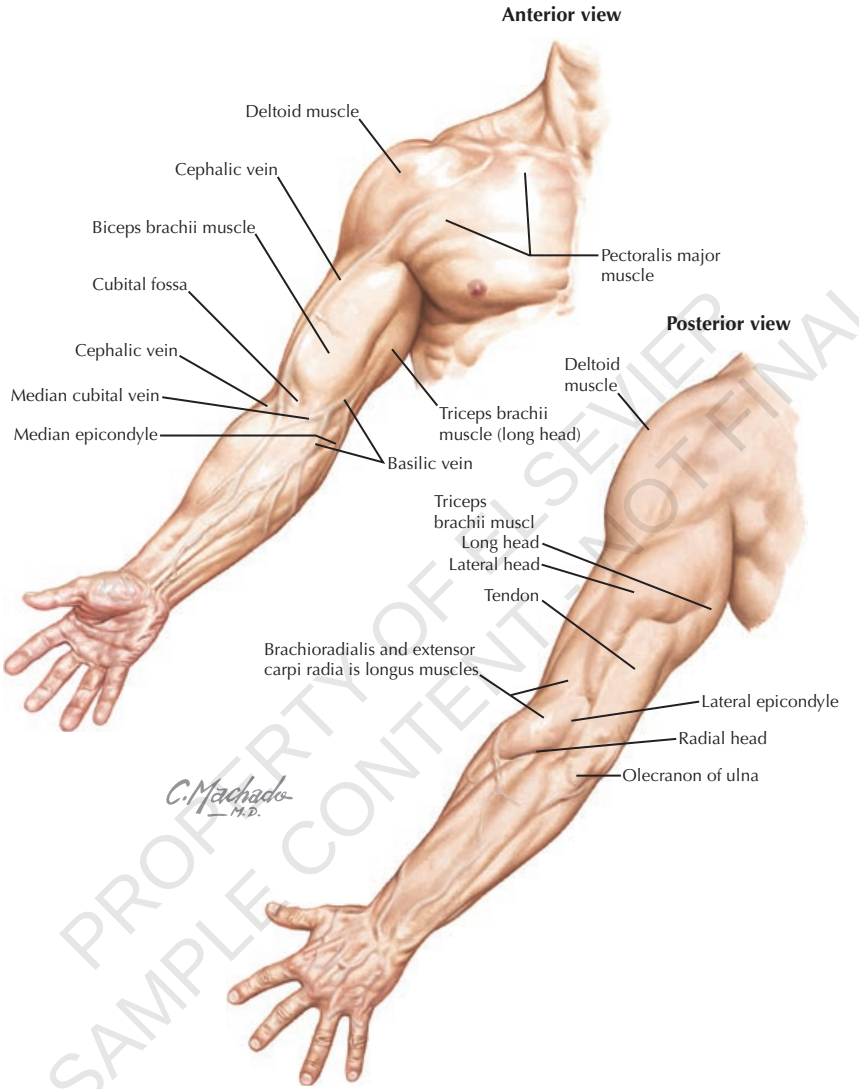
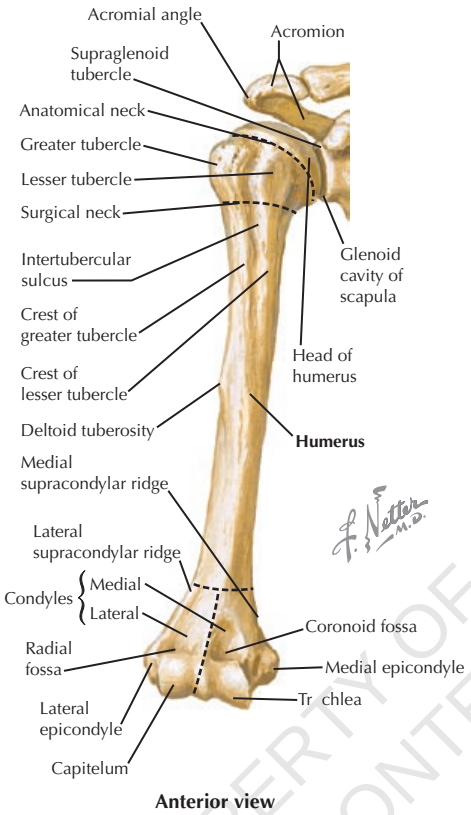
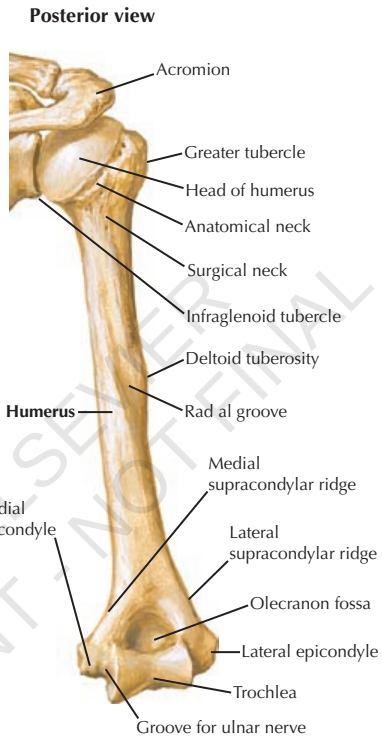
CHAPTER 4

Arm

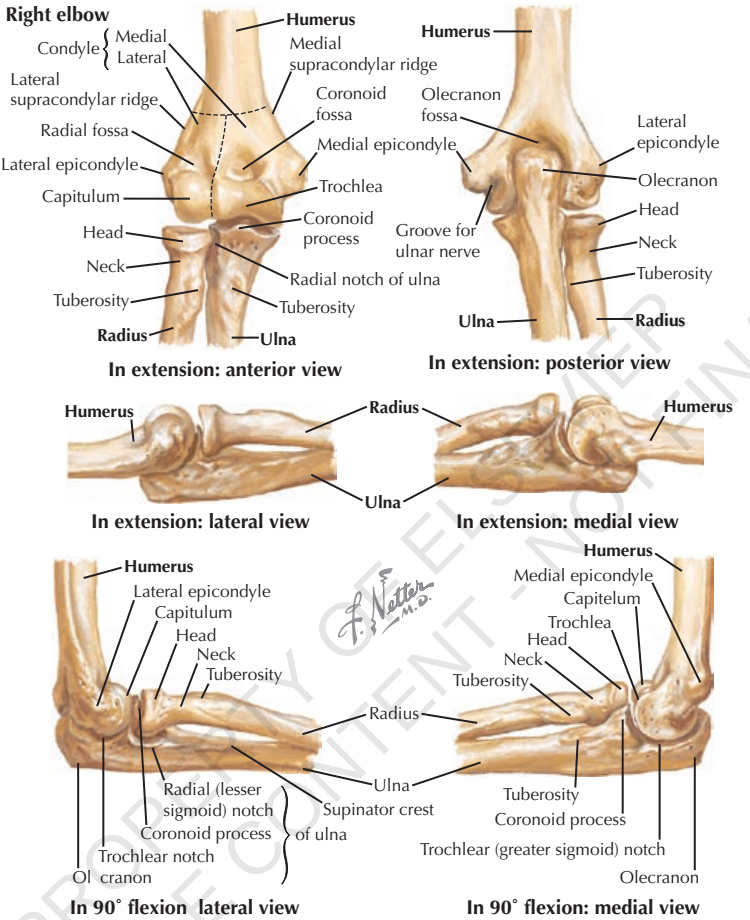


STRUCTURE	CLINICAL APPLICATION
Triceps	Can be palpated on the posterior aspect of the arm. A tendon avulsion/rupture can be palpated immediately proximal to the olecranon.
Biceps	Can be palpated on the anterior aspect of the arm.
Cubital fossa	Biceps tendon can be palpated here. If ruptured, the tendon cannot be palpated.
Lateral epicondyle	Site of common extensor origin. Tender in lateral epicondylitis ("tennis elbow")
Medial epicondyle	Site of common flexor origin. Tender in medial epicondylitis ("golfer's elbow")
Olecranon	Proximal tip of ulna. Tenderness can indicate fracture.
Radial head	Proximal end of radius. Tenderness can indicate fracture.



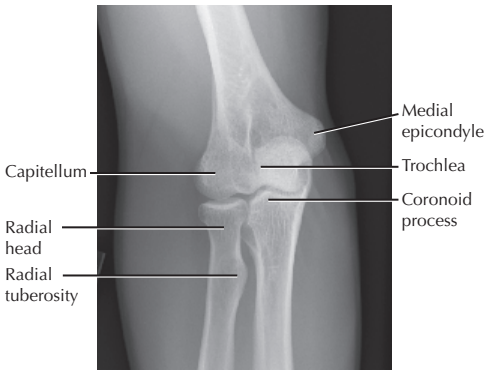


CHARACTERISTICS	OSSIFY	FUSE	COMMENTS
HUMERUS			
• Cylindrical long bone • Deltoid tuberosity • Spiral g oove radial nerve runs in groove posteriorly • Lateral condyle capitellum (articular) • Lateral epicondyle • Medial condyle trochlea (articular) • Medial epicondyle • Cubital tunnel • Olecranon and coronoid fossae	**Primary** Shaft 6-7wk (fetal) **Secondary** **Proximal (3):** Head Birth Tuberosities 1-4yr **Distal (4):** Capitellum 1yr Medial epicondyle 5yr Trochlea 7yr Lateral epicondyle 11yr	Birth 14-18yr 12-17yr	• Limited remodeling potential in distal fractures • Deltoid is a deforming force in shaft fractures • Radial nerve can be entrapped in distal ⅓ humeral shaft fractures (Holstein-Lewis fx) • Fx of lateral condyle common in pediatrics • Capitellum aligns with radial head on x-ray • Lateral epicondyle: origin of extensor mass & LCL • Supracondylar process present 5%: ligament of Struthers may entrap median nerve • Medial epicondyle: origin of flexor mass & MCL • Ulnar nerve runs posterior to medial epicondyle • Fossae filled with fat; can be displaced in fx
Elbow ossification order mnemonic: **C**aptain [capitellum] **R**oy [radial head] **M**akes [medial epicondyle] **T**rouble [trochlea] **O**n [olecranon] **L**eave [lateral epicondyle]; can be used to determine approximate age of patient.			

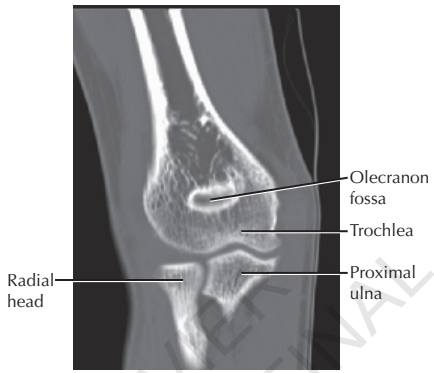


CHARACTERISTICS	OSSIFY	FUSE	COMMENTS
PROXIMAL RADIUS			
• Radial head is intraarticular; RH physis is also intraarticular • Radial neck: 10-15° angulated • Tuberosity: biceps insertion	Secondary Head 2-3yr	16-18yr	• Anterolateral portion of radial head has less subchondral bone and is most susceptible region for fracture • Radial head should always align with the capitellum • Tuberosity points ulnarly in supination
PROXIMAL ULNA			
• Olecranon • Coronoid process • Supinator crest • Ulnar tuberosity • Greater sigmoid notch • Lesser sigmoid notch	Secondary Olecranon 9yr	16-20yr	• Articulates with trochlea, covered with articular cartilage • Coronoid provides anterior stability & MCL insertion • Lateral ulnar collateral ligament (LUCL) inserts on supinator crest • Brachialis inserts on ulnar tuberosity • Greater sigmoid notch: formed by olecranon & coronoid • Lesser sigmoid (radial) notch: articulates with radial head

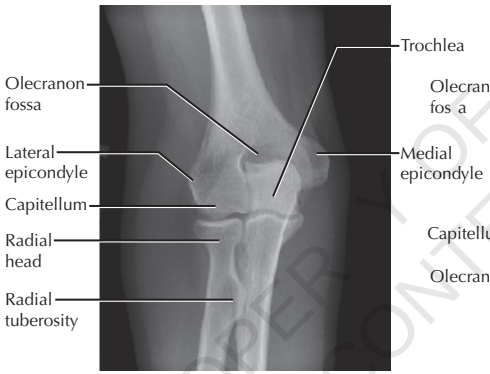
Elbow x-ray oblique



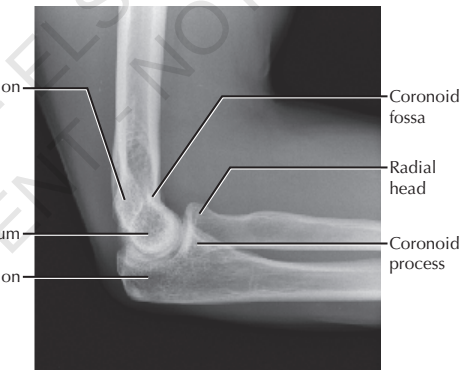
Elbow CT coronal



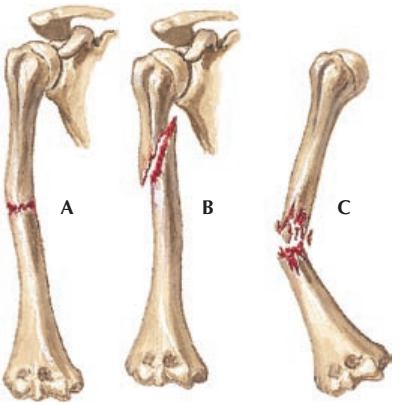
Elbow x-ray AP



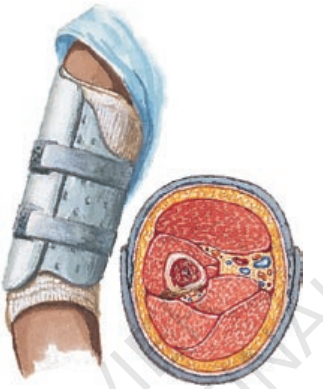
Elbow x-ray lateral



RADIOGRAPH	ECHNIQUE	FINDINGS	CLINICAL APPLICATION
Anteroposterior	Elbow extended, beam perpendicular to plate	Elbow joint, distal humerus, proximal radius and ulna	Fractures, dislocations, arthritis/DJD, supracondylar process
Lateral	Elbow flexed 90°, beam from lateral to radial head	Elbow joint, fat pads (fat is displaced by fracture hematoma)	Fractures (esp. peds: fat pads, ant. humeral line), DJD (osteophytes)
Oblique	Elbow extended, rotate 30º	Alignment & position of bones	Subtle fx (radial head, occult fx)
Radiocapitellar	Lateral, beam 45º to elbow	Isolates capitellum/radial head	Fx: RH, capitellum, coronoid
		OTHER STUDIES	
CT	Axial, coronal, and sagittal	Articular congruity, bone healing, bone alignment	Fractures (esp. coronoid, comminuted intraarticular fx)
MR	Sequence protocols vary	Soft tissues (ligaments, tendons, cartilage), bones	Ligament (e.g., MCL) & tendon (e.g., biceps) rupture, OCD
Bone scan		All bones evaluated	Infection, stress fractures, tumors



A. Transverse fracture of midshaft
B. Oblique (spiral) fracture
C. Comminuted fracture with marked angulation



After initial swelling subsides, most fractures of shaft of humerus can be t eated with functional brace of interlocking anterior and posterior component held together with Velcro straps

Open reduc on and fixa ion with compression plate indicated under special conditions

Fracture aligned and held with external fixator. Most useful for wounds requiring frequent changes of dressing.

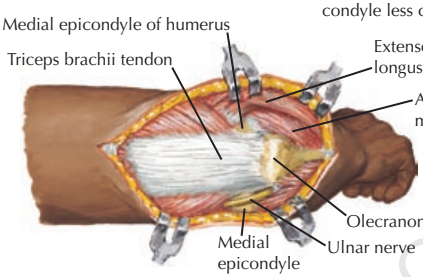
Entrapment of radial nerve in fracture of shaft of distal humerus may occur at time of fracture; must also be avoided during reduction.

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
HUMERUS SHAFT FRACTURE			
• Common long bone fracture • Mechanism: fall or direct blow • Displacement based on fracture location and muscle insertion sites. Pectoralis and deltoid are primary deforming forces. • High union rates • Site of pathologic fractures	**Hx:** Trauma/fall. Pain and swelling **PE:** Swelling +/− deformity, humerus is tender. Good neuro. exam (esp. radial n.) **XR:** AP & lateral of arm (also shoulder & elbow series) **CT:** Not usually needed	Descriptive: • Location: site of fx Displaced, angulated, or comminuted • Pattern: transverse, spiral, oblique	• Cast/brace: minimally displaced • Acceptable: <3cm shortening <20° A/P angulation <30° varus/valgus angulation • Surgical treatment: open fx, floating elbow, segmental fx, polytrauma, vascular injury • Options: ORIF, external fixation, IM nail
COMPLICATIONS: Radial nerve palsy (esp. distal ⅓ fractures [Holstein-Lewis]): most are neuropraxia and resolve Spontaneously; nerve exploration is controversial; nonunion/malunion are uncommon.			

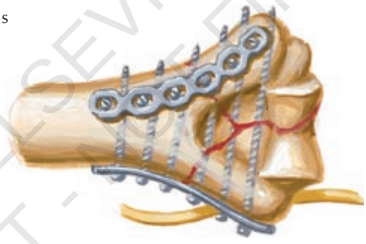
Intercondylar (T or Y) fracture of distal humerus

Fracture of lateral condyle of humerus. Fracture of medial condyle less common

Fractured condyle fixed with one or two compression screws



Open (transolecranon) repair. Posterior incision skirts medial margin of olecranon, exposing triceps brachii tendon and olecranon. Ulnar nerve identified on poster or surface of medial epicondyle. Incisions made along each side of olecranon and triceps brachii tendon



Articular surface of distal humerus reconstructed and fixed with transverse screw and buttress plates with screws. Ulnar nerve may be transposed anteriorly to prevent injury. Lateral column fixed with posterior plate and medial column fixed with plate on the medial ridge.

Olecranon osteotomized and reflected proximally with triceps brachii tendon

Olecranon reattached with longitudinal Kirschner wires and tension band wire wrapped around them and through hole drilled in ulna

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
DISTAL HUMERUS FRACTURE			
• Most often intraarticular (adults); extraarticular (supracondylar) fx uncommon in adults • Mechanism: fall • Unicondylar or bicondylar • Other: epicondyle, capitellum, trochlea fxs all less common	**Hx:** Trauma/fall. Pain, esp. w/elbow ROM (decreased) **PE:** Swelling & tenderness Good neurovascular exam **XR:** Elbow series **CT:** Essential for complete evaluation of fracture/joint	Descriptive: • Uni or bicondylar • T, Y, lambda type • Displaced, angulated comminuted (esp. coronal split)	• Nonoperative: rarely indicated • Surgical: ORIF (plates & screws) • Ulnar nerve often needs to be transposed anteriorly • Early ROM is important • Total elbow arthroplasty: if fx is too comminuted for ORIF
COMPLICATIONS: Elbow stiffness, heterotopic ossification (prophylaxis is indicated), ulnar nerve palsy, nonunion			

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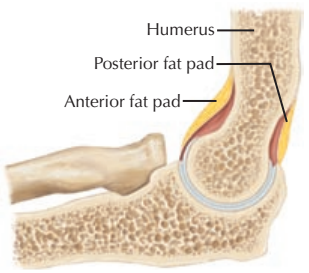
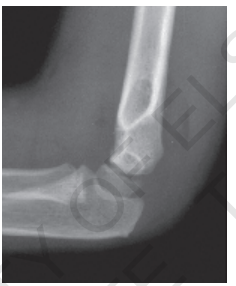
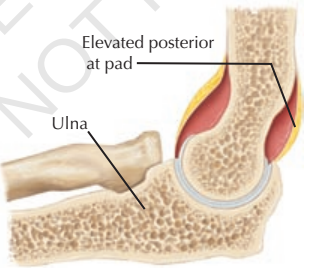
Extension type
Posterior displacement of distal fragment (most common)

Lateral radiograph

Flexion type
Anterior displacement of distal fragment (uncommon)







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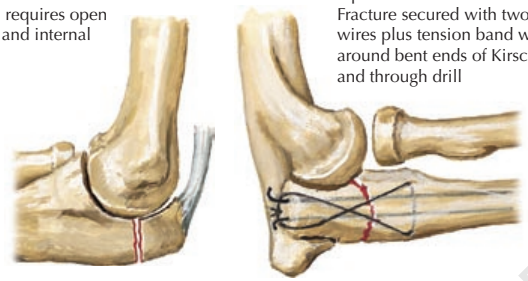
Lateral radiograph of elbow in a 5-year-old sustaining injury to left elbow. Radiograph shows elevation of anterior and posterior fat pads. No appa ent fracture on this view, but subsequent radiographs confirmed presence of a nondisplaced supracondylar humerus fracture.

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
SUPRACONDYLAR HUMERUS FRACTURE			
• Common pediatric fracture • Extraphyseal fx at thin portion of bone (1mm) between distal humeral fossae • Extension type most common • Malreduction leads to deformity: cubitus varus is most common • Relatively high incidence of neurovascular injury	**Hx:** Fall. Pain, +/− deformity **PE:** Swelling +/− deformity. Good neurovascular exam (esp. AIN, radial n., pulses) **XR:** Elbow series. Lateral view: anterior humeral line is anterior to capitellum center in displaced fxs. Post. fat pad indicates fx.	• Extension type (Gartland) ◦ Nondisplaced ◦ Partially displaced (post. cortex intact) ◦ Displaced (no cortical continuity) • Flexion type (uncommon)	• Type I: Long arm cast • Types II & III: Closed reduction & percutaneous pinning, 2 or 3 pins (crossed or divergent) Medial pins can injure ulnar n. • Open reduction for irreducible fractures (uncommon) • Explore pulseless/unperfused extremity for artery entrapment
COMPLICATIONS: Malunion (cubitus varus #1); neurovascular (median nerve/AIN #1, radial nerve, brachial artery)			

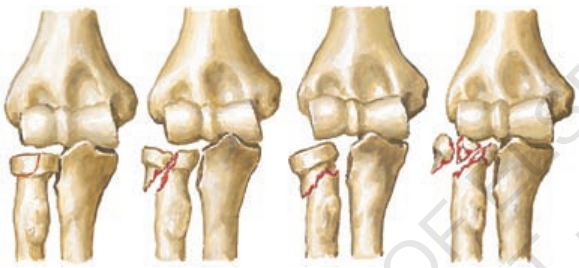
Olecranon fracture

Displaced fracture of olecranon requires open reduction and internal fixation

Open reduction of olecranon fracture. Fracture secured with two Kirschner wires plus tension band wire passed around bent ends of Kirschner wires and through drill



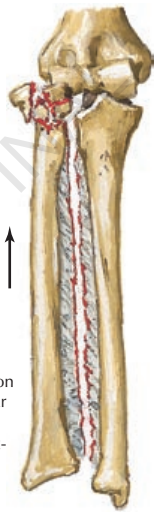
Fracture of head and neck of radius



Type I: nondisplaced or minimally displaced.

Type II: displaced single fragment (usually >2 mm) of the head or angulated (usually >30°) of the neck.

Type III: severely comminuted fractures of the radial head and neck.



Comminuted fracture of radial head with dislocation of distal radioulnar joint, proximal migration of radius, and tear of interosseous membrane (Essex-Lopresti fracture)

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
RADIAL HEAD FRACTURE			
• Mechanism: fall onto hand • Intraarticular fracture: anterolateral portion is weaker and is most common fracture site • Essex-Lopresti: RH fx w/disruption of IM membrane & DRUJ • Associated w/elbow dislocation	**Hx:** Trauma/fall. Pain **PE** Decreased motion (esp. pronosupination) Check DRUJ stability **XR:** Elbow series; radiocapitellar view is helpful, +/− fat pad sign **CT:** Useful in types II-IV	Mason: 4 types • I: Nondisplaced (<2mm) • II: Single displaced fragment • III: Comminuted • IV: Fracture with elbow dislocation	• Type I: Elbow aspiration, sling for 3 days, early ROM • Type II: ORIF (esp. for mechanical block to motion) • Type III: Radial head excision and/or RH arthroplasty • Essex-Lopresti: radial head arthroplasty is required
COMPLICATIONS: Elbow stiffness or instability; Wrist instability (Essex-Lopresti)			
OLECRANON FRACTURE			
• Mechanism: Fall directly onto elbow or fall onto hand • Intraarticular fracture: congruity important for good results • Triceps tendon is a deforming force on proximal fragment	**Hx:** Trauma (usually fall). Pain and swelling **PE:** Tenderness, limited elbow extension. Neuro exam, esp. ulnar nerve **XR:** Elbow series **CT:** Better defines fracture	Colton: • I. Undisplaced: <2mm • II. Displaced ◦ Avulsion ◦ Transverse/oblique ◦ Comminuted ◦ Displaced fx-dx	• Undisplaced: Long arm cast 3 weeks, then gentle ROM • Displaced: Transverse: ORIF tension band or IM screw. Oblique/comminuted: ORIF with contoured plate • Excision & reattach tendon
COMPLICATIONS: Painful hardware, Elbow stiffness, Nonunion, Arthritis (post-traumatic), Ulnar nerve injury			

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Elbow dislocation

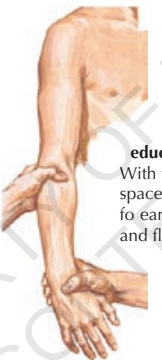
Posterior dislocation. Note prominence of olecranon posteriorly and distal humerus anteriorly.

Divergent dislocation, anterior-posterior type (rare). Medial-lateral type may also occur (extremely rare).

Lateral dislocation (ncommon)

Radial head subluxation

Dislocation of radius at elbow



eduction:
With thumb in antecubital space as a fulcrum, the fo earm is supinated and flexed

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
ELBOW DISLOCATION			
• Mech: usually a fall in young pt • #3 most common islocation • Associated with fractures: "Terrible triad" = elbow dx with radial head & coronoid fractures • Collateral ligaments & anterior capsule are typically all torn	**Hx:** Trauma/fall. Inability to move elbow **PE:** Swelling, deformity, limited/no elbow RO Good neurovasc. exam **XR:** Elbow series **CT:** To define assoc. fxs	By direction of forearm bones: • Posterior ◦ Posterolateral (>80%) • Medial • Lateral (rare) • Anterior (rare) • Divergent (rare)	• Acute: closed reduction ◦ Stable: splint for 7-10d ◦ Unstable: splint for 2-3wk • Open reduction for irreducible dxs and/or ORIF fxs • Hinged external fixation for grossly unstable elbows
COMPLICATIONS: Elbow stiffness and instability, neurovascular injury (median and ulnar nerves, brachial artery)			
RADIAL HEAD SUBLUXATION (NURSEMAID'S ELBOW)			
• Mech: usually a pull on the hand by an adult • Very common in toddlers • Decreased with increasing age • Annular ligament stretches & radial head subluxates	**Hx:** Child pulled by hand, child will not use arm **PE:** Elbow flexed, pronated. RH tender **XR:** Elbow series; normal, often not needed	None	• Closed reduction: fully extend elbow, fully supinate, then flex with gentle pressure on radial head. Usually a click or pop is felt as it reduces. • Immobilization rarely indicated
COMPLICATIONS: Recurrence			

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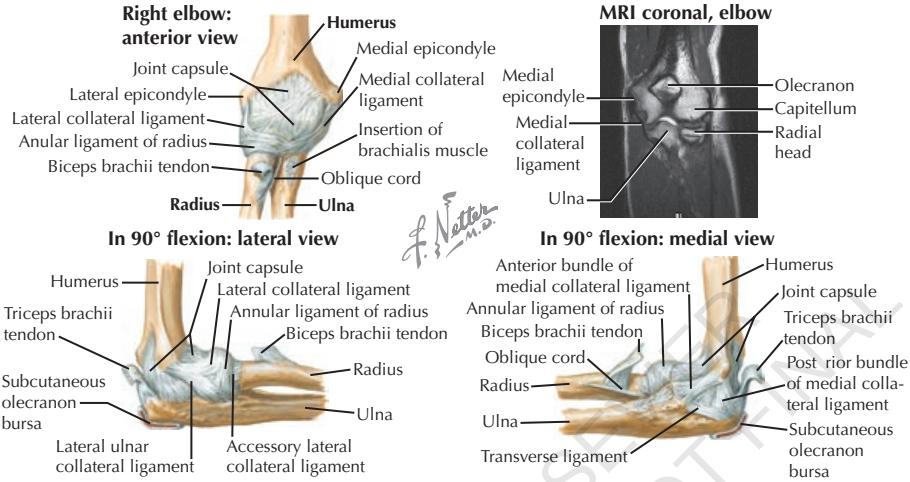
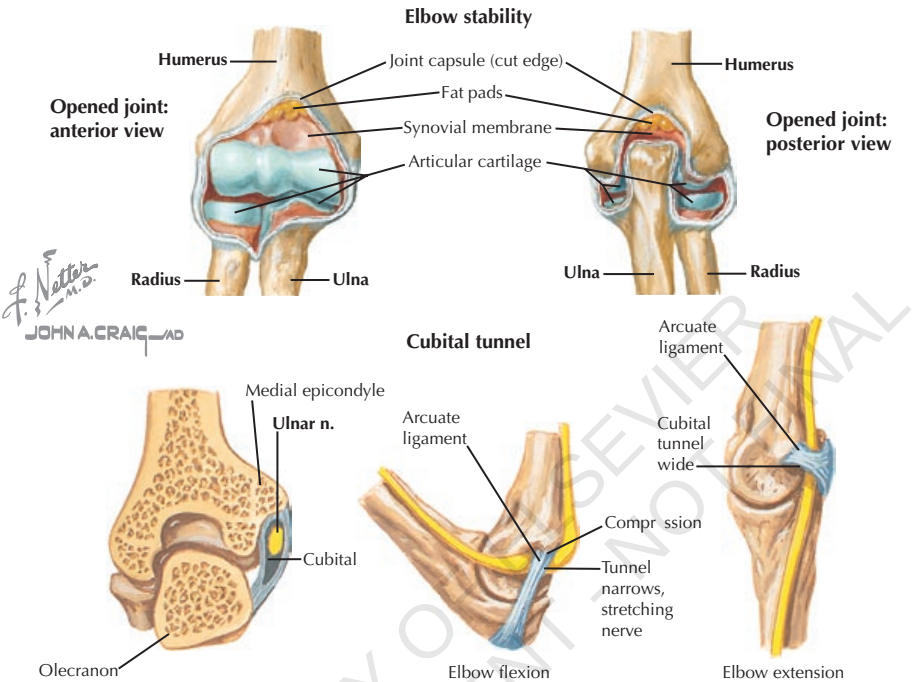
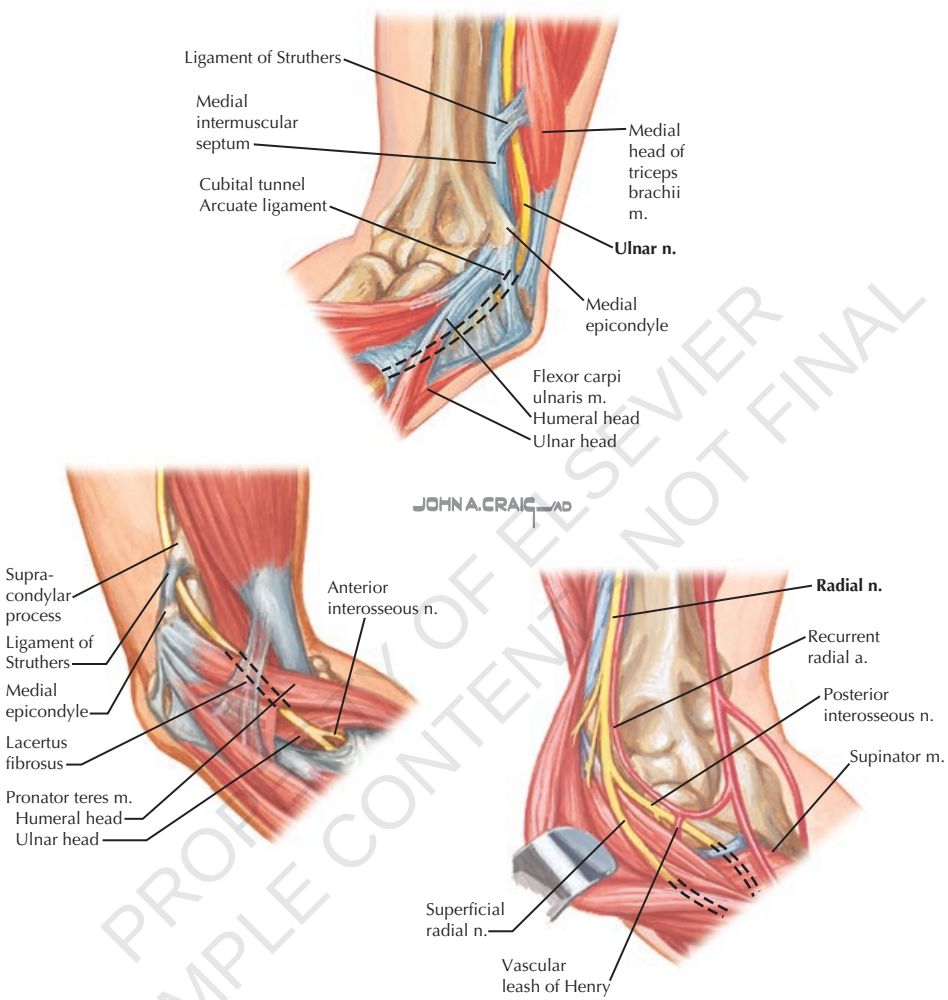


LIGAMENTS	ATTACHMENTS	COMMENTS
ELBOW		
The elbow comprises three articulations: 1. Ulnohumeral (trochlea and greater sigmoid notch): Ginglymus (hinge) joint; 2. Radiocapitellar (radial head and capitellum): Trochoid (pivot) joint; 3 Proximal radioulnar (radial head and lesser sigmoid notch) Primary function is as a lever for lifting and placing the hand appropriately in space Two primary motions: 1. Flexion and extension: 0-150º (functional ROM: 100º [30-130º]); axis is the trochlea; 2. Pronosupination: 70º pro. – 80º sup. (functional ROM: 100º [50 pro. – 50 sup.]); axis is RC joint Stability provided by combination of osseous (articulations) and ligamentous restraints; carrying angle 11-16º valgus		
Medial (Ulnar) Collateral (MCL)		
Anterior bundle	Inferior medial epicondyle to medial coronoid process ("sublime tubercle")	Most important restraint to valgus stress, always taut; usually ruptures off coronoid
Posterior bundle	Medial epicondyle to sigmoid notch	Taut in/resists valgus in flexion (>90º)
Transverse (oblique bundle)	Medial olecranon to inferior medial coronoid	Stabilizes the greater sigmoid notch
Lateral (Radial) Collateral (LCL)		
Lateral collateral (LCL)	Lateral epicondyle to anterior annular ligament	Varus restraint; stabilizes annular ligament
Lateral ulnar collateral (LUCL)	Lateral epicondyle to supinator crest of the ulna	Buttress to radial head subluxation; injury results in posterolateral rotatory instability
Accessory lateral collateral	Annular ligament to supinator crest (ulna)	Stabilizes annular ligament during varus stress
Annular ligament	Anterior and posterior portions of sigmoid notch	Allows radial head rotation; stretched or torn in radial head subluxation or dislocation
Other		
Capsule	Surrounds joint	Secondary stabilizer, prone to contracture
Quadrate ligament	Anterolateral ulna to anterior radial neck (under the annular ligament)	Tight in supination, stabilizes the proximal radioulnar joint (PRUJ)
Oblique cord	Proximal lateral ulna to radial neck	Stabilizes joint during pronosupination

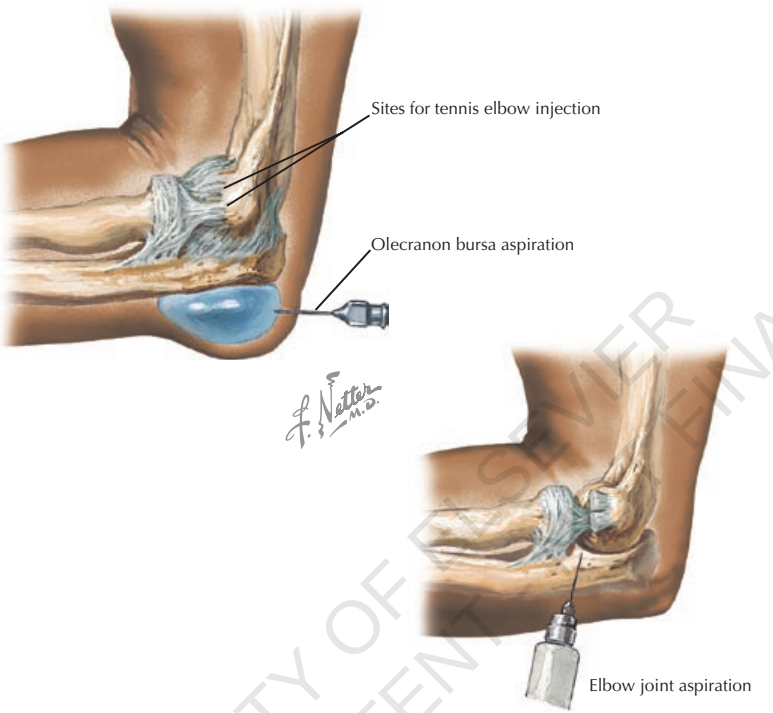


ELBOW STABILITY	
Primary Stabilizers	
Ulnohumeral articulation	Primary restraint to valgus: <20° or >12° of flexion Primary restraint to varus: in extension (2° in flexion)
Medial collateral ligament (MCL) (esp. anterior bundle)	Primary restraint to valgus: between 20-120° of flexion Anterior bundle is always taut, post. bundle taut >90°
Lateral collateral ligament (LCL) (esp. lateral ulnar collateral ligament [LUCL])	Primary restraint to varus: in flexion (2° in extension) LUCL prevents subluxation of radial head (e.g., PLRI)
Secondary Stabilizers	
Radiocapitellar articulation (radial head)	Restraint to valgus from 0-30º of flexion
Anterior and posterior capsule	Restraint to both varus and valgus stress
Common flexor and extensor origins	Dynamic forces act to restrain both varus and valgus stress

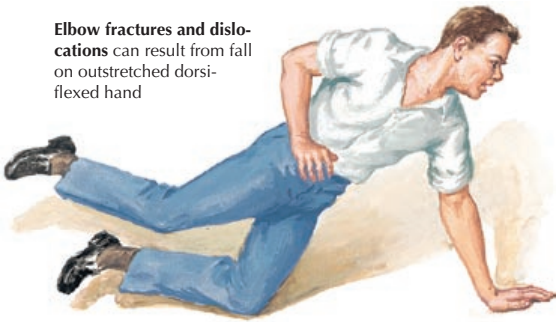
STRUCTURE	COMPONENTS	COMMENTS
CUBITAL TUNNEL		
Borders	• Roof: Arcuate (Osborne's) ligament • From med. epicondyle to olecranon • Floor: Medial collateral ligament (MCL) • Posterior: Medial head of the triceps • Anterior: Medial epicondyle • Lateral: Olecranon	• Tightens in flexion, compresses ulnar nerve within cubital tunnel • Can be injured in decompression surgery • Does not typically compress the nerve • Medial epicondylectomy occasionally indicated • Does not compress nerve
Contents	• Nerve: Ulnar nerve	• Compressed in cubital tunnel syndrome
Fractures (malunion) of the medial condyle can cause ulnar nerve entrapment in the cubital tunnel. Arcuate ligament is also known as Osborne's ligament/fascia and the cubital tunnel retinaculum. See Forearm chapter for radial tunnel.		



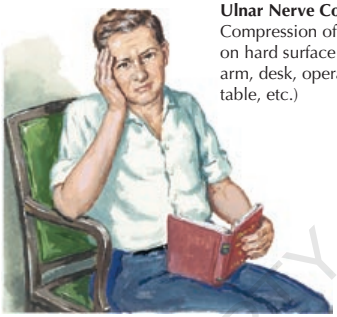
STRUCTURE	DESCRIPTION	COMMENTS
OTHER STRUCTURES		
Fat pads	Located in both the coronoid and olecranon fossae, engaged in full flexion or extension	Can be displaced by fracture hematoma and see on x-ray as a lucency ("sail sign")
Olecranon bursa	At the tip of the olecranon process	Can become inflamed or infected
Ligament of Struthers	A fibrous band running from an anomalous supracondylar process to medial epicondyle	Can compress the median nerve proximally
Biceps aponeurosis (lacertus fibrosis)	Fascial band from distal biceps and tendon that runs to deep forearm fascia	Covers median nerve and brachial artery and can compress median nerve
Arcade of Struthers	Thickened fascia from IM septum to triceps (medial head), 8cm proximal to epicondyle	Occurs in 70% of population; can compress ulnar nerve proximal to cubital tunnel
Leash of Henry	Branches of recurrent radial artery	Can compress radial nerve/PIN



STEPS
Elbow Arthrocentesis
1. Flex and extend elbow, palpate lateral condyle, radial head, and olecranon laterally; feel triangular sulcus ("soft spot") between all three 2. Prep skin over sulcus (iodine/antiseptic soap) 3. Anesthetize skin locally (quarter size spot) 4. May keep arm in extension or flex it. Insert needle in "triangle" between bony landmarks (aim to medial epicondyle) 5. Fluid should aspira e easily 6. Dress injection site
Olecranon Bursa Aspiration
1. Prep skin over olecranon (iodine/antiseptic soap) 2. Anesthetize skin locally (quarter size spot) 3. Insert 18-gauge needle into fluctuant portion of the bursa and aspirate fluid 4. If suspicious of infection, send fluid for Gram stain and culture 5. Dress injection site
Tennis Elbow Injection
1. Ask patient about allergies 2. Flex elbow 90º, palpate ECRB insertion (point of maximal tenderness) on the lateral epicondyle 3. Prep skin over lateral elbow (iodine/antiseptic soap) 4. Anesthetize skin locally (quarter size spot) 5. Insert 22-gauge or smaller needle into ERCB tendon at its insertion on the lateral epicondyle. Aspirate to ensure needle is not in a vessel, then inject 2-3ml of 1:1 local/corticosteroid preparation (fan out injection in broad tendon). 6. Dress insertion site 7. Annotate improvement in symptoms



Elbow fractures and dislocations can result from fall on outstretched dorsiflexed hand



Ulnar Nerve Compression
Compression of nerve on hard surface (chair arm, desk, operating table, etc.)

Numbness and tingling in ulnar nerve distribution in hand. Interosseous wasting between thumb and index finger

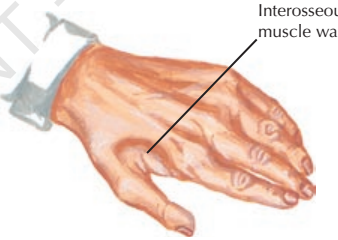
QUESTION	ANSWER	CLINICAL APPLICATION
1. Age	Young Middle age, elderly	Dislocation, fracture Tennis elbow (epicondylitis), nerve compression, arthritis
2. Pain a. Onset b. Location c. Occurrence	Acute Chronic Anterior Posterior Lateral Medial Night pain / at rest With activity	Dislocation, fracture, tendon avulsion/rupture, ligament injury Arthritis, cervical spine pathology Biceps tendon rupture, arthritis, elbow contracture Olecranon bursitis (inflammatory or septic) Lateral epicondylitis, fracture (especially radial head) Medial epicondylitis, nerve entrapment, fracture, MCL strain Infection, tumor Ligamentous and/or tendinous etiology
3. Stiffness	Without locking With locking	Arthritis, effusions (trauma), contracture Loose body, lateral collateral ligament injury
4. Swelling	Over olecranon	Olecranon bursitis. Other: dislocation, fracture, gout
5. Trauma	Fall on elbow, hand	Dislocation, fracture
6. Activity	Sports, repetitive motion Throwing	Epicondylitis, ulnar nerve palsy MCL strain or rupture
7. Neurologic symptoms	Pain, numbness, tingling	Nerve entrapments (multiple possible sites), cervical spine pathology, thoracic outlet syndrome
8. History of arthritides	Multiple joints involved	Lupus, rheumatoid arthritis, psoriasis, gout

Subluxation of head of radius
("pulled elbow"/ "nursemaids")

Olecranon bursitis
(student's elbow)

Epicondylitis (tennis elbow)
Exquisite tenderness over lateral or medial epicondyle of humerus

Cubitus varus deformity
Malunion of a supracondylar fracture can result in this deformity.



EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
INSPECTION		
Unwilling to use arm	Observe patient (child)	Fracture, dislocation, radial head subluxation (nursemaid's elbow)
Gross deformity, swelling	Compare both sides	Dislocation, fracture, bursitis
Carrying angle (normal 5-15°)	Negative (<5°) Positive (>15°)	Cubitus varus (e.g., supracondylar fracture) Cubitus valgus (e.g., lateral epicondyle fracture)
Muscle wasting	Inspect hand muscles	Nerve entrapment (e.g., cubital tunnel syndrome)
PALPATION		
Medial	Epicondyle and supracondylar line Ulnar nerve in ulnar groove	Pain: medial epicondylitis (golfer's elbow), fracture, MCL rupture/strain Paresthesias indicate ulnar nerve entrapment
Lateral	Epicondyle and supracondylar line Radial head	Pain: lateral epicondylitis (tennis elbow), fracture Pain: arthritis, fracture, synovitis
Anterior	Biceps tendon in antecubital fossa	Pain: absence of tendon indicates biceps tendon rupture
Posterior	Flex elbow: olecranon, olecranon fossa, triceps tendon	Olecranon bursitis, triceps tendon rupture

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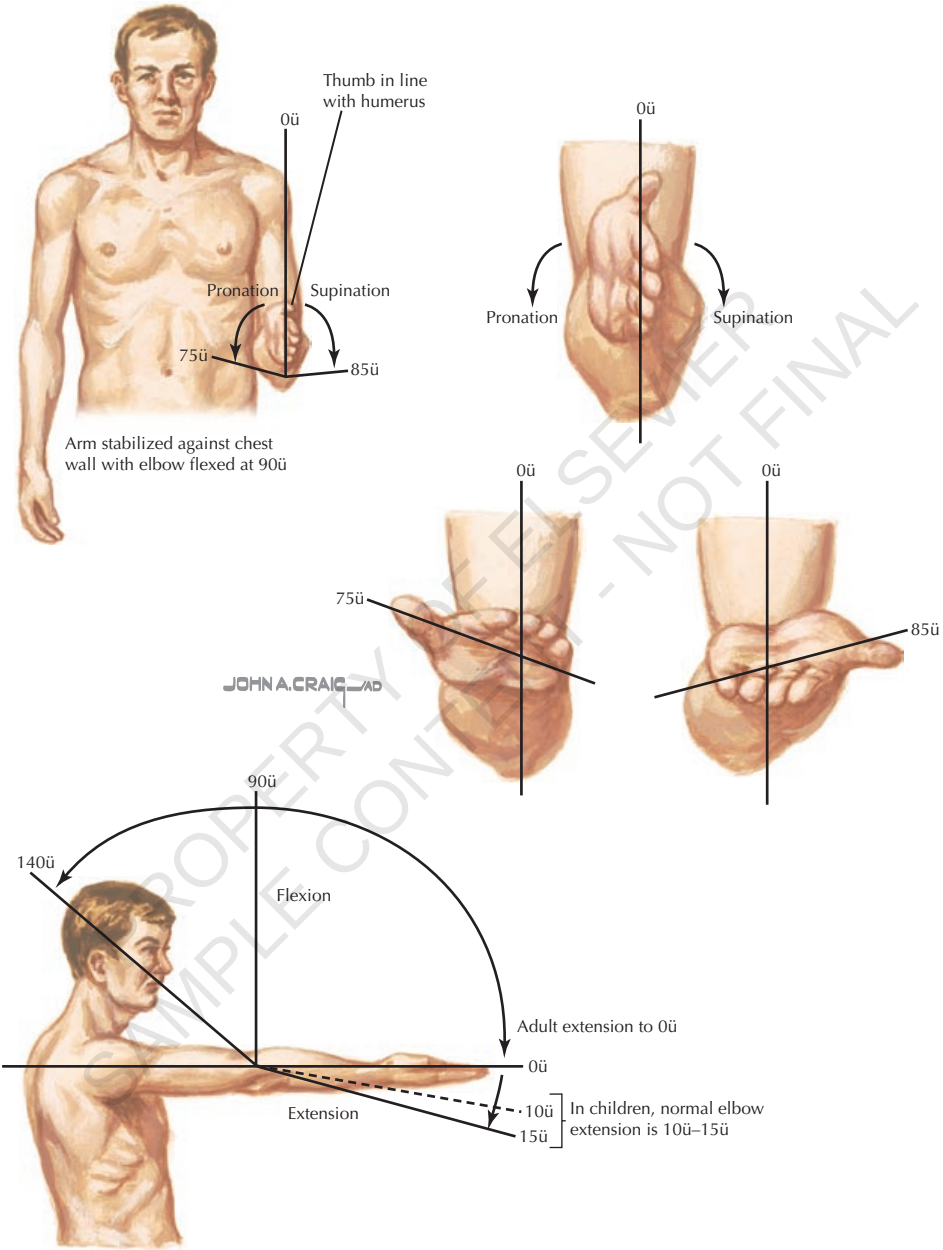
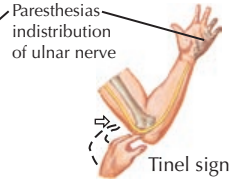
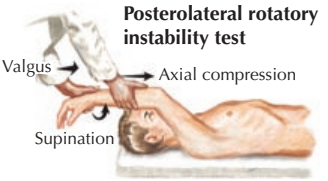
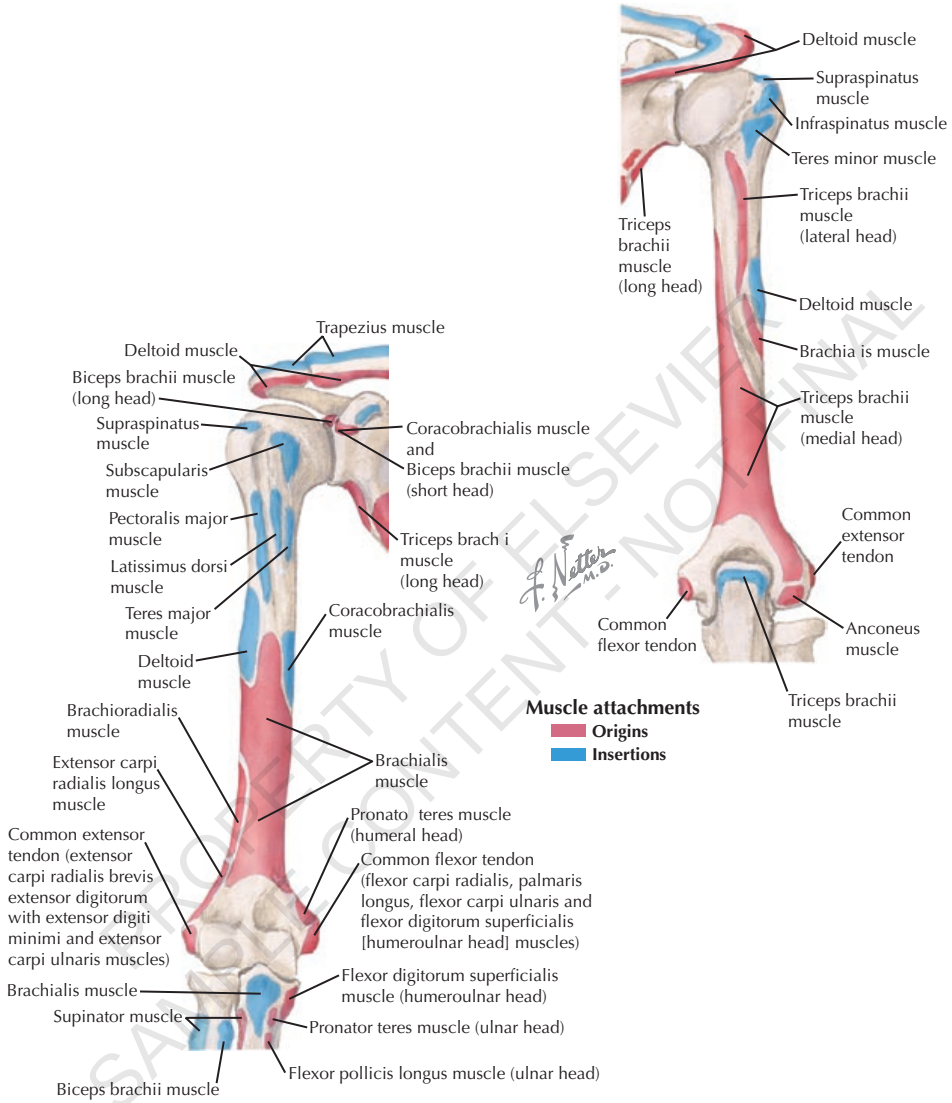


EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	RANGE OF MOTION	
Flex and extend	Elbow at side: flex and extend at elbow	Normal: 0° to 140-150°; note if PROM >AROM
Pronate and supinate	Tuck elbows, thumbs up, rotate forearm	Normal: supinate 80-85°, pronate 75-80°

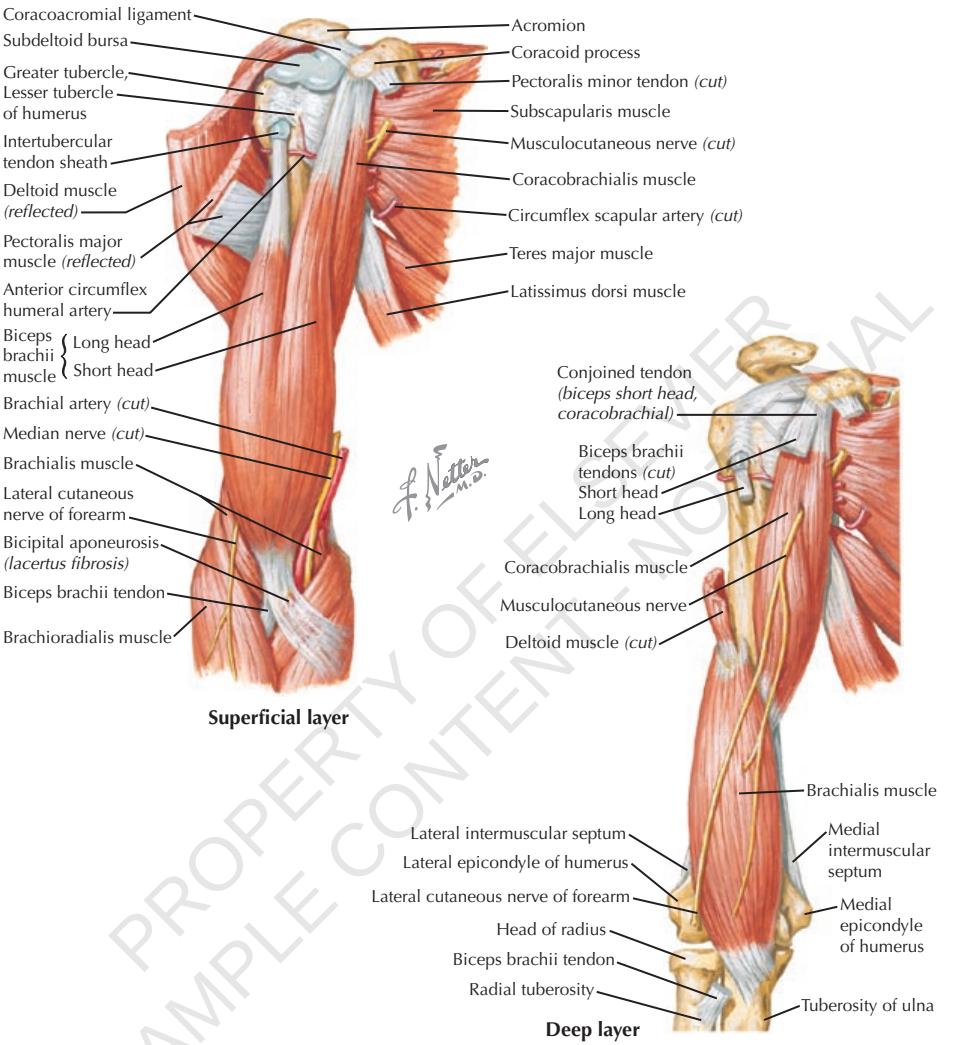




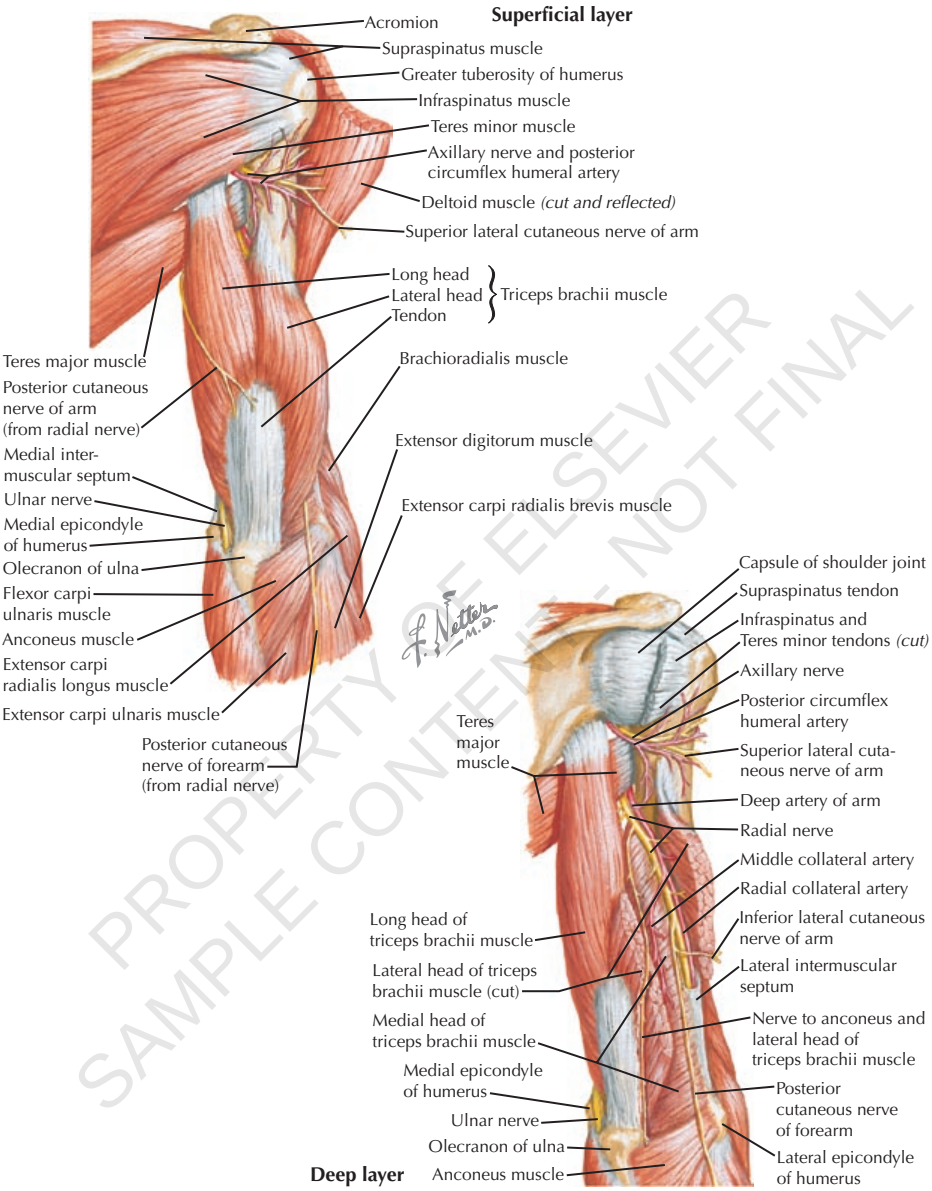
EXAM/ OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
NEUROVASCULAR		
Sensory (Light Touch, Pinprick, 2pt)		
Axillary n. (C5)	Proximal arm	Deficit indicates corresponding nerve/root lesi n
Radial n. (C5)	Inferolateral and posterior arm	Deficit indicates corresponding nerve/root lesion
Medial cutaneous n. of arm (T1)	Medial arm	Deficit indicates corresponding nerve/root lesion
Motor		
Musculocutaneous n. (C5-6)	Resisted elbow flexion	Weakness = Brachiali /biceps or corresponding nerve/ root lesion
Musculocutaneous n. (C6)	Resisted supination	Weakness = Biceps or corresponding nerve/root lesion
Median n. (C6)	Resisted pronation	Weakness = Pronator teres or corresponding nerve/ root lesion
Median n. (C7)	Resisted wrist flexion	Weakness = FCR or corresponding nerve/root lesion
Radial n. (C7)	Resisted elbow extension	Weakness = Triceps or corresponding nerve/root lesion
Radial n. /PIN (C6-7)	Resisted wrist extension	Weakness = ECRL-B or corresponding nerve/root lesion
Ulnar n. (C8)	Resisted wrist flexion	Weakness = FCU or corresponding nerve/root lesion
Reflexes		
C5	Biceps	Hypoactive/absence indicates radiculopathy
C6	Brachioradialis	Hypoactive/absence indicates radiculopathy
C7	Tr ceps	Hypoactive/absence indicates radiculopathy
Pulses: brachial, radial, ulnar		
SPECIAL TESTS		
Tennis elbow	Make fist, pronate, extend wrist and fingers against resistance	Pain at lateral epicondyle suggests lateral epicondylitis
Golfer's elbow	Supinate arm, extend wrist and elbow	Pain at medial epicondyle suggests medial epicondylitis
Ligament instability	25° flexion, apply varus/valgus stress	Pain or laxity indicates LCL/MCL damage
Pivot shift (PLRI)	Supine, extend elbow, flex shoulder above head. Supinate, axial load, valgus and flex elbow	Apprehension, palpable subluxation of radial head, or dimpling of skin over radial head positive test for pos- terolateral rotatory instability
Tinel's sign (at the elbow)	Tap on ulnar groove (nerve)	Tingling in ulnar distribution indicates entrapment
Elbow flexion	Maximal elbow flexion for 3 min	Tingling in ulnar distribution indicates entrapment
Pinch grip	Pinch tips of thumb and index finger	Inability (or pinching of pads, not tips) indicates AIN pathology



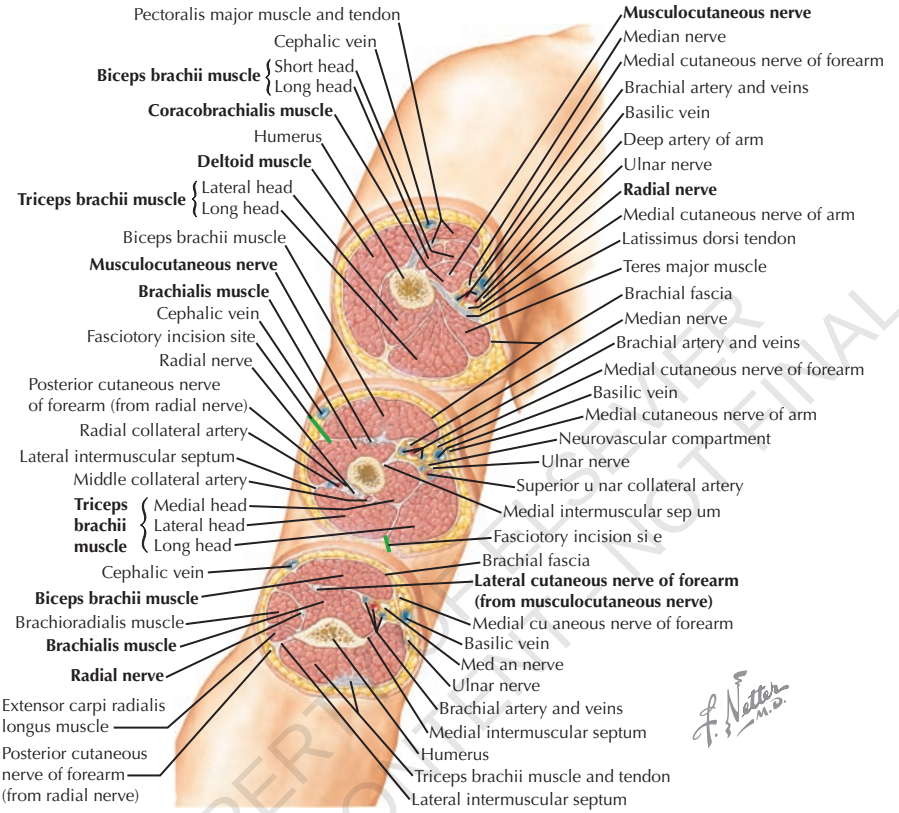
CORACOID PROCESS	GREATER TUBEROSITY	ANTERIOR PROXIMAL HUMERUS	MEDIAL EPICONDYLE	LATERAL EPICONDYLE
ORIGINS				
Biceps (SH) Coracobrachialis			Pronator teres Common flex. tendon (FCR, PL, FCU, FDS)	Anconeus Common ext. tendon (ECRB, EDC, EDQ, ECU)
INSERTIONS				
Pectoralis minor	Supraspinatus Infraspinatus Teres minor	Pectoralis major Latissimus dorsi Teres major		



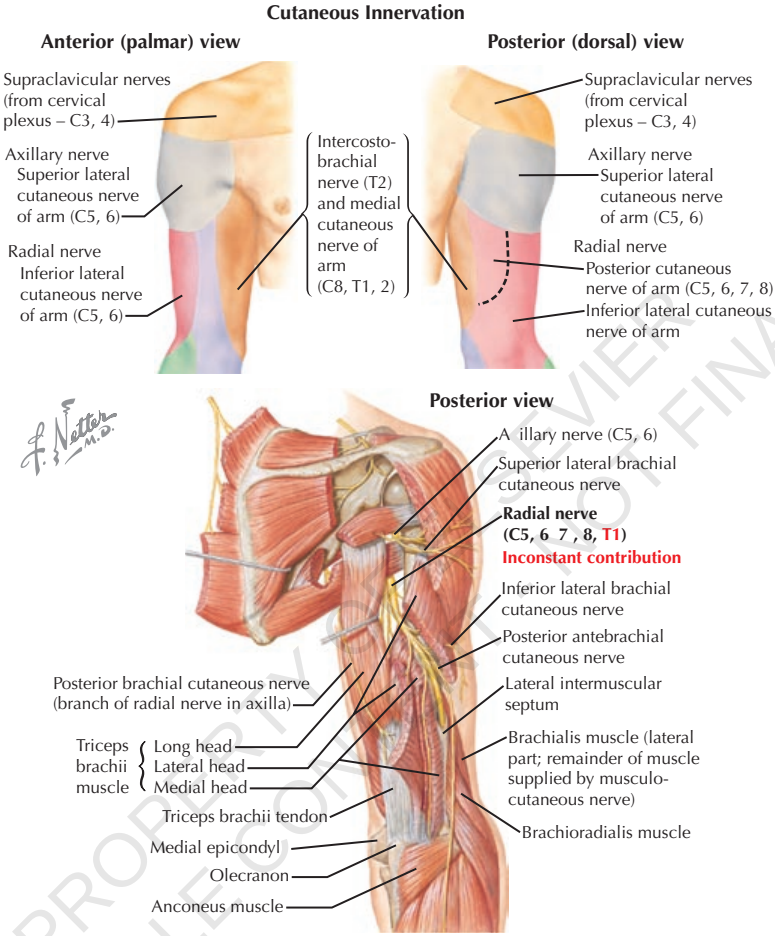
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Coracobrachialis	Coracoid process	Middle humerus	Musculocutaneous	Flex and adduct arm	Insertion part of "conjoined" tendon
Brachialis	Distal anterior humerus	Ulnar tuberosity (proximal ulnar)	Medial: MSC n. Lateral: Radial n.	Flex forearm	Often split in anterior surgical approach
Biceps brachii					
Long head	Supraglenoid tubercle	Radial tuberosity (proximal radius)	Musculocutaneous	Supinate and flex forearm	Can rupture, results in "Popeye arm"
Short head	Coracoid process				Part of "conjoined" tendon



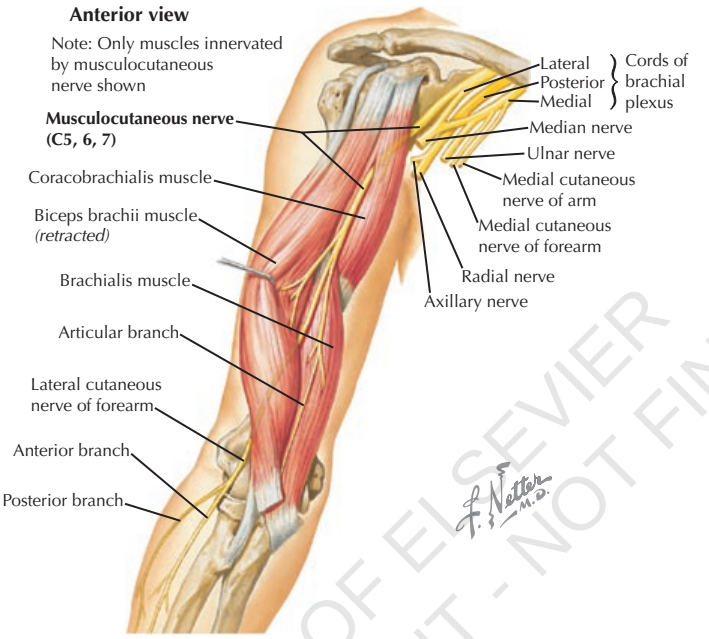
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Triceps brachii					
Long head	Infraglenoid tubercle				Border of quadrangular & triangular space & interval
Lateral head	Posterior humerus (proximal)	Olecranon	Radial nerve	Extends forearm	Border in lateral approach
Medial head	Posterior humerus (distal)				One muscular plane in posterior approach



STRUCTURE	RELATIONSHIP
RELATIONSHIPS	
Musculocutaneous n.	Pierces coracobrachialis 8cm distal to coracoid, then lies b/w the biceps and brachialis muscles where lateral antebrachial cutaneous nerve (terminal branch) emerges
Radial n.	Starts medial, then spirals posteriorly and laterally around humerus (in spiral groove) and emerges b/w brachialis and brachioradialis muscles in distal lateral arm
Ulnar n.	In medial arm, crosses from anterior to posterior compartment (across IM septum) into cubital tunnel
Median n.	In anteromedial arm, initially lateral to brachial artery, but crosses over it to become medial
Brachial n.	Runs with median nerve, then crosses under it to become more midline in distal arm/elbow
COMPARTMENTS	
Anterior	Muscles: brachialis, biceps brachii, coracobrachialis Neurovascular: musculocutaneous nerve, median nerve, brachial artery, radial nerve (distally)
Posterior	Muscles: triceps brachii Neurovascular: radial nerve (mid arm), ulnar nerve (distal arm), radial recurrent arteries
FASCIOTOMIES	
Anterior incision	Release the anterior compartment
Posterior incision	Release the posterior compartment



BRACHIAL PLEXUS
Lateral and Medial Cord
Median (C[5]6- 1): runs in medial arm (anterior compartment), medial to biceps and brachialis (lateral to brachial artery), then crosses over (medial) to artery and enters forearm under biceps aponeurosis (lacertus fibrosis) *Sensory:* None (in arm, see Hand chapter) *Motor:* None (in arm, see Forearm & Hand chapters)
Posterior Cord
Radial (C5-T1): starts medial to humerus, crosses posterior into spiral groove (where it can be entrapped in a humerus fracture, esp. distal ⅓ fractures) with deep artery of the arm, then exits between the brachioradialis & brachialis, then divides into deep (motor–PIN) and superficial (sensory) branches *Sensory:* Posterior arm: via posterior cutaneous n. of arm (posterior brachial cutaneous) Lateral arm: via inferior lateral cutaneous n. of arm *Motor:* Posterior compartment: triceps brachii Anterior compartment: brachialis (lateral portion)



BRACHIAL PLEXUS
Lateral Cord
Musculocutaneous (C5-7): pierces coracobrachialis (6-8cm below Coracoid, where it is at risk from retraction of the conjoined tendon) then runs between the biceps & brachialis, innerva ing both. Sensory terminal branch exits between the biceps and brachialis at elbow. *Sensory:* None (in arm, see Forearm chapter) *Motor:* Anterior compartment ◦ Coracobrachialis ◦ Biceps brachii ◦ Brachialis (medial portion)
Medial Cord
Medial cutaneous n. of arm (brachial cutaneous [C8-T1]): branches from the cord, joins intercostobrachial nerve, and runs subcutaneously in the medial arm. *Sensory:* Medial arm *Motor:* None
Ulnar (C[7]8-T1): runs from anterior to posterior compartment in medial arm over the IM septum, then under the arcade of Struthers onto the triceps (medial head), then into cubital tunnel posterior to epicondyle *Sensory:* None (in forearm, see Forearm & Hand chapters) *Motor:* None (in forearm, see Forearm & Hand chapters)

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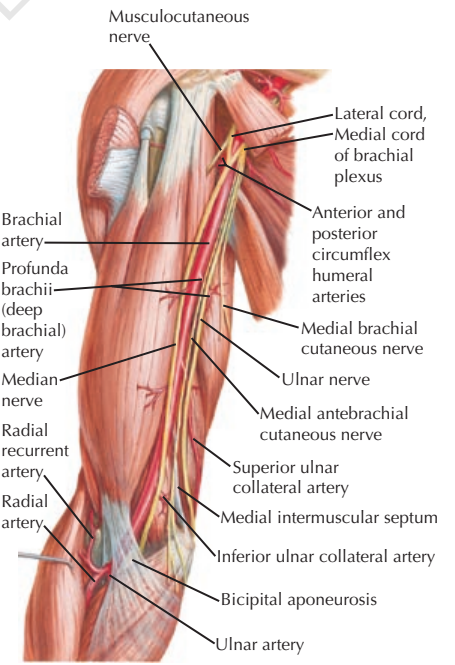
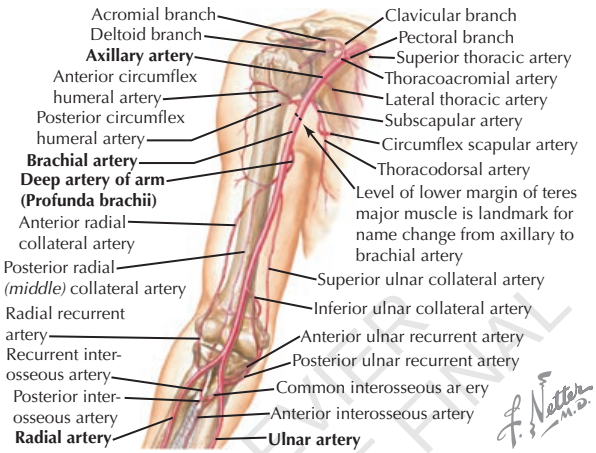
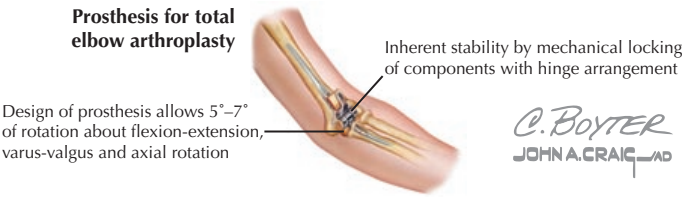


ANASTOMOSES AROUND THE ELBOW	
SUPERIOR	**INFERIOR**
Superior ulnar collateral	Posterior ulnar recurrent
Inferior ulnar collateral	Anterior ulnar recurrent
Middle collateral (branch of deep artery)	Interosseous recurrent
Radial collateral (branch of deep artery)	Radial recurrent

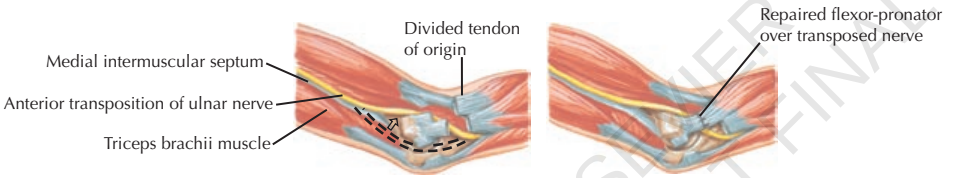


BRANCHES	COURSE	COMMENT/SUPPLY
BRACHIAL ARTERY		
The continuation/terminal branch of the axillary artery when it passes the teres major. It runs medial to the biceps and with (medial to) the median nerve, then crosses under (lateral) the median nerve to be midline at the antecubital fossa.		
Deep artery (profunda brachii)	In the spiral groove	Runs with the radial nerve, can be injured there
Nutrient humeral artery	Enters the nutrient canal	Supplies the humerus
Superior ulnar collateral	With ulnar n. in medial arm	Anastomosis with posterior ulnar recurrent artery
Inferior ulnar collateral	Branches in distal arm	Anastomosis with anterior ulnar recurrent artery
Muscular branches	Usually branch laterally	Supply musculature of the arm
Radial	Terminal branch	One of 2 terminal branches
Ulnar	Terminal branch	One of 2 terminal branches
DEEP ARTERY		
Anterior radial collateral	In anterolateral arm	Anastomosis with radial recurrent artery
Posterior (middle) radial collateral	Posterior to humerus	Anastomosis with recurrent interosseous artery Used as pedicle in lateral arm flap
RADIAL ARTERY		
Radial recurrent	Runs in anterolateral portion of the arm	Anastomosis with anterior radial collateral artery Branches (leash of Henry) can compress radial nerve
ULNAR ARTERY		
Anterior ulnar recurrent	In anteromedial arm	Anastomosis with inferior ulnar collateral artery
Posterior ulnar recurrent	In posteromedial arm	Anastomosis with superior ulnar collateral artery
Common interosseous	Midline branch	Is a trunk with multiple branches
Recurrent interosseous	Posterior to elbow	Anastomosis with posterior radial (middle) collateral artery
Anterior & posterior interosseous	Along intermuscular septum	Supplies forearm musculature
Collateral branches are superior and recurrent branches are inferior in the anastomosis at the elbow. See Chapter 3, Shoulder, for arteries of humeral head.		



Three types of total elbow arthroplasty have been used. Results were better with an unrestrained prosthesis but with 5%–20% incidence of postoperative instability, most patients are now treated with a semi-constrained prosthesis, which has inherent stability by linking of the component usually with a hinge (shown above) or a snap-fit axis arrangement.

Submuscular tranposition of ulnar nerve



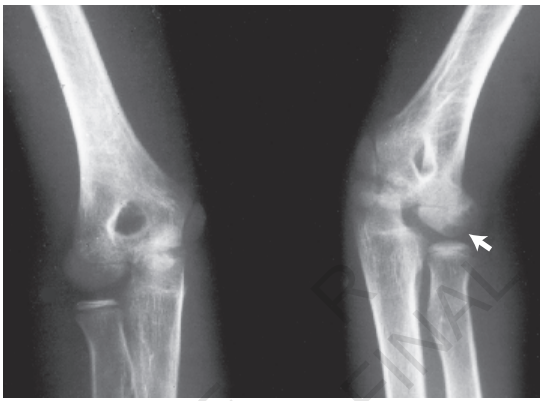
DESCRIPTION	Hx & PE	WORKUP/FINDINGS	TREATMENT
ARTHRITIS			
• Less common condition • Osteoarthritis seen in athletes/laborers • Site for arthritides	**Hx:** Chronic pain, stiffness, +/− previous trauma **PE:** Decreased ROM & tenderness (esp. extension)	• **XR:** OA vs inflammatory • **Blood:** RF, ESR, ANA • **Joint fluid:** crystals, cells, culture	1. Conservative (rest, NSAID) 2. Debridement (osteophytes, LB) 3. Ulnohumeral arthroplasty 4. Total elbow arthroplasty
CUBITAL TUNNEL SYNDROME			
• Entrapment of ulnar nerve at elbow • Sites: ◦ LM septum ◦ Arcade of Struthers ◦ Cubital tunnel ◦ FUC fasc a	**Hx:** Numbness/tingling (+/− pain) in ulnar di - ribution **PE:** +/− decreased grip strength intrinsic atrophy, + Tinel's and/or elbow flexion text	**XR:** Look for abnormal medial epicondyle EMG: Confirms diagnosis	1. Rest, ice, NSAIDs, activity modification 2. Splints (day and/or night) 3. Ulnar nerve transposition
LATERAL EPICONDYLITIS (TENNIS ELBOW)			
• Degenerative or com mon extensor tendons (esp. ECRB) • Due to overuse (e.g., tennis) and/or injury (microtrauma) to tendon	**Hx:** Age 30-60, chronic pain at lateral elbow, worse with wrist/finger extension **PE:** Lateral epicondyle TTP; pain with resisted wrist extension	**XR:** Rule out fracture & OA Calcification of tendons can occur (esp. ECRB)	1. Activity modification ice, NSAIDs 2. Use of brace/strap 3. Stretching/strengthening 4. Corticosteroid injection 5. Surgical debridement of tendon
MEDIAL EPICONDYLITIS (GOLFER'S ELBOW)			
• Degeneration of prona- tor/flexor group (PT & FCR) • Due to injury or overuse	**Hx:** Medial elbow pain **PE:** Focal medial epicon- dyle tenderness, pain with resisted wrist flexion	**XR:** Rule out fracture & OA; calcification of tendons can occur	• Same as tennis elbow • Surgery is less effective than for lateral epicondylitis
OLECRANON BURSITIS			
• Inflammation of bursa (infection/trauma/other)	**Hx:** Swelling, acute or chronic **PE:** Palpable/fluctuant mass at olecranon	**LAB:** Aspirate bursa, send fluid for culture, cell count, Gram stain	1. Compressive dressing 2. Activity modification 3. Corticosteroid injection 4. Surgical debridement

AU: What is LM?

AU: What is FCU? Should it be FCU for flexor carpi ulnaris

Osteochondral lesion of the capitellum

Bone resorption seen as radiolucent areas and irregular surface of capitellum of humerus



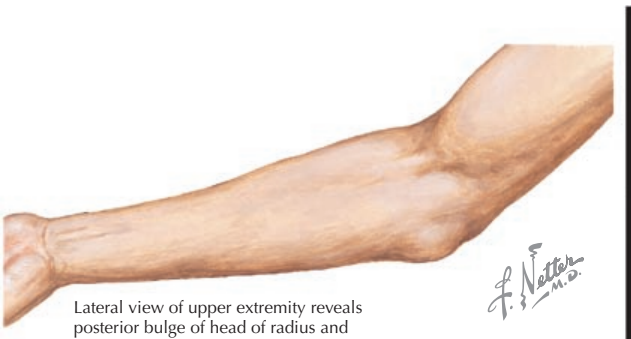
Characteristic changes in capitellum of left humerus (arrow) compared with normal right elbow

DESCRIPTION	Hx & PE	WORKUP/FINDINGS	TREATMENT
DISTAL BICEPS TENDON RUPTURE			
• Mechanism: eccentric overload of partially flexed elbow • Usually male 40-60y.o. • Early diagnosis important weak and/or painful flexion & supination	**Hx:** Acute injury/"pop" **PE:** No palpable tendon,	**XR:** Usually normal **MR:** Can confirm diagnosis but usually not needed	1. Early: primary repair (1 or 2 incision techniques) 2. Late: no surgery; physical therapy: ROM, strengthening
MEDIAL ELBOW INSTABILITY			
• MCL (anterior bundle) injury from repetitive valgus stress • Acute or chronic, associa ed with throwers (baseball, javelin)	**Hx:** Pain with throwing or inability to throw **PE:** MCL tenderness, +/− valgus laxity (30°)	**XR:** Stress view may show widening (usu. dynamic) Postmed. osteophytes. **MR:** Avulsion and tears	1. Rest, activity modification 2. Physical therapy (ROM) 3. Ligament reconstruction & debridement osteophytes/LBs
OSTEOCHONDRITIS DISSECANS OF ELBOW			
• Vascular insufficiency or microtrauma to capitel um • Adolescent throwers/gymnasts with valgus/compressive loads	**Hx:** Lateral elbow pain, +/− catching, stiffness **PE:** Capitellum TTP, pain with valgus stress	**XR:** Lucency, +/− fragmentation of the capitellum **CT:** Helpful to identify loose bodies	1. Rest & physical therapy 2. ORIF of fragments or arthroscopic debridement of loose bodies & chondroplasty
POSTEROLATERAL ROTATORY INSTABILITY			
• Lateral ulnar collateral ligament (LUCL) injury • Allows radial head to subluxate • Mech: traumatic (elbow dx) or iatrogenic (elbow surgery)	**Hx:** Hx of trauma or surgery, pain, +/− clicking **PE:** + lateral pivot shift test (often needs EUA)	**XR:** Often normal **Stress XR:** Shows radial head subluxation **MR:** Identifies LUCL tear	1. Rest, activity modification 2. Physical therapy (ROM) 3. LUCL reconstruction (usually with palmaris graft)
STIFF ELBOW			
• <30-120° • Intrinsic vs extrinsic etiology • Intrinsic: articular changes/ arthrosis (posttraumatic, etc) • Extrinsic: capsule contracture	**Hx:** Trauma, stiffness, minimal pain **PE:** Limited ROM (esp. in flexion and extension)	**XR:** AP/lateral/oblique Look for osteophytes or other signs of intrinsic joint arthrosis	1. Physical therapy: ROM 2. Operative: Intrinsic: excise osteophytes, loose bodies, etc. Extrinsic: capsular release

AU: What is LBs? Lamellar bodies? Loose bodies?

AU: What is EUA? Exam under anesthesia?

Congenital dislocation of radial head

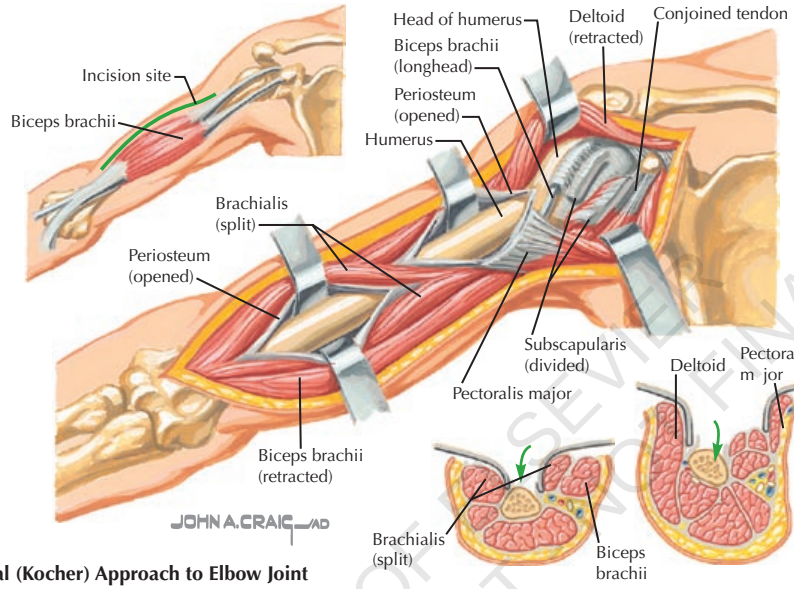


Lateral view of upper extremity reveals posterior bulge of head of radius and inability to fully extend elbow

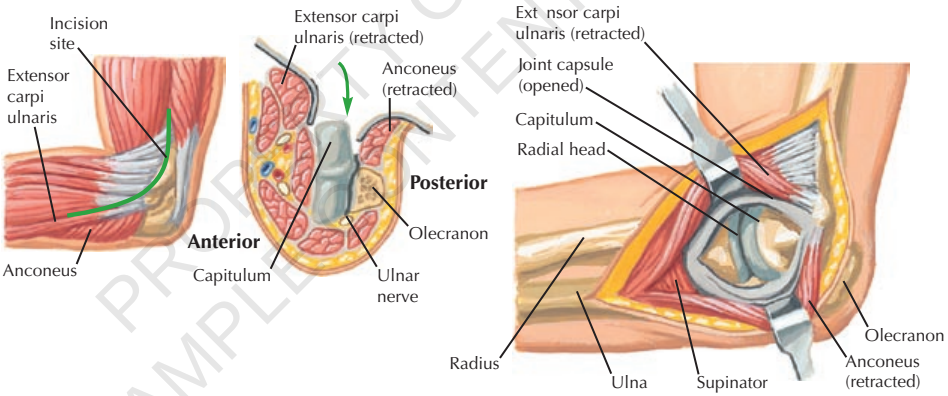
Anteroposterior and lateral radiographs reveal posterior dislocation of radial head, most evident on elbow flexion. Note also hypoplastic capitulum of humerus.

DESCRIPTION	EVALUATION	TREATMENT
CONGENITAL RADIAL HEAD DISLOCATION		
• Radial head congenitaly dislocated • Usually diagnosed f om 2-5y.o. • Patients are typically very functional • Unilateral or bila eral • Associated with other syndromes	**Hx:** Parents notice decreased ROM, +/− pain or deformity (late) **PE:** Decreased ROM, +/− visible radial head and/or tenderness **XR:** Malformed radial head & capitellum	• Asymptomatic: observation • Symptomatic (pain): excision of radial head at skeletal maturity (decreases pain, but does not typically increase ROM)
RADIOULNAR SYNOSTOSIS		
• Failure of separation of radius & ulna • Forearm rotation is absent • Can be assoc. with other syndromes • Bilateral in 60% of cases	**Hx/PE:** Absent pronosupination of the elbow/forearm. Varying degrees of fixed deformity (>60° is severe) **XR:** Radius is thickened, ulna is narrow	• Synostosis resection unsuccessful Mild/unilateral: observation • Osteotomy: dominant hand 20° of pronation, nondom. 30° supination
OSTEOCHONDROSIS OF CAPITELLUM (PANNER'S DISEASE)		
• Disordered endochondral ossification • Mech: valgus (pitchers) compression or axial overload (gymnasts) • Usually <10y.o.; male>female • Favorable long-term prognosis	**Hx:** Insidious onset lateral elbow pain and overuse (baseball, gymnastics) **PE:** Capitellum TTP, decreased ROM **XR:** Irregular borders, +/− fissuring, fragmentation (rarely loose bodies)	1. Rest (no pitching, tumbling, etc) 2. NSAIDs 3. Immobilization (3-4 weeks) Symptoms may persist for months, but most completely resolve

Anterolateral Approach to Humerus

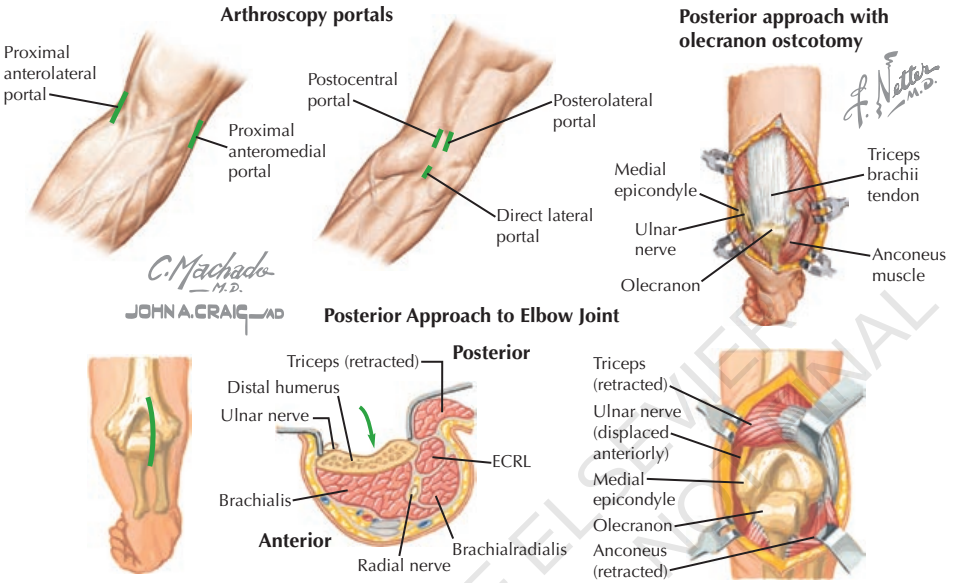


Lateral (Kocher) Approach to Elbow Joint



USES	INTERNERVOUS PLANES	DANGERS	COMMENT
HUMERUS: ANTERIOR APPROACH			
• ORIF of fractures • Bone biopsy/tumor removal	**Proximal** • Deltoid [Axillary] • Pectoralis major [Pectoral] **Distal** • Brachialis splitting • Lateral [radial] • Medial [MC]	**Proximal** • Axillary nerve • Humeral circumflex artery **Distal** • Radial nerve • Musculocutaneous nerve	• Anterior humeral circumflex artery may need ligation. • The brachialis has a split innervation that can be used for an internervous plane.
ELBOW: LATERAL APPROACH (KOCHER)			
Most radial head & lateral condyle procedures	• Anconeus (radial) • ECU (PIN)	PIN Radial nerve	Protect PIN: stay above annular ligament; keep forearm pronated

AU: Please review artwork. For 'portals' we used different art b/c the piece you selected could not be enlarged, so please check portal lines/labels are correct and insert labels/leaders for lateral/medial epicondyle if you still want shown.



USES	INTERNERVOUS PLANE	DANGERS	COMMENT
ELBOW: POSTERIOR APPROACH			
• Distal humerus fractures • Loose body removal, chondral injury procedures • Ulnohumeral arthroplasty • Total elbow arthroplasty	• No internervous plane • Olecranon is osteotomized and reflected to expose the distal humerus/joint.	• Ulnar nerve • Nonunion of olecranon osteotomy	• Best exposure of the joint • Olecranon should be drilled and tapped before osteotomy • Chevron osteotomy is best • Olecranon at risk of nonunion
POSTERIOR APPROACH: BRYAN/MORREY			
• Alternative to posterior approach with osteotomy • Same indications as above	• No internervous plane • Triceps is partially detached and reflected laterally	• Ulnar nerve	• Joint visualization is not as good as with osteotomy, no concern for nonunion
ARTHROSCOPY PORTALS			
Uses: Loose body removal/articular injuries, debridements and capsular release, fracture reduction, limited arthroplasty			
Proximal anteromedial	2cm prox. to med. epicondyle anterior to IM septum	Ulnar nerve Medial antebrachial cutaneous nerve	Anterior compartment, radial head & capitellum, capsule
Proximal anterolateral	2cm prox. to lat. epicondyle anterior to humerus/condyle	Radial nerve	Medial joint, lateral recess, and radiocapitellar joint
Posterocentral	3cm from olecranon tip	Safest portal (through tendon)	Posterior compartment, gutters
Posterolateral	3cm from olecranon tip at lateral edge of triceps tendon	Medial and posterior antebrachial cutaneous nerves	Olecranon tip & fossa, posterior trochlea
Direct lateral ("soft spot")	Between lat. epicondyle, radial head & olecranon	Posterior antebrachial cutaneous nerve	Inferior capitellum and radiocapitellar joint