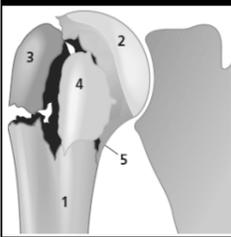


Fractures of Proximal Humerus



Parts of fracture :
 1 → shaft of humerus
 2 → head of humerus
 3 → greater tuberosity
 4 → lesser tuberosity

A part is displaced if
 >1cm of displacement
 or >45 degree of angulation

Fractures of the proximal humerus usually occur after middle age & most of the patients are osteoporotic, postmenopausal women.

Mechanism of injury:
 - Fracture usually follows a fall on the out-stretched arm (The type of injury which, in younger people, might cause dislocation of the shoulder)
 - Sometimes, a fracture-dislocation occurs.

Treatment

Neer's classification It distinguishes between the number of displaced fragments

One-part fracture: the fragments are undisplaced

- Immobilization:** Arm in a sling (for a week or two) until the pain subsides,
- Rehabilitation:**
 - Gentle passive movements of the shoulder. - Once the fracture has united (usually after 6 weeks), active exercises.

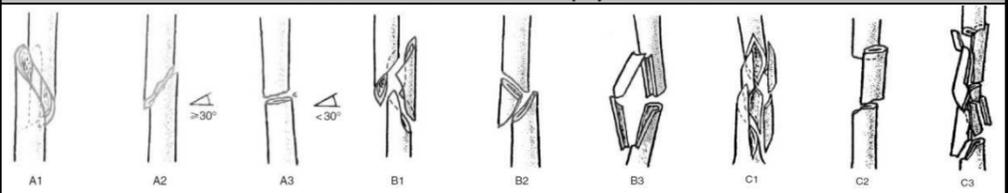
Two-part fracture: one segment is separated from the others (The neck fracture is displaced)

Surgical neck fractures	Greater tuberosity fractures	Anatomical neck fractures
<p>A) Conservative</p> <p>1- Closed Reduction: The fragments are gently manipulated into alignment</p> <p>2- Immobilization: in a sling for about four weeks or until the fracture feels stable</p> <p>3- Rehabilitation: Elbow & hand exercises.</p> <p>B) Surgical:</p> <p>Indication: 1- the fracture cannot be reduced closed 2- fracture is unstable after closed reduction</p> <p>Fixation options: percutaneous pins, bone sutures, locked intramedullary nail, plate fixation</p>	<p>Fracture of the greater tuberosity is often associated with anterior dislocation.</p> <p>A) Conservative: If shoulder is relocated → it reduces to a good position</p> <p>B) Surgical: If it does not reduce, the fragment can be re-attached through: - a small incision with interosseous sutures - in young hard bone, cancellous screws.</p>	<p>In young patients: the fracture should be fixed with a screw.</p> <p>In older patients: hemiarthroplasty is preferable because of the high risk of avascular necrosis of the humeral head.</p>

Three-part fracture: two fragments are displaced, (In addition to neck fracture, one tuberosity is fractured & displaced)	four-part fracture: all the major parts are displaced (In addition to neck fracture, both tuberosities are fractured & displaced)
Usually involve displacement of the surgical neck and the greater tuberosity. TTT → ORIF with plate & screws.	Carries risks of incomplete reduction, nonunion & avascular necrosis of the humeral head. In young patients → an attempt should be made at reconstruction. In older patients → Hemiarthroplasty .

Fractures of the Shaft of Humerus

AO Classification of Humeral Diaphyseal Fractures



Type A: Simple fracture

- A1: Spiral
- A2: Oblique (>30°)
- A3: Transverse (<30°)

Type B: Wedge fracture Type

- B1: Spiral wedge
- B2: Bending wedge
- B3: Fragmented wedge

C: Complex fracture

- C1: Spiral
- C2: Segmented
- C3: Irregular (significant comminution)

Mechanism of injury:

- A fall on the hand → may twist the humerus, causing a spiral fracture.
- A fall on the elbow with the arm abducted → exerts a bending force, resulting in an oblique or transverse fracture
- A direct blow to the arm → causes a fracture which is either transverse or comminuted.
- Fracture of the shaft in an elderly patient may be due to a metastasis. (pathological)

Conservative

- Fractures of the humerus heal readily.
- They require neither perfect reduction nor immobilization, the weight of the arm with an external cast is enough to pull the fragments into alignment.

In Oblique & Spiral fractures :

- **A hanging cast**, is applied from shoulder to wrist with the elbow flexed 90 degrees, and the forearm section is suspended by a sling around the patient's neck.
- **Rehabilitation:**
 - Pendulum exercises of the shoulder are begun within a week,
 - Active abduction is postponed until the fracture has united (about 6 weeks for spiral fractures.
 - The wrist and fingers are exercised from start.

In transverse fractures :

- **Coaptation splint**, for 7-10 days followed by → Functional brace.
- **U-shaped slab.**
- **Cast**

Surgical

Open reduction and internal fixation (ORIF)

Indications for surgery:

- severe multiple injuries.
- an open fracture.
- segmental fractures.
- displaced intra-articular extension of the fracture
- pathological fracture.
- floating elbow (simultaneous unstable humeral and forearm fractures).
- radial nerve palsy after manipulation.
- non-union.

Fixation can be achieved with :

- Compression plate and screws.
- Interlocking intramedullary nail .
- External fixator

External fixation may be the best option for high energy segmental fractures and open fractures.

Fractures of The Distal Humerus in Children

A) Supracondylar fractures (These are among the commonest fractures in children)

The distal fragment may be displaced either posteriorly (extension type) or anteriorly (flexion type)

Posterior angulation or displacement	Anterior angulation or displacement
95% commonest	5% rare
Suggests a hyperextension injury, usually due to : fall on the outstretched hand. The humerus breaks just above the condyles.	Due to direct violence (e.g. a fall on the point of the elbow) with the joint in flexion.
Distal fragment is : - Displaced posteriorly by triceps - Twisted inward, because forearm is usually in pronation.	Distal fragment is : - displaced anteriorly by biceps or brachialis.
Proximal fragment : - Pokes into the soft tissues anteriorly, - sometimes injuring the : brachial artery or median nerve.	

Classification



X-rays showing supracondylar fractures of increasing severity.
 (a) Undisplaced. (b) Distal fragment posteriorly angulated but in contact. (c) Distal fragment completely separated and displaced posteriorly.
 (d) A rarer variety with anterior angulation.

- Type I :** is an undisplaced fracture.
- Type II :** is an angulated fracture with the posterior cortex still in continuity.
IIA – less severe injury with the distal fragment merely angulated.
IIB – severe injury; the fragment is both angulated & malrotated.
- Type III** is a completely displaced fracture (although the posterior periosteum is usually still preserved, which will assist surgical reduction).

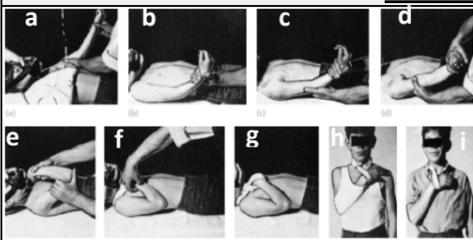
X-ray	Clinical Features
<p>A) Seen most clearly in the lateral view : In an undisplaced fracture: - The 'fat pad sign' should raise suspicions: there is a triangular lucency in front of the distal humerus, due to the fat pad being pushed forwards by a haematoma.</p> <p>In the posteriorly displaced fracture : - The fracture line runs obliquely downwards and forwards and - The distal fragment is tilted backwards and/or shifted backwards.</p> <p>B) An anteroposterior view : - It may show that the distal fragment is shifted or tilted sideways, and rotated (usually medially). - Measurement of Baumann's angle is useful in assessing the degree of medial angulation before and after reduction.</p>	<p>History: Following a fall</p> <p>Symptoms:</p> <ul style="list-style-type: none"> - pain & elbow is swollen. - with a posteriorly displaced fracture the S-shape deformity of the elbow is usually obvious - bony landmarks are abnormal. - passive extension of the flexor muscles should be pain-free. - Neuro-Vascular evaluation especially for: <ul style="list-style-type: none"> • Brachial artery → risk of acute ischemia • Median nerve → injury

Treatment

1- Undisplaced fractures

The elbow is immobilized at 90 degrees in a cast, and arm is supported in a sling.

2- Posteriorly angulated & displaced fractures (Closed reduction & fixation)



In post. displaced fractures :
Fracture is reduced by the method described & then held with **percutaneous crossed K-wires**. (post operative is the same as angulated)

3- Ant. Displaced fractures
The fracture is reduced by : pulling on the forearm with the elbow semi-flexed, applying thumb pressure over the front of the distal fragment and then extend the elbow fully. → Then, **posterior slab** is bandaged for 3 weeks.

The fracture can be reduced under general anaesthesia by the following manoeuvre:
(a) The uninjured arm is examined first
(b) Traction for 2-3 minutes in the length of the arm with counter-traction above the elbow;
(c) correction of any sideways tilt or shift (d) correction of rotation (both corrections in comparison with the other arm);
(e) Correction of posterior tilt : gradual flexion of the elbow to 120 degrees, and pronation of the forearm, while maintaining traction and exerting finger pressure behind the distal fragment to correct posterior tilt.
(f) Then feel the pulse and check the capillary return - if the distal circulation is suspect, immediately relax the amount of elbow flexion until it improves.
 Elbow is kept well flexed while x-ray films are taken:
 - confirm reduction,
 - checking carefully to see that there is no varus or valgus angulation and no rotational deformity
 • If the acutely flexed position cannot be maintained without disturbing the circulation, or if the reduction is unstable, (and most of these fractures are unstable) → the fracture should be fixed with **percutaneous crossed K-wires**.
(g,h,i) Following reduction, - the arm is held in a collar & cuff,
 - the circulation should be checked repeatedly during the first 24 hours
 - An x-ray is obtained after 3-5 days to confirm that the fracture has not slipped.
 - The splint is retained for 3 weeks, after which movements are begun.

Fractures of The Distal Humerus in Adults

Mechanism of injury: Fractures around the elbow in adults – especially those of the distal humerus – are often high-energy injuries which are associated with vascular and nerve damage.

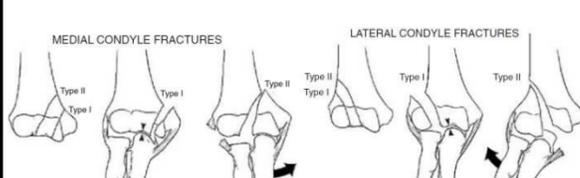
The AO-ASIF Group have defined three types of distal humeral fracture:

Extra-articular	Type A – Supracondylar fracture.
	<ul style="list-style-type: none"> - Supracondylar fractures are rare in adults. - When they do occur, they are usually displaced and unstable or comminuted (high energy injuries). <p>Treatment: ORIF is the treatment of choice → A simple transverse or oblique fracture, fixed with plates & screws. A comminuted fractures, fixed with double plates & transfixing screws</p>
Intra-articular	Type B – Unicondylar fracture / Type C – Bicondylar fractures with varying degrees of comminution.

Milch Classification

Two types for medial & lateral; the key is the lateral trochlear ridge :

- Type I:** Lateral trochlear ridge is left intact.
- Type II:** Lateral trochlear ridge is part of the condylar fragment (medial or lateral).



Except in osteoporotic individuals, intra-articular condylar fractures should be regarded as **high-energy injuries** with soft-tissue damage. (do → N.V. evaluation)

Mechanism of injury :

- A severe blow on the point of the elbow drives the olecranon process upwards, splitting the condyles apart.

X-Ray:

- The fracture extends from the lower humerus into the elbow joint
- There is often also comminution of the bone between the condyles.
- Sometimes the fracture extends into the metaphysis as a T- or Yshaped break, or else there may be multiple fragments (comminution) .

Treatment

1- Undisplaced fractures:

- Conservative :**
- **Posterior slab** with the elbow flexed almost 90 degrees
 - Movements are commenced after 2 weeks (N.B → movement after obtaining x-ray to exclude late displacement).

2- Displaced

Surgical: ORIF, through is the treatment of choice.

Procedure :

- Good exposure obtained by performing an **intra-articular olecranon osteotomy**.
- The **ulnar nerve** should be identified and protected throughout.
- The fragments are reduced and held temporarily with **K-wires**.
 - **Unicondylar fracture :**
 - If without comminution → can be fixed with screws.
 - If the fragment is large → a **contoured plate** is added to prevent re-displacement.
 - **Bicondylar fractures and comminuted fractures**
 - **double plates & screws fixation**, may with bone grafts in gap
- Postoperatively :**
 - Immobilization → the elbow is held at 90 degrees with the arm supported in a sling.
 - Rehabilitation → Movement is encouraged but should never be forced.
 - Fracture healing usually occurs by 12 weeks.



B) Fracture- separation of lateral condyle

- The child falls with elbow stressed in varus,
 - a large fragment including the lateral condyle can be avulsed by the attached wrist extensors.
 - **Undisplaced fractures** → splinting the elbow for 2 weeks, then exercise
 - **Displaced fractures :**
 - Closed reduction by manipulation
- If fails, **ORIF** with : a screw or K wires for 3-4 weeks, in cast .

C) Separation of medial epicondylary apophysis

- If the wrist is forced into extension, the medial epicondylar apophysis is avulsed by the attached wrist flexors;
- If the elbow opens up on that side, the epicondylar fragment may be pulled into the joint.
- **Minor displacement** → Splinting the elbow for 2 weeks
- **Markedly displaced** → Sutured back in position
- **If it's trapped :**
 - Manipulation with elbow in valgus and the wrist hyperextended (to pull the flexor muscles)
 - If fails, joint is opened and fragment retrieved.

D) Fracture-separation of the entire distal humeral epiphysis

- Occurs with severe violence, such as a birth injury or child abuse
- The injury is treated like a supracondylar fracture
- If diagnosis uncertain, elbow is splinted in flexion for 2 weeks.

Fractures around elbow – Fractures of forearm

Fracture	Mechanism of injury	Treatment	
		Conservative	Surgical
Elbow dislocation	<p>1- Post. or posto-laterally (90%):</p> <ul style="list-style-type: none"> - Fall on outstretched hand while elbow in mild flexion. <p>2- Ant. Dislocation :</p> <ul style="list-style-type: none"> - Direct trauma to elbow - Ulna migrates forward with associated fracture of olecranon (fracture dislocation) 	<p>Uncomplicated dislocation :</p> <p style="text-align: center;">Closed reduction (manipulation)</p> <ul style="list-style-type: none"> - Patient fully relaxed under anaesthesia. - Pulls on the forearm while the elbow is slightly flexed - With one hand, sideways displacement is corrected → then the elbow is further flexed while the olecranon process is pushed forward. - X-ray → confirms the reduction 	<p>Fracture- dislocation :</p> <p>Associated fractures of humeral condyles or epicondyles or the olecranon process, need:</p> <p style="text-align: center;">Internal fixation</p>
Pulled elbow	<p>In young children :</p> <p>The elbow is some times injured by a sharp tug on the wrist</p>	<p>What has happened is that the radius has been pulled distally and the orbicular ligament has slipped up over the head of radius.</p> <p>ITT:</p> <p>Forcefully supinating and then flexing the elbow; the ligament slips back with a snap.</p>	
Head of the radius	<p>1- <u>A fall on the outstretched hand with the elbow extended</u> and the forearm pronated causes impaction of the radial head against the capitulum.</p> <p>2- Sometimes fractured during elbow dislocation.</p>	<p>An undisplaced split (Type I):</p> <ul style="list-style-type: none"> - Pain relief by aspirating the haematoma and injecting local anaesthetic. - The arm is held in a collar and cuff for 3 weeks. - active flexion, extension and rotation are encouraged. 	<p>A single large fragment (Type II):</p> <p>If displaced → ORIF with small headless screws.</p> <p>A comminuted fracture (Type III) :</p> <ol style="list-style-type: none"> 1- Radial head excision , or 2- Reconstruction of radial head , <ul style="list-style-type: none"> - If associated with forearm injuries - If disruption of distal radio-ulnar joint. - associated soft tissue injury: <ul style="list-style-type: none"> <i>Rupture of the medial collateral ligament.</i> <i>Rupture of the interosseous membrane</i>
Olecranon process	<p>Two broad types of injury are seen:</p> <p>(1) a comminuted fracture: due to a direct blow or a fall on elbow.</p> <p>(2) a transverse fracture : due to traction when the patient falls onto the hand while the triceps muscle is contracted.</p>	<p><i>A comminuted fracture</i> , with intact triceps :</p> <ul style="list-style-type: none"> - The arm is rested in a sling for a week - x-ray is to ensure that there is no displacement - then exercises are begun. <p><i>An undisplaced transverse fracture</i> , that does not separate when the elbow is x-rayed in flexion :</p> <ul style="list-style-type: none"> - The elbow is immobilized by a cast in about 60 degrees of flexion for 2-3 weeks - then exercises are begun. 	<p><i>Displaced transverse fractures :</i></p> <p>Reduction & Fixation by :</p> <ol style="list-style-type: none"> 1- tension band wiring. 2- If fails → rigid internal fixation & bone grafting. <p><i>Displaced comminuted fractures :</i></p> <p style="text-align: center;">Rigid internal fixation and bone grafting</p> <p><i>In the osteoporotic bone of elderly patients:</i> good results can be achieved with : excision of fragments & re-attachment of triceps to ulna.</p>
Fracture radius & Ulna	<ul style="list-style-type: none"> - A twisting force (usually a fall on the hand) produces → a spiral fracture with the bones broken at different levels. - An angulating force causes a transverse fracture of both bones at the same level. - Rotation deformity & displacement may be produced by the pull of muscles attached to the radius: <i>they are the biceps & supinator muscles to the upper third, the pronator teres to the middle third, and the pronator quadratus to the lower third.</i> 	<p style="text-align: center;">CHILDREN</p> <p>A) Conservative : Closed reduction + Full-length cast</p> <ol style="list-style-type: none"> 1- Reduction : <ul style="list-style-type: none"> - In children, closed reduction ,because tough periosteum 2- Immobilization : <ul style="list-style-type: none"> - Full-length cast, from axilla to metacarpal shafts (to control rotation). - The cast is applied with the elbow at 90 degrees. <ul style="list-style-type: none"> • If the fracture is proximal to pronator teres, forearm is supinated; • if it is distal to pronator teres, then the forearm is held in neutral. - The position is checked by x-ray after a week, if it is satisfactory → splintage is retained until both fractures are united (usually 6-8 weeks). 3- Rehabilitation : <ul style="list-style-type: none"> - shoulder exercises are encouraged. <p>B) Operation : indicated if :</p> <ul style="list-style-type: none"> - the fracture cannot be reduced or unstable. <p>Fixation with :</p> <ol style="list-style-type: none"> 1- intramedullary nails is preferred, 2- plate & screws or 3- K-wire fixation can be used. 	<p style="text-align: center;">ADULTS → ORIF</p> <p>Unless the fragments are in close apposition, reduction is difficult and re-displacement in the cast almost invariable. So preferred line is → open reduction and internal fixation</p> <ol style="list-style-type: none"> 1- Reduction : Open reduction 2- Fixation : Internal fixation with plates and screws. 3- Healing: <ul style="list-style-type: none"> - Bone grafting → if there is comminution. - Deep fascia is left open to prevent a build-up of pressure in the muscle compartments, and only the skin is sutured. 4- Rehabilitation <ul style="list-style-type: none"> - After Operation the arm is kept elevated until the swelling subsides, - During this period active exercises of the hand encouraged. - It takes 8-12 weeks for the bones to unite.
Fractures of single forearm bone	<p>Fracture of the radius alone is very rare and Fracture of the ulna alone is uncommon.</p> <p>They are important for :</p> <p>An associated dislocation may be undiagnosed, if only one forearm bone is broken along its shaft and there is displacement and deformity or shortening of one bone , here either:</p> <ul style="list-style-type: none"> • Proximal radio-ulnar joint dislocation or • Distal radio-ulnar joint must be dislocated. 	<p style="text-align: center;">Isolated fracture of the ulna</p> <p>The fracture is rarely displaced;</p> <ol style="list-style-type: none"> 1- Forearm brace → may be sufficient. However, it takes about 8 weeks before full activity can be resumed. 2- Rigid internal fixation will allow : <ul style="list-style-type: none"> - earlier activity and - avoids the risk of displacement or non-union. 	<p style="text-align: center;">Isolated fracture of the radius:</p> <p>Radius fractures are prone to rotary displacement; so , internal fixation with :</p> <ul style="list-style-type: none"> - Compression plate & screws → in adults - Intramedullary nails → in children <p>With rigid fixation → early movement is encouraged.</p>
MONTEGGIA Fracture-Dislocation of Ulna	<p>Usually the cause is a fall on the hand and forced pronation of the forearm.</p> <ul style="list-style-type: none"> - The radial head dislocates forwards & - The upper third of the ulna fractures and bows forwards. <ul style="list-style-type: none"> • If the ulnar shaft fracture is angulated with the apex anterior (the commonest types) then the radial head is displaced → anteriorly • If the fracture apex is posterior, the radial dislocation is → posterior (flexion type) • If the fracture apex is lateral then the radial head is displaced → laterally. 		<p>The key to successful treatment is to restore the length of the fractured ulna, only then can the dislocated joint be fully reduced and remain stable.</p> <p style="text-align: center;">In adults: → ORIF</p> <ol style="list-style-type: none"> 1- Reduction <ul style="list-style-type: none"> - The ulnar fracture must be accurately reduced. 2- Fixation <ul style="list-style-type: none"> - then fixed with a plate and screws <p>The radial head usually reduces once the ulna has been fixed.</p> <ol style="list-style-type: none"> 3- Rehabilitation <ul style="list-style-type: none"> - If the elbow is completely stable, then flexion- extension & rotation can be started after very soon after surgery. - If there is doubt, then the arm should be immobilized in plaster with the elbow flexed for 6 weeks.
GALEAZZI Fracture-Dislocation of Radius	<p>The usual cause is a fall on the hand; probably with a superimposed rotation force.</p> <p>The radius fractures in its lower third & inferior radio-ulnar joint subluxates or dislocates</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 10px; font-size: small;"> <p>25.7 Galeazzi fracture-dislocation. The diagrams show the contrast between (a) Monteggia and (b) Galeazzi fracture-dislocations. (c,d) Galeazzi type before and after reduction and plating.</p> </div> </div>	<p>As with the Monteggia fracture , the important step is to restore the length of the fractures bone.</p> <p>In children → Closed Reduction is often successful.</p>	<p>In adults → ORIF with compression plating of the radius.</p> <ul style="list-style-type: none"> - X-ray : to ensure distal radio-ulnar joint is reduced & stable. - If it's reduced BUT unstable : radio-ulnar joint is fixed with K wire, and the forearm is splinted in an above-elbow cast for 6 weeks.

