Chapter 1

Fractures

GENERAL PRINCIPLES

PATHOGENESIS OF FRACTURE

Definition

Fracture is defined as break in the continuity of alignment of a bone, that includes all types of disruptions, i.e. hairline or microscopic to grossly comminuted fractures.

Mode of Injury (MOI)

Direct violence: Fracture occurring at the site of impact, i.e. being hit by a falling or moving object.

Example:
- Fracture skull vault due to fall of heavy weight
- Fracture of hand—being struck by a stick, etc.

Indirect violence: Fracture occurring away from the site of impact, i.e. twisting or bending force.

Example:
- Fall on outstretched hand, causing fracture of clavicle, fracture neck of humerus, dislocation of shoulder, fracture shaft of the humerus, fracture supracondylar humerus.
- Rotational trauma of foot may cause spiral fracture of tibia.

Muscular violence fracture: Occurring due to sudden, violent muscular contraction.

Example: Fracture patella due to sudden violent contraction of the quadriceps.

Stress (fatigue) fracture: Known as march fracture.

Example: Common in army and police personnel, participating in long marches and prolonged standings.

Site: Usually fracture of 2nd or 3rd metatarsals.

Pathological fracture: Fracture occurring in an abnormal or diseased bone, and a little force may be sufficient to break the affected eroded (osteoporotic), brittle (Paget's), cystic bone.

Example: Subtrochanteric fracture of femur due to secondary deposits.

TYPES OF FRACTURE

Simple fracture: Also known as closed fracture. Skin is intact. The wound, if present, does not communicate with the fracture. Hence, chances of infection are rare.

Compound fracture: Also known as open fracture. Skin is broken. The wound communicates with the fracture. Hence, chances of infection are common.

Types:
- From without in—due to direct violence, contaminating wound, thereby entry of microorganisms from outside.
- From within out-fractured bone pierces the skin. Chances of infection are comparatively less in this type.

PATTERN OF FRACTURE (Figs 1.1 and 1.2)

- **Transverse fracture:** Line of fracture at right angle to long axis of bone; sustained by direct violence (RSA, sports injury, direct hit by a stick/rod). It is a stable fracture without shortening and displacement; angulation may occur. Union favourable. Firm immobilization required because of smaller area of bony contact.
- **Oblique fracture:** Line of fracture at an angle, less than right angle to the long axis of bone; usually an unstable fracture; sustained by indirect violence, chances of displacement and shortening are common; union may be earlier, due to larger area of bony contact. Proper reduction and firm support required, as chances of shortening, displacement, and loss of bony contact are frequent.

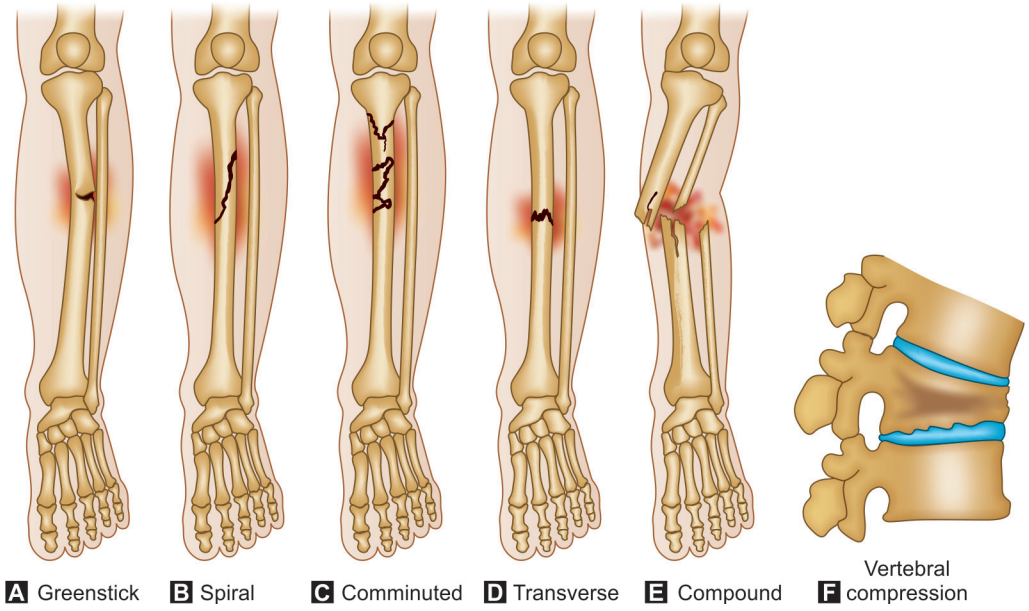

Fig. 1.1: Pattern of fractures

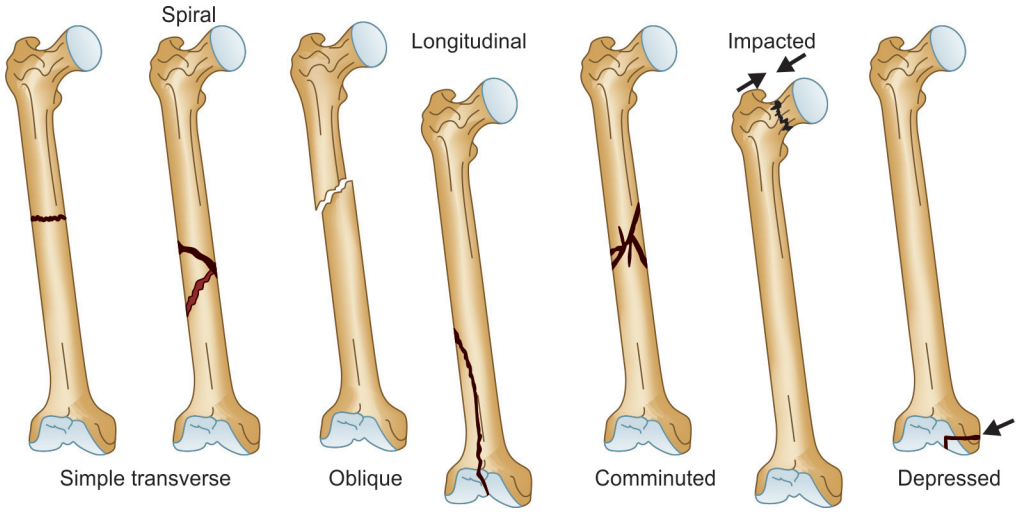

Fig. 1.2: Pattern of bone fractures

- **Spiral fracture:** Fracture occurs in a spiral form, across the bone; may be sustained by indirect violence (torsional forces); usually an unstable fracture; chances of displacement, loss of bony contact and shortning (due to unopposed muscle contraction, or premature weight-bearing) are common; union may be fast, due to larger area of bony contact. Proper reduction and firm support required.
- **Greenstick fracture:** It occurs in children. The bone bends and stays bent, one cortex (convex side) breaks, while the other cortex (concave side) remains intact (periosteum and adjoining soft tissues usually normal); mostly no displacement; healing is rapid; resulting in early obilization.

- **Hairline fracture:** Fracture may be complete or incomplete, no displacement, difficult to detect radiologically, repeated weekly X-rays and oblique view may reveal the fracture clearly, healing is rapid, and require mostly conservative treatment except fracture of scaphoid and fracture neck of femur.
  MOI: Mostly minimal violence.
- **Single fracture:** The bone is fractured at one level.
  MOI: Mostly direct violence.
- **Double fracture:** The affected bone is fractured at two different levels, difficult to reduce and fix the fragments, ORIF may further impair doubtful blood supply to central segment, and delayed/non-union common.
  MOI: Direct violence and fall from height.
- **Comminuted fracture:** The bone is broken into more than two fragments. Greater comminution indicates severe violence, marked damage to the adjoining muscles, tendons, nerves, vessels and skin. Comminuted fractures are mostly unstable and usually complicated ones.
  Types: Minor comminution at fracture site without any displacement; major comminution at the fracture site with a large "butterfly" type fragment.
- **Impacted fracture:** In this type of fracture, one fragment is driven into the other fagment. Usually seen at junction of cortical and cancellous bones, i.e. end of the shaft or impaction of one cancellous fragment.
  Example: Fractures of vertebral bodies (flexion injuries); fractures of calcaneus (fall from height)
- **Complicated fracture (syn. complex fracture):** Fracture associated with neighbouring structures, i.e. neurovascular, visceral injuries.
  Example: Fracture shaft of humerus with radial nerve injury.
- **Pathological fracture:** Fracture occurs in an abnormal or diseased bone. A little force may be sufficient to break the affected brittle, eroded, osteoporotic, and cystic bone.
- **Avulsion fracture:** Fracture occurs due to sudden, violent muscular contraction.
  Example:
  - Fracture patella (upper pole), due to violent contraction of quadriceps.
  - Fracture tibial tuberosity, due to contraction of patellar tendon.
  - Fracture base of fifth metatarsal, due to contraction of peroneus bravis.
  - Fracture lesser trochanter, due to contraction of iliopsoas.
- **Intra-articular fracture:** Fracture involving a joint, causing irregularity of joint surface, leading to complication of stiffness of joint and finally to development of secondary osteoarthritis.
- **Fracture-dislocation:** Joint dislocation, along with fracture of one of the bony components of the joint.
  Example:
  - Fracture dislocation of shoulder joint.
  - Monteggia fracture-dislocation.

DIAGNOSIS OF FRACTURE

Symptoms: 1. Pain, 2. Swelling, 3. Difficulty/inability to move part, 4. Bruising.

Signs: 1. Deformity, 2. Shortening, 3. Local tenderness, 4. Bone surface irregularity, 5. Crepitus, 6. Un-natural mobility, 7. Loss of function, 8. Wound, 9. Shock.

Deformity: Usually characteristic of a fracture, but a bone may be broken without any deformity; the deformity means separation of bony fragments from each other due to extensive tearing of the soft tissues, fascia, intermuscular septa, etc.

- *Types:* Displacement, angulation, and axial rotation
- *Displacement:* It is defined as shifting of distal fragment relative to proximal fragment. Displacement may be anterior/posterior/medial/lateral. It may be partial or complete (no bony contact of fragments) and may lead to shortening, malunion, or non-union due to interposition of soft tissues between fractured fragments.
- *Angulation:* It may be anterior/posterior/medial/lateral, depending upon point of angle or position (tilt) of distal fragment. Angulation should never be neglected, as deformity is regarded as sign of poor treatment. It may also interfere with normal functioniong especially in upper limb, affecting pronation/supination.
- *Axial rotation:* In this deformity, one fragment rotates on its long axis, relative to other fragments. It may or may not be associated with displacement or angulation. It may be detected radiologically, from the position of interlocking fragments, and from the differences in the relative diameters of the fragments.

Shortening: If present, is an important sign of fracture. Occurs due to overriding of fragments.

Local tenderness: In impacted fractures, local bony tenderness is the most important clinical sign while loss of function is the most important symptom.

Bone surface irregularity: In form of a gap, elevation, or a bend, if present, is a definite sign of a fracture.

Crepitus: While palpating or testing unnatural mobility, a crepitus or grating sensation may be felt or heard. It is also a definite sign of a fracture. It may also be positive in a hematoma, gas gangrene, surgical emphysema, and osteoarthritis.

Un-natural mobility: It is elicited by moving one fragment against the other. If present, is a definite sign of a fracture, but to be elicited with great care to avoid occurrence of complications. It is absent in impacted fracture and greenstick fracture.

Loss of function: There may be complete loss of function in a fracture case. Impacted fracture may present great difficulty in clinical diagnosis. X-ray is of great help in such cases.

Wound: If present may contain broken fragments, foreign body, blood clots, etc. There may be oozing of blood from the wound.

Shock: If present, is a life-threatening emergency, and to be managed on priority basis. It is oligemic due to hemorrhage and vasoconstriction (to maintain peripheral vascular resistance).

- *Signs of shock:*
  - Unconscious
  - Air gasping or breathless
  - Pale, cyanotic
  - Hypotension.

INVESTIGATIONS

- **X-ray examination:** It is the main investigation for confirming the clinical diagnosis of a fracture. X-rays of the affected bone taken, mostly in two planes (views),

i.e. anteroposterior (AP) and lateral views, reveal upward or downward displacement.
- Axial view: Required especially in fracture of calcaneum.
- AP view: Reveals lateral or medial displacement, whereas lateral view reveals anterior or posterior displacement of distal fragment. Both views reveal upward or downward displacement.
- Oblique view: Required especially in fracture of scaphoid.

X-ray findings in a fracture, reveal:
- Site and type of fracture.
- Displacement, angulation, rotation of fragments.
- Callus formation—sign of union.
- Sclerosis, rounding of fractured ends—sign of non-union.
- Avascular necrosis (AVN) of bone—decalcification of adjoining bones, while avascular necrotic bone preserves its density due to non-vascularization.
  Examples:
  - AVN of femoral head following fracture neck of femur.
  - AVN of proximal fragment following fracture of scaphoid.

Myositis ossificans: It is subperiosteal ossification, following fracture.
Example:
- Elbow fractures.
- Pathological fractures: X-ray may reveal the underlying pathological condition, responsible for erosion of bone, lowering the strength of bone—vulnerable to fracture even from trivial trauma.

- **MRI** of affected bone and joint
- **CT scan** of affected bone and joint

MANAGEMENT OF POLYTRAUMA

Preface

Trauma is the commonest cause of death in the developed countries; usually under the age of 40 yrs.; deaths from trauma exceed the combined deaths from CVS disorders and cancer; about 30% of these traumatic deaths occur as RSA.

Trimodal death pattern: Post-trauma death shows a trimodial pattern:
- *First peak:* Mortality occurs immediately or shortly post-trauma.
  Etiology: Major head (brain) or vascular (hemorrhagic shock) injury; mostly unsalvageable.
- *Second peak:* Mortality occurs within hours post-trauma; period spanning 1st and 2nd peaks called 'golden hr/s'
  Etiology: ABC (airway, breathing, circulatory) disorders; most of that could be treated ASAP.
- *Third peak:* Mortality occurs days or weeks post-trauma.
  Etiology: (i) Infection (sepsis), (ii) Organ/s failure.

Principles

I. Management of life-threatening-situations:
- Airway obstruction
- Breathing distress—tension pneumothorax, hemothorax, cardiac tamponade

- Bleeding (hemorrhage)
- Chest injuries—flail chest
- Head injuries and neurological disorders
- Shock
- Spine injuries
- Abdominal injuries
- Pelvis injuries

II. Management of fracture:

- Reduction of fracture
- Fixation (immobilization) of fracture
- External fixation and internal fixation
- Rehabilitation

Management of Life-Threatening Situations

Advanced Trauma Life Support (ATLS)

Priority of treatment: In the management of polytrauma (multiple injuries), priority of treatment is directed to life-threatening conditions such as airway obstruction, shock, or external hemorrhage, even before a detailed examination begins. The doctor incharge should plan the line of treatment in consultation with other specialists involved in the management of various lesions. It may be possible to manage all the injuries simultaneously but at times, these lesions to be dealt with, on priority basis, e.g. in a definite sequence. Compound fractures should preferably be treated along with head, neck, or chest injuries. Operative treatment for simple fractures may better be postponed to a later stage. But it is better not to postpone the corrective orthopedic measures for more than a day or so, in the patients who appeared unlikely to recover from their associated injuries.

Management of Fracture

First Aid Treatment

Principle

- **Immobilization:** To immobilize the joint above and below the fracture.
  - Upper limb: Arm to be held by the side of the body by the use of arm slings and bandages; shoulder and elbow held with a sling; forearm held with crammer wire splint or card board, wooden splint.
  - Lower limb: Splinted on a Thomas splint; femur held with traction or splint; tibia and ankle splinted with a wooden splint with foot-piece.
- **Pain relief:** Analgesics:
  - Inj. Morphine 10 mg IV. Repeat 8–12 hrly.
    - Side effects: Nausea, vomiting, constipation, sedation, respiratory depression.
    - Antidote: Inj. Nalorphine 5 mg IV + Inj. Stemetil or Inj. Perinorm
  - Inj. Pethidine 50 mg IV. Repeat 8–12 hrly.
    - Side effects: Addiction (dependence)
  - Inj. Pentazocine 30–60 mg IM or IV. Repeat 3–4 hrly
    - Side effects: Nausea, vomiting, dependence

Bleeding control by bandaging of wound.

Infection control by dressing of wound, antibiotics IM or IV.

Local Treatment

- **Reduction of fracture:**
  - **Aims:** To reduce a displaced fracture, so as to unite in good functional position, and the reduction is usually easier, if performed without unnecessary delay, prior to surrounding soft tissues becoming swollen and turgid. Often unreduced fractures unite rapidly, but may yield to malunion. Repeated manipulations to achieve perfect radiological reduction may lead to hazards (malunion/non-union). Slight/little displacement especially in children and old, weak patient may often be accepted (to outweigh undesirable risks).
  - **Indication:** Correction of deformities: Displacement, angulation, and rotation (cosmetic and functional issues).
- **Anesthesia:** General, regional, or local
  - General: Provides muscle relaxation, duration, and versatility.
  - Regional: Safer for minor procedures
  - Local: Safer for minor procedures.
- **Types of reduction:** Closed or open.

  Closed reduction: Majority of fractures are reduced by this method.
  - Advantages:
    - Relatively safe method—chances of infection are less.
    - Relatively much cheaper.
  - Disadvantages:
    - Failure of reduction sometimes—due to interposition of soft tissues between fragments.
    - Failure to maintain reduction.
    - Prolonged immobilization.
- **Technique:**
  - Most of fractures reduced manually by using longitudinal traction, angulation, or hingeing. Ideally post-reduction, the limb should look similar to its fellow in length and appearance. Frequently X-ray picture may be deceptive, thereby alarming inexperienced surgeon to resort to repeated manipulations or unnecessary open reduction, that may lead to undesirable results, as loss of alignment is of more serious consequences than lacking end-to-end apposition, especially in weight-bearing bones.
  - By continuous traction (fractures of femur and dislocation of cervical spine). In fractures of femur shaft, overlapping does not prevent union, although some shortening may occur.
- **Types:** Skin and skeletal tractions
  - **Skin traction** (by using an adhesive strapping): Mostly indicated in children and young adults for fractures femur and fractures of lower end of humerus.

    Method:
    - Toilet of skin with spirit/alcohol/betadine scrub, post skin-shaving
    - Apply adhesive tape (of traction kit) on both sides of leg, extending beyond foot for spreader bar
    - Place foam/cotton over malleoli (protection)
    - To secure adhesive tapes throughout with encircling elastic crepe-bandage
    - Apply desired weights to the cord.

- **Skeletal traction** (by using a Steinmann pin through tibial tuberosity): Indicated in an older patient, that require a heavy traction, but often complications, like pin track infection, do occur.

Open reduction: Should always be undertaken by a surgeon highly skilled in fracture management. Better to be avoided in children.

– *Indications*
  * Failure of closed reduction (fractures of medial malleolus)
  * Particular fractures—in need of perfect reduction and fixation, e.g. fracture neck of femur.
  * To reduce mortality and morbidity (internal fixation of trochanteric fractures)
  * To achieve acceptable reduction—not possible by closed methods (depressed comminuted fractures of tibial condyle)
  * To prevent occurrence of displacement, angulation, or deformity, common after closed reduction (Monteggia fracture dislocation, fracture patella, olecranon fracture)
  * Compound fractures, complicated fractures.
  * Early mobilization required—especially in elderly patients.

– *Disadvantages*
  * Relatively unsafe method, as chances of infection are more. Sometimes disastrous one: Resulting in gangrene, requiring amputation, or even death may occur.
  * To impair vascularity by stripping of soft tissues for exposure of fragments, and insert implants (risk of non-union), being absent in closed methods.
  * To produce scar that may impair muscle function (fractures of femur)
  * To produce foreign body reaction (metallic implants)
  * Relatively much costlier method.

- **Fixation (immobilization) of fracture:** External and internal fixation—attention must be given not only to the broken bone, but also to the soft parts, while considering the correct method of fixation of each type of fracture.

External fixation

A. Plaster fixation: It is the most widely used form of fixation, and has superseded all other forms of external fixation, e.g. splints (wooden, metallic), braces for treatment of majority of fractures.

Aims:
– To retain the limb/part in the desired comfortable position, by its adaptation, and not by traction or pressure.
– To be light in weight, but strong enough to be effective in use, and to be easily removable
– Cast-bracing: Sometimes indicated in the failed initial conservative treatment of a fracture (delayed union).

Example: Fractures of femur ant tibia in same limb

Post-care: Should be taken of swelling, change in the skin colour, numbness, etc. following application of plaster—if present, then:
– Immidiately loosen the plaster by splitting, or removing/changing the plaster.
– Elevation: To wear an arm sling in case of upper limb, while in case of lower limb, elevate the leg on pillows or RBE.
– Active exercises.

B. Traction: Fixed traction: In a Thomas splint or by continuous traction for couple of weeks, holding a reduced fracture. It is often used for treating fracture femoral shaft (skin traction by adhesive strapping, or skeletal traction by using a Steinmann pin).

C. Braces, splints, jackets, collars, belts, knee caps, anklets

D. Elastic crepe bandaging, adhesive strapping

E. External fixator and ring fixator: Bone fragments held in alignment by alignment by skeletal pins.

- **Indication:**
  - Compound fractures, wherein condition of skin and other soft tissues, disapprove use of internal fixation devices
  - Pin track (skeletal traction) infections

Ilizarov's method

Indication:

- Congenital deformities: Correction:
- Traumatic: Fractures (transosseous osteosynthesis):
- Infective:
  - Compound fractures: Wherein condition of skin and other soft tissues, disapprove use of internal fixation devices
  - Pin track (skeletal traction) infections
- Lengthening: Bone lengthening:
- Achondroplastic dwarfism: Limb lengthening

Internal Fixation

Principles of internal fixation of fractures: Anatomical and physiological factors involved in the healing of a fracture are essential to perfect management, especially in the case of treatment by open methods, using implants like plates and screws, screws, intramedullary nailing and interlocking nailing, tension wires, percutaneous wires, etc.

Aims

- Clinical: To achieve proper union (primary object)—as function of the adjoining soft tissues and joints depends upon it.
- Anatomical: To restore normal anatomical position of the bones after healing—as function of the adjoining soft tissues and joints depends upon it.
- Physiological: To restore normal function of the limb, relative to early mobilization of soft tissues and adjoining joints.
- Circulation: To maintain/re-establish the local circulation.

  Example: Fracture femoral neck, or fracture scaphoid.

Advantages of internal fixation:

- Firm fixation
- Early weight-bearing
- Early return to work.

Disadvantages of internal fixation:

- Infection
- Failure: Due to faulty technique or faulty (wrong) selection of implant.
- Failure: Due to faulty selection of treatment (closed or internal fixation) for needs of each and every particular case.

Implants:

- *Plates and screws:*
  - ***Plates:***
    - Sherman plate
    - Eggar plate
    - Dynamic compression plate (DCP)
    - Nail/blade plate
    - Buttress plates, Y plates, fracture plates, LC plates, cervical spine locking plates
  - ***Screws:*** Cortical and cancellous screws, available in large range of lengths but restricted in range of diameters.
    Types of screws:
    - Self-tapping screws: The screw cuts its own thread in the bone.
      Example: Sherman and Lanes screws.
    - Screws which require bone to be tapped prior to insertion.
      Example: AO series screws: AO.
- *Nails/pins:*
  - Intramedullary nailing: For fractures of shafts of long bones, e.g. Kuntscher nail for fracture shaft femur.
  - Interlocking nails: Antegrade femoral nail (AFN), proximal femoral nail (PFN), distal femoral nail (DFN), universal femoral nail (UFN)
  - Titanium solid nail, cannulated femoral nail (CFN)
  - Rush pins (nails) for fracture humerus, ulna, etc.

Rehabilitation

Principle/Aim of Rehabilitation

- To restore the patient to work at the earliest possible after injury, with the minimal residual disability.
- To start rehabilitation (physical, psychological, occupational) as soon as the patient overcomes the main discomfort (pain and fear of pain) in the early days, and muscle wasting and joint stiffness in the later periods of management.
- To apply a plaster cast that allows patient to feel comfortable and allows the limb to be utilized. Pain from a poorly applied plaster cast, or a joint fixed in an uncomfortable position, discourage patient to follow sugeon's instructions, e.g. pressure sore from a faulty plaster cast may discourage the patient to use the limb.
- To encourage patients for visiting fracture rehabilitation clinics in groups for physical, mental, and occupational therapy. The idea being the fractured limb may benefit from rehabilitation a lot while still inside the plaster cast/boot (retained until patient walks in it) so as to walk freely post removal of plaster.
- To encourage exercises, not only of the injured limb but also of the whole body, to take place (exercises based on postural reflexes, thereby ensuring maintenance of maximum tone). The exercise chosen should produce the required movement without disturbing the patient mentally (fatigue from exercise is due rather to mental exhaustion than to the physiological fatigue of muscle); balancing and ankle motion achieved by playing darts; arms and hand ovements by playing with balls of different sizes or shapes; walking achieved by playing skittles or bowls. Over all the patient must keep moving.

- To confine massage and physiotherapy (poor substitute) to early period of rehabilitation, because of local trauma, or necessity of using fixed splints, active exercise not feasible.

Factors Affecting Healing of Fracture

- **Definition:** Following factors may affect healing in a patient with a fracture or dislocation (Table 1.1).
- **Factors:**
  - **Age:** Younger the patient, better are chances of early union of fracture. In children, union of fracture is faster, which slows down as the age advances. Also power of remodelling of fracture is stronger in epiphyseal fusion is imminent; remodelling also poor in case of axial rotation.
  - **Type of bone:**
    Cancellous (spongy) bone: Healing in the fractured cancellous bone is comparatively earlier than in the fractured cortical bone, and the weight-bearing usually permitted:
    - In fractures of os calcaneus usually after 6/52,
    - In fractures vertebral bodies allowed after 6–8/52
    - In fractures tibial plateau allowed after 6–8/52
    - In fracture pelvis bed rest advised for 6/52
    - In Colles fracture plaster discarded after 6–8/52

    Cortical (compact) bone: Endosteal callus may be well established in a couple of months (appx. 10–15/52 to unite), while an abundant external bridging callus may permit an early recovery, e.g.
    - In fractures humeral shaft, union occurs usually in 10/52
    - In fractures tibial shaft, union occurs usually in 12–16/52
    - In fractures metacarpals, metatarsals, phalanges (substantial callus externally bridging) firm, union occurs in 4–6/52.
- **Distraction of bone ends**, due to:
  - Interposition of soft tissues between bone ends: Usually fasciae or ligaments seems to be a more effective barrier to growth of external callus across a fracture than muscle's interposition (e.g. fractures of patella, olecranon, and medial malleolus), resulting in impaired apposition of fractured surfaces, may cause delayed union, or even non-union.

Table 1.1: Factor affecting healing of fracture

Factor	*Healing*	
	Early	*Late/slow/delay/non-union*
Age	Younger	Adult/old
Type of bone	Cancellous	Cortical
Distraction of bone ends	—	Delayed/non-union
Unnatural mobility	—	Delayed/non-union
Infection	—	Delayed/non-union
Impaired blood supply	—	Delayed/non-union
Quality of bone	Clavicle	Tibia
Pathological fracture	—	Malignant tumors (delayed)
Intra-articular fracture	—	Delayed

(*Source:* Kapoor's Accident and Emergency)

- Excessive traction force applied during immobilization period following reduction of fracture, pulls apart the fractured bone ends thus favouring growth of fibrous tissue that insulates bone ends from each other (emphasizing use of mnimum traction force to obtain desired reduction).
- Faulty internal fixation of fractures: May cause resorption of bone ends at the fracture site, thus prevents bone fragments from meeting together.

- **Un-natural movements at the fracture site:** Faulty immobilization (fixation) of a fracture, resulting in movements at the fracture site, which in turn interupts the vascularization of hematoma, leading to the impaired formation of bridging callus, finally into delayed union, non-union.
- **Infection:** Mild infection that clears up shortly, may not cause any side effect, while severe infection (acute osteomyelitis) may result in delayed or non-union, due to resorption of callus. Usually common in compound fractures and fractures treated by internal fixation (implant acts as a forein body and a nidus in an established infection) advisable to retain implant until healing being achieved, otherwise its removal early may results in movements of fragments and finally non-union. Rare in fractures being treated by conservative measures.
- **Impaired blood supply:** Interruption of blood supply to the bone following fracture may lead to avascular necrosis of the bone, due to rupture of vessels supplying bone—becomes soft and distorted in size and shape, causing pain, stiffness, and osteoarthritis.

  Common sites:
  - Avascular necrosis of femoral head, following intracapsular fracture of femur neck or dislocation of hip.
  - Avascular necrosis of proximal segment of scaphoid following fracture scaphoid.
  - Avascular necrosis of talus following fractures or dislocations.
  - Avascular necrosis of lunate following dislocations.
- **Quality of bone:** Certain bones heal earlier or later than others following fracture, due to unknown factors, e.g.
  - Fracture clavicle that heals earlier inspite of uncontrolled movement at the fracture site.
  - Fracture tibia—heals slowly inspite of firm fixation.
- **Pathological fractures:** Occur spontaneously or after trivial trauma, in an abnormal or diseased bone due to progressive weakness of the bone that may heal slowly especially in case of primary and secondary malignant bone tumors, due to marked erosion of bone. On the other hand, union occurs without any delay, e.g. simple bone cyst.
- **Intra-articular fractures:** Union is delayed due to dilution of the hematoma by the sunovial fluid.

Complications of Fracture

Complications (general or local) that may occur in a patient who has suffered a fracture or dislocation may be classified in the following manner (Table 1.2).

General Complications

- **Shock:** Oligemic shock due to hemorrhage (external or internal)
  - **Diagnosis:** Unconscious, breathless, pale, cyanotic, pupils-dilated, hypotension, pulse rapid.

Table 1.2: Complications of a fracture

General complications	*Local complications*	
	Early	*Late*
Shock	Arterial injury	Slow union
Hemorrhage	Nerve injury	Delayed union
Fat embolism	Infection	Non-union
Hypostatic pneumonia		Malunion
Acute renal failure		Shortening
		Joint stiffness
		Myositis ossificance
		Osteoarthritis
		Sudeck's dystrophy
		Bed sores
		Visceral
		Cast syndrome

(*Source:* Kapoor's Accident and Emergency)

- **Management:** On top priority basis, measures:
  - A. *Airway maintenance:* Position of head, removal of any foreign body, endotracheal intubation, ventilator-oxygen therapy.
  - B. *Breathing monitoring:* Treatment of the cause, i.e. any chest injury, tension pneumothorax, hemothorax.
  - C. *Control of bleeding:* By bandage, tourniquet, etc. for external hemorrhage; by lligating torn vessel or soft tissue—for internal hemorrhage.
    Re-establishment of circulating blood volume:
    - IV fluids: Normal saline, dextrose
    - Blood transfusion—if loss more than 1–2 litres
    - Plasma or plasma expanders—if loss less than 1 litre or if whole blood not available.
    - Drugs:
      - Inj. Morphine 10 mg IV for relief from pain. Rpt after 8–12 hrly, if reqd.
      - Inj. Hydrocortisone 100 mg IV to combat hypotension. Rpt 4 hrly.
      - Inj. Ephedrine IV.
    - Splintage of fractured bone, by use of splints, braces, arm slings, traction.
- **Hemorrhage:** External or internal—due to rupture of vessels, soft tissues, bone fragments, etc.
  Management:
  - External hemorrhage: Control of bleeding by applying firm bandage, tourniquet.
  - Internal hemorrhage: Control of bleeding by ligating the torn vessel, soft tissue repair.
    Blood transfusion, and if not available, then give plasma or plasma expander and IV saline.
- **Fat embolism:** Due to entry of microparticles of fat particles from broken bone marrow, into the circulation. It is a serious, life-threatening emergency. Commonly seen in fracture of femoral shaft, fracture pelvis, and fracture tibia.
  - S/S: Confusion, irritation, or comatose, fever, patechial hemorrhages in the skin, palate, conjunctiva, renal failure, death.
  - Investigation: CBC: Fall in hemoglobin
  - Sputum: Fat droplets

- Eye: Fundus examination may reveal retinal hemorrhages, exudate
- CXR: May show mottling of lung fields (fat embolism)
- Management: Heparin IV, oxygen, IV fluids, monitoring vital signs

- **Hypostatic pneumonia:** May occur in an elderly patient, confined to bed, as commonly seen in fracture neck femur, fracture pelvis.
  - S/S: Fever, chest pain, cough with expectoration, dyspnea, orthopnea, pulse rapid.
  - Investigation: CBC, ESR, blood culture, and CXR.
  - *Management:*
    - Make patient comfortable in the bed with support of back rest
    - Oxygen therapy
    - IV fluids
    - Antibiotics
    - Analgesics
    - Expectorants
    - Steam inhalation
    - Monitoring—nursing care
- **Acute renal failure:** Following fracture (fall from height, RSA, blows), due to shock, excessive bleeding, fat embolism.
  - S/S: Confusion, irritation, coma, fever, edema face and legs, oliguria.
  - Investigation: Serum electrolytes, creatinine, ECG—to monitor the potassium level.
  - *Management:*
    - Bedrest
    - Indwelling catheterization
    - Inj. Morphine for pain and sedation
    - IV Dextrose 20% slowly
    - Blood transfusion
    - Antibiotics
    - Heparinization
    - Management of fracture.

Local Complications

Early complications:

- **Arterial injury:** Blood vessels may be torn, or occluded by pressure of bone fragments, or spasm of vessels, leading to ischemia of muscles, necrosis, fibrosis, and contractures.
  Example: Volkmann's ischemic contracture—brachial artery injury in a supracondylar fracture of humerus and popliteal artery injury in a fracture of lower end of femoral shaft.
  - S/S: Loss of distal pulses, pallor and cold skin, severe pain in the limb, paresthesia, muscle paralysis.
  - *Management:* Post reduction observation of fracture:
    - If pulse is doutful, then: Check the reduction, loosen/remove the external fixation, i.e. POP/splint
    - Still no pulse, then: Inj. papaverine.
    - Still no pulse, then: Exploration of artery
- **Nerve injury:** Types of injuries:
  - *Neurapraxia (concussion):* It is the commonest nerve injury and recovery occurs within a month or so.

- *Axonotmesis (lesion in continuity):* It is rupture of axons within an intact neural sheath and recovery occurs within a few months.
- *Neurotmesis:* It is complete division of nerve.

Examples:
- Radial nerve injury in fracture shaft humerus
- Median and ulnar nerve injuries in supracondylar fracture of humerus
- Axillary nerve injury in shoulder dislocation
- Sciatic nerve injury in hip dislocation
- Common peroneal nerve injury in knee dislocation

Management: Majority of nerve injuries are in continuity.

Conservative treatment:
- Post reduction of fracture or of dislocation, recovery in nerve injuries, ususally starts after about 6–8/56, then progressing satisfactiroly thereafter. During recovery period, the skin should be protected against trauma, burns, etc.
- Joints to be mobilized by passive exercises. Prevent deformities, by use of splints, etc.

Example: Cock up splint in wrist drop.

Surgical treatment:
- Exploration: Indicated in cases where recovery is delayed or absent.
- Suturing: Primary suturing of nerves, if no infection.
- Reconstructive surgery—where nerve repair not feasible.

- **Infection (osteitis):** In closed fractures is rare until infection is well established. Infection in a compound fracture, or following ORIF of a fracture, may cause:
  - Osteomylitis—with discharging pus for a long period, inspite of use of antibiotics and surgical measures.
  - Gas gangrene: A highly serious life-threatening emergency
  - Delayed or non-union.
- S/S: Fever (recurrent), pain, swelling, local tenderness, mobility painful.
- Investigation: CBC, ESR, blood culture, CXR.
  - *Management of compound fracture:*
    - Toilet of the wound with hydrogen peroxide and sterile fluids.
    - Debridement of wound and immobilization.
    - Antibiotics
  - *Management of osteomyelitis:*
    - Acute: Incision drainage of pus
    - Chronic: Saucerization; sequesterectomy; amputation.
  - *Management of gas gangrene:* Oxygen; antibiotics; gas gangrene antitoxin; amputation.
- **Avascular necrosis of bone (AVN):** It is defined as death of bone due to complete interruption of lood supply (torn vessels) to one of the fragments following a fracture or dislocation, common in certain bones due to specific blood supply, e.g.
  - Avascular necrosis of femoral head following intracapsular fracture neck femur.
  - Avascular necrosis of proximal segment of scaphoid following fracture through waist of os scaphoid.

  Management: Firm fixation (ORIF) may help in recovery, but not always successfull. In an established case, treatment of choice is THR, in case of AVN following fracture neck femur.
- **Volkmann ischemic contracture (VIC):** It is due to arterial spasm, following reduction of fractures. The arterial spasm yields to interruption of blood supply to muscles, resulting in necrosis, fibrosis, and finally to contractures.

Examples: VIC of flexor group of muscles of forearm, following reduction of supracondylar fracture of humerus and fractures of forearm. Also seen in leg and calf muscles. There may be ischemia of nerves, that may cause impaired conduction.

- Etiology: Exact cause of arterial spasm is unknown.

  Diagnosis:
  - Hand becomes white and numb
  - Radial pulse—absent
  - Failure to extend wrist and straighten fingers passively.

  Management:
  - Relax flexion at elbow and extend it beyond 90°
  - Exploration of artery
  - Inj. papaverine 2.5% sol.—to wash segment of artery in spasm
  - Physiotherapy.

- **Tight plasters:** Unfortunate incidence of loss of limbs occurs frequently, afer the application of plaster, due to impaired circulation often caused by arterial spasm (medicolegal problem, and surgeon held under Medical Negligence Act). In case a tight plaster, or a tourniquet, left in position too long, the circulation fails to return because of a secondary arterial spasm, that may resist all efforts at relaxation.

  Diagnosis:
  - Severe pain or numbness
  - Swelling of fingers/toes
  - Skin of fingers/toes: Pale, white, or cyanotic

  Management:
  - Preventive treatment:
    - Elevate the limb
    - Watch circulation
    - Active exercises of fingers/toes
  - Specific treatment:
    - Split the plaster
    - Check circulation
    - Check reduction: Clinically and radiologically.

- **Slow union:** Fracture takes comparatively longer time than usual to unite without any change from normal clinically or radiologically.

  Management:
  - Wait and watch for normal union, clinically and radiologically, periodically
  - No interference with reduction and fixation.

- **Delayed union:** Fracture fails to unite within specific time. There may be variations in the time taken by the bone for clinical union to occur (appx. 6 to 10/52), and wide differences may occur even in different bones in the same patient.

- **Investigation:** X-ray findings: No evidence of repair: No callus visible, ends of bone fragments well defined, no sclerosis, there may be generalized osteoporosis.

  Management:
  - As spontaneous union still possible (absent sclerosis and rounding off of bone ends): To continue with the fixation.
  - Active exercises.

- **Non-union:** Fracture fails to unite, and usually being the end result of a few cases of delayed union, that fail to unite spontaneously by the continued fixation.

- Etiology:
  - *General:*
    - Old age, poor health, vitamin deficiency
    - Systemic diseases: Tuberculosis and syphilis.
  - *Local:*
    - Delayed union: Fails to unite spontaneously by continued fixation
    - Inadequate fixation: Continuous movement of fragments leads to impaired bridging callus, bone ends insulated from each other by the formation of fibrous tissue, the bone rounded off and sclerosed (lower third of tibia).
    - Distraction: Excessive traction force pulls apart the bone ends, thus favours the growth of fibrous tissue that insulates the bone ends from each other.
    - Interposition of soft tissues between fragments: Interposed fasciae, ligaments, and muscles, act as barrier to the callus growth across a fracture (fractures patella, olecranon, medial malleolus).
    - Infection: Acute osteomyelitis, compound fractures, may cause the delayed union, and even non-union.
- Diagnosis: Unnatural mobility at fracture site, after expiry of normal union period (appx. 6/12).
- X-ray: Sclerosis, rounding off of bony ends, fracture line clearly visible, bony ends may be flared out.
- Management: Internal fixation and bone grafting.
- Indication: Fracture freely mobile (non-sticky).

- **Malunion:** Fracture united in an abnormal anatomical position.
  - Etiology: Defective reduction and fixation.
  - Diagnosis:
    - Deformity: Angulation or rotational deformity resulting in cosmetic effect and impaired functioning of the limb.
    - Shortening.
    - Secondary osteoarthritis.
  - Management:
    - Early case: If detected earlier, e.g. before union, the angulation may be corrected by wedging of plaster cast, and manipulation under anesthesia
    - In late cases, e.g. after union of fracture: Correction by osteotomy.
- **Shortening**
  - Etiology:
    - Malunited fracture—due to angular, and rotational deformities
    - Transverse, oblique and spiral fractures
    - Epiphyseal injuries (limb lengthens due to stimulated bone growth), e.g. fracture femoral shaft in a child.
  - Diagnosis:
    - Bones: Fractures femoral neck, fractures femoral shaft, fractures tibial shaft
    - Impaired functioning of the limb.
  - Management:
    - Up to 2.5 cm—compensated by pelvis tilt
    - More than 2.5 cm—corrected by alteration of the footwear, e.g. raising by a wedge incorporated within the shoe
    - Corrective osteotomy for shortening due to marked angulation.

- **Joint stiffness:** To be expected after a fracture, that may be temporary or permanent. Intra-articular fractures, or fractures very close to the joints, more prone to joint stiffness than fractures of shaft away from the joint.
  - Etiology:
    - Intra-articular, e.g.
      A. Fibrous adhesions (organized hematoma)
      B. Injury to articular cartilage
      C. Prolonged immobilization (degeneration)
    - Extra-articular, e.g.
      A. Injury to joint capsule, ligaments, tendons, muscles, etc.
      B. Fibrosis
    - Techanical obstruction, e.g.
      A. Intra-articular fractures
      B. Myositis ossificans.
  - Management
    - Preventive treatment:
      * First aid splintage, before reduction
      * Perfect reduction
      * Adequate fixation
      * Elevation of limb
      * Active exercises.
    - Specific treatment: Physiotherapy
    - Surgical treatment: Correction of the cause.
- **Myositis ossificans:** It is a complication of orthopedic trauma, wherein a bony mass appears in the tissues near a joint, resulting in restricted movements due to mechanical obstruction.
  - Etiology: Repeated manipulations for reduction of fracture. Elbow is the most common site for myositis ossification; also common in other sites like shoulder, hip, and knee, and frequently seen in patients of head and spinal injuries with paraplegia.
  - Pathogenesis: Hematoma formation in the muscle, leading to bone formation as a result of calcification and ossification of this hematoma.
    Example: Myositis ossificans of brachialis muscle at the front of elbow joint, following reduction of supracondylar fracture.
  - X-ray: Confirms diagnosis.
  - Management:
    - Early excision: Yields poor results, with recurrence
    - Late excision: Yields good results (mechanical obstruction removal) with less chances of recurrence.
- **Osteoarthritis:** Degeneration of the joint, following fracture.
  - Etiology:
    - Traumatic:
      * Intra-articular fractures
      * Malunited fractures (stressful joints)
      * Injury to articular cartilage, capsule, ligament (irregular surfaces)
      * Avascular necrosis (impaired blood supply of I/A bone fragment).
    - Infective
    - Malunion

- Management:
  - Conservative measures:
    - Treatment of the cause
    - Physiotherapy: Shortwave therapy, infrared therapy, exercises
    - Intra-articular injections of hydrocortisone with xylocain (lidocain)
    - 2%—once or twice a week.
  - Surgical measures:
    - Synovectomy
    - Excision osteophytes
    - Arthroscopy
    - Reconstruction
    - Total joint replacement
    - Arthrodesis.

- **Sudeck's dystrophy** is a complication of orthopedic trauma, found only after removal of plaster (4–6/52 of immobilization), seen most frequently after Colles fractures of the wrist, also seen after scaphoid fractures, or following any wrist injury.
  - Etiology:
    - Unknown
    - May be due to sympathetic response to fracture.
  - Diagnosis:
    - Painful, restricted movements
    - Swelling of hand and fingers
    - Skin—warm and shining
    - Tenderness present over wrist and metacarpals.
  - X-ray: Fracture united, osteoporosis, mottling of carpus
  - Management:
    - Anti-inflammatory analgesics.
    - Physiotherapy: Exercises.
- **Bedsores:** Due to local pressure by ridges, produced by uneven application of a bandage, loose plaster, infection, and malnutrition.
  - Pathogenesis: Local pressure over unprotected bony prominences by the cast indent prior to plaster setting, resulting in edema, gangrene.
  - Diagnosis: Pain, discomfort, edema, gangrene.
  - Management: Cut a window in the plaster cast, for AS dressings.
- **Visceral complications:** Frequently post-fracture, regional visceral complications occur:
  - Rupture of urethra, bladder, or rectum in fracture pelvis
  - Rupture of kidney, spleen, liver, intestine, etc. due to local trauma, e.g. compression of abdomen in RSA, fall from height, sports injury
  - Paralytic ileus: In fracture pelvis or lumbar spine.

  Etiology:
  - Direct violence: Blows, hits with a stick
  - RSA
  - Fall from height

  Pathogenesis: Disturbed autonomic control of bowl due to retroperitoneal hematoma.
  Diagnosis: Distension abdomen, absent bowel sounds, vomiting, constipation.
  Investigation:
  - Serum electrolytes

- Plain X-ray abdomen
- Abdominal paracentesis
- Laparotomy
- Laparoscopy

Management: Nasogastric suction, IV fluids.

- **Cast syndrome**
  - Etiology: Plaster jackets, hip spicas, or plaster beds
  - Diagnosis: Vomiting, constipation, abdominal distension.
  - Management:
    - Removal of plaster
    - Nasogastric suction
    - IV fluids.

PRINCIPLES OF FRACTURE TREATMENT IN CHILDREN

PREFACE

Childhood fractures are different from adult fractures, and also the principles of treatment are quite different. The treatment of fractures in children is simple as compared to complex one in adults. Fractures of the shaft of long bones in children hardly require open reduction, as bony growth relative to patient's age, mostly compensates for disparity in apposition, malalignment, and shortening, e.g. fractures of femur may stimulate hypergrowth of the limb. In infants, fractures shaft of the femur and humerus, relatively common, majority of these result in normal growth, irrespective of the position and alignment of the bone fragments. Spontaneous correction of an angular deformity in a child depends upon the age of the child; site of the fracture; and the degree of angulation. Major angulation near the bone's end is acceptable in young children, while fracture mid-shaft and near the bone end in adolscents require perfect reduction.

PRINCIPLES

Delayed union: Absent in children, due to remarkable osteogenic activity of all the osseous tissues (endosteum, periosteum, and cortex) that may bind large gaps, except in case of:

- Deformity: It is rare in children, due to great power of remodelling.
- Shortening of limb: Self-correctable, due to stimulation of growth.
- Joint stiffness: It is rare.
- Manipulation of greenstick fracture: It is easier, due to strong periosteum.
- Immunity of certain bones: Fracture spine rare, paraplegia unknown, fracture pelvis rare.

Problematically childhood fractures:

- Supracondylar fracture of humerus: Associated with vascular injuries.
- Fracture of capitellum: Associated with late cubitus valgus and ulnar nerve palsy.
  - Separation of lower femoral epiphysis – causing gangrene of foot, due to pressing of popliteal vessels.
- Epiphyseal fractures in children, complicated by infection, open reduction, repeated manipulations, usually result in growth disturbances.

PHYSIOTHERAPY MANAGEMENT

It includes management during immobilization and post-removal of fixator. Physiotherapist to avoid any risk factor that may delay healing of fracture or may lead to non-union, i.e. to discuss and plan role of physiotherapy amongst other members of team managing the concerned fracture.

During Immobilization

Aims

- To reduce edema: ASAP to prevent adhesion formation.
- To maintain circulation by active exercises (static or isotonic muscle activity).
- To maintain muscle function by active or static contractions
- To maintain joint range
- To teach patient about use of particular orthosis, e.g. crutches, sticks, frames, etc.
- Physiotherpy techniques:
  - Elevating limb: To reduce swelling
  - Muscle contractions: To prevent adhesions and joint stiffness, by performing isotonic or isometric contractions.

Post-Removal of Fixator

Aims

- To reduce swelling
- To restore full range of joint movement
- To restore muscle power
- To restore full function.
- Physiotherapy techniques:
  - Exercises
  - Manipulative therapy
  - Hydrotherapy
  - Electrotherapy.

BIBLIOGRAPHY

1. Adams J. Outline of Fractures, 9th edn., Churchill Livingstone, London, 1987.
2. Apley AG. Systems of Orthopedics and Fractures, 10th edn. Butterworths, London, 1985.
3. Bohler L. The treatment of Fractures. 4th edn. Wright, Bristol, 1935.
4. Charnley J. Fractures: Bailey and Love's Short Practice of Surgery, 13th edn. HK Lewis and Co. Ltd., London, 1965.
5. Clark JMP. Fracture Treatment: Modern Trends in Orthopedics, 3, Butterworths, 1962.
6. Downie PA. Cash's Textbook of Orthopedics and rheumatology for Physiotherapists, Faber and Faber, London, 1985.
7. Kapoor PS. Fractures: Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
8. Kapoor PS. Trauma and Orthopedics, 1st edn. CBS, New Delhi, 2017.
9. King JB. Fractures–the upper limb 2, British Journal of Hospital Medicine, 1982b.
10. McRae R. Fractures General Principles: 1, Practical Fracture Treatment. Churchill Livingstone, Edinburgh, 1984.
11. Keith T Oldham, Paul M Colomham, Robert P Folgia, Michel A Skinner. Principles and Practice of Pediatric Surgery. Vol 1: Trauma: 357–509.
12. Smith H. Fractures: Campbell's Oerative orthopedics, Vol. 1, 4th edn. CV. Mosby Co. 1963 Kimpton, 1956.
13. Watson JR. Fracturtes and other Bone and Joint Injuries. Livingstone, Edinburgh, 1940.
14. Wilson NJ. Watson Jones Fractures and Joints Injuries, 6th edn. Vols I and II, Churchill Livingstone, London, 1982.

REGIONAL FRACTURES

UPPER LIMB FRACTURES

Fractures about the shoulder girdle include:

- Fractures of clavicle
- Fracture of scapula
  - Fracture-dislocation of shoulder joint
  - Shoulder cuff injuries
- Fractures of greater tuberosity
- Fracture neck of humerus
- Fracure shaft of humerus

Shoulder Girdle

Anatomy: Shoulder girdle is formed by the bones of the shoulder, i.e. clavicle/collar bone, and the scapula/shoulder blade; these articulate with each other at the top of the shoulder to form the acromioclavicular joint; and the clavicle articulates with the upper end of the sternum/breast bone to form the sternoclavicular (large synovial) joint. The clavicle lies subcutaneously at the junction of neck and thorax; the sternum lies subcutaneously in the anterior midline and is palpable throughout its length; **in contrast to the clavicle, the scapula has no direct attachment to the axial skeleton, as it is attached to the ribs and the vertebral column by muscles only; its only connection to the axial skeleton is indirect one through the clavicle.**

Function: The clavicle serves as a brace for the shoulder, helping to keep the arm sufficiently far from the body so as to allow the free movements.

Fractures of Clavicle

Preface: The clavicle (collar bone) is the commonest long bone to fracture; being subcutaneous, it is prone to indirect violence, i.e. fall on the outstretched hand; and direct violence, and RSA.

Site: Fracture occurs commonly at the junction of outer flattened third and inner pyramidal portions; and may also occur in the middle third.

MOI: Indirect violence: Fall on the outstretched hand—the commonest cause

- Direct violence
- RSA
- Sports injury.

Pathogenesis: Patterns

- **In children:**
  - Green stick fracture: No deformity
  - Local tenderness present
  - Reluctance to move the arm.
- **In adults:**
  - Separation of bony ends,
  - Elevation of proximal end by the pull of sternomastoid,
  - Displacement of outer end—downwards, forwards, and inwards by the pull of pectoralis.

Diagnosis
- Pain
- Local tenderness
- Bony irregularity
- Crepitus
- Unnatural mobility at fracture site.

Investigation: X-ray clavicle—AP view.

Management
- **Fractures in children:**
  - Greenstick fracture in children:
    - Cuff and collar sling
    - Analgesics
- **Fractures in adults:**
  - Conservative treatment:
    - Apply figure of 8-bandage or a clavicle brace, Alt:
    - Three-slings method: Simplest method of all
    - After care: Cuff and collar sling or arm pouch
    - Analgesics.
  - Surgical treatment:
    - Surgery: ORIF—medullary fixation with 2 medullary pins
    - Alt: Plate and screws
- **Indications:**
  - Failure of conservative treatment, e.g. persistent separation of fragments
  - Neurological due to pressure exerted by displaced fragment upon the brachial plexus
  - Ligament injury (coracoclavicular) by distal fragment
  - After care: Arm supported in an arm pouch for 1–2/52
  - Removal of pins after 8–12/52.

Physiotherapy management: These fractures seldom require physiotherapy treatment except in case of complications leading to restricted shoulder movements and muscular weakness.

Fractures of Scapula

Preface: Fractures of the glenoid and neck of the scapula are difficult to treat both conservatively (closed reduction by skeletal traction) and surgically (ORIF); usually, inspite of medial displacement of the lateral fragment, the functional results are usually satisfactory; acromionectomy is indicated for acromion obstructing abduction.

Sites: Common sites are neck, body, and glenoid of scapula.

MOI: Direct violence.

Diagnosis:
- Flattening and drooping of shoulder
- Lengthening of arm
- Local tenderness
- Movements of shoulder painful and restricted.

Investigation: X-ray scapula—PA view.

Management:

Conservative treatment:

- Warm fomentation
- Massage—with warm oil or an anti-inflammatory cream
- Strapping—adhesive
- Analgesics
- Arm pouch for 2–3/52.

Surgical treatment:

- Surgery: Open reduction
- Indication: Dislocation of shoulder plus fracture neck of humerus.

Physiotherapy management: These fractures seldom require physiotherapy treatment except in case of complications leading to restricted shoulder movements and muscular weakness that require active exercises of fingers, wrist, elbow.

Shoulder cuff injuries: Described in Chapter of Affections of Muscles, Tendons, and Tendon Sheaths.

Fracture Neck of Humerus

Preface: Importance of fracture neck of humerus is that the fracture being nearer to a joint demands an early movement (ASAP).

Definition: Fracture line passes through the surgical neck, and rarely through the anatomical neck.

MOI: Indirect violence: Fall on the outstretched hand; sports trauma

- Direct violence
- RSA

Pathogenesis: Patterns:

- Greenstick fracture—in children
- Impacted (abduction and adduction) fracture—in adults
- Unimpacted fracture.

MOI: Fall on the outstretched hand, or direct violence.

Diagnosis: Patient supports the arm with the other hand:

- Local tenderness
- Deformity.

Investigation: X-ray shoulder—AP view.

Management:

Conservative treatment:

- Impacted fracture: Arm sling or cuff and collar sling for 4/52
  After care: Physiotherapy
- Unimpacted fracture: Closed reduction and arm sling
  After care: Physiotherapy.

Surgical treatment:

- Surgery: Internal fixation with:
  - Rush pinning/Ender nailing, Alt:
  - Plate and screws: Locking compression plate (LCP)
    After care: Physiotherapy.

Physiotherapy management: Early mobilization to avoid stiff shoulder (active exercises of shoulder ASAP + SWD/or IRR for relief from pain.

Fracture Shaft of Humerus

Preface: Fracture shaft of the humerus usually occur close to the midpoint; easily diagnosed by the visible deformity and unnatural mobility; radial nerve injury is common.

MOI: Fall on the outstretched hand, or direct violence.

Pathogenesis: Deformity:

- In fractures of proximal third: Proximal fragment adducted due to pull of pectoralis.
- In fractures of middle third: Proximal fragment abducted due to pull of deltoid.

Diagnosis: Patient supports the arm with the other hand.

Deformity: Mostly angulation

- Local tenderness
- Unnatural mobility.

Complication: Radial nerve palsy (wrist drop) may accompany the fracture.

Investigation: X-ray humerus—AP and lateral views.

Management

Conservative treatment:

- U-plaster method: Apply a U-slapped plaster slab, starting from axilla, to under the elbow, to the top of shoulder, supported by elastic crepe bandage.
- Hanging cast method: The weight of the limb plus that of plaster, reduce fracture and maintain reduction. It may lead to non-union due to distraction.
  After care: Cuff and collar sling. Union normally occurs in about 6–8/52.

Surgical treatment:

- Surgery: Internal fixation.
- After care: Physiotherapy.

Management of complications of internal fixation:

- Non-union: ORIF + bone grafting.
- Radial nerve palsy: Usually the recovery begins 8/52 after the injury/palsy. Provide the patient with a wrist drop splint and the regular physiotherapy.
- Wait for 8/52.
- Exploration of radial nerve—if no evidence of recovery.

Physiotherapy management: During immobilization, management depends on type of fixation and whether shoulder movements allowed.

- Assisted active movements (by physiotherapist) to be started ASAP followed by active exercises of fingers, wrist, elbow and shoulder.
- Post-removal of internal fixation: Patient to be reassessed and physiotherapy started to restore full range movement of shoulder joint, shoulder girdle and elbow, and to regain muscle power by active exercises + SWD × 2/52.

FRACTURES ABOUT THE ELBOW

Preface: Elbow trauma demand respect; result in a greater variety of fractures and epiphyseal injuries; usually associated with neurovascular damage than any other portion of the body; the intractable joint stiffness that occasionally occurs following

the comparatively minor trauma; and the marked sensitivity of the traumatized joint to the early passive mobility aggravates the difficulties of the management and prognosis; certain injuries require early open surgery and perfect reduction, some skilled manipulation, and knowledgable remodelling possibilities as the growth proceeds, while in others the best results obtained by confining to the inevitable joint disturbance and encouraging early movement.

Fractures

- **Fractures in children:**
  - Supracondylar fracture
  - Lateral condyle fracture
  - Medial epicondyle fracture
  - Lateral epicondyle fracture
  - Fracture neck of radius
- **Fractures in adults:**
  - Fracture of lower end of humerus (Y or T shaped)
  - Fracture of capitellum
  - Fracture of olecranon
  - Fracure head of Radius
- **Injuries of muscles and tendons:**
  - Tennis elbow (lateral epicondylitis).

Supracondylar Fracture of Humerus

Preface: The supracondylar fracture in children, when grossly displaced is one of the most difficult fractures to manage perfectly; being notorious for the neurovascular complications (partly attributed to the inadequate treatment).

Definition: It is one of the commonest fracture of childhood, involving distal end of humerus.

Pathogenesis: Fracture line is proximal to trochlea and capitulum.

Types: Postertior—common type, and anterior—rare type.

MOI: Fall on the outstretched hand.

Etiology: Direct violence

- RSA
- Sports injury.

Diagnosis: Deformity: Distal fragment is displaced backwards, upwards, and outwards

- Swelling
- Pain
- Local tenderness
- Olecranon, medial and lateral epicondyles—preserve their relation
- Shortening of the arm
- Movements at the elbow painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Complications:

- Injury to brachial vessels
- Injury to ulnar, median, or radial nerves
- Movements of elbow—painful and restricted

- Malunion
- Deformity: Cubitus valgus or varus
- Volkmann's ischemic contracture
- Myositis ossificans.

Management

Conservative treatment:

- Closed reduction under C-arm supervision with axis of humerus.
- After care:
  - Admit the child for overnight stay in the hospital, for observation of circulation.
  - Elevate the arm. Cuff and collar sling.

Surgical treatment:

- Surgery: Internal fixation—Rush pin/Ender nails, followed by plaster fixation.
- After care: Physiotherapy.

Physiotherapy management: Do not attempt/allow any forced extension of the elbow. Although, sometimes it may be helpful for the physiotherapist to guide the child simple free exercises in presence of his/her parents in order to monitor and encourage child besides feedback report by them. Failing that requires mandatory physiotherapy under supervision of the physiotherapist.

Fracture of Lateral Condyle

Preface: It is the commonest epiphyseal injury around the elbow in children; is an intra-articular fracture, therefore, accurate reduction is essential.

Pathogenesis: The detached fragment (capitellum and half of trochlea) is displaced and rotated by forearm extensors and lateral ligament, resulting in deformity of cubitus valgus with late ulnar palsy.

MOI: Fall on the outstretched hand or fall on the point of olecranon.

Etiology: Direct violence

- RSA
- Sports injury.

Diagnosis:

- Pain
- Swelling
- Deformity—cubitus valgus
- Local tenderness,
- Movements at elbow—painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Complications:

- Non-union
- Deformity—cubitus valgus
- Late ulnar nerve palsy

Management: The lesion being an intra-articular fracture, needs perfect reduction; even minor deghrees of displscement may indicate periosteal or soft-tissue interposition that may cause delayed/non-union; thus ORIF is the treatment of choice in majority of cases.

Surgical treatment:

- Surgery: ORIF: Kirschner wiring/screw fixation through metaphyseal portion of the fracture, is the treatment of choice.
- After care: Immobilization: Plaster cast from knuckles to middle of arm.

Physiotherapy management: Active exercises + Heat pads therapy.

Fracture of Medial Epicondyle

Etiology:

- Indirect violence: Fall on the outstretched hand
- Direct violence
  - RSA
  - Sports injury

Pathogenesis: Valgus strain with or without lateral dislocation of the elbow; probably an associated subluxation of the joint that has reduced spontaneously; the epicondyle may be retained post reduction of a dislocation—causing blockage of the joint in flexion.

Diagnosis:

- Pain
- Swelling
- Deformity—cubitus valgus
- Local tenderness
- Movements at elbow—painful and restricted.

Investigation: X-ray elbow—AP and lateral views

- Absence of medial epicondyle from its normal position
- Inclusion of fragment inside the joint.

Management:

- **Conservative treatment:** Closed reduction under general anesthesia
- **Immobilization:** Plaster cast for 4/52; Alt:
  - Cuff and collar sling for 2–3/52, with the elbow at a right angle
  - Exercises
- **Surgical treatment:** Surgery: Internal fixation—Kirschner wire fixation followed by plaster fixation.

Physiotherapy management: Free active exercises + heat pads.

Fracture of Lateral Epicondyle

Etiology

- Indirect violence: fall on the outstretched hand
- Direct violence
  - RSA
  - Sports injury

MOI: Fall on the outstretched hand or direct violence.

Diagnosis

- Pain
- Swelling
- Local tenderness
- Movements at elbow—painfull and restricted.

Investigation: X-ray elbow—AP and lateral views.

Management

Conservative treatment:

- Reduction: Closed reduction
- Immobilization: In a plaster cast for 3–4/52.

Physiotherapy management: Active exercises + SWD/IRR 3/52.

Fracture Neck of Radius

Preface: Usually a greenstick fracture.

Etiology:

- Indirect violence: Fall on the outstretched hand
- Direct violence
  - RSA
  - Sports injury

Pathogenesis: Fall on the outstretched hand causes a valgus strain on the elbow joint that drives the capitellum against the outer side of radial head, resulting in tilting and outward displacement; associated with a traction lesion of the inner side of the joint that may assume the form of a strain or rupture of the medial collateral ligament, avulsion of the medial condyle, or an associated fracture of the upper end of the ulna.

Diagnosis:

- Pain
- Deformity: Angulation
- Swelling
- Local tenderness
- Movements at elbow—painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Complications:

- Non-union
- Cross-union.

Management:

Conservative trteatment:

- Indication:
  - For little/or no tilt: Cuff and collar sling and analgesics
  - For marked tilt: Manipulation (traction, pronation, supination) under anesthesia.
- After care: Physiotherapy (exercises + SWD/IRR 2/52).

Surgical treatment:

- Surgery:
  - Open reduction
  - Excision of radial head

Physiotherapy management: Free active exercises + SWD/IRR 3/52.

Fracture of Lower End of Humerus (Intercondylar)

Preface: T or Y shaped fractures of lower end of humerus, usually occur as a result of fall on the point of the elbow; are very difficult fractures to treat; both occur in the

adult; being intra-articular fractures, the fundamental principle is early movement (ASAP), current tendency is to favour this at the expense of the anatomical position of the fragments.

Etiology

- Indirect violence: Fall on the point of the elbow
- Direct violence
  - RSA
  - Sports injury

Pathogenesis: Fall on the point of elbow, the olecranon wedges into the lower end of humerus, causing separation and comminution of the articular surface.

Diagnosis:

- Deformity
- Swelling
- Local tenderness
- Crepitus
- Un-natural mobility
- Movements at elbow—painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Management:

Conservative treatment:

- Indication: Comminuted fracture
- Technique:
  - Closed reduction
  - Immobilization: Plaster (POP) cast for 2–3/52; Alt: Cuff and collar sling for 2–3/52
- After care: Physiotherapy.

Surgical treatment:

- Surgery: ORIF: Plate and screws (LCP), Rush pin/Ender nail, or screws.
- Immobilization: POP cast—knuckles to above elbow.
- After care: Physiotherapy.

Physiotherapy management: Free active exercises + SWD/IRR 4/52.

Fracture of Capitellum

Preface: An isolated fracture of the capitellum is a common injury of childhood; one of considerable importance; in case of slight displacement, the elbow may be managed in a cuff and collar sling, with active movements starting post 3/52; while in cases of gross displacement (capitellum often rotated through 180° with articular surface of the capitellum facing fractured surface of the humerus.

Etiology:

- Indirect violence: Fall on the outstretched hand
- Direct violence:
  - Hit by a stick/rod
  - RSA
  - Sports injury.

MOI: Fall on the outstretched hand, causing fracture of the capitellum by an upward thrust transmitted by the radial head.

Diagnosis:
- Pain
- Swelling
- Local tenderness
- Movements at elbow—painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Management

Conservative treatment:
- Closed reduction
  - Immobilization: In a plaster cast applied to the extended elbow.

Surgical treatment:
- Surgery: ORIF (Smillie pins)
- Immobilization: In a plaster cast for 4–6/52
- After care: Physiotherapy.

Physiotherapy management: Active exercises + SWD/or IRR × 2/52.

Fracture of Olecranon

Preface: Majority of olecranon fractures usually occur in middle age; fractures frequently comminuted; often associated with abrasions; may be open fractures; an early movement is desirable of any type of management; attempts to replace and hold the displaced fragment in good position by closed reduction (manipulation) and plaster cast immobilization are to be avoided.

Etiology:
- Indirect violence: Fall on the outstretched hand.
- Direct violence
  - RSA
  - Sports injury

MOI: Avulsion injury caused by the opposing strains of sudden flexion of the elbow joint against the violent contraction of the triceps muscle.

Diagnosis:
- Pain
- Swelling
- Local tenderness
- Bone irregularity
- Movements at elbow: Painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Management:

Conservative treatment:
- Plaster cast above elbow for 6–8/52
- Indication: Hairline and undisplaced fracture.

Surgical treatment:
- Surgery: ORIF
- Displaced closed fractures:
  - Zuelzer hooked plate and screws
  - Croll olecranon screw

- Lag screw
- Tension band wiring (Kirschner wires, Rush pin)
- Open fractures:
  - Clamp cum compressor device
- After care: Physiotherapy.

Physiotherapy management: Free active exercises + SWD/IRR.

Fracture Head of Radius

Preface: Usually the extent of bone damage cannot be assessed radiologically and that relatively trivial fissure or marginal fractures may be associated with severe articular damage, often with disturbed capitellum; elderly patients unlikely to subject the joint to any vigorous use, to be managed with the arm in a sling until the acute symptoms subside, only then to utilize the elbow gradually; younger patients with comminuted fractures (esp. damaged capitellum) are to be managed by excision of the whole of radial head better within 3–4/7 of initial injury, to rlieve pain/stiffness and for increased range of movement.

Etiology:

- Indirect violence: Fall on the outstretched hand
- Direct violence
  - RSA
  - Sports injury

MOI: Fall on the outstretched hand, with the elbow extended, besides a valgus strain causing a compression injury of the radial head.

Types:

- Chip fracture involving less than a third of periphery.
- Comminuted fracture of whole head.

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Movements at elbow—painful and restricted.

Investigation: X-ray elbow—AP and lateral views.

Management:

Conservative treatment:

- Indication: Chip fractures
- Method: Plaster cast above elbow

Surgical treatment:

- Indication: Comminuted fractures
- Surgery: Excision of radial head.
  - After care: Physiotherapy.

Physiotherapy management: Free active exercises + heat pads therapy.

Tennis Elbow (Lateral Epicondylitis)

Described in Chapter 11 of Affections of Bones and Joints.

FOREARM BONES INJURIES

Types

- Fracture both bones forearm
- Isolated fracture radius
- Isolated fracture ulna

Fracture Both Bones Forearm in Adults

Preface: Complete functional recovery of forearm post-fractured shafts of radius and ulna depends upon the restoration, not only of full flexion and extension of wrist and elbow, but also of full pronation and supination (urgency to restore full pronation and supination make these fractures more difficult to manage).

Etiology:

- Direct violence: Hit by a stick/or rod
- Indirect violence:
  - Fall on the outstretched hand
  - RSA
  - Sports injury

Pathogenesis: Post-fractured bones, if the radial fragments unite with one rotated corresponding to the other one, then loss of corresponding degree of rotation inevitable; scarring with resultant shortening of interosseous membrane may bind radius to the ulna tightly causing restricted rotation (pronation and supination); massive scarring and shortening in case of bones uniting with deformity and the radius angulated towards ulna.

Diagnosis:

- Pain
- Deformity: Angulation, rotation
- Shortening
- Local tenderness
- Unnatural mobility
- Loss of function
- Movements: Painful and restricted

Investigation: X-ray of forearm includes elbow and wrist—AP and lateral views.

Management:

Conservative treatment:

- Reduction: Closed reduction under C-arm supervision.
- Immobilization: In a cast for 6–8/52.
- After care: Physiotherapy—exercises.

Surgical treatment:

- Surgery: ORIF: Is treatment of choice in adults.
  - Plating of both fractured bones, or
  - Plating of radius and nailing of ulna
- Postoperative: Plaster cast for 6–8/52.
- After care: Physiotherapy.

Physiotherapy management: Free active exercises + SWD/IRR × 2/52.

Fracture Both Bones Forearm in Children

Preface: Mostly greenstick fractures (undisplaced).

Etiology:

- Direct violence
- Indirect violence:
  - Fall on the outstretched hand
  - RSA
  - Sports injury.

MOI: Fall on the outstretched hand or direct violence.

Pathogenesis: Patterns: Mostly undislaced greenstick fractures of radius and ulna in middle thirds; distal fragments tilted anteriorly (posterior angulation) without any displacement; an intact posterior hinge (beneficial in the reduction); displaced fractures: Off ending of one or both bones; with potential instability; deformities: Shortening, angulation, and axial rotation may occur.

Diagnosis:

- Deformity—angulation, rotation
- Shortening
- Unnatural mobility
- Loss of function.

Investigation: X-ray of forearm includes elbow and wrist—AP and lateral views.

Management

Conservative treatment: Closed reduction of angulation deformity; usually the deformity is overcorrected, so as to prevent recurrence of angulation due to sagging.

- Immobilization: POP cast for 4–6/52
- After care: Physiotherapy.
- Displaced fractures:
  - Closed reduction of angulation, and rotation, deformities, and correction of displacement, under C-arm control.
  - Immobilization: POP cast for 4–6/52.
  - After care: Physiotherapy.

Surgical treatment:

- Surgery: ORIF.
- Postoperative: POP slab with flexed (90°) elbow, for 4–6/52.
- After care: Physiotherapy.

Physiotherapy management: Do not attempt/allow any forced extension of the elbow. Although, sometimes it may be helpful for the physiotherapist to guide the child simple free exercises in presence of his/her parents in order to monitor and encourage child besides feedback report by them. Failing that requires mandatory physiotherapy under supervision of the physiotherapist (assisted exercises by physiotherapist).

Isolated Fracture of Radius

Preface: Isolated fracture of the shaft of radius or ulna with deformities, i.e. of angulation or shortening, without involvement of inferior radioulnar joint, is a rare entity; failure to consider this primary fact results in permanent disability—not only from unreduced dislocation, but usually from difficulty in reducing fracture in presence of dislocation;

thereby for isolated fractures of shafts of radius or ulna, superior and inferior radioulnar joints must be included radiologically.

Etiology:

- Direct violence
- Indirect violence
  - RSA
  - Sports injury.

Pathogenesis: Oblique or comminuted fracture; radius shortened with rotated lower fragment; radial fragments angulated towards ulna; dislocated inferor radioulnar joint.

Diagnosis:

- Pain
- Swelling
- Deformity: Angulation, rotation, shortening
- Local tenderness
- Movements at wrist: Painful and restricted.

Investigation: X-ray forearm includes wrist and elbow—AP and lateral views.

Management

Conservative treatment:

- Reduction: Closed reduction
- Immobilization: In a POP cast
- Disadvantage: Difficulty in maintaining reduction by external splinting, due to muscle pull that invariably angulates the lower fragment towards ulna and the inferior radioulnar joint re-dislocates.

Surgical treatment:

- Surgery: ORIF of fractured radius (plating).
- Indication: Failure of conservative measures.
- Postoperative: POP for 6–8/52.
- After care: Physiotherapy

Physiotherapy management: Free active exercises.

Isolated Fracture of Ulna

Pattern: Mostly greenstick fractures.

MOI: Fall on the outsretched hand or direct violence.

Diagnosis: Swelling, tenderness, bone irregularity, ulnar angulation.

Investigation: X-ray forearm includes elbow and wrist—AP and lateral views.

Management

Conservative treatment:

- Indication: Displacement slight: Plaster in mid-pronation for 8–10/52.

Surgical treatment:

- Indication: Displacement/angulation marked
- Surgery: ORIF
- Postoperative: POP for 6–8/52.
- After care: Physiotherapy management: Free active exercises.

INJURIES ABOUT THE WRIST AND HAND

A. Closed hand injuries:
   i. Colles fracture*
   ii. Smith's fracture (Syn. Reversed Colles fracture)
   iii. Barton's fracture
   iv. Slipped radial epiphysis
   v. Fracture of the radial styloid
   vi. Scaphoid fracture*
   vii. Metacarpal fractures*
   viii. Rupture of ulnar collateral ligament (Gamekeeper's thumb)
   ix. Fractures of phlanges*
   x. Mallet finger
B. Open hand injuries

Colles Fracture

Preface: It is defined as a fracture of radius within 2.5 cm of the wrist and usually occurs in old ladies; associated with either avulsion of the styloid process of the ulna or ruptured triangular fibrocartilage of the wrist joint; shortening of radius causes subluxation of the inferior radioulnar joint and a prominent ulnar styloid; lower fragment of radius displaced backwards and radially, and rotated so that the articular surface points backwards, i.e. displaced and rotated in the direction of violence; all these deformities results in 'dinner fork' deformity; radial styloid process is at par with ulnar styloid process (instead of 1.25 cm below that of ulna).

Etiology:

- Indirect violence: Fall on the outstretched hand
- Direct violence:
  - Fighting
  - RSA
  - Sports injury.

MOI: Fall on the outstretched hand.

Pathogenesis: Avulsed ulnar styloid process; ruptured triangular fibrocartilage of the wrist joint; shortened radius; subluxated inferior radioulnar joint; prominent ulnar styloid; dinner fork deformity; radial styloid at par with ulnar styloid process.

Diagnosis:

- Deformity: Dinner fork, i.e. lower end of radius is displaced backwards, radially and rotated; radial and ulner styloid processes are on same level.
- Pain
- Swelling
- Local tenderness
- Movements painful and restricted

Investigation: X-ray forearm includes wrist—AP and lateral views.

Management: Closed reduction under general anesthesia.

Immobilization: The reduction is maintained by applying plaster slab to the dorsal and radial surfaces of the wrist, and the plaster extends from the level of metacarpal heads to the elbow—below its crease in front while up to olecranon level posteriorly.

- After care:
  - Elevate the hand in a cuff and collar sling; watch the circulation for any impairment, i.e. any swelling of the fingers, and numbness or severe pain in the fingers.
  - Active exercises of fingers, thumb, elbow, and shoulder.
  - Anti-inflammatory analgesics.
  - Removal of cast: After 6–8/52, followed by physiotherapy.
  - Physiotherapy: Active exercises + Heat pads therapy.

Complications:

- Malunion
  - Management: Physiotherapy
  - Surgery: Rarely indicated
- Rupture of extensor pollicis longus
  Management: In elderly—physiotherapy
- Sudeck's atrophy:
  - S/S: Swelling of fingers, skin of hands—warm and tendered, movements—painful and restricted.
  - X-ray—shows osteoporosis.

Physiotherapy management: Free active exercises + moist heat packs therapy.

Smith's Fracture (Syn. Reversed Colles Fracture)

Definition: It is defined as the deformity characterized by the reverse of that which occurs in Colles fracture; the distal fragment being displaced in front of the lower end of the radius.

Etiology:

- Indirect violence: Fall on the back of hand
- Direct violence
  - RSA
  - Sports injury.

Pathogenesis: Fall on the back of hand; distal fragment displaced in front of lower end of radius; articular surface looks forwards, i.e. displaced and angulated in the direction of violence.

Diagnosis: Deformity: In the opposite direction to that of Colles' fracture, i.e. lower end of radius is displaced forwards in front of lower end of radius, and tilted anteriorly (posterior angulation).

- Fracture: Usually impacted.
- Pain
- Swelling
- Local tenderness
- Movements: Painful and restricted.

Investigation: X-ray forearm incld. wrist—AP and lateral views.

Management:

- Closed reduction under general anesthesia.
- Immobilization: The reduction is maintained by applying plaster slab to the dorsal and radial surfaces of the wrist, and the plaster extends from the level of metacarpal heads to above elbow.

- After care:
  - Elevate the hand in a cuff and collar sling, watch the circulation for any impairment, i.e. any swelling of fingers, numbness or severe pain in the fingers.
  - Active exercises of fingers, thumb, elbow, and shoulder
  - Anti-inflammatory analgesics.
  - Removal of cast post 6–8/52, followed by physiotherapy.

Physiotherapy management: Free active exercises + heat pad therapy.

Barton's Fracture

Definition: It is defined as a form of Smith's fracture, characterized by involving only the anterior part of the radius.

Etiology:

- Indirect violence: Fall on the outstretched hand
- Direct violence
  - RSA
  - Sports injury.

Pathogenesis: Fall on the outstretched hand resulting in fractured anterior portion of the radius.

Diagnosis:

- Deformity
- Pain
- Swelling
- Local tenderness
- Movements of wrist: Painful and restricted.

Investigation: X-ray forearm includes wrist—AP and lateral views.

Management

Conservative treatment:

- Reduction: Closed reduction as for Smith's fracture.
- Immobilization: As for Smith's fracture.

Surgical treatment:

- Indication: Failure of closed reduction.
- Surgery: ORIF (screw—cancellous, or buttress plate).
- After care: Physiotherapy.

Physiotherapy management: Free active exercises + Heat pad therapy.

Slipped Radial Epiphysis

Definition: Common in adolescence and in childhood, is the counterpart of Colles fracture; displaced distal radial epiphysis is usally associated with a small fracture of the metaphysis (Salter Harris type II injury); deformity of the wrist occurs due to unequal growth of the radius and ulna.

Etiology:

- Direct violence
- Indirect violence:
  - Fall on the outstretched hand
  - RSA
  - Sports injury.

Pathogenesis: Fall on the outstretched hand; displaced distal radial epiphysis; mataphyseal fracture.

Diagnosis:
- Deformity: Displacement of distal radial epiphysis along with a small piece of metaphysis (Salter-Harris injury)
- Pain
- Swelling
- Local tenderness
- Movements: Painful and restricted

Investigation: X-ray wrist—AP and lateral views.

Management:
- **Conservative treatment:** Closed reduction and plaster fixation (same as for Colles fracture).
- After care: Physiotherapy.

Physiotherapy management: Assisted exercises by physiotherapist.

Fracture of the Radial Styloid (Chauffer's Fracture)

Definition: It is defined as a fracture of radial styloid; fracture line that involves the radiocarpal joint surface, is mostly without any gross displacement; that often involves a much larger piece of radius; so-called ~chauffer's fracture sustained by 'back-fires' while starting internal combustion engines (generators).

MOI: Fall on the outstretched hand
Engine (generator, pump, auto) starting handle—back-fires.

Diagnosis:
- Deformity—slight displacement
- Pain
- Swelling
- Local tenderness
- Movements at wrist: Painful and restricted.

Investigation: X-ray wrist—AP and lateral views.

Management:
- **Conservative treatment:** Closed reduction and plaster fixation (same as for Colles fracture).
- **Surgical treatment:**
  – Surgery: ORIF (screw—cancellous, or buttress plate).
  – After care: Physiotherapy.

Physiotherapy management: Exercises + Heat pads therapy.

Scaphoid Fracture

Definition: It is defined as the commonest bone to be fractured in the wrist; a sprained wrist following fall on a stretched hand, should arouse suspicion; with thumb and fingers fully extended, fullness of the anatomical snuff-box with local tenderness may happen due to fracture scaphoid.

Etiology:
- Indirect violence: Fall on the outstretched hand
- Direct violence
  - RSA
  - Sports injury.

Pathogenesis: Fall on the outstretched hand in men aged 20–40 yrs.
Engine (generator, pump, auto) starting handle—back-fires.

Diagnosis:
- Pain—outer aspect of wrist
- Fullness of snuffbox
- Local tenderness
- Movements at wrist—painful and restricted.

Investigation:
- X-ray wrist—AP, LAT, and oblique—views.
- Certain cases—fractures become visible only after 2–3/52.

Management

Conservative treatment:
- Cock-up plaster cast for 8–10/52:
- After care: Physiotherapy.

Surgical treatment:
- Surgery: ORIF (cancellous screw fixation).

Complications:
- Non-union: Symptomless or wrist pain, difficulty in performing work.
- Management: Symptomless—active exercises
- Symptoms (marked):
  - Early case: Screw fixation plus bone grafting
  - Late case: Excision radial styloid
- Sudeck's atrophy: Pain, swelling, local tenderness, painful and restricted movements of fingers and wrist
  - Management: Analgesics; immobilization of wrist—for 2–3/52.
  - Post care: Physiotherapy—active exercises.
- Osteoarthritis: Pain, swelling, painful and restricted movements of fingers and wrist
  - Management: Analgesics and physiotherapy.

Physiotherapy management: Mostly not required while physiotherapist should be aware of possible complications that need physiotherapy treatment (assisted exercises).

Fractures of Metacarpals

Definition: Defined as fractures involving the shaft of one or more of the inner four metacarpals as a result of knuckles striking objects, e.g. in boxing, or by objects striking the dorsum of the hand, as in industrial injuries.

Etiology:
- Direct violence
- Indirect violence
  - RSA
  - Sports injury: Knuckles striking face (boxing).

Pathogenesis: In sports injury, e.g. boxing—knuckles striking face, etc. In industrial injuries, e.g. objects striking the dorsum of the hand.

- Types: Transverse, oblique, or spiral.

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Bone irregularity
- Movements of hand—painful and restricted.

Investigation: X-ray hand—AP and lateral views.

Management:

Conservative treatment:

- Indication: Undisplaced fractures
- Technique: Plaster fixation (Colles type slab) for 3–4/52.
- After care: Physiotherapy—active exercises.

Surgical treatment:

- Indication: Displaced fractures
- Surgery: ORIF
- Postoperative: Plaster cast (Colles type slab).
- After care: Physiotherapy.

Physiotherapy management: Free active exercises monitored by the physiotherapist and occupational therapist (integrated plan of treatment).

Fracture Neck of Fifth Metacarpal

Definition: Defined as fractures usually caused by clenched fist facing resistance, e.g. as a result of a fight; angulation and impaction are common.

Etiology:

- Direct violence: Fighting—clenched fist facing resistance
- Indirect violence: Fall on an outstretched hand
  - RSA
  - Sports injury: Boxing.

Pathogenesis: Fractured neck 5th metacarpal; angulated; impacted fragment.

Diagnosis:

- Deformity—angulation
- Pain
- Swelling
- Local tenderness
- Movements: Painful and restricted.

Investigation: X-ray hand—AP and lateral views.

Management

Conservative treatment:

- Indication: Angulation—slight/moderate.
- Method: Closed reduction and plaster slab for 4/52.

Surgical treatment:
- Indication: Angulation—marked
- Surgery: ORIF (percutaneous/intramedullary Kirschner wiring).

Physiotherapy management: Active exercises.

Rupture of Ulnar Collateral Ligament (Gamekeeper's Thumb)

Described in Chapter 9 of Affections of Muscles, Tendons, and Tendon Sheaths.

Fracture of Phalanges

Definition: Defined as fractures sustained by direct violence (blow) or as a crush injury sustained by pressing in a door or window sash; fractures of the proximal phalanges are more difficult to manage than metacarpal injuries as the flexor tendon sheath may be involved in a displaced fracture.

MOI:
- Direct violence, e.g. by a hammer's blow.
- Crush injury: Pressed by a door/window—sash.

Diagnosis:
- Deformity: Angulation
- Pain
- Swelling of finger
- Local tenderness
- Bone irregularity
- Movements: Painful and restricted.

Investigation: X-ray hand (focusing affected finger)—AP and lateral views.

Management: Fractures of phalanges are difficult to treat, due to involvement of flexor tendon sheath.

- **Conservative treatment:**

  A. **Fracture of proximal and middle phalanges**: Methods: Closed reduction and fixation with:
     - Splintage: Aluminium splints covered with foam—plastic or rolled bandage held in the palm, or
     - Plaster slab (volar) for 3/52.

     Surgical treatment:
     - Surgery: Intramedullary Kirschner wires.
     - After care: Active exercises.

  B. **Fracture of terminal phalanx**:

     Surgery: Toilet of wound, debridement and suturing, followed by:
     - Strapping of finger to adjacent normal finger, or
     - Splintage—aluminium splints covered with foam—plastic.
     - After care: Physiotherapy

Physiotherapy management:
- Exercises: Active exercises.
- Waxbath therapy.

Mallet Finger

Described in Chapter 9 of Affections of Muscles, Tendons, and Tendon Sheaths.

Trigger Finger

Described in Chapter 9 of Affections of Muscles, Tendons, and Tendon Sheaths.

Open Hand Injuries

Principles: Post-traumatic:

- To restorte its function
- To prevent infection
- To salvage injured parts
- To promote primary healing
- To realign fractures and suturing nerves and tendons as secondary repairs to primary toilet (cleansing) of the wouind of foreign bodies and debridement of devitaslized tissue/s.
- To provide skin coverage even with skin grafing, if required.

Types:

- Cuts, lacerations, injection injuries
- Crush injuries
- Compound injuries
- Burns injuries.

Etiology:

- Direct violence, e.g. by a hammer's blow
- Crush injury: Pressed by a door/window-sash
  - RSA
  - Sports injury.

Pathogenesis: Wound may be lacerated, clean or dirty; foreign body/clots may be visible; skin may be denuded or lacerated; tendons may be torn; nerves may be torn; bones may be fractured.

Diagnosis: History of injury

- Mode of injury
- Time of injury
- Any first aid treatment received
- Any food taken and when it was taken
- Any history of allergy examination.

Investigation:

- X-ray examination.
- Pus/wound secretion: For culture sensitivity test
- CBC, ESR

Management:

Conservative treatment:

- Antibiotics, Inj. Tetanus toxoid
- Analgesics and NSAIDs.

Surgical treatment:
- Surgerry: Debridement of wound and repair of tissues.
- After care : Physiotherapy.

Physiotherapy management: Free active exercises after 3/52.

LOWER LIMB FRACTURES AND INJURIES

Principles: Fractures and injuries of the bones of lower limb (mostly weight-bearing) may lead to impaired mobility of joints resulting in unability to walk or may require helping orthoses like crutches, frame or stick(s). Elderly patients unable to walk for long may find difficulty in regain independence (regarded as priority that may affect selection of reduction and fixation of fractures. For young patients, early mobility is vital because of nature of their work.

FRACTURES OF PELVIS, HIP AND FEMORAL NECK

- Fractures pelvis and hip
  - Fractures iliac crest
  - Fractures true pelvis
- Fractures sacrum
- Fractures coccyx
- Fracture neck femur
- Intracapsular fractures
- Extracapsular fractures (trochanteric fractures)
- Slipped upper femoral epiphysis.

Fractures of Pelvis

Principles
- Pelvic ring: The pelvic ring is formed by union of two halves of pelvis to the sacrum by sacroiliac ligaments posteriorly, and by symphysis pubis anteriorly. This pelvic ring protects the pelvic organs.
- Fracture of hip bone may result from a blow or compression of pelvic ring by a crushing force, i.e. in RSA or fall of heavy weight, i.e. in mine industries.
- Fracture usually occurs across a weaker part of the bone, i.e. wing of the ileum or the obturator foramen.
- Displacement: Little in case of isolated/single fracture; while fractures across both the iliac wings and the obturator foramen, or across both obturator foramina permit displacement of a part of the pelvis.
- Fractures of pelvic ring at two different levels lead to marked separation of the ring, while isolated fractures are mostly stable injuries.
- Internal hemorrhage: Pelvis is richly supplied with blood vessels, which are damaged by fractures. Internal hemorrhage is mostly severe, leading to oligemic shock.
- Visceral injury: Pelvic fractures with displacement, especially of anterior parts, are often associated with damage to the viscera within the pelvis, the male urethra and urinary bladder being particularly vulnerable, and rarely the rectum.

Types of Pelvic Fractures
- Fractures of iliac crest
- Fractures of true pelvis

1. Fractures of Iliac Crest

Preface: Fractures of the iliac crest are not of significance as these are stable fractures, due to support from muscles on the inner side (iliacus) and outer side (glutei) of pelvic bone; displacement is slight.

MOI: Direct violence

- Fall from height
- RSA
- Sports injury.

Pathogenesis: Crush injury causing isolated fractures of the ileum or obturator foramina; little displacement.

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Movements: Painful and restricted

Investigation: X-ray pelvis—AP view

Management:

- Conservative treatment:
  - Bedrest
  - Analgesics and NSAIDs
- Support: A wide cloth support is sufficient for 2–3/52.

Physiotherapy management:

- Undisplaced fractures: During bedrest, exercises of legs advised; weight-bearing patients may require orthoses help like crutches, frame or sticks.
- Displaced fractures: Patient in a plaster spica requires mandatory static contractions for leg and trunk muscles.

2. Fractures of True Pelvis

Principles: Fractures of the true pelvis can occur either in the oblique diameter, i.e. through obturator foramen on one side and the sacral ala on the opposite side, or the pelvic ring may be fractured at two places on the same side.

- Fractures can occur at two levels on the same side or on the opposite side.
- Fractures of pelvis in trauma patients are reported to be 3–8.2%, with approximately half of these fractures being caused by high energy injuries with a potential for catastrophic hemorrhage and death.
- Fractures of anterior pelvic ring are important from treatment point of view (ORIF controversial because of fears of disturbing pelvic hematoma and causing additional hemorrhage).

MOI: Direct violence

- Fall from height or fall down stairs
- RSA
- Sports injury.

Diagnosis: Local signs: Bruising over the ileum, groin, or perineum

- Local tenderness
- Bone irregularity

- Signs of visceral complications:
  - Urethral injury: Blood per urethra, perineal hematoma, distended bladder
  - Bladder injury: Suprapubic tumor-like mass, strangury, local tenderness
  - Rectal and vaginal examinations—helpful in diagnosis.

Investigation: X-ray pelvis—AP view
- Hemogram, PCV, blood electrolytes,
- Blood urea, blood sugar, serum proteins,
- Blood grouping and cross-matching

Management:

Conservative treatment:
- General or first aid treatment
- Treatment of shock (if present):
  - Airways maintenance, oxygen therapy
  - IV fluids, blood transfusion, plasma or plasma expander
  - Inj Hydrocortisone IV, Inj Ephedrine—if reqd. urgently
  - Inj Morphine or Pethidine or Pentazocine (Fortwin)
- Bedrest
- Local treatment
- Reduction and immobilization:
  - Closed reduction and traction, Alt:
  - Closed reduction and plaster hip spica
- Physiotherapy

Surgical treatment:
- Surgery:
  - ORIF (plating and screws), Alt:
  - Fixation of the anterior pelvic ring fractures with percutaneous cannulated screw under fluoronavigation
- After care: Walking prohibited for 2–3/12.

Physiotherapy management:
- Undisplaced fractures: During bedrest, exercises of legs advised; weight-bearing patients may require orthoses help like crutches, frame or sticks.
- Displaced fractures: Patient in a plaster spica require mandatory static contractions for leg and trunk muscles.
- Postoperatively (fixator removed): Exercises to regain full range of movement in joints of leg and trunk and to re-educate walking.

Fracture of Sacrum

MOI: Direct violence:
- Kicks
- Fall from height
- RSA
- Sports injury.

Diagnosis:
- Pain
- Swelling
- Local tenderness
- Bone irregularity.

Investigation: X-ray sacrum—AP and lateral views.

Management: Conservative treatment: symptomatic:
- Bedrest for 2–3/52
- Analgesics: Paracetamol, NSAIDs, PO or IM
- Local block (puncture): Inj. Lignocaine 2% infiltration

Physiotherapy management: SWD/IRR + exercises in lying position of legs.

Fracture of Coccyx

MOI: Direct violence
- Fight, or kicks
- Fall from height
- RSA
- Sports injury.

Diagnosis:
- Pain: Often severe, occurs on walking, sitting, and aggravates on coughing or defecation
- Swelling
- Local tenderness
- Bone irregularity.

Physiotherapy management: SWD/IRR + exercises in lying of legs.

Traumatic Coccydinea

MOI: Direct violence
- Fall from height
- RSA
- Sports injury.

Diagnosis:
- No fracture
- Pain: Mostly severe
- Local tenderness

Investigation: X-ray pelvis—AP view

Management:
- **Conservative treatment:** Symptomatic treatment, e.g.
  - Bedrest
  - Warm fomentation
  - Seitz baths
  - Analgesics and NSAIDs
  - Local block—inj. Lignocaine 2% infiltration
  - Preventive: To sit on an inflated tube; avoid sitting on hard surface.
- **Surgical treatment:**
  - Surgery: Excision in extreme cases.
  - Physiotherapy management:
  - Heat therapy: SWD/IRR or heat pad therapy.

Fracture Neck of Femur

Preface: Fracture neck femur is one of the most common injuries amongst the geriatric population; prevalence of these fractures has further increased with improved life expectancy; aim of management of these fractures is restoration of pre-fracture function without associated morbidity; management of displaced femoral neck fractures in elderly has been controversial; in elderly, ORIF of these fractures has poor outcome—high rate of non-union and avascular necrosis; problems encountered are acetabular erosion and loosening of stem causing pain; inspite of these, superiority of prosthetic replacement over internal fixation well established.

Types: Intracapsular and extracapsular (Sir Astley Cooper division).

Intracapsular Fractures

Preface: Intracapsular fractures are prone to complications (non-union and avascular necrosis of femoral head) because of impaired blood supply to femoral head due to intracapsular fracture, leading to avascular necrosis; joint reconstruction (total hip replacement) revolutionized management of patients with advanced hip disorders; arthroplasty is a reconstructive procedure that alters the structure or function of a joint; many different types of hip arthroplasties have been introduced over the years.

Types:

- Subcapital and transcervical.
- Femoral head ischemia: More common in the subcapital than in the transcervical type.

MOI:

- Direct trauma in young adults
  - Fall from height
  - RSA
  - Sports injury
- Indirect trauma (missing a step) in elderly.

Pathogenesis: Osteoporotic bone (in elderly); healthy bone (in young adults); avascular necrosis of femoral head (increased density of femoral head).

Diagnosis:

- Age: Common in elderly persons (>80%), while uncommon in young adults.
- Sex: Common in females (>80%)
- Deformity:
  - Externally rotated lower limb (like paralysed)
  - Coxa vara (syn. adduction fracture)—is more serious (tendency to non-union) as the fracture line exposed to the shearing strain while weight-bearing attempt by the patient).
  - Coxa valga (syn. abduction fracture)—the strain of weight-bearing further impacts the fracture (unfortunately less common)
- Shortening of limb (due to coxa vara)
- Loss of function: Movements painful and restricted esp.in case of the recent trauma.

Complications:

- Non-union of fracture neck femur.
- Avascular necrosis (AVN) of femoral head.

Investigation:

- CBC, ESR, serum electrolytes, serum proteins, BUN
- Blood grouping and cross-matching
- Urine analysis
- ECG
- X-ray pelvis—AP view, to study type of fracture and the distorted Shenton's line.
- X-ray of affected hip—LAT view, to study angulation of femoral head over neck, and fragmentation
- CXR—PA view to rule out any pathology.

Management: Conservative treatment: Satisfactory as far as the union of fracture is the aim, but the mortality rate is relatively high, and also because of prolonged immobilization, restoration of function of the limb especially of knee may be slow or even restricted permanently, besides cardiorespiratory complications.

- Method:
  - Closed reduction
  - Immobilization: In POP hip spica in abduction and internal rotation (Whitman abduction plaster)
- Complications of conservative treatment:
  - Non-union
  - Avascular necrosis of femoral head
  - Bedsores: Prolonged immobilization in the bed
  - Ostyeoporosis: Disuse
  - Respiratory
  - Cardiovascular.
- Surgical treatment:
  - Surgery: Methods:
    - Reduction and internal fixation
    - Prosthesis
    - Total hip replacement (THR)
- Methods of internal fixation
  - Hip screws:
  - DHS (nail plate)—to prevent extrusion and rotation of the nail
  - Antegrade femoral nailing (AFN)
  - Moore/Knowles pins—to prevent avascular of head; of choice for children.
  - After care: Patient allowed out of bed within a few days; weight-bearing allowed after 2–3/12, depending upon union of fracture, and general condition of the patient.

Physiotherapy management: Post surgery (internal fixation/replacement arthroplasty). active exercises of legs in lying started ASAP and encouraged to move about in bed. Once patient is allowed to walk partial weight-bearing, patient is encouraged by the physiotherapist to concentrate on gaining independence with help of orthoses like crutches or frames.

Non-Union

Etiology:

- Inadequate immobilization (failure of internal fixation)
- Ischemia of femoral head.

Management:

- Head viable: Treatment of choice is:
  - Subtrochanteric displacement osteotomy
  - McMurray—no longer in vogue, or
  - Pauwel's valgization osteotomy
  - Nailing and bone grafting (Peg graft) in younger patient.
- Head non-viable: Either treatment is:
  - Prosthesis, or
  - Total hip replacement (THR).
- After care: Physiotherapy.

Physiotherapy management:

- Being fracture occurring in elderly, priority of treatment should be to achieve function ASAP.
- Exercises: Post surgery, active exercises for leg with movement in bed to be performed under supervision of physiotherapist, and post 8/52 partial weight-bearing allowed on crutches, till firm union (appx. 6/12).

Avascular Necrosis (AVN)

Preface: In majority of patients, the cause is interruption of blood supply due to rupture of blood vessels by the fracture. Although AVN of the femoral head is usually a deciding factor for non-union, it may not prevent union (neck absorption may not prevent union when fixation used permits nail extrusion, maintaining contact of fractured surfaces).

Diagnosis:

- Pain: Increasing type
- Disability: Limp
- Movements: Painful and restricted

Investigation: X-ray: Changes (sclerosed head, narrowed joint space, irregular articular surfaces, lipping of acetabulum) usually appear within a year or so of trauma.

Management:

- Total hip replacement (THR) is the treatment of choice in elderly
- Prosthetic replacement: In frail, elderly
- Prompt reduction + stable fixation, or osteotomy: In younger
- Arthrodesis hip: In difficult and unusual cases.
- After care: Physiotherapy

Physiotherapy management: Exercises: Post surgery, active exercises for leg with movement in bed to be performed under supervision of physiotherapist, and post 8/52, partial weight-bearing allowed on crutches, till firm union (appx. 6/12).

Traumatic Arthritis (Osteoarthritis) Hip

Definition: Incidence and severity of traumatic arthritis post fracture-dislocation or dislocation of hip is as per severity of trauma to osseous tissue and soft structures.

Management:

- Osteotomy: Valgus (abduction)
- After care: Physiotherapy.

Physiotherapy management: Exercises: Free active exercises + SWD/IRR.

Extracapsular Fractures or Trochanteric Fractures

Preface: It is defined as any fracture from the extracapsular part of the femoral neck, to a point 5 cm distal to the lesser trochanter. These fractures are becoming more common than the intracapsular fractures, as they usually occur in the oldest age (average age steadily increasing). Mostly the type of management (internal fixation and other treatment) remains the same for entire group.

Types:

- **Based on anatomy:**
  - *Intertrochanteric:* Fracture line extending from greater trochanter to lesser trochanter, along the intertrochanteric line.
    Reduction: Simple and easily maintained.
  - *Pertrochanteric (comminuted fractures):* Main fracture along the intertrochanteric line, along with multiple fractures in the cortex.
    Reduction: Difficult to achieve.
  - *Subtrochanteric:* Fracture of the trochanter extending from lesser trochanter to 5 cm distally, into the femoral shaft.
    Reduction: Difficult to achieve and maintained.
- **Based on stability:**
  - Stable: Undisplaced, non-comminuted, intertrochanteric fractures
  - Unstable fractures:
    - Displaced, comminuted, pertrochanteric
    - Subtrochanteric fracture extending into femoral neck
    - Reverse oblique fracture
    - Trochanteric fracture (comminuted) extending into femoral neck
    - Trochanteric wall (lateral) fracture.

Principles: Problem is of survival: As these fractures occur in comparatively older age, and longer period of immobilization.

- Fractures occur in the cancellous bone, thereby chances of an early union are comparatively better due to:
  - Safe blood vessels: Hence no chances of avascular necrosis
  - Adequate size of neck and head fragments: Good fixation achieved
- Non-union: Extremely rare.
- Early weight-bearing possible: Post-internal fixation
- Early mobilization: Post-internal fixation

MOI:

- Indirect violence, i.e. missing a step by an elderly patient
- Direct violence

Diagnosis: An elderly lady

- Lower limb externally rotated
- Shortening of limb
- Local tenderness
- Loss of function

Investigation: X-ray hip—AP view to confirm type of fracture

Management:

- **Conservative treatment:** For patient unwilling, or unfit for surgery:
  - Bedrest

- Traction: Fixed in Thomas splint.
- Analgesics, NSAIDs

- **Surgical treatment:**
  - Surgery: Internal fixation is treatment of choice
  - After care: Patient nursed free in bed and is up partial weight-bearing in 2–3 days.

Physiotherapy management: Post surgery (internal fixation or replacement arthroplasty active exercises of legs in lying started SAP and encouraged to move about in bed. Once patient is allowed to walk partial weight-bearing, patient is encouraged by the physiotherapist to concentrate on gaining independence with help of orthoses like crutches or frames.

Slipped Upper Femoral Epiphysis

Preface: Slipped upper femoral epiphysis (traumatic) usually occurs as a sudden epiphyseal separation; condition resembles fracture femoral neck; union often takes place in the deformed position leading to diminished neck-shaft angle, i.e. coxa vara; occurs in adolescence.

Etiology: Hormonal imbalance—Frohlich syndrome, Gigantism
History of trauma

Diagnosis:

- Adolescent, fatty, sexually immature, pain in groin or knee, limp.
- Leg—externally rotated.
- Movement (internal rotation)—painful and restricted.

Investigation:

- X-ray hip—AP and lateral views, to confirm slip especially in lateral view.
- X-ray normal hip—AP view, for comparison purpose.

Management:

- **Conservative treatment:**
  - Rest
  - Reduction
  - Immobilization: Traction
  - Analgesics and NSAIDs
- **Surgical treatment:**
  - Surgery:
    - Reduction and pinning
    - Osteotomy: For deformed late cases.

Complications:

- Avascular necrosis
- Management:
  - Preventive: Avoid forced manipulation to correct deformity
  - Surgical treatment: Osteotomy: Indicated in established cases.
  - After care: Physiotherapy.

Physiotherapy management:

- Free active exercises.
- SWD/IRR/heat pad therapy.

FRACTURES OF FEMUR AND INJURIES ABOUT KNEE

1. Fractures of femoral shaft
2. Fractures of upper third of femur
3. Supracondylar fracture of femur
4. Femoral condylar fractures
5. Fractures of patella
6. Internal derangements of knee (IDK)
   i. Injury medial collateral ligament and lateral collateral ligament
   ii. Injury medial meniscus
   iii. Injury cruciate (anterior and posterior) ligaments
   iv. Injury to infrapatellar pad of fat
   v. Fracture to tibial spine
   vi. Loose bodies.
7. Fractures lateral tibial plateau (bumper fracture)

Fractures of Femoral Shaft

Sites:

- Fractures of proximal third
- Fractures of middle third
- Fractures of distal third

MOI: Direct trauma:

- Hit by a stick
- Fall from height
- RSA
- Crush injuries
- Sports injury.

Diagnosis:

- Deformity:
  - In fractures of proximal third:
    - Proximal fragment: Flexed by iliopsoas, abducted by glutei, everted by external rotators
    - Distal fragment: Adducted by adductors, upwards by hamstrings and quadriceps, everted by weight of limb
  - In fractures of middle and distal thirds:
    - Backward angulation, shortening by quadriceps and hamstrings.
- Local tenderness
- Unnatural mobility
- Loss of function

Investigation: X-ray thigh including knee and and hip—AP and lateral views.

CBC, ESR, serum electrolytes, proteins, blood urea, blood grouping and cross-matching.

Management:

Aims of treatment: Three main aims:

- Restoration of alignment: It is essential as malalignment results in undue strain upon the knee joint, and later on development of osteoarthritis.
- Restoration of length: By prevention and correction of shortening due to contraction of powerful muscles of thigh.
- Prevention of knee stiffness: By prevention and correction.

Conservative treatment:

- Traction, and hip spica
- **Traction and countertraction:** To prevent and correct shortening
- **Fixed traction:** Traction is applied by tying the cords to the foot end of the Thomas splint, which is passed over the limb, so that padded ring of splint rests against the ischial tuberosity, which provides countertraction.

Types of traction:

- **Skin traction (Buck's):** Indicated in children and younger patients, using adhesive plaster (Fig. 1.3).
- **Gallows traction:** Indicated in children below the age of five years using strapping, and the legs are hung up by overhead pulley, so that buttocks lifted up from the bed. The child's weight acts as the countertraction (Fig. 1.4).
- **Skeletal traction:** Indicated in older patients and where heavy traction is required, using a Steinmann pin (Fig. 1.4)
- **Continuous traction (syn. balanced traction):** More comfortable and precise method. It is attached to the limb by skin or skeletal traction, which is applied to the pulleys of Bohler Brawn splint (Figs 1.5 and 1.6).

Hip spica:

- Indicated in a fretful child, and in a compound fracture
- Method: Hip spica to include:
  - From nipple line to the:
  - Injured leg—up to toes
  - Normal leg—above knee.

Surgical treatment:

- Indications:
  - Failure of closed reduction

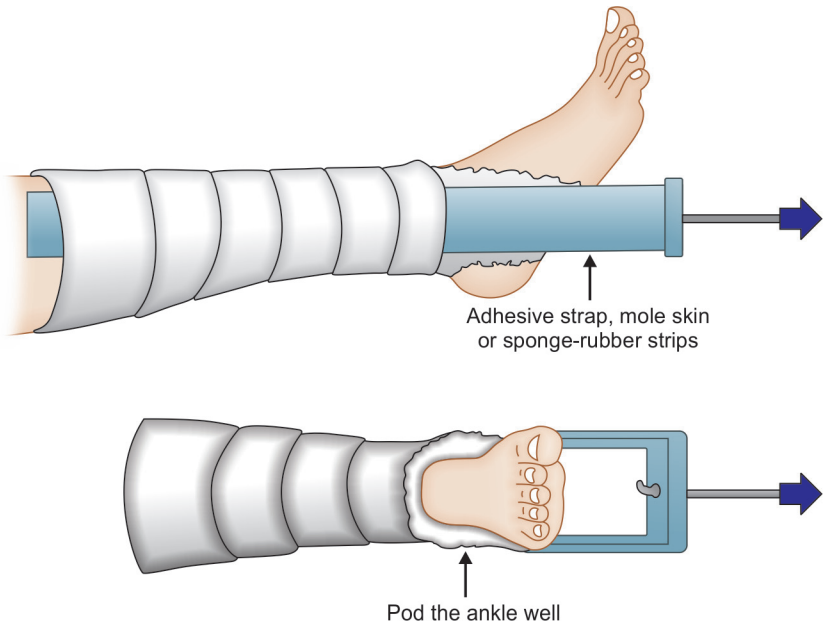

Fig. 1.3: Buck's extension traction

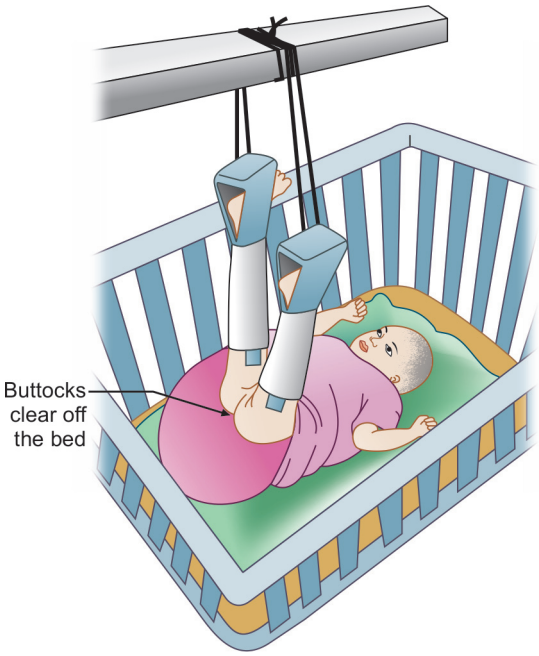

Fig. 1.4: Gallows traction

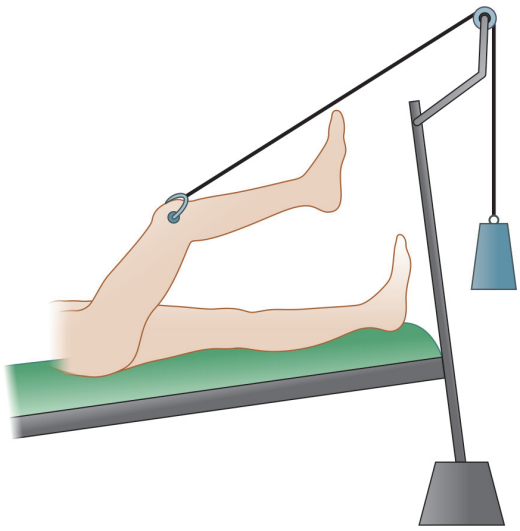

Fig. 1.5: Continuous traction with balanced suspension for fractured shaft of femur

- Multiple fractures
- Early mobilization required.

- Methods:
  - Intramedullary nailing
  - Intertlocking nailing under C-arm
  - Interlocking nailing (open) without C-arm
  - Plating and screws
  - External fixator.
- Post care: Physiotherapy.

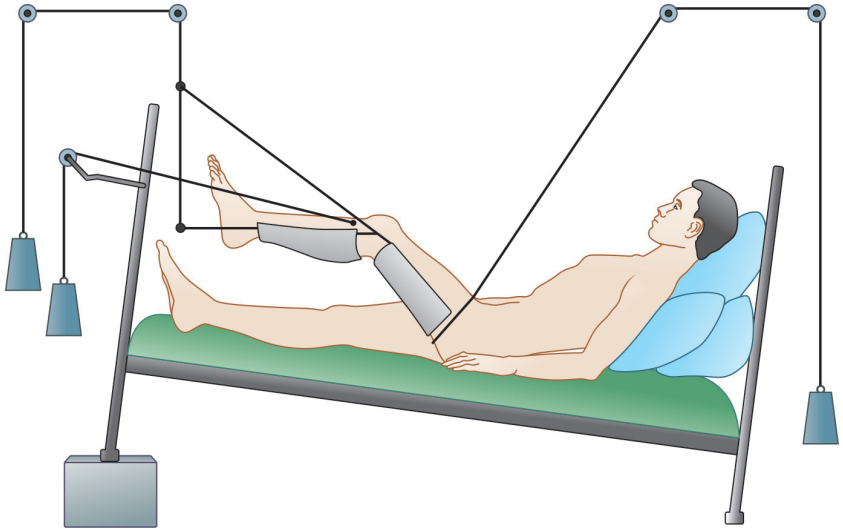

Fig. 1.6: Skin traction and skeletal traction

Complications of Fractures of Femur

- Shock (oligemic)
- Embolism (fat)
- Delayed union:
  - Management: Prolonged immobilization.
- **Non-union:** Management: Surgical treatment of choice:
  - Surgery: Intramedullary nailing and bone grafting.
- **Malunion:** Management: Surgical treatment of choice:
  - Surgery: Corrective osteotomy/osteoclasis.
- **Knee stiffness:**
  - Etiology:
    - Quadriceps tethering: Leading to adherence to fracture site.
    - Intra-articular fractures: Leading to adhesions formation or formation of a mechanical block.
    - Prolonged immobilization—especially in delayed union.
  - Management: Physiotherapy—active exercises, SWD/IRR.
- **Shortening:**
  - Management:
    - up to 2.5 cm (1") corrected by shoe modification
    - > 2.5 cm (1") corrected by surgery, i.e. osteotomy.

Physiotherapy management: During immobilization:

- Exercises: Active exercises of the toes and ankle along with static contractions for gluteal muscles. Once pain subsides, then start static quadriceps and hamstring contractions followed by knee movements.
  - With cast brace: Walking partial weight-bearing on crutches.
  - With internal fixator, mobilization occurs rapidly; walking partial weight-bearing progressed to full weight-bearing when surgeon and physiotherapist satisfied with progressive union and adequate muscle power and range of movement.
- Postoperative complications: Physiotherapist to assess for any physiotherapy requried.

Supracondylar Fracture of Femur

Preface: Supracondylar fracture of femur usually occurs either in older people whose bones are weak, or in younger people who have high energy injuries, such as from a car crash (RSA).

MOI: Direct violence
- Fall from height
- RSA
- Sports injury

Diagnosis:
- Deformity:
  - Angulation
  - Swelling
  - Local tenderness
- Movements:
  - Painful and restricted
  - Shortening.

Investigation: X-ray thigh including knee—AP and lateral views.

Management:

Conservative treatment:
- *In children*: Minimal displacement in majority of cases:
  - Closed reduction and a cylinder plaster/cast brace for 4–6/52.
  - Walking with crutches
  - Weight-bearing after formation of callus
- *In adults:* Distal fragment is angulated posteriorly by the pull of gastrocnemius.
  - Traction to the limb with knee in flexion by bending the Thomas splint at the fracture level.
- After care: Physiotherapy.

Surgical treatment:
- Surgery: ORIF
- Implant: Blade plate, nail plate, or distal femoral nail (DFN).

Physiotherapy management: For patient in traction, active movements for ankle and toes with static contractions for quadriceps and gluteal muscles to be started at earliest. When fracture becomers stable then knee movements to be started usually post 2–3/52.

Final rehabilitation depends on physiotherapist's assessment.

Fractures of Lateral Tibial Condyle (Bumper Fracture)

Preface: Bumper fracture is the commonest of all the condylar fractures caused by an abduction strain that forces the lower leg into valgus; usually associated with a downward thrust of the body weight.

MOI: Direct violence
- Fall from height
- RSA
- Sports injury.

Diagnosis:
- Swelling
- Local tenderness
- Movements of knee—painful and restricted.

Investigation: X-ray knee—AP and lateral views.

Management:
- **Conservative treatment:** Closed reduction and immobilization in a plaster cylinder for 4–6/52, followed by physiotherapy.
- **Surgical treatment:**
  - Surgery: ORIF
  - Indication: Fracture with displacement.

Physiotherapy management: Walking (partial weight-bearing) with some support like cast brace, crutches or sticks, followed by re-educate a correct gait in full weight-bearing.

Fractures of Patella

Preface: Fracture of the patella is the commonest fracture around the knee; majority of these fractures are undisplaced; prepatellar fibres remain intact and the power and mobility of the knee remains unaffected.

Pattern of fractures:
- Vertical fracture
- Transverse fracture
- Comminuted (stellate) fracture
- Avulsion fracture of upper pole
- Avulsion fracture of lower pole

MOI:
- Direct trauma
- Indirect trauma:
  - Violent contraction of the quadriceps
  - RSA
  - Sports injury.

Diagnosis:
- Vertical fracture: Swelling, local tenderness, movements—painful and restricted.
- Transverse fracture: Swelling, local tenderness, gaping between two fragments, movements—painful and restricted.
- Comminuted fracture: Mostly a compound fracture, articular surface of patella is damaged beyond repair, patella appears broader, and fragmented with grating on movement: Swelling, local tenderness, movements of knee—painful and restricted.
- Avulsion fracture of upper pole: A distinct gap between the tendon and the patella
- Avulsion fracture of lower pole: A distinct gap between the ligament and its bony attachment.

Investigation: X-ray knee—AP and lateral views.

Management:
- Vertical fracture:
  - Conservative treatment: Splintage of leg in full extension
  - Surgical treatment: Internal fixation (for irregular articular surface)

- Transverse fracture:
  - Surgical treatment: ORIF of fracture patella + repair of torn quadriceps:
- Comminuted fracture:
  - Surgical treatment: Partial patellectomy and repair of torn quadriceps
- Avulsion fracture:
  - Surgical treatment: Repair.
  - Post care: Physiotherapy.

Physiotherapy management:

- Physiotherapist to concentrate on regaining full range movement of knee, muscle power and normal gait.
- Physiotherapy: Active exercises + SWD or IRR.

Internal Derangements of Knee (IDK)

Classification: IDK includes following:

i. Injury to collateral ligaments—commonly medial
ii. Injury to meniscus or cartilage—commonly medial
iii. Cysts of lateral meniscus
iv. Injury to cruciate ligaments
v. Injury to infrapatellar pad of fat
vi. Fracture of tibial spine
vii. Loose bodies

Injury of Collateral Ligaments

Preface: Ligaments of knee joint commonly damaged are medial collateral, lateral collateral and anterior and posterior cruciates.

MOI:

- Traumatic—forced abduction to the extended leg.
- RSA
- Sports injury—especially common in footballers.

Mechanism of Injury: Medial one—commonly injured: Usually associated with injury to the medial meniscus, due to attachment of its deeper fibres to meniscus. With further continued strain, the cruciate ligament especially the anterior one may rupture.

Diagnosis: Pain, tenderness over bony attachments of the ligament, movements of knee (esp. abduction)—painful and restricted.

Investigation:

- X-ray knee—AP and lateral views, to rule out any bony lesion.
- MRI
- Arthroscopy (endoscopy)—diagnostic

Management

- **Conservative treatment:**
  - Analgesics
  - SWD/IRD, local massage
  - Elastic crepe bandage/knee cap/or brace
  - Plaster cylinder with knee flexed at 20°
  - Bedrest for 2/52.

- Surgical treatment:
  - Surgery: Repair of collateral ligament.

Physiotherapy management:

- During immobilization: Free active exercises of toes and ankle performed by the patient.
- Programme of progressive strengthening for qusdriceps and hamstrings followed by movements like stopping, starting, walking and running, performed in a circle wise.

Injury of Medial Meniscus

Preface: A *medial meniscus tear* or torn meniscus is a tear of semicircular cartilage in the knee joint causing pain on the inside of the knee.

MOI:

- Traumatic—RSA
- Sports injury—especially common in footballers.

Mechanism of Injury: The flexed knee is subjected to rotational and abduction strains. The knee momentarily opens up on the medial side, the meniscus is sucked inside and gets nipped between the condyles of femur and tibia, resulting in a tear. Repeated strains lead to a 'Bucket handle' tear.

Diagnosis: Common amongst footballers and mine workers

- Pain, tenderness over joint line—midway between patellar and medial collateral ligaments.
- History of locking of knee, followed by sudden unlocking and effusion.
- Local tenderness.
- McMurray's test: Positive (knee fully flexed, then extended with tibia rotated laterally and abducted, eliciting a 'click').

Investigation:

- X-ray knee—AP and lateral views, to rule out any bony lesion.
- MRI
- Arthroscopy (endoscopy)—diagnostic.

Management:

- **Conservative treatment:**
  - Analgesics/NSAIDs
  - Eelastic crepe bandage/knee cap/brace
  - SWD/IRD
  - Massage
  - Plaster cylinder with knee flexed at 20°
  - Bed rest for 2/52.
- **Surgical treatment:**
  - Surgery: Meniscectomy—in confirmed cases.
  - Method: Endoscopic or open surgery.
  - Postoperative: No weight-bearing for 1–2/52 in presence of effusion.

Physiotherapy management:

- Aims of physiotherapy:
  - To prevent effusion and haemarthrosis
  - To prevent muscle atrophy

- To strengthen muscles
- To teach patient how to use walking aids.

- Physiotherapy:
  - Exercises: Assisted quadriceps exercises by physiotherapist progressed to free active exercises by the patient.
  - Non-weight-bearing exercises with aid of crutches (elbow/axillary) taught by physiotherapist; progressed to hip hitching partial weight-bearing; knee flexion exercise.
  - Hydrotherapy: Post removal of stitches.

Injury to Cruciate Ligaments

Anterior Cruciate Ligament (ACL) Injury

Preface: An ACL injury is a tear or sprain of the anterior cruciate ligament (ACL) one of the major ligaments in the knee. ACL injuries most commonly occur during sports that involve sudden stops or changes in direction, jumping and landing—such as soccer, basketball, football and downhill skiing.

MOI:

- Direct violence.
- Traumatic: RSA, sports injury, fall from height.

Pathogenesis: Isolated tears are uncommon, and usually associated with tears of medial collateral ligament and/or medial meniscus.

Diagnosis: Anterior cruciate ligament (ACL)—commonly injured

- Pain, swelling, tenderness
- Movements: Abnormal forward/backward movements of tibia over femur
- Knee can be hyperextended.

Investigation:

- X-ray knee—AP and lateral views, for any bony lesion.
- MRI
- Arthroscopy (endoscopy)—diagnostic

Management:

- **Conservative treatment:**
  - Analgesics
  - Elastic crepe bandage or knee cap
  - Plaster cylinder with knee flexed at 20°, for 6/52, if anterior tibial spine is intact.
  - Bedrest for 2/52.
  - After care: Physiotherapy.
- **Surgical treatment:** Surgery:
  - ORIF (screw fixation), if anterior tibial spine is fractured.
  - Re-attach or ACL replacement (tendon of semitendinosus) is the treatment of choice, if ACL is avulsed.
  - Repair of associated tears of medial collateral ligament and medial meniscus.

Physiotherapy management:

- **Aims of physiotherapy:**
  - To prevent effusion and hemarthrosis
  - To prevent muscle atrophy

- To strengthen muscles
- To teach patient how to use walking aids.

- **Physiotherapy:**
  - Exercises: Assisted quadriceps exercises by physiotherapist progressed to free active exercises by the patient.
  - Non-weight-bearing exercises with aid of crutches (elbow/axillary) taught by physiotherapist; progressed to hip hitching partial weight-bearing; knee flexion exercise.
  - Hydrotherapy: Post removal of stitches.

Posterior Cruciate Ligament (PCL) Injury

MOI: Direct violence.

Pathogenesis: Tibia is forced backwards.

Diagnosis: Abnormal backward movement of tibia over femur.

Investigation:
- X-ray knee—AP and lateral views, for any bony lesion.
- MRI
- Arthroscopy (endoscopy)—diagnostic

Management: Same as for ACL injury.

Injury to Infrapatellar Pad of Fat

MOI: Traumatic—when hypertrophied, may be nipped in between the femur and tibia during extension of the knee.

Diagnosis: History of pain and locking of knee without being followed by sudden unlocking (e.g. medial meniscus injury).
Local tenderness over sides of ligamentum patellae.

Investigation:
- X-ray knee—AP and lateral views, for any bony lesion.
- Arthroscopy (endoscopy)—diagnostic

Management: Surgical treatment:
- Surgery: Excision of hypertrophied fat—by endoscopic surgery

Physiotherapy management: Free active exercises + SWD/IRR.

Fracture of Tibial Spine

Definition: It is a rare injury, mostly found in children.

MOI: Traumatic—RSA, sports injury.

Mechanism: Fall on the bent knee with a violent twist of tibia over the femur.

Diagnosis: Pain, swelling, tenderness, restricted extension of knee.

Investigation: X-ray knee—AP and lateral views.

Management:
- **Conservative treatment:**
  - Indication: Undisplaced fracture
  - Method:
    - Aspiration of knee
    - Elastic crepe bandage/knee cap/brace, or plaster cylinder
  - Bedrest for 2/52

- **Surgical treatment:**
  - Indication: Displaced fracture
  - Surgery: ORIF of fragment with a screw, or excision of fragment.

Physiotherapy management:
- Passive exercises: Assisted quadriceps exercises by physiotherapist progressed to free active exercises by the patient.
- Heat therapy: SWD/IRR or heat pad therapy.

Loose Bodies

MOI: Direct violence

Diagnosis: History of locking at different angles each time.

Investigation:
- X-ray knee—AP and lateral views
- Arthroscopy (endoscopy)—diagnostic

Management:
- Surgical treatment:
  - Surgery: Sugical removal—by endoscopic or by open surgery.

Physiotherapy management:
- Free active exercises
- Heat therapy: SWD/IRR.

FRACTURES OF TIBIA AND FIBULA

Preface: These are common fractures that can occur at all ages, due to direct or indirect trauma (RSA, sports injury, fall from height, hit by a rod). Direct trauma usually cause transverse, oblique or commiuted fracture with displaced fragments; rotatory force may cause spiral fractures. (Fractures of tibia and fibula may occur at different levels.)

Principles: It is vital to correct angulation deformity in fractures of this weight-bearing bone, to prevent development of osteoarthritis in ankle and knee.
- Prone to infection, as one-third of tibia is subcutaneous.
- Prone to torsional forces, causing oblique and spiral fractures as commonly seen in this bone.
- Prone to Volkmann ischemic contracture due to injury to the popliteal artery in fractures of upper third.

Fractures in Children

Types:
- Undisplaced (syn. greenstick) fractures of tibia
- Displaced fractures of tibia.

Pattern: Mostly greenstick fractures

MOI: Direct violence
- Fall from a height
- RSA
- Sports injury.

Diagnosis:
- Swelling
- Local tenderness
- Movements: Resents moving leg.

Investigation: X-ray leg including ankle and knee—AP and lateral views.

Management:

Conservative treatment:
- Undisplaced fractures of tibia:
  - Management: Plaster cast from groin to toes, with knee slightly flexed, for 4–6/52.
  - After care: Apply elastic crepe bandage for 1/52 post removal of the plaster.
- Displaced fractures of tibia:
  - Management: Closed reduction
  - Method: Traction, manipulation, and plaster cast above knee for 6/52.
  - After care: Same as for greenstick fractures.

Physiothrapy management: Passive exercises progressed to free active exercises.

Fractures of Tibial Tuberosity

Definition: Individual fractures of tibial tuberosity are rare, although it is usually involved in major fractures of the tibial head. It may be injured during its development period (evidence of apophyseal osteochondrosis).

MOI:
- Direct trauma: May separate small fragments from the apophysis.
- Indirect trauma: Violent quadriceps contraction.
- Pathogenesis: Small fragments, separated from tibial apophysis.

Diagnosis:
- Pain
- Swelling
- Disability
- D/d: Pathological fracture:
  - Paget's disease
  - Osteoclastoma.

Investigation: X-ray leg includes knee—AP and lateral views.

Management:
- **Conservative treatment:**
  - Rest
  - Analgesics, NSAIDs
  - SWD, IR therapy
- **Surgical treatment:**
  Surgery:
  - ORIF: In isolated fractures with separated tibial tuberosity.
  - Excision: Of small fragments detached from tibial epiphysis.

Physiotherapy management:
- Heat therapy: SWD/IRR or heat pad therapy.
- Exercises: Passive exercises progressed to free active exercises.

Fractures in Adults

Intra-articular Fractures

Preface: Intra-articular fractures are usually caused by direct violence on the extended knee, e.g. pedestrian suffering from a 'bumper' injury.

MOI: Direct trauma: To the extended knee (syn. bumper/compression fractures: Femoral condyle forced into the tibial condyle)

- RSA
- Fall from a height
- Sports injury: Athletics, cycling, jumps

Types:

- T-shaped vertical split in the tibial head
- Y-shaped involving both condyles, with the tail extending down into the upper end of tibial shaft.
- Inverted Y-shaped (transverse fracture of upper end of tibia, with the tail extending upward into the knee joint)

Pathogenesis: Ruptured opposite collateral ligament and capsule; ruptured cruciate ligaments (by rotational or anteroposterior forces); torn menisci in the crush injury; fractured bony fragments; hemarthrosis.

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Movements: Painful and restricted

Investigation: X-ray knee—AP and lateral views.

Management:

- **Conservative treatment:** (85% successful):
  - Aspiration and compression
  - Closed reduction (usually not possible because of intact fibula)
  - Plaster cylinder
- **Surgical treatment:**
  - Surgery: ORIF (screw or bolt)
  - After care: Immobilization (damaged articular surface) for 6/52.

Physiotherapy management:

- Exercises: Free active exercises
- Heat therapy: SWD/IRR/heat pad therapy
- Hydrotherapy.

Fractures of Upper Shaft

Preface: Extra-articular fractures of tibial head and upper shaft, often difficult to manage because of certain problems, e.g. grossly comminuted, and compound fractures.

MOI: Direct trauma:

- Hit by a stick
- Fall from a height
- RSA
- Sports injury.

Diagnosis:
- Pain
- Swelling
- Wound (open fracture)
- Local tenderness
- Movement: Painful and restricted

Investigation: X-ray leg includes knee—AP and lateral views.

Management:
- **Conservative treatment:**
  - Rest
  - Analgesic/NSAIDs
  - Antibiotics
  - Toilet of wound (open fracture)
  - Closed reduction under anesthesia
  - Immobilization: A long plaster cast from upper thigh to toes with knee flexed to 15° flexion for 8/52.
- **Surgical treatment:**
  - Surgery: ORIF.
  - After care: Immobilized leg in a long plaster cast above knee to toes for 8/52.

Physiotherapy management:
- Heat therapy: SWD/IRR or heat pad therapy.
- Exercises: Passive exercises progressed to free active exercises.

Fractures Both Bones (Tibia and Fibula) of Leg

MOI: Indirect trauma: Tibia usually fractured at junction of middle and lower thirds, while fibula at its centre.
- Torsional stresses: Fractured tibial shaft alone (# oblique or spiral)
- RSA
- Sports inuries (torsional stresses)
- Fall from a height

Pathogenesis: Compound tibial fractures usually occur (subcutaneous bone).

Diagnosis:
- Pain
- Swelling
- Local tenderness
- Wound (usually contaminated—tibial fragment penetrating skin)
- Movements: Painful and restricted.

Investigation: X-ray leg includes knee and ankle—AP and lateral views.

Management:
- **Conservative treatment:**
  - Reduction: Closed reduction
  - Immobilization: In plaster cast:
- **Surgical treatment:**
  - External fixator (Ilizarov)
  - ORIF
  - Amputation

- Indications:
  - Contaminated compound fractures
  - Ischemia of the part distal to ther septic wound
- Postoperative: Immobilization in a plaster cast or traction for 10–12/52.
- After care: Physiotherapy: Free active exercises + SWD

Physiotherapy management: During immobilization: Patient in lying position: Physiotherapist encourage toe and hip movements and static contractions of muscles round the ankle and knee. When allowed to walk allow partial or full weight-bearing with support of plaster cast, crutches or sticks.

Post removal of fixation: An intensive regimen of physiotherapy required: Initially non-weight-bearing exercises progressing to partial and full weight-bearing as per patient gaining range of movement and muscle power. Heavy manual workers require an intensive final stage rehabilitation regimen to gain full range of movements, muscle power and endurance as per their requirements (to attend special rehabilitation centre).

Fractures of Tibial Shaft without Fracture of Fibula

Definition: Are usually because of indirect trauma, and are mostly oblique or spiral.

MOI: Indirect trauma
- RSA
- Sports injuries
- Fall from a height

Diagnosis:
- Swelling
- Local tenderness
- Bone irregularity

Investigation: X-ray leg including ankle and knee—AP and lateral views.

Management:
- **Conservative treatment:**
  - Closed reduction
  - Immobilization: In a plaster cast from groin to toes for 8–10/52.
  - After care: Check X-ray, and if fracture united, then partial weight-bearing with the help of crutches for 2/52, followed by full weight-bearing.
- **Surgical treatment:** ORIF
  - External fixator (Ilizarov)
  - Post care: Immobilization in a plaster cast or traction for 10–12/52.
  - After care: Physiotherapy.

Physiotherapy management
- Exercises: Non-weight-bearing exercises progressing to partial and full weight-bearing as per gaining range of movement and muscle power.
- Rehabilitation: Intensive free active exercises.

Fractures of Distal Shaft

MOI: Direct trauma:
- Hit by a stick, iron rod, blows, kicks, torture
- RSA
- Sports injuries
- Fall from a height

Diagnosis:
- Swelling
- Local tenderness
- Bone irregularity
- Movements: Painful and restricted.

Investigation: X-ray leg includes ankle—AP and lateral views.

Management:
- **Conservative treatment:**
  - Closed reduction: Amenable to treatment
  - Immobilization: In a plaster cast for 8/52, followed by weight-bearing in a walking cast till firm union.
- **Surgical treatment:**
  - Indicsation: Failed closed reduction
  - Surgery: ORIF:
  - Method: Plate (DCP) with cortical screws proximally and cancellous screws distally.
  - Postoperative: Immobilization: In a plaster cast for 8/52.
  - After care: Physiotherapy.

Physiotherapy management:
- Free active exercises + SWD/IRR.
- Walking: Weight-bearing in a cast or brace.

INJURIES ABOUT THE ANKLE AND FOOT

Anatomy: Ankle joint is a synovial joint of the hinge variety; is a joint of great strength; its stability is provided by the strong ligaments, adjoining tendons, and by the close interlocking of the articular surfaces. The ankle joint resembles a mortise, e.g. tenon joint of a carpenter. The tenon is talus, whereas the mortise is formed by the inferior articular surface of tibia and medial and lateral malleoli. The lateral malleolus of fibula is firmly attached to the tibia by anterior and posterior tibiofibular ligaments. The ankle is firmly supported by the strong deltoid ligament on the medial side and lateral ligament on the lateral side. Ankle joint transmits more weight than any other body joint; thereby a very stable joint, with limited mobility.

Movements:
- At ankle:
  - Flexion (plantar flexion)
  - Extension (dorsiflexion
- At subtalar joint:
  - Inversion
  - Eversion
- At midtarsal joints:
  - Abduction
  - Adduction of forefoot.

Ankle Trauma

Injuries about the ankle and foot:
- Pott's fracture
- Isolated fracture malleolus

- Avulsion fracture of isolated malleolus
- Displaced medial malleolar fracture
- Fracture posterior malleolar
- Bimalleolar or trimalleolar fractures
- Fracture lower end of fibula
- Ankle sprain
- Epiphyseal injuries

Physiotherapy management:

- During immobilization: For below knee walking cast, the physiotherapist guides the patient to walk properly in the cast. For swelling, the patient is taught how to position limb while sitting or lying down and to peform active exercises of toes, knee and hip muscles while in cast.
- Post removal of fixation: Free active exercises while maintaining correct walking pattern.

Pott's Fracture

Definition: It is a fracture-dislocation of the ankle joint and requires accurate reduction and fixation; many patterns of Pott's fracture recognized, and all these differ, being caused by different types of violence; common Pott's fracture results from continuation of the same force/stress (external rotation and eversion) that causes an uncomplicated fracture of the lateral malleolus (spirally or obliquely); followed by fractured tip of the medial malleolus; then posterolateral subluxation of talus from tibia; a bone chip avulsed from the posterior surface of tibia.

MOI:

- Direct trauma
- RSA
- Sports injuries
- Fall from a height.

Classification:

A. Anatomically:
   - Type I: Fracture of one malleolus
   - Type II: Fractures of two malleoli (bimalleolar): Commonest injury
   - Type III: Fractures of three malleoli (trimalleolar): Displacement appreciable

B. Traumatic (mode of violence): External rotation and eversion fractures:
   - Fracture of lateral malleolus (oblique or spiral)
   - Fracture of medial malleolus (tip)
   - Subluxation of talus—posterolaterally causing
   - Fracture of posterior surface of tibia (third malleolus)

C. Eversion fractures (syn. abduction fractures):
   - Fracture of fibula—5–7 cm above its lower end.
   - Subluxation of talus—laterally, leading to avulsion fracture of medial malleolus.

Diagnosis:

- Pain
- Swelling: Diffuse in front of lateral malleolus; over lateral malleolus (sprain or fracture).
- Deformity: Prominent distal end of tibia (laterally displaced fracture medial malleolus); posterior displaced foot (fracture posterior malleolus).

- Disability: Difficulty in walking
- Movements: Painful and restricted

Investigation: X-ray ankle—AP and lateral views.

- Interpretation:
  - Site and slant of fracture
  - Ligament integrity for avulsion
  - Talar tilt

Management:

- **Conservative treatment:**
  - Type I:
    - Rest
    - Heat—SWD or IRR
    - Elastic crepe bandage, or adhesive plaster
      Physiotherapy: Ankle brace support in walking
    - Analgesics
  - Type II:
    - Below knee plaster cast for 4–6/52.
    - Physiotherapy: Ankle brace in walking + SWD/or IRR.
  - Type III:
    - Manipulation of ankle, followed by plaster cast for 4–6/52.
    - Physiotherapy: Ankle brace in walking + SWD/IRR.
- **Surgical treatment:**
  Surgery: Cross screwing, to avoid injury to the epiphyseal plate.
  - Type IV: Open reduction
  - Type V: Osteotomy may be required as corrective measure.
    - Physiotherapy: Ankle brace in walking + SWD/IR

Physiotherapy management:

- **During immobilization:** Initially the aim is to reduce edema by keeping the limb elevated (in lying position at hospital or home) and to perform active exercises of knee and hip. Toe movements and static contractions of muscles around ankle to be started ASAP the allows these. Patient may start non-weight-bearing exercises with crutches progressing to partial and later on full weight-bearing under supervision/guidance of physiotherapist.
- **Post removal of fixation:** Stable fractures (without displacement) hardly require physiotherapy. Displaced fractures being immobilized for longer period usually present with stiff ankle require physiotherapist assessment of range of movement of joints and power of affected muscles and thereby select the appropriate techniques for mobilizing and strengthening.

FRACTURES OF FOOT

Include:

1. Fractures of talus
2. Fractures of calcaneus
3. Fracture of fifth metatarsal
4. Fractures of metatarsals
5. Crush injuries of the foot

Physiotherapy management:

- **During immobilization:** For below knee walking cast, the physiotherapist guides the patient to walk properly in the cast. For swelling, the patient is taught how to position limb while sitting or lying down and to perform active exercises of toes, knee and hip muscles while in cast.
- **Post removal of fixation**: Free active exercises while maintaining correct walking pattern with support of ankle brace.

Fractures of Talus

Abstract: Fractures of talus create many problems pertaining to this bone, due to its wide articular surface. The vascular supply of talus is analogous to that of femoral head, i.e. talus receives its main vascular supply from a branch of dorsalis pedis artery that enters the neck (prone to trauma—fracture/fracture dislocation of proximal part of talar neck impairs blood supply—ausing avascular necrosis of talar body and arthritic changes).

Anatomy:

- The talus (astragalus) is the 2nd largest tarsal bone, that has a unique structure designed to channel and distribute body weight as it has no muscular or tendinous attachment; the talus rests on the superior surface of the calcaneus, its body hidden below the tibia, amongst the malleoli, while its anterior part ejects from underneath the tibia in an extended foot; its head rounded appears in front of lateral malleolus in an inverted foot.
- Joints of talus: Talus plays a main role in the following joints:
  - Ankle joint: Formed by the talus and the distal ends of the tibia and fibula; talus articulates by its three surfaces (superior, medial and lateral).
  - Talocalcanean joint: Gliding synovial, formed by bones (talus and calcaneus), supported by ankle's deltoid and calcaneofibular ligaments.
  - Talocalcaneonavicular joint: Ball and socket (ball is anterior talus and socket formed by anterior calcaneus, spring ligament (plantar calcaneonavicular), and navicular bone.

Fracture Neck of Talus

Preface: Fracture neck of talus is the commonest amongst fractures of the talus; the neck of talus may be shorn through by the sharp anterior border of the articular surface of the tibia; comminution is common, are often associated with injury to neighbouring bones; usually the body of talus extruded from the ankle joint by the velocity of the injury, leaving the head and neck in situ; displaced body may be palpable underneath the skin; defy all attempts at closed reduction

MOI: Direct trauma

- RSA
- Fall from a height
- Sports injuries.

Mechanism: Fracture of neck of talus occurs as a result of acute dorsiflexion and upward force resulting in shearing of talar neck by the sharp anterior border of the articular surface of the tibia:

- Type I: Fracture talar neck without any displacement.

- Type II: Continuing dorsiflexion force—resulting in fracture neck of the talus with displacement of proximal talar segment (plantar flexion) and subluxation of subtalar joint.
- Type III: Further continuation of force—resulting in thrusting of the tibia between the two talar fragments.
- Type IV: Rare type: Dislocation of talar head from the navicular bone along with Type III injury.

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Disability: Difficulty in walking
- Movements of ankle: Painful and restricted

Investigation: X-ray foot incld. ankle—AP, lateral and oblique views.

Management:

- **Conservative treatment:**
  - Closed reduction
  - Immobilization: Below knee plaster cast for 6/52.
  - Physiotherapy: SWD or IRR and active exercises of toes, knee and hip.
  - Walking in ankle brace.
- **Surgical treatment:**
  - Surgery: ORIF (K-wire)
- **Specific treatment of:**
  - Type I:
    - Below knee plaster cast for 6/52
    - Non-weight-bearing with crutches.
    - After care: Physiotherapy.
  - Type II: Closed reduction under anesthesia.
    - Method: Foot is plantar flexed and everted.
    - Immobilization: Below knee plaster cast for 8–10/52.
    - ORIF (K-wire) in case the closed reduction fails
    - After care: Physiotherapy: SWD or IRR + free exercises and walking in ankle brace.
  - Type III: Closed reduction under anesthesia
    - Immobilization: Apply below knee plaster cast for 8–10/52.
    - ORIF (K-wire) in case the closed reduction fails.
    - After care: Physiotherapy: SWD or IRR + free exercises and walking in ankle brace.
  - Type IV: ORIF is the treatment of choice.

Complications of fracture talus:

- Avascular necrosis: Leading to osteoarthritis of the ankle joint
  - Management: Arthrodesis of ankle joint.
- Pott's fracture: Malleolar fractures may complicate fracture neck of talus.
  - Management: ORIF—of malleolar fracture is treatment of choice.
- Osteoarthritis: Due to avascular necrosis or malunion.
  - Management: Arthrodesis of ankle joint is treatment of choice

Physiotherapy management:

- During immobilization: For below knee walking cast, the physiotherapist guides the patient to walk properly in the cast. For swelling, the patient is taught how to position limb while sitting or lying down and to perform active exercises of toes, knee and hip muscles while in cast.
- Post removal of fixation:
  - Free active exercises while maintaining correct walking pattern with support of ankle brace.
  - Waxbath therapy.

Fracture Body of Talus

Preface: The superior articular surface of talus may be fractured by the same mechanisms that result in compression fracturtes of the ankle; vertical splits without major disturbance of the ankle or subtalar joints may be managed as Type I talar neck fractures; any displacement commands perfect reduction and cross-screwing; for high degree of comminution (body convexity flattened; talus compressed between the tibia and the calcaneus; ankle and subtalar joints damaged) surgical reconstruction seldom possible.

MOI: Direct trauma

- RSA
- Fall from a height
- Sports injuries.

Pattern:

- Fracture of superior articular surface of the talus.
- Vertical fracture—splitting, without disturbing the ankle or subtalar joints.

Management

- **Conservative treatment:**
  - Closed reduction.
  - Immobilization: In a plaster cast from below knee to toes, for 8–10/52.
  - After care: Walking in plaster cast/ankle brace, till firm union.
- **Surgical treatment:**
  - ORIF (reduction and cross-screwing)
  - Arthrodesis.

Physiotherapy management:

- During immobilization: For below knee walking cast, the physiotherapist guides the patient to walk properly in the cast. For swelling, the patient is taught how to position limb while sitting or lying down and to perform active exercises of toes, knee and hip muscles while in cast.
- Post removal of fixation: Free active exercises while maintaining correct walking pattern with support of ankle brace.
- Waxbath therapy.

Fracture of Calcaneus (os Calcis)

Preface: The os calcaneus is usually fractured by falls from heights or by mine explosions; usually shattered like an eggshel involves the subtalar joint; degree of displacement variable as per violence (minor displacement to whole os calcis flattened and widened); tendo-Achillis pulls up the loose fragment of tuberosity and heel everted

(traumatic flat-foot); injury despite various types of management tried, causes stiff foot in the subtalar area, resulting in walking difficult on irregular surface; may experience incapacitating pain; best results achieved by accepting deformity and aiming for early mobilization.

MOI:

- Fall from a height: Common in window cleaners, construction workers.
- Impact from below: Mine explosions, below deck explosion on a boat
  - RSA
  - Sports injuries

Pathogenesis:

- Type I: Isolated, single fractures of the body, anterior end, or tuberosity, with minor/or no displacement, and without involvement of the articular surfaces.
- Typer II: Intra-articular fractures involving subtalar joint (tongue, and joint depression fractures).

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Deformity: Broadening of heel
- Movements: Inversion and eversion at the subtalar joint—painful and restricted

Investigation: X-ray foot—AP and lateral views.

Complications: Stiffness: Because of periarticular and intra-articular adhesions.

Management:

- **Conservative treatment:**
  - Type I: Isolated, single fractures (of body, anterior end, or tuberosity) without/minor displacement.
    - Treatment: Plaster cast, with early weight-bearing, with support of ankle brace.
  - Type II: Fractures without displacement, irrespective of involvement of the subtalar joint.
    - Treatment: Plaster cast, with early weight-bearing, with support of ankle brace.
- **Surgical treatment:**
  - Type I: Avulsion fracture of tuberosity with displacement:
    - Surgery: ORIF (reduction and screw fixation of fragment + tendocalcaneus insertion into calcaneus distally)
  - Type II: fractures involving subtalar joint (tongue fractures and joint depression fractures)
    - Surgery: ORIF (reduction and axial pin/screw fixation) for tongue fracture
    - After care: Immobilization: In a plaster cast for 8/52.
    - Physiotherapy: Weight-bearing after 8/52 (post radiological confirmation of union). Active exercises of ankle, toes, knee, hip.
- Arthrodesis (tripple): For permanent disability (incapacitated for work) and for avascular necrosis of fragment/s.
  - After care: Immobilization: In a plaster cast for 8/52.
  - Physiotherapy: Weight-bearing after 8/52.

Physiotherapy management:

- Aims: Reduction of edema and early mobilization.

- Management: Exercises of hip, knee followed by exercises of ankle and toes. While allowing weight-bearing, patient is subjected by physiotherapist to re-educate gait and concentrate on strengthening muscles and to regain range of movement of ankle and foot. For persisting pain, the physiotherapist advises patient on footwear and use of mol foam pads to relieve pressure on painful region.
- Waxbath therapy.

Fracture of Metatarsals

Anatomy: The metatarsus is formed by five matatarsals; set side by side behind toes; each consists of a base (posterior end), shaft, nack, and a head (anterior end).

- Joints:
  - Intermetatarsal: Bases articulate with one another;
  - Tarsometatarsal: Bases articulate with cuboid and cuneiform bones

MOI:

- Direct trauma: Crush injury, i.e. falling of heavy weight on the foot
- RSA: Vehicle wheel running over the foot
- Sports injuries
- Professionals: March fractures in soldiers, policemen, workers on strike

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Movements—painful and restricted

Investigation: X-ray foot—AP and lateral views.

Management:

- **Conservative treatment:**
  - Heat—SWD/IRD
  - Elastic crepe bandage
  - Analgesics/NSAIDs
  - Walking plaster shoe—in severe cases
- **Surgical treatment:**
  - Surgery: ORIF (open reduction and Kirschner wire fixation)
  - After care: Immobilization: In a plaster cast for 8/52.

Physiotherapy management: During immobilization:

- Swelling: Physiotherapist teaches patient how to position limb in sitting or lying down; active exercises by patient while in plaster.
- Walking plaster shoe: Physiotherapist teaches patient of walking in plaster shoe.
- Post removal of fixation: Weight-bearing exercises; ensure correct walking pattern.
- Waxbath therapy.

Fracture of Fifth Metatarsal

Preface: It is the commonest, but often overlooked fracture of the lower limb; is a minor injury that causes unnecessary disability when treated in a walking plaster.

MOI: It is an avulsion fracture of base of fifth metatarsal due to the sudden contraction of peroneus brevis muscle, as a result of inversion strain.

Diagnosis:
- Pain
- Swelling
- Local tenderness
- Disability
- Movements of adduction and abduction—painful and restricted.

Investigation: X-ray foot—AP and lateral views.

Management: Conservative treatment:
- Heat—SWD/IRR
- Elastic crepe bandage
- Analgesics/NSAIDs
- Plaster cast below knee for 3/52—in severe cases.

Physiotherapy management: During immobilization:
- Swelling: Physiotherapist teaches patient how to position limb in sitting or lying down; active exercises by patient while in plaster.
- Walking plaster shoe: Physiotherapist teaches patient of walking in plaster shoe.
- Post removal of fixation: Weight-bearing exercises; ensure correct walking pattern (walking in metatarsal support).
- Waxbath therapy.

March Fracture (syn. Fatigue Fracture)

Preface: March fracture usually occur near the necks of the second or third metatarsals; fracture occurs spontaneously, predisposed to by a short metatarsal, causing undue strain upon the heads of the sceond and third metatarsals by exertion, e.g. standing on toes; encouraged by loss of muscular tone, that is predisposed to by wearing heavy leather boots.

MOI: Repeated stress: As seen commonly in the army and the and police recruits (long marches).

Diagnosis:
- Pain: Sudden, localized over the dorsal aspect of the bone
- Local tenderness
- Disability on walking
- Movements: Painful and restricted—in severe cases.

Investigation: X-ray foot—AP and lateral views.

Management: Conservative treatment:
- Rest
- Elastic crepe bandage
- Analgesics and NSAIDs
- Plaster shoe in severe cases.

Physiotherapy management:
- Walking in metatarsal support
- Waxbath therapy.

Phalangeal Fractures

MOI: Direct trauma
- RSA

- Sports injury
- Fall of heavy weight on the foot

Diagnosis:

- Pain
- Swelling
- Disability: Difficulty in walking
- Wound

Investigation: X-ray foot—AP and lateral views.

Management:

- **Conservative treatment:**
  - Toilet of the wound
  - Débridement of wound
  - Reduction: Closed reduction
  - Immobilization of toe:
    - By adhesive strapping to adjacent toe, or
    - A walking plaster with toe platform for 4/52.
- **Surgical treatment:**
  - Surgery:
    - ORIF (open reduction and Kirschner wire fixation) of fracture

Physiotherapy management:

- Walking in foot support (orthotic full insole)
- Waxbath therapy.

Crush Injury of the Foot

MOI: Direct trauma

- RSA
- Fall of heavy weight on the foot
- Sports injuries

Diagnosis:

- Pain
- Swelling
- Local tenderness
- Wound
- Disability: Difficulty in waklling

Management:

- Conservative treatment:
  - Toilet of the wound
  - Débridement of wound
  - Dressing
  - Immobilization: With POP cast or brace for 2/12
  - Antibiotics
  - Analgesics and NSAIDs
  - After care: Physiotherapy: Exercises
- **Surgical treatment:**
  - Surgery: ORIF (open reduction and Kirschner wire fixation) of fractures
  - Postoperative: Immobilization with a POP cast for 2/12
  - After care: Physiotherapy.

Physiotherapy management:
- Heat: SWD/IRD
- Elastic crepe bandage
- Exercises

DELAYED UNION AND NON-UNION OF FRACTURES

Definition:
- Delayed union: Fracture fails to unite within specific time. There may be variations in the time taken by the bone for clinical union to occur (appx. 6–10/52) and wide differences may occu even in different bones in the same patient.
- Non-union: Fracture fails to unite, and usually being the end result of delayed union that fails to unite spontaneously by the continued fixation.

Etiology:
- General:
  - Old age, poor health, vitamin deficiency
  - Systemic diseases: Tuberculosis and syphilis.
- Local:
  - Delayed union: Fails to unite spontaneously by continued fixation
  - Inadequate fixation: Continuous movement of fragments leads to impaired bridging callus, bone ends insulated from each other by the formation of fibrous tissue, the bone rounded off and sclerosed (lower third of tibia).
  - Distraction: Excessive traction force pulls apart the bone ends, thus favours the growth of fibrous tissue that insulates the bone ends from each other.
  - Interposition of soft tissues between fragments: Interposed fasciae, ligaments, and muscles act as barrier to the callus growth across a fracture (fractures patella, olecranon, medial malleolus).
  - Infection: Acute osteomyelitis, compound fractures, may cause the delayed union, and even non-union.

Diagnosis: Un-natural mobility at fracture site, after expiry of normal union period (appx. 6/12).

Investigation: X-ray findings:
- **Delayed union:**
  - No evidence of repair
  - No callus visible
  - Ends of bone fragments well defined
  - No sclerosis
  - Generalized osteoporosis
- **Non-union:** Types:
  - Hypertroophic non-union:
    - Bony ends appear sclerotic, and are flared out so that diameter of the bone fragment at the level of fracture increased (elephant's foot)
    - Fracture line clearly visible
  - No evidence of repair
  - No callus visible
- Atrophic non-union: Bony ends are narrow, rounded, and osteoporotic; are frequently avascular.

Management:

Delayed union:

- **Conservative treatment:** As spontaneous union still possible (absent sclerosis and rounding off of bone ends):
  - To continue with the fixation.
  - Active exercises.
- **Surgical treatment:** A difficult and risky decision.
  Surgery: Phemister graft (only bone graft without internal fixation).

Non-union:

- Conservative treatment: fracture fails to unite, and usually being the end result of a few cases of delayed union, that fail to unite spontaneously by the continued fixation.
- Surgical treatment: Of choice in established non-union (clinically and radiologically).
  Surgery:
  - ORIF
    - Bone grafting (onlay; cancellous; Phemister).
    - Postoperative: POP cast/splint for 2–3/52, followed by a walking cast for 2–3/12, then a brace until firm union.
  - After care: Active exercises.

Physiotherapy management: Physiotherapy has a vital role to play in fracture non-union.

The physiotherapist manage fracture non-union by delivering progressive and guided longitudinal pressure to the fracture plane.

This procedure usually stimulates callus formation. But delayed trochanteric fracture of the femur may throw a big risk with this method without paying adequate attention to some things. That the fracture was reduced with a k-nail or screw depending on the surgeon discretion and the pattern of the fracture with some other things be equal. The physiotherapist must facilitate callus formation by partial weight-bearing, the weight is transmitted longitudinal along gravitational axis parallel to the trochanteric fracture plane. One would be doing more damage and aggravating the problem. If the fracture site is well secured with fixation, then exercise of the affected limb could make a difference. If the surgeon opts for full leg cast, a partial weight-bearing on parallel bar in a progressive manner could stimulate a dramatic improvement.

Malunion

Fracture united in an abnormal anatomical position.

Etiology: Defective reduction and fixation.

Diagnosis: Deformity: Angulation or rotational deformity resulting in cosmetic effect and impaired functioning of the limb.

- Shortening.
- Secondary osteoarthritis.

Management:

- Conservative treatment:
  - Early case: If detected earlier, e.g. before union, the angulation may be corrected by wedging of plaster cast, and manipulation under anesthesia.
- Surgical treatment:
  - In late cases, e.g. after union of fracture.

- Surgery: Correction by osteotomy.
- After care: Physiotherapy.

Physiotherapy management:

- Heat: SWD/IRD
- Elastic crepe bandage
- Exercises.

BIBLIOGRAPHY

UPPER LIMB FRACTURES

1. Charnley J. The Closed Treatment of Common Fractures. Churchill Livingstone, Edinburgh (Recently reprinted by the John Charnley Trust), 1968.
2. Einarsson F. Fracture of the upper end of the humerus. Discussion based on the follow up of 302 cass. Acta orthop. Scandinav (Supp. 32), 1958.
3. Kapoor PS. Fractures treatment: Kapoor's Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
4. Kapoor PS. Fractures treatment: Kapoor's Trauma and orthopedics, 1st edn. CBS, New Delhi, 2017.
5. King JB. Fractures—the upper limb 2, British Journal of Hospital Medicine, 1986b.
6. McRAE R, Esser M. Practical Fracture Treatment, 4th edn. Churchill Livingstone, Edinburgh, 2002.
7. Moore JR. The Closed Fracture of the Long Bones. J Bone Jt Surg. 1960;42A:869.
8. Stern PJ, Mattingly DA, Pomeroy DL, et al. Intramedullary Fixation of Humeral Shaft Fractures. Am J Bone Joint Surg. 1984;66A:639–46.
9. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, 12th edn. VPH, Mumbai, 1996.

FRACTURES ELBOW

1. Charnley J. The Closed Treatment of Common Fractures. Churchill Livingstone, Edinburgh (Recently reprinted by the John Charnley Trust), 1968.
2. Einarsson F. Fracture of the upper end of the humerus. Discussion based on the follow up of 302 cass. Acta orthop. Scandinav 1958;(Supp. 32).
3. Gilfillan C. Replacement prosthesis in shoulder injuries. Am J Surg. 1956;91:900.
4. Gille J, et al. Hook plate for medial clavicle fracture. Indian Journal of Orthopaedics, 2010;44(2):221–23.
5. Henderson RS. Fracture-dislocation of the shoulder with interposition of long head of biceps, J Bone and Joint Surg. 1952;34-B:240.
6. Kapoor PS. Fractures treatment: Kapoor's Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
7. Kapoor PS. Fractures treatment: Kapoor's Orthopedics and Trauma, 1st edn. CBS, New Delhi, 2017.
8. Lee HG. Treatment of fracturte of the clavicle by internal nail fixation; report of case, New England J Med 1946;234:222.
9. McRAE R, Esser M. Practical Fracture Treatment, 4th edn. Churchill Livingstone, Edinburgh, 2002.
10. Robinson CM, Bell KM, Court Brown CM, et al. Locked Nailing of Humeral Shaft Fractures: experience in Edinburgh over a two year period. Br J Bone Joint Surg. 1992;74B:558–62.
11. Rommens PM, Blum J, Runkel M. Retrograde Nailing of Humeral Shaft Fractures. Clin. Orthop. 350;26–39:1998.
12. Stern PJ, Mattingly DA, Pomeroy DL, et al. Intramedullary Fixation of Humeral Shaft Fractures. Am J Bone Joint Surg. 1984;66A:639–46.

13. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, 12th edn. VHB, Mumbai, 1996.
14. Throckmorton T, Kuhn JE. Fractures of the medial end of the clavicle. J Shoulder Elbow Surg 2007;16:49–54.
15. Vander Griend R, Tomasin J, Ward EF. Open Reduction and Internal Fixation of Humeral Shaft Fractures: Results using AO Plating Techniques. Am J Bone Joint Surg. 1986;68A:430–33.

FOREARM BONES INJURIES

1. Evans EM. Fractures of the Radius and Ulna. J Bone Jt Surg. 1951;33B:548.
2. Hodsworth F. Fractures of the Radius and Ulna. Modern Trends in Orthopedics. 1962;3:84.
3. Kapoor PS. Fractures treatment: Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
4. Kapoor PS. Fractures treatment: Kapoor's Orthopedics and Trauma, 1st edn. CBS, New Delhi, 2017.
5. Knight RA, Purvis GD. Fractures of Both Bones of the Forearm in Adults J Bone Jt Surg. 1949; 31A:755.
6. Moore JR. The closed Fractures of the long bones. J Bone Jt Surg. 1960;42A:869.
7. Robertson RC. Intramedullary Fixation of Fractures of the Forearm. Am J Surg. 1953;85:496.
8. Smith H, Sage FP. Internal Fixation of Fractures of the Radius and Ulna. J Bone Jt Surg. 1959; 41B:172.
9. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, 12th edn. VHB, Mumbai, 1996.

WRIST AND HAND

1. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, 12th edn. VHB, Mumbai, 1996.
2. Holdsworth F. Fractures of the Radius and Ulna. Modern Trends in Orthopaedics 1962;3:84.
3. Furlong R. Injuries of the hand. Boston, Little, Brown, and Co., 1957.
4. Kapoor PS. Fractures treatment: Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
5. Kapoor PS. Fractures treatment: Kapoor's Orthopedics and Trauma, 1st edn. CBS, New Delhi, 2017.
6. Milford L. Hand Surgery. Campbell's Operative Orthopaedics. IGAKU SHOIN Ltd. Tokyo, 1965.
7. Riordan, Daniel C. Emergency treatment of compound injury of the hand. Orthopedics 1957;1:30.

LOWER LIMB FRACTURES AND INJURIES

Fractures Pelvis and Hip

1. Addison J. Prosthetic Replacement in the Primary Treatment of Fracture of Femoral Neck. Proc. R. Soc. Med. 1959;52:908.
2. Blocky NJ, Purser DW. The treatment of Displaced Fractures of the Neck of the Femur by Compression. A Preliminary report. J Bone and Joint Surg. 1957;39-B:45.
3. Charnley J. The treatment of Fractures of the Neck of the Femur by Compression. Acta Orthop Scand. 1961;30:29.
4. Charnley J. Total Hip Replacement by Low Friction Arthroplasty. Clin Orthop. 1970;72:7–21.
5. Claffey TJ. Avascular Necrosis of the Femoral Head. An Anatomical Study. J Bone and Joint Surg. 1960;42-B:802.
6. Coleman SS, Compere CL. Femoral Neck Fractures, pathogenesis of Avascular Necrosis, Non-union, and Late Degenerative Changes. J Bone and Joint Surg. 1957;39A:1419.
7. Crawford HB. Conservative Treatment of Impacted Fracture of the Femoral Neck. A report of fifty cases. J Bone Jt Surg. 1960;42A:471.
8. Eftekhar NS. Principles of Total Hip Replacement. St. Louis Mosby, 1978.
9. Garden RS. Low-angle Fixation in Fractures of the Femoral Neck. J Bone and Joint Surg. 1961; 43B:647.
10. Kapoor PS. Fractures treatment: Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
11. Kapoor PS. Fractures treatment: Kapoor's Orthopedics and Trauma, 1st edn. CBS, New Delhi, 2017.

12. Marya SKS, Thukral R, Bawri R, Gupta R. Failed fixation: Trochanteric Fracture: Revision Hip Arthroplasty. Indian Journal of Orthopaedics. 2004;38(3).
13. Oh I, Harris WH. A cement Fixation System for Total Hip Arthroplasty Clin Orthop. 1982;164: 221–29.
14. Phemister DB. The Recognition of Dead Bone based on Pathological and X-ray studies. Ann Surg. 1920;72:466.
15. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, ed. 12th, VHB, Mumbai, 1996.
16. Trueta J. The Normal Vascular Anatomy of the Human Femoral Head during Growth. J Bone Jt Surg. 1957;35B:442.

Fractures Femur and Knee

1. ASAMI Group. Operative Principles of Ilizarov: Fracture Treatment – Nonunion, Osteomyelitis – Lengthening, Deformity correction, Williams and Wilkins, Milan, Italy, 1991.
2. Attenberg AR, Shorkey RL. Blade-plate Fixation in Non-union and in Complicated Fractures of the Supracondylar Region of the Femur. J Bone Jt Surg. 1949;31A–312.
3. Apley AG. Fracture of the Lateral Tibial Condyle Treated by Skeletal Traction and Early Mobilisation. J Bone Jt Surg. 1956;38B–699.
4. Aritomi H, Yamamoto M. A method of Arthroscopic Surgery. Clinical evaluation of Synovectomy with the Electric Resectoscope and Removal of Loose bodies in the Knee Joint, Orthopedic Clinics of North America. 1979;10:565–84.
5. Gilltes H, Seligson D. Arthrograpgy and Arthroscopy: Precision in the Diagnosis of Meniscal Lesions: A Comparison of Clinical Evaluation. J Bone and Joint Surg. 1979;61-A:343–46.
6. McGinty JB, Matza RA. Arthroscopy of the Knee: Evaluation of an out-Patient Procedure under Local Anesthesia. J Bone and Joint Surg. 1978;60-A:787–89.
7. Bohler L, Bohler J. Kuntscher's Medullary Nailing. J Bone Jt Surg. 1949;31A:295.
8. Bradford CH, Kilfoyle RM, Kellcher JJ. Fracture of the Lateral Tibial Condyle. J Bone Jt Surg. 1950;32A:39.
9. Terry S Canale, Kay Daugherty, Linda Jones. Campbell Operative Orthopaedics 9th edn. Vol I–IV. Mosby. 1998.
10. Charnley JC, Baker SL. Compression Arthrodesis of the Knee. A Clinical and Histological Study. J Bone Jt Surg. 1952;34B:187.
11. Dehne E, Immermann EW. Dislocation of Hip Combined with Fracture of Shaft of Femur on same side. J Bone Jt Surg. 1951;33-A:731.
12. Duthie HL, Hutchinson JR. The Results of Partial and Total Excision of the Patella. J Bone Jt Surg. 1958;40B:75.
13. Gilltes H, Seligson D. Arthrograpgy and Arthroscopy: Precision in the Diagnosis of Meniscal Lesions: A comparison of Clinical Evaluation, J Bone and Joint Surg. 1979;61-A:343–46.
14. Hargreaves DJ, Seedhom BB. On the 'bucket-handle' tear: Partial or total meniscectomy? A quantitative study. J Bone and Joint Surg. 1979;61-B:381.
15. McGinty JB, Matza RA. Arthroscopy of the Knee: Evaluation of an out-Patient Procedure under Local Anesthesia, J Bone and Joint Surg. 1978;60-A:787–89.
16. Hohl M, Luck JV. Fractures of the Tibial Condyle. J Bone Jt Surg. 1956;38A:1001.
17. Jackson JP, Waugh WL. Tibial Osteotomy for Osteoarthritis of the Knee. J Bone Jt Surg 1961; 43B:114.
18. Kapoor PS. Internal derangements of knee: Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
19. Kapoor PS. Internal Derangements of Knee: Kapoor's Orthopedics and Trauma, 1st edn. CBS, New Delhi, 2017.
20. Kapoor PS. Physiotherapy management of fractures: Trauma and Orthopedics, 1st edn. CBS, New Delhi, 2017.
21. Kapoor SK, et al. Expandable self-locking nail in the management of closed diaphyseal fractures of femur and tibia. Indian Journal of Orthopaedics. 2009;43(3)264–70.
22. Krettek C, Manss J, Konemann B, et al. Deformation of Femoral Nails with Intramedullary insertion. J Orthop Res. 1998;16(5):572–75.

23. Krettek C, Konemann B, Miclau T, et al. A New Technique for the Distal Locking of Solid AO Unreamed Tibial Nails. J Orthop Trauma. 1997;11(16):446–51.
24. Kulkarni GS, et al. Intertrochanteric fractures. Indian Journal of Orthopaedics. 2006;40(1): 16–23.
25. Arthroscopy of the Knee: Evaluation of an out-Patient Procedure under Local.
26. McGinty JB, Matza RA. Arthroscopy of the Knee: Evaluation of an out- Patient Procedure under Local Anesthesia, J Bone and Joint Surg. 1978;60-A:787–89.
27. Meyers MH, McKeever FM. Fracture of the Intercondylar Eminence of the Tibia. J Bone Jt Surg. 1959;41A:209.
28. O Donoghue DH. Surgical Treatment of Fresh Injuries to the Major Ligaments of the Knee. J Bone Jt Surg. 1950;32:725.
An Analysis of End-results of Surgical Treatment of Major Injuries to Ligaments of the Knee. J Bone Jt Surg. 37A, 1955
29. Palmar I. Fracture of the Upper end of the Tibia. J Bone Jt Surg. 1951;33B:160.
30. Shekhar L, Mayanger JC. A clinical study of Ender nails fixation in femoral shaft fractures in children. Indian Journal of Orthopaedics. 2006;40(1):16–23.
31. Shetty MS, Kumar A, Kanthi KG. Locking Compression Plate – LCP – A Boon in Traumatology.
32. Shorbe HB, Dobson CH. Patellectomy (Repair of Extensor Mechanism) J Bone Jt Surg. 1958;40A:1281.
33. Slee GC. Fractures of Tibial Condyles. J Bone Jt Surg. 1955;37B:427.
34. Smillie IS. Injuries of the Knee Joint. Edinburgh; Livingstone, 1951.
35. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, 12th edn. VHB, Mumbai, 1996.
36. Wilson EF. Repair of Cruciate Ligaments. J Bone Jt Surg. 1961;43B: 342.

Ankle and Foot

1. Kapoor PS. Accident and Emergency: Fractures Management. 2nd edn. CBS, New Delhi, 2016.
2. Allan JH. The open reduction of fractures of the os calcis. Ann. Surg. 1955;141:890.
3. Charnley J. Bailey and Love's Short Practice of Surgery. Injuries to bones: HK Lewis and Co. London, 1965;13:184.
4. Blair HC. Comminuted fractures and fracture dislocations of the body of the astragalaux. Am J Surg. 1943;59:37–43.
5. Blount WP. Fractures in children. Williams and Wilkins Co., Baltimore, 1954.
6. Bohler L. The Treatment of Fractures. 4th edn. Wright, Bristol 1935.
7. Breathnach AS: The skeleton of the foot. In: Frazer's Anatomy of the human skeleton. 2nd edn. pp 141–45, Churchill Livingstone, 1965.
8. Canale ST, et al. Campbell's Operative Orthopaedics, 9th edn. CV Mosby Co. Saint Louis, 1998;Vol I–IV.
9. Canale ST, Kelly FB Jr. Fractures of the neck of the talus. J Bone Joint Surg. 1980;62A:97–102.
10. Clark JMP. Modern Trends in Orthopedics Fracture Treatment, Butterworths, London, 1962.
11. Hawkins LG. Fractures of the neck of the talus. J Bone Joint Surg. 1970;52A:991–1002.
12. Jones FW. The foot. In: Structure and function as seen in the foot. 2nd edn. 68–74, Covent Garden W Co. London, 1946.
13. Kapoor PS. Pott's fracture: Accident and Emergency, 2nd edn. CBS, New Delhi, 2016.
14. Kapoor PS. Pott's Fractures: Kapoor's Orthopedics and Trauma, 1st edn. CBS, New Delhi, 2017.
15. Kleiger B. Fractures of the talus. J Bone Joint Surg. 1948;30A:735–43.
16. McMinn RMH. Bones of the foot. In: Lasst's Anatomy – Regional and Applied. 9th edn. pp 231–233, Churchill Livingstone, London, 1993.
17. McRae R. Practical Fracture Treatment. Churchill Livingstone, Edinburgh, 1984; pp 289–293.
18. Modern Trends in Orthopedics Fracture Treatment. Clark JMP. Butterworths, London, 1962.
19. Stewart MJ. Twenty five years of progress in the treatment of fractures. Am Surgeon. 1956;22:485.
20. Thomson A, Skinner A, Piercy J. Tidy's Physiotherapy, 12th edn. VHB, Mumbai, 1996.
21. Watson-Jones R. Fractures and Joint Injuries. 4th edn. Williams and Wilkins Co. Baltimore, vol. 1, 1952 and vol. 2, 1955.