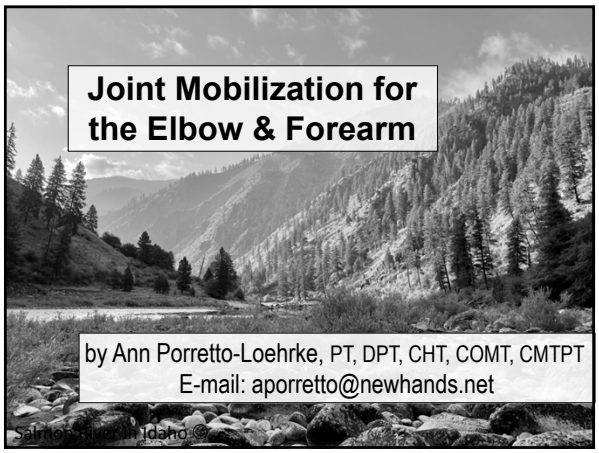
Joint Mobilization for the Elbow & Forearm
by Ann Porretto-Loehrke, PT, DPT, CHT, COMT, CMTPT
E-mail: aporretto@newhands.net
Salmon River in Idaho @

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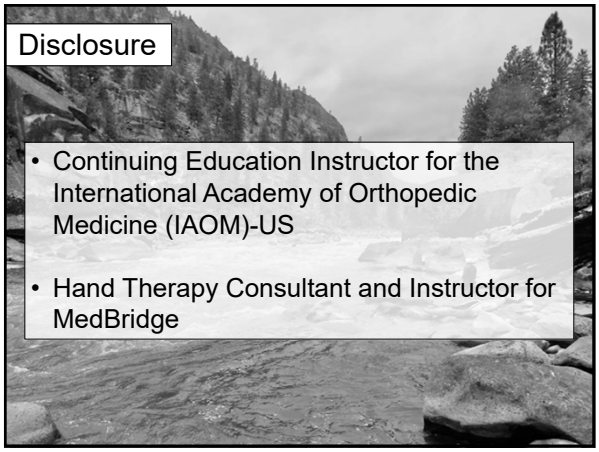
Disclosure
• Continuing Education Instructor for the International Academy of Orthopedic Medicine (IAOM)-US
• Hand Therapy Consultant and Instructor for MedBridge

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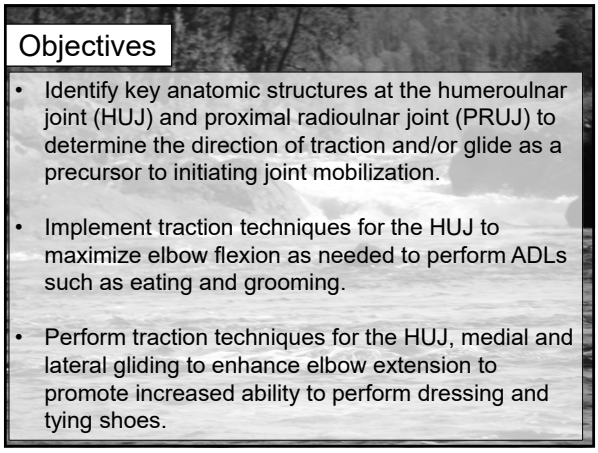

Objectives
• Identify key anatomic structures at the humeroulnar joint (HUJ) and proximal radioulnar joint (PRUJ) to determine the direction of traction and/or glide as a precursor to initiating joint mobilization.
• Implement traction techniques for the HUJ to maximize elbow flexion as needed to perform ADLs such as eating and grooming.
• Perform traction techniques for the HUJ, medial and lateral gliding to enhance elbow extension to promote increased ability to perform dressing and tying shoes.

3

Objectives

- Demonstrate joint mobilization techniques for the PRUJ to address limitations with forearm pronation and supination.
- Explain the home program patients can perform to maximize forearm motion with neuromuscular re-education at the PRUJ.

4

The elbow…

Intricate Joint System

Large Curved Congruency

Highest Priority → Stability

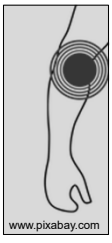
1° Source = Architecture
2° Source = Ligaments
3° Source = Muscles

Cage DJN, Abrams RA, Callahan JJ, Botte MJ. Soft tissue attachments of the ulnar coronoid process. *Clin Orthop Rel Res* 1995; 154-158.

Beingessner DM et al. The effect of radial head fracture size on radiocapitellar joint stability. Clin Biomech 2003; 18:677-81.

5

The elbow…



Pain Reference

More reliable than shoulder
Localized to the area
Moderately Trustworthy

6

The elbow…

www.pixabay.com

Functional Coupling

Flexion + Supination
Extension + Pronation

Postural Coupling

Flexion or Extension +
Valgus,
Neutral, or
Varus

Shaaban H, Pereira C, Williams R, et al. The effect of elbow position on the range of supination and pronation of the forearm. J Hand Surg Eur 2008;33(1):3-8.

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Elbow anatomy

The Elbow Complex…

- Humeroulnar
- Humeroradial
- Proximal radioulnar
- (Distal radioulnar)

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Elbow anatomy

Humeroulnar Joint (HUJ)

Maximal loose-packed position (MLPP)

70° Flexion
10° Supination

Stability Based on Form

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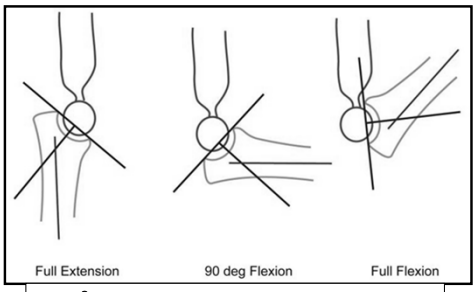
Elbow anatomy

Humeroulnar Joint Orientation



- **45° from ulnar diaphysis**
- **Traction direction**

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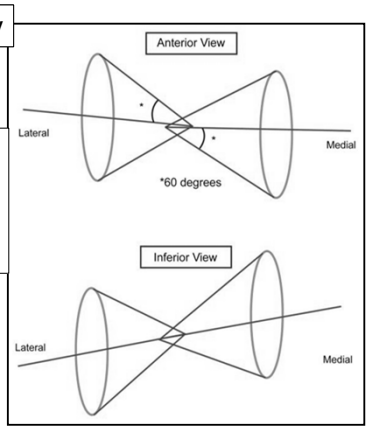
Elbow anatomy

Trochlea

- 2 opposing cones
- Medial side more inferior versus the lateral side



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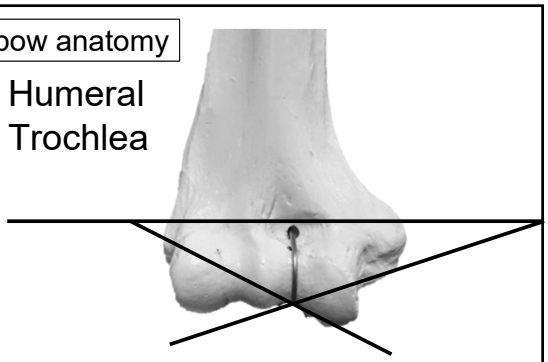
Elbow anatomy

Humeral Trochlea



Medial & lateral glide direction: 60° from a line connecting the epicondyles

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Elbow anatomy

Ulnar Trochlear Notch

10N load → 10% surface area contact

1280N → ↑surface area contact to 64-73%

Eckstein, et al. Physiological incongruity of the humero-ulnar joint: a functional principle of optimized stress distribution acting upon articulating surfaces? Anat Embryol (Berl). 1993 Nov;188(5):449-55.

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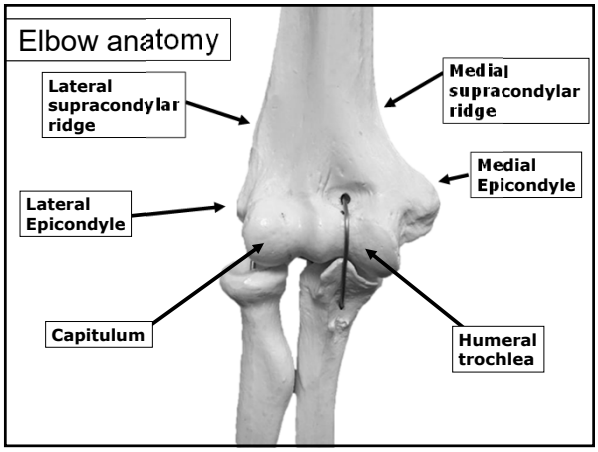
Elbow anatomy



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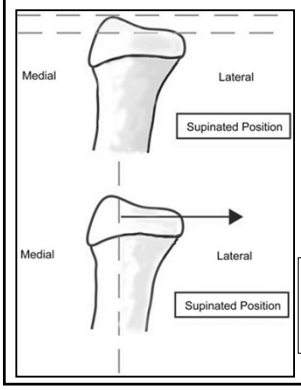
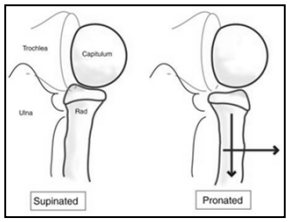
Elbow anatomy

Radial Head Asymmetries





Schenk RC et al. Biomechanical analysis of articular cartilage of the human elbow and potential relationship to osteochondritis dissecans. Clin Orthop Rel Res 1994; 299:305-12.

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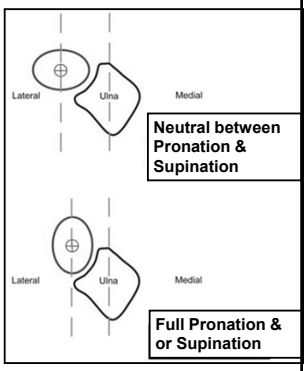
Elbow anatomy

Radial Head Asymmetries



Deschrijver M, Lamquet S, Planckaert G, et al. Positioning of longest axis of the radial head in neutral forearm rotation. Shoulder & Elbow. 2020;12(5):362-367.

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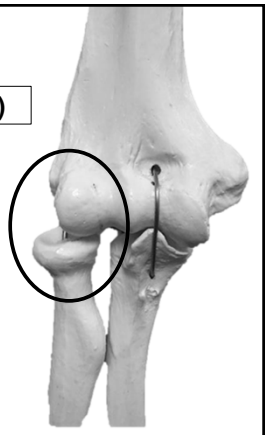
Elbow anatomy

Humeroradial Joint (HRJ)

Stability Through Force Closure

Loading (such as grip), provides stability to the humeroradial joint



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Elbow anatomy

Radial Head: Mechanical Stability Dual Role!

- Radial head is a bony block against valgus and supports the MCL
- Radial head positioning pretensions the lateral ulnar collateral ligament complex to help restrain varus
- Transfers 60% compressive load in full elbow extension

Wilps T, Kaufmann RA, Yamakawa S, Fowler JR. Elbow biomechanics: Bony and dynamic stabilizers. J Hand Surg Am. 2020;45(6):528-535.

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Elbow anatomy

Proximal Radioulnar Joint (PRUJ)

Maximal loose-packed position (MLPP)

70° Flexion
35° Supination

The HUJ, HRJ, and PRUJ all share a common joint capsule

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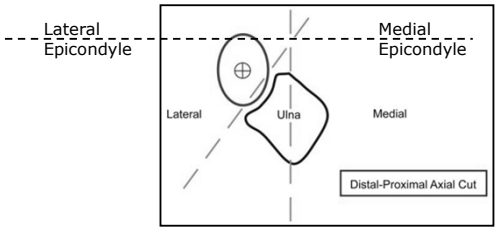
Elbow anatomy

PRUJ: Radial Notch



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Elbow anatomy

Distal Radioulnar Joint (DRUJ)

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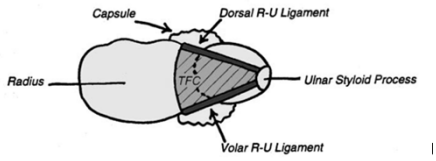
Elbow anatomy

DRUJ



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Elbow anatomy

Capsule and Ligamentous Support

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Elbow anatomy

Elbow Complex Capsule: Anterior

Not as important biomechanically

Nielsen KK, Osen BS. No stabilizing effect of the elbow joint capsule - A kinematic study . Acta Orthopaedica Scandinavica: 1999, Vol 70, (1): 6-8.

More important clinically—very thick

Sakai K, et al. Extension restriction of the elbow caused by a synovial fold - a report on 2 athletes . Acta Orthopaedica Scandinavica, 1999;70 (1): 85-86.

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Elbow anatomy

Elbow Complex Capsule: Posterior

- Not very extensive vs anterior capsule
- The posterior portion of the capsule can become entrapped between the radial head & capitulum

Sakai K, et al. Extension restriction of the elbow caused by a synovial fold - a report on 2 athletes. Acta Orthopaedica Scandinavica, 1999;70 (1): 85-86.

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Elbow anatomy

Elbow Complex Capsule: volume

The distribution of joint fluid in the elbow is influenced by flexion and extension of the joint, which is good for joint health!

In flexion, fluid is initially collected posteriorly. With increased volume, fluid collected anteriorly.

Demaeseneer M, et al. Elbow Effusions - Distribution of joint fluid with flexion and extension and imaging implications. Investigative Radiology, 1998; 33:117-125.

26

Elbow anatomy

Elbow Complex Capsule: innervation

All 3 major nerves contribute articular branches to the elbow complex capsule: posterior interosseous nerve (PIN), median nerve, and ulnar nerve

Cavalherio CS, Filho MR, Rozas J, et al. Anatomical study on the innervation of the elbow capsule. Rev Bras Orthop. 2015:Oct 19;50(6):673-9.

Bekler H, Riansuwan K, Vroeman JC, et al. Innervation of the elbow joint and surgical perspectives of denervation: a cadaveric anatomic study. J Hand Surg. 2008;33(5):740-5.

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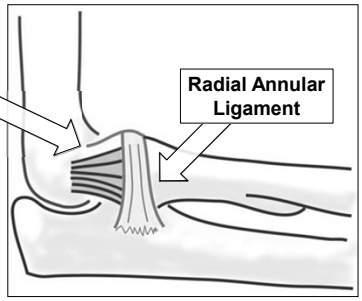
Elbow anatomy

Lateral Ligaments



These ligaments do not provide strong stabilization to the lateral aspect of the elbow

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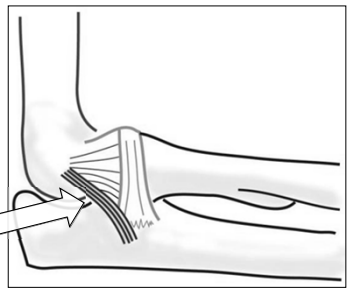
Elbow anatomy

Lateral Ligaments

- This is the most important lateral stabilizer
- Limits varus stability from 0-140˚



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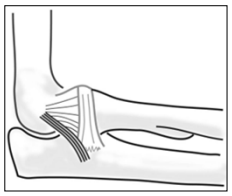
Elbow anatomy

Lateral Ligaments



- The lateral ulnar collateral ligament (LUCL) arises from the lateral epicondyle and inserts onto the proximal ulna
- Taut in both elbow flexion & extension

Imatani J, Ogura T, Morito Y, et al. Anatomic and histologic studies of lateral collateral ligament complex of the elbow joint. J Shoulder Elbow Surg 1999; 8:625-627.

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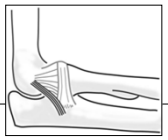
Elbow anatomy

Lateral Ligaments



- **<u>Lateral Ulnar-Collateral Ligament (LUCL)</u> = most important stabilizer to prevent Posterior Lateral Rotatory Instability (PLRI)**
- **PLRI → PRUJ is intact; forearm moves as a unit**

Dunning CE, Zarzour ZDS, Patterson SD, Johnson JA, King GJW. Muscle forces and pronation stabilize the lateral ligament deficient elbow. Clin Orthop Rel Res 2001; 118-124.

O'Driscoll SW, Bell DF, Morrey BF. Posterolateral rotatory instability of the elbow. JBJS 1991; 73 A: 440-446.

Smith JP, Savoie FH, Field LD. Posterolateral rotatory instability of the elbow. Clin Sports Med 2001; 20:47-58

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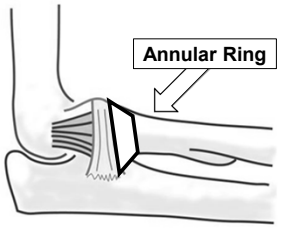
Elbow anatomy

Annular Ring

- The proximal portion is cartilage (Type I collagen), the distal portion synovial tissue
- The radial head translates during pronation & supination; but primary function of annular ring is to protect radius from inferior dislocation



Galik K, Baratz ME, Butler AL, et al. The effect of the annular ligament on kinematics of the radial head. J Hand Surg. 2007;32(8):1218-24.

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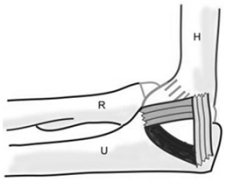
Elbow anatomy

Medial Ligaments



Bundles: Anterior, Posterior, Intermediate (or Transverse)

Timmerman LA, Andrews JR. Histology and arthroscopic anatomy of the ulnar collateral ligament of the elbow. Am J Sports Med 1994; 22:667-673.

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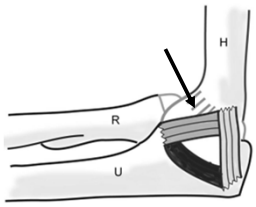
Elbow anatomy

Medial Ligaments



Anterior Bundle, Load Bearer:

- 54% of the valgus torque load is carried by the MCL. 33% carried by the HRJ.
- Restrains pronation of the ulna on the humerus.

Kamineni S. et al. Partial posteromedial olecranon resection: A kinematic study. J Bone Joint Surg 2003; 85-A:1005-11.

Pomianowski S, O' Driscoll SW, Neale PG, et al. The effect of forearm rotation on laxity and stability of the elbow. Clin Biomech. 2001;16:401-407.

Armstrong AD, Dunning CE, Faber KJ, et al. Rehabilitation of the medial collateral ligament-deficient elbow: An in vitro biomechanical study. J Hand Surg. 2000; 25A:1051-1057.

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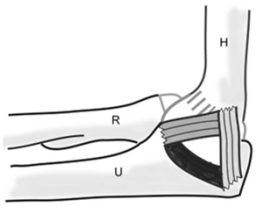
Elbow anatomy

Medial Ligaments



- Cadaver study demonstrated the most valgus stress at 90º of elbow flexion
- The moving valgus stress test produced more elongation of the MCL compared with static stress testing

Wigton MD, Schimoler PJ, Kharlamov A, et al. The moving valgus stress test produces more ulnar collateral ligament change in length during extension during flexion: a biomechanical study. J Shoulder Elbow Surg. 2022 Jun;29(6):1230-1235.

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Elbow anatomy

Medial Ligaments

The anterior bundle is the only structure of the MCL whose isolated sectioning allows the valgus opening of the elbow, acting as the main elbow stabilizer in valgus instability.

Tribst MF, Zoppi A, Camargo JC, et al. Anatomical and functional study of the medial collateral ligament complex of the elbow. Acta Ortop Bras. 2012:Dec;20(6):334-8.

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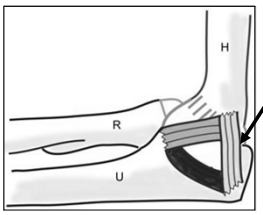
Elbow anatomy



Medial Ligaments

Posterior Bundle
-Tight in valgus at elbow positioned > 60° of flexion.
-Works in concert with medial capsule to provide stability in greater flexed positions

Sójberg et al. Experimental instability of the elbow after transection of the UCL in Clin. Orth. # 218, 1987, 186-190.

Wavreille G, Seraphin J, Chantelot C, Marchandise X, Fontaine C. Ligament fibre recruitment of the elbow joint during gravity-loaded passive motion: an experimental study. Clin Biomech (Bristol, Avon). 2008;23(2):193-202.

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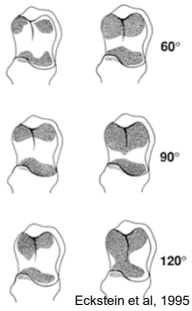
Optimizing stability…

- **elbow flexion:** *improves contact area*
- **the larger the contact area, the greater the stability**

- **with rehabilitation, limit elbow extension to promote stability**



Eckstein et al, 1995

Eckstein F, et al. Morphomechanics of the humero-ulnar joint: I. Joint space width and contact areas as a function of load and flexion angle. Anat Rec. 1995; 243(3): 318-326.

Szekeres M, Chinchalkar SJ, King GJW. Optimizing elbow rehabilitation after instability. Hand Clin. 2008; 24: 27-38.

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Optimizing stability…

***Dynamic elbow stability* involves the congruency of the joint when the muscles crossing it contract to enable motion**

- 1° stabilizer: HUJ articular articulation, MCL & LCL complex. MCL is the primary stabilizer in flexion. Removal of MCL will result in instability in all positions except extension
- HRJ is the 2° stabilizer, providing up to 30% of the lateral and anterior stability throughout the flexion arc.
- With a valgus stress, the MCL is stretched and the HRJ compressed, making them the 1° stabilizers.
- With a varus stress, the LUCL and HUJ are the 1° stabilizers

Jones ADR, Jordan RW. Complex elbow dislocations and the “terrible triad” injury. The Open Orthopadics Journal. 2017, 11(Suppl-8, M7):1394-1404.

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The elbow…

Of the large joints in the adult population….

The elbow is the second most commonly dislocated joint

In the pediatric population, it's the most commonly dislocated joint!

Parsons BO & Ramsey ML. Acute elbow dislocations in athletes. Clin Sports Med. 2010; 29: 599-609.

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The elbow…

Definitions…

Simple dislocation: dissociation of the humeroulnar joint without concomitant fracture (soft tissue injury only)

Complex instability: occurs when a fracture is associated with the dislocation. This can include radial head and neck fractures, coronoid fractures, and avulsion of the medial &/or lateral epicondyles

Parsons BO & Ramsey ML. Acute elbow dislocations in athletes. Clin Sports Med. 2010; 29: 599-609.

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The elbow…

Incidence of elbow dislocations in the US

- highest incidence (43.5%) in patients 10-19 years old
- 53% occurred in males and 47% in females
- 44.5% of the total dislocations were sustained in sports
  - males: football, wrestling, basketball
  - females: gymnastics and skating activities

Stoneback JW, Owens BD, Sykes J, et al. Incidence of elbow dislocations in the united states population. J Bone Joint Surg Am. 2012; 94: 240-245.

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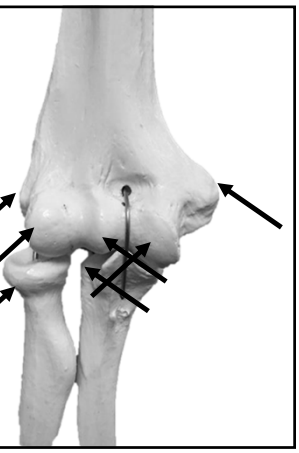
The elbow…

Loose Bodies

Osteochondral/Chondral fragments of articular surface 2° Traumatic event or underlying pathologies



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Which ligament provides key stability to the lateral aspect of the elbow? When comprised, this causes a posterolateral rotatory instability (PLRI):

a. Radial Annular Ligament (RCL)
b. Lateral Collateral Ligament (LCL)
c. Lateral Ulnar Collateral Ligament (LUCL)

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Which portion of the medial collateral ligament complex is the most important?

a. Anterior bundle
b. Intermediate bundle
c. Posterior bundle

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