1

Injuries of Upper Limb

- Clavicle fractures
- Acromioclavicular joint injuries
- Sternoclavicular joint dislocation
- Scapula fractures
- Scapulothoracic dissociation
- Proximal humerus fractures
- Humeral shaft fractures
- Intercondylar fractures
- Capitellum fractures
- Trochlea fractures (Laugier fracture)
- Glenohumeral dislocation
- Elbow dislocation
- Coronoid fractures
- Olecranon fractures
- Radial head fractures
- Monteggia fractures
- Galeazzi fractures
- Fracture of shafts of forearm
- Distal radius fractures

CLAVICLE FRACTURES

Features of clavicle:
1. First bone to ossify
2. Last ossification centre to fuse (at 22 to 25 years)
3. It is the only long bone to ossify in intramembranous ossification without a cartilaginous state
4. The clavicle is the only bone connecting the axial skeleton to the appendicular skeleton.
5. The medial third is tubular and the lateral third is flat
6. The junction of medial two thirds and lateral one third is a junction of two cross sectional configurations, hence a weak area
7. Middle third of clavicle is not supported by muscles or ligaments which again makes it susceptible to fracture

Mechanism of injury: Direct fall onto the shoulder is the most common mode of violence to produce a clavicular fracture

Clinical Features:
1. Splinting of the affected extremity with the arm held in adduction across the chest. supported by the normal extremity is common.
2. Crepitus may be felt
3. Tenting of the skin due to the proximal fragment
4. Look for evidence of associated injuries. Diminished breath sounds with hyper resonance on percussion may herald an underlying pneumothorax.
5. Look for associated neurovascular injuries

Allmann Classification

Group I: Fracture of the middle third
- Type I: Displaced secondary to a fracture medial to the coracoclavicular
- Type II A: Conoid and trapezoid attached to the distal segment
- Type IIB: Conoid torn, trapezoid attached

Group II: Fracture of the distal third
- Type I: Minimal displacement
- Type II: Displaced
- Type III: Intra-articular
- Type IV: Epiphyseal separation
- Type V: Comminuted.

X-Rays:

Middle third fractures and proximal third fractures:
- AP view and 45° caudal tilt view

Distal third fractures:
- According to Neer the following views are essential:
1. AP view of both shoulders with 10 lb weight tied to the wrists (similar to AC joint stress view)
2. Anterior 45° oblique view. This provides a true lateral view of the scapula, the distal fragment is displaced anteriorly and the proximal fragment is displaced posteriorly.
3. Posterior 45° oblique view.

CT scan:
1. May be essential in proximal third fractures to differentiate medial epiphyseal injury from sternal-clavicular joint dislocation
2. In distal third fractures it helps to rule out intraarticular involvement

Treatment:

Nonoperative Treatment
- Sling immobilisation
- Figure-of-eight bandages are commonly used.

Operative Treatment (Indications)
- Neurovascular injury
- Associated injuries
- Flail chest
- Multiple rib #
- Scapulothoracic dissociation
- Group II, type II fractures (high nonunion rate)
- Floating shoulder (clavicular # and glenoid neck #): clavicle alone is operated

Recently, relative indications for surgical treatment have been expanded to include:
1. high-energy closed fractures with >15 to 20 mm of shortening.
2. fractures with complete displacement, and
3. Fractures with comminution.

(Controlled trials are necessary to determine the outcome of these indications.

Pearls and Pitfalls- ORIF for clavicle fractures:
- 3.5mm LCDCP or Low profile reconstruction plates are ideal. Pins are not recommended because of danger of migration of pins into the thorax. Recently, a Rockwood pin is being used that doesn’t migrate.
- Plates should be precontoured to save operative time. Precontoured clavicle plates are becoming commercially available. Also are locking plates for the clavicle
- Incision is placed on the superior surface (or anterior surface) of the bone with the patient in a beach chair or semi sitting position.
- Plates are placed on the superior surface or the anterior surface
- Anteriorly placed plates are supposed to produce less complications like injury to underlying neurovascular structures (as when the plate is placed superiorly and drilled.)
- They occupy the widest part of the clavicle and hence offer better stability and are associated with less prominence
- An 8 hole plate is typically used, lag screws are used whenever possible
- Plate must be bent to the shape of an ‘S’, when viewed on edge and without bend when viewed with screw holes in plane view.
- Anterior plates require more contouring.
- A minimum of 3 screws should be placed on either side
- Screws are placed in a posterosuperior direction.
- Care should be taken while drilling, and a protective instrument should be placed to avoid injury to critical structures
- In cases of malunion/nonunion where there is shortening an intercalary bone graft may be necessary
- Malrotation may be addressed by apposing the superior flat surfaces together.

Complications
1. Malunion: Defined as union of the fracture in a shortened, angulated, or displaced position with weakness, rapid fatigability, pain with overhead activity, neurologic symptoms (numbness and paresthesia of the hand and forearm with elevation of the limb), and shoulder asymmetry.
2. Neurovascular injury (Laceration of subclavian vessels or brachial plexus)
3. Non-union. This is rare. It occurs in
   a) Group II type II fractures,
   b) Following ORIF, or
   c) Due to soft tissue interposition
   Current literature quotes a higher incidence of non-union in middle third clavicle fractures (as high as 10-15%) especially when there is a shortening more than 20mm
4. Post traumatic arthritis (in intraarticular fractures involving the medial and lateral ends)
Indications for surgery in middle third clavicle # malunion/non union after initial conservative management include (Robinson et al. JBJS 1998, 80B: 476-484):

1. Malunion or non union with shortening (>15mm)
2. Angular deformity (>30°) or translation >1cm
3. Symptoms consistent with Thoracic outlet syndrome
4. Chronic pain with repeated overhead or resisted activity
5. Pain when using shoulder straps or backpacks
6. Dissatisfaction with the appearance or asymmetry of the shoulders
7. Substantial disability detected on patient-oriented limb specific health measures

Contraindications for operative management
- Active infection in the area
- Previous soft-tissue irradiation to the operative area
- Burns over the clavicular area
- A high risk of poor patient compliance, especially due to drugs or alcohol
- An elderly patient with a sedentary lifestyle

ACROMIOCLAVICULAR JOINT INJURIES

Mechanism of Injury:
1. Direct force is the commonest cause due to fall on the shoulder with arm adducted
2. It can also occur with indirect force due to fall on the outstretched hand

Features of Acromioclavicular joint:
- Is a diarthrodal (synovial) joint
- Horizontal stability is provided by the acromioclavicular ligaments
- The AC joint has a thin capsule that is stabilized by anterior, posterior, superior, and inferior AC ligaments. Superior AC ligament is the most important of all ligaments
- A fibrocartilaginous disk of varying size and shape exists inside the joint
- Vertical stability is by the coracoclavicular ligaments
- Normal coracoclavicular distance is 1.1 to 1.3 cm

Rockwood Classification
- Type I: Sprain of the AC ligament
  Normal radiograph
- Type II: AC ligament tear, coracoclavicular ligaments sprained
  Radiograph demonstrates AC joint widening (normal AC joint distance is 1 to 3mm). Stress views show identical coracoclavicular distance compared to uninvolved side
- Type III: AC and coracoclavicular ligament torn. Radiograph demonstrates loss of AC joint relationship and increased coracoclavicular distance in stress view (25% to 100% greater than the normal side.)
- Type IV: Type III with distal clavicle displaced posteriorly into or through the trapezius
- Type V: Type III with the distal clavicle grossly displaced superiorly.
- Type VI: AC dislocated with the clavicle displaced inferior to the acromion or the coracoid.

A type VII injury has been described: It is complete dislocation of the AC and Sternooclavicular joints. It is a severe form of a type IV, with a posterior clavicle dislocation.

Clinical Features:
- As in all fractures pain, tenderness and difficulty in moving the affected part is seen.
- An apparent step-off deformity is seen at the AC joint
- There may tenting of the skin over the distal clavicle

X Rays:
- AP view of the shoulder, scapular Y view and axillary views
- Stress views of the AC joint are obtained by tying 10 to 15 lb weight to the wrists and taking an AP view. The Acromioclavicular and coracoclavicular distances are compared with the normal shoulder.
- Stryker notch view: will rule out an associated coracoid fracture. A coracoid fracture is suspected when there is an AC joint dislocation on the AP projection but the coracoclavicular distance is normal, or equal to that on the opposite, uninvolved side.
Treatment
- Type I: Sling immobilisation
- Type II: Sling immobilisation
- Type III: Inactive, non-labouring patient: - nonoperative treatment with sling.

Operative treatment in heavy labourers.
- Type IV, V, VI: Open reduction and surgical repair of coracoclavicular ligaments.
- When surgical repair is done, open reduction is performed and acromioclavicular joint is fixed with K wires or indirect fixation is achieved by coracoclavicular fixation with a Bosworth screw.
- Reconstruction of the coracoclavicular ligaments is performed by using the coracoacromial ligament as a substitute, and by the placement of a synthetic augmentation device (such as a band made of absorbable braid or ribbon, Dacron tape) between the coracoid and clavicle.

Clavicular HOOK PLATE:
- The clavicular hook plate was developed for treatment of AC joint dislocations and clavicle fractures in which the distal fragment is too small to allow conventional plate fixation.
- The plate has an offset lateral hook, designed to engage distal to the posterior aspect of the acromion.
- It has been used with some success for displaced lateral-end clavicular fractures, but there are concerns that the plate may induce shoulder stiffness and osteoarthritic of the acromioclavicular joint, and there is also a risk of skin slough and infection.
- Improper positioning of the hook may lead to inadequate fixation.
- Osteolysis has been noted around the hole for the hook as shoulder movement increases and this requires routine removal of the plate at the end of 3 months.
- The timing of plate removal is critical, as early removal may result in nonunion or refracture due to instability at the fracture site, whereas delayed removal can lead to shoulder stiffness or even fracture medial to the plate.

Advantages and disadvantages of AC joint dislocation fixation methods:

d) Intra-articular AC fixation
   Adv: Anatomic reduction
   Disadv: Hardware failure or migration, Distal clavicle osteolysis

  

  e) Extra-articular coracoclavicular repairs
   Adv: Superior strength of initial fixation (screw)
   Disadv: Screw failure, Bone resorption secondary to hardware, Does not address soft tissue injury

  

  f) Ligament reconstruction
   Adv: Anatomic repair
   No risk of metallic hardware failure or retention
   Disadv: Less initial fixation strength, Harvest coracoacromial ligament

Chronic AC joint dislocations:
Type 1: nonoperative treatment will suffice
Type 2: initial conservative, on failure surgery.
- Surgery involves distal clavicle excision combined with AC joint capsule reconstruction with CA ligament transfer
Type 3 to 6: Surgical treatment, distal clavicle excision with CA (coracoacromial) ligament transfer. The acromial attachment is detached and transferred to the resected end of clavicle.

Complications:
1. Pneumothorax and pulmonary contusion are common with type VI injuries
2. Osteolysis of distal clavicle
3. Coracoclavicular ossification (disability is minimal)
4. AC joint arthritis is treated by Weaver Dunn technique: distal clavicle excision with CA (coracoacromial) ligament transfer
5. Complications of surgery include migration of pins as far as posterior mediastinal vessels and even carotids.
6. Failure of fixation is common

Role of Arthroscopy:
- The CA ligament can be released from the acromion during routine subacromial decompression and this will facilitate AC ligament reconstruction, including transfer of the coracoclavicular ligament by decreasing the necessary size of the incision in the deltotrapezial fascia
- Wolf and Pennington described an all-arthroscopic technique of AC joint reconstruction

STERNOCLAVICULAR JOINT DISLOCATION

Features of the sternoclavicular joint:
- Is a diarthrodal joint.
- Has less stability since articular surface of the medial end of clavicle is much larger than the articular surface of the manubrium sternum.
- Is a saddle joint.
- Many sternoclavicular dislocations are truly medial clavicular physeal injuries, since the ossification of medial epiphysis appears at 20 years and fuses with the remaining at around 25-30 years.

Mechanism of Injury:
1. Direct force over the anteromedial aspect of the clavicle produces characteristically a posterior sternoclavicular dislocation
2. Indirect force, when applied from the anterolateral part to the shoulder produces an anterior sternoclavicular dislocation and when applied from the posterolateral part produces a posterior sternoclavicular dislocation

Anatomic Classification
- Anterior dislocation—more common
- Posterior dislocation

Aetiologic Classification
- Sprain
- Mild subluxation: Joint stable, ligamentous integrity maintained.
- Moderate: Subluxation, with partial ligamentous disruption.
- Severe: Unstable joint, with complete ligamentous compromise.

Clinical Features:
- Typically presents with arm supported by the opposite arm.
- Pain, tenderness over the joint will be present as in all fractures
- Head may be tilted towards the injured side
- Look for associated neurovascular injury. Posterior dislocation is an emergency because it may injure the neighbouring structures including the trachea, oesophagus and the great vessels.

X Rays:
1. AP view: Asymmetry of the clavicle is present. Look for associated pneumothorax.
2. Serendipity view: This is a 40° cephalic tilt view. If the medial clavicle projects above the interclavicular line anterior dislocation is present. If it lies below this line a posterior dislocation is present.
3. Hobbs view which is a 90° cephalocaudal view, the patient leans over the plate, and the radiographic beam is angled behind the neck
4. CT scan helps to differentiate medial physeal fractures from true dislocations

Grading: injury may be sprains or dislocation
1. Mild sprain: joint stable, ligamentous integrity maintained
2. Moderate: subluxation, with partial ligamentous disruption
3. Severe: unstable joint, with complete ligamentous compromise
4. Acute dislocation

Treatment:
- Mild sprain: Ice, sling for 3 to 4 days and a gradual return to normal activities as tolerated.
- Moderate sprain or subluxation: Ice, sling and swath, or figure-of-eight bandage for 1 week, then sling immobilisation for 4 to 6 weeks.
- Anterior dislocation: Nonoperative treatment is done with sling or reverse figure of 8 bandage. Closed reduction is advised by some surgeons
- Posterior: Prompt closed or open reduction.