4-2017

Glenohumeral Joint Dissection: A New Protocol

Philip A. Fabrizio
Philadelphia College of Osteopathic Medicine, philipfa@pcom.edu

Danielle Topping

Kathleen Wolfe

Teaching Anatomy

www.anatomy.org.tr
Received: March 8, 2017; Accepted: April 17, 2017
doi:10.2399/ana.16.057

anatomy
An International Journal of Experimental and Clinical Anatomy
www.anatomy.org.tr

Glenohumeral joint dissection: a new protocol

Philip A. Fabrizio, Danielle Topping, Kathleen Wolfe

The Springfield Clinic, 800 N. 1st Street, Springfield, IL 62702, USA

Abstract

Objectives: The glenohumeral joint, as a component of the shoulder girdle, is one of the most frequently injured joints of the upper extremity. Typical dissection of the glenohumeral joint does not allow an intracapsular view without sacrificing the joint capsule and surrounding structures.

Methods: A dissection method is presented which reveals the internal capsule of the glenohumeral joint, the glenoid labrum, the proximal insertion of the long head of the biceps tendon, and glenohumeral joint surfaces while preserving the posterior aspect of the capsule and surrounding supportive muscles and tendons of the joint.

Results: The novel dissection technique allowed for preservation of glenohumeral joint structures and consideration or reexamination of the relationships and structures.

Conclusion: The authors present an alternative protocol for dissection of the glenohumeral joint that minimizes destruction of the surrounding structures while allowing visualization of the internal capsule and maintains the relationships of the surrounding supporting structures of the pectoral girdle that may be used for study at a later time.

Keywords: anatomy education; applied anatomy; shoulder dissection

Anatomy 2017;11(1):37–41 ©2017 Turkish Society of Anatomy and Clinical Anatomy (TSACA)

Introduction

The shoulder complex, consisting of the sternoclavicular, acromioclavicular, glenohumeral and scapulothoracic joints, is one the most commonly injured regions of the upper quarter.[1-6] Glenohumeral joint injuries may involve any of the supportive structures alone or in combinations. The highest incidence of glenohumeral joint injuries involve the muscles and tendons of the rotator cuff, the glenoid labrum, glenohumeral ligaments or capsule, and glenohumeral articular surface defects.[1–3,7] Rotator cuff injuries may account for 65% of all shoulder-related patient-physician interactions, and the prevalence of rotator-cuff injury for patients aged 60–80 years has been demonstrated between 20–50%.[6,8] Vogel et al.[9] showed a population increase in superior labral anterior to posterior (SLAP) lesions and repairs of 238% during the period between 2002 and 2009 in New York state. Further, additional intra-articular injuries often accompany rotator cuff injuries and SLAP lesions.[10,11] Feeney et al.[10] showed a positive correlation between rotator cuff injuries and articular cartilage deterioration at the glenohumeral joint. Kim et al.[11] showed that as many as 85% of SLAP cases also have additional intra-articular damage.

Shoulder pathology can be seen in cadaver specimens and pathologic findings serve to illustrate clinical anatomy concepts to students performing dissections.[4,8] Reilly et al.[4] showed, in a systematic review, that full thickness rotator cuff tears were seen in 11.75% and partial thick-ness rotator cuff tears were seen in 18.49% out of 2553 shoulders from cadaver specimens. Kane et al.[8] identified rotator cuff tissue damage in 50% of cadaver shoulders examined in one study, among them 52% showed partial-thickness tears and 47%, full-thickness tears. Moreover, as the age represented by the cadaveric samples increased, the incidence and the severity of rotator-cuff damage also increased.[8] In these studies, the pathologic shoulder findings could serve to reinforce clinical anatomy to students performing dissections. Further, the positive correlation between rotator cuff pathology and articular cartilage injury indicates the need for a novel dissection protocol that would allow for the comparison of the integrity of internal joint structures to the external structures such as the rotator cuff muscles. Cadaver specimens provide an ideal medium on which to explore shoulder dysfunction. However, at the present time, typical shoulder dissection protocols do not allow one to simultaneously appreciate the internal components of the glenohumeral joint, while maintaining the relationships of the surrounding musculature and other structures. Further, current traditional dissection protocols are performed in a manner that "destroys" many of the surrounding structures and does not allow one to revisit the relationships between the glenohumeral joint and supporting structures due to the removal of the superficial structures and destruction of the joint capsule.

Dissection protocols that are frequently used to examine the glenohumeral joint do not allow unobstructed visualizations of the entire glenohumeral joint, and in some techniques, the method requires release of the rotator cuff muscle attachments and completely dislocating the shoulder to view the interior capsular components, thus limiting the ability to examine and re-examine the relationships of rotator cuff to internal joint morphology. Traditional glenohumeral joint dissection protocols proceed following reflection of the muscles overlying the joint.[12–16] The deltoid, coracobrachialis, and biceps brachii muscles are typically reflected inferiorly from their proximal attachments.[12,13] The distal tendons of the infraspinatus, teres minor and supraspinatus muscles are then cut and the muscles are reflected medially from the humerus to visualize the posterior aspect of the glenohumeral joint capsule which is then incised to gain access to the interior of the glenohumeral joint.[12,13] Laurenson[16] and Cahill and Carmichael[17] describe protocols where the anterior muscles of the arm have been reflected and access into the glenohumeral joint is gained by reflecting the subscapularis muscle and incising the anterior portion of the glenohumeral joint capsule.

The purpose of the current study was to demonstrate a dissection protocol that allowed for visualizing the internal glenohumeral joint structures while maintaining superficial structures in order to maximize the utility of the cadaver. Specifically, the purpose was to develop a dissection protocol that would allow visualization of the glenoid labrum, the tendon of the long head of the biceps brachii muscle, and the articular surfaces of the glenohumeral joint while sparing surrounding supportive structures such as the distal tendons of the rotator cuff muscles and anterior and posterior aspects of the glenohumeral joint capsule, thus allowing for continued study of all of the related structures by students at a later date.

Materials and Methods

The project was reviewed and approved by the Institutional Review Board. Three embalmed cadaver shoulders were dissected in the following manner. The subcutaneous tissues of the pectoral girdle, axilla, superficial back, and arm were removed and cleaned using standard dissection techniques. After removal of these tissues, the deltoid, pectoralis major, trapezius, biceps brachii, and triceps brachii muscles were cleaned and identified. The deltoid and pectoralis major mus-cles were reflected from their distal attachments. The trapezius was reflected from its medial attachment to allow visualization of the supraspinatus muscle. With the arm in lateral rotation, the subscapularis muscle was exposed and cleaned. The deltoid muscle was reflected proximally to visualize the joint capsule and the tendons of the rotator cuff muscles which were subsequently cleaned. With the humerus positioned in lateral rotation, the tendon of the long head of the biceps brachii muscle was identified in the intertubercular groove and preserved in its place. An incision was made circumferentially at the midpoint of the arm to incise the soft tissues of the anterior and posterior compartments of the arm. The biceps brachii and coracobrachialis muscles were cut the proximal one third of the muscle bellies and reflected in a way to preserve the position of the proximal attachments. A longitudinal saw cut was made through the proximal 1/3 of the humerus, in line with the shaft of the humerus, oriented near the frontal plane (**Figure 1**). Saw cuts were made using a Dremel Multi-Maxx MM30 Oscillating Tool equipped with a 0.7 inch "wood flush cut blade" (Robert Bosch Tool Corporation, 1800 W. Central Rd., Mount Prospect, IL 60056, USA). The longitudinal saw cut was started at the greater tubercle, at a position anterior to the supraspinatus tendon, bisected the humeral head, and proceeded distally along the antero-lateral surface of the shaft of the humerus (**Figure 1**). With the biceps brachii muscle reflected superiorly, a second saw cut was made transversely through a point at the middle one third of the shaft of the humerus (**Figure 1**). The result of the two saw cuts was a bisection of the proximal half of the humerus into sections which could then be separated to expose the interior of the glenohumeral joint (**Figure 2**). To aid in the separation and improve viewing, small incisions were made to the superior and inferior portions of the glenohumeral joint capsule. The neurovascular structures were identified and dissected, but were removed for this preparation. At this point the dissection protocol was complete with the shoulder complex remaining in situ. However, the authors continued dissection with the intent of creating a prosection of the shoulder complex using the dissection protocol. Creating the prosection proceeded with cutting the serratus anterior, lattissimus dorsi, levator scapula, rhomboid major and minor, and pectoralis minor muscles from their proximal attachments. The clavicle was cut at its midpoint. The result was a prosection that demonstrated the muscles and relationships associated with the scapula and glenohumeral joint (**Figures 3** and **4**).

Discussion

The current dissection protocol was modeled after a novel procedure for dissection of the knee in which the authors “split” the femur to expose the internal structures of the knee joint.[18] Similarly, the current dissection protocol is comprised of two phases that, when completed, distinguish it from previous or traditional shoulder dissection protocols. Phase one consisted of identifying, preserving, and judiciously removing soft tissue structures. In the current presentation, the muscles of the rotator cuff were emphasized. However, the neurovascular structures could also be preserved to provide additional relationships for students to consider. Once the soft tissues were removed from the pectoral girdle and superficial back region, the rotator cuff muscles were clearly identified and left intact. The current protocol is consistent with previous dissection protocols of the glenohumeral joint to the point of identifying the rotator cuff muscles. However, unlike other dissection protocols previously used, where the rotator cuff muscles were cut and/or removed and either the anterior or posterior aspect of the glenohumeral joint capsule was cut, in the current protocol, the integrity of the rotator cuff muscles and majority of the capsule were maintained throughout the dissection. Maintaining the rotator cuff muscles and the majority of the joint capsule allows the bisected humerus to be opened while visualizing the internal joint structures and then to be replaced into its original position to examine the support structures such as the muscles of the rotator cuff. Further, the more superficial muscles could be judiciously reflected to allow another layer that can remain partially intact to maintain a greater set of relationships. For example, the pectoralis major muscle could be reflected from its proximal attachments allowing students to reexamine that muscle’s relationship to the glenohumeral structures.

Phase two of the current protocol, bisecting the humerus, is key to maintaining the integrity of the ante-

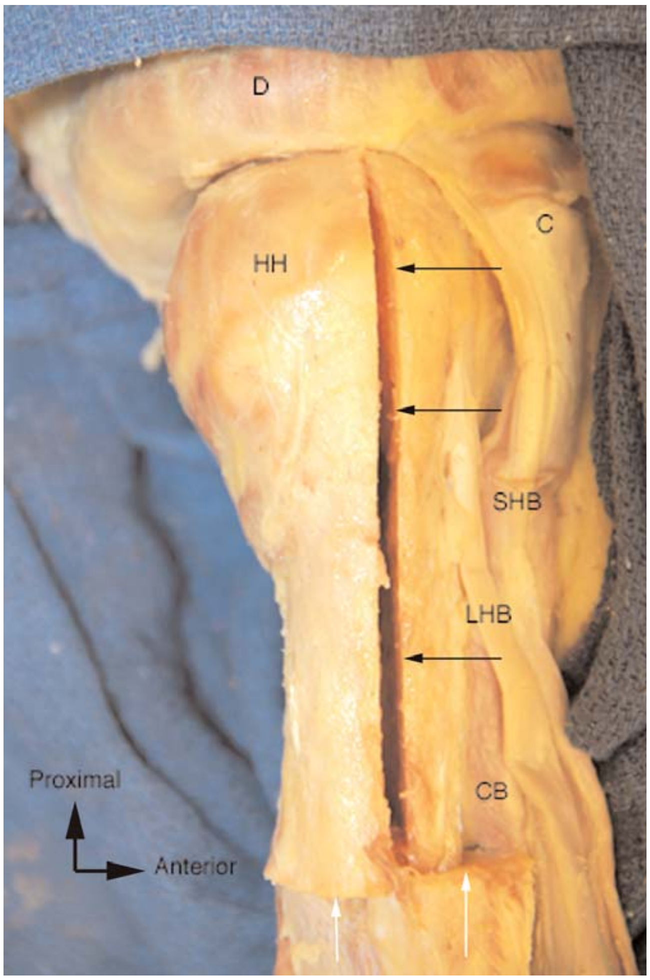

Figure 1. Photograph of the antero-lateral view of the right shoulder showing the resultant saw cuts of the novel protocol done in situ. **Black arrows:** longitudinal saw cut; **white arrows:** transverse saw cut; **C:** coracoid process; **CB:** coracobrachialis muscle; **D:** deltoid muscle; **HH:** head of the humerus; **LHB:** tendon of the long head of the biceps brachii muscle; **SHB:** tendon of the short head of the biceps brachii muscle. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

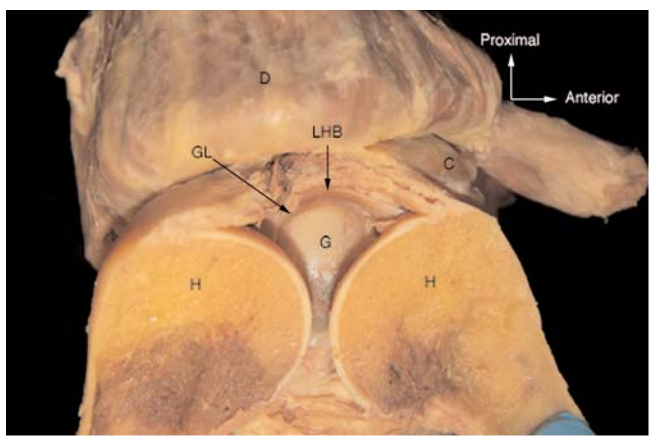

Figure 2. Photograph of the completed glenohumeral joint dissection protocol showing the interior of the glenohumeral joint taken with the completed dissection removed from the cadaver. **C:** coracoid process; **D:** deltoid muscle; **G:** glenoid cavity of the scapula; **GL:** glenoid labrum; **H:** bisected humeral head; **LHB:** tendon of the long head of the biceps brachii muscle. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

rior and posterior aspects of the glenohumeral joint capsule. By cutting the humerus just anterior to the supraspinatus tendon, the humerus can be reflected within the joint capsule, thus preserving the anterior aspect of the joint capsule along with the glenohumeral ligaments. The posterior aspect of the joint capsule is also preserved, allowing students to visual the expanse of the glenohumeral joint space. When both of the critical phases of this protocol are completed, this dissection approach provides the observer with clear and full visualization of the internal joint capsule and the relationship to the outside musculature. Further, the protocol allows for greater utilization of the cadaver by creating a dissection that can be reevaluated by students for continued study at a later time without sacrificing all of the important relationships in the region.

Conclusion

The primary purpose of developing this dissection protocol was to be able to successfully examine the elements of the glenohumeral joint capsule while ensuring the preservation of the attachments of the rotator cuff muscles. Although the dissection approach presented here differs from more traditional approaches to dissecting the glenohumeral joint, it can be done by students with typical anatomy laboratory equipment. This technique could be used to improve student under-standing of structures of the internal joint capsule and their relationship to the function of the glenohumeral joint in clinical classes. This unique dissection could also be used to further a clinicians understanding of the glenohumeral joint, the structures associated with the glenohumeral joint and the joint capsule, and the attachments of the rotator cuff muscles. Finally, because this technique preserves the joint capsule and the associated structures, it improves the utilization of each specimen.

Acknowledgements

The authors wish to thank the individuals who donate their bodies and tissues for the advancement of education and research.

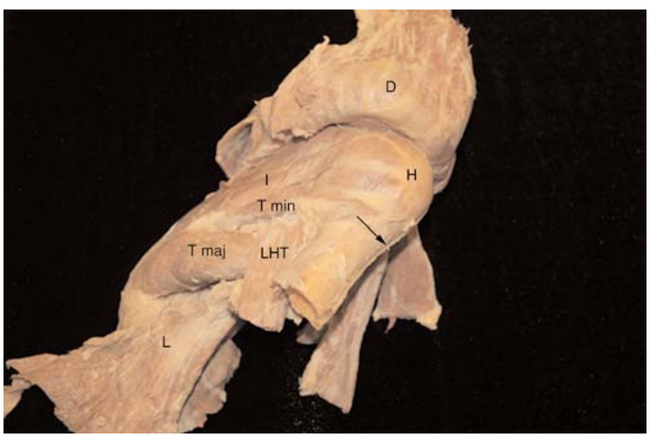

Figure 3. Photograph of completed prosection, posterolateral view, showing the bisected humerus (**black arrow**), put back together for continued study of the rotator cuff muscles. **D:** deltoid muscle; **H:** head of the humerus; **I:** infraspinatus muscle; **L:** latissimus dorsi muscle; **LHT:** long head of the triceps brachii muscle; **T maj:** teres major muscle; **T min:** teres minor muscle. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

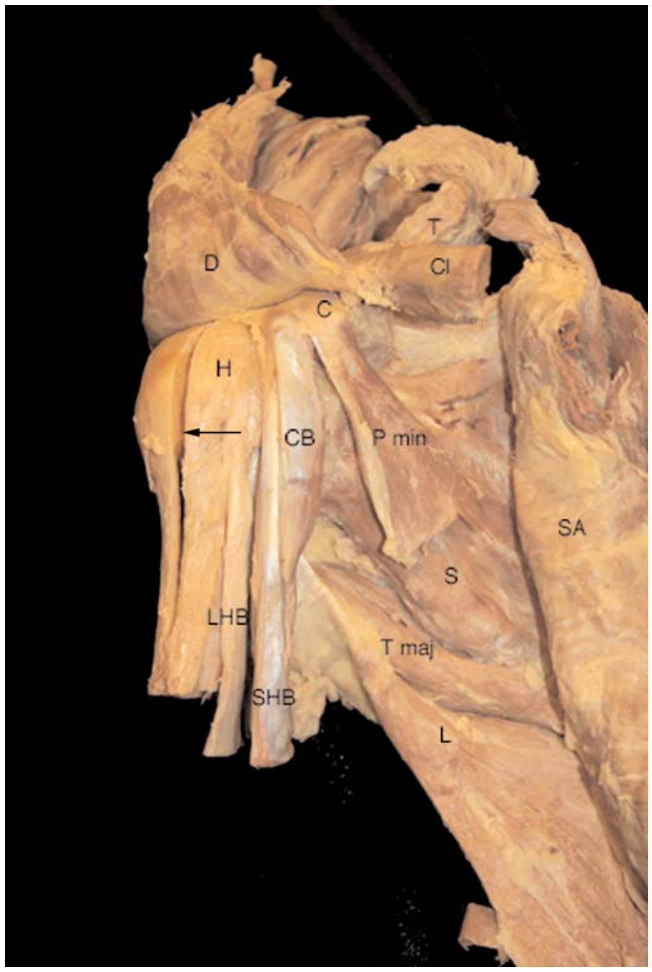

Figure 4. Photograph of the completed prosection, anterior view, showing the bisected humerus (**black arrow**), put back together for continued study of the muscles of the rotator cuff and pectoral girdle. **C:** coracoid process; **CB:** coracobrachialis muscle; **D:** deltoid muscle; **H:** head of the humerus; **L:** lattissimus dorsi muscle; **LHB:** long head of the biceps brachii muscle; **P min:** pectoralis minor muscle; **S:** subscapularis muscle; **SA**: serratus anterior muscle; **SHB:** short head of the biceps brachii; **T:** trapezius muscle; **T maj:** teres major muscle. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

References

1. Robinson TW, Corlette J, Collins CL, Comstock RD. Shoulder injuries among high school athletes, 2005/2006-2011/2012. Pediatrics 2007;133:272–9.
2. White JJE, Titchener AG, Fakis A, Tambe AA, Hubbard RB, Clark DI. An epidemiological study of rotator cuff pathology using The Health Improvement database. Bone Joint J 2014;96–B:350–3.
3. Bureau of Labor Statistics. 2012. US Department of Labor. Survey of occupational in-juries and illnesses in cooperation with participating state agencies. Percent distribution of nonfatal occupational injuries and illnesses involving days away from work by se-lected injury or illness characteristics and number of days away from work (Table R6). [Internet] [Cited 107 Apr 1]. Available from: http://www.bls.gov/iif/oshwc/osh/os/osh06_b2.pdf
4. Reilly P, Macleod I, Macfarlane R, Windley J, Emery RJ. Dead men and radiologists don't lie: a review of cadaveric and radiological studies of rotator cuff tear prevalence. Ann R Coll Surg Engl 2006;88:116–21.
5. Kelly BT, Williams RJ, Cordasco FA, Backus SI, Otis JC, Weiland DE, Altchek DW, Craig EV, Wickiewicz TL, Warren RF. Differential patterns of muscle activation in pa-tients with symptomatic and asymptomatic rotator cuff tears. J Shoulder Elbow Surg 2005;14:165–71.
6. Vecchio P, Kavanagh R, Hazleman BL, King RH. Shoulder pain in a community-based rheumatology clinic. Br J Rheumatol 1995; 34:440–2.
7. Leclerc A, Chastang JF, Niedhammer I, Landre MF, Roquelaure Y, Study Group on Re-petitive Work. Incidence of shoulder pain and repetitive work. Occup Environ Med 2004;61:39–44.
8. Kane SM, Dave A, Haque A, Langston K. The incidence of rotator cuff disease in smoking and non-smoking patients: a cadaveric study. Orthopedics 2006;29:363–6.
9. Vogel LA, Moen TC, Macaulay AA, Arons RR, Cadet ER, Ahmad CS, Levine WN. Superior labral anterior-to-posterior repair incidence: a longitudinal investigation of com-munity and academic databases. J Shoulder Elbow Surg 2014;23:e119-e126.
10. Feeney MS, O'Dowd J, Kay EW, Colville J. Glenohumeral articular cartilage changes in rotator cuff Disease. J Shoulder Elbow Surg 2003;12:20–3.
11. Kim TK, Queale WS, Cosgarea AJ, McFarland EG. 2003. Clinical features of different types of SLAP lesions: an analysis of one hundred and thirty-nine cases. J Bone Joint Surg 2003;85:66–71.
12. Clemente CD. Clemente's anatomy dissector. 2nd ed., Baltimore (MA): Lippincott, Williams and Wilkins; 2007. p. 65–8.
13. Tank PW. Grant's dissector. 15th ed. Baltimore (MA): Lippincott, Williams and Wilkins; 2005. p. 57–60.
14. Mizeres NJ, Jackson AJ. Methods of dissection in human anatomy. New York (NY): Elsevier; 1983. p. 34.
15. Zuckerman S. A new system of anatomy, a dissector's guide and atlas. Oxford (UK): Oxford University Press; 1981. p. 135–40.
16. Laurenson RD. An introduction to clinical anatomy by dissection of the human body. Philadelphia (PA): W.B. Saunders; 1968. p. 499–504.
17. Cahill DR, Carmichael SW. Supplemental clinical dissections for freshman gross anatomy. Anat Rec 1985;212:218–22.
18. Clemente FR, Fabrizio PA, Shumaker M. A novel approach to dissection of the knee. Anat Sci Educ 2009;2:41–6.

Online available at:
www.anatomy.org.tr
doi:10.2399/ana.16.057
QR code:

deomed.

Correspondence to: Philip A. Fabrizio, PT, MS, DPT
The Springfield Clinic, 800 N. 1st Street, Springfield,
IL 62702, USA
Phone: +1 404 769 8706
e-mail: pafabpt@gmail.com

Conflict of interest statement: No conflicts declared.