

# Macroscopic footprint of the glenoid labrum

Mehmet Emin Şimşek<sup>1</sup> , Mustafa Akkaya<sup>2</sup> , Safa Gürsoy<sup>2</sup> , Özgür Kaya<sup>3</sup> ,  
Nihal Apaydın<sup>4</sup> , Murat Bozkurt<sup>2</sup> 

<sup>1</sup>Department of Orthopedics and Traumatology, School of Medicine, Lokman Hekim University, Ankara, Turkey

<sup>2</sup>Department of Orthopedics and Traumatology, School of Medicine, Ankara Yıldırım Beyazıt University, Ankara, Turkey

<sup>3</sup>Department of Orthopedics and Traumatology, Lokman Hekim Etlik Hospital, Ankara, Turkey

<sup>4</sup>Department of Anatomy, School of Medicine, Ankara University, Ankara, Turkey

## Abstract

**Objectives:** Glenoid labrum lesions are one of the main causes of traumatic shoulder dislocations. Arthroscopic or open repair using suture anchors is commonly used to treat labral lesions. Proper placement of suture anchors in order to replace the normal ligamentous restraint is essential to restore normal anatomy that determines the final location of the repaired labrum. Yet, the most efficient and safest location of the glenoid bone has not been precisely described. Therefore, this study aimed to describe the macroscopic footprint of the glenoid labrum in order to depict the ideal anchor placement location precisely.

**Methods:** Twenty-two shoulders from 11 cadavers were dissected to reveal glenoid labrum. Clock positions were determined on glenoid labrum circumferentially to evaluate the footprint of the glenoid labrum. The distance between the bony edge of the glenoid rim and the edge of the labrum was measured.

**Results:** The mean distance from the glenoid labrum to the bony glenoid rim was measured as 5.1 mm (3 o'clock position), 6.2 mm (6 o'clock position), 5.1 mm (9 o'clock position) and 4.1 mm (12 o'clock position) in the anterior, inferior, posterior and superior aspects, respectively. 29.3% of the specimens had a completely defective anterior labrum.

**Conclusion:** Location of the labrum with respect to the bony glenoid rim should be considered for proper suture placements in treatment of labral tears. It is suggested that the most important step in the stabilization of joint laxity is appropriate placement of the sutures in the anterior and inferior aspects of the glenoid labrum.

**Keywords:** anatomy; footprint; glenoid labrum

Anatomy 2019;13(3):168–173 ©2019 Turkish Society of Anatomy and Clinical Anatomy (TSACA)

## Introduction

The glenoid labrum is a ring of fibrocartilage that lies around the margin of the glenoid cavity. The articular cavity is deepened by the labrum and the labrum also protects the bone edges and facilitates lubrication of the joint.<sup>[1,2]</sup> Synovium lines the inner surface of the labrum, whereas the outer surface is continuous with the scapular neck periosteum and attaches to the capsule. Edges of the glenoid fossa become more flexible since the shape of the labrum changes to contain the rotation of the humeral head. The labrum represents a fold of the capsule that serves as an attachment for glenohumeral ligaments.<sup>[3,4]</sup>

In general, traumatic shoulder dislocation is the main cause of extensive glenoid labrum lesions. Labral tears are

typically divided into two categories according to the location of the lesion. Anterior labral tears or Bankart lesions, posterior labral tears or reverse Bankart lesions, and superior labral tears or superior labrum anterior and posterior (SLAP) lesions are among such tears.<sup>[5,6]</sup>

Today, the best method to reattach the labrum and the capsule to the glenoid is to place suture anchors. The degree of capsulolabral detachment determines the number of suture anchors that will be used. For instance, in a standard Bankart repair in the right shoulder, 3 or 4 anchors would be placed at the 5 o'clock, 4 o'clock, 3 o'clock and 2 o'clock positions.<sup>[7,8]</sup> The repair performed by placing suture anchors is conducted from the inferior to the superior aspect. Posterior labral repair is conducted

with 3 anchors from the inferior aspect to the mid-glenoid posteriorly, after placing an anchor placement guide through the infraspinatus muscle. Then, the same technique is used to repair the anterior labrum. The anchor placement guide is placed through the subscapularis muscle so as to place the anchors. Starting from the inferior aspect, three anchors are placed until the anterior labrum.<sup>[9]</sup>

The repair of soft tissue detachments highly relies on suture anchors. Recurrent instability, which is one of the most frequent complications of glenoid repair, can be encountered due to improper suture anchor placement or problems during insertion. Such a problem can also be observed due to pathological laxity or inadequate capsular tension.<sup>[10,11]</sup>

Today, it is suggested to place the anchors 2–3 mm onto the articular surface on the chondral rim of the glenoid. The safest and most effective location of labral reattachment on the glenoid rim should be depicted well, since surgical failure has been associated with improper surgical technique. Today, this is referred to as the “art of repair” by surgeons. The aim of this study is to describe the macroscopic footprint of the glenoid labrum in order to depict the ideal anchor placement location precisely.

## Materials and Methods

Twenty-two shoulders from 11 cadavers were dissected for this study. The age and sex of the cadavers and the side from which specimens were collected were recorded. Of these, 12 were females and 10 males. The mean age of the cadavers was 67 years (min. 57 – max. 78 years). 9 specimens were collected from the left side and 13 specimens from the right side (**Figure 1**). There was no history of

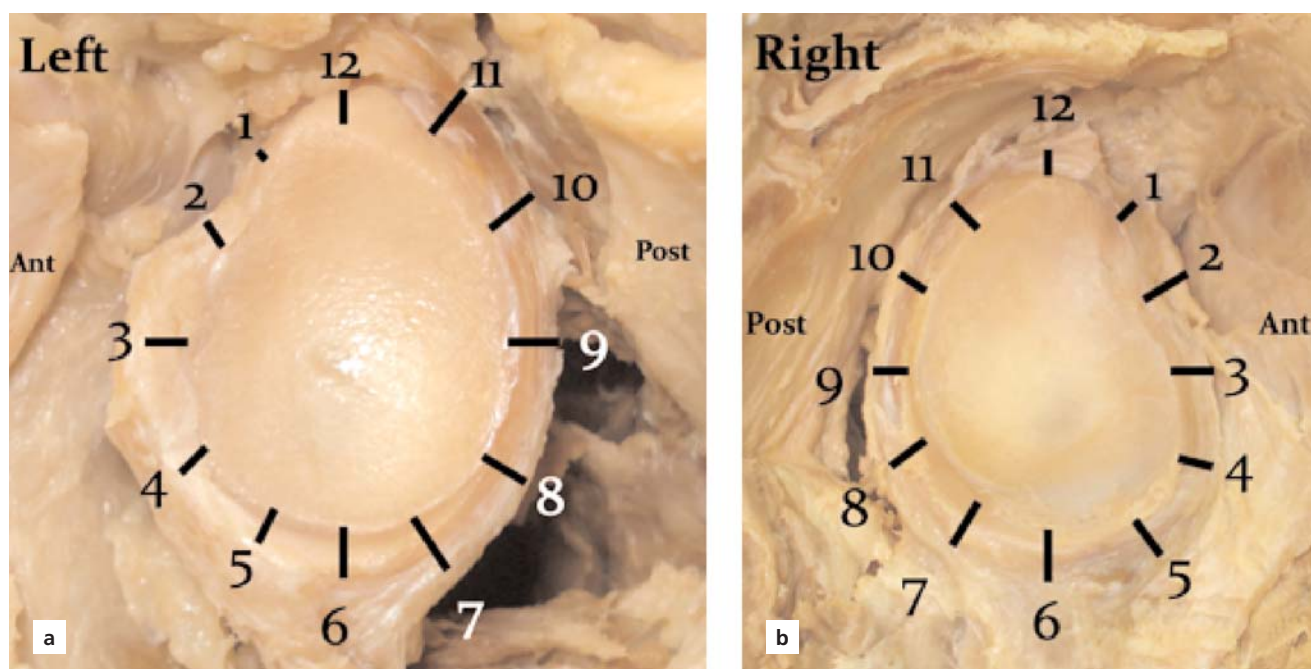


**Figure 1.** Dissection of the glenoid, left shoulder. [Color figure can be viewed in the online issue, which is available at [www.anatomy.org.tr](http://www.anatomy.org.tr)]

significant trauma or upper extremity surgery in any of the specimens. First, the skin was removed from the scapula, and the specimen was cleared of subcutaneous tissue and muscular connections. Then, the capsule was removed at the capsulolabral junction. In general practice, clock positions were used to depict the location and extent of labral tears and in the course of surgical treatment. Therefore, same clock positions were used to evaluate the morphological characteristics of the glenoid labrum and its footprint. Moreover, the relationship between the capsular ligaments and glenoid labrum was also evaluated using clock positions. The distance between the bony edge of the glenoid fossa and the edge of the labrum was measured in order to evaluate the footprint of the glenoid labrum. Efforts were made not to disrupt the labrum and the cartilage covering the glenoid. The apex of the line passing through the midglenoid in parallel to the scapular edge plane was marked as 12 o'clock and the clock plane was placed on the glenoid in order to determine 12 measurement points with 1-hour intervals. 12 o'clock was designated as the superior edge; 1 and 2 o'clock as the antero-superior; 3, 4 and 5 o'clock as the anterior; 6 o'clock as the inferior; 7, 8 and 9 o'clock as the posterior; 10 and 11 o'clock as the posterosuperior edge (**Figure 2**). There was severe glenohumeral arthrosis with significant degenerative changes in three specimens, which were not suitable for measurement. Accordingly, 19 cadaveric specimens were used for performing measurements in the study. Microcalipers (General Tools, New York, NY) were used for all measurements and the mean values were recorded. 3 experienced specialist orthopedic surgeons conducted all measurements on images and a double-blind setup was used to minimize inter- and intraobserver errors.

SPSS software package (Version 25.0, SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Normal distribution of the continuous variables were evaluated using the Kolmogorov Smirnov and Shapiro-Wilk tests and histograms. Numerical variables were expressed with mean $\pm$ SD, median values (minimum-maximum) or with proportions. Intergroup comparisons were performed using Student's t-test for normally distributed data and Mann-Whitney U test for data that did not have a normal distribution.  $p < 0.05$  was considered statistically significant. Relative intra- and interobserver reliabilities were determined using the intra-class correlation coefficient (ICC) model 2.1.

The specimens used in the present study were unclaimed bodies obtained from the forensic medicine according to official regulations. Conducting scientific studies on cadavers or cadaveric body parts do not require ethical approval in our institution.



**Figure 2.** Clock positions of the left (a) and right (b) glenoid labrum. [Color figure can be viewed in the online issue, which is available at [www.anatomy.org.tr](http://www.anatomy.org.tr)]

## Results

The dissections revealed that the morphology of the superior labrum was significantly different than that of the inferior labrum. It had a meniscal pattern and a loose attachment to the glenoid process. Moreover, the anterior part was completely missing in 29.3% of the specimens. The anterosuperior part of the labrum inserted into the fibers of the middle or inferior glenohumeral ligament, rather than to the actual glenoid margin. The mentioned meniscal pattern was also observed in the posterosuperior part of the labrum with a loose attachment to the glenoid rim. The inferior portion of the labrum was rounded and fibrous and appeared like an immobile extension of articular cartilage.

Starting at the 12 o'clock position, the mean distance from the bony edge in hourly intervals was  $4.86 \pm 0.87$  mm at 12 o'clock,  $4.20 \pm 1.5$  mm at 1 o'clock,  $4.41 \pm 1.2$  mm at 2 o'clock,  $5.23 \pm 1.28$  mm at 3 o'clock,  $5.52 \pm 1.23$  mm at 4 o'clock,  $6.25 \pm 1.02$  mm at 5 o'clock,  $6.10 \pm 0.86$  mm at 6 o'clock,  $5.98 \pm 0.82$  mm at 7 o'clock position of glenoid labrum; and  $5.71 \pm 0.91$  mm at 8 o'clock,  $5.52 \pm 0.85$  mm at 9 o'clock,  $5.14 \pm 0.98$  mm at 10 o'clock and  $5.52 \pm 0.73$  mm at 11 o'clock position of glenoid labrum (Table 1). The inter- and intraobserver variability of the measurements did not exceed 0.1 mm (Table 2).

According to the statistical analysis, there was a trend towards the differences between different locations on the glenoid face, but it was not statistically significant. The greatest difference between the measurements were observed between the 6 and 11, 12, 1 and 2 o'clock positions (Figure 3).

**Table 1**

Distance from macroscopic edge of the glenoid labrum to bony edge of the glenoid for the measured regions and positions.

Region	Position	Mean $\pm$ SD (mm)
Anterosuperior	1 o'clock	$4.20 \pm 1.15$
	2 o'clock	$4.41 \pm 1.20$
Anterior	3 o'clock	$5.23 \pm 1.28$
	4 o'clock	$5.52 \pm 1.23$
	5 o'clock	$6.25 \pm 1.02$
Inferior	6 o'clock	$6.10 \pm 0.86$
	7 o'clock	$5.98 \pm 0.82$
Posterior	8 o'clock	$5.71 \pm 0.91$
	9 o'clock	$5.52 \pm 0.85$
Posterosuperior	10 o'clock	$5.14 \pm 0.98$
	11 o'clock	$5.52 \pm 0.73$
Superior	12 o'clock	$4.86 \pm 0.87$

**Table 2**  
Intraobserver and interobserver reliabilities for the measured regions of the glenoid labrum.

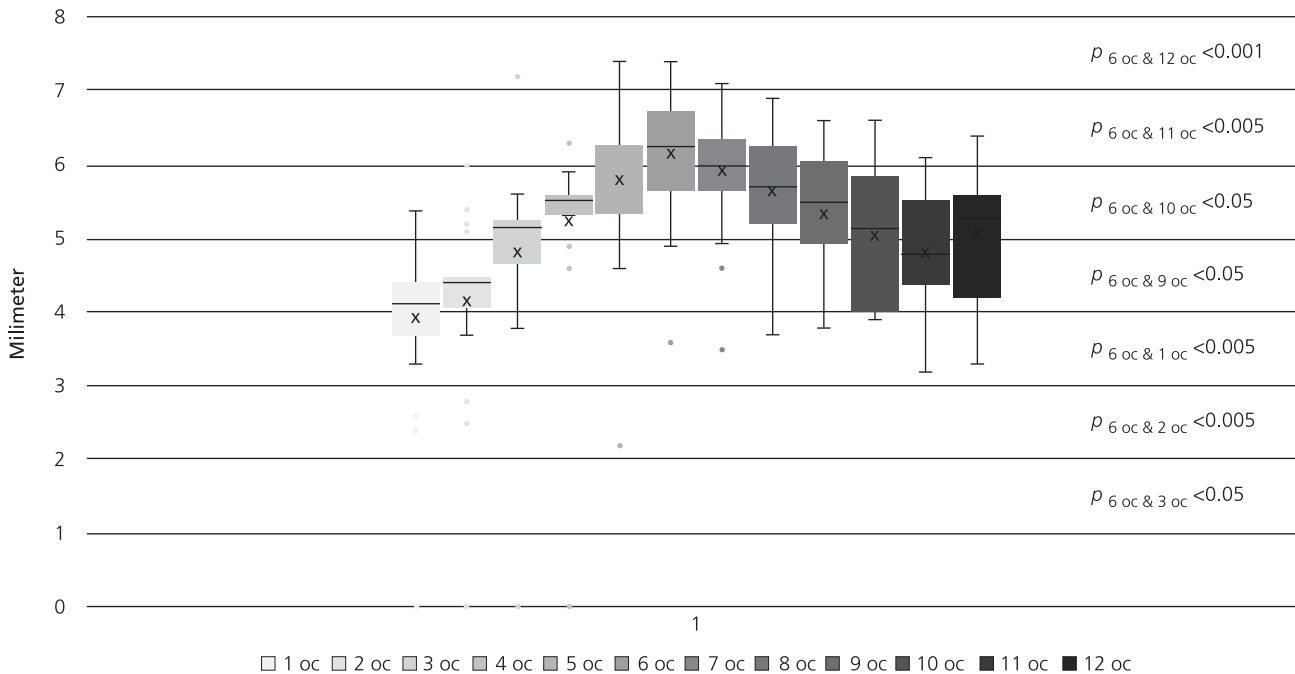
Region	Position	Intraobserver reliability % CI	p	Interobserver reliability % CI	p
Antero-superior	1 o'clock	0.97 (0.96–0.99)	0.214	0.99 (0.98–0.99)	0.141
	2 o'clock	0.98 (0.96–0.99)	0.128	0.98 (0.96–0.99)	0.126
Anterior	3 o'clock	0.96 (0.95–0.97)	0.168	0.93 (0.87–0.97)	0.168
	4 o'clock	0.98 (0.98–0.99)	0.099	0.98 (0.98–0.99)	0.099
	5 o'clock	0.96 (0.95–0.97)	0.210	0.91 (0.92–0.97)	0.210
Inferior	6 o'clock	0.97 (0.96–0.99)	0.157	0.98 (0.98–0.99)	0.152
Posterior	7 o'clock	0.95 (0.93–0.97)	0.238	0.93 (0.87–0.97)	0.168
	8 o'clock	0.85 (0.71–0.94)	0.147	0.85 (0.71–0.94)	0.147
	9 o'clock	0.92 (0.82–0.96)	0.164	0.91 (0.82–0.96)	0.154
Postero-superior	10 o'clock	0.98 (0.97–0.99)	0.456	0.98 (0.97–0.99)	0.470
	11 o'clock	0.94 (0.90–0.96)	0.188	0.93 (0.90–0.96)	0.178
Superior	12 o'clock	0.987 (0.96–0.99)	0.504	0.98 (0.97–0.99)	0.907

**Discussion**

Pathomorphological changes may initially be observed at three different locations in traumatic anterior dislocations of the shoulder: at the capsule, at its origin or insertion. Typically, the injury is in the form of an avulsion of the capsule and labrum from the glenoid.<sup>[12]</sup> The normal glenohumeral joint restraints can be recreated by anatomic

restoration of the glenoid labrum following a traumatic detachment.<sup>[13]</sup>

Anchor placement is of vital importance to achieve successful outcomes in labral repairs.<sup>[14]</sup> Recent studies suggest to start 5 o'clock and use the 4 and 3 o'clock position for an anchor placement,<sup>[15–17]</sup> because these locations provide the strongest anchor placement to gle-



**Figure 3.** Labrum measurements at 12 different clock positions.

noid labrum. There were some conflicts about the ideal site of fixation in the past. Some surgeons asserted that the anchors should be placed on articular surface in order to enhance stability.<sup>[18,19]</sup> However, anchor placement right on the edge of articular surface did not cause any changes in stability and even prevented potential arthropathies on the glenohumeral joint surface.<sup>[20-22]</sup>

According to the results of the present study, the insertion of the glenoid labrum was observed at a variable distance from the bony edge of the glenoid. It is required to place the suture anchor on the glenoid face at the articular margin in order to perform the anatomic reconstruction of the detached labrum. During anatomic dissections, we observed that the macroscopic edge of the labrum, described as the visible line of transition between the labrum and articular cartilage, was significantly more medial to the edge of the glenoid bone than expected.<sup>[7,9,23]</sup>

A smooth transition from the cartilaginous surface to the labrum is necessary for the translation of the glenohumeral joint. Therefore, a suture anchor should be placed in the vicinity of the glenohumeral articulation with caution.

The most important causes of glenohumeral arthropathy after an open or arthroscopic shoulder surgery were associated with anchor placement, regardless of the anchor type, i.e. metallic or biodegradable in recent studies.<sup>[24-28]</sup> With this perspective, knowing the anatomy of the labrum and glenoid is important and it should be kept in mind that the anatomy may be different in each person.

The limitations of this study were as follows: open surgical visualization was performed and there were no arthroscopic evaluations in the study. Arthroscopic visualization of the macroscopic edge of the glenoid labrum could be different in comparison to open surgical visualization. Moreover, other parameters concerning glenoid variability were not measured, which made it impossible to make any further associations with glenoid morphology.

## Conclusion

The results of this study suggest that insertion of the glenoid labrum onto the bony face of the glenoid occurs at a variable distance. Reattachment of the capsule and labrum to the glenoid articular surface essentially relies on suture anchors. In suture placement, location of the labrum with respect to the bony glenoid rim should be considered. It is suggested that the most important step in stabilizing joint laxity is proper placement along the anterior and inferior side of the glenoid labrum.

## References

- Cooper DE, Arnoczky SP, O'Brien SJ, Warren RF, DiCarlo E, Allen AA. Anatomy, histology, and vascularity of the glenoid labrum. An anatomical study. *J Bone Joint Surg Am* 1992;74:46-52.
- Barthel T, König U, Böhm D, Loehr JF, Gohlke F. Anatomy of the glenoid labrum. [Article in German] *Orthopäde* 2003;32:578-85.
- Tischer T, Putz R. Anatomy of the superior labrum complex of the shoulder. [Article in German] *Orthopäde* 2003;32:572-7.
- Alashkham A, Alraddadi A, Felts P, Soames R. Histology, vascularity and innervation of the glenoid labrum. *J Orthop Surg (Hong Kong)* 2018;26:2309499018770900.
- Sailer J, Imhof H. Shoulder instability. [Article in German] *Radiologe* 2004;44:578-90.
- Antonio GE, Griffith JF, Yu AB, Yung PS, Chan KM, Ahuja AT. First-time shoulder dislocation. High prevalence of labral injury and age-related differences revealed by MR arthrography. *J Magn Reson Imaging* 2007;26:983-91.
- Valis P, Nydrle M. Arthroscopic stabilization of the shoulder using anchors. *Acta Chir Orthop Traumatol Cech* 2003;70:233-36.
- Zarzycki W. Arthroscopic Bankart repair. [Article in Polish] *Chir Narzadow Ruchu Ortop Pol* 2006;71:309-11.
- Lehtinen JT, Tingart MJ, Apreleva M, Ticker JB, Warner JJ. Anatomy of the superior glenoid rim. Repair of superior labral anterior to posterior tears. *Am J Sports Med* 2003;31:257-60.
- Rowe CR, Zarins B, Ciullo JV. Recurrent anterior dislocation of the shoulder after surgical repair. Apparent causes of failure and treatment. *J Bone Joint Surg Am* 1984;66:159-68.
- Zhu W, Lu W, Zhang L, Han Y, Ou Y, Peng L, Liu H, Wang D, Zeng Y. Arthroscopic findings in the recurrent anterior instability of the shoulder. *Eur J Orthop Surg Traumatol* 2014;24:699-705.
- Wiedemann E, Jäger A, Nebelung W. Pathomorphology of shoulder instability. [Article in German] *Orthopäde* 2009;38:16-20, 22-3.
- Slabaugh MA, Friel NA, Wang VM, Cole BJ. Restoring the labral height for treatment of Bankart lesions: a comparison of suture anchor constructs. *Arthroscopy* 2010;26:587-91.
- Koulalis D, Kendoff D, Citak M, O'Loughlin PF, Pearle AD. Freehand versus navigated glenoid anchor positioning in anterior labral repair. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1554-7.
- Carreira DS, Mazzocca AD, Oryhon J, Brown FM, Hayden JK, Romeo AA. A prospective outcome evaluation of arthroscopic Bankart repairs: minimum 2-year follow-up. *Am J Sports Med* 2006;34:771-7.
- Boileau P, Ahrens P. The TOTS (temporary outside traction suture): a new technique to allow easy suture placement and improve capsular shift in arthroscopic bankart repair. *Arthroscopy* 2003;19:672-7.
- Tischer T, Vogt S, Imhoff AB. Arthroscopic stabilization of the shoulder with suture anchors with special reference to the deep anterior-inferior portal (5.30 o'clock). *Oper Orthop Traumatol* 2007;19:133-54.
- Gartsman GM, Roddey TS, Hammerman SM. Arthroscopic treatment of anterior-inferior glenohumeral instability. Two to five-year follow-up. *J Bone Joint Surg Am* 2000;82-A:991-1003.
- Mazzocca AD, Brown FM Jr, Carreira DS, Hayden J, Romeo AA. Arthroscopic anterior shoulder stabilization of collision and contact athletes. *Am J Sports Med* 2005;33:52-60.

20. Yamamoto N, Muraki T, Sperling JW, Steinmann SP, Itoi E, Cofield RH, An KN. Does the “bumper” created during Bankart repair contribute to shoulder stability? *J Shoulder Elbow Surg* 2013; 22:828–34.
21. Thal R. A knotless suture anchor. Technique for use in arthroscopic Bankart repair. *Arthroscopy* 2001;17:213–8.
22. Wolf EM. Arthroscopic capsulolabral repair using suture anchors. *Orthop Clin North Am* 1993;24:59–69.
23. Lehtinen JT, Tingart MJ, Apreleva M, Ticker JB, Warner JJ. Variations in glenoid rim anatomy: implications regarding anchor insertion. *Arthroscopy* 2004;20:175–8.
24. McNickle AG, L’Heureux DR, Provencher MT, Romeo AA, Cole BJ. Postsurgical glenohumeral arthritis in young adults. *Am J Sports Med* 2009;37:1784–91.
25. Dines JS, Elattrache NS. Horizontal mattress with a knotless anchor to better recreate the normal superior labrum anatomy. *Arthroscopy* 2008;24:1422–5.
26. Kaar TK, Schenck RC Jr, Wirth MA, Rockwood CA Jr. Complications of metallic suture anchors in shoulder surgery: a report of 8 cases. *Arthroscopy* 2001;17:31–7.
27. Athwal GS, Shridharani SM, O’Driscoll SW. Osteolysis and arthropathy of the shoulder after use of bioabsorbable knotless suture anchors. A report of four cases. *J Bone Joint Surg Am* 2006;88:1840–5.
28. Ekelund A, Ahmed M, Bjurholm A, Nilsson O. Neuropeptides in heterotopic bone induced by bone matrix in immunosuppressed rats. *Clin Orthop Relat Res* 1997;(345)229–38.

**ORCID ID:**

M. E. Şimşek 0000-0002-8081-0550; M. Akkaya 0000-0002-2694-4208;  
S. Gürsoy 0000-0003-4466-9657; Ö. Kaya 0000-0003-2033-9020;  
N. Apaydın 0000-0002-7680-1766; M. Bozkurt 0000-0001-8160-5375

deomed®

**Correspondence to:** Mustafa Akkaya, MD

Department of Orthopedics and Traumatology, School of Medicine,  
Ankara Yıldırım Beyazıt University, Ankara, Turkey  
Phone: +90 312 578 20 00  
e-mail: makkaya@outlook.com

*Conflict of interest statement:* No conflicts declared.

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported (CC BY-NC-ND3.0) Licence (<http://creativecommons.org/licenses/by-nc-nd/3.0/>) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited. *Please cite this article as:* Şimşek ME, Akkaya M, Gürsoy S, Kaya Ö, Apaydın N, Bozkurt M. Macroscopic footprint of the glenoid labrum. *Anatomy* 2019;13(3):168–173.