealous reduction can result in caval compression
- After conservative treatment a ventral hernia repair may be required at about one year of age

### Gastroschisis

- A gastroschisis never has a sac
- Umbilical cord arises from normal place in abdominal wall
- Usually to the left of the abdominal wall defect
- Evisceration usually only contains intestinal loops
- Rarely associated with major congenital anomalies
- But may be associated with intestinal atresia
- Infants have better prognosis than those with an omphalocele
- Mortality is approximately 10%

### Treatment

- Can often be treated by direct full-layer closure of abdominal wall
- May be associated with postoperative gut dysfunction
- Usually require postoperative nutritional and ventilatory support

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### **Congenital diaphragmatic hernia**

- Occurs in 1 in 4000 live births
- Results from failure of closure of the pleuro-peritoneal canals
- 95% occur through the posterior foreman of Bochdalek
- Less than 5% occur through the anterior foreman of Morgagni
- 90% occur on the left
- The midgut herniates into the chest impairing lung development
- Usually associated with gastrointestinal malrotation

### **Clinical features**

- Often presents with cyanosis and respiratory distress soon after birth
- Prognosis is related to the time of onset and degree of respiratory impairment
- Examination shows the abdomen to flat
- Air entry is reduced on the affected side
- Heart sounds are often displaced
- Chest x-ray will confirm the presence of gastrointestinal loops in the chest
- Occasionally presents with respiratory distress of intestinal obstruction later in life

### **Management**

- Respiratory support with intubation and ventilation is usually required
- A nasogastric tube should be passed
- Gas exchange and acid-base status should be assessed
- Acidosis may need correction with bicarbonate infusion
- Surgery should be considered early after resuscitation
- Hernial content are usually reduced via an abdominal approach
- Hernial sac is excised and diaphragm repaired with nonabsorbable suture or a Gortex patch
- A Ladd's procedure may be required for malrotation
- A chest drain is usually not required
- Early respiratory failure is associated with a poor prognosis

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### **Oesophageal atresia**

- Affects 1 in 3000 live births
- Aetiology is unknown but incidence is increased in first degree relatives
- Often associated with a trachea-oesophageal fistula (TOF)
- Varies presentations include:
  - Oesophageal atresia with TOF - 85%
  - Isolated oesophageal atresia - 8%
  - Isolated TOF - 4%
- Oesophageal atresia with proximal and distal TOF
- 50% of patients have other congenital abnormalities
- Usually involving the cardiovascular, urogenital or anorectal systems

### **Clinical features**

- Prenatally diagnosed by the finding of polyhydramnios
- Stomach is empty on ultrasound
- Postnatally diagnosed by the neonate drooling or unable to swallow
- Cyanosed during feeding
- Develop aspiration pneumonia
- A 10 Fr nasogastric tube can not be passed more than 10 cm
- On chest x-ray if there is gas in the stomach there is a distal TOF

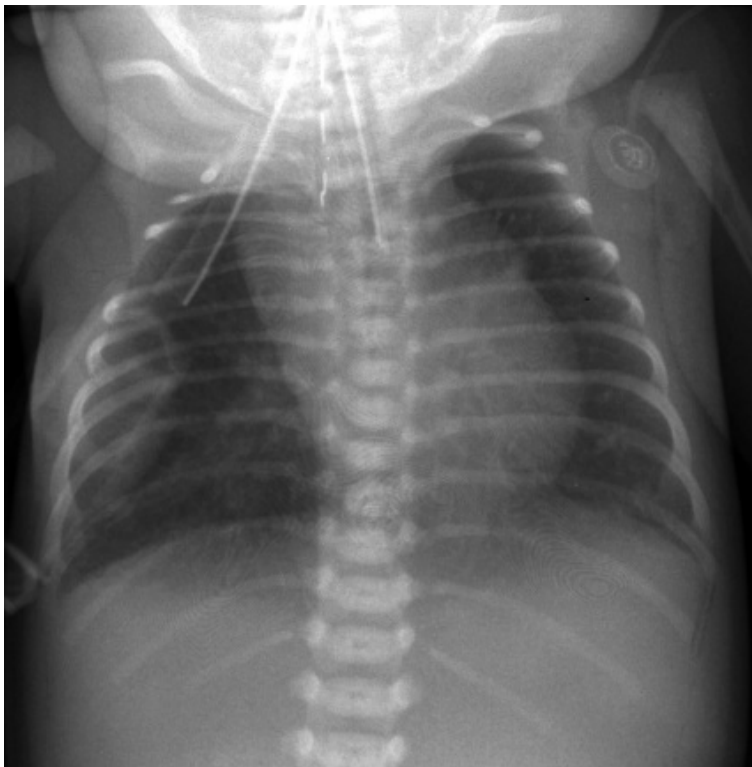


Figure 264 Radiological appearances of isolated oesophageal atresia





### Management

- Feeding is withheld and suction applied to oesophageal pouch
- Nursed in upright position
- Associated congenital abnormalities are identified
- Surgery required within first 24 hours of life
- Operation involves:
  - Right thoracotomy and extrapleural approach
  - Azygos vein is divided
  - TOF divided
  - Oesophagus mobilised and primary anastomosis is usually achieved
  - If anastomosis impossible a staged procedure required
  - Gastrostomy performed and fistula divided at initial operation
  - Oesophagus replaced by colon or stomach after a few months

### Complications

- Oesophageal dysfunction
- Dilated proximal pouch
- Gastro-oesophageal reflux
- Anastomotic stricture
- Recurrent fistula

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del Rosario J F, Orenstein S R. Common pediatric esophageal disorders. *Gastroenterologist* 1998; 6: 104-121.



### **Neonatal intestinal obstruction**

- Neonatal intestinal obstruction can be due to a variety of causes
- Presenting clinical features are often similar
- Bile-stained vomiting is never normal in a neonate and implies obstruction
- 95% of babies pass meconium within the first 24 hours of life
- Failure to pass meconium is also a feature of obstruction
- The degree of abdominal distension is variable

### **Duodenal atresia**

- Occurs in 1 in 10,000 live births
- Site of obstruction is most commonly in 2nd part of duodenum
- Proximal duodenum become hypertrophied
- 50% are associated with polyhydramnios
- 60% of such pregnancies are complicated or end prematurely
- Can often be diagnosed with antenatal ultrasound
- 30% of babies with duodenal atresia have Down's syndrome
- Other associated abnormalities are cardiac anomalies, malrotation and biliary atresia
- Postnatally presents with bilious or non-bile stained vomiting
- X-ray may show a 'double-bubble' and no gas within the bowel distally



Figure 265 Radiological appearances of duodenal obstruction

### **Management**

- A nasogastric tube should be passed
- Intravenous fluid resuscitation should be given
- Major cardiac and other defects should be excluded
- Duodenoduodenostomy should be performed when resuscitated



### Other atresias

- Atresias of the small bowel and colon are less common
- Often associated with polyhydramnios
- Bilious vomiting and distension are key features
- x-ray will show dilated bowel and a gas-free rectum
- A nasogastric tube should be passed
- Intravenous fluid resuscitation should be given
- At operation, dilated proximal bowel should be resected or tapered
- A primary anastomosis may be possible

### Meconium ileus

- Commonest cause of neonatal intraluminal intestinal obstruction
- 80% cases are associated with cystic fibrosis
- Cystic fibrosis occurs in 1 in 2000 live births
- Inherited as an autosomal recessive trait
- Viscid pancreatic secretions cause autodigestion of pancreatic acinar cells
- Resulting meconium is abnormal and putty-like in consistency
- Meconium becomes inspissated in the lower ileum
- There is a microcolon
- Presents with bilious vomiting and distension usually on first day of life
- Passage of meconium is delayed
- Meconium filled loops of bowel may be palpable
- X-ray may show a 'ground-glass' appearance, especially in the right upper quadrant

### Management

- Gastrografen enemas may be successful in 50% of patients
- If unsuccessful, surgery will be required
- Limited resection and stomas may be required

### Malrotation

- Between 4 and 10 weeks of development intestines herniate into umbilical cord
- When returned to abdomen they rotate 270 degrees anticlockwise
- As a result:
- Duodenojejunal flexure lies to the left of the midline
- Caecum lies in right iliac fossa
- Transverse colon lies anterior to the small bowel mesentery
- Partial failure of rotation results in malrotation
- Commonest abnormality results in caecum lying close to DJ flexure
- Resulting midgut mesentery is abnormally narrow and liable to volvulus
- Fibrous bands may be present between caecum and DJ flexure (Ladd's bands)
- Two principal clinical presentations
- Presents late with intermittent bile stained vomiting and distension
- Presents early with collapse and acidosis due to intestinal infarction
- Radiological investigations are often unhelpful

### Management

- After resuscitation, early laparotomy may be required
- Any volvulus should be reduced
- Resection may be required if there has been small bowel infarction
- Any Ladd's bands should be divided



- The base of the mesentery should be elongated
- Colon should be placed on the left of the abdomen
- Small bowel should be placed on the right
- Inversion appendicectomy should be performed to prevent future diagnostic uncertainty



Figure 266 Operative appearances of malrotation

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### **Hirschsprung's disease**

- Due to absence of autonomic ganglion cells in Auerbach's plexus of distal large intestine
- Commences at internal sphincter and progresses for variable distance proximally
- Affects 1 in 5000 live births
- Male :Female ratio 4:1
- Some appear to be due to autosomal dominant inheritance
- 75% cases confined to recto-sigmoid
- 10% cases have total colonic involvement

#### **Clinical features**

- 80% present in neonatal period with delayed passage of meconium
- Followed by increasing abdominal distension and vomiting
- Accounts for 10% of neonatal intestinal obstruction
- Child is at increased risk of enterocolitis and perforation
- Occasionally presents with chronic constipation in infancy



Figure 267 Clinical appearances of Hirschsprung's disease

#### **Diagnosis**

- Plain abdominal x-ray will confirm intestinal obstruction
- Barium enema may show contracted rectum, cone shaped transitional zone and proximal dilatation
- Anorectal manometry may show recto-sphincteric inhibition reflex on rectal distension
- Rectal biopsy shows:
  - Absent ganglion cells in submucosa
  - Increased acetylcholinesterase cells in muscularis mucosa
  - Increased unmyelinated nerves in bowel wall

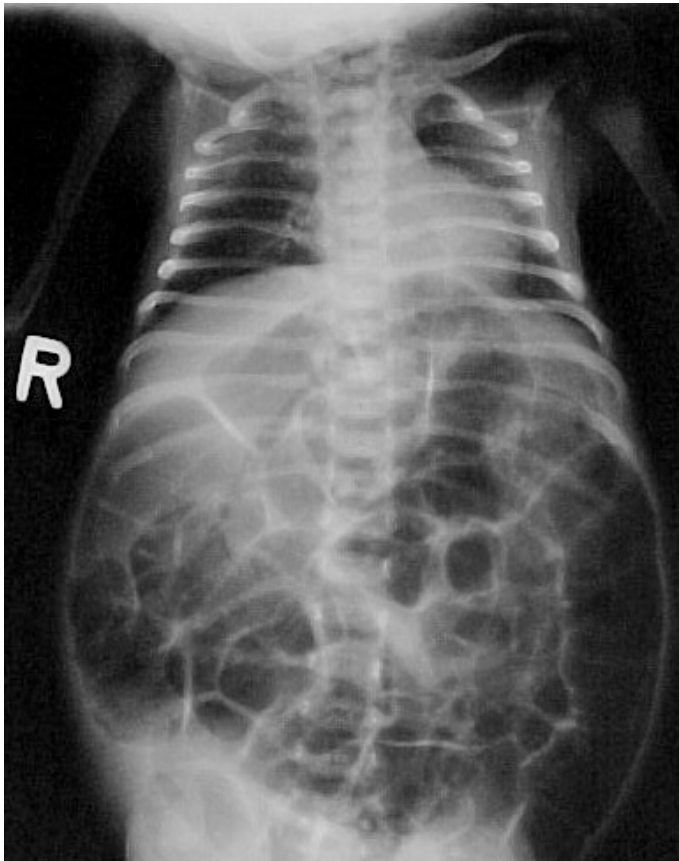


Figure 268 Radiological appearances of Hirschsprung's disease

#### **Treatment**

- Initial defunctioning stoma to relieve obstruction
- Bypass of affected segment - Duhamal or Soave bypass
- Excision of aganglionic segment - Swenson procedure

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## Hypospadias

- Affects approximately 1 in 500 boys
- Due to incomplete fusion of genital folds and glandular urethra
- Urethra found on ventral surface of penis
- Replaced distally fibrous chordee
- Deformity consists of malpositioned meatus, chordee and abnormal foreskin
- If any degree of hypospadias is present circumcision is contraindicated

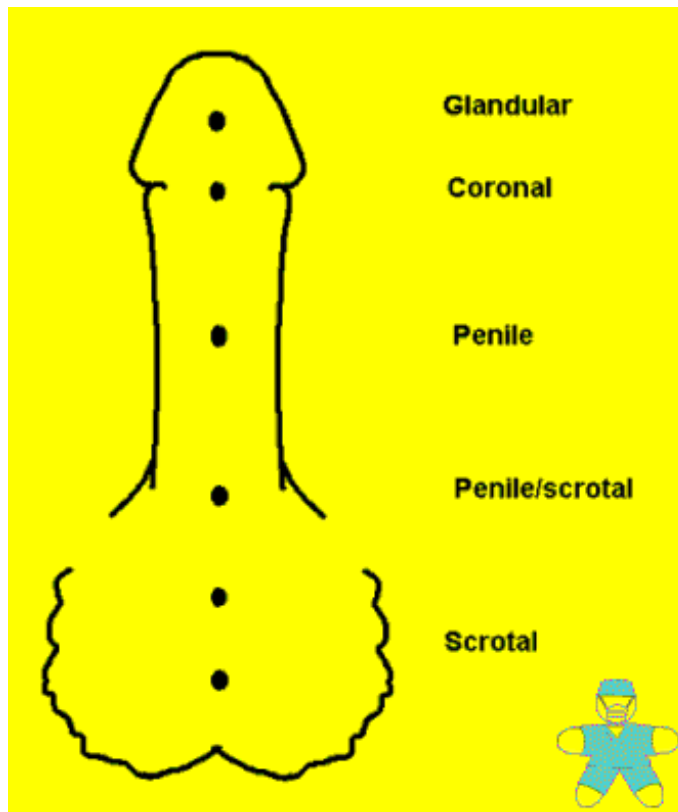


Figure 269 Types of hypospadias

- 70% are glandular or coronal
- 10% are penile
- 20% are scrotal
- Perineal hypospadias is associated with intersex and anorectal anomalies

### Management

- Treatment is required
  - To improve urinary stream
  - To allow sexual intercourse
- Usually performed between 2 and 4 years of age
- Glandular hypospadias requires a glandular meatotomy
- Coronal hypospadias requires a meatal advancement and glanduloplasty (MAGPI operation)
- Proximal hypospadias without a chordee can be treated by a skin flap advancement
- If chordee present it should be excised and an island flap urethroplasty performed



### **Complications**

- Complications of hypospadias surgery include:
  - Urethral fistula
  - Urethral stricture

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## Neural tube defects

### Embryology

- The nervous system develops from the dorsal ectoderm
- The lateral edges of the neural plate fold to form the neural groove
- Fusion of the edges of the neural groove forms the neural tube
- Fusion start cranially and progresses caudally
- Both caudal and cranial ends of the tube remain temporarily open
- The anterior neuropore closes at about 25 days
- The posterior neuropore closes at about 27 days

### Spina bifida

- The term spina bifida covers a range of vertebral and neural tube defects
- Result from failure of the posterior vertebral arch to fuse
- Most commonly occur in lumbo-sacral region

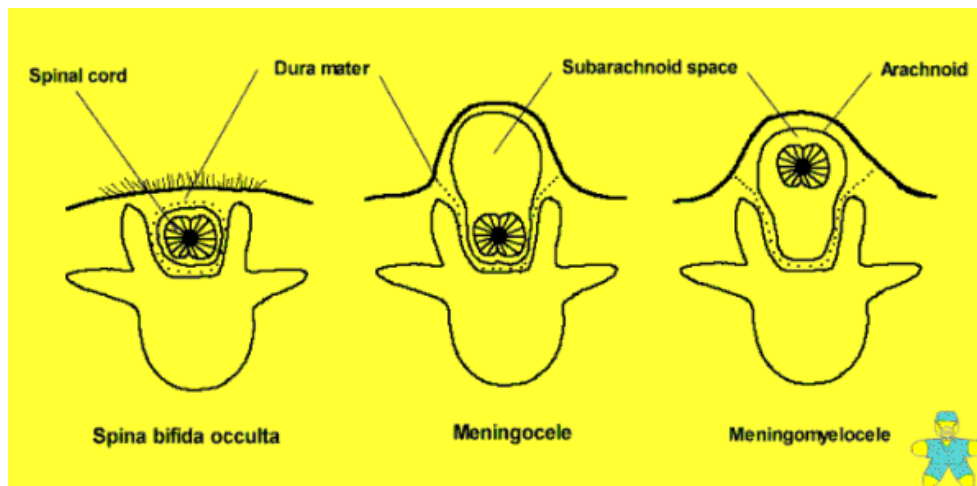


Figure 270 Neural tube defects

### Spina bifida occulta

- Commonest form of spina bifida
- True prevalence is unclear
- Isolated laminar defects are seen on about 5% of lumbar spine x-rays
- The spinal cord is usually normal
- Only clinical sign is often a tuft of hairs or skin dimple at the site of the defect
- Neurological deficit is rare
- May present with subtle neurological abnormalities such as enuresis or incontinence

### Meningocele and myelomeningocele

- If meninges bulge through defect can result in a meningocele or myelomeningocele
- Meningocele does not contain spinal cord elements
- Myelomeningocele contains spinal cord and nerve roots
- May be associated with caudal displacement of medulla and cerebellum
- Can result in hydrocephalus (Arnold-Chiari malformation)



- Also associated with other abnormalities such as talipes and hip dislocation

#### **Clinical features**

- Occurs in 2-3 per 1000 live births
- Can be detected prenatally by increased serum alpha-fetoprotein
- Spinal defect is clinically obvious
- Can result in various degrees of
  - Limb weakness
  - Sensory loss
  - Joint dislocation and contractures
  - Urinary disorders
- Of patients with a meningocele
- One-third have complete paralysis and loss of sensation below the level of the defect
- One-third have preservation of distal segments below the level of the defect
- One-third have an incomplete lesion
- 90% of children develop urinary problems



Figure 271 A meningocele

#### **Management**

- Management is complicated and should involve a multidisciplinary team
- Team should include paediatrician, orthopaedic surgeon, neurologist, physiotherapist etc
- Treatment depend on level and severity of defect
- Patients with high defects and gross neurological defects many not be candidates for surgery
- If good prognosis the aim should be to achieve skin closure with 48 hours of birth
- Ventriculo-caval shunting may be required in the first week
- Early treatment of orthopaedic abnormalities is by physiotherapy
- Surgical intervention (e.g. osteotomies) may be required in the first few years of life



Figure 272 A myelomeningocele

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## Common paediatric surgical disorders

### *infantile hypertrophic pyloric stenosis*

- It is not truly a congenital disorder
- Results in hypertrophy and hyperplasia of pyloric sphincter in neonatal period
- Mainly affects circular muscle fibres
- Pylorus becomes elongated and thickened
- Possibly due to failure of nitric oxide synthesis
- Results in gastric outflow obstruction, vomiting and dehydration
- Multifactorial inheritance
- Strong genetic factor
- Affects 3 per 1000 live births
- Male : female 4:1
- Most common in first born males
  - Risk to son if affected mother is 20%
  - Risk to daughter if affected mother is 7%
  - Risk to son if affected father is 5%
  - Risk to daughter if affected father is 2%

### *Clinical features*

- Usually presents between 3 and 6 weeks of age
- Late presentation up to 6 months can occur
- Rapidly progressive projectile vomiting without bile
- Child hungry and often feeds immediately after vomiting
- Dehydration and alkalosis is a prominent clinical feature
- Clinical features of dehydration include:
  - Sunken eyes
  - Depressed anterior fontanelle
  - Reduced skin turgor
  - Dry mucous membranes
  - Increased capillary refill time
  - Lethargy
- Palpable 'tumour' in right upper quadrant best felt from left during test feed
- Visible peristalsis often seen
- Diagnosis can be confirmed by abdominal ultrasound
- Needs assessment of length, diameter and thickness of the pylorus
- A wall thickness of greater than 3mm supports the diagnosis
- Biochemically a hypochloraemic alkalosis exists
- Serum electrolytes and capillary gases should be measured
- They should be corrected prior to surgery

### *Treatment*

- Correct dehydration over a 24 - 72 hour period
- Nasogastric tube is often required
- Ramstedt's pyloromyotomy first described in 1911
- Transverse right upper quadrant or circumumbilical incision
- Longitudinal incision in pylorus down to mucosa
- Incision extend from duodenum onto gastric antrum
- Avoid mucosal perforation
- Feeding re-established within 12-24 hours of surgery



- Recurrence rarely occurs
- Complications are rare and mortality is negligible
- Persistent postoperative vomiting may be due to
  - Delayed return of normal gastric motility
  - Gastro-oesophageal reflux
  - Inadequate pyloromyotomy

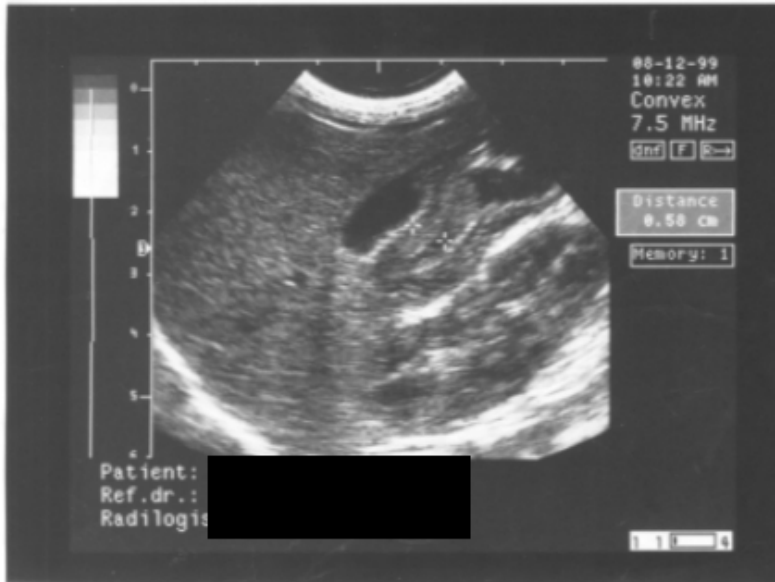


Figure 273 Ultrasound appearances of pyloric stenosis



Figure 274 Operative appearance of pyloric stenosis

- Operation has been described using a laparoscopic approach
- No clear benefit has been demonstrated over a circumumbilical approach



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### ***Intussusception***

- Occurs when one part of bowel invaginates (intussusceptum) into an adjacent section (intussusciens) resulting in intestinal obstruction and venous compression
- If uncorrected it can result in arterial insufficiency and necrosis
- Commonest abdominal emergency between 3 months and 2 years
- Peak incidence 6 to 9 months
- Most idiopathic with the lead point due to enlarge Peyer's patches due to a viral infection
- 5% due to polyp, Meckel's diverticulum, duplication cyst or tumour
- Commonest site involved is the ileocaecal junction

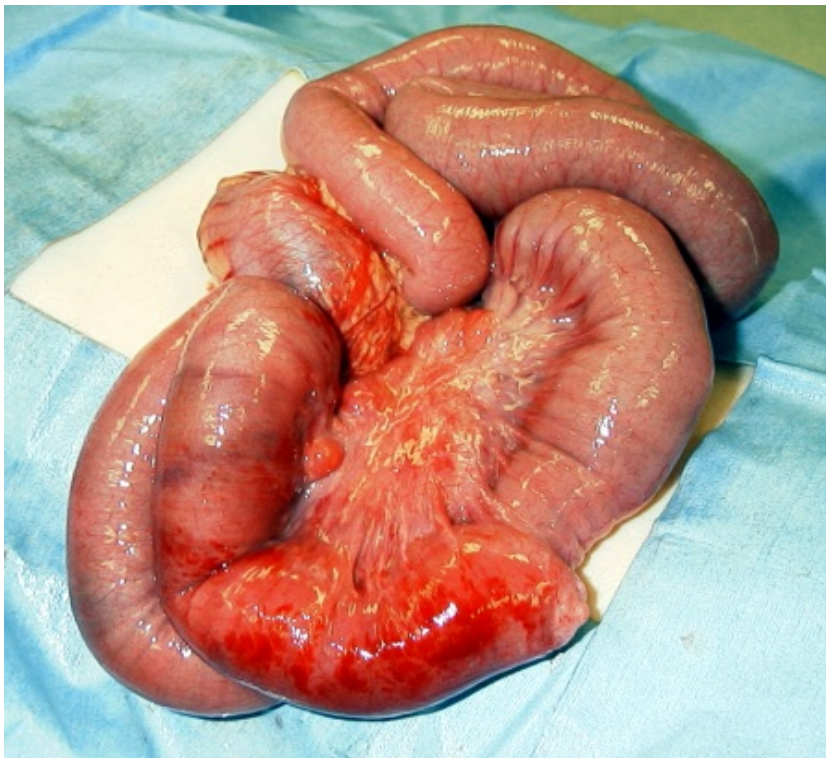


Figure 275 Operative appearance of an intussusception

### ***Clinical features***

- Intermittent colicky abdominal pain and vomiting
- Each episode classically last 1-2 min and recurs every 15-20 min
- Passage of blood -'red currant jelly' pr
- Sausage shaped abdominal mass
- Diagnosis confirmed with water soluble contrast enema or ultrasound

### ***Treatment***

- Resuscitation with intravenous fluids and nasogastric tube
- Attempt reduction with air or contrast enema under radiological guidance
- If peritonitis, shock or failed reduction requires surgery
- If bowel necrosis requires resection with primary anastomosis



Figure 276 Appearances of intussusception on barium enema



Figure 277 Appearance of intussusception on ultrasound

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### **Necrotising enterocolitis**

- Affects 0.5 to 1 per 1000 live births
- Aetiology unknown but bacterial infection and hypoxia appear important
- Occurs in premature or low birth weight infants
- Associated with premature rupture of membranes, prolonged labour and respiratory distress
- Also well recognised following umbilical artery catheterisation
- Usually affects terminal ileum and colon to a variable extent
- Characterised by mucosal necrosis with progression to intestinal infarction and perforation

### **Clinical features**

- Usually occurs in the first week of life
- Child is lethargic and apathetic with vomiting and increasing abdominal distension
- Bloody diarrhoea is a late feature
- Abdominal examination may show peritonitis or a mass
- Abdominal x-ray may show:
  - Distended bowel with mucosal oedema
  - Intramural gas (= pneumatosis intestinalis)
  - Portal venous gas or free intraperitoneal gas
- Extent of pneumatosis is not proportional to severity of illness
- The presence of pneumatosis *per se* is not an indication for surgical intervention
- Portal venous gas is a poor prognostic sign



Figure 278 Radiological appearances of necrotising enterocolitis



## Treatment

- Initial treatment involves vigorous resuscitation and medical management
- Nasogastric intubation, fluids and antibiotics are important
- Parenteral nutrition should be considered
- Indications for surgery include:
  - Increasing peritonitis
  - Failure of stabilisation with medical treatment
  - Development of an abdominal mass
  - Persistent loop or free gas on an abdominal x-ray
- Surgical treatment will involve resection with possible primary anastomosis



Figure 279 Necrotising enterocolitis

## Prognosis

- Overall the prognosis is poor
- Mortality of those undergoing medical treatment is about 20%
- Mortality of those coming to surgery is about 30%
- Amongst survivors about 30% develop ischaemic colonic strictures

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Hall N, Pierro A. Necrotising enterocolitis. *Hosp Med* 2004; 65: 220-225.

Voss M, Moore S W, van der Merwe I, Pieper C. Fulminating necrotising enterocolitis. outcome and prognosis. *Pediatr Surg Int* 1998; 13: 576-586.



## ***Abdominal masses in children***

### **Causes of abdominal masses**

#### ***Gastrointestinal***

- Congenital hypertrophic pyloric stenosis
- Crohn's disease
- Intussusception
- Constipation

#### ***Liver***

- Biliary atresia
- Choledochal cysts
- Hepatitis
- Hepatoblastoma

#### ***Genitourinary***

- Hydronephrosis
- Nephroblastoma
- Urethral valves

#### ***Other***

- Neuroblastoma
- Splenomegaly
- Retroperitoneal sarcoma
- Teratoma

### **Nephroblastoma (Wilms' tumour)**

- Originates from the embryonal kidney
- Pathologically contains renal tissue with various degrees of differentiation
- Affects about 1 in 10,000 live births
- 60% present before the age of three years
- 10% tumours are bilateral
- The presentation is with an:
  - Abdominal mass (90%)
  - Abdominal pain (20%)
  - Haematuria (30%)
- Diagnosis can be confirmed by CT scan
- 40% have metastatic spread at presentation but do not prevent cure
- Treatment is with nephrectomy and postoperative chemotherapy and radiotherapy
- Stage 1 disease (localised to kidney) has 3-year survival of >80%
- Stage 4 disease (haematogenous spread) has 3-year survival less than 30%



Figure 280 Clinical appearance of a nephroblastoma

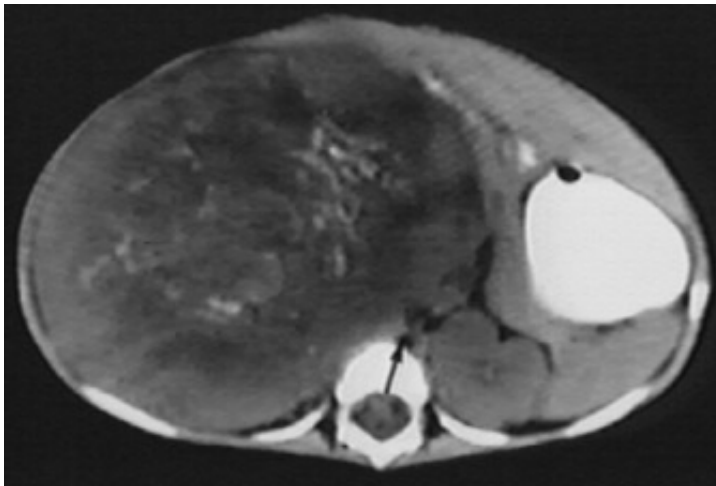


Figure 281 CT appearance of a nephroblastoma

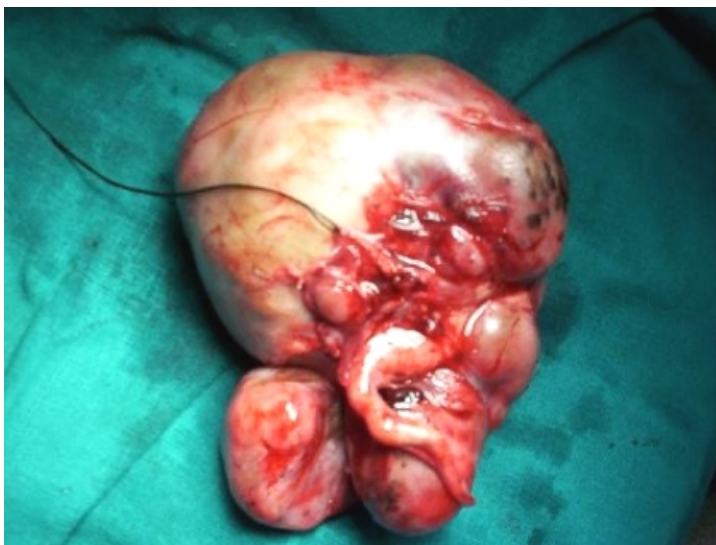


Figure 282 Pathological appearance of nephroblastoma



### Neuroblastoma

- Arises from neural crest tissue - usually adrenal medulla or sympathetic ganglia
- Show a range of malignancy from benign ganglioneuroma to malignant neuroblastoma
- Tumours in children are usually malignant
  - 75% are abdominal
  - 25% arise in thorax, pelvis or neck
- Affects about 1 in 8,000 live births
- Usually occur in first five years of life
- Clinical presentation depends on site of tumour and presence of metastases
- Bone and pulmonary metastases are relatively common
- Symptoms often due to metastases include:
  - Pallor, weight loss, irritability (40%)
  - Limb pain and hypertension (15%)
  - Abdominal mass or pain (30%)
- 90% have increased urinary VMA and HVA
- Pain abdominal x-ray often shows diffused speckled calcification
- Diagnosis can be confirmed by CT scan
- Treatment is with surgery and post-operative radiotherapy
- Prognosis is best in children presenting before 2 years
- Stage 1 disease (localised to kidney) has 3-year survival of >90%
- Stage 4 disease (haematogenous spread) has 3-year survival less than 30%

### Bibliography

Geller E, Smergel E M, Lowry P A. Renal neoplasms of childhood. *Radiol Clin North Am* 1997; 35: 1391-1413.

Petruzzi M J, Green D M. Wilms' tumor. *Pediatr Clin North Am* 1997; 44: 939-952.



## Choledochal cysts

- Localised cystic dilatation of all or part of the common bile duct
- 80% present in childhood
- Most common in Japan (1 in 1000 live births)
- Relatively rare in Western Europe (1 in 100,000 live births)
- Male : female ratio is 1:4
- Aetiology unknown

### Pathology

- Cyst wall consists of fibrous tissue without muscle
- May contain up to 2 litres of fluid
- Often associated with distal common bile duct stenosis
- If not diagnosed they can progress to biliary fibrosis, cirrhosis and liver failure
- Three types are described

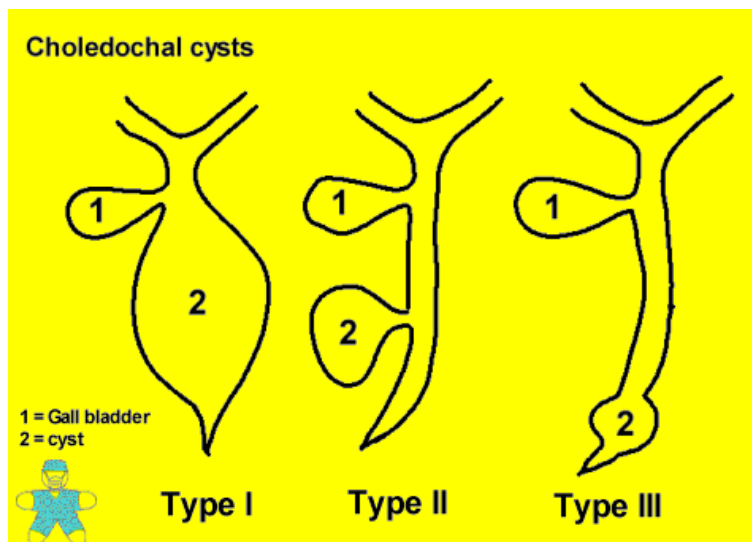


Figure 283 Classification of choledochal cysts

### Presentation

- May be diagnosed prenatally on ultrasound
- 25% present in neonates with prolonged jaundice and cholestasis
- 75% later in childhood with triad of:
  - Abdominal pain
  - Abdominal mass
  - Intermittent jaundice
- Differential diagnosis includes biliary atresia and neonatal hepatitis

### Investigation

- Abdominal ultrasound usually reveals the cyst
- Cyst can also be imaged by ERCP or PTC
- Radioisotope scanning may show delayed biliary excretion and accumulation in the cyst

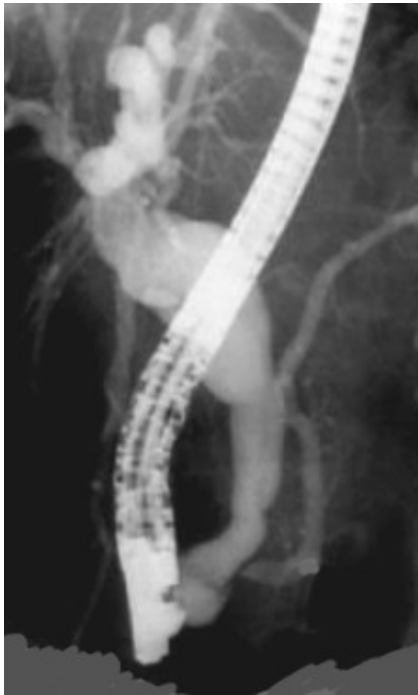


Figure 284 ERCP appearances of a choledochal cyst

### **Complications**

- Recurrent cholangitis
- Hepatic fibrosis
- Biliary cirrhosis and portal hypertension
- Rupture with biliary peritonitis
- Pancreatitis
- Hepatic abscess
- Gall stones
- Carcinoma of the biliary tree

### **Treatment**

- Type I and II cysts
  - Cyst should be resected and a hepaticojejunostomy performed
  - Prevents anastomotic stricture and malignancy in the cyst
  - Postoperative cholangitis is uncommon
- Type III cysts
  - Cholecystectomy and choledochojejunostomy or choledochoduodenostomy

### **Prognosis**

- If diagnosed early liver fibrosis regresses and normal hepatic function can be expected
- Prognosis is poor if advanced disease with portal hypertension

### **Bibliography**

Geller E, Smergel E M, Lowry P A. Renal neoplasms of childhood. *Radiol Clin North Am* 1997; 35: 1391-1413.

Petruzzi M J, Green D M. Wilms' tumor. *Pediatr Clin North Am* 1997; 44: 939-952.



### Rectal bleeding in children

- Most rectal bleeding in children is benign
- It however may signify a life-threatening disease
- Likely aetiology can be dictated by patients age and other associated clinical features

	Neonates	Infants	Children
Common	Anal fissure	Anal fissure	Anal fissure
	Necrotising enterocolitis	Intussusception	Juvenile polyp
	Viral gastroenteritis	Gastroenteritis	Meckel's diverticulum
Less common	Midgut volvulus	Meckel's diverticulum	Inflammatory bowel disease
	Intussusception	Upper GI haemorrhage	Intussusception
			Vascular malformations
			Solitary rectal ulcer
			Henoch Schonlein purpura

#### Anal fissures

- Can occur at any age in child
- Child is often constipated
- Fissure is often visible
- Often settles with laxative but may need anal stretch

#### Necrotising enterocolitis

- Typically seen in premature and sick neonates
- Presents with abdominal distension, vomiting and rectal bleeding
- Plain AXR shows intramural gas
- Treatment is with fluid resuscitation, antibiotics and parenteral nutrition
- Surgery necessary if perforation, stricture or abscess formation

#### Large bowel polyps

- Present with painless bleeding in other fit and well child
- Juvenile polyps account for 80% of rectal polyps in childhood
- 70% of patients are less than 5 years old
- Polyps are usually solitary and are often found in the rectum

#### Infective enteritis

- Infective enteritis can occur at any age
- Causative agents include:
  - Viruses - rotavirus, cytomegalovirus
  - Bacteria - Campylobacter, Shigella, Salmonella, *E. coli*
  - Protozoa - Amoeba, Giardia
- Fresh stool should be sent for microscopy, virology and culture





### ***Meckel's diverticulum***

- Remnant of vitello-intestinal duct
- Found in 2% of population
- 30% have heterotopic rectal mucosa that can result in ulceration and bleeding
- Usually presents with painless rectal bleeding
- Best diagnosed with radioisotope scan
- Other complications include:
  - Intussusception
  - Small bowel obstruction
  - Meckel's diverticulitis
  - Gastrointestinal perforation

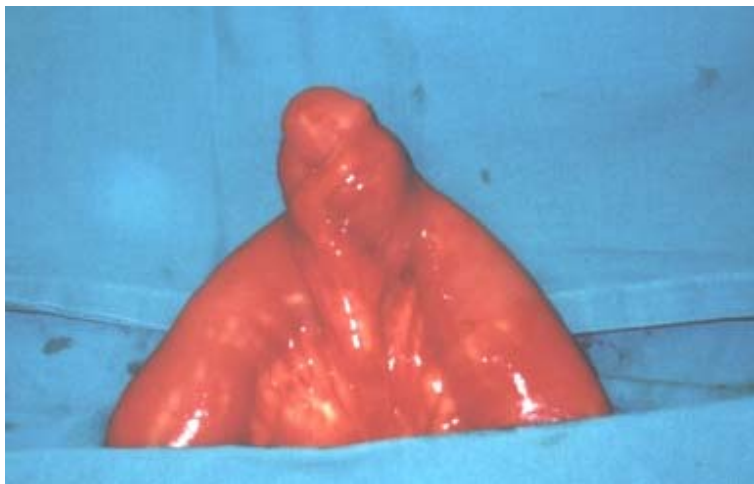


Figure 285 A Meckel's diverticulum

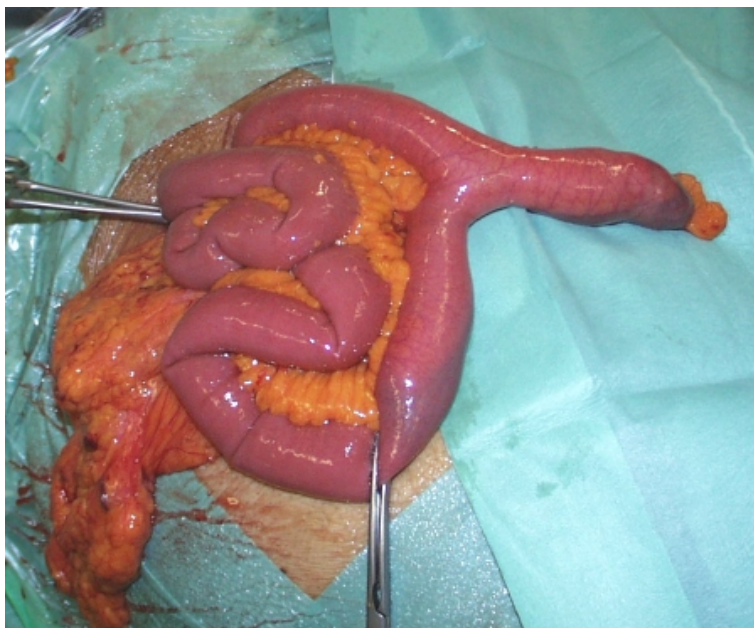


Figure 286 Another Meckel's diverticulum



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Fa-Si-Oen P R, Roumen R M, Croiset van Uchelen F A. Complications and management of Meckel's diverticulum - a review. *Eur J Surg* 1999; 165: 674-678.



## **Circumcision**

- A circumcision was first performed on Abraham at age of 90 years!
- Several other references to circumcision exist in the Old Testament
- It is also depicted on several Egyptian tombs and murals
- At birth the prepuce is normally adherent to the glans penis
- Produces a physiologically non-retractile foreskin
- Only 4% of boys have retractile foreskin at birth
- By 5 years, 90% will have a retractile foreskin
- Only 1% of boys have a true phimosis
- Only 3% boys have recurrent balanitis
- Each year 21,000 circumcisions are performed in the United Kingdom
- In the United kingdom, 4% of boys will have had a circumcision by the age of 15 years
- In Scandinavia, 2% of boys are circumcised
- Many operations are probably unnecessary

## **Indications**

- Social and cultural
- Phimosis due to balanitis xerotica obliterans, lichen sclerosis or trauma
- Balanitis or posthitis
- Ballooning of foreskin
- Paraphimosis



Figure 287 Paraphimosis



### **Technique**

- Free all adhesions
- Avoid excessive tension in order to preserve skin
- Avoid blind dissection of foreskin to avoid glans injury
- Use sutures or bipolar diathermy for haemostasis
- Avoid excessive skin sutures

### **Complications**

- 1% need reoperation for bleeding or haematoma
- Ulceration or suppuration
- Urethral meatitis

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Williams N, Chell J, Kapila L. Why are children referred for circumcision? *Br Med J* 1993; 306: 28.

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## ***Neck lumps in children***

### ***Aetiology***

- Neoplasia in children is rare
- Most head and neck lumps result from congenital or inflammatory processes

### ***Anterior triangle***

- Lymphadenopathy
  - Primary infection - tuberculosis, toxoplasmosis
  - Secondary infection - lymphadenitis
  - Primary tumours - Hodgkin's' or non-Hodgkin's lymphoma
  - Secondary tumours
- Thyroglossal cysts
- Dermoid cyst
- Goitre
- Branchial cyst

### ***Posterior triangle***

- Lymph nodes
- Cystic hygroma
- Sternomastoid tumours
- Parotid swellings

### ***Branchial remnants***

- Branchial sinuses and cysts arise from second branchial sinus
- Arise on anterior border of sternomastoid
- Often bilateral and extend deep into neck
- Internal opening occasionally found in tonsillar fossa
- Treatment is by surgical excision



Figure 288 Branchial fistula



### **Cystic hygroma**

- Hamartomatous lymphatic malformations resulting in multi-cystic mass
- 60% are found in neck region
- Often present in early childhood as expanding mass
- Contain clear fluid and transilluminate brightly
- Large lesions can be diagnosed prenatally and can result in obstructed labour
- Surgical excision is difficult and can result in a poor cosmetic result
- Sclerosants may be useful



Figure 289 Cystic hygroma

### **Sternomastoid tumours**

- Mass in middle third of sternomastoid muscle
- Results from muscle damage during labour
- Presents with neck lump and torticollis away from affected side
- Treatment should involve physiotherapy to correct the torticollis
- Surgery to the lump is rarely required.

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## **Paediatric hernias**

### **Inguinal hernias**

- Commonest surgical condition encountered in childhood
- 2.5% of children require an operation for an inguinal hernia
- Incidence is increased in premature and low birth weight infants
- Male: female ratio is 9:1
- 5% new born male have an inguinal hernia
  - 70% are right sided
  - 25% are left sided
  - 5% are bilateral
- 99% are indirect hernias
- 30% present within the first year of life
- 15% present with incarceration
- 75% incarcerated hernias present less than one year of age

### **Embryology**

- Testis descends into scrotum during 7th month of gestation
- Preceded by processus vaginalis - an outpouching of peritoneum
- Processus normally begins to obliterate prior to birth
- Closure normally complete during first year of life
- Persistence of all or part of the processus can result in:
  - Inguinal hernia
  - Communicating hydrocele
  - Non-communicating
  - Hydrocele of the cord

### **Clinical features**

- Usually presents with intermittent groin lump
- In girls the lump is in the upper part of the labia majora
- Hernias can be difficult to detect in a quiet child
- Increases in size with straining or crying
- May reach into the scrotum

### **Management**

- Less than one year old should be operated on as urgent elective cases
- Older one year old surgery is less urgent
- Can often be performed as a day case procedure
- Inguinal herniotomy is performed
- Transverse incision made in lowest inguinal skin crease
- Scarpa's fascia is divided
- External ring is identified
- Sac is dissected off the cord and divided
- Dissection is continued proximally until the peritoneal reflection is identified
- Sac is then transfixed and excised
- The wound is closed and the testis pulled back into the scrotum
- 20% children develop a contralateral hernia
- Controversial as to whether contralateral exploration should be performed



Figure 290 Left inguinal hernia

#### ***Irreducible hernias***

- Initial management should be with reduction by taxis
- Required gentle pressure usually without sedation
- Forcible reduction under general anaesthesia is contraindicated
- If remains irreducible should be operated on within 24 hours
- If intestinal obstruction present preoperative resuscitation is essential

#### ***Complications***

- Wound infection
- Recurrence
- Vas injury
- Undescended testis
- Testicular atrophy

#### ***Paediatric umbilical hernia***

- Common surgical problem of newborn infants
- Present in 10% caucasian babies
- Seen in 90% of babies of Afro-Caribbean descent
- Incidence is increased
  - Low birth weight
  - Down's syndrome
  - Beckwith-Wiedemann syndrome
- Hernia is usually symptomless
- Strangulation is extremely rare
- 95% spontaneously close by 2 years of age
- Surgical repair only needs to be considered if present beyond this age



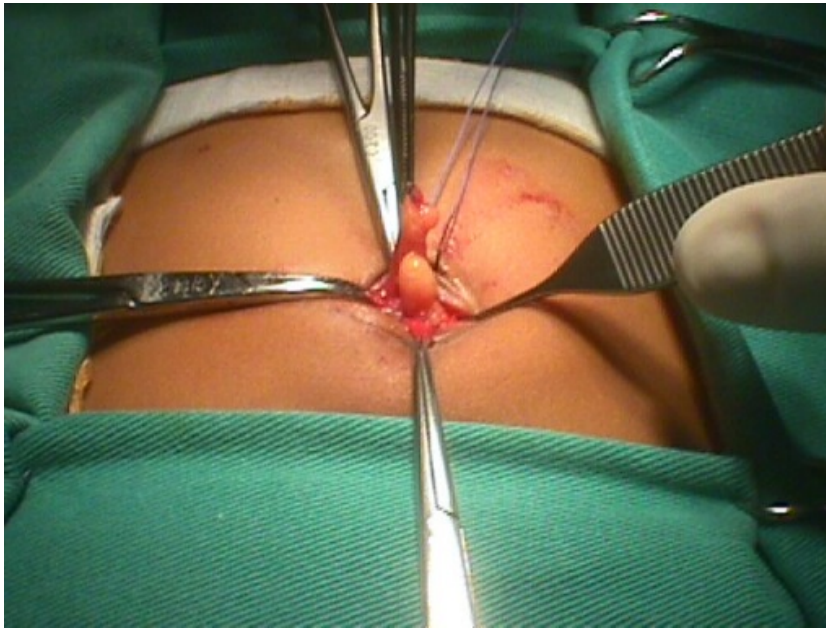


Figure 291 Paediatric umbilical hernia

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### **Undescended testes**

- Cryptorchidism is testis in abnormal position
- Testis undergoes intra-abdominal descent up to 28 weeks
- Normally found in inguinal canal from 28-32 weeks
- Should be expected to be found in scrotum from 30 weeks onwards
- In full-term infants incidence of cryptorchidism is 6%
- By three months incidence has fallen to 2%
- High incidence of cryptorchidism seen in premature infants
- 'Normal' testis = scrotal or retractile testis
- 'Abnormal' testis = Never been seen low in scrotum and can not be manipulated to that position



Figure 292 Left Maldescended testis

### **Undescended testis**

- Found in normal path of descent
- Usually found in inguinal canal or abdomen

### **Maldescended testis**

- Has exited via the superficial inguinal ring but is now in an ectopic position
- Usual sites are the femoral triangle or perineum
- In 80% of patients with cryptorchidism the testis is palpable
- 90% of impalpable testes are either high in inguinal canal or abdomen
- True anorchidism is rare and is due to primary agenesis or neonatal torsion
- Cryptorchidism increases risk of testicular tumours by x10
- 10% of patients with testicular tumours give a history of testicular maldescent
- Cryptorchidism also increases risk of infertility
- Of patients with cryptorchidism - 30% have oligospermia and 10% azospermia

### **Treatment of cryptorchidism**

- If testis palpable in inguinal canal or high in scrotum patient requires orchidopexy
- Should be performed during second year of life



- Usually performed via 'groin and scrotum' incision
- Testis often placed in dartos pouch
- Early orchidopexy may improve fertility
- No evidence that it reduces risk of malignancy but allows early identification
- If testis is impalpable, laparoscopy is best means of identifying intra-abdominal testis, vas and vessels.
- If no vas, vessels or testis = primary agenesis
- If vas vessels but no testis = neonatal testis or other vascular event
- If intrabdominal testis identified consider staged orchidopexy or microvascular transfer
- If vas vessels seen entering inguinal canal then explore the groin
- No evidence that hormonal treatment (e.g. LHRH) induces descent

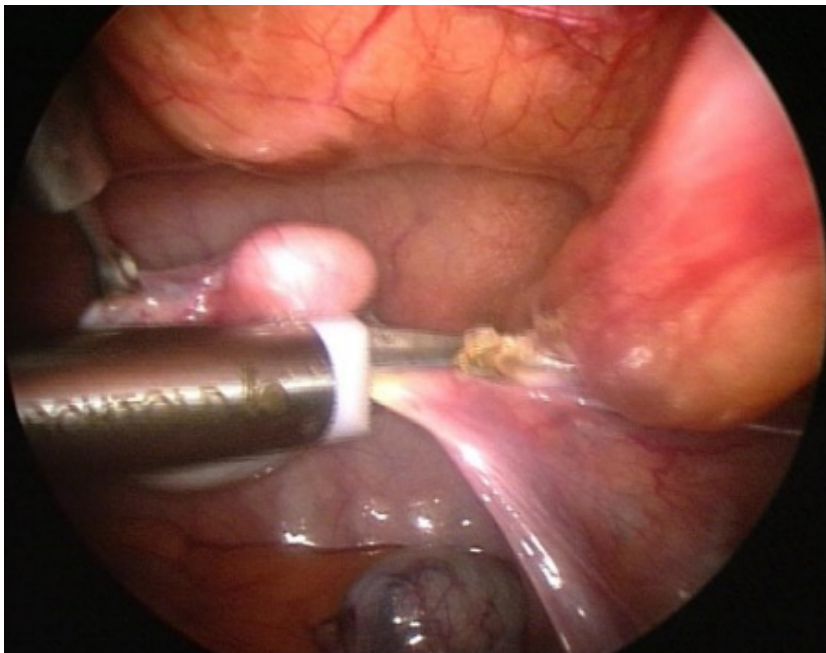


Figure 293 Laparoscopic orchidopexy

#### **Fowler-Stephen's orchidopexy**

- This is a two-staged procedure
- Gonadal vessels are divided at first operation
- This can be achieved laparoscopically
- This encourages a collateral blood supply to develop via cremasteric and vassal vessels
- Six months later the testis is mobilised on these vessels
- Testis is delivered through abdominal wall medial to inferior epigastric vessels

#### **Outcome of orchidopexy**

- Testis is often smaller and higher in the scrotum than normal testis
- Testis may atrophy and retract to higher position
- Fertility may be reduced



- Following bilateral orchidopexy
  - 25% men will have normal sperm counts
  - >50% will have azospermia
- Following unilateral orchidopexy
  - 50% have subnormal sperm counts
  - 50% have normal sperm counts

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## Orthopaedic disorders of infancy and childhood

### Hip disorders

Table 60 Diagnostic calendar of hip disorders

Age at onset (years)	Probable diagnoses
Birth	Congenital dislocation
0 - 5	Perthe's disease
	Late presentation of CDH
	Irritable hip
5 - 10	Perthe's disease
	Irritable hip
10 - 15	Slipped upper femoral epiphysis
	Infection
	Rheumatoid arthritis

#### Congenital dislocation of the hip

- Developmental dysplasia of the hip is a more accurate term
- Common features include:
  - Dysplasia of the acetabulum
  - Femoral neck anteversion
- Apparent incidence depends on age
- 20 per 1000 neonates have clinical evidence of hip instability
- Only 1 per 1000 have evidence of hip dislocation at 3 months

#### Aetiology

- Family history - increases risk by x 30
- Sex - female : male ratio is 5:1
- Breech presentation
- Foot deformity
- Torticollis
- Neuromuscular disorders
- Skeletal dysplasias

#### Clinical features

- Congenital dislocation of the hip can present as
  - Neonate with hip instability
  - Infant with limited hip abduction
  - Toddler with a limp
  - Adult with degenerative hip changes
- All neonates should be screened for hip instability
- Hips are flexed to 90 degrees and instability detected by:
  - Reduction of dislocation by abduction and forward pressure (Ortalan's test)
  - Dislocation of hip by adduction and backward pressure (Barlow's test)
- Ultrasound may be useful but with a high sensitivity it results in significant over diagnosis
- Plain x-rays not reliable until child is 3 months old
- In infant diagnosis should be suspected if there is a limp
- Examination may show limb shortening, extra thigh skin crease and hip external rotation



- X-ray will show shallow acetabulum with underdeveloped femoral head

### **Management**

- The aim of treatment are:
  - To reduce the dislocation by traction or open reduction
  - To maintain reduction by harness, cast, soft tissue release or osteotomy
- Need to achieve stable congruous reduction without damaging the growth plate
- The above aims can be achieved by:
  - Pavlick hip harness or Von Rosen splint in a neonate
  - Traction in a infant
  - Open reduction +/- osteotomy or acetabuloplasty in an older child

### **Causes of an 'irritable hip'**

- Perthe's disease
- Slipped upper femoral epiphysis
- Juvenile chronic arthritis
- Septic arthritis
- Osteomyelitis
- Rheumatic fever

### **Perthe's disease**

- A childhood osteochondrosis of the hip
- Occurs secondary to avascular necrosis of the capital femoral epiphysis
- It is a self-limiting disorder with revascularisation occurring within 2 - 4 years
- The femoral head may remain deformed resulting in osteoarthritis
- Four stages of the disease are recognised
  - Stage 1 - Avascular necrosis
  - Stage 2 - Fragmentation of the femoral epiphysis
  - Stage 3 - Regeneration and revascularisation
  - Stage 4 - Healing

### **Clinical features**

- Median age of onset is 6 years
- Male : female ratio is approximately 4:1
- Presents with hip pain and a limp
- Examination shows reduced movement - especially abduction & internal rotation
- 10% have fixed deformity

### **Radiology**

- Xray shows capital femoral epiphysis to be smaller, denser and flattened
- Medial joint space is increased and ossific nucleus is fragmented
- Bone scan will show a 'cold' femoral epiphysis



Figure 294 Perthe's disease of the right hip

#### **Treatment**

- Aims of treatment are to prevent deformation of femoral head and prevent osteoarthritis
- Can be achieved by:
  - Period of bed rest & reduced weight bearing
  - Surgical containment achieved by a subtrochanteric or innominate osteotomy

#### **Slipped upper femoral epiphysis**

- Commonest significant hip disorder of adolescence
- Femoral head 'slips' posteriorly and into varus
- Occurs in the obese and skeletally immature child
- A progressive disorder and therefore early diagnosis is essential
- Male : female ratio 3:1
- 20% of cases are bilateral
- 5% of patients have family history

#### **Clinical features**

- Usually presents with gradual onset of hip or knee pain
- Clinical features are initial minimal and diagnosis is often missed
- Occasionally presents with sudden onset of pain after exercise
- Examination shows an antalgic gait
- Initially hip may have full range of movement
- A severe slip results in fixed external rotation

#### **Radiology**

- Radiological diagnosis can be difficult
- A 'frog lateral' radiograph is possibly best at demonstrating the slipped epiphysis

#### **Treatment**

- The aims of treatment are to
  - Preserve blood supply to femoral head
  - Stabilise the physis
  - Prevent avascular necrosis and chondrolysis
- Usually achieved by *in-situ* pinning of the epiphysis



- Occasionally reconstructive subtrochanteric osteotomy is required



Figure 295 Slipped up left femoral epiphysis

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## **Scoliosis**

- A scoliosis is an apparent lateral curvature of the spine
- It is a triplanar deformity with lateral, anteroposterior and rotational components
- Postural scoliosis is secondary to pathology away from the spine (e.g. short leg or pelvic tilt)
- Curvature disappears when patient sits down
- Structural scoliosis is a non-correctable deformity
- Vertebral rotation results in spinal processes swinging to concavity of curve
- Secondary changes occur to counterbalance primary deformity
- Most cases of structural scoliosis are idiopathic
- Can also result from bone, neurological or muscular disease

### **Clinical features**

- A scoliosis shows a typical deformity with a skew back and rib hump
- The hip normally protrudes on the concave side
- The scapula normally protrudes on the convex side
- The level and direction of the major curve convexity should be noted
- Convexity of curvatures determines the nomenclature of the lesion
- e.g. A right thoracic scoliosis has the thoracic spine convex to the right
- A balanced deformity keeps occiput in midline
- A fixed scoliosis become more obvious on flexion
- The younger the child and greater the curvature the worse the prognosis

### **Radiology**

- Full length PA and lateral films of the spine are required
- Upper and lower ends of spinal curve can be identified
- Angle of curvature (Cobb's angle) can be measured
- Lateral bending view can assess degree of correctability
- Skeletal maturity important as scoliosis can progress during skeletal growth

### **Idiopathic scoliosis**

- 80% of scolioses are idiopathic
- Patients often have a family history
- Many patients have a trivial curvature
- About 0.2% of population have greater than 30° of curvature
- Age of onset defines three groups as adolescent, juvenile and infantile

### **Adolescent idiopathic scoliosis**

- Occurs with an onset older than 10 years
- 90% patients are female
- Progression is not inevitable
- With curvature of less than 20° spontaneous resolution can occur
- Predictors of progression include young age, marked curvature and skeletal immaturity
- Main aim of treatment is to prevent mild deformity becoming severe
- If mild scoliosis with progression consider brace
- If greater than 30° and progressing operative intervention may be required
- Harrington rods used to reduce rotational deformity and lateral curvature



### **Juvenile idiopathic scoliosis**

- Occurs with an onset between 4 and 9 years
- Relatively uncommon condition
- Prognosis is worse than adolescent group
- Spinal fusion may be necessary before puberty

### **Infantile idiopathic scoliosis**

- Occurs with an onset less than 3 years
- Is a rare condition
- 60% patients are boys
- In 90% the deformity resolves spontaneously
- In those in whom progression occurs the curvature can be severe
- Associated with a high incidence of cardiopulmonary dysfunction

### **Osteopathic scoliosis**

- Associated with hemivertebrae, wedged vertebrae and fused vertebrae
- Overlying tissue often shows angiomas, naevi and skin dimples
- Scoliosis usually mild
- Before considering surgery need to exclude and meningomyelocele

### **Neuropathic / myopathic scoliosis**

- Associated with polio, cerebral palsy and muscular dystrophy
- Scoliosis is typically long and convex towards side of muscle weakness
- Xray with traction with assess the degree of correctability

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## Plastic & reconstructive surgery

### Burns

#### Pathophysiology

- A burn is defined as coagulative destruction of the skin or mucous membrane
- Can be caused by:
  - Heat
  - Chemical
  - Irradiation
- Thermal damage occurs above 48 °C
- Extent of necrosis is related to temperature and duration of contact
- Burns can result in:
  - Increased capillary permeability and fluid loss
  - Hypovolaemia and shock
  - Increased plasma viscosity and microthrombosis formation
  - Haemoglobinuria and renal damage
  - Increased metabolic rate and energy metabolism

#### Assessment

- Initial assessment should be by ATLS principles
- Good early management is required to prevent morbidity or mortality

#### Airway

- Look for signs of inhalation injury
- Facial burns, soot in nostrils or sputum

#### Breathing

- Be aware of carbon monoxide poisoning
- Patient may appear 'pink' with a normal pulse oximeter reading

#### Circulation

- The fluid loss from a burn is significant
- It can result in hypovolaemic shock and acute renal failure

#### Assessment of extent

- Need to assess percentage body surface area (BSA) involved
- Estimated from Lund & Browder chart or Wallace 'Rule of nines'
- Surface area covered by patients hand with fingers closed is 1%



Table 61 Wallace 'Rule of nine'

Body area	Percentage (%)
Head	9
Each upper limb	9
Each lower limb	18
Front of trunk	18
Back of trunk	18
Perineum	1

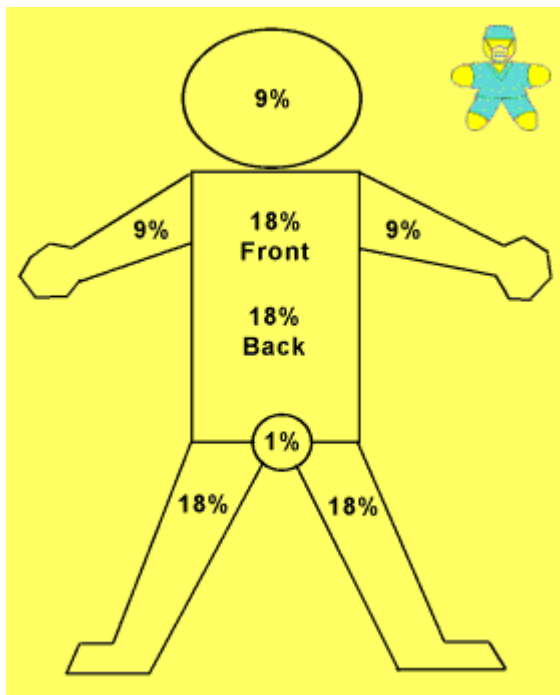


Figure 296 Wallace's rule of nines

### Burn depth

- Ability of skin to repair depends on depth of burn
- Burns can be classified as:
  - Superficial burns
  - Partial thickness burns
  - Full-thickness burns

### Superficial burns

- Needs to be differentiated from erythema
- Epidermis and papillae only are involved
- Results in red serum-filled blisters
- Skin blanches on pressure
- Burn is painful and sensitive
- Healing occurs in 10 days with no scarring



### **Partial-thickness burns**

- Epidermis is lost with varying degrees of dermis
- Burn is usually coloured pink and white
- May or may not blanch on pressure
- Variable degrees of reduced sensation may be present
- Epithelial cells are present in hair follicles and sweat glands
- Results in regeneration and spread
- Healing occurs in 14 days
- Some depigmentation of scar may occur
- May require skin grafting

### **Full-thickness burns**

- Both epidermis and dermis are destroyed
- Burn appears white and does not blanch
- Sensation is absent
- Without grafting healing occurs from edge of wound

### **Fluid replacement**

- To assess fluid replacement need to know:
  - Time of injury
  - Patients weight
  - Percent BSA involved
- Intravenous fluid replacement needed for >10% BSA in a child and 15% BSA in adult
- Many formulas devised to estimate fluid requirement

### **Muir and Barclay formula**

- $Weight(Kg) \times \% BSA / 2$  per period
- Provides volume (in ml) of colloid to be given in first 4 hours
- This volume can be repeated
- Every 4 hours for the first 12 hours
- Every 6 hours between 12 and 24 hours
- Once between 24 and 36 hours

### **ATLS formula**

- $Weight(Kg) \times \% BSA \times (2to4)$
- Gives total volume (in ml) to be infused in first 24 hours

### **Metabolic water**

- Metabolic water should be given in addition to resuscitation fluid
- In adult = 2L 5% dextrose
- In child = 100ml/Kg for first 10 kg + 50 ml/Kg for each subsequent Kg

### **Assessment of resuscitation**

- Patient should be monitored to assess adequacy of resuscitation by
  - Clinical assessment
  - Vital signs - pulse, BP
  - Urine output (> 50 ml/ hour in adult)
  - Haematocrit (aim for 0.35)



### Criteria for referral to burns unit

- Greater than 10% BSA in child
- Greater than 15% BSA in adult
- Inhalation injuries
- Burns involving the airway
- Electrical burns
- Chemical burns
- Specials areas - eyes, face, hand, perineum



Figure 297 Facial and hand burns

### Escharotomy

- Deep circumferential burns of torso can impair respiration
- In a limb can reduce distal vasculature
- In both situations escharotomies should be considered
- No anaesthetic is required
- Burn should be incised into subcutaneous fat
- Release of underlying soft tissue should be ensured
- On chest should be performed bilaterally in anterior axillary line
- Bleeding may be significant and transfusion may be required



## Special situations

### Respiratory burns

- Smoke inhalations should be suspected if:
  - Explosion in enclosed environment
  - Flame burns to the face
  - Soot in mouth or nostrils
  - Hoarseness or stridor
- Intubation may be required
- Blood carboxyhaemoglobin levels can give indication of extent of lung injury



Figure 298 Escherotomy to full-thickness leg burn

### Electrical burns

- Most electrical burns are flash burns and are superficial
- Do not occur by electrical conduction
- Flash from an electrical burn can reach 4000 °C
- Low-tension burns are usually small but full thickness
- High-tension burns usually have an entry and exit wound
- Current passes along path of least resistance (e.g. blood vessels, fascia, muscle)
- Extent of tissue destruction can often be underestimated
- High-tension burns can be associated with cardiac arrhythmias
- Myonecrosis and myoglobinuria can also occur

### Chemical burns

- Commonest acids involved are hydrochloric, hydrofluoric and sulphuric
- Acid burns may penetrate deeply down to bone
- First aid treatment involves liberal irrigation with running water
- Calcium gluconate may be useful in hydrofluoric acid burns
- Commonest alkalis are sodium hydroxide and cement
- Again can cause deep-dermal or full-thickness burns



Figure 299 Chemical burn left leg and foot



Figure 300 Burns contracture





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## Malignant skin lesions

### *Malignant melanoma*

#### Epidemiology

- Incidence of melanoma is doubling every 10 years
- 40 per 100,000 per year in Queensland, Australia
- 4 per 100,000 per year in Scotland
- Overall 1000 deaths / year in United Kingdom
- Education increasing the number of thin tumours detected
- Number of thick tumours detected annually remains constant

#### Risk factors

- Giant melanocytic naevus
- Total number of naevi
- Dysplastic naevus syndrome
- History of recurrent sunburn
- 10% autosomal dominant with reduced penetrance

#### Clinical features

##### *Major Sign*

- Change in size
- Change in shape
- Change in colour
- Diameter >7 mm

##### *Minor signs*

- Inflammation
- Bleeding
- Sensory changes



Figure 301 Nodular malignant melanoma



### Early detection

- Lesion unlikely to be a melanoma without at least one major sign
- Early detection
- Lesion unlikely to be a melanoma without at least one major sign
- Educational efforts at early detection are proving successful
- Need to assess
  - A = Asymmetry
  - B = Border irregularity
  - C = Colour variegation
  - D = Diameter



Figure 302 Acral lentiginous melanoma on the sole of the foot

### Pathology

- 60% arise in pre-existing naevi
- Have initial radial and then vertical growth phase
- Determines growth characteristics of the tumour

### **Superficial spreading melanoma (65%)**

- Occurs in middle age
- Female : male ratio 2:1
- Commonest sites - lower leg in women and trunk in man
- Usually slightly elevated lesion with variable colour

**Nodular melanoma (27%)**

- Aggressive tumour
- Occurs in younger age group
- Female : male ratio 1:2
- Early vertical growth phase
- Usually uniform colour, early ulceration and bleeding

**Lentigo maligna melanoma (7%)**

- Least malignant
- Usually found on face of elderly
- Long radial growth phase
- Presents as flat light brown macule

**Acral lentiginous melanoma (1%)**

- Aggressive tumour
- Commonest type found in Negro and orientals
- Occurs on soles of feet and palms of hand
- Subungual melanomas included in this group

**Intransit metastases**

- Uncommon. Seen in less than 2% tumours
- Appear as intracutaneous metastases or 'satellites'
- Those within 2 cm of primary classified as part of it
- Usually associated with regional lymphadenopathy

**Lymph node metastases**

- Commonest metastatic presentation
- Reduces survival by 50%
- 70 - 80% patients with regional lymphadenopathy have distant disease

**Tumour thickness**

- Tumour thickness most important prognostic factor for local, distant recurrence and survival
- With regional lymphadenopathy 10-year survival is less than 10%
- No internationally agreed classification of definition of thin, intermediate and thick tumours
- Review of trials and comparison of trials difficult

Table 62. Five-year survival related to Breslow thickness (mm)

	<b>Five-year survival (%)</b>
Less than 0.75 mm	95-99
0.76-1.49 mm	80-90
1.5-3.99 mm	60-75
More than 4.0 mm	<50



## Melanoma surgery

### Resection margins

- Until recently history and not controlled trials have dictated practice
- Handley (1907)
  - Hunterian Lecture based on one case
  - Recommended 5 cm margin
- Butterworth and Klaude (1934)
  - Found microscopic lymphatic invasion to 3 cm
  - Recommended 5 cm resection margins
- Olson (1966)
  - Trial of resection 1 cm vs. 3 cm resection margins
  - Identical local recurrence rate but still recommended 5 cm margin !
- WHO Melanoma Group (1990)
  - Randomised controlled trial of 1 cm vs. 3 cm resection margins
  - Resection margins did not influence survival
- Generally accepted resection margins based on clinical appearance are:
  - Impalpable lesions - 1 cm margin
  - Palpable lesion - 2 cm margin
  - Nodular lesion - 3 cm margin

### Regional lymphadenectomy

- 20% clinically palpable nodes are histologically negative
- 20% palpably normal nodes have occult metastases
- Therapeutic lymph node dissection provides regional control and prognostic information
- No improvement in survival
- For tumours less than 0.75 mm thick - 90% cured by local excision alone
- For tumours more than 4.0 mm thick - 70% have distant metastases at presentation
- For these two groups lymphadenectomy provides no added survival benefit
- Lymphadenectomy for 'intermediate' thickness tumours controversial

### Morbidity of lymphadenectomy

- Lymphoedema (26%)
- Seroma (23%)
- 'Functional deficit' (8%)
- Wound Infection (5%)
- Persistent pain (5%)

### Adjuvant Therapy

- Patients at high risk of recurrence should be considered for systemic adjuvant therapy
- Patients include those with:
  - Primary tumour > 4 mm thick
  - Resectable positive locoregional lymph nodes
- No standard adjuvant therapy exists
- Interferon  $\alpha 2b$  has shown promising results
- Shown to increase disease-free and overall survival



### Isolated limb perfusion

- Intra-arterial chemotherapy
- Commonly used agents - Melphalan +/- TNF-alpha
- Used with hyperoxygenation
- Hyperthermia at temperature of 41-42 °C
- Perfusion generally last about 1 hour
- Usually combined with lymphadenectomy

### Indications

- Intransit metastases
- Irresectable local recurrence
- Adjuvant therapy for poor prognosis tumours
- Palliation to maintain limb function



Figure 303 Locally recurrent malignant melanoma

### Morbidity of ILP

- Mortality (2%)
- Limb oedema (76%)
- Persistent pain (60%)
- Neuropathy (25%)
- Venous thrombosis (10%)
- Septicaemia & thrombocytopenia (3%)



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## **Other skin cancers**

### **Basal cell carcinoma**

- Commonest skin malignancy
- Occurs on sun exposed skin
- Commonest site face above line from angle of mouth to ear
  - Predisposing factors
  - Xeroderma pigmentosa
  - Radiotherapy
- BCC are locally invasive. They rarely metastasise

### **Clinical types of BCC**

- Nodular or noduloulcerative
- Cystic
- Pigmented
- Sclerosing
- Cicatrical
- Superficial



Figure 304 Basal cell carcinomas

### **Treatment**

- Local excision with 0.5 cm margins
- May require full thickness graft
- Radiotherapy
- Mohs Surgery
- Cure rate more than 95%





### Squamous cell carcinoma

- Second commonest cutaneous malignancy
- Commonest site - face & hands
- Arises from keratinising cell layer
- Predisposing factors:
  - Solar keratoses
  - Bowen's disease
  - Viral warts
  - Chronic ulceration or sinuses ( = Marjolin's Ulcers)
- Appear as keratotic nodule with ulcerated centre



Figure 305 Squamous cell carcinoma

### Differential diagnosis

- Keratoacanthoma
- Basal cell carcinoma
- Amelanotic melanomas
- Skin adnexal tumours

### Treatment

- Wide local excision +/- elective lymph node dissection

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## ***Benign skin lesions and manifestations of systemic disease***

### ***Peutz Jeghers syndrome***

- Inherited as autosomal dominant disorder
- Circumoral mucocutaneous pigment lesions on lower lip, buccal mucosa, palate
- Hamartomatous polyps in small Intestine but also colon and stomach
- Polyps have fibrous and smooth muscle core with normal epithelium
- Variable size from few mm to several cm
- Presents in childhood with GI bleeding, anaemia or Intussusception
- Malignant change in 2 - 3%

### ***External angular dermoid***

- Sequestration dermoid lined by epidermis
- Occur on face at lines of fusion of embryonic processes
- Commonest site around eye at site of fusion of frontal / maxillary processes
- Often extend into orbit / skull
- Need x-ray prior to excision

### ***Tricholemmal cyst***

- Inherited as autosomal dominant condition
- 90% occur on scalp and are often multiple
- Derived from hair follicles
- Not simple epidermoid cysts

### ***Pyogenic granuloma***

- Not Pyogenic & Not Granuloma
- Capillary Haemangioma with ? traumatic aetiology
- Bright red friable nodule.
- Characterised by contact bleeding
- Commonest site - Hands
- Treatment - curettage or diathermy but unusually regress if untreated

### ***Cylindroma***

- Benign tumour of eccrine sweat glands
- Can be solitary or multiple
- Multiple tumours = Turban Tumour
- Treatment - Local excision

### ***Dermatofibroma***

- Benign Histiocytoma
- More common in women than men
- Small firm pigmented nodule usually pink or brown
- Commonest site - Leg
- Treatment - Local excision

### ***Keratoacanthoma***

- Aetiology unknown
- More common in men than women
- Rapidly growing usually over 6-8 weeks
- Dome shaped with keratin filled crater up to 3 cm diameter



- If untreated involutes over 6 months leaving irregular pitted scar
- Differential Diagnosis = SCC
- Treatment - Excision biopsy



Figure 306 External angular dermoid



Figure 307. Pilar cysts



Figure 308 Peutz Jegher's syndrome



Figure 309 Pyogenic granuloma



Figure 310 keratoacanthoma



Figure 311 Cylindroma



## ***Pigmented skin lesions***

- Melanocytes are of neuroendocrine origin
- Migrate to skin during first 3 months of intrauterine development
- Produce melanin from tyrosine
- Melanin stored in melanosomes before being exported to keratinocytes
- Freckle is increased production by normal number of melanocytes
- Naevus is pigmented lesion due to increased number of melanocytes
- Naevi believed to evolve from Junctional - Compound - Intradermal

### ***Junctional naevus***

- Usually presents as small flat macule
- Often appear in childhood
- Homogenous brown / black
- Increased melanocytes in rete pegs

### ***Compound naevus***

- Presents as raised papule
- Pale brown
- Junctional component and nest of cells in dermis

### ***Intradermal naevus***

- Flesh coloured papule
- Increase prevalence in middle age
- No junctional activity
- Only intradermal nests

### ***Blue naevus***

- Dome shaped blue / black papule
- Middle aged
- More common in women
- Commonest site - scalp & face
- Dermal collection of spindle melanocytes with melanin in dendritic cells
- Possibly due to incomplete migration of melanocytes to epidermis

### ***Halo naevus***

- Benign naevus with pale rim
- Needs to be differentiated from melanoma with regression
- Naevus with lymphocytic invasion and melanocyte destruction

### ***Juvenile melanoma (= Spitz naevus)***

- Benign tumour
- Histologically mimic melanoma
- Regular melanocytes with a vascular stroma
- Epidermal hypertrophy
- Young adults
- More common in women
- Single pink domed shaped nodule
- Commonest site - head & neck



Figure 312 Basal cell papilloma

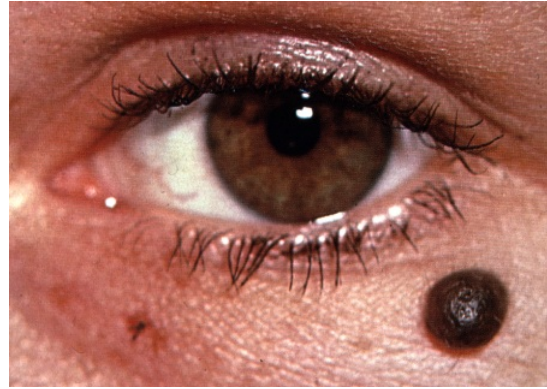


Figure 313 Compound naevus



Figure 314 Halo naevus



Figure 315 Spitz naevus

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## ***Nail disorders***

### ***Ingrowing toenails***

- Common problem in adolescents and young adults
- Usually affects the hallux but other nails may be affected
- Due to lateral edge of nail cutting and growing into adjacent soft tissue
- Bacterial or fungal infection may be superimposed
- Attempted healing may result in over granulation nail bed
- Possible aetiological factors include:
  - Poorly fitting shoes
  - Poor foot care
  - Inappropriate nail cutting



Figure 316 Bilateral ingrowing toe nails

### ***Management***

- In the early stages conservative management should be attempted
- This should include:
  - Regular soaking and washing of feet
  - Careful drying after washing
  - Well fitting shoes
- Education into cutting nails transversely
- Possible use of pledgets of cotton wool under nail to encourage growing out
- Surgery may be required if conservative measures fail
  - Nail can be removed by:
    - Avulsion of the whole nail
    - Wedge resection of the involved side of the nail
- Recurrence is common
- If simple avulsion fails ablation of the nail bed should be considered
- This can be achieved either chemically or surgically
  - Chemical ablation can be achieved with phenol
  - Surgical removal usually involves a Zadek's procedure
- Avulsion and phenolisation is more effective than surgical procedures



### Subungual haematoma

- Result from blunt trauma to the hallux and nail bed
- Blood collects under the nail
- Increased pressure causes severe pain
- Nail initially appears red
- Becomes purple as blood coagulates
- Differential diagnosis includes:
  - Subungual melanoma
  - Glomus tumour
  - Kaposi's sarcoma
- Haematoma can be evacuated by nail trephine with needle or drill
- Blood under pressure is released
- Symptoms immediately settle

### Onychogryphosis



Figure 317 Onychogryphosis

### The nails in systemic disease

- Abnormalities of the nail may indicate the presence of systemic disease
- Examination of the nails is an important part of any physical examination

#### **Clubbing**

- Clubbing is the loss of the normal angle between the nail and nail bed
- Associated with:
  - Bronchogenic carcinoma
  - Bronchiectasis
  - Congenital heart disease
  - Liver cirrhosis

#### **Koilonychia**

- Thin brittle, concave nails
- Often associated with iron-deficiency anaemia
- Also seen following nail trauma and lichen planus



### ***Splinter haemorrhages***

- Small, linear streaks of blood in the long axis of the nail
- Caused by haemorrhage from vessels of the nail bed
- Due to microemboli from bacterial endocarditis

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## Skin loss - flaps and grafts

### Definitions

- Autograft is graft from one part of body to another in the same individual
- Allograft is graft from one individual to another in the same species
- Xenograft is graft from one species to another

### Skin grafts

- A skin graft is an autograft
- Can be partial or full thickness depending on the amount of dermis taken

#### *Partial-thickness skin grafts*

- Contains epidermis and superficial part of dermis
- Usually taken from donor site with dermatome or Humby knife
- Donor site epithelium grows back from sweat glands and hair follicles
- Graft can be 'meshed' to increase the area that can be covered
- Excess skin can be stored in fridge and reused for up to 3 weeks
- Partial-thickness grafts can not be used on infected wounds
- Not suitable for covering bone, tendon or cartilage
- Cosmetic result is often not good

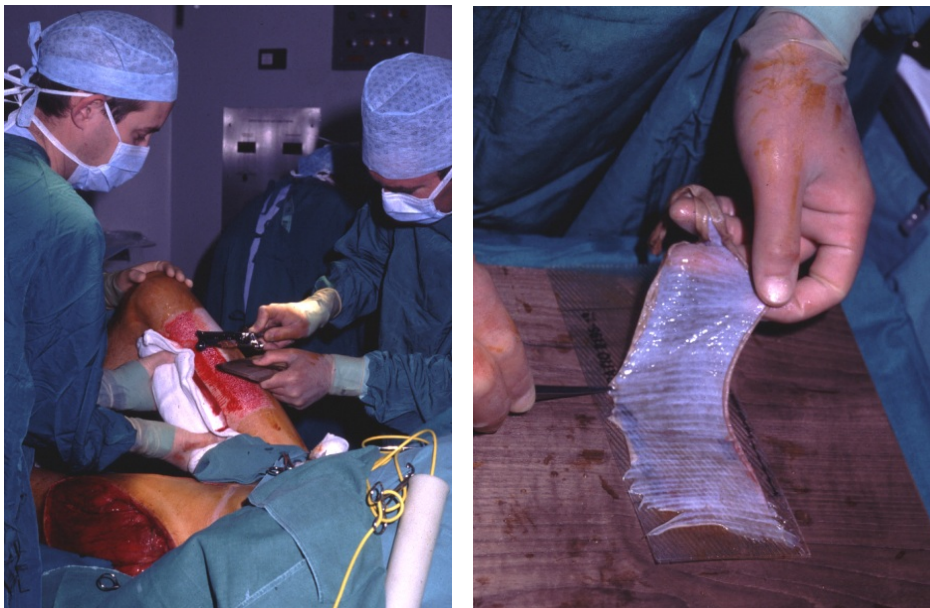


Figure 318 Split skin graft being taken and prepared

#### *Full-thickness skin grafts*

- Contains epidermis and all of dermis
- Can only be used to cover small defects
- Good cosmetic results can be obtained
- Donor site needs to be closed with primary suture or partial thickness graft
- Common donor sites include the postauricular skin and supraclavicular fossa



## Skin flaps

- Classified according to blood supply

### Random pattern grafts

- Receives blood supply from segmental anastomotic or axial artery
- Examples include advancement and rotation flaps

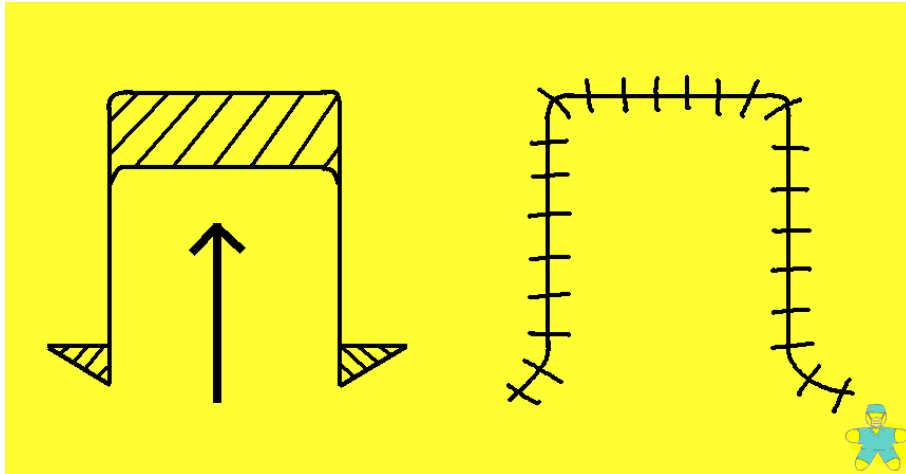


Figure 319 Advancement flap

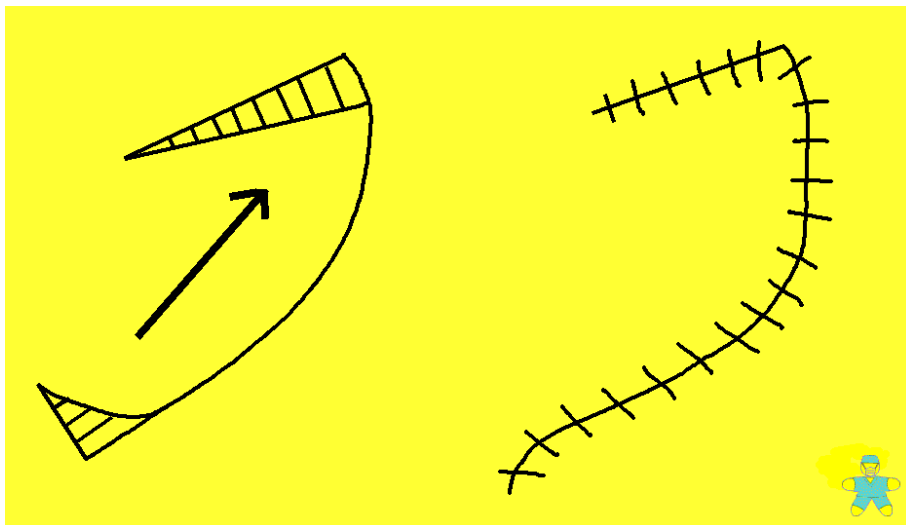


Figure 320 Rotation flap

### Axial pattern grafts

- Receives blood supply from a direct cutaneous arteries
- Examples include:
  - Iliofemoral island flap supplied by superficial circumflex iliac artery
  - Lateral forehead flap supplied superficial temporal artery
  - Deltopectoral island flap supplied by perforating branches of internal mammary artery
- Survival of all flaps depends on it receiving an adequate blood supply
- Depend on length of flap in relationship to its base



- Blood supply can be improved by the use of 'delaying' techniques
- The flap is partially raised and replaced prior to use
- Encourages the flap to increase its blood supply through the pedicle

#### **Tube pedicle grafts**

- Frequently raised from abdomen or inner arm
- Parallel skin incisions allow tube of skin to be formed
- Skin defect is then closed
- The length of the tube should not be greater than twice the base
- Long axis of tube should parallel the direction of the cutaneous blood vessels
- Good means of delaying tissue transfer over a long distance
- Produces a good cosmetic result

#### **Myocutaneous flaps**

- In most parts of the body the skin receives its blood supply from the underlying muscle
- Muscle, fascia and overlying skin can therefore be moved as one unit
- The survives on major blood vessel supplying the muscle
- Examples include:
  - Latissimus dorsi flap supplied by thoracodorsal artery
  - Transverse rectus abdominis supplied by superior epigastric artery
- Allow tissue transfer to poorly vascularised areas
- Bone can also be transferred for osseous reconstruction
- Flaps usually have no sensation

#### **Free myocutaneous flaps**

- Microvascular techniques allow the anastomosis of arteries and veins
- Myocutaneous flaps can therefore be detached from blood supply
- Can be transferred to other parts of body
- Examples include the free transverse rectus abdominis flap

#### **Tissue expansion**

- Skin can be gradually stretched to accommodate a greater area
- If skin loss is anticipated it is possible to expand adjacent skin prior to operation
- Tissue expanders can be placed subcutaneously in collapsed state
- Over several weeks can be inflated with saline through a subcutaneous port
- Expanded skin can be used to cover defect and tissue expander removed

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## Neurosurgery

### Neurological trauma

#### *Head injuries*

##### **Pathophysiology of head injury**

- One million patients attend A+E each year in UK with head injury
  - 80% are minor (GCS 13 -15)
  - 10% are moderate (GCS 9 -12)
  - 10% are severe (GCS less than 8)
- Severe head injuries account for 50% of trauma related deaths

##### **Primary brain injury**

- Damage caused at time of impact
- Can be focal or diffuse
- Diffuse axonal injury is due to deceleration and shearing forces
- Dependent on extent of initial injury
- Not able to be treated

##### **Secondary brain injury**

- Insult imposed after primary injury
- Due to:
  - Hypoxaemia
  - Hypercapnia
  - Systemic hypotension
  - Intracranial haematoma
  - Intracranial hypertension
- The early treatment of head injured patients is aimed at the prevention of secondary brain injury
- Autoregulation of cerebral blood flow is lost after head injury

### Skull X-rays

#### **Types of views**

- Lateral - right or left according to site of injury
- Anteroposterior
- Half axial (Towne's) view

#### **Criteria for skull x-rays after recent head injury**

- Loss of consciousness or amnesia at any time
- Neurological symptoms or signs
- CSF leak from nose or ear
- Suspected penetrating injury or foreign body
- Tense fontanelle, scalp bruising or laceration in a child < 5 years
- Presence of other trauma that might imply a strong impact
- Alcoholic intoxication



### ***Causes of intracranial calcification***

- Normal
  - Pineal gland
  - Dural (commonly falx)
  - Vascular (carotid arteries)
  - Basal ganglia
- Abnormal
  - Tumours - craniopharyngioma, meningioma
  - Arteriovenous malformations
  - Aneurysms
  - Vault or sinus osteomas

### ***Causes of skull radiolucencies***

- Normal
  - Squamous temporal bone
  - Pacchionian granulations
- Air
  - Superficial - after scalp injury
  - Intracranial - after open fracture
- Outer skull table
  - Rodent ulcer
- Inner skull table
  - Slow growing tumours
  - Chronic subdural haematoma
- Diffuse lesions
  - Metastases
  - Multiple myeloma
  - Paget's disease
  - Hyperparathyroidism

### ***Causes of skull vault densities***

- Generalised
  - Renal osteodystrophy
  - Fibrous dysplasia
  - Acromegaly
  - Drugs - e.g. Phenytoin
- Multifocal
  - Sclerotic metastases
  - Paget's disease
- Localised
  - Foreign body
  - Hyperostosis frontalis interna
  - Osteoma
  - Meningioma

### ***Characteristics of fractures, sutures and vascular markings***

#### ***Fractures***

- Straight translucent lines
- More radiolucent - fractures affect both tables
- Most are straight but can change direction suddenly
- Sharply demarcated



- Parallel margins - no tapering
- May run across sutures



Figure 321 Left frontal skull fracture

#### **Sutures**

- Winding serpiginous lines
- Fine sclerotic or corticated margins
- Typical anatomical sites
- Symmetrical

#### **Vascular markings**

- Less translucent - affect inner table only
- Not sharply demarcated
- Meningeal grooves taper as they run peripherally
- Branching pattern and symmetrical
- Diploetic venous channels are wide

#### **Management of head injuries**

- Patients should be managed according to ATLS protocols to prevent secondary brain injury
- 5-10% patients with severe head injury have cervical spine injury
  - Full assessment requires:
  - Glasgow Coma Scale
  - Pulse, blood pressure
  - Assessment of pupil diameter and response
  - Assessment of limb movement



- Patients with GCS less than 8 require early intubation
- Intravenous steroids are probably of no benefit



Figure 322 Dilated left pupil due to extradural haematoma

Table 63 Glasgow coma scale

Eye opening		Motor response		Verbal response	
Spontaneous	4	Obeys	6	Orientated	5
To speech	3	Localises	5	Confused	4
To pain	2	Withdraws	4	Inappropriate	3
None	1	Abnormal flexion	3	Incomprehensible	2
		Extensor response	2	None	1
		None	1		

#### ***Criteria for admission after head injury***

- Altered level of consciousness
- Skull fracture
- Neurological symptoms or signs
- Difficult assessment – Drugs or alcohol
- No responsible carer

#### ***Signs of basal skull fracture***

- Blood or cerebrospinal fluid from nose or ear
- Periorbital haematoma
- Mastoid Haematoma (Battle's Sign)
- Haemotympanum
- Radiological evidence of intra-cranial air
- Radiological evidence of fluid levels in sinuses



Figure 323 Bilateral Periorbital haematomas due to basal skull fracture

***Indications for head CT scanning***

- Confusion (GCS<14) persisting after initial assessment and resuscitation
- Skull fracture with neurological signs
- Skull fracture and epileptic fit

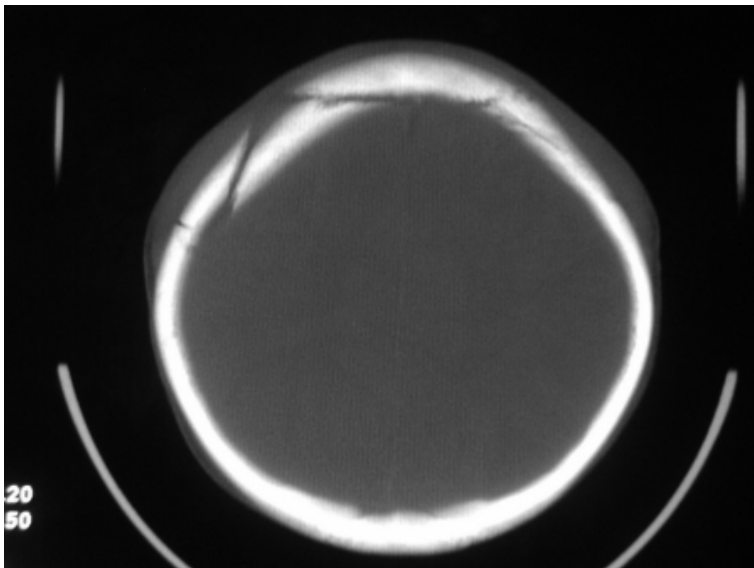


Figure 324 Skull fracture on bone windows on CT scan

***Indications for transfer without preliminary head CT scan***

- Deterioration in level of consciousness
- Progressive neurological deficit
- Tense fontanelle in child
- Penetrating injury
- Depressed skull fracture





### **NICE Guidelines (2003)**

- CT is the primary investigation of choice for clinically important brain injury
- MRI is not currently indicated as the primary investigation
- Skull x-rays have a role in the detection of non-accidental injuries in children
- CT should be available within one hour of being requested

### **Indications for CT**

- GCS less than 13 at any point since the injury
- GCS equal to 13 or 14 at 2 hours after the injury
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture
- Post-traumatic seizure
- Focal neurological deficit
- More than one episode of vomiting
- Amnesia for greater than 30 minutes of events before impact
- If LOC in patients older than 65 years, coagulopathy or dangerous mechanism of injury

### **Investigation of cervical spine**

- The current investigation of choice is three-view plane radiographs
- CT is indicated if satisfactory plain radiographs can not be obtained
- MRI is indicated in the presence of neurological signs and symptoms
- Indications for imaging of cervical spine
- GCS less than 15 at the time of assessment
- Paraesthesia in the extremities
- Focal neurological deficit
- Not possible to test range of movement in neck

### **Indications for referral to neurosurgeon**

- Persistent coma (GCS<8) after initial resuscitation
- Unexplained confusion persisting for more than 4 hours
- Deterioration in GCS after admission
- A seizure without full recovery
- Progressive focal neurological signs
- Definite or suspected penetrating injury
- CSF leak

### **Indications for admission to hospital**

- Patients with new, clinically significant abnormalities on imaging
- Patients who have not returned to GCS equal to 15
- Patients fulfilling criteria for CT scanning
- Continuing worrying signs of concern to the clinician

### **Indications for intubation and ventilation**

- GCS less than or equal to 8
- Loss of protective laryngeal reflexes
- Ventilatory insufficiency as judged by blood gases
  - PaO<sub>2</sub> less than 9kPa
  - PaCO<sub>2</sub> greater than 6kPa



- Spontaneous hyperventilation
- Respiratory arrhythmia
- Bilateral fractured mandible
- Copious bleeding into mouth
- Seizures

#### Antibiotics and anticonvulsants

- Antibiotics and anticonvulsants are of no benefit in uncomplicated head injuries
- Both may be use in compound depressed fractures and penetrating brain injury

#### Complications of head injuries

##### *Risk factor for intracranial haematoma*

- Most significant risk factors are
- Reduced level of consciousness
- Presence of a skull fracture

Table 64 Risk factors for intracranial haematoma

GCS	Risk	Other features	Risk
15	1: 3,615	None	1: 31,300
		Post traumatic amnesia (PTA)	1: 6,700
		Skull fracture	1: 81
		Skull fracture + PTA	1: 29
9-14	1: 51	No fracture	1: 180
		Skull fracture	1: 5
3-8	1: 7	No fracture	1: 27
		Skull fracture	1: 4

##### *Extradural haematoma*

- Complication of low velocity injuries
- Classic presentation
- Transient loss of consciousness with rapid recovery
- Lucid interval
- Rapid deterioration in level of consciousness
- Increased blood pressure
- Falling pulse rate
- Contralateral limb weakness
- Ipsilateral pupillary dilatation
- Treatment is by emergency burr holes

##### *Subdural haematoma*

- Complication of high velocity injury
- Patient usually unconscious from the time of injury
- Deteriorating level of consciousness
- Treatment is by decompressive craniotomy

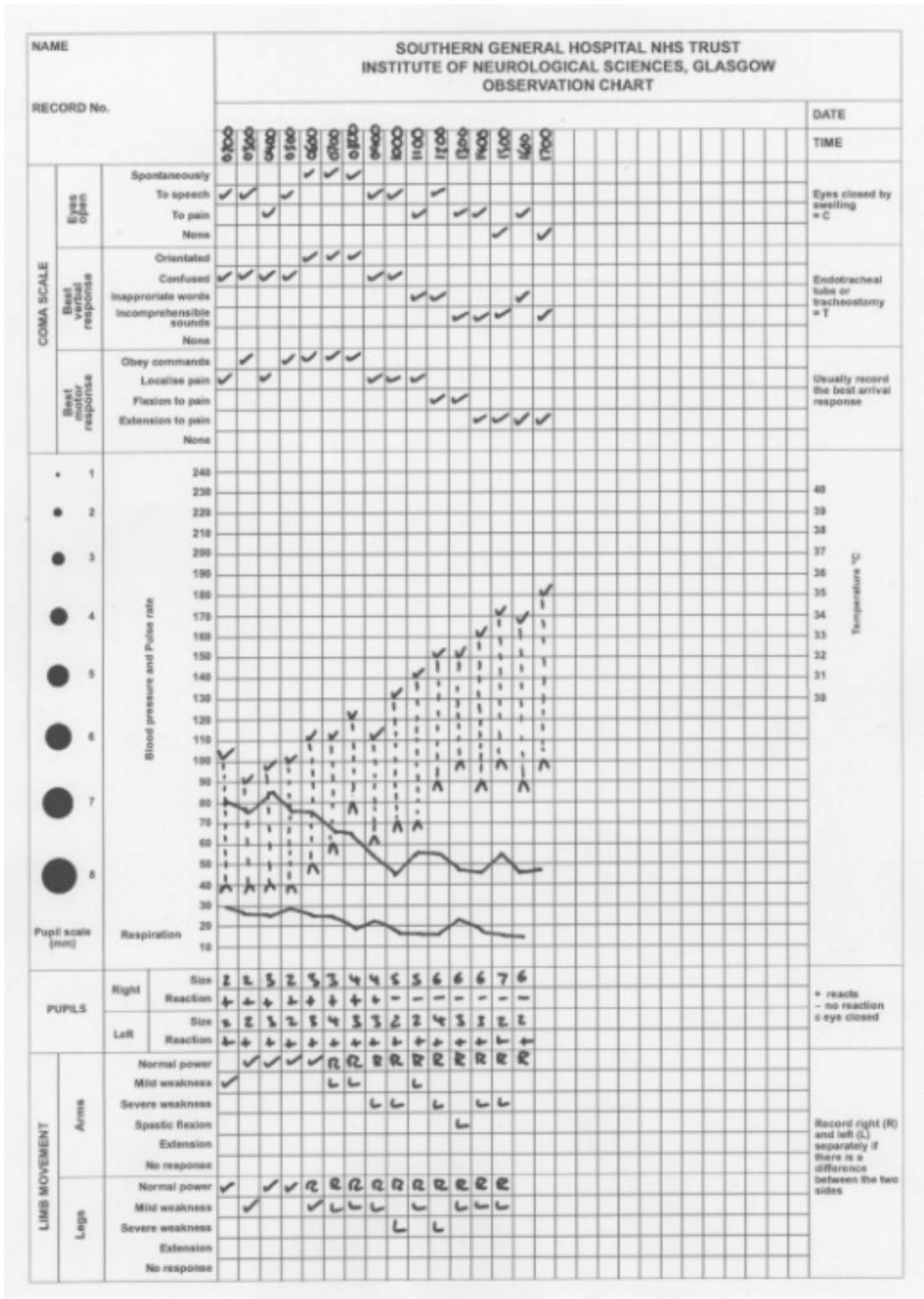


Figure 325 Head injury chart and CT scan appearances from a patient with an extradural haematoma

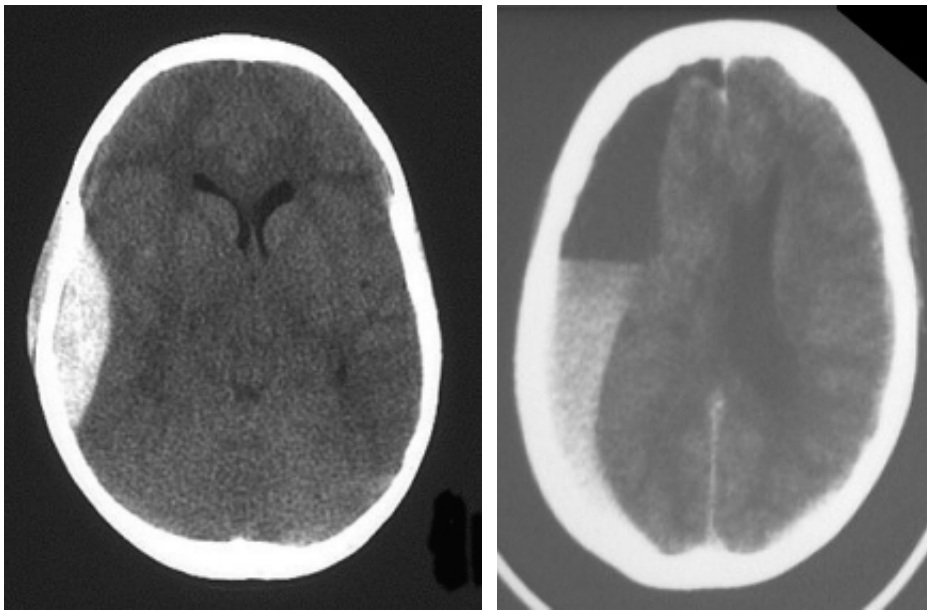


Figure 326 CT scan appearances of a extradural (Left) and subdural (right) haematoma

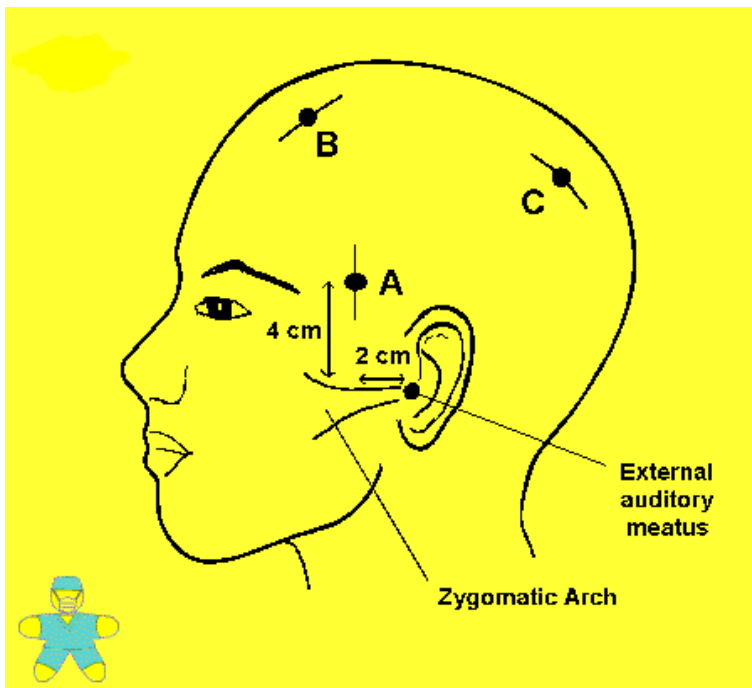


Figure 327 Position of emergency burr holes



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## **Spinal cord injuries**

- All patients with multiple trauma should be suspected of having a spinal injury
- Failure to detect usually results from failure to suspect
- Cervical spine and thoraco-lumbar junction are the commonest site of injury
- The percentage of nerve injuries seen in patients with spinal fractures are:
  - Cervical spine (40%)
  - Thoracic spine (10%)
  - Thoraco-lumbar junction (35%)
  - Lumbar spine (3%)
- All injuries should be assumed to be unstable until proven otherwise

## **Management**

### **At scene of accident**

- Maintain in-line spinal immobilisation
- Requires supporting of neck with stiff collar and sandbags
- Patient should be transported on spinal board

### **Primary survey**

- Intubation required maintenance of in-line immobilisation
- Pharyngeal stimulation with airway can cause vagal discharge and cardiac arrest
- Consider pre-medication with atropine
- Cervical spine injuries reduce sympathetic outflow
- Patients may be both hypotensive and bradycardic
- (NB - Not a feature of hypovolaemia therefore suspect spinal cord injury)
- May require both atropine and inotropic support
- Aggressive fluid resuscitation can induce pulmonary oedema

### **Secondary survey**

- Patients may develop respiratory failure due to
  - In tetraplegic patients
    - Intercostal paralysis
    - Partial phrenic nerve palsy
    - Impaired ability to cough
    - Ventilation-perfusion mismatch
  - In paraplegic patients
    - Variable intercostal nerve paralysis
    - Associated chest injuries
- May develop as a late feature due to ascending oedema in the cervical cord
- Abdomen may be flaccid with absent sensation
- Features of peritonism may be absent
- Priapism may develop

### **Partial cord lesions**

- Function preserved distal to level of cord injury
- May be missed if do not fit classical injury pattern
  - Central cord lesion - flaccid paralysis of upper limbs
  - Anterior cord lesion - loss of temperature and sensation
  - Posterior cord lesion - loss of vibration sensation and proprioception



- Brown - Sequard syndrome - loss of ipsilateral power and contralateral pain and temperature

Table 65 Assessing level of injury

Muscle group	Nerve supply	Reflex
Diaphragm	C3, C4, C5	
Shoulder abductors	C5	
Elbow flexors	C5, C6	Biceps jerk
Supinators / pronators	C6	Supinator jerk
Wrist extensors	C6	
Wrist flexors	C7	
Elbow extensors	C7	Triceps jerk
Finger extensors	C7	
Finger flexors	C8	
Intrinsic hand muscles	T1	
Hip flexors	L1, L2	
Hip adductors	L2, L3	
Knee extensors	L3, L4	Knee jerk
Ankle dorsiflexors	L4, L5	
Toe extensors	L5	
Knee flexors	L4, L5, S1	
Ankle plantar flexors	S1, S2	Ankle jerk
Toe flexors	S1, S2	
Anal sphincter	S2, S3, S4	Bulbocavernosus reflex
		Anal reflex

### Radiological assessment of cervical spine

- 20% patients with spinal cord injury have no radiological evidence of bony injury
- Lateral cervical spine x-ray should be taken during primary survey
- Should ensure that the junction between C7 and T1 is seen
- Antero-posterior and odontoid peg views should be taken during secondary survey
- If unable to see the C7 / T1 junction consider a 'swimmer's view'
- On lateral cervical spine films need to assess:
  - Anterior vertebral alignment
  - Posterior vertebral alignment
  - Posterior facet joint margins
  - Anterior border of spinous processes
  - Posterior border of spinous processes
  - Integrity of vertebral bodies, laminae, pedicles and arches
  - Pre-vertebral space
  - Retropharyngeal space should be less than 6 mm
  - Retrotracheal space should be less than 22 mm
  - Interspinous gaps



Figure 328 Lateral cervical spine x-ray showing bifacet dislocation at the level of C6/C7

### **Classification of cervical spine fractures**

#### ***Hyperflexion injuries***

- Anterior subluxation
- Bilateral locked facet joints
- Teardrop fracture
- Spinous process fractures (Clay shoveller's fracture)

#### ***Hyperextension injuries***

- Fracture of the anterior or posterior arch of C1
- Anterior-inferior vertebral chip fracture
- Laminar fracture
- Axial compression

#### ***Burst fractures***

- Fracture of the pedicle of C2

#### ***Flexion rotation injuries***

- Unilateral facet dislocation





### **Radiological signs of spinal instability**

- Compression of vertebral body more than 25%
- Kyphotic angle of more than 10%
- Facet joint widening
- Teardrop fracture
- Base of odontoid peg fracture
- Atlanto-axial gap more than 3 mm
- Atlanto-occipital dislocation

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## **Peripheral nerve injuries**

### **Neurapraxia**

- Temporary loss of function caused by minor trauma or pressure
- Recovery occurs within minutes

### **Axonotmesis**

- Loss of function due to severe ischaemia
- Recovery occurs within weeks

### **Neurotmesis**

- Loss of function due to division of nerve
- No recovery occurs unless nerve is repaired

### **Radial nerve**

- Often injured in radial groove of humerus
- Motor paralysis results in typical 'wrist drop' due to loss of:
  - Extension of elbow, wrist, knuckles and all joints of thumb
  - Supinator and brachioradialis
- Sensory loss involves dorsum of 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> metacarpals
- May be as small as the anatomical snuffbox

### **Median nerve**

- Often injured by penetrating wounds of the forearm
- Motor paralysis due to loss of:
  - The pronators
  - Radial flexor of the wrist
  - Flexors of all of the proximal interphalangeal joints
  - Flexors of the terminal joint of the thumb, index and middle finger
  - Abductor and opponens pollicis
- Sensory loss over thumb, index, middle and half of ring fingers

### **Ulnar nerve**

- Often injured with fractures of the medial epicondyle of the elbow
- Motor paralysis results in 'claw hand' and hypothenar wasting due to loss of:
  - Ulnar flexor of the wrist
  - Flexors of the terminal phalanx of the ring and little finger
  - Muscles of the hypothenar eminence
  - Adductor pollicis
  - Palmar brevis
  - All the interossei and the medial two lumbricals
- Sensory loss over little and half of ring finger



Figure 329 Ulnar nerve palsy



Figure 330 A further ulnar nerve palsy

### Brachial plexus injuries

- Usually occur in two situations
  - Difficult vaginal deliveries associated with the use of forceps
  - Traction during a fall or road traffic accident



### ***Erb's palsy***

- Due to damage to the upper nerve roots
- Usually involves C5, C6, C7
- Abductors and external rotators of the shoulder are affected
- Loss of finger extension
- Sensation is intact

### ***Klumpke's palsy***

- Due to damage to the lower nerve roots
- Usually involves C8, T1
- All finger muscles are paralysed
- Loss of sensation
- Often associated with unilateral Horner's syndrome

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## Intracranial haemorrhage

### Subarachnoid haemorrhage

- Subarachnoid haemorrhage accounts for approximately 5% of CVAs
- Outcome depends on the degree of neurological deficit
- The lower the GCS on presentation the worse the prognosis
- 70% are due Berry aneurysms
- 10% are due to arteriovenous malformations
- 10% are due to hypertension
- 5% are idiopathic

### Pathology of Berry aneurysms

- Aneurysms are found in 8% of individuals at post mortem
- They are thin walled saccular aneurysms found at arterial bifurcations
- Occur due to turbulent flow and damage to internal elastic lamina
- Commonest site of aneurysms are:
  - Posterior communicating artery 30%
  - Anterior communicating artery 25%
  - Middle cerebral artery 25%
- Estimated to have a population prevalence of 1.5%
- Most remain asymptomatic but they are a common cause of sudden death

### Clinical features

- Classic presentation is with a sudden onset of severe headache
- Often associated with nausea, vomiting, photophobia and neck stiffness
- Neurological symptoms and signs may be present
- Level of consciousness may be reduced
- Fundoscopy may show subhyoid haemorrhages
- The clinical course is unpredictable
- Overall mortality is approximately 40%
- Many patients die before reaching hospital

### Investigations

- Diagnosis can often be confirmed by an early CT
- Has a sensitivity of 90% if performed within the first 24 hours
- Sensitivity reduced to 50% by 72 hours as blood is reabsorbed
- CT may also identify source of haemorrhage
- If diagnosis is on doubt then lumbar puncture may be indicated
- Will show uniform blood-staining of CSF and xanthochromia
- Cerebral angiography will identify site of an aneurysm
- 15% of aneurysms are multiple

### Complications

- The major complications are:
  - Rebleed
  - Delayed ischaemic neurological deficit
  - Hydrocephalus
- Risk of rebleed is 4% at 24 hours, 25% at 2 weeks and 60% at 6 months
- Rebleeding is associated with a 60% mortality



- Delayed ischaemic neurological deficit (DIND) is due to intense vasospasm
- Treatment is by maintaining cerebral perfusion with adequate hydration
- Calcium channel blocks may also be useful
- Hydrocephalus results from impaired CSF reabsorption through arachnoid villi
- 10% of patients will require CSF diversion or shunting

### Management

- In patients fit for surgery the aneurysm should be clipped at craniotomy
- Aim is clip neck of aneurysm whilst maintaining flow in native vessel
- May also be embolised endovascularly with platinum coils
- Timing of intervention is controversial
- Vasospasm usually greatest at 5 days
- Surgery traditionally deferred until 10 days after the initial bleed
- Patients may die as a result of rebleed during this period
- Early surgery may be associated with reduced mortality and no increased morbidity

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## Brain Stem Death

### **Preconditions**

- Diagnosis compatible with brain stem death
- Presence of irreversible structural brain damage
- Presence of apnoeic coma

### **Exclusions**

- Therapeutic drug effects (sedatives, hypnotics, muscle relaxants)
- Hypothermia (Temp  $>35^{\circ}\text{C}$ )
- Metabolic abnormalities
- Endocrine abnormalities
- Intoxication

### **Clinical tests**

- Confirmation of absent brain stem reflexes
- Confirmation of persistent apnoea
- Clinical tests should be performed by 2 experienced practitioners
- At least one should be a consultant
- Neither should be part of the transplant team
- Should be performed on 2 separate occasions
- No prescribed time interval

### **Clinical tests for absent brain stem reflexes**

- No pupillary response to light
- Absent corneal reflex
- No motor response within cranial nerve distribution
- Absent gag reflex
- Absent cough reflex
- Absent vestibulo-ocular reflex

### **Test for confirmation of persistent apnoea**

- Preoxygenation with 100% oxygen for 10 minutes
- Allow  $\text{PaCO}_2$  to rise above 5.0 kPa before test
- Disconnect from ventilator
- Maintain adequate oxygenation during test
- Allow  $\text{PaCO}_2$  to climb above 6.65 kPa
- Confirm no spontaneous respiration
- Reconnect ventilator

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## Surgical aspects of meningitis

### *Central nervous system infections*

#### **Intracranial abscess**

- Intracranial abscesses are rare but require prompt recognition
- Intracranial pus may be:
  - Extradural
  - Subdural
  - Intracerebral
- Delayed diagnosis often results in disability or death
- Most are bacterial infections that reach the CNS by:
  - Inoculation from penetrating wound
  - Spread from adjacent infective focus (e.g. otitis media, sinusitis)
  - Blood-borne spread from distant focus (e.g. endocarditic, lung abscess, dental caries)
- In 20% no source of infection is identified
- In United Kingdom otitis media and sinusitis are commonest causes

#### **Pathology**

- From local focus of infection bacteria penetrate skull through diploic veins
- Local osteomyelitis results in venous sinus thrombosis
- Pus in extradural space causes an empyema
- Dura is normally a good barrier to the intracranial spread of infection
- Subdural empyema causes oedema and cortical venous thrombosis
- Brain penetration causes an early diffuse cerebritis
- A localised abscess develops with oedema and increased ICP
- The abscess usually forms in subcortical white matter near to septic focus
- Haematogenous abscesses may be multiple

#### **Clinical presentation**

- Can affect any age or sex
- Systemic upset is often mild
- Symptoms of increased ICP include headache, vomiting
- Often associated with progressive clouding of consciousness
- As abscess develops focal neurological symptoms appear
- Symptoms of increased ICP with focal signs requires urgent neurosurgical assessment
- Differential diagnosis includes meningitis or intracranial tumour

#### **Investigations**

- CT is investigation of choice
- Cerebral abscess appears as radiolucent space occupying lesion
- Ring enhancement of capsule occurs in contrast enhanced scans
- Often surrounded by considerable oedema
- Position, size and number of abscesses may suggest underlying pathology
- Lumbar puncture is contraindicated
- In presence of raised ICP can precipitate tentorial or tonsillar herniation





### **Management**

- The principles of treatment are:
  - Drain intracranial collection
  - Administer effective antibiotic therapy
  - Eliminate primary source of infection
- Supratentorial abscesses can be drained via a burr hole
- Pus should be aspirated and sent for culture
- Clinical progress can be monitored by serial CT scans
- Stereotactic drainage may be required for multiple or multiloculated abscesses
- Cerebellar abscess may require a suboccipital craniectomy and open drainage
- Subdural empyemas are often diffuse and difficult to drain
- May require craniectomy and open drainage
- Parenteral antibiotic should be administered for at least two weeks
- Choice of antibiotics depends on primary pathology and sensitivities

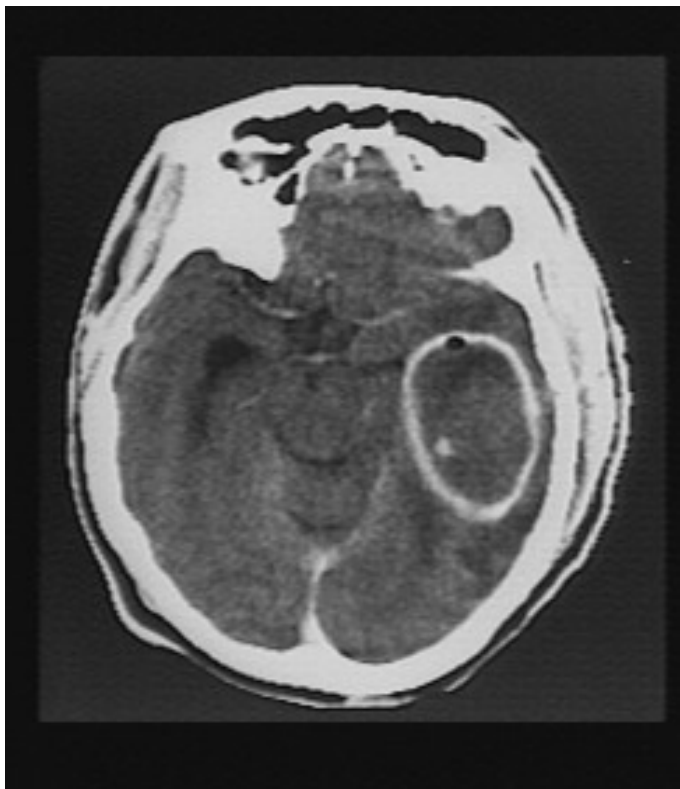


Figure 331 CT scan of a cerebral abscess

### **Outcome**

- Prompt treatment results in mortality less than 10%
- Delayed treatment results in mortality greater than 50%
- 50% of survivors have neurological sequelae
- These include hemiparesis, visual field losses and epilepsy



### Extradural abscess

- Usually associated with osteomyelitis due to frontal sinusitis or middle ear disease
- Produces localised swelling (Pott's puffy tumour)
- Treatment usually requires removal of infected bone
- Dura is a good barrier to spread of infection
- Intradural extension of infection is rare

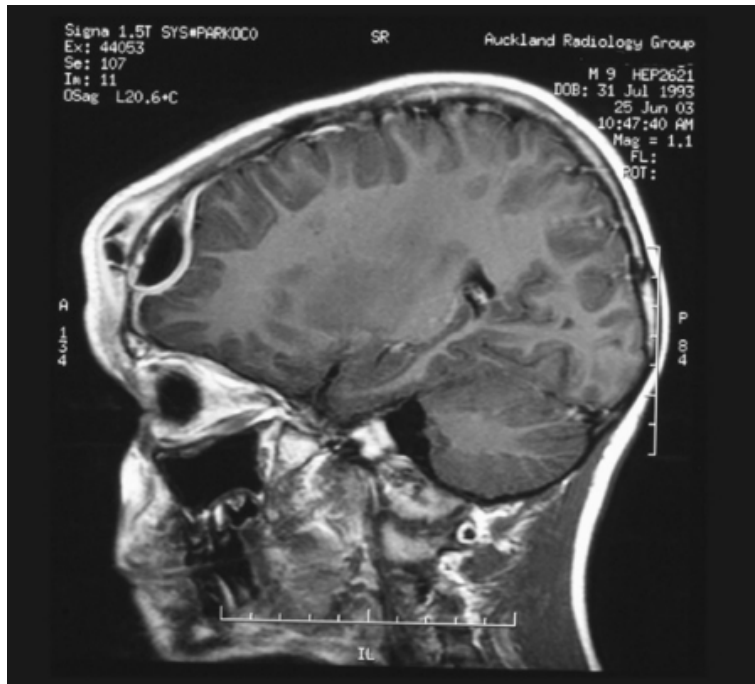


Figure 332 MRI showing an extradural abscess (Pott's puffy tumour)

### Spinal abscess

- Spinal abscesses are usually bacterial
- Infection arises in adjacent bone or by haematogenous spread
- Commonest organisms are staphylococcal and streptococcal species
- Pus is usually confined to extradural space
- Subdural and intramedullary infections are rare

### Clinical features

- Patient is often systemically unwell
- Often present with severe thoracic pain at level of abscess
- The pain is worse on movement and associated with marked spasm and tenderness
- Radicular signs are often present at level of lesion
- Cord compression results in long tract signs
- Thrombophlebitis can cause cord vessel thrombosis and cord infarction
- Precipitates complete paralysis, sensory and sphincter loss

### Investigations

- Serum white cell count, ESR and CRP are invariably raised
- X-rays are often normal
- May show soft tissue swelling or vertebral collapse



- MRI is investigations of choice

### **Management**

- High index of suspicion is required to make the diagnosis
- Once identified prompt neurosurgical assessment is required
- If vertebral body collapse consider anterior decompression and stabilisation
- If no vertebral collapse laminectomy or CT guided aspiration may be appropriate

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## Trauma & orthopaedic surgery

### Skeletal fractures

#### Life threatening limb injuries

- Traumatic amputation
- Major vascular injury
- Pelvic fracture disruption
- Haemorrhage from open fracture
- Multiple long bone fractures
- Severe crush injury

#### Limb threatening injuries

- Vascular injury
- Major joint dislocation
- Crush injury
- Open fracture
- Compartment syndrome
- Nerve injury

#### *Pathophysiology of fracture healing*

- Dislocation is total loss of congruity between articular surfaces
- Subluxation is partial loss of congruity between articular surfaces
- Fracture is a break in continuity of a bone

#### Fracture healing

- Fractures heal by restoration of bone continuity
- Rate of healing varies with age and is quicker in children
- Cancellous bone heals more quickly than cortical bone
- Some movement at fractures site is required for healing to occur
- Also requires an uninterrupted blood supply
- Bone healing can arbitrarily be divided in to five stages

#### *Stage one*

- Haematoma formation
- Bone ends bleed
- Periosteum is stripped for variable length
- Surrounding soft tissues may be damaged

#### *Stage two*

- Acute inflammation
- Cell division begins within 8 hours
- Cell proliferation seen within periosteum

#### *Stage three*

- Callus formation
- Dead bone is resorbed
- Immature woven bone is laid down



#### **Stage four**

- Woven bone is replaced by lamellar bone
- Fracture becomes united

#### **Stage five**

- Phase of remodelling
- Medullary cavity is restored
- Bone returns to normal shape

#### **Principles of fracture management**

- Some general principles need to be applied to fracture management
- Need to consider:
  - Reduction of the fracture
  - Immobilisation of the fracture
  - Rehabilitation
- Need for reduction varies from fracture to fracture
- Usually need to correct rotational or valgus or varus deformity
- Intra-articular fractures need anatomical reduction
- Reduction can be performed as either an open or closed procedure
- Immobilisation is required until fracture union
- Can be performed by external or internal methods
- External methods include:
  - Plaster casts
  - Traction
  - External fixation
- Internal methods include
  - Plates
  - Intramedullary nails
  - K-wires

#### **Indications for internal fixation**

- Intra-articular fractures - to stabilise anatomical reduction
- Repair of blood vessels and nerves - to protect vascular and nerve repair
- Multiple injuries
- Elderly patients - to allow early mobilisation
- Long bone fractures - tibia, femur and humerus
- Failure of conservative management
- Pathological fractures
- Fractures that require open reduction
- Unstable fractures

#### **Complications of internal fixation**

- Infection
- Non-union
- Implant failure
- Refracture

#### **Indications for external fixation**

- Acute trauma - open and unstable fractures
- Non union of fractures



- Arthrodesis
- Correction of joint contracture
- Filling of segmental limb defects - trauma, tumour and osteomyelitis
- Limb lengthening

#### **Complications of external fixation**

- Overdistraction
- Pin-tract infection

#### **Complications of fractures**

##### **Early**

- Infection
- Fat embolism
- Muscle and tendon injuries
- Nerve injuries
- Vascular injuries
- Visceral injuries

##### **Late**

- Delayed union
- Non-union
- Malunion
- Avascular necrosis
- Myositis ossificans
- Volkmann's contracture
- Stiffness and instability
- Algodystrophy
- Reflex sympathetic dystrophy

Table 66 Estimated blood loss caused by fractures

Site of fracture	Blood loss (litres)
Humerus	0.5 - 1.5
Tibia	0.5 - 1.5
Femur	1.0 - 2.5
Pelvis	1.0 -4.0

#### **Compound fractures**

- All open fractures must be assumed to be contaminated
- Object of treatment is to prevent them becoming infected
- First aid treatment is the same as for a closed fracture
- Peripheral neurovascular status should be assessed
- In addition the wound should be covered with a sterile dressing
- Wound should be photographed so that repeated uncovering is avoided repeated exposure
- Antibiotic prophylaxis should be given
- Tetanus immunisation status should be evaluated



Figure 333 Compound fracture of the tibia and fibula

### **Management**

- Open fractures require early operation
- Ideally this should be performed within 6 hours of injury
- Aims of surgery are to:
  - Clean the wound
  - Remove devitalised tissue
  - Stabilise the fracture
- Small clean wounds can be sutured
- Large dirty wounds should be debrided and left open
- Debrided wounds can be closed by delayed primary suture at 5 days

### **Pathological fractures**

#### **Generalised bone disease**

- Osteoporosis
- Metabolic bone disease - osteomalacia, hyperparathyroidism
- Paget's disease
- Myelomatosis

#### **Localised benign bone disorder**

- Chronic infection
- Solitary bone cyst
- Fibrous cortical defect
- Chondroma

#### **Primary malignant bone tumours**

- Osteosarcoma
- Chondrosarcoma
- Ewing's tumour



Figure 334 Pathological fracture due to multiple myeloma

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## ***Common and eponymous fractures***

### **Management of common fractures**

#### ***Clavicle***

- Rest in sling or collar and cuff for two weeks
- Active shoulder movement started after first week

#### ***Femur - trochanteric region***

- Fixation with dynamic hip screw
- Early postoperative mobilisation is important

#### ***Femur - shaft***

- Operative reduction usually required
- Internal fixation achieved with intramedullary nail

#### ***Fibula - shaft***

- Protect limb in below knee walking cast for 3 weeks

#### ***Humerus - neck***

- In elderly disregard fracture and concentrate on shoulder movement
- If fracture impacted begin mobilisation early

#### ***Humerus - supracondylar region***

- Reduce by manipulation under anaesthesia
- Place in full length cast with elbow at 90 degrees
- Observe carefully distal circulation

#### ***Olecranon***

- Undisplaced fractures need immobilisation in right angled arm plaster
- Displaced and comminuted fractures require internal fixation
- Internal fixation can be achieved with tension band wires

#### ***Patella***

- Undisplaced fractures should be protected in full leg cast for 3 weeks
- Displaced fractures require internal fixation with screw or tension band wire
- Comminuted fractures may require patellectomy

#### ***Phalanges***

- Undisplaced fractures should be strapped for 2-3 weeks
- Displaced fractures may require manipulation and external fixation

#### ***Radius - head***

- If minimal displacement place in collar and cuff for 3 weeks
- If severely comminuted excise radial head

#### ***Scaphoid***

- Immobilise in scaphoid cast until fracture united
- If delayed union consider fixation with Herbert screw



### **Tibia - shaft**

- Undisplaced fracture require immobilisation in full leg cast
- Displaced fractures may require internal fixation with intramedullary nail

### **Eponymous fractures**

#### ***Bennett's fracture***

- Intra-articular fracture of the base of the first metacarpal
- Usually requires open reduction and internal screw fixation

#### ***Colle's fractures***

- Fracture of the distal radius with dorsal and radial angulation and backward displacement
- Closed reduction should be followed by immobilisation in forearm cast for 6 weeks
- Position should be checked by radiography one week after injury

#### ***Galeazzi fracture***

- Fracture of the radial shaft with dislocation of the inferior radio-ulnar joint
- Usually requires internal fixation of the radius

#### ***Monteggia fracture***

- Fracture of the proximal ulna with anterior dislocation of the radial head
- Usually requires internal fixation of the ulna
- Radial head should be reduced or excised

#### ***Pott's fracture***

- A general term applied to ankle fracture's

#### ***Smith's fracture***

- Fracture of the distal radius with anterior displacement of the distal fragment
- Closed reduction may be successful
- If fails requires open reduction and fixation with a buttress plate

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## **Hip fractures**

- Refers to fractures of the proximal femur
- 60,000 hip fractures occur per year in the United Kingdom
- Mean age of patient is 80 years
- Incidence increases exponentially above the age of 65 years
- Main risk factors are female sex and osteoporosis

## **Clinical features**

- Usually occur following a fall
- Patient usually has other significant co-morbidity
- Main symptom is hip pain and inability to weight bear
- The leg is shortened and externally rotated
- Diagnosis confirmed by AP and lateral x-ray
- Impacted undisplaced fractures may present diagnostic difficulty

## **Garden classification**

- Stage 1 - incomplete or impacted fracture
- Stage 2 - complete fracture with no displacement
- Stage 3 - complete fracture with partial displacement
- Stage 4 - complete fracture with full displacement

## **'Practical' classification**

- Fractures best separated into intracapsular and extracapsular fractures
- Intracapsular fractures reduce the blood supply to femoral head
- At high risk of delayed union, non-union or avascular necrosis
- If head is to be preserved they need anatomical reduction
- Extracapsular fractures do not interfere with femoral head blood supply
- Do not require anatomical reduction

## **Management**

- All patients require surgery if fit for an operation
- Early mobilisation is associated with improved long-term prognosis
- Ideally surgery should be performed within 24 hours
- Postoperative rehabilitation should be by a multidisciplinary team

## **Intracapsular fractures**

- The two treatment options are:
  - Reduction and internal fixation
  - Femoral head replacement
- Internal fixation indicated in:
  - Undisplaced fractures
  - Displaced fractures in young patients (<70 years)
- Usually achieved with the use of three cancellous screws
- Complications include non-union and avascular necrosis
- Femoral head replacement indicated in:
  - Displaced fractures
  - Pathological fractures



- Options available include:
  - Cemented Thompson prosthesis
  - Uncemented Austin Moore prosthesis
  - Bipolar prosthesis
  - Total hip replacement
- Complications include:
  - Dislocation
  - Loosening
  - Peri-prosthetic femoral fracture



Figure 335 Intracapsular fracture (Garden IV) left neck of femur

#### ***Extracapsular fractures***

- Usually repaired with a dynamic hip screw
- Allows impaction and stabilisation of fracture
- Prognosis related to the number of bone fragments
- 90% of fractures proceed to uncomplicated fracture union

#### **Prognosis**

- 40% of patients with a hip fracture die within a year
- 50% of survivors are less independent than before the injury
- Most morbidity is related to coexisting medical conditions



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## Paediatric fractures

- Salter and Harris fractures occur through the growth plate
- Therefore they are unique to children
- Classified according to degree of involvement of physis, metaphysis and epiphysis
- Classification is important as it
  - Determines treatment
  - Determines prognosis

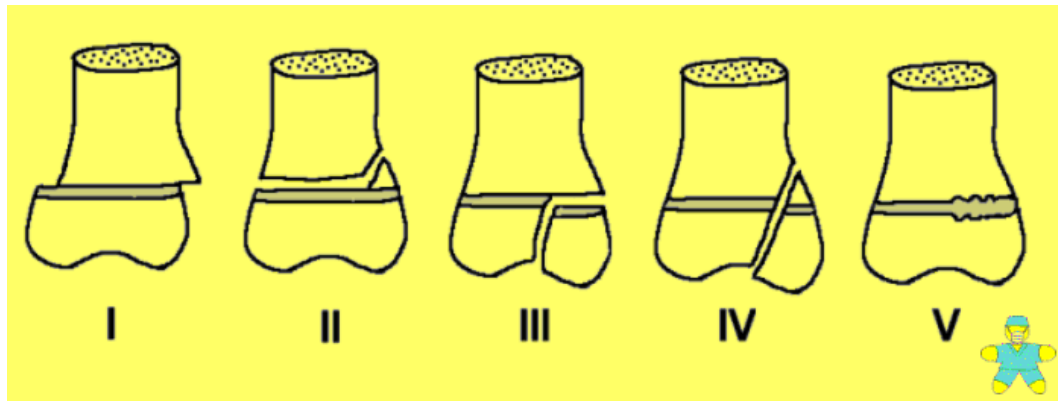


Figure 336 Salter and Harris classification of epiphyseal injuries

- Type I - Epiphyseal slip - no fracture
- Type II - Fracture through epiphyseal plate with proximal fragment
- Type III - Fracture through epiphysis extending into the epiphyseal plate
- Type IV - Fracture through both epiphysis and shaft crossing the epiphyseal plate
- Type V - Crush injury causing obliteration of the growth plate

## Management

- In general the following statements hold true for Slater and Harris Fractures
- Type I involve growth plate but growth is rarely disturbed
- Type II fractures are the most common
- Type III fractures involve the joint and can result in chronic morbidity
- Type III fractures often require surgical treatment
- Type IV fractures can also result in chronic morbidity
- Type V fractures are difficult diagnose and can result in limb shortening

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## ***Delayed and non-union and other fracture complications***

### **Union and consolidation**

- Fracture repair is a continuous process
- The stages into which it is divided is an arbitrary process
- Union should be regarded as incomplete repair
- Present when an ensheathing callus is formed
- Fracture site is still tender
- Minimal movement at the fracture site is present
- Consolidation should be regarded as complete repair
- Radiologically fracture line is obliterated
- Fracture site is non-tender
- No movement is possible at the fracture site
- Time to union and consolidation depends on many factors including
  - Age
  - Fracture type
  - Blood supply
- Fractures heal quicker in children
- Upper limb fractures heal quicker than lower limb
- Spiral fractures heal quicker than transverse fractures

### **Delayed union**

- Delayed union is prolongation of time to fracture union
- No definite timetable to define delayed union exists
- Delayed union is due to:
  - Inadequate blood supply
  - Infection
  - Incorrect splintage
  - Intact fellow bone

### **Clinical features**

- Fracture site remains tender
- Bone may still move when stressed
- On x-ray the fracture remains visible
- May be little callus formation or periosteal reaction

### **Management**

- Usually continue previous treatment of fracture
- May need to replace cast or reduce traction
- Functional bracing promotes bone union
- For tibial fracture may need to excise portion of fibula
- If union is delayed more than 6 months may need to consider
  - Internal fixation
  - Bone grafting

### **Non-union**

- Non-union has many causes including:
  - Bone or soft tissue loss
  - Soft tissue interposition



- Poor blood supply
- Infection
- Pathological fracture
- Poor splintage or fixation
- Fracture distraction

#### **Clinical features**

- Movement remains present at the fracture site
- Movement is often relatively painless
- Radiologically the fracture is still visible
- Bone ends on either side of the fracture are sclerosed
- Non-union can be either hypertrophic or atrophic



Figure 337 Atrophic non-union of a femoral fracture

#### **Management**

- Non-union is occasionally symptomless
- Asymptomatic non-union may not require active treatment except splintage
- For hypertrophic non-union internal or external fixation may lead to union
- For atrophic non-union bone grafting is often required

#### **Myositis ossificans**

- Due to heterotopic ossification with an muscle
- Elbow is the commonest joint involved
- Seen following dislocation or muscle rupture
- Also occurs without injury in unconscious or paraplegic patients
- Pain is an early symptom





- Stiffness and reduced range of movement are late features
- In the late stage of the process a bony lump is often palpable
- Early x-ray shows fluffy calcification
- Late x-ray shows none formation

#### **Management**

- Rest joint in position of function
- Once pain settles begin mobilisation
- After several months consider excision of bony mass

#### **Avascular necrosis**

- Certain bony regions are prone to bone ischaemia and necrosis
- These areas include
  - Head of femur
  - Proximal scaphoid
  - Body of the talus
- Interruption of blood supply by a fracture results in avascular necrosis
- Pain due to fracture non-union is the main symptom
- X-ray shows increase in bone density

#### **Management**

- Surgical intervention required if there is a reduction in function
- May require arthrodesis or arthroplasty

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Ehara S. Complications of skeletal trauma. *Radiol Clin North Am* 1997; 35: 767-781.



### ***Principles of bone grafting***

- Loss of bone can occur in several situations including
  - Trauma
  - Tumours
  - Man-made prostheses
- Bone grafts can be used to fill the defect

### ***Classification of bone grafts***

- Autograft = bone from the same individual
- Allograft = bone from another individual of the same species
- Xenograft = bone from another species

### ***Autografts***

- Autogenous bone is the best graft material
- May only be available in a limited amount
- Also not suitable for significant load bearing
- Cancellous bone can be used to fill cavity defects
- Cortical bone can be used to provide structural support
- Forms scaffold into which osteoblasts and osteoclasts can grow
- Osteoblast differentiation leads graft resorption
- Stimulates local bone growth by the process of osteoinduction
- Remodelling occurs as load is applied to the graft

### ***Harvesting of bone grafts***

- Bone can be harvested from the following sites
  - Iliac crest
  - Proximal tibia
  - Distal radius
- Iliac crest is the most common but its use is associated with significant morbidity
- Cortico-cancellous grafts are harvested as strips
- Cancellous bone can be taken from the inner or outer table

### ***Vascularised grafts***

- Segments of bone can be transplanted as free vascularised grafts
- Local rotational bone grafts may also be used
- Blood supply to the graft is maintained
- Technically difficult to perform
- Results are unpredictable

### ***Allografts***

- Allograft bone is more plentiful
- Can be harvested from living donors or cadavers
- Donor site morbidity is eliminated
- Cadaveric bone and femoral heads are stored in tissue banks
- Bone is frozen at -20 to -86 degrees
- Freeze drying and storage at room temperature is occasionally used
- Used in reconstruction after:
  - Tumour resection
  - Revision hip surgery



- Infection is the major concern with the used of allografts
- Bacterial contamination may occur, especially with cadaveric grafts
- Can be eliminated with irradiation of the graft
- Viral contamination with hepatitis or HIV is a concern
- Bone should be kept in quarantine and living donors tested 90 days post surgery
- Allograft bone is available as:
  - Morsellised bone for impaction grafting
  - Strut grafts to cover cortical bone
  - Massive allografts to replace significant proportions of native bone

### **Bone substitutes**

- Interest exists in artificial bone substitutes
- Would eliminate supply and infection problems associated with auto and allografts
- Possible bone substitutes include:
  - Calcium triphosphate
  - Hydroxyapatite
  - Calcium carbonate
  - Glass-based cements
- Most bone substitutes are brittle
- Unable to withstand significant load bearing

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## Degenerative and rheumatoid arthritis

### Osteoarthritis

- Osteoarthritis is the commonest condition affecting synovial joints
- No longer considered simple joint 'wear and tear'
- Change in cartilaginous matrix is probably important
- Primary osteoarthritis is of unknown aetiology
- Secondary osteoarthritis is the result of congenital, infective joint disorders or trauma
- Pathology characterised by:
  - Loss of hyaline cartilage
  - Subchondral bone sclerosis
  - Subchondral cyst formation
  - Osteophyte formation
- Several patterns of joint involvement recognised including:
  - Generalised nodular osteoarthritis
  - Large joint osteoarthritis

### Clinical features

- Joint pain - worse after exercise or at end of day
- Pain relieved by rest
- Limited early morning stiffness
- Limited stiffness after rest
- Bony joint swelling
- Few systemic features



Figure 338 Osteoarthritis of the hip and knee

### Management

- Aims of treatment are to:
  - Reduce joint pain
  - Improve joint function
- In early stages pain can often be improved with simple analgesia



- Life style modification is also important
- NSAIDs can often help
- Intra-articular steroids can reduce symptoms
- If fails to improve with conservative measures surgery may be required
- Surgical options for degenerative joints are:
  - Arthroscopic lavage and debridement
  - Osteotomy - alteration of joint alignment
  - Arthroplasty - replacement of diseased joint
  - Arthrodesis - fusion of disease joint

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### **Rheumatoid arthritis**

- Rheumatoid arthritis is an autoimmune inflammatory synovial disease
- Aetiology if unknown
- Worldwide prevalence is approximately 1%
- Female : male ratio is 3:1
- Onset most often seen between 20 and 40 years
- Usually symmetrically affects multiple joints
- Commonest joints affected are hand, elbow, knee and cervical spine
- Also affects synovium of tendon sheaths
- Often part of a systemic inflammatory process
- More common in those with HLA DR4 and DW4
- Pathologically characterised by:
  - An inflammatory process within the synovium
  - Joint destruction and pannus formation
  - Periarticular erosions

### **Clinical features**

- Joint pain - worse during exercise
- Pain relieved by movement
- Prolonged early morning stiffness
- Prolonged stiffness after rest
- Marked soft tissue swelling and erythema
- Systemic features often present



Figure 339 Rheumatoid hands



### **Extra-articular manifestations**

- Occur in approximately 20% of patients

#### **Ocular**

- Keratoconjunctivitis sicca
- Episcleritis
- Scleritis

#### **Pulmonary**

- Pulmonary nodules
- Pleural effusion
- Fibrosing alveolitis

#### **Cardiac**

- Pericarditis / pericardial effusion
- Valvular heart disease
- Conduction defects

#### **Cutaneous**

- Palmar erythema
- Rheumatoid nodules
- Pyoderma gangrenosum
- Vasculitic rashes and leg ulceration

#### **Neurological**

- Nerve entrapment
- Cervical myelopathy
- Peripheral neuropathy
- Mononeuritis multiplex

#### **Management**

- Requires a multidisciplinary approach
- Disease modifying drugs include:
  - NSAIDs
  - Methotrexate, sulphasalazine, penicillamine, gold
  - Corticosteroids
  - Cytotoxic drugs

#### **Specific syndromes**

- Several syndromes have been described associated with rheumatoid arthritis
- Felty's syndrome
  - Rheumatoid arthritis
  - Neutropenia
  - Lymphadenopathy
  - Splenomegaly
- Still's disease
  - Rheumatoid arthritis in childhood
  - Rash
  - Fever
  - Splenomegaly



- Sjogren's syndrome
  - Rheumatoid arthritis
  - Reduced lacrimal and salivary secretion

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## ***Hip replacement surgery***

- Operation developed by Sir John Charnley in 1960s
- More than 50,000 hip replacements are performed each year in United Kingdom
- Over one million hips have been replaced worldwide
- Over 100 different types of prosthesis have been used
- The 'gold standard' is the Charnley cemented prosthesis

### **Principle components**

#### ***Acetabular component***

- Usually made of high density polyethylene
- Biocompatible, low coefficient of friction, low rate of wear
- Ceramic acetabular component have improved surface properties
- Are expensive and have tendency to brittle failure
- Metal cups are obsolete due to high friction, loosening and wear

#### ***Femoral component***

- Usually made of stainless steel, titanium or cobalt chrome alloy
- Resistant to corrosion with high endurance
- Improved longevity seen with small femoral head

#### ***Polymethylmethacrylate cement***

- Acts as a filling agent without adhesive properties
- Macrolocking occurs with cement in drilled holes
- Microlocking occurs with cement in interstices of cancellous bone
- Produces an exothermic reaction during preparation
- Addition of barium weakens the cement
- Antibiotic impregnation may increase resistance to infection
- Recently uncemented prostheses have been developed
- Require more exacting insertion technique
- Anchored by interference fit achieved by porous surface or hydroxyapatite coating
- Uncemented prostheses have a tendency early failure

### **Indications**

- Osteoarthritis
- Rheumatoid arthritis
- Still's disease
- Ankylosing spondylitis
- Congenital dysplastic or dislocated hips
- Paget's disease
- Trauma or avascular necrosis
- Septic arthritis

### **Contraindications**

- Uncontrolled medical problems
- Skeletal immaturity
- Active infection
- Neuropathic joint
- Progressive neurological disease



- Muscle weakness

#### **Aims of surgery**

- Patients should have significant pain, functional disturbance and failed conservative therapy
- The principle aims of surgery are:
  - To reduce joint pain
  - Improve joint function

#### **Operative technique**

- Avoid operation in patients with a septic focus
- Thorough skin preparation with sterile adhesive plastic drapes
- Operating team should wear two pairs of gloves
- Body exhaust suites may be worn
- Laminar air flow should be provided in operative field
- Antibiotic prophylaxis should be given



Figure 340 Dislocated total hip replacement

#### **Specific complications**

- Neurovascular injuries
- Leg length discrepancy
- Dislocation
- Infection
- Aseptic loosening
- Implant wear and failure
- Heterotopic ossification
- Femoral fractures



- Trochanteric non-union
- Abductor mechanism weakness

#### Outcome

- Outcome is affected by many factors including:
  - Type of implant used
  - Underlying diagnosis
  - Sex of patient
  - Cement type
  - Cementing technique
  - Surgical approach

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### **Infected joint replacements**

- Over 100,000 knee and hip replacements are performed in the UK each year
- Most are carried out with few complications
- Infections is an uncommon but devastating complication
- Occurs in approximately 1% cases
- Results in major morbidity and considerable cost
- Risk can be reduced by:
  - Excluding patients who have active infection
  - Antibiotic prophylaxis
  - Careful theatre technique

### **Microbiology**

- Commonest organisms identified are:
  - Coagulase-negative staphylococcus (45%)
  - *Staph. aureus* (35%)
  - *Streptococci* (10%)
  - Gram-negative bacteria (<5%)
- Early infection results from intraoperative contamination
- Late infection usually results from haematogenous spread
- Bacteria adhere to prosthetic material and produce a biofilm
- Biofilm isolates the bacteria from host defences and antibiotics
- Significant infection can result from small bacterial inoculum
- A low-grade inflammatory process then occurs
- This leads to bone erosion and loss of bone stock

### **Clinical features**

- Acute infection presents with sign of a wound infection
- A purulent discharge from the wound is often present
- Chronic infection presents more insidiously
- Pain is often the prominent symptom
- The diagnosis of chronic infection can be difficult

### **Investigation**

- The following investigations should be considered
  - Microbial culture
  - Inflammatory markers
  - Plain radiography
  - Bone scan
  - Histology
  - Molecular methods
- Diagnosis depend on identification of bacteria from fluid around joint

### **Management**

- Antibiotics should be started once diagnosis is considered
- Rarely eradicate establish infection
- Antibiotic choice should be based on culture results
- If cultures are negative or unavailable then vancomycin is the organism of choice



### **Surgery**

- In acute infection joint debridement and washout may be appropriate
- In chronic infection with a loose joint, implant should be removed
- Revision surgery can be performed as a one-stage or two-stage procedure
- If insertion of new prosthesis is impossible consider:
  - Excision arthroplasty
  - Joint fusion
- Complications following revision joint surgery include:
  - Massive bone loss
  - Periprosthetic fracture
  - Recurrence of infection

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## Infections of bones and joints

### Acute osteomyelitis

- Acute osteomyelitis usually occurs in children
- Usually a haematogenous infection from distant focus
- Organisms responsible include:
  - *Staph. aureus*
  - *Strep. pyogenes*
  - *H. influenzae*
  - Gram-negative organisms
- Salmonella infections are often seen in those with sickle-cell anaemia
- Infection usually occurs in metaphysis of long bones

### Pathology

- Acute inflammation results in raised intraosseous pressure and intravascular thrombosis
- Suppuration produces a subperiosteal abscess that may discharge into soft tissues
- Spread of infection into epiphysis can result in joint infection
- Within days bone death can occur
- Fragments of dead bone become separated in medullary canal (sequestrum)
- New bone forms below stripped Periosteum (involucrum)
- If infection rapidly controlled resolution can occur
- If infection poorly controlled chronic osteomyelitis can develop

### Clinical features

- Child usually presents with pain, malaise and fever
- Often unable to weight bear
- Early signs of inflammation are often few
- Bone is often exquisitely tender with reduced joint movement
- Late infection presents with soft-tissue swellings or discharging sinus
- Diagnosis can be confirmed by aspiration of pus from abscess or metaphysis
- 50% of patients have positive blood cultures

### Radiology

- X-rays can be normal during first 3 to 5 days
- In the second week radiological signs include:
  - Periosteal new bone formation
  - Patchy rarefaction of metaphysis
  - Metaphyseal bone destruction
- In cases of diagnostic doubt bone scanning can be helpful

### Differential diagnosis

- Cellulitis
- Acute suppurative arthritis
- Rheumatic fever
- Sickle-cell crisis

### Management

- General supportive measures should include intravenous fluids and analgesia
- Painful limb often requires a splint of skin traction to relieve symptoms
- Aggressive antibiotic therapy should be instituted
- Flucloxacillin is often the antibiotic of choice



- If fails to respond to conservative treatment surgery may be required
- A subperiosteal abscess should be drained
- Drilling of metaphysis is occasionally required
- Overall, about 50% of children require surgery



Figure 341 Plain x-ray appearance of osteomyelitis of the distal tibia

### Complications

- Metastatic infection can occurs at distant sites (e.g. brain, lung)
- Spread into joint can result in a septic arthritis
- This complication occurs in:
  - Young children in whom the growth plate is permeable
  - Bones in which the metaphysis is intracapsular
  - Epiphysis of bones involved in metastatic infection
- Involvement of physis can result in altered bone growth
- Failure to eradicate infection can result in chronic osteomyelitis

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## Septic arthritis

- Acute inflammatory condition of a joint
- Usually results from bacterial infection
- Untreated it will lead to destruction of the articular cartilage
- 50% cases occur in children less than 3 years of age
- In infants less than one year old the hip is the commonest joint involved
- In older children the knee is the commonest joint affected
- 10% of patients have multiple joints involved

## Microbiology

- Infecting organism depends on age
- Organism can enter joint via a number of routes
  - Penetrating wound
  - From epiphysis or metaphysis
  - Haematogenous spread
- Provoke an acute inflammatory response
- Large number of neutrophils accumulate in joint
- Release proteolytic enzymes that break down the articular cartilage
- Results in joint effusion and reduced synovial blood supply
- Complications of septic arthritis include:
  - Avascular necrosis of epiphysis
  - Joint subluxation / dislocation
  - Growth disturbance
  - Secondary osteoarthritis
  - Persistent or recurrent infection

Table 67 Infecting organism depending on age

Children		Adults	
< 3 years old	> 3 years old	< 50 years old	> 50 years old
<i>H. influenzae</i>	<i>Staph aureus</i>	<i>Staph aureus</i>	<i>Staph aureus</i>
<i>Staph aureus</i>	<i>H. influenzae</i>	<i>Neisseria gonorrhoea</i>	Gram-negative
Coliforms			Streptococci

## Clinical features

- Exact presentation depends on age
- Children are usually systemically unwell
- Present with pain in the affected joint
- All movements of the joint are painful
- Reluctant to stand on weight-bearing joints
- Affected joint is usually swollen, red and warm
- Hip involvement results in flexion and external rotation
- In adults septic arthritis is usually associated with immunosuppression

## Investigations

- Key investigation is culture of a joint aspirate
- Should be performed prior to the administration of antibiotics
- Other appropriate investigations should include





- Inflammatory markers
- Plain x-rays
- Bone scan



Figure 342 Late presentation of septic arthritis

#### Differential diagnosis

- Irritable hip
- Perthe's disease
- Osteomyelitis
- Gout
- Pseudogout

#### Management

- Antibiotics should be started after joint aspiration
- Empirical therapy should be commenced based on likely organisms
- Adjusted depending antibiotic sensitivity
- Antibiotics should be continued for 6 weeks

#### Surgery

- Involves joint drainage and lavage
- May be performed arthroscopically
- Early joint mobilisation should be encouraged

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## **Other bone infections**

### **Pott's disease**

- Pott's disease is tuberculous spondylitis
- Well recognised in Egyptian mummies
- Described by Percival Pott in 1779
- Now rare in western countries
- Still prevalent in the developing world

### **Pathology**

- Usually occurs secondary to infection elsewhere
- Due to a combination of osteomyelitis and arthritis
- Often occurs at more than one vertebral level
- Usually affects anterior part of vertebral body
- More common in thoracic spine
- Bone destruction lead to vertebral collapse and kyphosis
- Spinal cord can be narrowed resulting in cord compression and neurological deficit

### **Clinical presentation**

- Back pain is the commonest symptom
- Pain may be present for several months
- Pain can be both spinal and radicular
- 50% patients have neurological signs at presentation
- Most patients have some degree of kyphosis
- Cold abscess may point in the groin

### **Investigations**

- Serum ESR is usually massively raised
- Tuberculin skin test is usually positive
- Plain x-rays may show
  - Lytic destruction of anterior vertebral body
  - Anterior vertebral collapse
  - Reactive sclerosis
  - Enlarged psoas shadow
- CT or MRI provides information on disc space and neurological involvement
- As allows CT guided biopsy to obtain microbiological and pathological specimens

### **Treatment**

- Treatment involves both tuberculous chemotherapy and possible surgery
- Nine months of combination chemotherapy should be used
- This involves 3 or 4 drugs
- Isoniazid and rifampicin should be given for full nine months
- Pyrazinamide, ethambutol or streptomycin should be give for first 2 months
- Surgery is indicated if:
  - Neurological deficit
  - Spinal deformity with instability
  - No response to medical treatment
  - Non-diagnostic percutaneous biopsy
- Surgical approach depends on extent of disease and level of spinal involvement
- Usually involves radical debridement and posterior stabilisation



Figure 343 MRI showing kyphosis secondary to spinal tuberculosis

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## Thoracic outlet compression syndrome

- Describes a collection of upper limb neurological and vascular symptoms
- Arise from proximal compression of neurovascular structures
- Usually affects middle aged women
- Male : female ratio 1:3
- 10% have bilateral symptoms

### Pathophysiology

- Compression can result from a bone, muscle or fibromuscular band
- Compressing lesion is usually congenital
- 30% of cases follow trauma (e.g. whiplash injury)

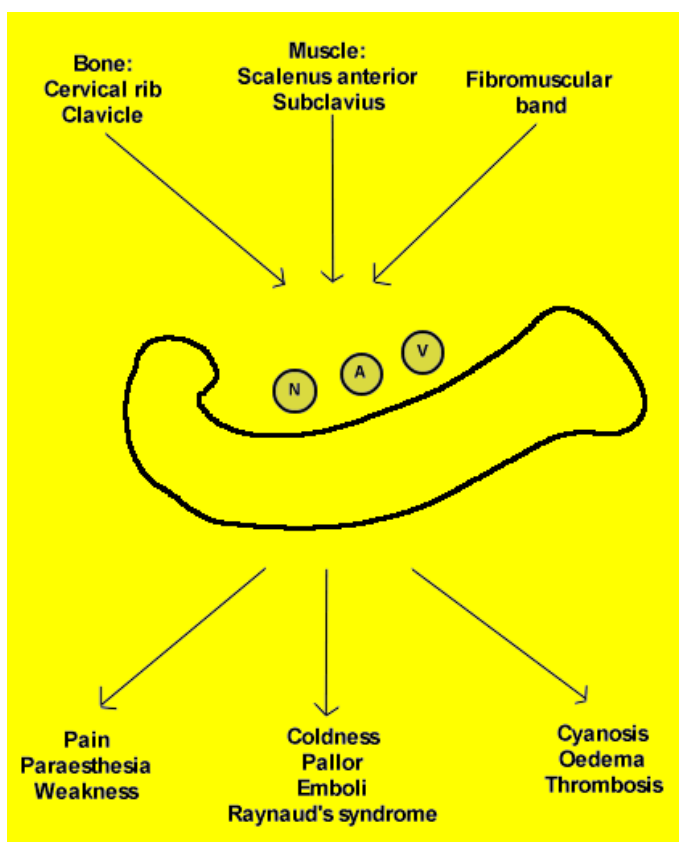


Figure 344 Mechanism of thoracic outlet syndrome

### Clinical features

- Neurological features are more common than vascular
- Subclavian artery aneurysm and axillary vein thrombosis are uncommon
- Symptoms often worsened by carrying weights or lifting arms above head
- Differential diagnosis includes:
  - Cervical spondylosis
  - Distal nerve compression
  - Pancoast's tumour
  - Connective tissue disorders
  - Vascular and venous embolic disease
- Diagnosis depends mainly on the history



- Signs are few but diagnosis may be confirmed with the

#### **Roos test**

- Reproduction of symptoms with arms flexed and abducted

#### **Subclavian compression tests**

- e.g. Adson's manoeuvre
- Loss of radial pulse with head turned to opposite side and neck extended

#### **Investigations**

- The results of investigations are often normal
- A CXR may show a cervical rib
- Nerve conduction studies may be needed to exclude a distal nerve compression
- Arch aortogram may show a subclavian artery aneurysm
- Duplex scanning may show arterial or venous compression and the effect of position

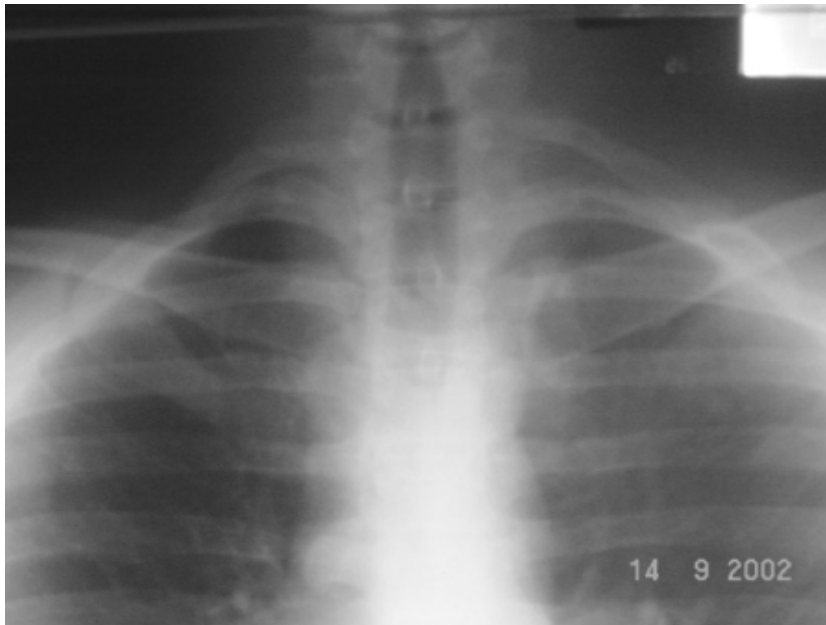


Figure 345 Chest x-ray showing a cervical rib

#### **Treatment**

- Symptoms may improve with physiotherapy
- If disabling symptoms need to consider surgical decompression
- Involves resection of most of first rib
- Can be achieved through either a supraclavicular or transaxillary approach
- 10% will develop a pneumothorax

#### **Prognosis**

- 80% report a symptomatic improvement
- More than 50% of patients are usually symptom free
- Failure to improve is often due to:
  - A double crush compression syndrome
  - Incomplete division of compressing structure



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## Common disorders of the extremities

### *Disorders of the upper limb*

#### Painful shoulder

##### **Anatomy**

- Shoulder joint is made up of a complex of five joints
  - Sternoclavicular joint
  - Acromioclavicular joint
  - Subacromial space
  - Glenohumeral joint
  - Scapulothoracic joint
- Glenohumeral joint is stabilised by a number of muscles
- These include deltoid muscle and the rotator cuff muscles
- The rotator cuff is made up of:
  - Supraspinatus
  - Infraspinatus
  - Teres minor
  - Subscapularis

##### **Clinical features**

- Causes of shoulder pain include:
  - Impingement syndromes
  - Rotator cuff tears
  - Frozen shoulder
  - Calcific tendonitis

#### Lateral epicondylitis

- Often referred to as tennis elbow
- Due to inflammation at the origin of the wrist and finger extensors
- Its is an enthesopathy of the lateral epicondyle

##### **Clinical features**

- Occurs between 30 and 50 years of age
- Men and women are equally affected
- 75% experience symptoms in their dominant arm
- Causes pain over the lateral epicondyle radiating to the forearm
- Tenderness is usually maximum 5 mm distal to the insertion of the tendon
- Resisted wrist extension increases the pain
- Plain x-ray may show calcification in the soft tissues

##### **Management**

- Non surgical management involves
  - Rest
  - Non-steroidal anti-inflammatory medication
  - Steroid injection
- Surgical treatment if no improvement with 6 months conservative treatment
- Involves division and reattachment of the tendon
- 85% notice a dramatic improvement in symptoms



### Medial epicondylitis

- Often referred to as golfer's elbow
- It is less common than lateral epicondylitis
- Occurs in same age group
- is is an enthesopathy of the pronator teres and flexor carpi radialis tendon
- Characterised by pain over the medial aspect of the elbow
- Pain is exacerbated by wrist flexion
- Tenderness is distal to medial epicondyle
- Management is similar to lateral epicondylitis
- Ulnar nerve entrapment at the elbow
- Ulnar nerve runs behind medial epicondyle at the elbow
- Runs in a tunnel formed by aponeurosis between tow head of flexor carpi ulnaris
- Aponeurosis is slack in elbow extension
- Becomes tight in elbow flexion
- Disorders of the elbow joint can result in nerve compression
- Symptoms are often worse when elbow is flexed

### Clinical features

- Pain and paraesthesia in the ring and little finger
- Weakness of grasp and grip
- Loss of manual dexterity
- Wasting of the intrinsic muscles of the hand

### Management

- Night splints to reduce elbow flexion may improve symptoms
- Surgical options include
- Ulnar nerve decompression
- Medial epicondylectomy
- Anterior transposition

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## **Common disorders of the hand**

### **Carpal tunnel syndrome**

- Carpal tunnel formed by flexor retinaculum stretching across carpus
- Forms a tight tunnel through which passes
  - Long flexors to fingers and thumb
  - Median nerve
- Swelling within the tunnel causes nerve compression and ischaemia
- Carpal tunnel syndrome affects 3% of women and 2% of men
- 30% cases due to underlying medical condition

### **Causes**

- Idiopathic
- Hormonal - pregnancy / menopause
- Rheumatoid arthritis
- Hypothyroidism
- Diabetes

### **Clinical features**

- Usually presents in middle age
- Female : male ratio is approximately 8:1
- Pain and paraesthesia in distribution of median nerve
- Symptoms are often worse at night
- Signs are few
- Tapping over carpal tunnel can reproduce symptoms (Tinel's sign)
- Flexion of wrist for 60 seconds reproduces symptoms (Phalen's sign)
- Thenar wasting and loss of 2-point discrimination are late features
- Diagnosis confirmed by electromyogram
- Shows slowed nerve conduction across the wrist

### **Management**

- Treat underlying associated medical problems
- Nocturnal symptoms can often be controlled with night splints
- Steroid injections may produce temporary symptomatic relief
- Troublesome symptoms require division of flexor retinaculum
- May be performed endoscopically
- 70-90% are symptom-free following surgery

### **de Quervain's disease**

- Also known as stenosing tenovaginitis
- Due to inflammation and thickening of tendon sheaths of :
  - Extensor pollicis brevis
  - Abductor pollicis longus
- Occurs where both tendons cross the distal radius

### **Clinical features**

- Usually presents in middle age
- Pain noted over radial aspect of wrist
- Often occurs after repetitive activity
- Tendon sheath is thickened and tender over the radial styloid



- Pain often worsened by abduction of thumb against resistance
- Passive abduction across palm often causes pain (Finkelstein's test)

#### **Management**

- Symptoms can often be improved with steroid injections into tendon sheath
- Persistent symptoms require surgery
- Tendon sheath should be split avoiding the dorsal sensory branch of radial nerve

#### **Dupuytren's contracture**

- Fibroproliferative disease of the palmar fascia
- First described in 1614
- Detailed anatomical study presented by Dupuytren in 1831
- Aetiology unclear
- Possibly inherited as an autosomal dominant condition with limited penetrance
- Occasionally associated with plantar fasciitis and Peyronie's disease
- More common in northern Europe
- Male to female ratio 4:1
- Affects 5% men older than 50 years

#### **Clinical features**

- Thickening of palmar fascia with nodule formation
- Flexion contracture at MCPJ and PIPJ
- Usually affects ring and little finger
- In late stage of the disease cords develop proximal to the nodules
- 65% cases are bilateral



Figure 346 Dupuytren's contracture



### **Risk factors**

- Diabetes mellitus
- Alcohol excess
- HIV infection
- Epilepsy
- Trauma
- Manual labour

### **Management**

- Excision or incision of the palmar fascia
- Options include fasciotomy, fasciectomy or dermofasciectomy
- Consider surgery if:
  - MCP contracture is greater than 30 degrees
  - There is functional disability
- Need intensive postoperative physiotherapy
- Approximately 20% patients develop complications
- Recurrence rate is approximately 50%

### **Ganglions**

- Commonest cause of swellings around the hand and wrist
- Cystic lesions arising from either the joint capsule or tendon sheath
- Aetiology is unknown
- More common in women
- Usually occur between 20 and 40 yrs of age
- 70% of ganglions occur around the wrist

### **Clinical features**

- Most present as smooth swellings 2-4 cm in diameter
- Most are painless
- Pain can occur due to compression of adjacent neurovascular structures



Figure 347 A ganglion on the dorsal aspect of the wrist



### **Management**

- If ganglion is asymptomatic no specific treatment is required
- The hold treatment of 'hitting with the family bible' should be condemned
- Aspiration can be attempted but outcome is poor
- Excision is the treatment of choice
- Lesion should be explored down to joint capsule or tendon sheath
- Inadequate surgery results in a high recurrence rate

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## ***Disorders of the foot***

### **Hallux valgus**

- Commonest deformity of the foot
- Results in excessive valgus angulation of the big toe
- Only seen in populations that wear shoes
- Splaying of the forefoot with varus angulation of the first metatarsal predisposes
- The anatomical deformity consists of:
  - Increased forefoot width
  - Lateral deviation of the hallux
  - Prominence of the first metatarsal head
- As deformity increases long tendons of the hallux are shifted laterally

### ***Clinical features***

- More common in women
- Often bilateral
- Symptoms result from
  - A bursa over metatarsal head = bunion
  - Hammer toes
  - Metatarsalgia
  - Osteoarthritis of the first MTPJ
- Diagnosis can be confirmed on x-ray
- Intermetatarsal angle should be less than 20 degrees
- Hallux angle should be less than 15 degrees



Figure 348 Clinical features of hallux valgus



### **Management**

- Surgical management should be considered if patient is symptomatic
- Options include:
  - First metatarsal osteotomy
  - Exostectomy and capsulorrhaphy
  - Excision of proximal one-third of proximal phalanx (Keller operation)
  - Arthrodesis

### **Hallux rigidus**

- Due to osteoarthritis of first MTPJ
- Affects men more often than women
- Results in pain on walking, especially on rough ground
- There is no valgus deviation of the hallux
- MTPJ is swollen and enlarged
- Dorsiflexion of the MTPJ is reduced
- A rocker-soled shoe may improve symptoms
- If significant symptoms occur then surgery may be required
- Options include:
  - Extension osteotomy
  - Cheilectomy
  - Arthroplasty
  - Arthrodesis

### **Claw toes**

- Results from:
  - Flexion of the interphalangeal joints
  - Hyperextension of the metatarsophalangeal joints
- Often idiopathic
- Can be associated with:
  - Rheumatoid arthritis
  - Poliomyelitis
  - Peroneal muscular atrophy

### **Clinical features**

- Pain in the forefoot = metatarsalgia
- Symptoms are usually bilateral
- Walking may be restricted
- Painful callosities on the dorsum of the toes or under the metatarsal heads

### **Management**

- If the toes can be passively straightened than a 'metatarsal bar' may help
- Special footwear may reduce symptoms
- If non-operative management fails then surgical options include:
  - Interphalangeal arthrodesis
  - Joint excision
  - Metatarsal osteotomy
  - Digital amputation



Figure 349 Clinical features of claw toes

### Plantar fasciitis

- Self-limiting condition that occurs in middle age
- Presents with intermittent inferior heel pain
- Usually unilateral but 15% cases are bilateral
- Pain often worse early in the morning
- Examination show tenderness over the medial plantar aspect of the calcaneal tuberosity
- 50% have heel spur on plain x-ray
- Differential diagnosis includes:
  - Reiter's syndrome
  - Entrapment neuropathy
  - Calcaneal stress fracture
- Management should involve the use of
  - Supportive heel pads and other orthotic devices
  - Non-steroidal anti-inflammatory drugs
- Surgery is rarely indicated

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## Osteoporosis

- Osteoporosis is a systemic skeletal disease characterised by:
  - Low bone mass
  - Micro-architectural deterioration
- It is associated with increased bone fragility and susceptibility to fractures
- It is defined as a bone mineral density less than 2.5 standard deviations below the mean
- Established osteoporosis is a low bone mineral density associated with an osteoporosis-related fracture

### Pathophysiology

- Bone undergoes continuous resorption and formation
- 10% of adult skeleton is remodelled each year
- Bone loss results from an imbalance between resorption and formation
- Human skeleton comprises approximately
  - 80% cortical bone
  - 20% trabecular bone
- Osteoporotic fractures occur at sites with more than 50% trabecular bone
  - Vertebral body
  - Proximal femur
  - Distal forearm
- Bone loss leads to thinning of the trabecular plates
- This causes a disproportionate loss of bone strength
- Peak bone mass is achieved by the age of 30 years
- After skeletal maturity bone is lost at about 1% per year
- Women experience accelerated bone loss after the menopause

### ***Factors associated with increased bone loss include:***

- Inactivity
- Cigarette smoking
- Poor diet
- Family history
- Early menopause
- Endocrine disease - Cushing's syndrome, diabetes, hyperthyroidism
- Drugs - Steroids, thyroxine, diuretics

### Clinical features

- Osteoporosis-related fractures
- Increased mortality
- Pain
- Deformity
- Loss of independence

### Investigation

- Radiology
- Dual-energy x-ray absorptionometry
- Quantitative CT scanning
- Quantitative ultrasound
- Bone biopsy
- Biochemical markers of bone turnover





### Prevention

- Optimisation of peak bone mass
  - Exercise
  - Dietary calcium
- Reduce rate of bone loss
  - Hormonal replacement therapy
  - Moderate alcohol intake
  - Stop smoking

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## Metabolic bone disease

- Bone is composed of both cells and matrix
- Also contains blood vessels, nerves and haemopoietic system

### *Bones cells*

- Osteoblasts are responsible for bone formation
- Osteoclasts are responsible for bone resorption
- Serum alkaline phosphatase reflects osteoblastic activity

### *Matrix*

- Has both mineralised and unmineralised components
- Mineralised component is made up of hydroxyapatite
- Osteoid is the unmineralised component
- Made up of 90% collagen and 10% non-collagenous proteins
- Non-collagenous proteins include proteoglycans and glycoproteins

### *Calcium homeostasis*

- 98% of bodies calcium is stored within the skeleton
- At homeostasis turnover results in equal flux in and out of skeleton
- Calcium homeostasis is maintained by parathyroid hormone, Vitamin D3 and calcitonin

### *Parathyroid hormone*

- 84 amino acid protein produced by parathyroid glands
- Increases serum calcium
- Increases renal calcium reabsorption
- Increases skeletal turnover
- Increases renal production of dihydroxy-vitamin D3

### *Cholecalciferol*

- Is vitamin D3
- Under normal circumstances is produced in the skin by action of sunlight on precursors
- Hydroxylated in the liver to 25-hydroxy-vitamin D3
- Hydroxylated in kidney to 1,25 dihydroxy-vitamin D3
- Increases renal reabsorption of calcium
- Increases gastrointestinal absorption of calcium
- Increases skeletal calcium resorption

### *Calcitonin*

- Produced by thyroid parafollicular C cells
- Reduces serum calcium
- Inhibits bone calcium resorption



### **Osteomalacia and rickets**

- Vitamin D deficiency results in incomplete osteoid mineralisation
- In childhood, prior to epiphyseal closure, causes rickets
- In adults causes osteomalacia

#### **Causes of osteomalacia**

- Vitamin D deficiency
- Malabsorption
  - Post-gastrectomy or bowel resection
  - Coeliac disease
  - Cirrhosis
- Renal disease
  - Renal tubular disorder (e.g. familial hypophosphataemic rickets)
  - Chronic renal failure
- Anticonvulsant therapy
- Tumours

#### **Clinical features**

- Osteomalacia usually due to dietary deficiency in the elderly or Asian population
- Rickets usually due to familial hypophosphataemic rickets
- Rickets usually presents in early childhood with:
  - Failure to thrive
  - Valgus or varus long bone deformities
  - Skull deformities = craniotabes
  - Enlarged costochondral junctions = Rickety rosary
  - Lateral indentation of the chest wall = Harrison's sulcus
  - Xray shows widened epiphyses and cupped distal metaphysis
- Osteomalacia presents with
  - Bone pain and tenderness
  - Proximal myopathy
  - True pathological or pseudo-fractures
  - Xray shows translucent bands in medial femoral cortex, pubic ramus or scapula
  - = Looser's zones
- In osteomalacia
  - Serum calcium and phosphate are low
  - Alkaline phosphatase is increased
  - In familial hypophosphataemic rickets
  - Serum calcium is normal and phosphate is low
  - Bone biopsy would show increased unmineralised osteoid

#### **Treatment**

- Vitamin D replacement therapy
- Phosphate supplements in familial hypophosphataemic rickets



Figure 350 Radiological features of rickets



Figure 351 Looser's zone in osteomalacia



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### **Paget's disease of bone**

- Named after Sir James Paget (1814-1899)
- First described *osteitis deformans* in 1877
- Aetiology is unknown - possibly due to a viral infection
- Often an incidental finding on x-ray in an asymptomatic patient
- If symptomatic usually causes bone pain
- Clinical signs include characteristic skull and long bone deformities

### **Complications**

- Pathological fractures - complete or incomplete
- Neurological effects
  - Cranial nerve lesions
  - Spinal cord lesions
- Osteoarthritis
- Sarcomas
- Cardiac failure

### **Histological features**

- Osteoclasts are enlarged
- Increased bone turnover produces a mosaic pattern of lamellar bone
- Three phases recognised - osteolytic, mixed and sclerotic

### **Radiological features**

- Osteolytic phase can produce osteoporosis circumscripta
- Bone softening can produce bowing, platybasia, protrusion acetabuli or greenstick fractures
- Mixed phase shows generalised bone enlargement
- Sclerotic phase shows increased density, trabeculae and cortical thickening

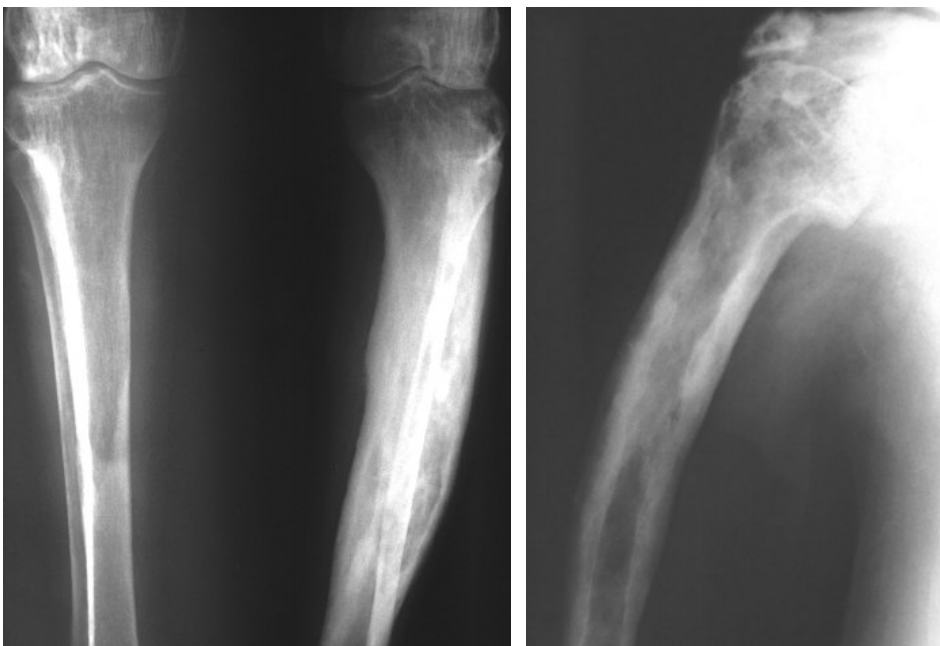


Figure 352 Paget's disease of the tibia and humerus



### **Biochemistry**

- Serum calcium and phosphate are usually normal
- Serum alkaline phosphatase is increased
- Uric acid increased in about 30% of patients

### **Treatment**

- Non-steroidal antiinflammatory agents will control bone pain
- Biphosphonates will reduced bone turnover
- Neurological complications and fractures may require surgical intervention

### **Paget's sarcomas**

- Most osteosarcomas that develop lat in life are associated with Paget's disease
- Malignant change occurs in less than 1% patients with Paget's disease
  - 50% are osteosarcomas
  - 25% are fibrosarcomas
  - 25% are giant-cell sarcomas
- The commonest site is the femur
- Prognosis of Paget's sarcomas is poor
- Median survival is one year
- Only 5% alive at five years

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## Locomotor pain

### *Low back pain*

- Lumbar back pain is one of the commonest causes of chronic disability
- Usually due to abnormality of intervertebral discs at L4/5 or L5/S1 level

### **Pathology**

- With age nucleus pulposus of disc dries out
- Annulus fibrosis also develops fissures
- Nuclear material may herniate through annulus
- May perforate vertebral end-plate to produce a Schmorl node
- Flattening of the disc with marginal osteophyte formation is known as spondylosis
- Osteoarthritis may develop in the facet joints
- Osteophyte formation may narrow lateral recesses of spinal canal
- These can encroach on spinal canal and result in spinal stenosis
- Acute herniation of disc contents can occur
- Usually occurs to one side of the posterior longitudinal ligament
- Posterolateral rupture can compress nerve roots
- Central posterior rupture can compress the cauda equina

### **Acute disc rupture**

- Can occur at any age
- Usually occurs in fit adults between 20-45 years

### **Clinical features**

- Presents with acute low back pain on stooping or lifting
- Pain often radiates to buttock or leg
- May be associated with paraesthesia or numbness in the leg
- Cauda equina compression can cause urinary retention
- Examination may show a 'sciatic' scoliosis
- All back movement is restricted
- May be lumbar tenderness and paravertebral spasm
- Straight leg raising is often restricted
- Neurological examination is essential
- L5 root signs include:
  - Weakness of hallux extension
  - Loss of knee reflex
  - Sensory loss over the lateral aspect of the leg and dorsum of the foot
- S1 root signs include:
  - Weakness of foot plantar flexion
  - Loss of ankle reflex
  - Sensory loss over the lateral aspect of the foot
- Cauda equina compression causes
  - Urinary retention
  - Loss or perianal sensation





### **Imaging**

- Lumbar spine x-ray will exclude other bone lesions
- Myelography is a historical investigation
- MRI is now the investigation of choice

### **Management**

- Bed rest is of unproven benefit
- Recovery is not hasten by traction
- NSAID provide symptomatic relief
- The role of epidural steroid injection is unclear
- Chemonucleolysis is less effective than surgical discectomy
- Surgery is required if:
  - Cauda equina compression - neurosurgical emergency
  - Neurological deterioration with conservative management
  - Persistent symptoms and neurological signs
- Surgical options are:
  - Partial laminectomy
  - Microdiscectomy
- Postoperative rehabilitation and physiotherapy are essential

### **Facet joint dysfunction**

- Usually present with recurrent low back pain
- Pain often related to physical activity
- May be referred to the buttock
- Often relieved by lying down
- Lumbar spine movement is often good
- Neurological signs may be few
- Lumbar spine x-rays show narrowing of the disc space
- Oblique views may show facet joint malalignment
- Treatment includes:
  - Physiotherapy
  - Analgesia
  - Facet joint injections
  - Spinal fusion

### **Spinal stenosis**

- Narrowing of the spinal canal due to hypertrophy of the posterior disc margin
- May be compounded by facet joint osteophyte formation
- Spinal stenosis may also be associated with:
  - Achondroplasia
  - Spondylolisthesis
  - Paget's disease
- Usually presents with either unilateral or bilateral leg pain
- Initiated by standing or walking
- Relieved by sitting or leaning forward - 'spinal claudication'
- Patient prefers to walk uphill rather than downhill
- X-rays often show degenerative spondylolisthesis
- Diagnosis can be confirmed by MRI
- Often treated conservatively
- Surgery involves wide laminectomy and decompression



## Spondylolisthesis

- Spondylolisthesis means forward shift of the spine
- Occurs at L4/L5 or L5/S1 level
- Can only occur if facet joint locking mechanism has failed
- Classified as:
  - Dysplastic - 20%
  - Lytic - 50%
  - Degenerative - 25%
  - Post-traumatic
  - Pathological
  - Postoperative
- In lytic spondylolisthesis the pars interarticularis is in two pieces (spondylolysis)
- Vertebral body and superior facet joints subluxate and dislocate forward
- Degree of overlap is usually expressed as percentage
- Cauda equina or nerve roots may be compressed
- Presents with back pain and neurological symptoms
- Patients have a characteristic stance
- A 'step' in the lumbar spine may be palpable
- Diagnosis can be confirmed on a plain x-ray
- Most patients improve with conservative management
- Surgery may be required if:
  - Disabling symptoms
  - Progressive displacement more than 50%
  - Significant neurological compromise
- Anterior or posterior fusion may be required

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## **Spinal cord compression**

- The clinical features of a spinal cord lesion depend on its rate of development
- Trauma produces acute compression with rapidly developing effects
- Benign neoplasms can cause substantial compression with little neurological deficit

### **Anatomy**

- The spinal cord is shorter than spinal canal
- The cord ends at the interspace between the L1 and L2 vertebrae
- Below the termination of the cord the nerve roots form the cauda equina
- Within cervical spine segmental levels of cord correspond to bony landmarks
- Below this level there is increasing disparity between levels
- Spinal pathology below L1 presents with only root signs

### **Aetiology**

- Trauma - vertebral body fracture or facet joint dislocation
- Neoplasia - benign or malignant
- Degenerative - prolapsed intervertebral disc, osteophyte formation
- Vascular - epidural or subdural haematoma
- Inflammatory - rheumatoid arthritis
- Infection - tuberculosis or pyogenic infections

### **Clinical presentation**

- Clinical features depend on extent and rate of development of cord compression
- Motor symptoms include easy fatigue and gait disturbance
- Cervical spine disease produces quadriplegia
- Thoracic spine disease produces paraplegia
- Lumbar spine disease affects L4, L5 and sacral nerve roots
- Sensory symptoms include sensory loss and parasthesia
- Light touch, proprioception and joint position sense are reduced
- Tendon reflexes are often:
  - Increased below level of compression
  - Absent at level of compression
  - Normal above level of compression
- Reflex changes may not coincide with sensory level
- Sphincter disturbances are late features of cervical and thoracic cord compression
- Cauda equina compression due to central disc prolapse produces:
  - Loss of perianal sensation
  - 'Root pain' in both legs
  - Painless urinary retention
- Most patients with surgically treatable causes of spinal compression have spinal pain
- Movement induced pain suggests vertebral fracture or collapse
- Exquisite tenderness suggests an epidural abscess
- Low-grade background pain suggests tumour infiltration or osteomyelitis

### **Investigation**

- Plain x-rays may show bone or paravertebral soft tissue disease
- Features include vertebral collapse, lytic lesions, loss of pedicle
- Integrity of disc may indicate diagnosis
- 'Good disc = bad news' often indicates malignancy



- 'Bad disc = good news' may indicate infection
- MRI is investigation of choice to define extent of soft tissue disease
- Bone scan may indicate pattern and extent of bone pathology

### **Management**

- Acute cord compression is a 'surgical' emergency
- In those with malignant disease radiotherapy may be treatment of choice
- In general, tumour, infection and disc disease produces anterior compression
- Surgical decompression should be achieved through an anterior approach
- Cervical spine can be approached between larynx medially and carotid sheath laterally
- Thoracic spine can be approached through chest by a posterior thoracotomy or costotransversectomy

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## Bone tumours and amputations

### Primary bone tumours

- Primary bone tumours are rare
- Secondaries tumours are more common especially in the elderly

Table 68 Classification of primary bone tumours

Cell type	Benign	Malignant
Bone	Osteoid osteoma	Osteosarcoma
Cartilage	Chondroma	Chondrosarcoma
	Osteochondroma	
Fibrous tissue	Fibroma	Fibrosarcoma
Bone marrow	Eosinophilic granuloma	Ewing's sarcoma
		Myeloma
Vascular	Haemangioma	Angiosarcoma
Uncertain	Giant-cell tumour	Malignant giant cell tumour

### Clinical features

- Most present with pain, swelling and localised tenderness
- Rapid growth and erythema are suggestive of malignancy
- May cause pathological fractures
- Diagnosis confirmed by:
  - Plain x-ray
  - CT scan
  - Bone scan
  - Carefully planned biopsy

### Osteoid osteoma

- Benign bone tumour
- Usually less than 1 cm in diameter and surround by dense osteoid
- Occurs in young adults
- Tibia and femur are the commonest site
- Pain (relieved by aspirin) is presenting complaint
- Xray has characteristic appearance of a radiolucency surrounded by dense bone
- Local excision is curative

### Osteochondroma

- Commonest bone tumour
- Lesions can be single or multiple
- Appears in adolescence as cartilaginous overgrowth at epiphyseal plate
- Grows with underlying bone
- Metaphyses of long bones are the commonest sites
- Presents as painless lump or occasionally joint pain
- Excision should be considered if causing significant symptoms

### Chondroma

- Benign tumour of cartilage
- Lesions may be single or multiple (Ollier's disease)
- Appears in tubular bones of hands and feet



- Xray shows well defined osteopenic area in the medulla
- Lesion should excised and bone grafted

#### ***Giant-cell tumour (Osteoclastoma)***

- Equal proportions are benign, locally invasive and metastatic
- Found in sub-articular cancellous region of long bones
- Only occurs after closure of epiphyses
- Patients are usually between 20 and 40 years
- Xray shows an asymmetric rarefied area at the end of a long bone
- Cortex is thinned or even perforated
- Treatment by local excision and grafting often leads to recurrence
- Wide excision and joint replacement is the treatment of choice
- Amputation if malignant or recurrent tumour

#### ***Osteosarcoma***

- Occurs in the metaphyses of long bones
- Commonest sites are around the knee or proximal humerus
- Destroys bone and spreads into the surrounding tissue
- Rapidly metastasises to the lung
- Usually occurs between 10 and 20 years
- In later life is seen associated with Paget's disease
- X-ray shows combination of bone destruction and formation
- Periosteum may be lifted (Codman's triangle)
- Soft tissue calcification produces a 'sunburst' appearance
- Treatment involves amputation and chemotherapy
- Amputations are often limited with prosthetic replacement
- 50% five years survival
- Worst prognosis seen with proximal and axial skeletal lesions

#### ***Chondrosarcoma***

- Occurs in two forms
- 'Central' tumour in pelvis or proximal long bones

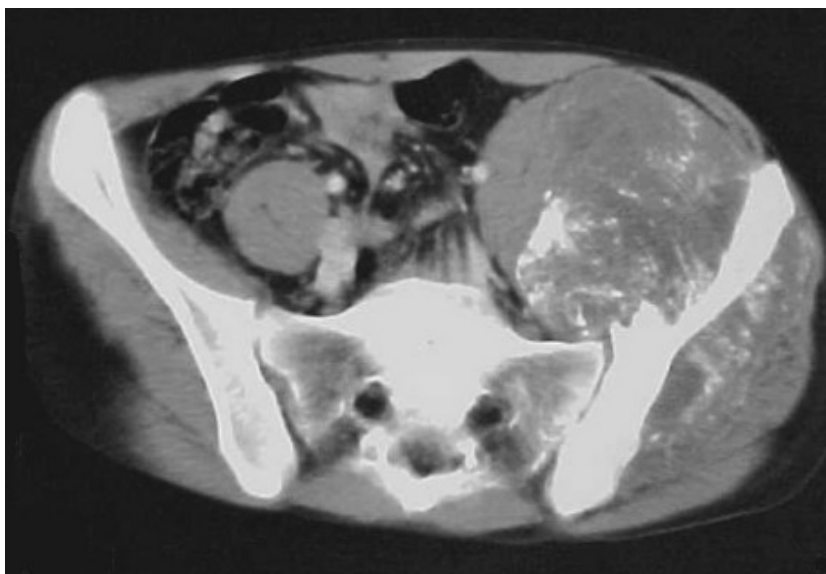


Figure 353 Chondrosarcoma arising from iliac crest



- 'Peripheral' tumour in the cartilaginous cap of an Osteochondroma
- Tend to metastasise late
- Wide local excision is often possible

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### **Metastatic bone tumours**

- 30% of patients with malignant disease will develop bone metastases
- 10% of these patients will develop a pathological fracture
- Tumours spread to bone by:
  - Direct invasion
  - Haematogenous spread
  - Lymphatic spread
  - Spread via paravertebral venous plexus
- Commonest sites lumbar vertebrae, pelvis and ribs

### **Primary tumours which spread to bone**

- Breast (35%)
- Prostate (30%)
- Bronchus (10%)
- Kidney (5%)
- Thyroid (2%)
- Others (18%)

### **Clinical features**

- Pain or localised bone lump
- Pathological fracture
- Hypercalcaemia
- Cord compression

### **Radiology**

- Plain x-rays can be normal
- If abnormal will show either an osteolytic or sclerotic lesion
- Bone scan has higher sensitivity than x-rays
- May identify other asymptomatic lesions



Figure 354 Multiple osteosclerotic bone metastases



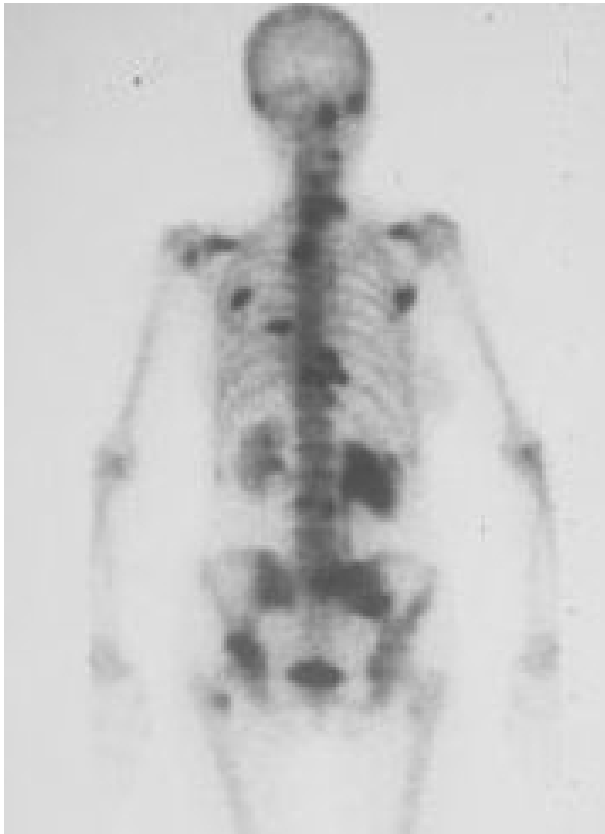


Figure 355 Bone scan showing multiple bone metastases

***Differential diagnosis***

- Calcified enchondroma
- Hyperparathyroidism
- Chronic sclerosing osteomyelitis
- Bone infarct
- Myeloma deposit

***Treatment***

- The aims of treatment are to relieve pain and preserve mobility
- If pathological fracture consider internal fixation for early mobilisation and pain relief
- Consider radiotherapy for back pain
- Spinal decompression may be needed for cord compression
- Prophylactic internal fixation may be required if :
  - Greater than 50% erosion of a long bone cortex
  - A metastasis of more than 2.5 cm in diameter
  - Metastasis in high risk area (e.g. subtrochanteric femur)
  - Metastasis with persistent pain



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## **Multiple myeloma**

- Multiple myeloma is a malignant disease of plasma cells in bone marrow
- Accounts for 1% of all cancers
- 2,500 new cases each year in United Kingdom
- Most patients are over 60 years of age
- Characterised by production of monoclonal immunoglobulins
- These can be detected in serum, urine or both

### **Pathogenesis**

- Monoclonal overgrowth of one clone of plasma cells occurs
- Produces monoclonal immunoglobulin or paraprotein
- In 80% patients an IgG or IgA is detectable in serum
- In 20% no paraprotein is detectable in the serum
- Free light chains may cross glomerulus and appear in urine
- These are known as Bence-Jones proteins

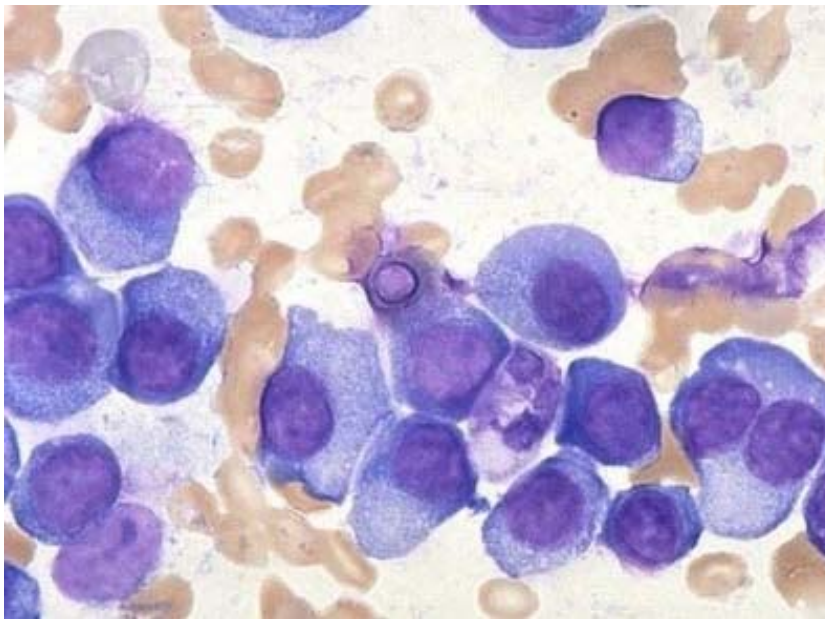


Figure 356 Bone marrow aspirate showing multiple myeloma

### **Clinical features**

- Bone pain - especially back pain
- Pathological fracture
- Cord compression
- Hypercalcaemia
- Renal failure
- Anaemia
- Immunosuppression
- Amyloidosis



## Investigations

- Diagnosis confirmed by:
  - Paraprotein in serum or urine on electrophoresis
  - Lytic lesions on radiography
  - Bone marrow aspirate with more than 10% plasma cells



Figure 357 Pathological humeral fracture due to multiple myeloma

## Management

- 70% patients respond to therapy
- Complete remission is rare
- Median survival is 3 years
- Treatment options
  - Melphalan chemotherapy
  - Interferon-alpha
  - Bone marrow transplantation
- Treatment of complications
  - Dialysis for renal failure
  - Bisphosphonates for hypercalcaemia
  - Radiotherapy for localised bone pain



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## Urology

### Urological trauma

#### Renal trauma

- In UK, 90% of renal injuries result from blunt trauma
- Isolated renal trauma is uncommon
- About 40% have associated intra-abdominal injuries
- Direct trauma crushes kidney against ribs
- Indirect trauma can result in vascular or pelviureteric disruption

#### Clinical features

- Loin or abdominal abrasions or bruising
- Loin tenderness
- Loss of loin contour
- Loin mass
- Macroscopic haematuria and possible clot colic
- A renal pedicle injury is possible in the absence of haematuria

#### Imaging

- The aims of imaging are to:
  - Assess extent of injury
  - Determine function of contralateral kidney
- Plain radiograph may show rib fractures, loss of psoas shadow and renal outline
- Stable patients with microscopic haematuria do not require an IVU
- IVU will detect extravasation of urine and distortion of caliceal system
- Provides a crude index of renal function
- Failure of excretion suggests renal pedicle injury and need for angiography
- Ultrasound will identify haematomas and perirenal collections

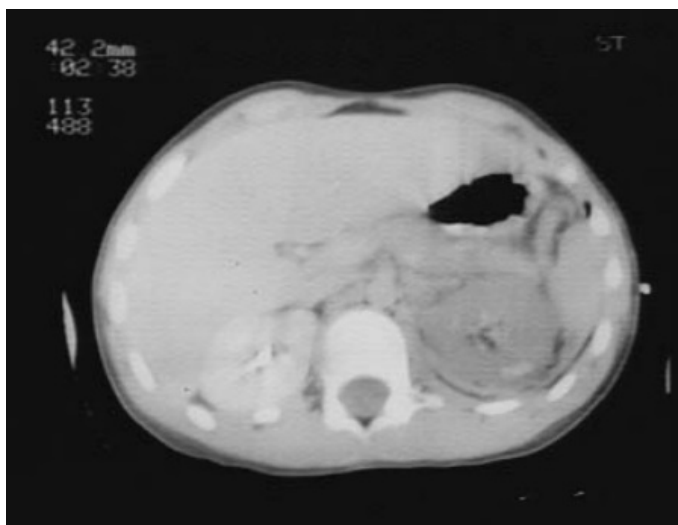


Figure 358 CT appearance of left Class V renal injury



### Classification

- Class I - Renal contusion or contained subcapsular haematoma
- Class II - Cortical laceration without urinary extravasation
- Class III - Parenchymal lesion extending more than 1 cm into renal substance
- Class IV - Laceration extending across cortico-medullary junction
- Class V - Renal fragmentation or reno-vascular pedicle injury

### Management

- 80% injuries are minor (Class I/II) and can be managed conservatively
- Early surgical intervention is required for:
  - Reno-vascular pedicle injury
  - Pelviureteric junction disruption
  - Shock with signs of intraperitoneal or retroperitoneal trauma
- Surgery should be performed through a midline incision and transperitoneal approach
- Control of the renal pedicle should be obtained before the retroperitoneal haematoma is opened
- Surgical priorities are:
  - Save life - early nephrectomy may be required
  - Remove devitalised tissue
  - Preserve renal function - consider partial nephrectomy if possible
  - Repair and drain collecting system



Figure 359 Intraoperative appearance of Class IV renal injury

### Late complications

- Hypertension
- Arteriovenous fistula
- Hydronephrosis
- Pseudocyst or calculi formation
- Chronic pyelonephritis
- Loss of renal function



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### **Lower urinary tract trauma**

- Management is controversial and often confusing
- In multiply injured patient there are the conflicting priorities of:
  - Monitoring urine output with a urethral catheter
  - Preventing exacerbation of a urethral injury
- Lower urinary tract injury should be suspected if the following are seen:
  - Blood from urethral meatus
  - Perineal bruising
  - High riding prostate on rectal examination
- Potentially useful investigations include IVU, ascending urethrogram or cystogram

### **Bladder injury**

- Often associated with pelvic fractures
- Also seen following direct blow to abdomen with a full bladder
- Rupture can either intraperitoneal or extraperitoneal
- Clinical features include lower abdominal peritonism and inability to pass urine
- IVU may show urine extravasation
- Diagnosis can be confirmed by cystography
- Intraperitoneal rupture requires laparotomy, bladder repair, urethral and suprapubic drainage
- Extraperitoneal rupture can be treated conservatively with urethral drainage
- Prophylactic antibiotics should be given

### **Bulbar urethral injury**

- Is the commonest type of urethral injury
- Usually the result of direct trauma caused by falling astride an object
- Clinical features include blood from meatus and perineal bruising
- If unable to pass urine a urethral catheter should not be passed
- Can convert a partial tear into a complete urethral injury
- If catheter is required it should be inserted via the suprapubic route
- Diagnosis can be confirmed by ascending urethrogram
- Prophylactic antibiotics should be given
- Complications include a urethral stricture

### **Membranous urethral injury**

- Often occur in multiply injured patient and unless suspected can be missed
- 10% of men with pelvic fracture have a membranous urethral injury
- Tear can be either partial or complete
- Partial injuries present with urethral bleeding and perineal bruising
- Complete injuries present with inability to pass urine
- On rectal examination the bladder and prostate is displaced upwards
- If injury suspected a urethral catheter should not be passed
- Diagnosis can be confirmed by ascending urethrogram
- Treatment is with suprapubic catheter
- Urethroplasty may be required
- Complications include stricture, impotence and incontinence



Figure 360 Urethrogram showing bulbar urethral disruption

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## Urinary tract infections and calculi

### Urinary tract infection

- Bacteriuria is the presence of bacteria in the urine
- Significant bacteriuria is present when more than  $10^5$  colony forming units are present per ml of urine
- Commonest organisms involved are:
  - *Escherichia coli* (80%)
  - *Proteus mirabilis*
  - *Pseudomonas aeruginosa*

### Pathogenesis

- Urine proximal to the distal urethra is normally sterile
- Most UTIs are due organisms arising from faecal flora
- They are invariably the result of ascending infection
- Rarely urinary tract infections can arise secondary to bacteraemia
- Host defences against infection include:
  - Voiding of urine
  - Urinary antibodies
  - Desquamation of epithelial surfaces
  - Antibacterial enzymes - lactoferrin and lysozyme
  - Secretory urinary IgA
- UTIs can be uncomplicated or complicated
- Uncomplicated UTIs have no underlying structural abnormality
- Complicated UTIs arise secondary to a structural lesion and can result in renal damage

### Investigation

- All upper UTIs require investigation
- Lower UTIs in children and men should be investigated
- The aims of investigation are to:
  - Establish the diagnosis of a UTI
  - Identify the organism involved and its antibiotic sensitivity
  - Exclude a structural or pathological abnormality of the urinary tract
- The diagnosis of a UTI can be suggested by dip-stick testing of urine
- The presence of nitrites or leucocyte esterase is very suggestive of a gram-negative infection
- Diagnosis can be confirmed by microscopy and culture of a MSU
- Investigation of the urinary tract in adults may involve ultrasound, IVU and cystoscopy

### Lower urinary tract infection

- Symptoms include suprapubic pain, frequency and dysuria
- Treat with increased fluid intake and antibiotics
- Symptoms can be improved by alkalinisation of the urine
- MSU should be repeated at 7 days to check that the infection has been cleared



### Acute pyelonephritis

- Presents with pyrexia, frequency, dysuria and loin pain
- MSU will be positive for the infecting organism
- Imaging in the acute situation is not required
- Treatment is by parenteral antibiotics
- Complications included Pyonephrosis
- Occurs if coexisting upper tract obstruction
- Required urgent decompression usually by percutaneous nephrostomy
- If inadequately treated can result in a perinephric abscess

### Urinary tract infection in men

- Men are less susceptible to UTIs
- Infection is usually the result of bladder outflow obstruction
- Residual urine acts a nidus of infection
- A proven UTI in man required US, urinary flow rates and possible cystoscopy
- Urinary tract infection in children
  - 1% of boys and 3% of girls develop a UTI
  - Risk factors include posterior urethral valves, neuropathic bladder and stones
  - UTIs in childhood are associated with vesico-ureteric reflux
  - Reflux of infected urine can result in scarring, hypertension and renal failure
  - Scarring in the presence of sterile reflux is uncommon
  - 30% of children with UTIs have VUR
  - 50% of children with UTIs and VUR have renal scarring
  - Most renal scarring occurs in the first two years of life
- Aims of treatment in children are to:
  - Relieve symptoms
  - Prevent recurrence
  - Identify predisposing factors
  - Prevent renal damage
- All neonates and boys require investigation after one infection
- Investigations will include US, IVU and possibly micturating cystogram
- Prophylactic antibiotics may be required for recurrent infections

### Vesico-ureteric reflux

- Spontaneous resolution occurs in 80% of patients
- Indications for surgical reimplantation of the ureters are:
  - Recurrent UTIs resulting from poor compliance with antibiotic prophylaxis
  - Breakthrough infections with prophylaxis
  - Gross VUR with atonic ureters
  - Alternatives to surgery includes subendothelial injection of collagen or Teflon at VUJ

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### **Urinary tract calculi**

- Form from crystalline aggregates of organic molecules
- Factors favouring formation:
  - Increased urinary concentration of constituents
  - Presence of promoter substances
  - Reduction in concentration of inhibitors
- Life time risk of developing a ureteric calculus is about 5%
- Occur most commonly in men aged between 30 - 60 years
- 90% are idiopathic
- 10% are due to metabolic derangement
  - Hyperparathyroidism
  - Vitamin D excess
  - Primary hyperoxaluria
- Recurrence rate at 10 years is about 50%

### **Chemical composition**

- Calcium oxalate (40%)
- Calcium phosphate (15%)
- Mixed oxalate / phosphate (20%)
- Struvite (15%)
- Uric acid (10%)

### **Clinical features**

- Stones usually present with pain due to obstruction of urinary flow
- May cause few symptoms or may present with typical ureteric colic
- Ureteric colic typically is severe colicky loin to groin pain
- Pain may radiate into scrotum in men and labia in women
- May also cause frequency, urgency and dysuria
- Pain may settle with passage of the stone or if stone fails to migrate
- Abdominal examination is usually unremarkable
- Microscopic haematuria is often present

### **Differential diagnosis**

- The differential diagnosis included renal and non-renal causes
- Non-renal causes include:
  - Appendicitis
  - Diverticulitis
  - Ectopic pregnancy
  - Salpingitis
  - Torted ovarian cyst
  - Abdominal aortic aneurysm
- Renal causes include:
  - Tumour (colic)
  - Pyelonephritis
  - Retroperitoneal fibrosis
  - Stricture
  - Papillary necrosis



### Investigation

- The following investigations should be considered
  - Midstream urine specimen
  - KUB plus ultrasound
  - Intravenous urogram (IVU)
- CT scanning may provide useful information
- Radiation dose from IVU = 1.5 mSv
- Radiation dose from CT scan = 4.5 mSv

### Complications

- Complications of ureteric calculi include:
  - Obstruction
  - Ureteric strictures
  - Infection
- Acute infection in an obstructed kidney is a urological emergency
- Patient is usually unwell with loin pain, swinging pyrexia and dysuria
- Without drainage, rapid renal destruction may occur
- Requires emergency percutaneous nephrostomy
- Chronic infection with urease-producing organisms (e.g. *Proteus*) precipitates stone formation
- Magnesium ammonium phosphate or staghorn calculi result
- Large staghorn calculi may be asymptomatic
- Staghorn calculi can lead to a deterioration in renal function

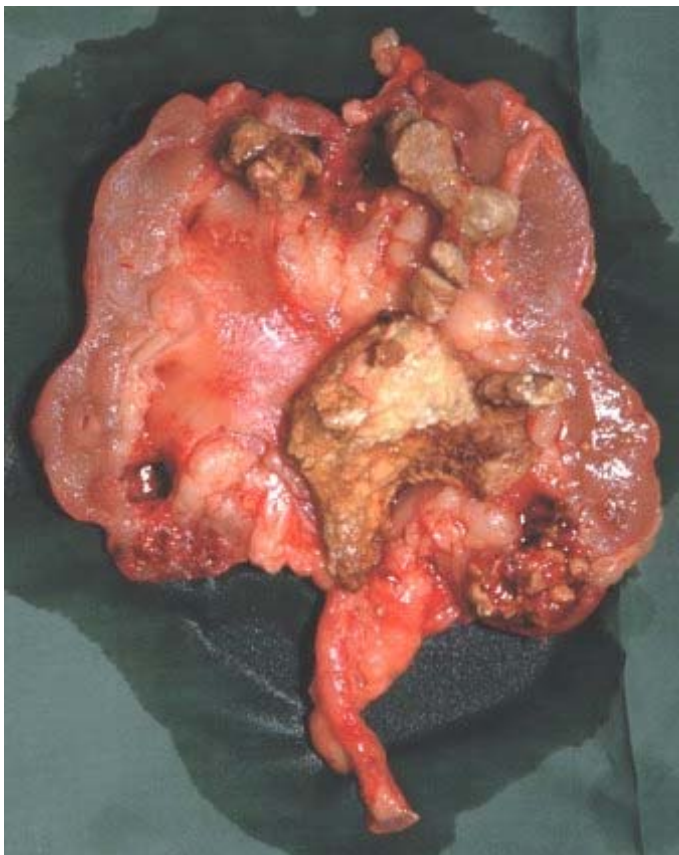


Figure 361 A staghorn calculus



### Management of ureteric calculi

- Initial conservative treatment with oral fluids and adequate analgesia
- Check serum electrolytes and calcium
- Urinalysis will normally show microscopic haematuria
- IVU to confirm diagnosis and presence of ureteric obstruction
- Most stones < 5 mm in diameter will pass spontaneously
- If greater 5-10 mm in diameter and fail to pass spontaneously consider:
  - Upper third of ureter - Extracorporeal shock wave lithotripsy (ESWL)
  - Lower third of ureter - Ureteroscopy (USC) + lithotripsy
  - Middle third of ureter - Either ESWL or USC
- If total obstruction occurs in the presence of infected urine need urgent decompression with percutaneous nephrostomy.
- If large stones in renal pelvis or upper ureter consider percutaneous nephrolithotomy.
- Particularly if stone > 3 cm in diameter or a 'staghorn calculus'
- Less than 1% patients with stones require open surgery - uretero- or nephrolithotomy



Figure 362 KUB showing a staghorn calculus



### Lithotripsy

- Is the use of shock waves to break up stones
- Lithotripsy requires:
  - An energy source - spark-gap electrode or piezoceramic array
  - A coupling device between patient and electrode - water bath or cushion
  - A method of stone localisation - fluoroscopy or ultrasound

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### **Bladder calculi**

- Bladder calculi are uncommon in the Western world
- They are well described in ancient medical literature
- Hippocrates wrote about the management of bladder stone
- Operations to remove stones via the perineum were described in the centuries BC
- Suprapubic lithotomy was described in the 15th century
- Transurethral lithotomy became popular in the 18th century
- Lithotripsy was first described in 1822
- Surgery was often associated with significant morbidity and mortality

### **Pathophysiology**

- Bladder calculi are usually associated with urinary stasis
- Urinary infections increase the risk of stone formation
- Foreign bodies (e.g. suture material) can also act as a nidus for stone formation
- They can however form in a normal bladder
- There is no recognised association with ureteric calculi
- Most bladder calculi form in the bladder and are not from the upper urinary tract
- They vary in size and can be multiple
- They are more common in elderly men
- In Asia, they are seen more commonly in children
- Most stones in adults are formed of uric acid
- Long-standing untreated bladder stones are associated with squamous cell carcinoma

### **Clinical features**

- Bladder calculi can be asymptomatic
- Common symptoms include
  - Suprapubic pain
  - Dysuria
  - Haematuria
- Abdominal examination may be normal



Figure 363 Plain abdominal x-ray showing a bladder calculus



## Diagnosis

- Historically stones were diagnosed by the passage of urethral 'sounds'
- Today they can be identified on
  - Plain abdominal x-ray
  - Bladder ultrasound
  - CT scan
  - Cystoscopy
- Uric acid stones are radiolucent but may have an opaque calcified layer
- Patients may present in acute urinary retention

## Surgery

- Indications for surgery include
  - Recurrent urinary tract infections
  - Acute urinary retention
  - Frank haematuria
- Any underlying bladder abnormality should be sought
- Historically the surgical approach involved 'cutting for a stone'
- This was via either a perineal or suprapubic approach
- The three common approaches today are
  - Transurethral cystolitholapaxy
  - Percutaneous cystolitholapaxy
  - Open suprapubic cystostomy
- Extracorporeal shockwave lithotripsy is relatively ineffective
- Complications of cystolitholapaxy include
  - Infection
  - Haemorrhage
  - Bladder perforation
  - Hyponatraemia
  -



Figure 364 Open suprapubic cystostomy for a bladder stone

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## ***Pelviureteric junction obstruction***

### **Causes of upper urinary tract obstruction**

- PUJ obstruction - idiopathic, retroperitoneal fibrosis, secondary to trauma or infection
- Extrinsic ureteric compression - e.g. retrocaval ureter, AAA
- Intraluminal pathology - tumour or stone
- Intramural pathology - primary megaureter

### **Idiopathic PUJ obstruction**

- PUJ obstruction is more common in men
- Affects left kidney more often than right
- 10% cases are bilateral
- Aetiology is unknown but important factors may be
- Aberrant lower pole vessels
- Persistent foetal urothelial fold



Figure 365 Pelviureteric junction obstruction



### **Clinical features**

- Usually presents in adolescence or early adult life
- Presenting symptom may be loin pain - worse after alcohol
- In late cases a renal mass may be palpable
- Haematuria is an uncommon feature
- 10% develop UTIs and 3% renal colic

### **Investigation**

- Diagnosis can be confirmed by ultrasound
- IVU shows a classical appearance
- Isotope renography allows assessment of percentage of renal function

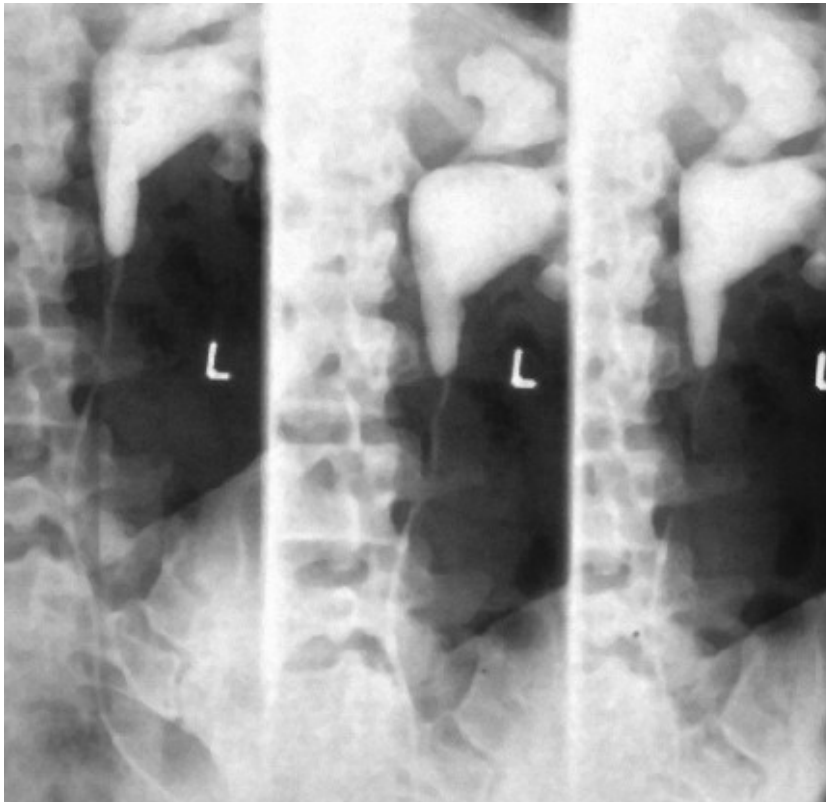


Figure 366 Pelviureteric junction obstruction on IVU

### **Management**

- The aims of treatment are to:
  - Relieve symptoms
  - Preserve renal function
- Can be achieved by a pyeloplasty
- In the United Kingdom the Anderson-Hynes pyeloplasty is the commonest procedure
- If severe renal impairment (<20% function)
- Nephrectomy may be required

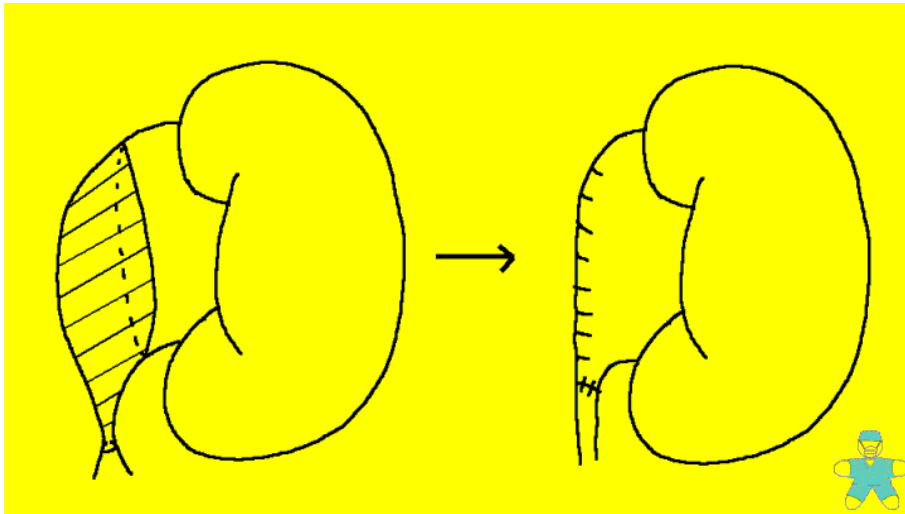


Figure 367 The Anderson-Hynes pyeloplasty

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## Haematuria

### **Classification and assessment**

- Both microscopic and macroscopic haematuria are abnormal
- Invariably requires investigation
- Population prevalence of macroscopic haematuria is approximately 1%
- Prevalence of microscopic haematuria is about 5%
- 50% of patients with haematuria will have an underlying abnormality
- 10% patients with microscopic haematuria will have a urological malignancy
- 35% patients with macroscopic haematuria will have an underlying tumour

### **Causes of haematuria**

#### **Surgical causes**

- Transitional cell carcinoma - bladder, ureter, renal pelvis
- Stone disease
- Renal cell carcinoma
- Trauma
- Benign prostatic hyperplasia
- Urethral stricture

#### **Glomerular medical causes**

- IgA nephropathy
- Glomerulonephritis
- Systemic lupus erythematosus
- Bacterial endocarditis

#### **Non-glomerular medical causes**

- Urinary tract infections
- Tuberculosis
- Schistosomiasis
- Drugs
- Blood dyscrasias
- Exercise-induced haematuria

### **Investigation of haematuria**

- Investigation should be aimed at excluding a surgical cause
- All patients should undergo:
  - Urine microscopy and culture
  - Urine cytology
  - KUB and ultrasound or an IVU
  - Cystoscopy
- If normal then patient should be referred for a nephrological opinion

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## Renal cell carcinoma

- Benign tumours of the kidney are rare
- All renal neoplasms should be regarded as potentially malignant
- Renal cell carcinomas arise from proximal tubule cells
- Alternative names include:
  - Hypernephroma - Initially believed to arise from adrenal gland
  - Clear cell carcinoma - Histologically have small nuclei and abundant cytoplasm
  - Grawitz tumour

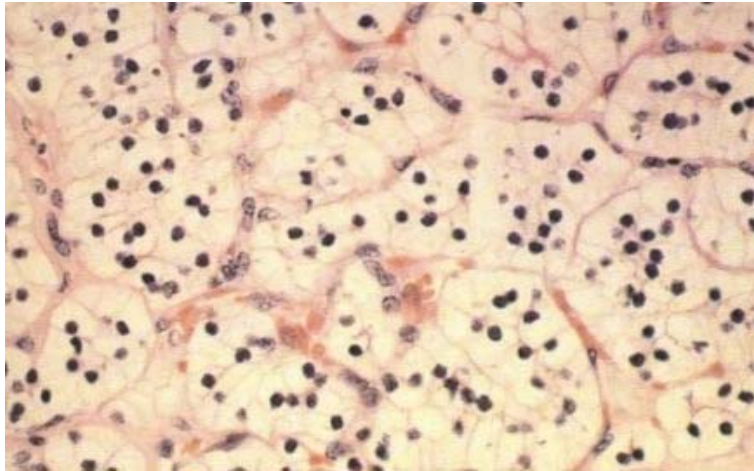


Figure 368 Histological appearance of clear cell carcinoma

- Male : female ratio is approximately 2:1
- Increased incidence seen in von Hippel-Lindau syndrome
- Pathologically may extend into renal vein and inferior vena cava
- Blood born spread can result in 'cannon ball' pulmonary metastases

### Clinical presentation

- 10% present with classic triad of haematuria, loin pain and a mass
- Other presentation include a pyrexia of unknown origin, hypertension
- Polycythaemia due to erythropoietin production
- Hypercalcaemia due to production of a PTH-like hormone

### Robson Staging

- Stage 1 - Confined to the kidney
- Stage 2 - Involvement of perinephric fat but Gerota's fascia intact
- Stage 3 - Spread into renal vein
- Stage 4 - Spread into adjacent or distant organs
- Prognosis depends on pathological stage, tumour size, nuclear grade and histological type

### Investigation

- Diagnosis can often be confirmed by renal ultrasound
- CT scanning allows assessment of renal vein and caval spread
- Echocardiogram should be considered if clot in IVC extends above diaphragm



Figure 369 CT scan appearance of left renal cell carcinoma

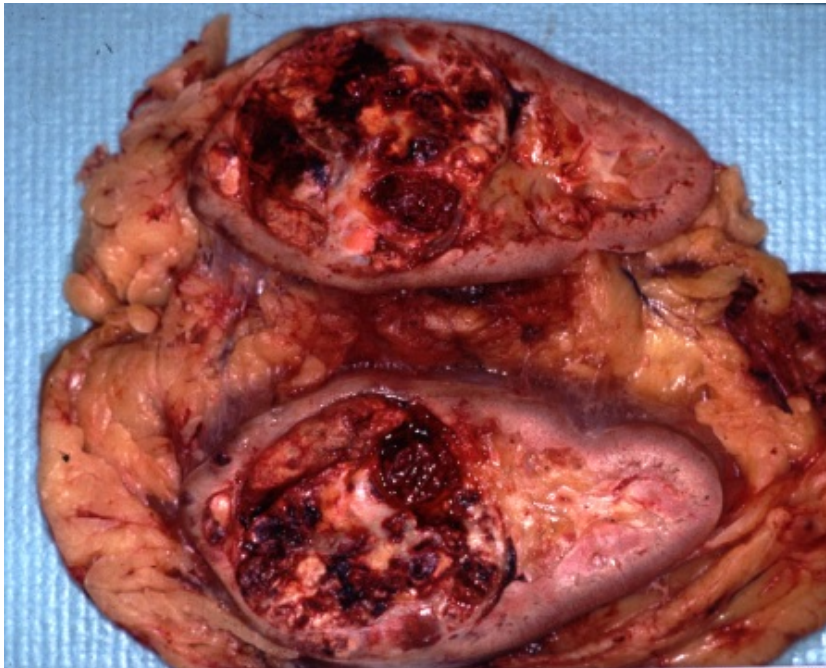


Figure 370 Gross pathological appearance of a renal cell carcinoma

### Treatment

- Unless extensive metastatic disease it invariably involves surgery
- Surgical option usually involves a radical nephrectomy
- Kidney approached through either a transabdominal or loin incision
- Renal vein ligated early to reduce tumour propagation
- Kidney and adjacent tissue (adrenal, perinephric fat) excised
- Lymph node dissection of no proven benefit
- Solitary (e.g. lung metastases) can occasionally be resected
- Radiotherapy and chemotherapy have little role





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## Bladder carcinoma

- Most are transitional cell carcinomas
- Superficial tumours are usually low grade and associated with a good prognosis
- Muscle invasive tumours are of higher grade and have a poorer prognosis

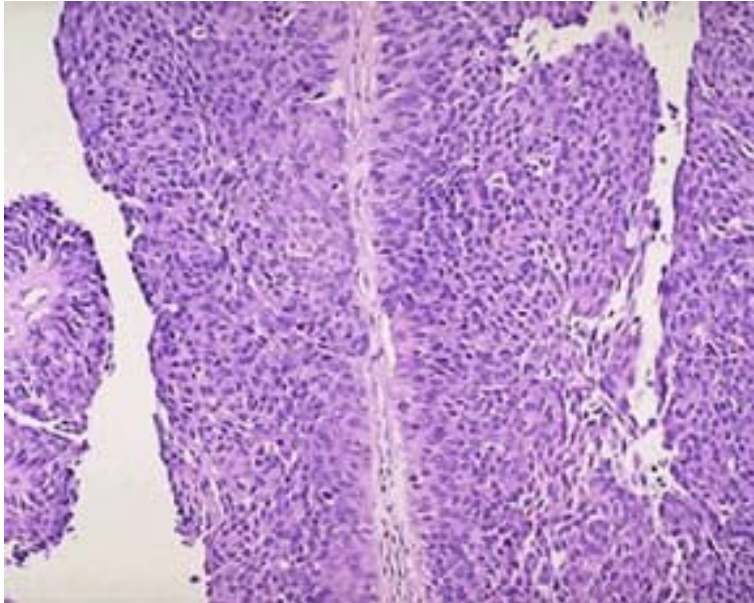


Figure 371 Transitional cell carcinoma of the bladder

### Pathology

- Of all bladder carcinomas
  - 90% are transitional cell carcinomas
  - 5% are squamous carcinoma
  - 2% are adenocarcinomas
- TCCs should be regarded a 'field change' disease with a spectrum of aggression
- 80% of TCCs are superficial and well differentiated
- Only 20% progress to muscle invasion
- Associated with good prognosis
- 20% of TCCs are high-grade and muscle invasive
- 50% have muscle invasion at time of presentation
- Associated with poor prognosis

### Aetiological factors

- Occupational exposure
  - 20% of transitional cell carcinomas are believed to result from occupational factors
  - Chemical implicated - analine dyes, chlorinated hydrocarbons
- Cigarette smoking
- Analgesic abuse e.g. phenacitin
- Pelvic irradiation - for carcinoma of the cervix
- *Schistosoma haematobium* associated with increased risk of squamous carcinoma



### Pathological staging

- Requires bladder muscle to be included in specimen
- Staged according to depth of tumour invasion
  - T<sub>is</sub> - In-situ disease
  - T<sub>a</sub> - Epithelium only
  - T<sub>1</sub> - Lamina propria invasion
  - T<sub>2</sub> - Superficial muscle invasion
  - T<sub>3a</sub> - Deep muscle invasion
  - T<sub>3b</sub> - Perivesical fat invasion
  - T<sub>4</sub> - Prostate or contiguous muscle
- Grade of tumour also important
  - G<sub>1</sub> - Well differentiated
  - G<sub>2</sub> - Moderately well differentiated
  - G<sub>3</sub> - Poorly differentiated

### Presentation

- 80% present with painless haematuria
- Also present with treatment-resistant infection or bladder irritability and sterile pyuria

### Investigation of painless haematuria

- Often performed in haematuria clinic
  - Urinalysis
  - Mid stream urine
  - Serum urea and creatinine
  - Ultrasound - bladder and kidneys
  - KUB - to exclude urinary tract calcification
  - Flexible cystoscopy
- Consider IVU if no pathology identified

### Treatment of bladder carcinomas

#### Superficial TCC

- Requires transurethral resection and regular cystoscopic follow-up
- Consider prophylactic chemotherapy if risk factor for recurrence or invasion (e.g. high grade)
- Consider immunotherapy
- BCG = Attenuated strain of *Mycobacterium bovis*
- Reduces risk of recurrence and progression
- 50-70% response rate recorded
- Occasionally associated with development of systemic mycobacterial infection

#### Carcinoma in-situ

- Carcinoma *in-situ* is an aggressive disease
- Often associated with positive cytology
- 50% patients progress to muscle invasion
- Consider immunotherapy
- If fails patient may need radical cystectomy

#### Invasive TCC

- Choices are between radical cystectomy and radiotherapy



- Radical cystectomy has an operative mortality of about 5%
- Urinary diversion achieved by:
  - Valve rectal pouch - modified ureterosigmoidostomy
  - Ileal conduit
  - Neo-bladder
- Local recurrence rates after surgery are about 15% and after DXT alone about 50%
- Pre-operative radiotherapy is no better than surgery alone
- Adjuvant chemotherapy may have a role

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## Urinary tract obstruction

### *Bladder outflow obstruction*

#### Causes of bladder outflow obstruction

- Congenital - urethral valves & strictures
- Structural
  - Benign prostatic hyperplasia
  - Carcinoma of the prostate
  - Bladder neck stenosis
  - Urethral stricture
- Functional
  - Bladder neck dyssynergia
  - Neurological disease - spinal cord lesions, MS, diabetes
  - Drugs - anticholinergics, antidepressants
- Prostate cancer develops in the periphery of the gland
- BPH affects urethral glands in the transitional zone of the prostate

#### Benign prostatic hyperplasia

- Affects 50% men older than 60 years
- Affects 90% of men older than 90 years
- Presents with obstructive and irritative symptoms
- Obstruction causes poor stream, hesitancy, dribbling and retention
- Irritation causes frequency, nocturia, urgency and urge incontinence
- Diagnosis can be confirmed by uroflowmetry

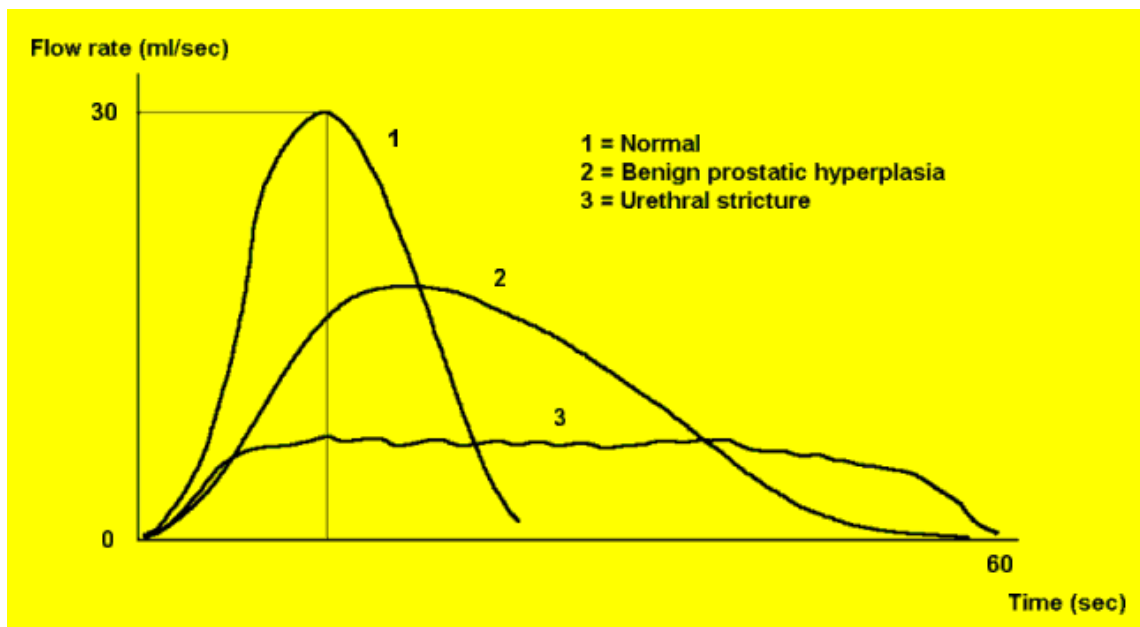


Figure 372 Characteristic uroflowmetry results

- Only 70% of men with lower urinary tract symptoms have proven bladder outflow obstruction



- Other investigations should include:
  - Urea and electrolytes to check renal function
  - Ultrasound to excluded hydronephrosis and measure post-micturition volume
  - Serum PSA to excluded malignancy

### **Management**

- The aims of treatment are to:
  - Relieve symptoms and include quality of life
  - Relieve bladder outflow obstruction
  - Treat complications resulting from bladder outflow obstruction

### **Treatment options**

- Observation
  - Pharmacological
    - $\alpha$ -adrenergic antagonists
    - 5 $\alpha$ - reductase inhibitors
    - LHRH antagonists
- Surgery
  - Transurethral prostatectomy
  - Transurethral or interstitial thermotherapy
  - Urethral stents
  - Interstitial laser prostatectomy

### **Complications following TURP**

#### **Early**

- Primary haemorrhage
- Extravasation
- Fluid absorption (TUR syndrome)
- Infection
- Clot retention
- Epididymo-orchitis
- Incontinence

#### **Intermediate**

- Secondary haemorrhage
- Retrograde ejaculation
- Erectile dysfunction

#### **Late**

- Bladder neck stenosis
- Urethral stricture

### **Urethral strictures**

#### **Aetiology**

- Congenital
- Trauma - instrumentation, urethral rupture
- Infection - gonococcal, non-specific urethritis, syphilis, TB
- Inflammatory - balanitis xerotica obliterans
- Neoplasia - squamous, transitional cell or adenocarcinoma



### **Management**

- Dilatation - gum-elastic bougie, metal sounds
- Urethrotomy - internal or external
- Urethroplasty

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## **Prostate carcinoma**

- Commonest malignancy of male urogenital tract
- There are about 10,000 cases per year in the United Kingdom
- Rare before the age of 50 years
- Found at post-mortem in 50% of men older than 80 years
- 5-10% of operation for benign disease reveal unsuspected prostate cancer

### **Pathology**

- The tumours are adenocarcinomas
- Arise in the posterior part of the gland
- Spread through capsule into perineural spaces, bladder neck, pelvic wall and rectum
- Lymphatic spread is common
- Haematogenous spread occurs to axial skeleton
- Tumours are graded by Gleason classification

### **Clinical features**

- 60% present with symptoms of bladder outflow obstruction
- 10% are incidental findings at TURP
- Remainder present with bone pain, cord compression or leuco-erythroblastic anaemia
- Renal failure can occur due to bilateral ureteric obstruction

### **Diagnosis**

- With locally advanced tumours diagnosis can be confirmed by rectal examination
- Features include hard nodule or loss of central sulcus
- Transrectal ultrasound is useful in cases of diagnostic doubt
- Transrectal or transperineal biopsy should be performed
- Pelvic CT or MRI is useful in the staging of the disease
- Bone scanning will detect the presence of metastases
- Unlikely to be abnormal if asymptomatic and PSA < 10 ng/ml

### **Serum prostate specific antigen (PSA)**

- Kallikrein-like protein produced by prostatic epithelial cells
- 4 ng/ml is the upper limit of normal
- >10 ng/ml is highly suggestive of prostatic carcinoma
- Can be significantly raised in BPH
- useful marker for monitoring response to treatment

### **Treatment**

- More men die with than from prostate cancer
- Treatment depends on stage of disease, patient's age and general fitness
- Treatment options are for:
  - Local disease
    - Observation
    - Radical radiotherapy
    - Radical prostatectomy
  - Locally advanced disease
    - Radical radiotherapy
    - Hormonal therapy
  - Metastatic disease
    - Hormonal therapy





### **Hormonal therapy**

- 80% of prostate cancers are androgen dependent for their growth
- Hormonal therapy involves androgen depletion
- Produces good palliation until tumours 'escape' from hormonal control
- Androgen depletion can be achieved by:
  - Bilateral subcapsular orchidectomy
  - LHRH agonists - gosereline
  - Anti-androgens - cyproterone acetate, flutamide
  - Oestrogens - stilbeostrol
  - Complete androgen blockade

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## **Urinary retention**

- Retention of urine can be acute or chronic
- Chronic retention can be associated with either low or high intravesical pressure

### **Acute retention**

- Presents with inability to pass urine for several hours
- Usually associated with lower abdominal pain
- Bladder is visible and palpable
- Bladder is tender on palpation

### **Causes**

- Bladder outflow obstruction
- Faecal impaction
- Urethral stricture
- Acute or chronic prostatitis
- Blood clot in bladder
- Retroverted gravid uterus
- Post operation
- Spinal anaesthesia
- Spinal cord injury
- Urethral rupture
- Anal pain
- Drug induced - anticholinergics, antidepressants

### **Management**

- The immediate management is usually urethral catheterisation
- Catheter is passed using a full aseptic technique
- Urethral analgesia can be achieved with lignocaine gel
- Gel is massaged into posterior urethra and catheter not passed for at least 5 minutes
- 12 to 16 Fr gauge Foley catheter (usually with 10 ml balloon) is then inserted
- Catheter should pass easily into bladder and balloon can be inflated
- Attach the drainage bag and record volume of urine drained
- If fails to drain significant volume of urine reconsider the diagnosis
- If no symptoms of bladder outflow obstruction attempt 'Trial without catheter' at 48 hours
- If difficulty is encountered in passing the catheter:
  - Do not use force
  - Do not inflate catheter balloon until urine has been seen in the catheter
  - Do not use a catheter introducer unless adequately trained in its use
- If unable to pass a urethral catheter the use a suprapubic puncture is desirable

### **Complications of catheterisation**

- If appropriate technique used then complications are rare
- False passages and urethral strictures can occur if significant trauma to prostate or urethra
- Minor haematuria can occur but usually clears spontaneously
- Hypotension and collapse is a rare complication
- Post obstruction diuresis has been described but is usually self-limiting
- It occasionally requires intravenous crystalloid volume replacement
- There is no evidence to support gradual decompression of the bladder



### Chronic retention

- Chronic retention is usually relatively painless
- High intravesical pressure can cause hydronephrosis and renal impairment
- Can present as late-onset enuresis
- May also present with hypertension
- Low pressure chronic retention presents with symptoms of bladder outflow obstruction
- Need to perform neurological examination to exclude disc prolapse
- Patients with chronic retention and renal impairment need urgent urological assessment

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## Pain & swelling in the scrotum

### **Testicular tumours**

- Commonest malignancy in young men
- Highest incidence in caucasians in northern Europe and USA
- 1400 new cases per year in UK
- Peak incidence for teratomas is 25 years and seminomas is 35 years
- In those with disease localised to testis >95% 5 year survival possible
- Risk factors include:
  - Cryptorchidism
  - Testicular maldescent
  - Klinefelter's syndrome

### **Classification of testicular tumours**

- British Testicular Tumour Panel Classification
- Seminomas (~40%)
- Teratomas (~50%)
  - Teratoma differentiated
  - Malignant teratoma intermediate
  - Malignant teratoma undifferentiated
  - Malignant teratoma trophoblastic
- Yolk sac tumours

### **Presentation of testicular tumours**

- Usually present with testicular swelling or mass
- Amount of pain is variable, but, often the mass is painless
- May present with gynaecomastia due to  $\beta$ HCG production
- May present with symptoms of metastatic disease
- Seminomas metastasise to para-aortic nodes and produce back pain
- Teratomas under go blood borne spread to liver, lung, bone and brain

### **Investigation of testicular tumours**

- Diagnosis can often be confirmed by testicular ultrasound
- Pathological diagnosis made by performing an inguinal orchidectomy
- Disease can be staged by thoraco-abdominal CT scanning
- Tumour markers are useful in staging and assessing response to treatment

### **Alpha-fetoprotein ( $\alpha$ FP)**

- Produced by yolk sac elements
- Not produced by seminomas

### **Beta-human chorionic gonadotrophin ( $\beta$ HCG)**

- Produced by trophoblastic elements
- Elevated levels seen in both teratomas and seminomas



Table 69 Royal Marsden staging of testicular tumours

Stage		Definition
I	Disease confined to testis	
IM	Rising post-orchidectomy tumour marker	
II	Abdominal lymphadenopathy	A Less than 2 cm
		B 2-5 cm
		C More than 5 cm
III	Supra-diaphragmatic disease	O No abdominal disease
		A, B, C, Abdominal nodal disease
IV	Extra-lymphatic metastases	
L1	Less than 3 lung metastases	
L2	More than 3 lung metastases	
L3	More than 3 lung metastases 1 or more greater than 2 cm	
H+	Liver involvement	

### Treatment of testicular tumours

#### Seminomas

- Seminomas are radiosensitive
- Stage I and II disease treated by inguinal orchidectomy plus
- Radiotherapy to ipsilateral abdominal and pelvic nodes ('Dog leg') or surveillance
- Stage IIC and above treated with chemotherapy

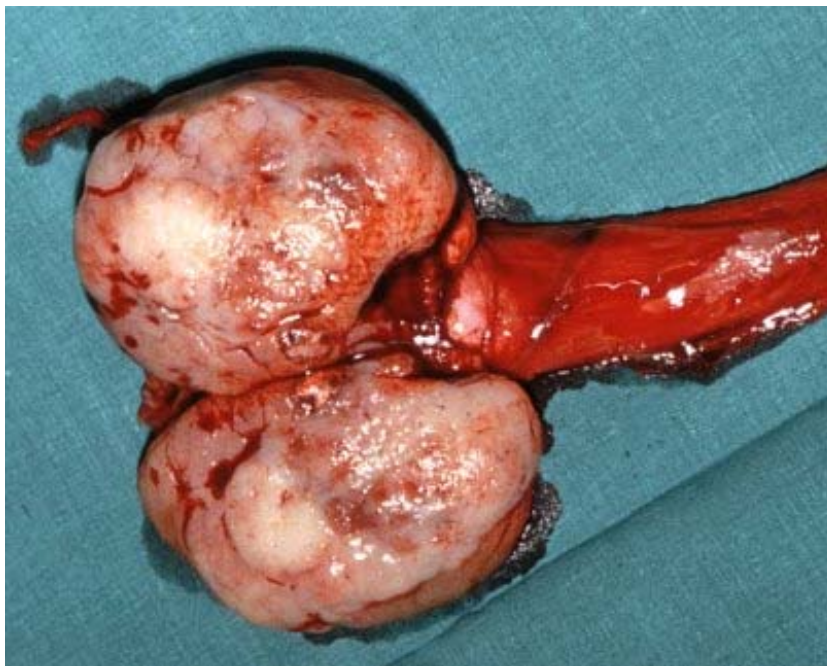


Figure 373 Operative appearance of a seminoma



### Teratomas

- Teratomas are not radiosensitive
- Stage I disease treated by orchidectomy and surveillance
- Chemotherapy (BEP = Bleomycin, Etoposide, Cisplatin) given to:
  - Stage I patients who relapse
  - Metastatic disease at presentation

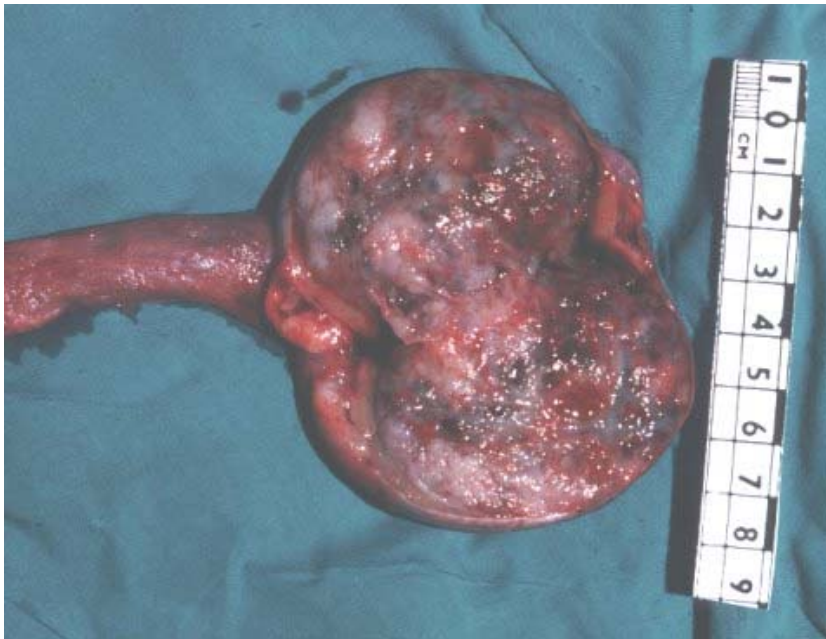


Figure 374 Operative appearance of a teratoma

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## **Scrotal swellings**

### **Diagnosis of scrotal swellings**

- To determine the nature of a scrotal swelling four aspects need to be assessed.
  - Can you get above the swelling?
  - Can the testis and epididymis be identified separately?
  - Does the swelling transilluminate?
  - Is the swelling tender?

### **Swellings not confined to the scrotum**

- Hernias
  - May be reducible with cough impulse
  - Testis is palpable
- Infantile hydrocele
  - Irreducible
  - No cough impulse
  - Testis impalpable

### **Swellings confined to scrotum**

- Epididymo-orchitis
  - Testis and epididymis definable
  - Testis tender
- Testicular tumour
  - Testis and epididymis definable
  - Lump within testis
  - Testis non tender
- Epididymal cysts
  - Testis and epididymis definable
  - Lump separate
  - Testis non tender
- Vaginal hydrocele
  - Testis and epididymis not definable
  - Transilluminates brightly
- Torsion testis
  - Testis and epididymis not definable
  - Testis tender
- Gumma
  - Testis and epididymis not definable
  - Irregular non-tender lump

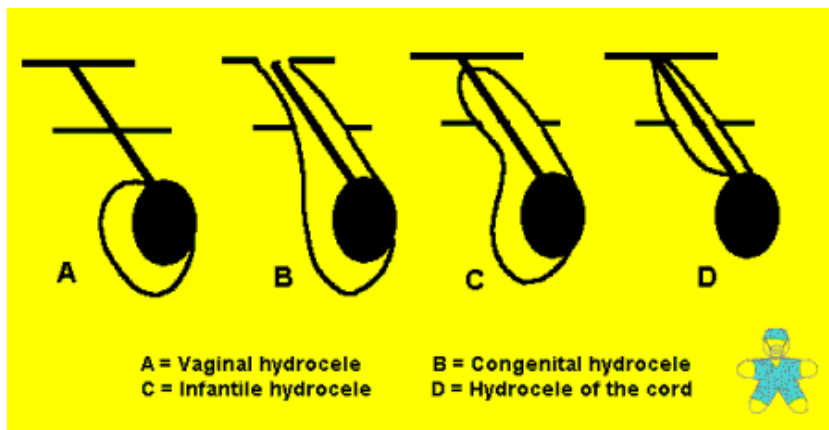


Figure 375 Types of hydroceles



Figure 376 Epididymal cyst

### Testicular torsion

- Common surgical emergency in adolescent boys
- Peak incidence in second decade of life
- A high insertion of tunica vaginalis ('Bell clapper testis') predisposes
- Abnormality usually bilateral. Contralateral testis has horizontal lie
- Usually presents with acute scrotal pain
- May present with abdominal pain
- Always examine in the scrotum in boys with abdominal pain
- Urinary symptoms are uncommon
- 50% have had previous episode of pain





- Examination shows tender high-riding testis often with a small hydrocele



Figure 377 Testicular torsion

#### **Management**

- Investigation usually not required.
- Testicular torsion is a clinical diagnosis requiring urgent surgical exploration
- Diagnosis usually obvious
- If testis infarcted - Needs orchidectomy
- If viability in doubt wrap in warm swab and wait
- If viable both ipsilateral and contralateral side require an orchidopexy

#### **Outcome**

- Approximately 60% of testes are salvageable
- Re-examination at 6 months post shows about 10% to be atrophic
- Outcome best in those operated on with less than 6 hours symptoms
- Beyond 12 hours salvage of testis less assured.
- Long-term sub-fertility occasionally is a problem
- Possibly due to an auto-immune response affecting both testes



### Epididymitis

- Uncommon in adolescents - Be wary about making the diagnosis
- Usually has a more prolonged history, less pain and urinary symptoms
- Tenderness is greatest over the epididymis

### Idiopathic scrotal oedema

- Usually occurs in boys less than 10 years old
- Presents with scrotal redness and oedema
- Pain is slight and testis feels normal

### Torsion of testicular appendix

- Presents with sudden testicular pain but often not severe
- Hydrocele with tender appendage (hydatid of Morgagni) often apparent
- If discovered during scrotal exploration appendage should be excised



Figure 378 Torsion of the Hydatid of Morgagni

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## Varicocele

- A varicocele consists of dilatation of veins draining the testis
- In the scrotum the veins form the pampiniform plexus
- Reduce to one or two veins in the inguinal ligament
- One testicular vein is formed at the deep inguinal ring
- Left testicular veins drains into the left renal vein
- Right testicular vein drains into the inferior vena cava
- Some venous drainage also occurs via cremasteric vein into the inferior epigastric veins

## Clinical features

- Most varicocele are detected in adolescence or early adult life
- 95% occur on the left side and are idiopathic
- Occasionally associated with left renal tumours
- Most are asymptomatic
- If they do cause symptoms it is usually a vague or annoying discomfort
- Examination shows the typical 'bag of worms'
- Reduces in size in the supine position
- Varicoceles are occasionally associated with infertility
- But no evidence that surgery increased semen quality or conception rate

## Management

- Varicoceles only need treatment if symptomatic
- Veins can be ligated via either a scrotal or inguinal approach
- Recent laparoscopic ligation has been reported
- Recurrence can occur due to collateral supply via cremasteric vein

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## Priapism

- Priapism is persistent erection of the penis
- It is uncommon but early diagnosis and treatment is essential
- Delayed presentation or treatment results in corporal anoxia and loss of erectile function

## Pathophysiology

- Two types of priapism exist
  - High-flow
  - Low-flow
- Low-flow priapism is more common
- Due to venous stasis and ischaemia
- Aetiological factors include:
- Intracavernosal injection
  - Pelvic malignancy
  - Blood disorders - sickle-cell disease, leukaemia
  - Trauma - spinal cord injury
  - Prolonged sexual activity
  - Urogenital tract inflammation
  - Drugs
- High-flow priapism is uncommon
- Due to the development of an arteriocavernosal fistula
- Can follow blunt or penetrating penile or perineal trauma

## Clinical features

- History and clinical features will allow differentiation of low-flow and high-flow priapism
- Low-flow priapism presents with painful persistent erection
- Penile shaft is firm and glans penis is usually soft
- High-flow priapism is often painless
- There is invariably a clear history of trauma

## Management

- Aspiration of the corpora will distinguish the two types
  - In high-flow priapism the blood is arterial
  - In low-flow priapism the blood is dark and viscous and is similar to venous
- Early treatment is essential, preferably within 12 hours of onset
- Low-flow priapism requires urgent aspiration and instillation of a vasoconstrictor
- This should be followed by a drainage procedure into
  - The glans penis (Modified Winter / Ebbehøj shunt)
  - The corpora spongiosum (Quackel's procedure)
  - The long saphenous vein (Grayhack procedure)
- Detumescence can be achieved in 50-70% of patients
- Maintenance of erectile function is present in about 40%
- High-flow priapism requires closure of the arteriocavernosal fistula
- Can often be performed by an interventional radiologist



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## Aspects of pelvic surgery

### *Gynaecological causes of acute abdominal pain*

#### Ectopic pregnancy

- Defined as a gestation outside uterine cavity
- Occurs in 1% of pregnancies
- 11, 000 cases per year in United Kingdom and incidence is increasing
- Mortality is less than 1%
- Risk factors include
  - Previous PID
  - Infertility
  - Tubal surgery
  - IUCD
  - Previous ectopic pregnancy
- PID increases risk of ectopic seven fold
- Commonest site is in the tubal ampulla
- Usually presents at 6-8 weeks amenorrhoea
- Clinically patient has lower abdominal pain and slight vaginal bleeding
- Cardiovascular collapse and shoulder tip pain suggest large intraperitoneal bleed
- Examination will often show abdominal and adnexal tenderness
- Patient invariably has positive urinary pregnancy test
- In cases of doubt sensitive  $\beta$ -HCG assay may be helpful
- Ultrasound shows empty uterus and may identify ectopic
- An intrauterine pregnancy on US almost invariably excludes an ectopic
- If patient is shocked immediate laparotomy is essential
- If no evidence of cardiovascular compromise laparoscopy is investigation of choice
- Foetus can then be removed by salpingotomy or salpingectomy

#### Pelvic inflammatory disease

- Pelvic inflammatory disease usually synonymous with acute salpingitis
- Ascending sexually transmitted disease
- Due to chlamydia (60%), *Neisseria gonorrhoea* (30%) +/- anaerobes
- Untreated can progress to pyosalpinx or tubo-ovarian abscess.
- Presents with lower abdominal pain and vaginal discharge
- Pelvic examination is uncomfortable
- High vaginal and endocervical swabs essential
- If doubt over diagnosis consider laparoscopy or ultrasound examinations
- Often improves with antibiotics (tetracycline and metronidazole)
- Surgery rarely required
- 40% chance of tubal occlusion after three episodes
- Increases risk of ectopic pregnancy by a factor of six
- 20% develop chronic pelvic pain

#### Endometriosis

- Functional endometrial tissue outside the uterine cavity
- Results from either retrograde menstruation or celomic metaplasia
- Usually affects ovaries, fallopian tubes, serosal surface of the bowel
- Most commonly seen in women between 30 and 50 years



- Presents with premenstrual lower abdominal pain
- May also cause back pain, intestinal obstruction and urological symptoms
- Large 'chocolate' cysts may rupture causing acute abdominal pain
- Also a cause of infertility
- Diagnosis can be confirmed at laparoscopy
- Hormonal therapy may improve symptoms
- Danazol is probably the first line treatment

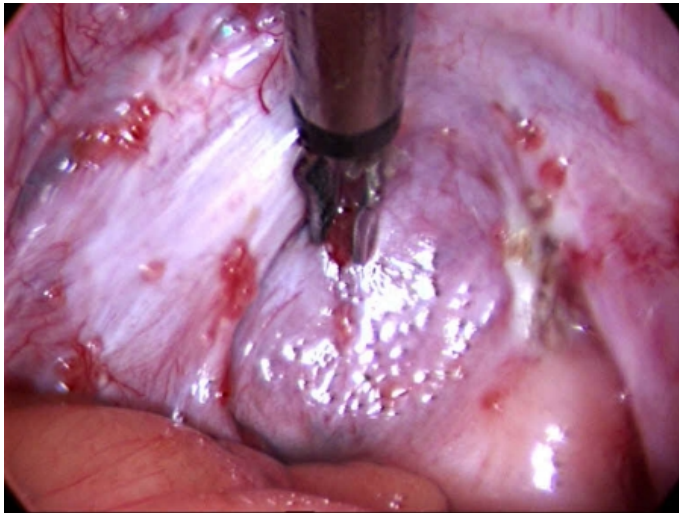


Figure 379 Laparoscopic appearance of endometriosis

#### Ruptured ovarian cyst

- Ovarian cysts are either functional or proliferative
- Cause abdominal pain if rupture, torsion or infarction occur
- Patients present with sudden onset severe lower abdominal pain
- Differential diagnosis includes ruptured ectopic pregnancy
- Cyst may be palpable on bimanual examination
- Diagnosis can be confirmed by ultrasound or laparoscopy
- Treatment usually involves ovarian cystectomy

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## Ovarian cysts

### Functional cysts

- Commonest type of ovarian cyst
- Present as follicular, corpus luteal or theca luteal cysts
- Benign and usually resolve spontaneously
- May be an incidental finding on a clinical or radiological investigation
- Symptoms result from pressure or rupture
- Differential diagnosis includes:
  - Tubo-ovarian abscess
  - Ectopic pregnancy
- Most regress in 6-10 weeks



Figure 380 Benign ovarian cysts

### Mature cystic teratoma

- Account for 10% of ovarian neoplasms
- Develop from totipotential cells
- Have well differentiated mesodermal and ectodermal elements
- 10% are bilateral
- Cystic teratomas have a smooth capsule and may grow to 30 cm in diameter
- May contain bone, hair, teeth
- Functioning thyroid tissue may cause thyrotoxicosis (struma ovarii)
- Malignant transformation is rare
- Treatment is by ovarian cystectomy





Figure 381 Mature cystic teratoma

### Ovarian germ cell tumours

- In adolescents and young women the majority of ovarian neoplasms are germ cell tumours
- Approximately 25% of these tumours are malignant
- If functioning they can present with precocious puberty or early menarche
- Tumour markers such as CEA, alpha-fetoprotein or beta-hCG may be increased
- CA125 is usually not raised in germ cell tumours
- Types of malignant tumour include:
  - Dysgerminoma
  - Embryonal carcinomas
- Treatment is usually by surgical debulking and chemotherapy

### Ovarian carcinoma

- Arise from ovarian or celomic epithelium
- 75% are serous and 20% are mucinous
- Risk factors include:
  - Advancing age
  - Nulliparity
  - Family history (BRCA1 and BRCA2)
  - Possibly fertility drugs
- Role of screening is currently under investigation
- Currently no evidence for CA-125 or ultrasound screening of general population

### Clinical features

- Clinical features are non-specific
- Early features include urinary frequency, abdominal discomfort
- Later features include distension, early satiety and anorexia
- Abdominal mass and ascites are late features



### Staging

- Ovarian carcinoma spreads by three routes
  - Trans-celomic
  - Lymphatic
  - Haematogenous
- The staging of the disease is surgical
- 20-40% of patients are upstaged after surgical intervention

### FIGO staging of ovarian cancer

- Stage 1 - Tumour limited to ovaries
- Stage 2 - Involvement of one or both ovaries with pelvic extension
- Stage 3 - Involvement of one or both ovaries with extension beyond the pelvis
- Stage 4 - Involvement of one or both ovaries with distant metastases

### Management

- Thorough surgical staging should be undertaken of all patients
- For Stage 1 disease a unilateral salpingo-oophorectomy should be performed if future fertility required
- Otherwise Stage 1 disease should be treated with a total abdominal hysterectomy and bilateral salpingo-oophorectomy +/- omentectomy and peritoneal biopsies
- For Stage 2 and 3 disease surgical debulking should be performed
- This should be followed by chemotherapy
- Platinum-based chemotherapy regimens are the most effective
- The role of a second-look laparotomy and further debulking is controversial

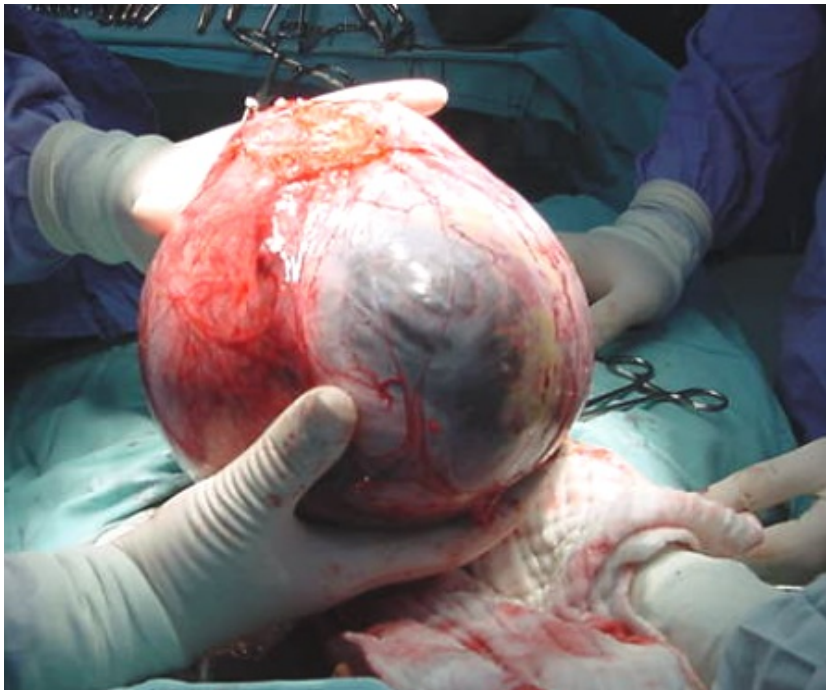


Figure 382 Ovarian cystadenocarcinoma



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## **Urinary incontinence**

- A definition of incontinence involves:
  - Involuntary loss of urine
  - Causing social or hygiene problems
  - That can be objectively demonstrated
- Common and under reported problem
- Affects 4 million people in United Kingdom
- Affects women more than men, particularly the elderly

### **Classification**

- Stress incontinence
- Urge incontinence
- Overflow incontinence

### **Stress incontinence**

- Affects about 30% of women over 30 years
- Usually develops after childbirth
- Symptoms worsen with age
- Incontinence occurs with effort or exertion and is worse when upright
- Urine loss is seen immediately after a rise in intra-abdominal pressure

### **Urge incontinence**

- Part of the overactive bladder symptom syndrome
- Patients experience frequency, urgency and incontinence
- Due to detrusor muscle overactivity

### **Overflow incontinence**

- Occurs in both sexes
- Symptoms are often relatively few
- Patients tend to dribble urine
- Men often have a full and palpable bladder
- Women often have abnormal anatomy or a vesicovaginal fistula

### **Investigation**

- The following investigations should be considered
  - Mid stream urine specimen
  - Renal function
  - PSA in men
  - Renal ultrasound
  - Flexible cystoscopy
- Urodynamic assessment evaluates the function of the bladder
- Results must be interpreted with the clinical presentation
- Assessment can involve
  - Frequency-volume chart
  - Pad test
  - Flow rates
  - Residual volume by ultrasound
  - Conventional cystometry
  - Videocysturethrography - filling and voiding



## Management

- Management of incontinence should start with general support
- This involves specialist nurses using appliances, pads, catheters etc
- Specific treatment will depend on the underlying cause

## Urge incontinence

- Overactive bladder syndrome can be managed by
  - Behaviour change
  - Drugs - anti-muscarinic agents, desmopressin
  - Surgery
- Surgical options include:
  - Injection of botulinum toxin
  - Neuromodulation
  - Clam cystoplasty
  - Detrusor myectomy
  - Urinary diversion

## Stress incontinence

- Stress incontinence can be managed by:
  - Physiotherapy
  - Biofeedback
  - Electrical stimulation
  - Drugs - duloxetine
- Surgical options include:
  - Burch colposuspension
  - Anterior colporrhaphy
  - Marshall-Marchetti-Krantz procedure
  - Needle suspension of bladder neck
  - Pubovaginal slings
  - Periurethral bulking agents
  - Implantation of artificial sphincters

## Complications of urinary diversions

- Renal and intestinal reservoir stones
- Urinary tract infections
- Metabolic derangements
  - Hyperchloraemic acidosis
  - Bone demineralisation
  - Gallstone
- Reservoir rupture
- Neoplasia

## Post-prostatectomy incontinence

- Is a transient phenomenon in many men
- Becomes a persistent problem in about 5% men
- Risk factors include
  - Preoperative incontinence
  - Neurological disease
  - Previous pelvic or prostatic surgery
  - Large benign prostate



- 75% cases due to sphincter damage
- 15% due to detrusor abnormality
- Conservative management improves symptoms in 50% patients

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## Glossary of derivation of anatomical and pathological terms

- L = Latin, Gr = Greek

Term	Derivation
Acetabulum (L)	Vinegar cup
Antrum (L)	Cave
Azygos (Gr)	Unpaired
Branchial (Gr)	Gills
Falciform (L)	Sickle
Gubernaculum (L)	Rudder
Haemorrhoid (Gr)	Flow of blood
Incus (L)	Anvil
Lumbrical (L)	Earthworm
Miliary (L)	Millet seed
Pelvis (L)	Basin
Phalanx (Gr)	Line of soldiers
Pons (L)	Bridge
Phimosis (L)	Muzzle
Porta (L)	Entrance
Pylorus (Gr)	Gatekeeper
Salpinx (Gr)	Trumpet
Scrotum (L)	Bag
Seton (L)	Horse hair
Stapes (L)	Stirrup
Stoma (Gr)	Mouth
Villous (L)	Tuft of hair
Vagus (L)	Wandering

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