NCBI Bookshelf. A service of the National Library of Medicine, National Institutes of Health.

StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2018 Jan-.

Anatomy, Shoulder and Upper Limb, Humerus

Authors

Evan Mostafa[1]; Matthew Varacallo[2].

Affiliations

[1] Albert Einstein College of Medicine
[2] Department of Orthopaedic Surgery, University of Kentucky School of Medicine

Last Update: December 3, 2018.

Introduction

The humerus is the largest bone of the upper extremity and defines the human brachium (arm). It articulates proximally with the glenoid via the glenohumeral (GH) joint, and distally with the radius and ulna at the elbow joint. The most proximal portion of the humerus is the head of the humerus, which forms a ball and socket joint with the glenoid cavity on the scapula.[1] Just inferior to the head of the humerus is the anatomical neck of the humerus, which divides the head of the humerus from the greater and lesser tubercles. The anatomical neck of the humerus is the residual epiphyseal plate. An intertubercular groove is located proximally, which demarcates the two tubercles vertically. Following the tubercles is the surgical neck of the humerus, a site commonly susceptible to fractures.

Continuing distally is the cylindrical-shaped shaft of the humerus, which contains a deltoid tubercle on its lateral aspect and a radial groove on its posterior aspect (also referred to as the spiral groove).[2] At the distal portion of the humerus, there exists a widening of the bone that forms the medial and lateral epicondyles. The distal portion of the humerus ends with an area referred to as the condyle which is composed of the trochlea, capitulum, olecranon, coronoid and radial fossae.[3] On the anterior lateral surface of the condyle is the lateral capitulum which articulates with the head of the radius bone, and on the anterior medial surface of the condyle is the trochlea which articulates the trochlear notch of the ulna bone. The coronoid fossa is located superior to the trochlea and accommodates the coronoid process of the ulna and superior to the capitulum on the anterior surface of the condyle, is the radial fossa which receives with the head of the radius, both upon flexion of the elbow joint. On the posterior surface of the condyle is the olecranon fossa which articulates with the olecranon of the ulnar bone upon flexion of the elbow joint. [4]

Structure and Function

The humeral head articulates with the glenoid fossa of the scapula and forms the glenohumeral joint, a synovial ball and socket joint.[5] This joint allows movement along multiple planes, including internal and external rotation, abduction and adduction, flexion and extension, and is principally determined by activation of the rotator cuff muscles (teres minor, subscapularis, supraspinatus, infraspinatus) pectoralis major and deltoid. The glenohumeral joint contains multiple synovial bursae that allow frictionless mobility, including the subacromial, subdeltoid, subcoracoid and coracobrachial bursae.[6] The coracoacromial and acromioclavicular ligaments stabilize the GH joint; these prevent proximal migration of the humerus.[7]

Articulation of the capitellum and trochlea of the humerus with the head of the radius bone and trochlear notch of the ulna forms the elbow joint, a synovial hinge joint. This joint is stabilized by the ulnar (medial) collateral ligament and radial (lateral) collateral ligament complexes [8]. The ulnar collateral ligament (UCL) has three components:

- Anterior oblique band: the strongest and most significant stabilizer to valgus stress forces
    - Courses from the medial epicondyle of the humerus to the sublime tubercle at the proximal ulna

- Posterior oblique band: tightest in flexion; the posterior component of the UCL demonstrates the most significant change in tension from flexion to extension range of motion (ROM) at the elbow
- Transverse ligament: contributes minimal, if any, to elbow joint stability

An olecranon bursa exists here to reduce friction during movement as well. This joint allows only extension and flexion. Elbow movement is principally the result of the biceps brachii, coracobrachialis, and triceps muscles [9]. It should be noted that in anatomical position, the humerus and antebrachial bones do not perfectly align, and instead form what is known as a carrying angle. In males, this angle varies from 5 to 10 degrees, and in females may reach up to 18 degrees [10]. This angle allows clearing of the hips, and an excessive lateral deviation is referred to as cubitus valgus and excessive medial deviation is referred to as cubitus varus

Embryology

As one of the many long bones within the appendicular skeleton, the humerus develops via endochondral ossification. [11]. This process is characterized by the replacement of a cartilage template by bone. Initially**,** a relatively tiny cartilage model is laid down by mesenchymal cells that form cartilage secreting chondrocytes. Second, in the center of the cartilage template (ossification center), there is chondrocyte hypertrophy and secretion factors such as alkaline phosphatase to promote calcification of that cartilage. This action forms a blockade to nutrients and causes chondrocyte death. However, before dying, these cells also secrete vascular endothelial growth factor (VEGF) to support angiogenesis towards the interior of this calcifying cartilage. Meanwhile, under the influence of Indian hedgehog homolog (IHH) protein, cells outside in the perichondrium differentiate into osteoblasts and form a layer of bone surrounding the center of cartilage known as the bony collar.[11]

As time progresses, a central area of dead chondrocytes develops, with little pieces of calcified cartilage left behind, a shell of bone around the center, and a vascular supply going around the interior. Vascular supply brings into the interior mesenchymal cells that differentiate into more osteoblasts and monocytes that form osteoclasts. In the center of the initial cartilage template, bone is resorbed on the inside and deposited on the outside, creating the growth in width of a hollow entity (forming a marrow). Simultaneously, the proximal and distal ends of the cartilage template have chondrocytes that continue to proliferate as secondary ossification centers. This activity allows cartilage growth at the end of the bones, providing vertically expansive capabilities. Ultimately, the areas where bone meets cartilage forms the epiphyseal plate (a linear zone of cartilage), where bone replaces cartilage continuously until bone growth completely fuses and stops around puberty. In the humerus specifically, there are eight ossification centers, at the head of the humerus, humeral shaft, greater and lesser tubercles, medial and lateral epicondyles, trochlea and olecranon.

The ossification of the shaft occurs at eight weeks gestation, with the humeral head ossification occurring at birth/after birth. The greater tubercles ossification takes place during the first year of life and the lesser tubercle ossification within the first six years of life.[12][13] By the time of adolescence, all proximal ossification centers of the humerus have fully fused with the shaft. The distal ossifications at the condyle and trochlea and olecranon take place between early and later adolescence and fuse with the shaft of the humerus by late adolescence.[14]

Blood Supply and Lymphatics

The primary blood supply of the proximal humerus comes from anastomoses between the anterior and posterior circumflex humeral arteries.[15] These are branches of the distal third of the axillary artery. Recent studies suggest the posterior humeral circumflex artery to be the primary source of blood supply to the humeral head.[16] The terminal division of the anterior humeral circumflex artery is the arcuate artery, which supplies the majority of the greater tuberosity.

The axillary artery continues on to become the brachial artery which, along with one of its branches the profunda brachii artery, will give off peri-osteal arteries to provide the blood supply for the rest humerus and its attached muscles.[17] The inner portions of the humerus are vascularized by nutrient arteries that also branch off from the brachial artery, in the vicinity of the middle of the humerus.[18]

Nerves

The axillary nerve, formed from the posterior cord of the brachial plexus, wraps around the surgical neck of the humerus, and provides innervation to the deltoid and rotator cuff muscles, specifically the teres minor.[19] Innervation of the anterior portion of the brachium is supplied by the musculocutaneous nerve, which forms as a division of the lateral cord of the brachial plexus. This nerve pierces through the coracobrachialis muscle and travels between the biceps brachii and coracobrachialis, ultimately finding its termination as the lateral cutaneous nerve of the forearm. The radial nerve from the posterior cord of the brachial plexus courses through the spiral groove of the humerus, posterior to the brachial artery, and anterior to the long head of the triceps.[20] It innervates the posterior muscles of the arm, forearm and overlying skin. The radial nerve is also responsible for innervation of the lateral and medial epicondyle of the humerus.[21] One should note that the median nerve and ulnar nerve likewise come off the brachial plexus and travel down along the brachium, however, do not supply innervation to this region.

Muscles

The humerus serves as the origin and insertion site of many upper limb muscles that divide into the following distinctions: scapulohumeral muscles, anterior compartment muscles, posterior compartment muscles.

Scapulohumeral muscles: The deltoid muscle, which defines the shoulder contour of the upper limb, originates at 3 locations: the acromion of the scapula, the spine of the scapula and clavicle, with each part inserting into the deltoid tuberosity of the humerus. The deltoid muscle allows internal/external rotation and abduction/adduction of the humerus.[22] The pectoralis major muscle originates at the clavicle, manubrium, sternum body and true ribs and inserts into the intertubercular sulcus of the humerus. It allows adduction, flexion, extension and medial rotation of the humerus.[23] Four muscles form the rotator cuff; the subscapularis, supraspinatus, infraspinatus, and teres minor. The subscapularis muscle originates from the subscapular fossa of the scapula and inserts onto the lesser tubercle of the humerus, facilitating internal rotation of the humerus. The supraspinatus muscle originates in the supraspinous fossa of the scapula and inserts into the greater tubercle of the humerus, facilitating abduction of the humerus. The infraspinatus muscle originates in the infraspinous fossa and scapula spine and inserts into the greater tubercle of the humerus as well and allows external rotation of the humerus. The teres major originates the inferior angle of the scapula and inserts into the lesser tuberosity of the humerus, allowing internal rotation and adduction. The teres minor originates on the lateral border of the scapula and inserts into the greater tubercle and allows external rotation.[24][25][26][27]

Anterior compartment muscles: The biceps brachii muscle has a long head and short head but does not have an actual origin or insertion sites on the humerus [28]. However, there is a transverse humeral ligament which projects from the lesser tubercle to the greater tubercle of the humerus and converts the humeral intertubercular groove into a canal which the tendon of the biceps brachii long head travels through on its way from its origination on the supraglenoid tubercle of the scapula to the radius. The coracobrachialis originates on the coracoid process of the scapula and inserts onto the humerus and its medial surface, allowing flexion and internal rotation.[29] The brachialis muscle originates on the anterior surface of the distal humerus and inserts onto the ulna for flexion of the forearm.[30]

Posterior compartment muscles: The triceps brachii muscle contains 3 heads, with the medial head originating on the posterior aspect of the humerus, inferior to the spiral groove, and the lateral head originating on the posterior surface, both insert into the olecranon process of the ulna and allow extension of the forearm at the elbow joint.[31] Of note, the humerus along with the long head of the triceps, teres major and teres minor, form a quadrangular space through which the posterior circumflex artery and vein and radian nerve travel.[32]

Surgical Considerations

Elderly patients who fall on their shoulder or land on their outstretched arm can sustain proximal humeral fractures.[33] This injury presents with shoulder pain and immobility of the extremity. Multiple fragmentations of these proximal fractures can also lead to post-traumatic osteonecrosis, which can cause long-term morbidity.[34] The majority of proximal humerus fractures receive non-operative treatment. However, elderly patients with severe

displacement can benefit from operative intervention, as these patients have limited bone remodeling and growth. Internal fixation via smooth wires, threaded wires, cannulated screws and intramedullary nailing are interventional choices.[35]. Reverse shoulder arthroplasty can also be utilized for proximal humerus fracture in the elderly, glenohumeral dislocations, rotator cuff tears or joint disease.[36] Shoulder arthroplasty can also be indicated for shoulder osteoarthritis, inflammatory arthritis.[37] Anterior dislocation of the glenohumeral joint is common among young and active patients.[38] The greater tuberosity of the humerus is susceptible to displacement fractures which can affect the rotator cuff muscles and also cause subacromial impingement. Surgical intervention is usually required with displacements greater than 3 mm.[39]

Children ages 3 and younger, can sustain transphyseal fractures of the distal humerus after a fall or trauma.[40] On radiologic imaging, the humerus and forearm bone will not align according to the standard carrying angle and will have a noticeable cubitus varus. Surgical intervention should take place with closed reduction and percutaneous pinning techniques. Common sequelae include osteonecrosis of the condyles and growth arrest. Surgical intervention usually includes lateral closing wedge osteotomy, dome osteotomy or multi-planar osteotomy.[41]

Intercondylar fractures at the distal humerus are often treated surgically as well with olecranon osteotomy.[42] Post-traumatic supracondylar humeral fractures can lead to avascular necrosis as there is an interruption of the trochlear blood supply. Patients may present asymptomatically at the time of the injury but can develop pain or loss of motion due to necrosis within six months.[43]

Clinical Significance

Radial nerve injury

Radial nerve palsy is one of the most common peripheral nerve injuries following humeral fracture.[44]. Typically, treatment includes observation, unless nerve recovery (as demonstrated on EMG/NCS studies) does not occur within 3 to 6 months. Advocates for early exploration of the radial nerve cite delayed repair and significant internal loss of patient function as deterrents for late exploration. Trauma or fracture at the radial groove (mid-shaft) may cause radial nerve injury.

Conditions of the shoulder

Conditions such as calcific tendinitis of the rotator cuff and adhesive capsulitis of the shoulder (i.e. frozen shoulder syndrome) are relatively common conditions with controversial and/or multifactorial etiologies.[45] Treatment consists of rest and exercise, with little need for operative intervention. However, surgical management of frozen shoulder syndrome can occur via infiltration brisement under general anesthesia.

Metastatic disease

Metastatic bone disease causes destructive bone lesions and significant localized pain, most often in the humerus. Lesions can increase the risk of fracture within the humerus.[46]. In patients with lesions less than 50% of the cortex, treatment is done via external beam irradiation. However, with destructive lesions involving more than half the cortex treatment consist or intramedullary nailing with postoperative external beam irradiation. Bone resection/reconstruction may be indicated in the instance where the disease persists.

Other/Miscellanous conditions

Hematologic, infectious, genetic and neurologic disorders may cause humerus varus.[47]. In this condition, the medial portion of the proximal humerus will fail to develop properly and the lateral portion will develop more rapidly. This creates a varus rotation of the humerus causing decreased arm abduction and limited flexion at the shoulder joint. However, functional impairment is not commonly seen. Surgical intervention involves a valgus osteotomy of the humerus using a plate screw fixation.

Disappearing bone disease is a rare musculoskeletal condition marked by bone resorption, lack of bone formation and lack of vascular proliferation. This disorder has severe quality of life implications.[48]Similarly, Gorham-Stout

disease in the humerus is characterized by resorption of the osseous matrix with a lack of bone formation.[49] Etiology of the disease is unknown however lymphovascular malformation in the bone is seen. Common symptoms include aching pain, progressive weakness, and subsequent fractures. Treatment is challenging and involves a combination of surgical intervention, medication, and radiotherapy.

Charcot arthropathy is a rare disorder characterized by debilitating joint destruction. The disease can lead to bone and soft tissue loss around the humerus and can alter muscular control. Treatment involves shoulder arthroplasty.[50]

Osteochondrosis of the humerus is associated with Panner's disease and Osteochondritis dissecans. The two diseases present similarly.[51]Panner's disease involves avascular necrosis of the capitulum and onset is typically between ages 7 and 10, younger than the onset of Osteochondritis dissecans. Panner's is typically not treated with operative intervention.[52]

Questions

To access free multiple choice questions on this topic, click here.

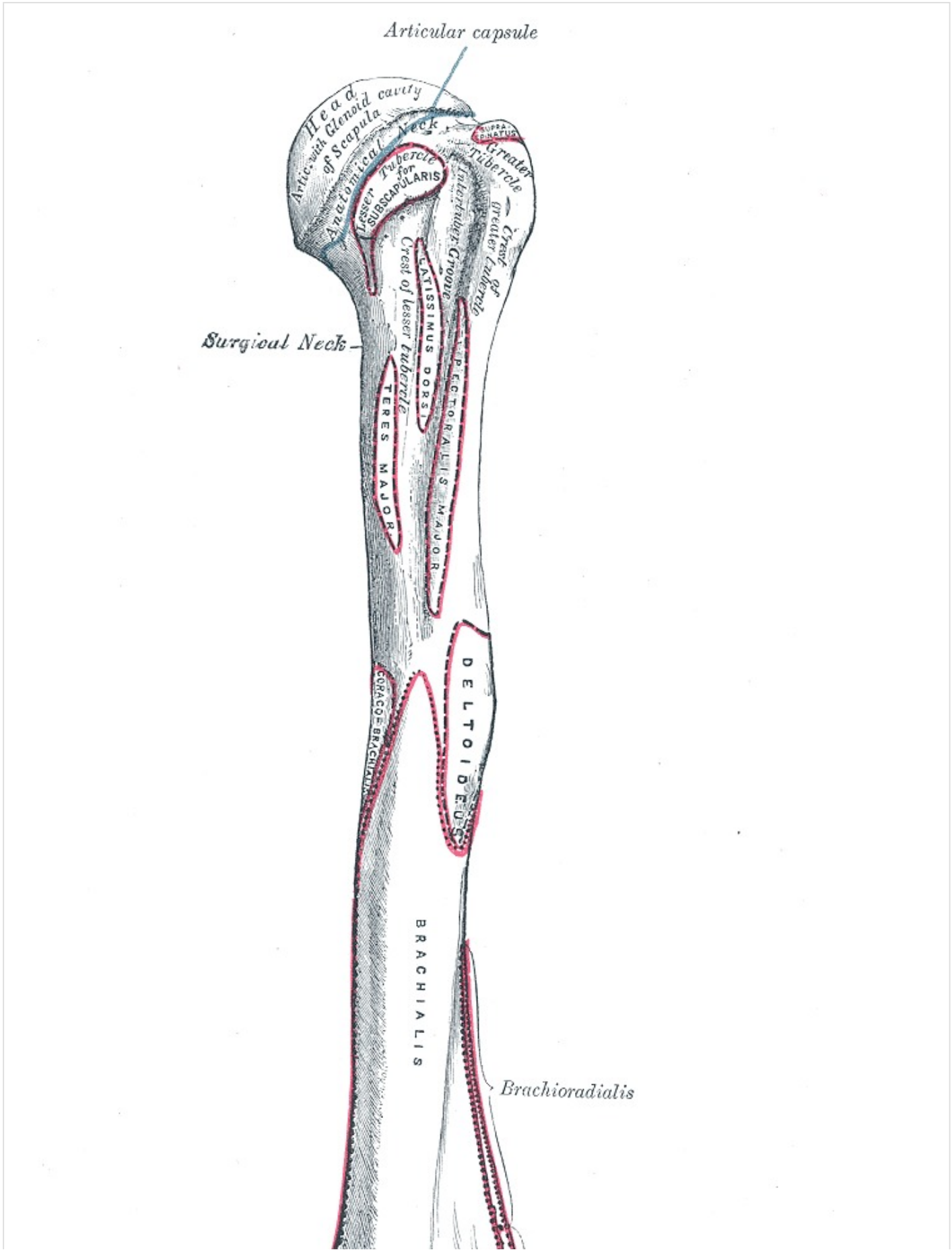
References

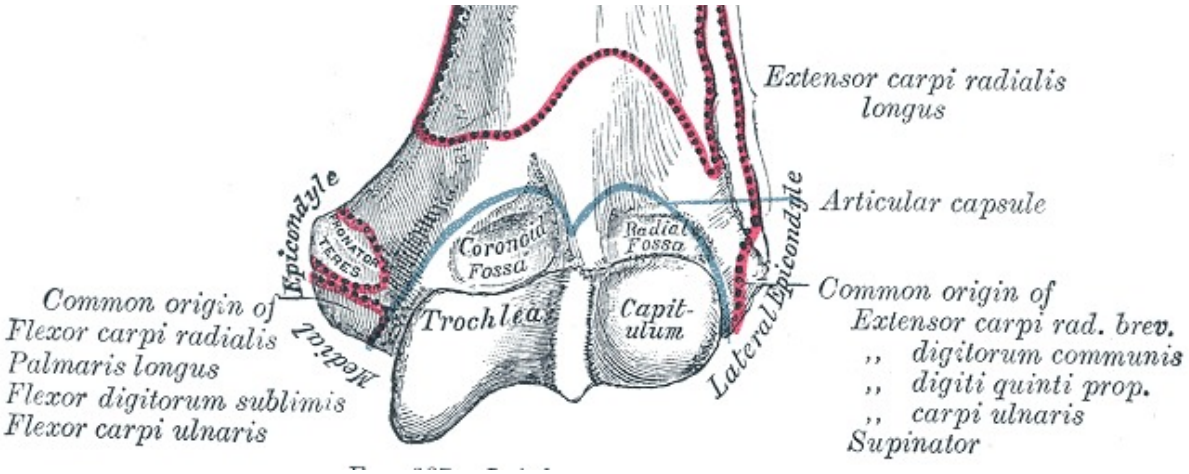
1. Capo JT, Criner KT, Shamian B. Exposures of the humerus for fracture fixation. Hand Clin. 2014 Nov;30(4):401-14, v. [PubMed: 25440069]
2. Paryavi E, Pensy RA, Higgins TF, Chia B, Eglseder WA. Salvage of upper extremities with humeral fracture and associated brachial artery injury. Injury. 2014 Dec;45(12):1870-5. [PubMed: 25249243]
3. Samart S, Apivatgaroon A, Lakchayapakorn K, Chemchujit B. The correlation between acromion-axillary nerve distance and upper arm length; a cadaveric study. J Med Assoc Thai. 2014 Aug;97 Suppl 8:S27-33. [PubMed: 25518290]
4. Hamilton MA, Diep P, Roche C, Flurin PH, Wright TW, Zuckerman JD, Routman H. Effect of reverse shoulder design philosophy on muscle moment arms. J. Orthop. Res. 2015 Apr;33(4):605-13. [PubMed: 25640775]
5. Prescher A. Anatomical basics, variations, and degenerative changes of the shoulder joint and shoulder girdle. Eur J Radiol. 2000 Aug;35(2):88-102. [PubMed: 10963915]
6. Wilk KE, Arrigo CA, Andrews JR. Current concepts: the stabilizing structures of the glenohumeral joint. J Orthop Sports Phys Ther. 1997 Jun;25(6):364-79. [PubMed: 9168344]
7. Kanatli U, Bölükbaşi S, Ekin A, Ozkan M, Simşek A. [Anatomy, biomechanics, and pathophysiology of instability of the glenohumeral joint]. Acta Orthop Traumatol Turc. 2005;39 Suppl 1:4-13. [PubMed: 15925914]
8. Karbach LE, Elfar J. Elbow Instability: Anatomy, Biomechanics, Diagnostic Maneuvers, and Testing. J Hand Surg Am. 2017 Feb;42(2):118-126. [PMC free article: PMC5821063] [PubMed: 28160902]
9. Martin S, Sanchez E. Anatomy and biomechanics of the elbow joint. Semin Musculoskelet Radiol. 2013 Nov;17(5):429-36. [PubMed: 24327407]
10. Paraskevas G, Papadopoulos A, Papaziogas B, Spanidou S, Argiriadou H, Gigis J. Study of the carrying angle of the human elbow joint in full extension: a morphometric analysis. Surg Radiol Anat. 2004 Feb;26(1):19-23. [PubMed: 14648036]
11. Long F, Ornitz DM. Development of the endochondral skeleton. Cold Spring Harb Perspect Biol. 2013 Jan 01;5(1):a008334. [PMC free article: PMC3579395] [PubMed: 23284041]
12. Kwong S, Kothary S, Poncinelli LL. Skeletal development of the proximal humerus in the pediatric population: MRI features. AJR Am J Roentgenol. 2014 Feb;202(2):418-25. [PubMed: 24450686]
13. Zember JS, Rosenberg ZS, Kwong S, Kothary SP, Bedoya MA. Normal Skeletal Maturation and Imaging Pitfalls in the Pediatric Shoulder. Radiographics. 2015 Jul-Aug;35(4):1108-22. [PubMed: 26172355]
14. Jaimes C, Jimenez M, Marin D, Ho-Fung V, Jaramillo D. The trochlear pre-ossification center: a normal developmental stage and potential pitfall on MR images. Pediatr Radiol. 2012 Nov;42(11):1364-71. [PubMed: 22810145]
15. Menck J, Döbler A, Döhler JR. [Vascularization of the humerus]. Langenbecks Arch Chir. 1997;382(3):123-7. [PubMed: 9324609]

16. Attum B, Thompson JH. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Nov 15, 2018. Humerus Fracture.
17. Ichimura K, Kinose S, Kawasaki Y, Okamura T, Kato K, Sakai T. Anatomic characterization of the humeral nutrient artery: Application to fracture and surgery of the humerus. Clin Anat. 2017 Oct;30(7):978-987. [PubMed: 28795436]
18. Marion B, Leclère FM, Casoli V, Paganini F, Unglaub F, Spies C, Valenti P. Potential axillary nerve stretching during RSA implantation: an anatomical study. Anat Sci Int. 2014 Sep;89(4):232-7. [PubMed: 24497198]
19. Ozer H, Açar HI, Cömert A, Tekdemir I, Elhan A, Turanli S. Course of the innervation supply of medial head of triceps muscle and anconeus muscle at the posterior aspect of humerus (anatomical study). Arch Orthop Trauma Surg. 2006 Oct;126(8):549-53. [PubMed: 16826408]
20. Dellon AL, Ducic I, Dejesus RA. The innervation of the medial humeral epicondyle: implications for medial epicondylar pain. J Hand Surg Br. 2006 Jun;31(3):331-3. [PubMed: 16580101]
21. Sakoma Y, Sano H, Shinozaki N, Itoigawa Y, Yamamoto N, Ozaki T, Itoi E. Anatomical and functional segments of the deltoid muscle. J. Anat. 2011 Feb;218(2):185-90. [PMC free article: PMC3042752] [PubMed: 21118198]
22. Sanchez ER, Howland N, Kaltwasser K, Moliver CL. Anatomy of the sternal origin of the pectoralis major: implications for subpectoral augmentation. Aesthet Surg J. 2014 Nov;34(8):1179-84. [PubMed: 25121786]
23. Curtis AS, Burbank KM, Tierney JJ, Scheller AD, Curran AR. The insertional footprint of the rotator cuff: an anatomic study. Arthroscopy. 2006 Jun;22(6):609.e1. [PubMed: 16762697]
24. Salhi A, Burdin V, Mutsvangwa T, Sivarasu S, Brochard S, Borotikar B. Subject-specific shoulder muscle attachment region prediction using statistical shape models: A validity study. Conf Proc IEEE Eng Med Biol Soc. 2017 Jul;2017:1640-1643. [PubMed: 29060198]
25. Vosloo M, Keough N, De Beer MA. The clinical anatomy of the insertion of the rotator cuff tendons. Eur J Orthop Surg Traumatol. 2017 Apr;27(3):359-366. [PubMed: 28204962]
26. Dancker M, Lambert S, Brenner E. Teres major muscle - insertion footprint. J. Anat. 2017 May;230(5):631-638. [PMC free article: PMC5382588] [PubMed: 28185265]
27. Quach T, Jazayeri R, Sherman OH, Rosen JE. Distal biceps tendon injuries--current treatment options. Bull NYU Hosp Jt Dis. 2010;68(2):103-11. [PubMed: 20632985]
28. Ilayperuma I, Nanayakkara BG, Hasan R, Uluwitiya SM, Palahepitiya KN. Coracobrachialis muscle: morphology, morphometry and gender differences. Surg Radiol Anat. 2016 Apr;38(3):335-40. [PubMed: 26464302]
29. Tagliafico A, Michaud J, Perez MM, Martinoli C. Ultrasound of distal brachialis tendon attachment: normal and abnormal findings. Br J Radiol. 2013 May;86(1025):20130004. [PMC free article: PMC3635801] [PubMed: 23420050]
30. Handling MA, Curtis AS, Miller SL. The origin of the long head of the triceps: a cadaveric study. J Shoulder Elbow Surg. 2010 Jan;19(1):69-72. [PubMed: 19748801]
31. Brown SA, Doolittle DA, Bohanon CJ, Jayaraj A, Naidu SG, Huettl EA, Renfree KJ, Oderich GS, Bjarnason H, Gloviczki P, Wysokinski WE, McPhail IR. Quadrilateral space syndrome: the Mayo Clinic experience with a new classification system and case series. Mayo Clin. Proc. 2015 Mar;90(3):382-94. [PubMed: 25649966]
32. Launonen AP, Sumrein BO, Lepola V. Treatment of proximal humerus fractures in the elderly. Duodecim. 2017;133(4):353-8. [PubMed: 29205983]
33. Patel S, Colaco HB, Elvey ME, Lee MH. Post-traumatic osteonecrosis of the proximal humerus. Injury. 2015 Oct;46(10):1878-84. [PubMed: 26113032]
34. King EC, Ihnow SB. Which Proximal Humerus Fractures Should Be Pinned? Treatment in Skeletally Immature Patients. J Pediatr Orthop. 2016 Jun;36 Suppl 1:S44-8. [PubMed: 27100038]
35. Acevedo DC, Vanbeek C, Lazarus MD, Williams GR, Abboud JA. Reverse shoulder arthroplasty for proximal humeral fractures: update on indications, technique, and results. J Shoulder Elbow Surg. 2014 Feb;23(2):279-89. [PubMed: 24418780]
36. Lin DJ, Wong TT, Kazam JK. Shoulder Arthroplasty, from Indications to Complications: What the Radiologist Needs to Know. Radiographics. 2016 Jan-Feb;36(1):192-208. [PubMed: 26761537]
37. Kane P, Bifano SM, Dodson CC, Freedman KB. Approach to the treatment of primary anterior shoulder

dislocation: A review. Phys Sportsmed. 2015 Feb;43(1):54-64. [PubMed: 25559018]
38. Rouleau DM, Mutch J, Laflamme GY. Surgical Treatment of Displaced Greater Tuberosity Fractures of the Humerus. J Am Acad Orthop Surg. 2016 Jan;24(1):46-56. [PubMed: 26700632]
39. Abzug JM, Ho CA, Ritzman TF, Brighton BK. Transphyseal Fracture of the Distal Humerus. J Am Acad Orthop Surg. 2016 Feb;24(2):e39-44. [PubMed: 26808044]
40. Bauer AS, Pham B, Lattanza LL. Surgical Correction of Cubitus Varus. J Hand Surg Am. 2016 Mar;41(3):447-52. [PubMed: 26787408]
41. Chen H, Li D, Zhang J, Xiong X. Comparison of treatments in patients with distal humerus intercondylar fracture: a systematic review and meta-analysis. Ann. Med. 2017 Nov;49(7):613-625. [PubMed: 28537435]
42. Etier BE, Doyle JS, Gilbert SR. Avascular Necrosis of Trochlea After Supracondylar Humerus Fractures in Children. Am J. Orthop. 2015 Oct;44(10):E390-3. [PubMed: 26447417]
43. Niver GE, Ilyas AM. Management of radial nerve palsy following fractures of the humerus. Orthop. Clin. North Am. 2013 Jul;44(3):419-24, x. [PubMed: 23827843]
44. Simon WH. Soft tissue disorders of the shoulder. Frozen shoulder, calcific tendintis, and bicipital tendinitis. Orthop. Clin. North Am. 1975 Apr;6(2):521-39. [PubMed: 1093096]
45. Frassica FJ, Frassica DA. Metastatic bone disease of the humerus. J Am Acad Orthop Surg. 2003 Jul-Aug;11(4):282-8. [PubMed: 12889867]
46. Ogden JA, Weil UH, Hempton RF. Developmental humerus varus. Clin. Orthop. Relat. Res. 1976 May;(116):158-65. [PubMed: 819197]
47. Ganal-Antonio AK, Samartzis D, Bow C, Cheung KM, Luk KD, Wong YW. Disappearing bone disease of the humerus and the cervico-thoracic spine: a case report with 42-year follow-up. Spine J. 2016 Feb;16(2):e67-75. [PubMed: 26436955]
48. Ellati R, Attili A, Haddad H, Al-Hussaini M, Shehadeh A. Novel approach of treating Gorham-Stout disease in the humerus--Case report and review of literature. Eur Rev Med Pharmacol Sci. 2016;20(3):426-32. [PubMed: 26914115]
49. Schoch B, Werthel JD, Sperling JW, Cofield RH, Sanchez-Sotelo J. Is shoulder arthroplasty an option for charcot arthropathy? Int Orthop. 2016 Dec;40(12):2589-2595. [PubMed: 27743013]
50. Wróblewski R, Urban M, Michalik D, Zakrzewski P, Langner M, Pomianowski S. Osteochondrosis of the capitellum of the humerus (Panner's disease, Osteochondritis Dissecans). Case study. Ortop Traumatol Rehabil. 2014 Jan-Feb;16(1):79-90. [PubMed: 24728797]
51. Sakata R, Fujioka H, Tomatsuri M, Kokubu T, Mifune Y, Inui A, Kurosaka M. Treatment and Diagnosis of Panner's Disease. A Report of Three Cases. Kobe J Med Sci. 2015 Apr 22;61(2):E36-9. [PubMed: 26628012]
52. Hettrich CM, Boraiah S, Dyke JP, Neviaser A, Helfet DL, Lorich DG. Quantitative assessment of the vascularity of the proximal part of the humerus. J Bone Joint Surg Am. 2010 Apr;92(4):943-8. [PubMed: 20360519]

Figures


Articular capsule
Head
Artic. with Glenoid cavity of Scapula
Anatomical Neck
Lesser Tubercle for SUBSCAPULARIS
Intertubercular Groove
Greater Tubercle
Crest for greater tuberosity
Surgical Neck
Crest of lesser tubercle
LATISSIMUS DORSI
PECTORALIS MAJOR
TERES MAJOR
CORACO-BRACHIALIS
DELTOIDEUS
BRACHIALIS
Brachioradialis



Humerus, Anterior, Head, Glenoid cavity, Surgical neck, Lesser Tubercle, Subscapularis, Greater Tubercle, Anatomical neck, Teres Major, Latissimus Dorsi, Crest of Lesser Tubercle, Pectoralis major, Deltoid, Brachialis, Brachioradialis, Trochlea Capitulum, Lateral Epicondyle, Radial Fossa, Coronoid Fossa, Medial Epicondyle, Extensor, Carpi radialis longus,. Contributed by Gray's Anatomy Plates

Bookshelf ID: NBK534821 PMID: 30521242