Extremity Injury

- Appropriate treatment of extremity trauma is important to return the patient to optimal function as quickly and as safely as possible.
- The management of extremity trauma is step-wise and involves initially saving the patient's life by the identification and treatment of life and limb threatening injuries first, according to the Advanced Trauma Life Support (ATLS) principles.
- Treatment depends on injury specific factors, patient factors and surgeon factors, including the resources available.
- It is imperative for the clinician to involve the patient in the decision making process when it comes to the choice of treatment for that individual.
- Moreover, treatment priorities, functional demands and risk versus benefit vary from individual to individual.

DIAGNOSIS

- The diagnosis of extremity trauma begins with the taking of a pertinent history followed by focussed physical examination and appropriate special tests.

History

- It is important to ascertain the mechanism of injury and the amount of force involved in the injury.
- Take time to gather sufficient detail in order to do this.

- Following the history of the presenting complaint, it is important to collect information beyond that of the injury and the AMPLE mnemonic is an abbreviated system taught in ATLS.
  - **A**: Allergies
  - **M**: Medication – important to ask about anticoagulant and antiplatelet therapies, corticosteroid use and any possible immunosuppressive treatment
  - **P**: Past medical and surgical history – has the patient had an anaesthetic in the past and were there any complications
  - **L**: Last time – something to eat or drink
  - **E**: Events – events that led to the injury

Examination

- An initial general examination, including vital signs and general assessment, should be conducted.
- Examination of the individual extremity only begins once you are sure the patient is stable and life- and limb-threatening conditions have been excluded.
- A top to toe evaluation is achieved by a systematic approach to the injured extremity:
  - look;
  - feel;
  - move (active and passive);
  - special tests;
  - special investigations.

- Ensure you examine the joint above and the joint below the site of injury.
- Consider the events and mechanism of injury and examine the areas that could possibly be affected.

Investigations

- The mainstay of extremity trauma investigation remains radiography of the affected limb to see if there is a bony injury.
- Simple haematological investigations are seldom useful in the evaluation of single limb injury.
- In the polytrauma patient a full blood count, serum biochemistry, clotting factor and creatinine kinase may be useful.
- A blood gas, including PH, base excess and lactate, can be useful to show the severity of the injury and the response to resuscitation.

- Ultrasound is very useful to define soft tissue injuries.
- Computed axial tomography (CT) is very good for characterizing the bony anatomy of injuries, allowing for multiplanar reconstruction of injury anatomy and providing other 3D information.
- It is very useful for periarticular injuries, where the exact characterisation of the bony injury is essential.
- Magnetic resonance imaging (MRI) provides 3D information without the radiation involved in CT.
- It provides useful information, particularly about the soft tissues.
- MRI can provide information on the blood supply to the bone.

DESCRIPTION AND CLASSIFICATION OF THE INJURY

Soft tissue injury

- There are several classification systems for soft tissue injuries, the Tscherne classification for closed injuries, the Gustilo and Anderson for open injuries and the Ganga classification of severe open injuries.

Neurological injury

- Seddon classified nerve injuries into neurapraxia, axonotmesis and neurotmesis:
  - **neurapraxia** – no loss of nerve sheath continuity or peripheral Wallerian degeneration. Recovery potential good may take months if the pressure is removed from the nerve;
  - **axonotmesis** – nerve sheath remains intact, with internal nerve fibre damage with Wallerian degeneration. The neural tube (endoneurium) can guide the regenerating nerve fibres to their target. Good potential for recovery; nerve fibre regrowth is at 1 mm per day;
  - **neurotmesis** – complete division of the nerve, nerve sheath and nerve fibre. Functionally poor outcome without surgical intervention to restore continuity of the nerve sheath.

Bony injury

- Describing the bony injury depends on several characteristics and includes the:
  1. name of the bone that has been injured
  2. region of bone injured;
  3. pattern of fracture line: transverse, oblique, spiral, segmental or multifragmentary
  4. presence of compression; compression fractures occur when cancellous bone collapses; vertebral wedge compression fracture;
  5. presence of displacement of the fracture fragments, undisplaced or displaced;
  6. type and degree of displacement (angulation, translation, rotation, shortening)
  7. presence of pre-existing pathology;
  8. associated joint pathology, dislocation or subluxation.

TREATMENT

- The main principle of extremity fracture management builds on the classical concept of reduction and stabilization of the fracture.
- Treatment can be considered under the following headings:
  - **reduce;**
  - **hold;**
  - **heal;**
  - **rehabilitate.**
- The main objective of any treatment is to return the patient to normal function as soon and as safely as possible.
- Broadly speaking, treatment may be operative or non-operative, with differing risks and benefits

Reduction

- Reduction has two components: reducing the fragments and assessing adequacy of reduction.
- Reduction can be performed open or closed.
- The principle is to reverse the movement which created the fracture.
- Over-angulation allows the intact periosteum to guide the fragments into position.

Hold

- If the fracture fragments are in an acceptable position, or have been reduced into an acceptable position, they then need to be held in that position until they heal.
- When choosing a method to hold a fracture the aim is to:
  - optimise the biological and mechanical environment to create the most favourable conditions possible for fracture healing;
  - minimise the period of disability by speeding up the healing process or providing enough stability to return to normal function while the fracture heals.

- There are several methods of holding fracture fragments in place:
  - plaster cast/ splints
  - traction
  - Kirschner (K-) wires
  - external fixation
  - plates and screws
  - intramedullary nails.
- Arthroplasty may be used where fragments cannot be held together.

Heal

- Time to fracture healing depends on several factors: patient co-morbidities, the age of the patient, bone involved, patient factors (diabetes), choice of treatment.
- Well known factors that slow down bone healing include diabetes mellitus (doubles time to union), diminished blood supply (peripheral vascular disease, vascular injury at time of injury), smoking, non-steroidal anti-inflammatory drugs and infection at the fracture site.

- Several chemical and mechanical methods have been attempted to enhance fracture healing, including bone marrow injections into the fracture site and other orthobiologics such as bone morphogenic proteins.
- Mechanical methods include controlled axial micromotion (using an external fixator), electromagnetic stimulation and low intensity pulsed ultrasound.

Rehabilitate

- The main aim of treatment is to return the patient to a similar level of pre-morbid function as quickly as possible.
- Rehabilitation begins as soon as feasible.
- It is often not necessary to wait until bone union before beginning rehabilitation.
- It is important to move the affected joints and the joints in close proximity to the fracture (e.g. elbow and shoulder exercise while in a cast for a distal radial fracture), limiting global stiffness and wasting of the muscles on that limb.

TREATMENT BY FRACTURE LOCATION

- In general, the principles of treatment described above are dependent on the fracture location: diaphyseal, metaphyseal and intra-articular.

Diaphyseal fractures

- Extra articular fractures do not require an anatomical reduction, but rather a mechanical restoration by correction of length, alignment and rotation.

Metaphyseal fractures

- In the AO classification metaphyseal fractures are classified into A type – extra-articular, B type – partial articular, and C type – complete articular.
- In A type fractures, joint congruity is not an issue and as such the principles of mechanical alignment, length and rotation need to be considered.
- Fixation of metaphyseal fractures is less predictable with intramedullary nailing, therefore plate and screw fixation, external fixation or, in the smaller joints, K-wire fixation is used.
- Metaphyseal fractures are close to the joint and so consideration is given to stable fixation to allow early joint movement and rehabilitation.

Intra-articular fractures

- AO type B and type C fractures are intra-articular and as such the principles of treating intra-articular fractures need to be respected; namely, anatomical reduction of the articular surface and rigid stabilisation to allow early joint movement and avoidance of degenerative joint disease.
- Osteoporotic intra-articular fractures are a considerable challenge.
- Although anatomical reduction may be achieved, rigid fixation devices may cut out of soft bone.
- Injectable bone substitutes may be used to fill bone voids and augment fixation.

- If stable fixation is not possible, then consideration might be given to non-operative treatment and delayed joint replacement or, on occasion, primary joint replacement may be undertaken.
- In type C fractures where the articular surface has separated from the metaphysis, the articular surface is initially anatomically reduced with temporary K-wires or lag screws and then the articular block is reattached to the shaft.

Fractures in the skeletally immature

- Do not forget non-accidental injury.
- Be reluctant to remanipulate a physeal injury.
- Elastic nails are a significant step forward in fracture treatment in children.
- Not many fractures require operative intervention in children.

SPECIAL CONSIDERATIONS

- Special consideration needs to be given to osteoporotic and pathological fractures, for example the ability to hold the fracture until union.
- Furthermore, open fractures require urgent appropriate treatment to ensure bone healing in the absence of infection.

Osteoporotic fractures

- Osteoporotic bone is liable to fracture with low energy injuries (e.g. a fall from standing height).
- Treatment of lower limb osteoporotic fractures in older patients are challenging.
- Such patients are unable to partially weight bear and so fixation should be strong enough to allow immediate weight bearing and to hold the position until union.
- Locking plate technology improves fixation in osteoporotic bone, and bone void fillers can be utilised

Pathological fractures

- A pathological fracture should be suspected if the history is not consistent with the severity of the injury.
- The patient may give a history of low energy injury that normally would not cause a fracture.
- If a pathological fracture is suspected, the cause should be actively sought.
- Pathological fractures may not heal and require load-bearing not load-sharing implants.

Open fractures

- Any fracture with an overlying wound should be considered an open fracture.
- Open fractures require particular mention because adequate stabilisation of the bony injury and appropriate management of the soft tissue injury is paramount to ensure a good outcome with a low complication rate.
- The treatment of bone and joint infection is expensive, laborious and time-consuming for the professional as well as the patient.
- Open fractures require prompt debridement, stabilization and adequate soft tissue cover to prevent infection.