UCSF
UC San Francisco Previously Published Works

Title
Imaging-Based Prevalence of Superior Labral Anterior-Posterior Tears Significantly Increases in the Aging Shoulder.

Permalink
https://escholarship.org/uc/item/0t19236t

Journal
Orthopaedic journal of sports medicine, 6(9)

ISSN
2325-9671

Authors
Lansdown, Drew A
Bendich, Ilya
Motamedi, Daria
et al.

Publication Date
2018-09-17

DOI
10.1177/2325967118797065

Peer reviewed
Imaging-Based Prevalence of Superior Labral Anterior-Posterior Tears Significantly Increases in the Aging Shoulder

Drew A. Lansdown,*† MD, Ilya Bendich,† MD, Daria Motamedi,‡ MD, and Brian T. Feeley,† MD

Investigation performed at the University of California, San Francisco, San Francisco, California, USA

Background: Superior labral anterior-posterior (SLAP) tears can be associated with pain and shoulder dysfunction. Relatively little is known about the age-related prevalence of SLAP tears.

Purpose: To investigate the age-related prevalence of imaging-diagnosed SLAP tears in a heterogeneous grouping of shoulder conditions in a large cohort at a single institution with multiple blinded reviewers.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: A total of 281 shoulder magnetic resonance imaging (MRI) scans obtained over 8 months were reviewed by a musculoskeletal radiologist and an orthopaedic surgeon. The mean ± SD age of the group was 49.6 ± 15.5 years, and 107 of the patients were female (38.1%). Patients were divided into 4 age groups: 35 years or younger, 36 to 50 years, 51 to 65 years, and older than 65 years. Statistical analyses were completed by use of the Fisher exact test to compare proportions of SLAP tears between age groups, odds ratios to determine the likelihood of having a SLAP tear in each age group, and a logistic regression to control for associated abnormalities.

Results: There was a significant difference in the proportion of SLAP tears found on the MRIs for each age group (P < .001). Patients were significantly more likely to have SLAP tears if aged 51 to 65 years (66.7%; odds ratio [OR], 2.00; 95% CI, 1.27-3.15) and if older than 65 years (81.2%; OR, 4.31; 95% CI, 2.36-7.88). No increased prevalence was observed in patients aged 35 years or younger (47.5%; OR, 0.91; 95% CI, 0.55-1.50) or 36 to 50 years (51.8%; OR, 1.08; 95% CI, 0.70-1.67). Logistic regression demonstrated that age was the only significant predictor for having a SLAP tear (P < .001). Kappa values were 0.46 to 0.65 between reviewers, indicating moderate to substantial agreement.

Conclusion: An increasing prevalence of MRI-based SLAP tears was observed with increasing patient age. Patients older than 50 years were significantly more likely to have superior labral abnormalities regardless of other shoulder injury or disease.

Keywords: shoulder magnetic resonance imaging; superior labral anterior-posterior tears; aging

Superior labral anterior-posterior (SLAP) tears are associated with pain and shoulder dysfunction. SLAP tears were first described more than 30 years ago in a population of throwing athletes. The indications for treatment and management of these lesions remain controversial. Despite this controversy, up to 13% of all shoulder arthroscopic procedures performed in the United States in 2006 were for the primary indication of instability/SLAP tears.

From 2004 to 2009, the incidence of SLAP procedures, including repair and debridement, increased nearly 65%; the incidence of repair in patients older than 40 years nearly matched that of patients younger than 40 years. Provencer et al found that age older than 36 years was an independent risk factor for SLAP repair failure, and SLAP repairs have been performed in patients as old as 85 years.

*Address correspondence to Drew A. Lansdown, MD, Department of Orthopaedic Surgery, University of California, San Francisco, 1500 Owens Street, San Francisco, CA 94158, USA (email: drew.lansdown@ucsf.edu).
†Department of Orthopaedic Surgery, University of California, San Francisco, San Francisco, California, USA.
‡Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, California, USA.

One or more of the authors has declared the following potential conflict of interest or source of funding: D.A.L. has received educational and research support from Arthrex and Smith & Nephew. B.T.F. has received hospitality payments from Zimmer/Biomet. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was obtained from the University of California, San Francisco, Committee on Human Research.

The Orthopaedic Journal of Sports Medicine, 6(9), 2325967118797065 DOI: 10.1177/2325967118797065 © The Author(s) 2018

This open-access article is published and distributed under the Creative Commons Attribution - NonCommercial - No Derivatives License (http://creativecommons.org/licenses/by-nc-nd/4.0/), which permits the noncommercial use, distribution, and reproduction of the article in any medium, provided the original author and source are credited. You may not alter, transform, or build upon this article without the permission of the Author(s). For article reuse guidelines, please visit SAGE's website at http://www.sagepub.com/journals-permissions.
Although age affects the management and treatment of SLAP lesions, relatively little is known about the age-related nature of SLAP tears. A histological study from more than a decade ago showed an increase in the number of SLAP lesions with increasing age. Moreover, a recent study showed that up to 75% of asymptomatic shoulders in patients aged between 45 and 60 years had magnetic resonance imaging (MRI)-based evidence of SLAP tears. Importantly, however, the clinical age-based prevalence of SLAP tears on MRI has not been defined. Patients frequently describe a painful shoulder and have imaging that reveals abnormality at the superior labrum, although the frequency of these imaging findings is not established.

The purpose of this study was to investigate the age-related prevalence of imaging-diagnosed SLAP tears by using a large cohort at a single institution, with multiple blinded reviewers. We hypothesized that an increasing prevalence of SLAP tears would be significantly associated with older age.

METHODS

All consecutive shoulder MRI scans obtained at a single academic medical center in an 8-month period were retrospectively reviewed. A total of 318 shoulder scans were completed. The review included scans for patients 18 years and older and scans ordered for all indications. Patients were excluded for a documented history of prior surgery, and scans ordered for all indications. Patients were divided into 4 age groups for analysis: 35 years or younger, 36 to 50 years, 51 to 65 years, and older than 65 years. The Fisher exact test was used to determine statistical significance between the proportion of superior labral tears in these 4 groups. Odds ratios (ORs) were determined to calculate the likelihood of having a SLAP tear for each age range.

A logistic regression was then performed to evaluate multiple factors as potential contributors to SLAP tears. The presence or absence of a SLAP tear was used as the dependent variable, with age, sex, body mass index, supraspinatus condition, infraspinatus condition, and subscapularis condition as independent variables. For all statistical analyses, significance was defined as alpha less than .05.

RESULTS

A total of 281 MRI scans were included for analyses. From the original 318 scans, the following were excluded: 27 from patients with a documented history of prior shoulder surgery, 6 from patients younger than 18 years, 2 from patients with no clinical documentation, and 2 for pectoralis tendon injuries with poor imaging quality of the glenohumeral joint. The mean age of the full group was 49.6 ± 15.5 years, and the mean body mass index was 26.0 ± 4.7 kg/m² (Table 1). The group consisted of 107 female patients (38.1%) and 174 male patients (61.9%).
magnetic resonance (MR) arthrograms (26.3%) and 207 nonarthrogram studies (73.7%).

Rotator cuff concerns were the primary indication for the examination (46.8%), with instability (15.6%) and biceps/SLAP concerns (10.9%) as the next most frequent complaints. The remainder of the indications (26.8%) included arthritis, avascular necrosis, oncologic conditions, and recent trauma.

SLAP tears were observed in 169 patients (60.1%). No significant difference was observed in the prevalence between patients with a nonarthrogram study (129/207; 62.3%) versus an MR arthrogram (40/74; 54.1%) (P = .13).

SLAP injuries were observed most frequently in patients with suspected biceps/SLAP abnormality (75.0%; OR, 3.00; 95% CI, 1.35-6.68) (Figure 2). Patients with rotator cuff tear/external impingement syndrome as the indication for the imaging study were also more likely to be diagnosed with a SLAP tear (64.5%; OR, 1.82; 95% CI, 1.28-2.57). No significantly increased prevalence was found for patients with instability (56.5%; OR, 1.30; 95% CI, 0.73-2.33) or other diagnoses (55.7%; OR, 1.26; 95% CI, 0.81-1.96).

Full-thickness supraspinatus tears were identified in 66 of 281 patients (23.5%), full-thickness infraspinatus tears in 17 patients (6.1%), and full-thickness subscapularis tears in 11 patients (3.9%).

There was a significant difference in the proportion of SLAP tears found on the MRIs for each age group (P < .001) (Figure 3). Patients were significantly more likely to have SLAP tears if they were 51 to 65 years old (66.7%; OR, 2.00; 95% CI, 1.27-3.15) and older than 65 years (81.2%; OR, 4.31; 95% CI, 2.36-7.88). No significant increased prevalence was observed in patients 35 years or younger (47.5%; OR, 0.91; 95% CI, 0.55-1.50) or those aged 36 to 50 years (51.8%; OR, 1.08; 95% CI, 0.70-1.67).

The agreement rates for identification of SLAP tears ranged from 73% between the orthopaedic surgeon and the radiology report to 83.1% between the orthopaedic surgeon and the musculoskeletal radiologist (Table 2). The agreement between all reviewers was higher for patients with an arthrogram compared with a nonarthrogram study.

Logistic regression analysis demonstrated that age was the only significant independent predictor for a patient having a SLAP tear (OR, 1.05; 95% CI, 1.03-1.08; P < .001). Relative to other diagnoses, patients were significantly

---

**Figure 2.** The prevalence of superior labral anterior-posterior (SLAP) tears is displayed according to the indication for obtaining the shoulder magnetic resonance imaging (MRI). SLAP tears were most frequently observed if the MRI was obtained to evaluate for biceps/SLAP abnormality or for rotator cuff tears/external impingement syndrome.

**Figure 3.** The age-based prevalence of superior labral anterior-posterior (SLAP) tears as detected by shoulder magnetic resonance imaging (MRI) and according to at least 2 of 3 reviewers. The prevalence of SLAP tears is significantly different between age groups, with P < .001 by Fisher exact test.

---

**Table 1.** Demographics of Patients Undergoing Shoulder MRI

| Characteristic                        | Value       |
|--------------------------------------|-------------|
| Age, y, mean ± SD                   | 49.6 ± 15.5 |
| Body mass index, kg/m², mean ± SD   | 26.0 ± 4.7  |
| Sex, n (%)                           |             |
| Female                               | 107 ± 38.1  |
| Male                                 | 174 ± 61.9  |
| Primary shoulder abnormality, n (%)  |             |
| Rotator cuff tear/external impingement syndrome | 138 ± 46.8 |
| Instability                          | 46 ± 15.6   |
| Biceps/SLAP                          | 32 ± 10.9   |
| Other                                | 79 ± 26.8   |
| Study type, n (%)                    |             |
| Nonarthrogram MRI                    | 207 ± 73.7  |
| MR arthrogram                        | 74 ± 26.3   |

*MR, magnetic resonance; MRI, magnetic resonance imaging; SLAP, superior labral anterior-posterior.
more likely to have a SLAP tear on MRI if the scan was ordered for concern of biceps tendon or SLAP injury (OR, 7.18; 95% CI, 2.57-20.1; \(P < .001\)), concern for shoulder instability (OR, 3.90; 95% CI, 1.59-9.60; \(P = .003\)), or concern for rotator cuff injury (OR, 2.05; 95% CI, 1.02-4.14; \(P = .044\)). Patient sex, body mass index, and status of the supraspinatus, infraspinatus, or subscapularis tendons were not significant independent predictors of having a SLAP tear.

### DISCUSSION

A significant association was found between SLAP tears and increasing patient age, consistent with our initial hypothesis. This effect was most pronounced for patients older than 60 years. Additionally, when we controlled for other factors that could affect the condition of the labrum, age remained the only significant predictive variable for SLAP abnormality. This age-related increase in prevalence of superior labral abnormalities is consistent with a prior histopathological report.\(^9\)

The great anatomic detail offered by MRI may lead to the detection of incidental findings of uncertain significance. In a recent study, the MRI-diagnosed prevalence of SLAP tears in 53 asymptomatic patients aged 45 to 60 years was 55% to 72%.\(^13\) The proportion of patients with SLAP abnormality in the current study is similar to that prior report, with the important distinction that the current cohort had preimaging shoulder symptoms that prompted the treating physician to obtain the study. This distinction helps generalize our findings to the patient with shoulder pain and the concern for potential tearing of the superior labrum, and it especially highlights the need for further research on the contributions SLAP tears may make with regard to shoulder pain.

The high prevalence of SLAP abnormalities on MRI that we observed is similar to findings of prior studies of the hip, knee, and spine. Acetabular labral abnormalities were observed in 69% of asymptomatic hips, with a greater risk of labral abnormality in patients older than 37 years.\(^11\) In a study on the cervical spine of asymptomatic patients, Matsumoto et al\(^10\) found intervertebral disc degeneration in 12% of women and 17% of men in the third decade, compared with 89% of women and 86% of men older than 60. Finally, Englund et al\(^9\) evaluated knee MRIs in older patients without knee complaints. The prevalence of meniscal tears was 56% for men between the ages of 70 and 90 years. These prior studies have helped establish the age-related prevalence of degenerative musculoskeletal conditions as observed on MRI. While these findings may be responsible for painful symptoms, special care must be taken in attributing symptoms to the superior labrum given how common signal abnormalities are at this location.

SLAP abnormality is a challenging entity to understand with regard to its role in shoulder symptoms and implications for treatment. We found that preimaging concern for a biceps tendon injury or SLAP tear was a significant independent predictor of the presence of a SLAP abnormality; however, only a small subset of our population obtained imaging with this concern. Cook et al\(^4\) reported on the poor diagnostic capabilities of 5 physical examination tests for SLAP injuries: the O’Brien active compression test, biceps load II test, dynamic labral shear test, Speed test, and labral tension test. In a group of patients with heterogeneous shoulder injuries, none of these tests alone or in combination were able to reliably diagnose a SLAP injury. Due to the difficulty in making a clinical diagnosis, advanced imaging may be used for surgical decision making, leading to the high prevalence of surgical treatment of SLAP tears.

Nonarthrogram MRI has been shown to be inconsistent with the diagnosis of SLAP tear, and variability exists between musculoskeletal-trained radiologists and general radiologists in the interpretation of shoulder MRI.\(^12\) Magee and Williams,\(^7\) however, reported 90% sensitivity and 100% specificity when correlating MRI diagnosis of SLAP tears with arthroscopic evaluation if the MRI was obtained with a 3-T scanner. In the current study, the agreement on the diagnosis of a SLAP tear on MRI was moderate between surgeon and radiologist interpretations, which compares favorably with prior reports.\(^13\) The agreement in our cohort was higher across all readers for patients with MR arthrograms. Without intra-articular contrast, abnormal signal in the labrum that does not approach fluid signal on MRI can be interpreted differently by different radiologists and reviewers. This discrepancy is less of an issue on MR arthrograms because contrast insinuation defines the tear and those cases are less equivocal. Given the difficulty with a clinical diagnosis and the high prevalence of abnormal findings on MRI, there is a clear need for improved physical examination tests and diagnostic imaging modalities.

This study has multiple strengths. It included a large collection of consecutive imaging studies performed at a single institution. The patient cohort included patients of

### TABLE 2
Evaluation of Agreement Between Orthopaedic Surgeon, Musculoskeletal Radiologist, and Radiology Report for Diagnosis of Superior Labral Anterior-Posterior Tear on Shoulder MRI\(^a\)

| Group         | Overall Agreement, % | Kappa | Nonarthrogram Agreement, % | Kappa | Arthrogram Agreement, % | Kappa |
|---------------|----------------------|-------|----------------------------|-------|--------------------------|-------|
| Ortho vs report | 73.0                 | 0.46  | 70.1                       | 0.41  | 81.1                     | 0.62  |
| MSK vs report  | 75.4                 | 0.51  | 69.6                       | 0.39  | 81.9                     | 0.84  |
| Ortho vs MSK  | 83.1                 | 0.65  | 82.8                       | 0.63  | 83.8                     | 0.68  |

\(^a\)MSK, musculoskeletal radiologist; ortho, orthopaedic surgeon; report, radiology report.
a wide age range and with varying shoulder abnormalities. We included the interpretations of both an orthopaedic surgeon and a fellowship-trained musculoskeletal radiologist, in addition to the official radiology interpretation by a fellowship-trained musculoskeletal radiologist.

This retrospective study should be interpreted with an understanding of specific weaknesses. We did not have arthroscopic confirmation of SLAP tears in this cohort and rather relied on an agreement between 2 reviewers on MRI, which is in line with the methods of prior reports. Given the difficulty in attributing pain to the superior labrum, we also did not have a gold standard physical examination or history element for SLAP tears. We may have overestimated the true prevalence of SLAP tears, but we believe that our interpretations are similar to those often used in clinical practice. Our agreement between readers was moderate; however, we required a consensus between at least 2 reviewers to categorize an injury as a SLAP tear, which has been used in prior studies of the superior labrum. The patients had a variety of presenting symptoms, but we believe that this heterogeneity may help make the results more generalizable. We also did not have an asymptomatic control group for comparison. Finally, we did not have specific patient-related information, such as overhead activity level, to determine potential risk factors for imaging-based SLAP tears.

CONCLUSION

The study results show the association of patient age and MR-based changes at the superior labrum. When interpreting imaging studies and reports, both the treating physician and the patient should understand the high prevalence of these findings. This study also highlights the need for further research on examination and imaging findings to clarify when SLAP tears are responsible for a patient’s symptoms.

REFERENCES

1. Alpert JM, Wuerz TH, O’Donnell TFX, Carroll KM, Brucker NN, Gill TJ. The effect of age on the outcomes of arthroscopic repair of type II superior labral anterior and posterior lesions. Am J Sports Med. 2010; 38(1):2299-2303.
2. Andrews JR, Carson WG, Mcleod WD. Glenoid labrum tears related to the long head of the biceps. Am J Sports Med. 1985;13(5):337-341.
3. Brockmeyer M, Tompkins M, Kohn DM, Lorbach O. SLAP lesions: a treatment algorithm. Knee Surg Sports Traumatol Arthrosc. 2016; 24(2):447-455.
4. Cook C, Beaty S, Kissenberth MJ, Siffri P, Pill SG, Hawkins RJ. Diagnostic accuracy of five orthopedic clinical tests for diagnosis of superior labrum anterior posterior (SLAP) lesions. J Shoulder Elbow Surg. 2012;21(1):13-22.
5. Englund M, Guermazi A, Gale D, et al. Incidental meniscal findings on knee MRI in middle-aged and elderly persons. N Engl J Med. 2008; 359(11):1108-1115.
6. Jain NB, Higgins LD, Losina E, Collins J, Blazar PE, Katz JN. Epidemiology of musculoskeletal upper extremity ambulatory surgery in the United States. BMC Musculoskelet Disord. 2014;15(1):1-7.
7. Magee TH, Williams D. Sensitivity and specificity in detection of labral tears with 3.0-T MRI of the shoulder. AJR Am J Roentgenol. 2006; 187(6):1448-1452.
8. Matsumoto M, Fujimura Y, Suzuki N, et al. MRI of cervical intervertebral discs in asymptomatic subjects. J Bone Joint Surg Br. 1998; 80-B(1):19-24.
9. Pfahler M, Haraida S, Schulz C, et al. Age-related changes of the glenoid labrum in normal shoulders. J Shoulder Elbow Surg. 2003; 12(1):40-52.
10. Provencer MT, McCormick F, Dewing C, McIntire S, Solomon D. A prospective analysis of 179 type 2 superior labrum anterior and posterior repairs: outcomes and factors associated with success and failure. Am J Sports Med. 2012;40(4):880-886.
11. Register B, Pennock AT, Ho CP, Strickland CD, Lawand A, Phillipson MJ. Prevalence of abnormal hip findings in asymptomatic participants: a prospective, blinded study. Am J Sports Med. 2012;40(12):2720-2724.
12. Reuss BL, Schwartzberg R, Zlatkin MB, Cooperman A, Dixon JR. Magnetic resonance imaging accuracy for the diagnosis of superior labrum anterior-posterior lesions in the community setting: eighty-three arthroscopically confirmed cases. J Shoulder Elbow Surg. 2006;15(3):580-585.
13. Schwartzberg R, Reuss BL, Burkhart BG, Butterfield M, Wu JY, McLean KW. High prevalence of superior labral tears diagnosed by MRI in middle-aged patients with asymptomatic shoulders. Orthop J Sports Med. 2016;4(1):2325967115623212.
14. Weber SC, Martin DF, Seiler JG, Harrast JJ. Superior labrum anterior and posterior lesions of the shoulder: incidence rates, complications, and outcomes as reported by American Board of Orthopaedic Surgery, part II: candidates. Am J Sports Med. 2012;40(7):1538-1543.
15. Zhang AL, Kreulen C, Ngo SS, Hame SL, Wang JC, Gamradt SC. Demographic trends in arthroscopic SLAP repair in the United States. Am J Sports Med. 2012;40(5):1144-1147.