Elbow Fracture and dislocation

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Elbow D/L

■ Second most commonly dislocated joint, after shoulder, in adults
- In pediatric age group : most common

■ Most common pattern
- a posterolaterally directed force

• Combination of axial compressive load with flexion,supination & valgus force is the mechanism that results in a posterolateral rotatory subluxation or dislocation of the elbow
• Resulting pattern of recurrent instability is PL rotatory instability

Classification

1. Posterior D/L
- Most common

2. Anterior D/L
- Extremely rare
- Usually seen in young individuals
- There is forward rebounding response that allows the anterior projection after extensive hyperextension has allowed the olecrenon to slide under the trochlea
- In adults, the olecrenon is usually fractured

3. Divergent D/L
- Rare injury associated energetic trauma
- Interosseous membrane, annular ligament, DRUJ capsule are necessarily torn

Technique for elbow reduction

1. Extend elbow & Countertraction on upper arm & maneuver olecanon distally & anteriorly with thumb
2. Medial & lateral displacement
(median N.), then traction

3. Forearm supination
4. With pt' s elbow mildly flexed, longitudinal traction & surgeon' s thumb is used to push olecranon forward over trochlea

Anatomy

■ Trochoginglymoid joint and one of the most congrous joints in the body

- Ulnohumeral articulation : hinge that allows flexion and extension
- Radiohumeral and prox. Radioulnar : axial rotation or apivoting type motion

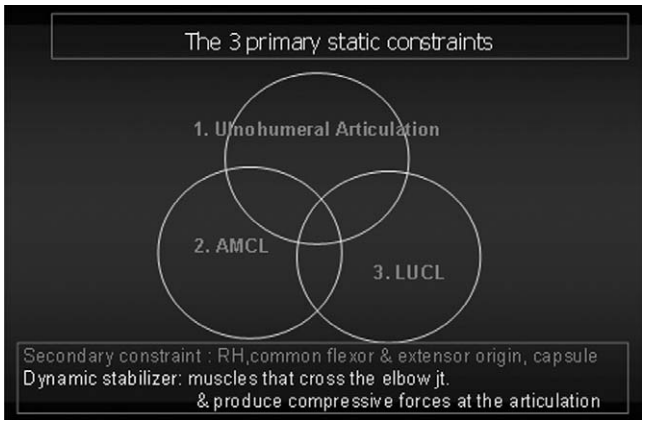
■ Distal humerus

• Trochlea
1. Spool shape
2. Articulation with greater sigmoid notch of the ulnar
3. Two surface are separated by the trochlea sulcus
4. Lies slightly medial to the central axis fo the humerus and course in ahelical fashion
A. from anterolateral to posteromedial

• Capitulum
1. Spheroidal in shaped
2. Separated from the trochlea by a groove in which the rim of the radial head articulates
3. 30 degrees in humerus shaft

• Greater sigmoid notch
1. Ellipse with an arc of 190 degrees
2. Longitudinal guiding ridge articulates with the apex of trochlea sulcus in all degrees of elbow flexion
3. Significant inherent stability

• Radial head
1. Concave disk
2. Neck in turn angulated 15 degrees radial shaft
3. 240 degrees of the outside circumference of the radial head articulation with ulnar at the lesser sigmoid notch



Contribution to normal stability

1. 〈 20' and 〉 120'
   - bony anatomy : primary stability to varus & valgus stress

2. Between 20-120'
   - soft tissue provide chief stability

3. Joint articulation
   - 55% of the stabilizing contribution to varus stability in extension
   - Up to 75% in 90 degrees of flexion

4. Valgus stability is equal divide among the MCL, the ant. Capsule,and bony articulation in full extension

5. 90 degrees flexion, MCL provides 55%

■ Articular elements

• Radial head: important secondary stabilizer to valgus stress (if MCL is intact)
   1. Resistance to valgus stress provided by radial head is minimal, when the MCL is intact
   2. However, the radiohumeral joint offers enough resistence to valgus stress to prevent subluxation if the MCL is attenuated or torn
   3. When radial head is intact, Major structure resisting initial valgus stress is MCL
   4. secondary stabilizer to valgus stress (if MCL is intact)
   5. Some resistance to posterolaterl rotatory instability

• Olecrenon

1. Major determinant of stability of the elbow is clearly the ulnohumeral joint
2. 50% of the coronoid must be present for the ulnohumeral joint to be functional
Contribution to normal stability

• Coronoid process

1. Anterior bony butress to resist the posteriorly directed forces that occur from both the flexor and extensor musculature
   - Forward flexion of the distal humeral articulation and the 30 degree posterior opening of the greater sigmoid notch also may be important in the regard
2. At the least 50% of the coronoid must be present for the ulnohumeral joint to be functional

■ Capsuloligamentous structures

• Capsule

1. Almost translucent
2. Important stabilizing effect when taut in extension
3. Ant. Capsules
   - In extension: 32 % varus stress, 38% valgus stress
   - 90 degree flexion; 13% varus stress and 10% valgus stress
   - Distal insertion site of ant. Capsule: coronoid precess distal 6 mm
   - Coronoid precess Fx (type I): not avulsion fracture , shear force fracture

• MCL

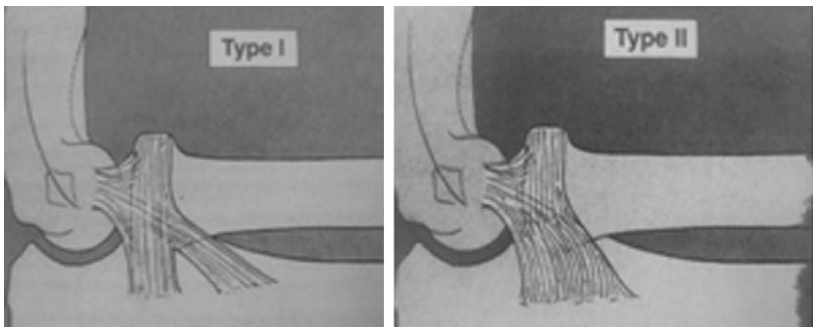
- Anterior bundle(distinct) :most important
  1. Lateral two thirds of antinf. aspect of med.epicondyle
  2. Coronoid process at sublime tubercle of ulna, 18 mm distal to the coronoid tip
  3. 4.7 mm, 27 mm length
  4. Primary resistance to valgus stress contributing 55%~70%
- Posterior bundle
  1. post.humeral epicondyle-ulna
  2. Less differentiated form capsule and does not contribute significantly to valgus stability except near terminal flexion
- Transverse component
  1. Little to elbow stability because they originate from and insert on the ulnar

Taut throughout most of the entire arc of flexion, with sequential tightening of the fobers as the elbow flexes
Greatest instability occurred at 90'
At least some of the fibers are isometric
- Ant.bundle widens slightly from proximal to distal subdivide into ant. &

post. bands of equal width they are easily identifiable isometric fibers

• Lateral ligament complex
- Origin: lat.epicondyle
- Its fibers blend with annular ligament and progress superf. & distally to insert on tubercle of ulna supinator crest
    1. Annular ligament
    2. Radial collateral ligament
    3. Lateral ulnar collateral ligament
    4. Accessory ligament
        * This complex therefore is isometric throughout the normal range of flexion and extension
        * Terminates indistinguishably in the annular ligament, which stabilizes the proximal radioulnar joint
        * LCL complex also resists varus forces
        * LCL complex is farther away from the varus-valgus axis of the elbow joint than MCL, thus allowing greater excursion to occur with dysfunction of the ligament when it is put under stress

• Two types of insertion(by Cohen & Hastings)
    1. Type I: a bilobed insertion
    2. Type II: a broad single expansion with a smooth transition bet. Proximal & distal
• Primary restraint to PLRI : combination of LUCL & annular ligament



Posterolateral rotatory instability

■ Chronic deficiency of lateral stabilizer , esp. LUCL.
■ LUCL. : 1' constraint to PL rotatory instability
■ Dx. : lateral pivot shift test
■ Sx: Locking & clicking, esp. elbow is supinate & extended

O' Driscoll SW. 1991. JBJS.

■ Chronic deficiency of lat.side

1. post. D/L of elbow(50%)

■ Prev. OP (overaggressiv. debridement around LCL complex for tennis elbow)

■ Posttraumatic cubitus varus deformity

1. cubitus varus deformity increase strain in LUCL & increase in U-H jt. Opening
2. amount of varus angulation: 20' -25'
3. corrective distal humeral osteotomy to treat PL rot.instability 2004. JBJS. Murray

■ Post.capitellar impression Fx(case report)

Dynamic stability

■ Dynamic stability of elbow joint

- Flexor, extensor muscles providing compression across the joint, increasing the inherent stability provided by the highly congruent articular surface

■ Extent of instability of elbow after dislocation

- Amount of muscular damage at the medial and lateral epicondyles

• Brachialis and triceps muscles

1. in particular have broad cross section, and their insertions are close to the axis of joint rotation

• Anconeus muscle

1. Unclear
2. May be important dynamic constraint to varus and PL

• Elbow medial side

1. FCR: Predominant musculotendinous unit overlying MCL, at high degree elbow flexion
2. FDS: Best suited to provide medial elbow support and may augment the stability of the MCL

• Elbow lateral side

1. Principal dynamic restraint is Extensor muscle origins with their fascial bands and intermuscular septa
2. In supination, these serve to support the forearm unit and prevent it.

• LUCL

1. Adheres closely to supinator, anconeus, extensor muscles and their muscular fascia

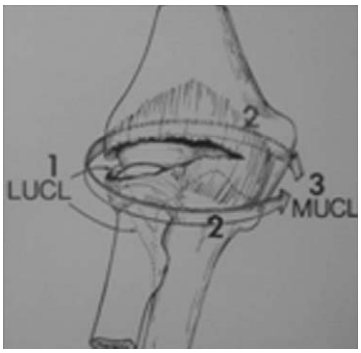
The horii circle of soft-tissue injury

• Stage1 : LUCL disruption

• Stage 2: other lat.ligaments & ant. & post. Capsule disruption

• Stage 3: MUCL is either partially disrupted, involving post.medial UCL only(A)or complete

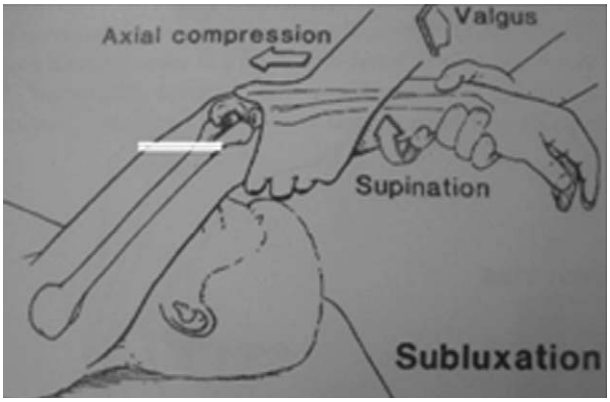
disrupted(B)



Posterolateral rotatory instability

1. In PLRL, prox. R-U joint intact
   laxity or avulsion of LUCL → increase in ER of U-H joint → secodary subluxation of RH
2. differentiated from isolated post.head sublx. with disruption of prox. R-U joint & intact U-H joint
   O' Driscoll 1991 JBJS

• Lateral pivot shift test
   1. Supination/valgus monent applied during Flex. causing the elbow to subluxate maximally at 40' flexion
   2. Create apprehension & highly sensitive
   3. Further flexion produce palpable visible clunk (as elbow reduces)
   4. Unfortunately, sublx. /reduction maneuver is usually not possible in the awake patient.



Diagnosis

• Stage 1

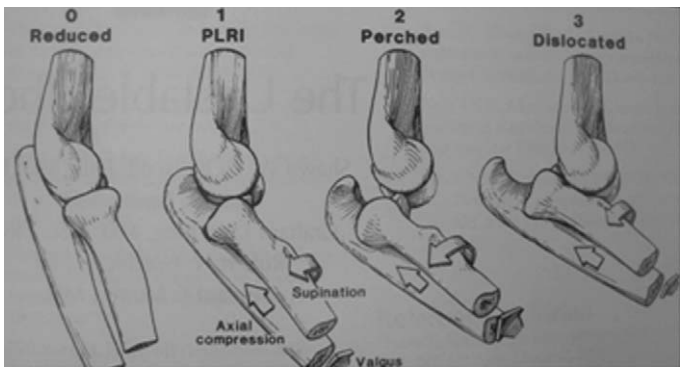
1. disruption of LCL partially or completely
2. PL rotatory subluxation of elbow spontaneously reduction

• Stage 2
1. ant. & posteriorly incomplete PL D/L of the elbow
2. concave medial edge of ulna rests on trochlea
3. lateral X-ray : CP perched on the trochlea

• Stage 3A
1. all soft tissue are disrupted around to and including the posterior part MUCL only
2. this permits posterior dislocation by the posterolateral rotatory mechanism
3. Elbow pivots around on the intact anterior band of the MCL
4. intact ant.band of MCL provide stability if forearm is kept in pronation to prevent PL rotatory sublx. during valgus stress-testing
5. stage 3A inst. most commonly seen in CP & RH Fx.

• Stage 3B
1. Entire medial collateral complex disruption
2. Gross varus,valgus,rotatory instability are all present following reduction

• Stage 3C
1. elbow D/L in 90' flexion (entire distal aspect of humerus stripped of soft ts.)
2. reduction maintain only by flexing elbow beyond 90' to 110



A feeling of instability with elbow extension & supination of the forearm
Stage1 : recurrent snapping,clicking or locking & experience their Sx.(supin. & extend)
Mistaken recurrent D/L of radial head

Previous elbow injury & subsequent Sx. Of sublx. & complaints of recurrent snapping & clicking must be further evaluated for lat.ulnar collateral lig.insufficiency and resultant PLRI.

Elbow instability from subluxation to dislocation

Physical examination

■ Neurovascular injury
- Must focus on uncovering any neurovascular injury
- Examine the invloved limb both before and after reduction

■ Brachial artery injury
- Because of collateral blood flow around the elbow, radial and ulnar artery pulses may be present at the wrists even when the brachial artery ruptures

→ carefully evaluate each patient for this injury
→ Pain and swelling of the fore arm should alert patients to this possibility
→ Confirmed by arteriogram

■ Median and ulnar nerve injury
- More common ulnar nerve injury
- Typically stretch injury

■ Median nerve entrapment
- Typically in children
- Occur during reduction

■ If neurologic deficit is not worse following reduction
→ closely observation
→ If do not improve within 3 months, surgical exploration is appropriate

■ Median nerve fuction that worsens after reduction particulary in a child
→ strong indication for surgical exploration

Medial Epicondylar fractures

■ Injury mechanism
1. In a fall on the outstretched arm : direct blow
2. avulsion and extension mechanism(valgus stress)
3. chronic tension stress injuries (little leaguer' s elbow)
4. isolated avulsion in adolescents while pitching a baseball

■ Surgical treatment
1. Fx that cannot be reduced because of an incarcerated fragment in the joint (absolute Ix)
2. Fx with more than 1 cm of displacement
3. ulnar nerve dysfunction
4. pts with high upper extremity functional demands
5. Stiffness

* the most common complication → stable fixation → early active motion

Coronoid process & radial head as posterolateral stabilizers of the elbow

2004. JBJS. Schneeberger

1. 10 fresh frozen Cadevar study
   A. isolated removal of RH in elbows with intact collateral ligaments result in a significant increase in the PLRI of 9.6' compared with that in the test condition.
2. A defect involving 50% of the coronoid can cause instability and one involving 70% virtually always cause instability.
3. In our experiments, possible to restore stability in such elbows by reconstructing the coronoid & inserting a radial head prosthesis

Fracture of the radial head

■ Mason classification

- 1 = undisplaced
- 2 = displaced
- 3 = comminuted
- 4 = 3 + elbow dislocation

■ Op Indication

• Fracture type : Mason type II
  - Less than 30% of the radial head
  - Displacement more than 3 mm
• Associated injury causing instability
  - Elbow dislocation, MCL rupture, Essex-Lopresti injury
• Age
  - All type II radial head fractures under 50 to 55 age
  - Type II fractures with instability at any age

Fractures of the Radial head with dislocation of the elbow

■ Often refereed to as Mason IV injury
■ If coronoid is intact --〉 first to reduce the dislocation and then to determine the extent to which the ulnohumeral articulation provides stability
■ Type I fractures
• Elbow stable within 45~50degrees of extension
  --〉 nothing more need be done except to place the elbow in a splint with 60 degree extension stop for 1~2 weeks

- Full extension is then allowed as tolerated while elbow is protected with a hinged splint

■ Type II fractures

• Treated by ORIF with collateral ligament repair
  - As these injury result in chronic instability if the radial head is resected
  - Safe zone

■ Type III fractures

• Radial head should be excised acutely if it cannot be fixed
• If elbow is unstable, then direct repair of the collateral ligaments might be considered
• If sufficient stability cannot be achieved, radial head reconstruction may be employed

Treatment of RH fractures

1. Consideration should be given to fixation of displaced RH Fx. Smaller than 1/3 of RH. even with intact ligaments
2. Ligament insuffiency had a greater effect on elbow instability than small osseous defects
3. Therefore, Ligament repair is essential during OP. management of RH Fx.
4. Repair of small osseous defects in the setting of ligament insuffiency should be considered to further improve elbow stability

Coronoid process Fx. (Radiologic classification system of Regan & Morrey)

■ Type I

• Fx. Involving the tip of CP
• Small chip of the tip of coronoid
• not avulsion Fx
• ant. Capsule insert 5 to 6 mm from tip of Coronoid process
• Tx: open reduction is not necessary of the elbow is stable

■ Type II

• 〈 50% of CP
• As much as 50% of CP involved
• Usually elbow is unstable, especially if the radial head is also fractured
• If post. Displacement occurs with less than 40 to 45 degreees of flexion, the articulation is considered inadequate, and the ulnohumeral joint must be stabilized
• Fx fragment is large : screw fixation
• Fx fragment is small : suture tie

■ Type III

• 〉 50% of CP
• Ulnohumeral joint grossly unstable

• Type IIIA : not communited Fx , May be fixed with a screw and the joint will be stable
• Type IIIB : communited Fx. Use a heavy suture
• Most important goal is to prevent posterior displacement of the ulna against trochlea

1. CP offer osseous constraint against post. translation of the ulna.
2. attachment of MCL(valgus stab.) to its base
3. Repair of type III CP: reduce risk of valgus & post.instability

■ OP Indication

• Type II with intact radial head and in which elbow is grossly unstable when flexed less than 40 or 60 degreee
• Type II in which radial head fracture and elbow dislocated (terrible triad)
• All type III
• Isolated anteromedial coronoid fractures, because of their propensity for slight articular incongruity and subluxation

■ Shearing mechanism that produces a transverse Fx.
■ Results as CP is driven against unyielding distal part of humerus
■ Pathognomic sign of an episode of (post)elbow instability

Standard surgicalprotocol to treat elbow D/L with RH & CP 2004. JSJS

The terrible triad of the elbow

■ Fracture Of Radial head
■ Fracture Of coronoid process
■ Elbow dislocation

• Surgical protocol

1. Fixation or replacement of the radial head
2. Fixation of the CP Fx. If possible
3. Repair of associated capsular & lat.ligamentous injuries
4. In select case, repair of MCL/ hinged EF.

Complication of elbow DL

1. Neurovascular

a. Spasm, intimal damage, thrombosis, brachial artery rupture
b. Median nerve symptom
- Associated with artery injury (because close proximity of nerve and artery in their course between the brachialis and pronator teres)

- More common in children

2. Compartment syndrome
   a. Intramuscular bleeding and edema
   b. Pain of passive finger and wrist extension
   c. Arteriography in necessary if arterial injury is suspected
   Tx ; anterior decompression (lacertus fibrosus, lower brachial and forearm fascia)
3. Articular injury
4. Late contracture
   a.Limitation of extension is common following dislocation
   b.After 1 years Limitation of 30 degreee or more, capsulolysis may be considered
   - Ant. Capsule is often thickened and shortened
   - Lateral incision
   - Release from proximal humeral attachment.
5. Heterotopic bone formation
   a. Lateral and medial collateral ligaments occur frequently
   b. Marked heterotopic ossification : brachialis muscle
   c. Excision is delayed until bone formation is mature, usually 1 year

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