Fractures and Trauma

Classification
Fracture = discontinuity in cortex.
Bone is either cancellous (at end of long bones near joints, filling centre of long bones and in small round bones – designed to absorb impacts) or cortical (long bones, very strong tubes, Haversian formations).
Bones have physis (growth plate or scar where it used to be), diaphysis (between growth plates), epiphysis (beyond growth plate), metaphysis (bit between diaphysis and epiphysis). Growth plates have calcified zone, hypertrophic zone and proliferative zone.
Bones develop either by intramembranous ossification (flat bones e.g. skull) or endochondral ossification (long bones).
Mineralisation of bone occurs by deposition of hydroxyapatite (calcium and phosphate crystals).

Types of fractures
Transverse – right angles to shaft. Mostly due to side force.
Oblique – less than 90 deg to long axis.
Spiral – curving or twisting along bone. Due to rotational force.
Butterfly – 1 fragment.
Comminuted – more than 2 fragments.
Impacted – one fragment driven into the other.
Intra-articular – involves articular surface.
Displacement – bone ends shift in relation to each other, describe in relation to distal fragment.
Angulation – describe in relation to distal fragment.
Shortening and rotation.

Main symptoms are pain, deformity and decreased movement.

Salter-Harris fractures:
Fractures through growth plate. Children’s bones have shaft (diaphysis), growth plate, epiphysis.
1 – straight through growth plate.
2 – through growth plate with a bit of metaphysis (Thurston Holland fragment), most common.
3 – through growth plate with a bit of epiphysis, these are intra-articular.
4 – crosses growth plate with a bit of epiphysis and metaphysis, risk of growth problems and deformity.
5 – crush injury to growth plate, can cause partial growth arrest and progressive deformity.
6 – avulsion of growth plate by ligament.

Pathology
Mechanisms - direct trauma, indirect trauma, stress injury, pathological process.

Fracture repair
Long bones:
External callous - periosteal reaction (about 3 weeks), get callous forming around old fracture.
Haematoma, inflammation and then resolution, woven bone, lamellar bone and resolution.
If periosteum damaged – delayed union, heal slowly by endostial callous.
If rigidly fixed – primary cortical healing.

Cancellous bone:
Creeping substitution – intra-medullary formation of new bone.
Management

Initial – ABC, control haemorrhage (direct pressure and splinting), fluid resuscitation, pain control (including splinting), immobilisation, cover with sterile dressing.

Assess fracture – mechanism of injury, pre-hospital care, blood supply (active bleeding, colour, temp, pulses, cap refill), nerve supply (movement, sensation), soft tissue injury (open wounds, swelling, tenderness), bone injury (deformity, crepitus), movement (active may be restricted by pain, passive for joint stability).

Xray – 2 views at right angles, include joint above and below. Reduce prior to xray if skin at risk or vascular compromise. Signs – soft tissue swelling, lipohaemarthrosis (intra-articular fracture), loss of continuity of cortex (may only see after time), angulation of bone.

Signs of fracture severity – damage to soft tissues (esp if devitalised skin and muscle), impairment of circulation to distal limb, compartment syndrome, comminution, wide displacement.

Principles of management – reduction, stabilisation, rehabilitation.

Fracture reduction
Reduction can be closed (manipulation or traction – risk of pressure sores, DVT and pneumonia) or open at surgery.
Reasons - pain management, reduce neurovascular complications, decrease blood loss – can lose up to 1l in humerus, 2l in femurs (Thomas splint), 5l in pelvis (corset or belt or sheet). Not always required.

Fracture stabilisation
Maintain reduction until stable enough to mobilise:
Conservative:
Plaster of paris - immobilises joints but poor fracture control, skin problems under plaster.
Cast brace - allows joint to move, not suitable for all fractures.
Traction - joint stiffness, pressure sores etc.

Operative:
Need this for open and displaced intra-articular fractures.
Percutaneous – K wires.
Internal fixation – plates and screws, with open reduction, allow early mobilisation, risk of infection.
Intra-medullary nail - with closed reduction, early mobilisation, can’t use near joints.
External fixation – pins and wires with external frame. Can place percutaneously and use across joints.

May need prosthetic replacement – hemiarthroplasty or total joint replacement. Used if severe joint damage or risk of avascular necrosis, esp hip, shoulder, knee, elbow, radial head.

Rehabilitation
For all fractures. Early mobilisation leads to better recovery as increases flow of synovial fluid so better nourishment of cartilage. Also decreases risk of adhesions.

Children’s fractures – heal quicker, remodel well, risk of damage to growth plate.
Complications
Immediate, early and late. Local and general.

Life-threatening:
**Pelvic fracture** – haemorrhage.
**Arterial injury** - penetrating or blunt injury close to joint, get haemorrhage or haematoma and ischaemic extremity. Need to repair artery and stabilise joint.
**Crush injury** – release of cell breakdown products e.g. calcium, potassium, myoglobin. Treat with alkaline diuresis.
DVT and PE or fat embolus (causes ARDS).

Limb-threatening:
**Open fractures** – outside communicates with fracture haematoma. Risk of infection. Give antibiotics, tetanus prophylaxis, wound debridement, fracture stabilisation. Generally avoid internal fixation as risk of colonisation, may need to excise bone. Gustilo grade – 1-4, 1=small laceration, II=moderate laceration, IIIa=significant laceration with a-nonviable tissue, b-contamination and periosteal stripping, c-vascular injury, IV=amputation.
**Dislocations** – xray prior to reduction. May need GA.
**Vascular injury** – can be due to fracture or dislocation. Realign and recheck. May need surgical repair.
**Compartment syndrome** – swelling causes increased pressure within fascial space (which exceeds capillary pressure), results in muscle necrosis. Especially with tibial fractures. Get increasing pain and pain on passive stretching. Monitor pressure. Release bandages, if still problem need fasciotomy.
**Neurological injury** – document findings, immobilise, may need early reduction (e.g. axillary nerve in shoulder dislocation), may need early decompression (median nerve and distal radius fracture). Also get peroneal n damage with knee, sciatic with hip, brachial plexus with shoulder. Some may recover e.g. radial nerve and humerus fractures. Normally nerves are bruised rather than traumatised.
**Intra-articular fractures** – risk of subluxation or dislocation. If involved synovial cartilage has limited ability to repair – replaced by fibrocartilage which deteriorates earlier. Cartilage may be damaged directly or if damaged articular surface then abnormal loading and stress on cartilage and secondary OA. Try to reduce and maintain anatomical position.
Infection – especially open fractures and after operative management.

Late:
**Mal-union** – fracture unites in unacceptable position, not always symptomatic. Can treat with osteotomies.
**Avascular necrosis** – blood supply to part of bone is disrupted by fracture. Especially hip, shoulder, scaphoid and talus. Get collapse and early traumatic arthritis.
**Traumatic arthropathy** – if intra-articular fracture is not reduced or avascular necrosis damages joint.
Radiologically and pathologically similar to osteoarthritis.
**Growth disturbance** – with unreduced Salter-Harris growth plate injuries. Can get progressive deformity, joint instability, nerve traction injuries and traumatic arthropathy.
**Contractures** – e.g. Volkmann’s ischaemic contracture.
Common fractures

Greenstick fracture
In children with flexible bones. Bone bends, cortex does not break on one side, longitudinal breaks in medulla.

Colles fracture
Fracture of distal radius within 2.5cm of wrist with dorsal angulation, dorsal and radial displacement, impaction, ulna styloid avulsion and rotational deformity. Usually fall on outstretched hand, especially osteoporotic old ladies.

Reduce fracture:
Bier’s block – to anaesthetise lower arm. Inflate blood pressure cuff to 100mmHg above systolic BP and give IV lignocaine to hand. Then inflate distal cuff (so cuff is over anaesthetised bit) and deflate proximal cuff.
Traction – hang arm off fingers to pull out impaction with ulnar angulation. Plaster with ulnar and volar angulation.
Risk of median nerve damage due to swelling.

May need internal or external fixation.
Complications – malunion, algodystrophy, ongoing pain.

Smith’s
Reverse Colles – distal radius fracture with volar angulation and displacement. Usually a fall on flexed hand. More unstable as flexors are stronger.
Mostly internal fixation or plaster in extension and up to elbow as unstable in supination and pronation.

Scaphoid fracture
Usually due to fall on outstretched hand. Easy to miss, if missed later wrist dysfunction as proximal fragment suffers avascular necrosis (supply from palmar carpal artery).
Scaphoid fracture until proven otherwise if tenderness in anatomical snuff box. Put in scaphoid cast and xray at 1wk. complications are malunion and avn causing later arthritis.

Hand fractures
Typically 5th metacarpal with punch injuries, 1st and 2nd with boxers.
1st metacarpal base (Bennet’s) – fall to thumb, get fracture subluxation of 1st MCPJ. Either manipulate and plaster or internal fixation. Complications are malunion and arthritis.

Phalangeal – mostly from falls and fighting. Ensure no rotational deformity clinically. Splint to next finger.

Forearm
Due to falls, RTAs, greenstick in children.
Mostly open reduction and internal fixation. In children can do manipulation and plaster.
Galeazzi – fracture of radius and distal ulna dislocation.
Monteggia – fracture of ulna and radial head dislocation.

Elbow
Often hard to see.
If sailing anterior fat pad or posterior fat pad visible likely to be intraarticular injury.
**Humerus**

**Surgical neck** – needs fixation, risk of avascular necrosis and fracture dislocation. May need hemiarthroplasty, otherwise sling.

**Humeral shaft** – disrupts radial groove, check radial n (runs in spiral groove, wrist extension, also damaged by hanging arm over chair) and radial a. Manage with traction and hanging cast, if poor reduction needs intramedullary nail.

**Supracondylar fracture** – FOOSH in children. Risk of damage to brachial a.

**Femoral neck fracture**

Usually due to fall in old people with osteoporosis. Often complicated by co-morbidities. Get shortened externally rotated leg.

**Intracapsular** - transcervical or subcapital.

**Extracapsular** - inter-trochanteric or subtrochanteric.

If intracapsular:

**Hemiarthroplasty** - in elderly patients as risk of avascular necrosis and non-union. Use bipolar hip replacement as less stress and can be converted easily to THR.

**Internal fixation** - in young patients or if undisplaced as hemiarthroplasty has limited life. Anatomically reduce and fix in theatre as an emergency – 60% chance success, 40% chance AVN but hemiarthroplasty or THR won’t last long.

**Total hip replacement** - if there are other problems e.g. mets.

If extracapsular:

**Dynamic hip screw** - dynamic as compresses to allow bones to come together so better healing.

**Fluid balance** – often hypovolaemic due to blood loss and not drinking since fall. However may get SIADH so careful with fluids.

**Blood supply to the femoral head** – extracapsular arterial ring at base of femoral neck formed by med and lat femoral circumflex artery, these give off ascending cervical branches. Femoral nutrient artery in medulla. Also have artery of the round ligament of femoral head (ligamentum teres), this is inadequate to supply the whole of the head with displaced fractures.

**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.

40% of patients with a hip fracture die within a year.

Often elderly people so increased risk of complications of bed rest – pneumonia, bed sores, PE. Incidence is increasing – more old people, age-specific incidence also increasing, possibly due to more osteoporosis.

**Femoral shaft**

Usually high energy injury – often associated with knee injuries e.g. menisci or cruciate. Can get substantial blood loss.

In adults usually internal fixation, complications with thromboemboli.

**Pelvic fracture**

Bleeding from posterior bone and venous plexuses. Can lose up to 6l into pelvis. Always 2 breaks.
Ankle and lower leg fractures

**Fibular fracture:**

**Weber classification** – A is below syndosmosis, B is through (may be unstable depending on medial collateral/deltoid ligaments, which gives stability to medial malleolus, look for tenderness over this), C is above (always unstable).

Pott’s fracture – fracture of lateral malleolus due to sudden inversion.

Common peroneal n runs around neck of fibula. Damage causes foot drop and loss of sensation on ant lat leg and dorsum of foot.

**Tibial fracture:**

Risk of damage to deep peroneal n and foot drop, due to direct damage or compartment syndrome. May be difficult to check muscles so check sensation – deep peroneal between 1st and 2nd toes, superficial on dorsum of lateral toes and foot.

Often open fracture.

If close then plaster and brace, if open wound toilet, external fixation and plastics if needed.

Complications – malunion, compartment syndrome.

With ankle fractures ‘push off’ gives oblique fracture ‘pull off’ gives transverse fracture. This can show direction of injury.

Ottawa guidelines – features in examination which are predictive or ankle fractures.

**Calcaneus** – to assess fracture use Bohler’s angle (line from highest point of calcaneus to each tip), should be greater than 30deg. Usually from fall from a height.

**Stress fractures** – due to vigorous unaccustomed exercise, like fatigue fractures. Get persistent ache, worse on weight bearing. Usually conservative treatment – support to allow bone to heal.

**Patellar fracture**

Need to check extensor mechanism.

**Lumbar spine fractures**

Often fall from a height or low energy pathological fractures. May get back pain, radiculopathy, cauda equina syndrome, neurological compromise.

Manage by immobilisation and bed rest, possible internal fixation.

**C spine fractures**

**C1** – Jafferson fracture, multiple fractures, dens comes through, increased distance from dens to lateral masses. Usually due to hyperflexion.

**C2** – Hangman’s fracture, pars interarticularis fracture, anterior dislocation of C2 vertebral body, pre-vertebral soft tissue swelling. Usually due to hyperextension. Wedge fracture – though vertebral body, get loss of height of body.

**To clear C spine injury** – need fully conscious patient with no distraction injury, normay C spine xray, normal C spine examination, normal neurology.
**Joint dislocation**

**Dislocation** = complete loss of contact between joint surfaces.

**Subluxation** = partial loss of contact.

**Acute dislocations**
High risk of neurovascular problems – decrease risk by early reduction.

**Management** – early reduction with anaesthesia and analgesia (except ACJ, if reduce needs surgical fixation, mostly leave). Most can be reduced by manipulation, in a small proportion open reduction may be needed (e.g. if blocked by tissue or bone). Rest limb for a few days then early mobilisation and continuous passive motion to prevent adhesions.

**Complications** – recurrent instability (need minimal force to dislocate), persistent neurovascular problems.

**Shoulder**
Following FOOSH or forcing externally rotated and abducted arm back.

**Investigation:**
Check nerves esp axillary n – military badge area.
Xray – need axial and AP view, often associated with Hill-Sack’s fracture (break of bit of humeral articular surface when dislocates). 98% anterior dislocations. With posterior dislocations (mainly epilepsy) get light bulb sign (see lateral view of humeral head on AP film), see better on axial view.

**Reduction:**
Reduce with entonox or morphine and midazolam (to relax muscles), may need GA.
Either modified Cocker’s manoeuvre (flex elbow, slowly externally rotate, bring elbow medially, flick round – risk of fracture of surgical neck of humerus) or traction and counter traction.
Harder to reduce if out for a long time as muscles spasm.
Check blood supply and axillary nerve after.

**Recurrent dislocations:**
Common in shoulder as stability depends on ligaments which are damaged by dislocation. Up to 50% dislocations in young people recur, less in older people. Usually because of damage to anterior glenohumeral ligament and labrum (Bankart lesion) and development of Hill-Sack’s lesion.
Manage with physio or surgery (to limit external rotation or reconstruct joint).

**Patellar dislocation**
Dislocates laterally.
Management – reduction, short period immobilisation, physiotherapy.
Surgery is needed for recurrent dislocations.
**Soft tissue injuries**

General management – PRICE, protection, rest, ice, compression, elevation.

**Ligament**
Can sprain (damage collagen fibres but not structural failure) or rupture. Damage causes joint instability and pain – may need EUA to diagnose. Often get haemarthrosis with acute injury.
Can often compensate for injury with muscles. Otherwise surgical reconstruction of ligament.

**Rupture of collateral ligaments** – usually MCL. Manage MCL conservatively with brace. LCL needs surgery.

**Rupture of cruciate ligaments** – mainly by twisting on a flexed knee of hyperextension. Get haemarthrosis (sudden swelling) and positive anterior drawer and Lachman’s test. Some may present years later with recurrent mensical injury.
Manage by physio or surgical reconstruction. Wait for surgery for 3wks to see if recover. Do patellar tendon or hamstring graft. Long-term complications are OA. With partial tears mostly spontaneous healing, need to move to prevent adhesions and support joint to prevent rotation.
With complete tears 1/3 can do sport, 1/3 can do normal activities, 1/3 disabled.
PCL tears are rarer, usually manage conservatively as risk of damage to popliteal artery during surgery.
Do surgery if avulsed tibial fragment.

**Tendon rupture or injury**
**Signs** – gap in tendon, pain, decreased power.

**In hand** – often cut, especially over proximal phalanx and wrist. Also need to check for nerve injuries. Differentiate between FDP and FDS. Extensor tendons – thumb and index have 2 each, others have one which crossconnect on dorsum of hand (extensor retinaculum), cutting these produces mallet finger (if at distal end) or Boutonniere deformity (if more proximal but doesn’t affect slips passing to DIP).

**Achilles** – Simmond’s test (squeezing calf doesn’t lead to plantarflexion).
Patellar tendon – can’t straight leg raise.

**Management** - can surgical repair tendons but problems with adhesions to sheath, esp in fingers. With Achilles can do repair but risk of infection and necrosis so often manage conservatively in cast in plantarflexion.

**Meniscal injury**
Can be degenerative due to ageing or due to trauma – mostly twisting on bent knee or forced varus or valgus. Medial meniscus injuries are more common as lateral is more mobile.
Get well localised joint line pain, giving way and locking to extension.
May develop effusion.
Investigate with MRI and arthroscopy. Mostly bucket handle tears, cause locking if flip over.
Treat conservatively or with repair (only periphery has vascular supply so can heal) or excision (meniscotomy, minimise amount excised).

**Skin**
**Contusions and abrasions** – partial thickness damage.
**Lacerations** – full thickness damage.
**Degloving** – shear off perforating blood supply from underlying fascia.
Nerve injuries
Due to deep skin injuries or traction injuries.

**Neuropraxia** – recoverable conduction block due to crushing of nerve. Good return of function.

**Axonotmesis** – severe crush or traction, get Wallerian degeneration (nerve distal to injury dies and debris is scavenged) but endoneurial tubes remain intact so can get nerve regeneration (1mm/day), need to prevent contractures whilst this occurs.

**Neurotmesis** – nerve is divided. Neural sprouts can cross gap to distal stump so some function may be recovered. Suturing cut ends together and epineural repair aids this.

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Important Note
These notes were written by Liz Tatman, as a fourth year medical student in 2006. They are presented in good faith and every effort has been taken to ensure their accuracy. Nevertheless, medical practice changes over time and it is always important to check the information with your clinical teachers and with other reliable sources.

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