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(Including Clinical Methods)

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13 Injuries Around the Shoulder, Fracture Humerus

Learning Objectives

Topics covered

- Relevant anatomy
- Fracture of the clavicle
- Fractures of the scapula
- Dislocation of the sternoclavicular joint
- Subluxation or dislocation of the acromioclavicular joint
- Dislocation of the shoulder
- Fracture of the surgical neck of the humerus
- Fracture of the greater tuberosity of the humerus
- Fracture of the shaft of the humerus

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After reading this chapter, the learner will be able to:

- Describe and discuss the aetiopathogenesis, clinical features, investigations, and principles of management of dislocation of major joints, shoulder, knee, hip **(OR1.4)**.
- Describe and discuss the mechanism of injury, clinical features, investigations and plan management of fracture of clavicle **(OR2.1)**.
- Describe and discuss the mechanism of injury, clinical features, investigations and plan management of fractures of proximal humerus **(OR2.2)**.
- Describe and discuss the mechanism of injury, clinical features, investigations and principles of management of fracture of shaft of humerus and intercondylar fracture humerus with emphasis on neurovascular deficit **(OR2.4)**.

RELEVANT ANATOMY

Shoulder girdle: It comprises of the clavicle, the scapula and the humerus. These three bones articulate with one another to give the shoulder a unique feature of freedom of movement in all directions. This maximises the reach of the hand in all directions.

The *clavicle* is the only long bone with membranous ossification. The muscles attached to its medial and lateral thirds are responsible for displacement following a fracture. Medial end of the clavicle articulates with the sternum to form the *sternoclavicular joint,* the stability of which is provided by thickened portions of the capsule. The lateral end of the clavicle articulates with the acromion process to form the *acromioclavicular joint.* The stability of this joint depends partially upon the acromioclavicular ligaments, and the more important stabilising structures, the coracoclavicular ligaments. The latter connect the conoid tubercle on the undersurface of the lateral end of clavicle to the coracoid process. This ligament has two parts—conoid and trapezoid (Fig. 13.1). These ligaments must be torn before the acromio-clavicular joint can widely displace following an injury.

The *scapula* is a flat bone, thickly covered by muscles. Such thick cover do not allow displacement of fractures of this bone. Also, because of its rich vascularity, scapular fractures usually unite.

The proximal end of the humerus consists of the head articulating with glenoid cavity of the scapula (the gleno-humeral joint or the shoulder joint proper).

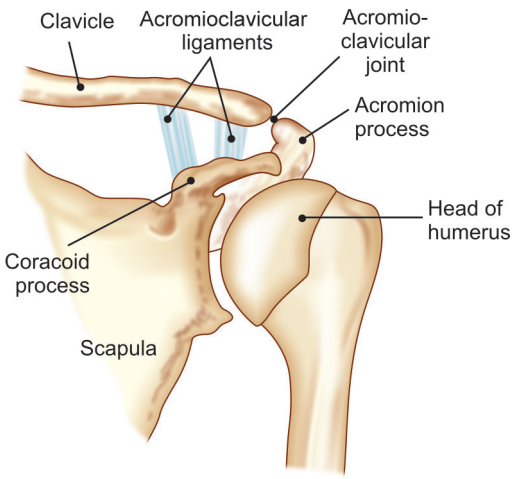


Fig. 13.1: Anatomy of the shoulder.

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The head is separated from the greater and lesser tuberosities by *anatomical neck.* The region below the tuberosities where the globular upper end of the bone joins the tubular shaft of the bone is called the *surgical neck.* Fractures are more common at the surgical than the anatomical neck.

Shoulder (glenohumeral) joint: This is a ball and socket joint, inherently unstable because the 'ball' is big and the 'socket' is small and shallow. Consequently, only about one-third of the humeral head is in contact with the glenoid cavity at any one time. The capsule of the shoulder joint is lax and permits freedom of movement. The strong muscles surrounding the joint contribute a great deal to the stability of this joint. The important among these are the *'rotator-cuff' muscles* (supraspinatus, infraspinatus, teres minor, subscapularis). The interval between subscapularis tendon and supraspinatous tendon is called *rotator interval.*

FRACTURE OF THE CLAVICLE

This is a common fracture at all age groups. It usually results from a fall on the shoulder or sometimes on an outstretched hand.

PATHOANATOMY

The junction of the middle and outer-third of the clavicle is the *most common* site; the other common site being the outer-third of the clavicle. This fracture is usually displaced. The outer fragment displaces medially and downwards because of the gravity and pull by the pectoralis major muscle attached to it (Fig. 13.2). The inner fragment displaces upwards because of the pull by the sternocleidomastoid muscle attached to it.

DIAGNOSIS

Diagnosis is simple in most cases. There is a history of trauma followed by pain, swelling, crepitus, etc., at the site of fracture. One must look for any evidence of neurovascular deficit in the distal limb. The diagnosis can be confirmed on an X-ray.

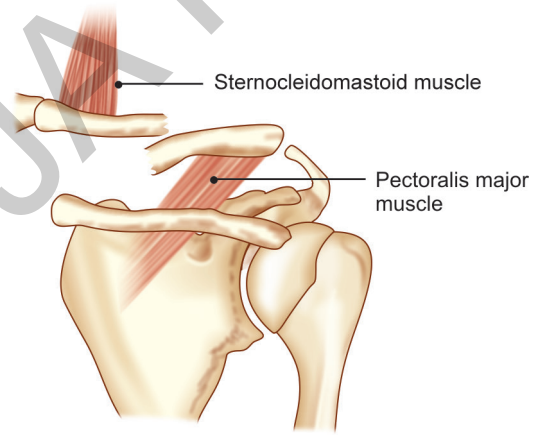


Fig. 13.2: Displacement of clavicle fracture.

TREATMENT

Fractures of the clavicle *unite readily* even if displaced, hence reduction of the fragment is not essential. A *triangular sling* is sufficient in cases with minimum displacement. Active shoulder exercises should be started as soon as the initial severe pain subsides, usually 10–14 days after the injury. A *figure-of-8 bandage* may be applied to a young adult with a displaced fracture (Fig. 13.3). It serves the purpose of immobilisation, and gives pain relief. Open reduction and internal fixation is required, either when the fracture is associated with neurovascular deficit, or in some severely displaced fractures, where it may be more of a cosmetic concern. In such cases, the fracture is fixed internally with a plate or a nail.

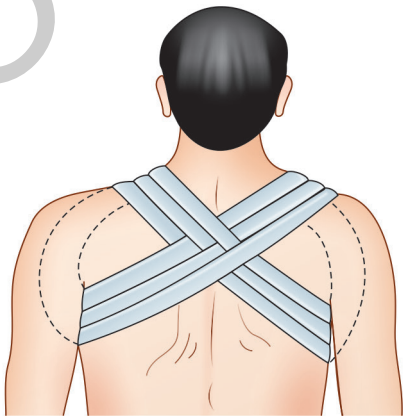


Fig. 13.3: Figure-of-8 bandage.

COMPLICATIONS

Early complications: The fractured fragment may injure the subclavian vessels or brachial plexus.

Late complications: Shoulder stiffness is a common complication, especially in elderly patients. It can be prevented by shoulder mobilisation as soon as the patient becomes pain free. Malunion and non-union (the latter being very rare) often cause no functional disability and need no treatment. Rarely, for a painful non-union of the clavicle, open reduction and internal fixation with bone grafting may be necessary.

FRACTURES OF THE SCAPULA

Fractures of the scapula are less common, and in most cases unimportant because patients recover well without much treatment. The scapula can break at

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four sites: (i) the body; (ii) the neck; (iii) the acromion process; and (iv) the coracoid process. Most often the fracture is undisplaced because the fragments are held in position by the surrounding muscles.

TREATMENT

The mainstay of treatment is to restore shoulder mobility by active exercises as soon as the pain subsides. A triangular sling for the period of pain and swelling (usually 1 week–10 days) is usually sufficient. In some severely displaced fractures, open reduction and internal fixation is done.

DISLOCATION OF THE STERNOCLAVICULAR JOINT

This is a rare injury. Here, the medial end of the clavicle is displaced forwards, or rarely backwards. Diagnosis is easier clinically than radiologically, because it is difficult to visualise this joint on X-ray, and hence CT scan is often required.

TREATMENT

This is by reduction using direct pressure over the dislocated end. Reduction is maintained by a figure-of-8 bandage. Recurrence is common, but causes no disability.

SUBLUXATION OR DISLOCATION OF THE ACROMIOCLAVICULAR JOINT

This is a common injury, caused by a fall on the outer prominence of the shoulder.

PATHOANATOMY

The injury may result in a partial or complete rupture of the acromioclavicular or coracoclavicular ligaments. Acromio-clavicular joint injuries are divided into three grades depending upon their severity (Table 13.1).

DIAGNOSIS

Pain and swelling localised to the acromioclavicular joint indicates an injury to this joint. In a Grade III injury the lateral end of the clavicle may be unusually prominent. X-ray with the acromioclavicular joints of both sides, for comparison, in the same film will show the subluxation or dislocation.

Table 13.1: Grades of acromioclavicular injury.

Grades	Pathoanatomy
Grade I	Minimal strain to acromioclavicular ligament and joint capsule
Grade II	Rupture of acromioclavicular ligament and joint capsule
Grade III	Rupture of acromioclavicular ligament, joint capsule and coracoclavicular ligaments

TREATMENT

Grades I and II injuries are treated by rest in a triangular sling and analgesics. Grade III injury in young athletic individuals is treated by surgical repair.

DISLOCATION OF THE SHOULDER

This is the *most common* joint in the human body to dislocate. It occurs more commonly in adults, and is rare in children. Anterior dislocation is much more common than posterior dislocation.

Shoulder instability: This is a broad term used for shoulder problems where head of the humerus is not stable in the glenoid. It has a wide, spectrum - from minor instability or a 'loose shoulder' to a frank dislocation. In the former, the patient may present with just pain in the shoulder, more so on using the shoulder. Pain occurs due to stretching of the capsule, as the head 'moves out' in some direction without actually dislocating. A patient with frank instability may present with an 'abnormal' movement of the head of the humerus. This could be partial movement (subluxation) which gets spontaneously reduced, or a dislocation. Once dislocated, it usually needs reduction by another person, with or without anaesthesia. The instability may be in one direction (unidirectional) or more (bidirectional). It may be instability in multiple directions - anterior, inferior, posterior, when it is called multi-directional instability (MDI). Isolated posterior instability is well-recognized, and presents with only pain.

MECHANISM

A fall on outstretched hand with the shoulder abducted and externally rotated, is the common mechanism of injury. Occasionally, it results from a direct force pushing the humerus head out of the glenoid cavity. A posterior dislocation may result from a direct blow on the front of the shoulder, driving the head backwards. More often, however, posterior dislocation is the consequence of an electric shock or an epileptiform convulsion.

PATHOANATOMY

Classification: Dislocations of the shoulder may be of the following types:

a. *Anterior dislocation:* In this injury, the head of the humerus comes out of the glenoid cavity and

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lies anteriorly. It may be further classified into three subtypes depending on the position of the dislocated head (Fig. 13.4).
- Preglenoid: The head lies in front of the glenoid.
- Subcoracoid: The head lies below the coracoid process. Most common type of dislocation.
- Subclavicular: The head lies below the clavicle.

b. *Posterior dislocation*: In this injury, the head of the humerus comes to lie posteriorly, behind the glenoid.
c. *Luxatio erecta (inferior dislocation):* This is a rare type, where the head comes to lie in the subglenoid position.

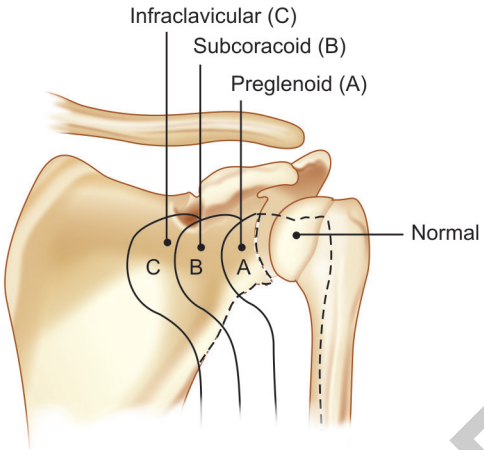


Fig. 13.4: Types of anterior dislocation of shoulder.

Pathological changes: The following pathological changes occur in the more common, anterior dislocation (Fig. 13.5):
a. *Bankart's lesion:* Dislocation causes stripping of the glenoid labrum along with the periosteum from the antero-inferior surface of the glenoid and scapular neck. The head thus comes to lie in front of the scapular neck, in the pouch thereby created. In severe injuries, it may be avulsion of a piece of bone from antero-inferior glenoid rim, called *bony Bankart lesion*.
b. *Hill-Sachs lesion:* This is a depression on the humeral head in its posterolateral quadrant, caused by impingement by the anterior edge of the glenoid on the head as it dislocates.
c. *Rounding off* of the anterior glenoid rim occurs in chronic cases as the head dislocates repeatedly over it.
d. There may be *associated injuries:* like fracture of greater tuberosity, rotator-cuff tear, chondral damage, etc.

DIAGNOSIS

Presenting complaints: The patient enters the casualty with his shoulder abducted and the elbow

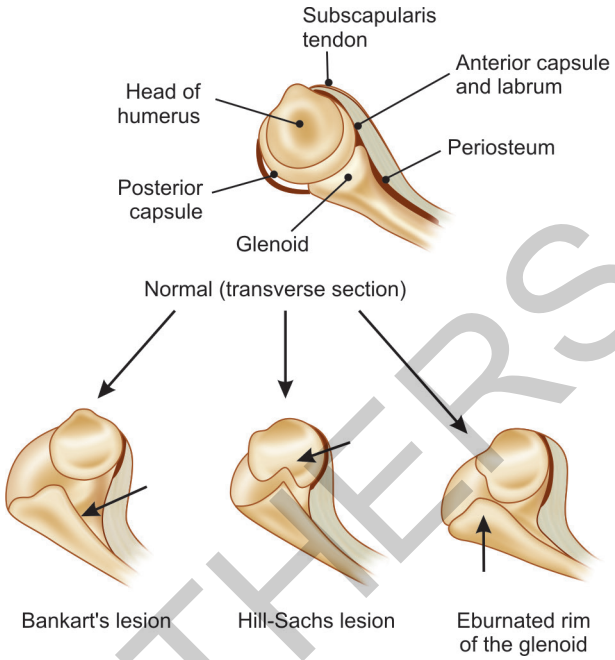


Fig. 13.5: Pathoanatomy of anterior dislocation of shoulder.

supported with opposite hand. There is a history of a fall on an outstretched hand followed by pain and inability to move the shoulder. There may be a history of similar episodes in the past.

On examination: The patient keeps his arm abducted. The normal round contour of the shoulder joint is lost, and it becomes flattened. On careful inspection, one may notice fullness below the clavicle due to the displaced head. This can be felt by rotating the arm. The following are some of the signs, associated with anterior dislocation mostly of academic significance:
- *Dugas' test:* Inability to touch the opposite shoulder.
- *Hamilton ruler test:* Because of the flattening of the shoulder, it is possible to place a ruler on the lateral side of the arm. This touches the acromion and lateral condyle of the humerus simultaneously.

The diagnosis is easily confirmed on an antero-posterior X-ray of the shoulder (Fig. 13.6). An axillary view is sometimes required.

Posterior dislocation usually occurs following a convulsion. There are few symptoms and signs.

This injury is often missed on X-ray. A clinical examination eliciting loss of external rotation, and a careful look at the X-ray may help diagnose these cases. CT scan may be diagnostic.

TREATMENT

Treatment of acute dislocation is reduction under sedation or general anaesthesia, followed by immobilisation of the shoulder in a chest-arm bandage for

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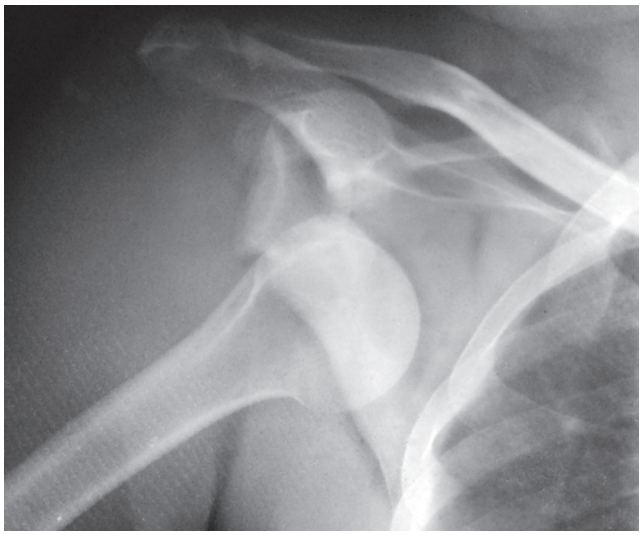


Fig. 13.6: X-ray of the shoulder, AP view, showing anterior dislocation of the shoulder.

three weeks. After the bandage is removed, shoulder exercises are begun.

TECHNIQUES OF REDUCTION OF SHOULDER DISLOCATION

Kocher's manoeuvre: This is the most commonly used method. The steps* are as follows: (i) traction - with the elbow flexed to a right angle steady traction is applied along the long axis of the humerus; (ii) external rotation - the arm is rotated externally; (iii) adduction - the externally rotated arm is adducted by carrying the elbow across the body towards the midline; and (iv) internal rotation the arm is rotated internally so that the hand falls across to the opposite shoulder.

Hippocrates manoeuvre: In this method, the surgeon applies a firm and steady pull on the semi-abducted arm. He keeps his foot in the axilla against the chest wall. The head of the humerus is levered back into position using the foot as a fulcrum.

A fracture of the greater tuberosity, often associated with an anterior dislocation usually comes back to its position as the head is reduced, and needs no special treatment.

COMPLICATIONS

Complications can be divided into early and late.

Early complications: Injury to the axillary nerve may occur resulting in paralysis of the deltoid muscle, with a small area of anaesthesia over the lateral aspect of the shoulder. The diagnosis is confirmed by asking the patient to try to abduct the shoulder. Though shoulder abduction may not be possible because of pain, one can feel the absence of contraction of the deltoid. Treatment is conservative, and the prognosis is good.

Late complications: The shoulder is the *most common* joint to undergo recurrent dislocation. This results from the following causes: (i) anatomically unstable joint, e.g., in Marfan's syndrome; (ii) inadequate healing after the first dislocation, or (iii) an epileptic patient.

Treatment: If the disability is troublesome, operation is required. The following operations may be considered:

a. *Bankart's operation:* The glenoid labrum and capsule are re-attached to the front of the glenoid rim. This is a technically demanding procedure. Special fixation devices, called anchors are used to fix the labrum to the bone.
b. *Latarjet operation:* In this operation, the coracoid process, along with its attached muscles, is osteotomized at its base and fixed to lower-half of the anterior margin of the glenoid. The bone part helps by augmenting bone loss form anterior glenoid, and the attached muscles (strap muscles) provide a dynamic sling support to the head of the humerus.
c. *Arthroscopic Bankart repair* (Fig. 13.7): With the development of arthroscopic techniques, it has become possible to stabilise a recurrently unstable shoulder arthroscopically. Apart from being a more cosmetic option, the rehabilitation after arthroscopic repair is faster and better. It is a technically demanding operation, and the anchor sutures used for repair are expensive. This technique is available only in select centres.

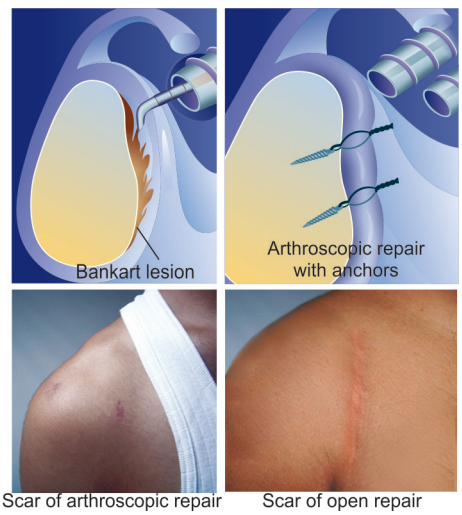


Fig. 13.7: Arthroscopic repair of shoulder dislocation.

*To remember the steps of reduction, remember TEA-I (Traction, External rotation, Adduction, Internal rotation).

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FRACTURE OF THE SURGICAL NECK OF THE HUMERUS

Fracture through the surgical neck of the humerus occurs most often in elderly women. The fracture is usually caused by a fall on the shoulder. In the majority of cases, these fractures are impacted; sometimes they are widely displaced. The possibility of this fracture should be kept in mind in all elderly persons complaining of pain in the shoulder following a fall. Often the symptoms are minimal.

It is important to properly evaluate these fractures by AP and axial X-rays. Neer has classified these fractures into 4 types depending upon the construction of the fracture. He identified 4 parts in the upper end of the humerus—shaft, head, greater tuberosity and lesser tuberosity. Depending upon in how many parts the bone has fractured, he divided them into one to four part fracture. For example, a fracture where the head, the greater tuberosity, the lesser tuberosity and the shaft, all have separated, it will be called a four-part fracture. This classification helps in deciding the treatment and prognosis.

TREATMENT

Treatment falls in the following categories:

- *Conservative treatment:* In elderly persons, even with moderate displacements, it is generally adequate to immobilise the affected shoulder in a triangular sling. As soon as the pain subsides, shoulder mobilisation is started.
- *Operative treatment:* If the fragments are widely displaced, particularly in young and active individuals, operative treatment is resorted to. It varies from minimally invasive fixation methods, to joint replacement.
- *Percutaneous pinning*: Here, once the fracture is reduced, it is held in place by passing multiple K-wires percutaneously under image intensifier control. No cut is made. It is suitable for some stable fractures, particularly in cosmetically conscious young ladies.
- *Open reduction and internal fixation*: This is used in complex fractures which are often unstable and difficult to keep in place by non-operative methods. A number of internal fixation devices have been in use—modern LCP based special plate (PHILOS), and Multiloc nail (Fig. 13.8).
- *Replacement arthroplasty* (Fig. 13.9): In badly comminuted fractures in an elderly, straightaway replacement arthroplasty is desirable. There are two types of replacement arthroplasty for comminuted fractures of proximal humerus – hemiarthroplasty (only head replaced), or reverse shoulder arthroplasty (a special implant where anatomy of the shoulder is reversed, as shown in Figure 13.9). Axillary nerve palsy and shoulder stiffness are common complications.

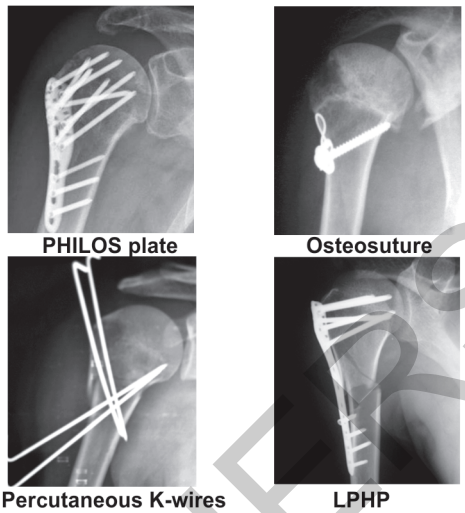


Fig. 13.8: Methods of fixation of surgical neck of the humerus.

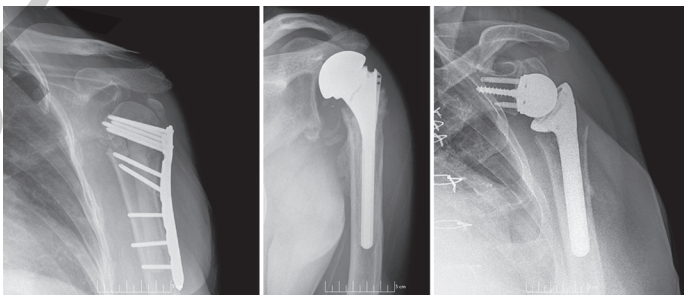


Fig. 13.9: Types of arthoplasty done for a fracture upper humerus.

FRACTURE OF THE GREATER TUBEROSITY OF THE HUMERUS

Fracture of the greater tuberosity of the humerus occurs in adults. The fracture is usually caused by a fall on the shoulder, and is undisplaced and comminuted. Sometimes, it is widely separated due to the pull by the muscle (supraspinatus) attached to it.

TREATMENT

For minimally displaced, comminuted fractures, rest in a triangular sling is enough. The shoulder is mobilised as soon as the pain subsides. For displaced fractures, open reduction and internal fixation is usually required. Painful arc syndrome (see page 304), non-union and shoulder stiffness are the usual complications.

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FRACTURE OF THE SHAFT OF THE HUMERUS

This is a common fracture in patients at any age. It is usually sustained from an indirect twisting or bending force—as may be sustained in a fall on outstretched hand or by a direct injury to the arm.

RELEVANT ANATOMY

The humerus is a typical long bone (see page 8). The upper-half of the shaft is roughly cylindrical, and begins to flatten in its lower-half in the anteroposterior direction. The deltoid muscle is inserted on the deltoid tuberosity on the antero- lateral surface of the bone just proximal to its middle-third. The posterior surface is crossed obliquely by a shallow groove for the radial nerve.

The humerus is surrounded by muscles. This has the following clinical relevance: (i) the incidence of compound fractures is low; (ii) the union of fractures occurs early because a bone so well surrounded by muscles has a rich periosteal blood supply; and (iii) some degree of malunion is masked by the thick muscle cover.

PATHOANATOMY

A humerus fracture can be considered a prototype fracture because it occurs in all patterns (transverse, oblique, spiral, comminuted, segmental, etc.), may be closed or open, and may be traumatic or pathological.

Displacements are variable. It may be an undisplaced fracture, or there may be marked angulation or overlapping of fragments. Lateral angulation is common because of the abduction of the proximal fragment by the deltoid muscle (Fig. 13.10). This angulation is further increased by the tendency of the patient to keep the limb by the side of his chest, resulting in adduction of the distal fragment. Often, distraction occurs at the fracture site because of the gravity.

DIAGNOSIS

Diagnosis is simple because the patient presents with the classic signs and symptoms of a fracture. There may be wrist drop, if the radial nerve is injured. An X-ray of the whole arm including the shoulder and elbow should be done.

TREATMENT

Most of these fractures unite easily. *Anatomical reduction is not necessary as long as the fracture is stable*. Some amount of displacement and angulation is acceptable.

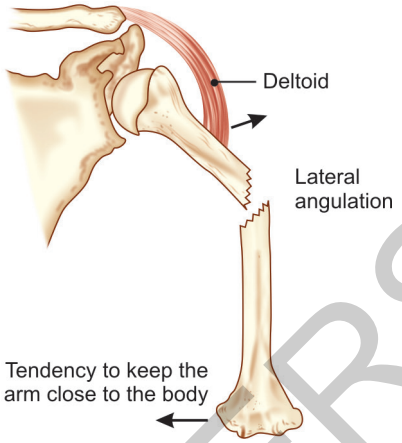


Fig. 13.10: Displacement in fracture shaft of the humerus.

This is due to the following reasons: (i) limitation of motion because of a moderate malunion in angulation or rotation goes unnoticed because of the multi-axial shoulder joint proximally; (ii) some amount of shortening goes undetected in the upper limb (unlike in the lower limb where shortening produces a limp); and (iii) the bone is covered with thick muscles so that a malunited fracture is not noticeable (unlike the tibia where malunion is easily noticeable).

Strict immobilisation is not necessary. The aim of treatment is pain relief and prevention of lateral angulation and distraction. It is possible to achieve this by conservative means in most cases.

Conservative methods: The following conservative methods are useful in most cases:

a. *U-slab* (Fig. 13.11A): This is a plaster slab extending from the base of the neck, over the shoulder onto the lateral aspect of the arm; under the elbow to the medial side of the arm. It should be molded on the lateral side of the arm in order to prevent lateral angulation. The U-slab is supported with a triangular sling. Once the fracture unites, the slab is removed (approximately 6-8 weeks) and shoulder exercises started.

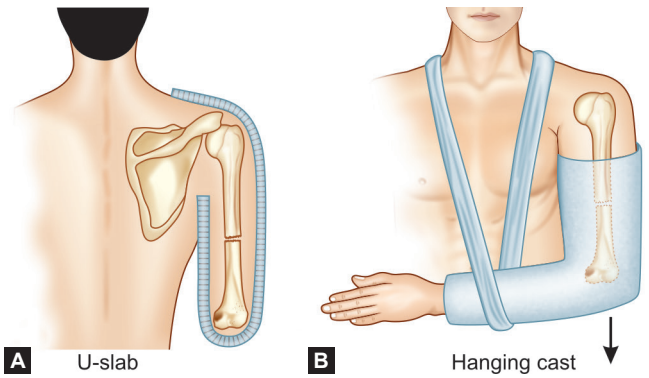


Fig. 13.11: Methods of treating fracture humerus.

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b. *Hanging cast* (Fig. 13.11B): It is used in some cases of lower-third fractures of the humerus. The weight of the limb and the cast is supposed to provide necessary traction to keep the fracture aligned.
c. *Chest-arm bandage*: The arm is strapped to the chest. This much immobilisation is sufficient for fracture of the humerus in children less than five years of age.

In adults, early mobilisation of the limb can be begun by using a cast-brace once the fracture becomes sticky.

Operative method: In cases where a reduction is not possible by closed manipulation or if the fracture is very unstable, open reduction and internal fixation is required. Most fractures can be fixed well with plate and screws. Intramedullary nailing is another method of internal fixation. Contaminated open or infected fractures are stabilised by an external fixator.

COMPLICATIONS

Nerve injury: The radial nerve is commonly injured in a fracture of the humeral shaft. The injury to the nerve is generally a neurapraxia only. It may be sustained at the time of fracture, during manipulation of the fracture or while the fracture is healing (nerve entrapment in the callus). A special type of humerus fracture, where there is a spiral fracture at the junction of the middle and distal third, is commonly known to be associated with a radial nerve palsy. This is called *Holstein Lewis fracture*. The radial nerve injury results in paralysis of the wrist, finger and thumb extensors (wrist drop), brachioradialis and the supinator. There is a sensory change in a small area on the radial side of the back of the hand.

Treatment: For cases reporting early, treatment depends on the expected type of nerve injury (for details, refer to Chapter 10). In most closed fractures, the nerve recovers spontaneously. In open fractures, exploration is usually required. In neglected cases or when repair of a divided nerve is impractical, tendon transfers are needed. Modified Jone's transfer is most popular. Here the muscles of the forearm, supplied by median and ulnar nerves, are used for substituting wrist extension, finger extension and thumb abduction-extension. The following tendons are used:

- Pronator teres → Extensor carpi radialis brevis
- Flexor carpi ulnaris → Extensor digitorum
- Palmaris longus → Extensor pollicis longus

Delayed and non-union: Fractures of the shaft of the humerus, especially transverse fracture of the midshaft, often go into delayed or non-union. The causes of non-union are: inadequate immobilisation or distraction at the fracture site because of the gravity.

Treatment: Open reduction, internal fixation with a plate, and bone grafting is usually performed. In cases where the quality of bone is poor, an intramedullary fibular graft may be used to enhance the fixation. The limb is suitably immobilised, in addition, using a U-slab or sometimes, even a shoulder spica cast.

Summary

When we see a fracture, we must find out:

- Shoulder is a group of joints—sternoclavicular, acromioclavicular, glenohumeral and scapulothoracic.
- Rotator cuff muscles are important for shoulder functions.
- Fracture of the clavicle is usually treated non-operatively.
- Anterior shoulder dislocation is a common injury. It frequently leads to recurrent dislocation.
- Treatment of humerus shaft fractures is essentially non-operative. Unstable fractures need to be operated. Non-union is treated with plating and bone grafting.

Additional information: From the entrance exams point of view

- Inferior capsule is the weakest portion of the shoulder joint.
- Tests for anterior glenohumeral instability are apprehension test, fulcrum test, crank test, Jobe's relocation test and surprise test.
- Test for posterior glenohumeral instability is jerk test.
- Sulcus test done for multi-directional and inferior instability.
- Lift off test evaluates subscapularis muscle activity.

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Highlights

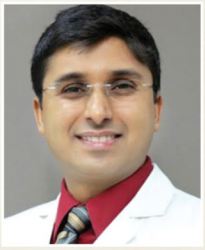
- All chapters have been thoroughly revised and updated as per the new curriculum by NMC (2024)
- Contents have been tailored to the requirement of a medical student and those preparing for PG entrance examination
- Annexures now include Review Questions, Case Scenario-based Questions, and Previous Year Questions (NEET PG and INICET) for comprehensive exam preparation
- The Annexure on 'Clinical Methods' makes it an 'all-in-one' book for medical students and residents
- The 'problem-solving approach' has been updated and uniformly appreciated by students, teachers and practising doctors
- The Annexure on 'Orthopaedic Terminology' helps to review-at-glance, the meaning of different terms used in orthopaedics
- A number of diagrams and X-rays have been replaced for better clarity and understanding
- QR codes are provided at the begining of the chapters for videos on chapter summary and examination videos (for details check list in prelims).



J Maheshwari did his MBBS and MS (Orth) from the prestigious AIIMS, New Delhi, India. He was a senior resident at Maulana Azad Medical College and associated LNJP Hospital, New Delhi. He was appointed as an Assistant Professor in the Department of Orthopaedics at AIIMS, where he subsequently became an Additional Professor.

He has had an illustrious career in the course of which, in addition to this book, he has published a number of other books on subjects related to orthopaedics. He has also published a number of papers in scientific journals. He was awarded the Commonwealth Fellowship, UK and the Johnson & Johnson Fellowship. He is an active member of orthopaedic associations at local and national levels. His expertise has been recognised worldwide, making him a sought after faculty at most national and international conferences on knee and shoulder surgery. He has a vast experience of teaching undergraduates, postgraduates and paramedical staff.

He is a stalwart in the field of knee and shoulder surgery, and is currently in private practice at New Delhi. He was earlier Head of the Department at Max Super Speciality Hospital, Saket, New Delhi. He is currently Director of Sports Injury Management Institute (SIMI) at Sitaram Bhartia Institute of Science and Research, New Delhi.



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