Superior labrum anterior-to-posterior repair incidence: a longitudinal investigation of community and academic databases

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Background: Superior labrum anterior-to-posterior (SLAP) lesion repair is controversial regarding indications and potential complications.

Methods: Databases were used to determine the SLAP repair incidence compared with all orthopaedic procedures over a period of 10 years. In part A, the New York Statewide Planning and Research Cooperative System ambulatory surgery database was investigated from 2002 to 2009. In part B, the California Office of Statewide Health Planning and Development ambulatory surgery database was investigated from 2005 to 2009. In part C, the American Board of Orthopaedic Surgery (ABOS) database was investigated from 2003 to 2010.

Results: In part A, from 2002 to 2009, there was a 238% increase in SLAP repair volume compared with a 125% increase in all orthopaedic procedures. In part B, from 2005 to 2009, there was a 20.17% increase in SLAP repair volume compared with a decrease of 13.64% in all orthopaedic procedures. In part C, among candidates performing at least 1 SLAP repair, there was no statistically significant difference in likelihood of performing a SLAP repair (95% confidence interval, 0.973-1.003) in 2010 as compared with 2003 (P > .10).

Conclusions: There has been a significant increase in the incidence of SLAP repairs in the past 10 years in statewide databases. This pattern was not seen in the ABOS database, in which the annual volume of SLAP repairs remained stable over the same period. This suggests that SLAP lesions have been over-treated with surgical repair but that part II ABOS candidates are becoming more aware of the need to narrow indications.

Level of evidence: Epidemiology Study, Database Analysis.

Keywords: SLAP lesion; incidence; SPARCS; OSHPD; ABOS

Tears of the superior labrum were initially recognized as a pathologic entity by Andrews et al. and were ultimately described as superior labrum anterior-to-posterior (SLAP) tears by Snyder et al. Since their initial characterization and description in the late 1980s, the understanding of the
superior labrum and its pathology has been enhanced considerably. Cadaveric studies have shown the superior labrum to be a largely triangular fibrocartilaginous structure, intimately related to the long head of the biceps tendon, with tremendous anatomic variation.44 Multiple acute and chronic mechanisms of injury have been identified as causes of SLAP tears,21 with the stress inherent in overhead athletic activities among the most frequently cited. Surgeons have devised novel physical examination maneuvers and special tests in an attempt to more accurately diagnose SLAP tears,19,26 and studies have attempted to delineate the key features on imaging3,43 and on direct arthroscopic examination to more accurately identify SLAP tears. Multiple nonoperative5 and operative1,2,3,9,11,34,35,37,38 treatment strategies have been developed and refined to treat pathologic lesions of the superior labrum.

Despite extensive research, many questions remain about the superior labrum and SLAP tears. To begin, there is a lack of consensus as to what constitutes a pathologic SLAP tear and what constitutes a normal anatomic variant.23 When a pathologic lesion of the superior labrum is identified, surgeons have difficulty agreeing on how to classify the pathology.12,15 Even when a SLAP lesion is clearly identified in a patient and symptoms from the lesion are refractory to conservative management,8 how to best surgically address the lesion is controversial. Multiple authors report success repairing the labrum using a variety of constructs,9,34,35,37,38 whereas others advocate biceps tenotomy11 or tenodesis.5 These controversies in the identification and treatment of SLAP lesions are relevant because considerable complications from the surgical treatment of SLAP lesions can occur4,18; moreover, the results of revision treatment of SLAP lesions are inferior to the results of primary treatment.30

Despite an expanding body of literature on SLAP tears and SLAP repairs, it is unclear how frequently SLAP repairs are being performed. To our knowledge, no study has ever examined the surgical volume of arthroscopic SLAP repairs in multiple databases. One recent study performed using only the New York Statewide Planning and Research Cooperative System (SPARCS) database found a substantial increase in the rate of SLAP repair compared with outpatient orthopaedic procedures.27

The purpose of this study was to determine the volume of SLAP repairs that were performed over the past decade using 1 national and 2 statewide orthopaedic databases. The hypothesis for this study is that the volume of SLAP repairs being performed has progressively increased over the past 5 to 10 years.

Materials and methods

The SPARCS database was used for part A of this study; it has been used for numerous studies investigating aspects of practice in surgical subspecialties.32,45 The inclusion criteria for part A of the study were (1) all SLAP lesion repair procedures (Current Procedural Terminology [CPT] code 29807) and (2) all other orthopaedic surgical procedures (CPT codes 20000 through 29999) that were reported in each year of the SPARCS ambulatory surgery database from 2002 (the year in which CPT code 29807 was first published) to 2009 (the most recent year of SPARCS data available at the time of our study). Demographic data were collected for each case including patient age; patient sex; patient race; payer; primary International Classification of Diseases, Ninth Revision diagnosis code; CPT procedure codes; and procedure year. No cases were excluded on the basis of primary diagnosis.

The Office of Statewide Health Planning and Development (OSHPD) database was used for part B of this study. OSHPD databases have been used for numerous large-scale research studies in orthopaedic surgery.14,40,46 The inclusion criteria for part B of the study were (1) all SLAP lesion repair procedures (CPT code 29807) and (2) all other orthopaedic surgical procedures (CPT codes 20000 through 29999) that were reported in each year of the OSHPD ambulatory surgery database from 2005 (the first year in which ambulatory surgery data were available in the OSHPD database) to 2009 (the most recent year of OSHPD data available at the time of our study). The data points collected for each case were the same as those listed earlier for the SPARCS database.

Data from the American Board of Orthopaedic Surgery (ABOS) was used for part C of this study. The ABOS database contains information that is voluntarily self-reported by candidates who have applied and been approved for admission to part II (oral) of the examination for specialty board certification in orthopaedic surgery. These candidates have completed an accredited residency in orthopaedic surgery, passed part I (written) of the examination, actively practiced orthopaedic surgery for 22 months, and undergone peer review. Since 1999, the approved candidates have used a Web-based program (Scribe) to submit information about all of their operative cases, in all of the facilities for which each candidate has privileges, performed over a defined 6-month period. The ABOS requires notarized signatures of the medical records custodian certifying that the lists are complete. The candidates report demographic information for each patient and diagnosis, procedure, complication, and outcome data for each case. Ten cases are selected from the list by the ABOS and form the basis of the oral examination. During the examination, the medical records and images of the 10 cases are reviewed and investigated by 6 volunteer board-certified trained examiners. A similar process is used by board-certified surgeons who choose to recertify by an oral examination pathway. Repeat testing is currently required at 10-year intervals.

The ABOS database has been used to investigate practice trends in orthopaedic surgery for numerous procedures.22,34,48 The inclusion criteria for part C of the study were (1) all SLAP lesion repair procedures (CPT code 29807) and (2) all other orthopaedic surgical procedures (CPT codes 20000 through 29999) that were reported in each year of the ABOS database from 2003 (the first year in which CPT code 29807 was used as an official examination code) to 2010 (the most recent year of ABOS data available at the time of our study). Cases reported by surgeons taking board examinations for (1) recertification, (2) sports medicine subspecialty certification, or (3) maintenance of certification were excluded to maintain data homogeneity. For part C, case volume is reported in the ABOS database as procedure volume per individual examination candidate; this information was separated into
2 categories: all candidates and candidates who performed at least 1 SLAP repair. Although the latter subgroup analysis may increase the apparent number of SLAP procedures per number of orthopaedic surgeons taking part II of the board examination, it may be a more accurate representation of the average number of SLAP repairs performed by surgeons who actually perform this procedure as part of their practice.

This research protocol was reviewed by the institutional review board and was judged to be exempt from requiring consent.

**Statistical methods**

For parts A, B, and C, descriptive statistics were reported on demographic variables, procedure volumes, and incidence rates. For parts A and B, we constructed a multivariate logistic regression model with procedure type as the response variable, controlling for age, sex, race, ethnicity, payer, and year of procedure. All tested effects were categorical except for age, which was a continuous variable. Variables were chosen a priori based on clinical experience and previous research as factors that may affect the likelihood of surgery. Because the variables analyzed in parts A and B were not available in the ABOS database, for part C, a univariate logistic regression model was created with procedure type as the response variable as a function of procedure year. Ninety-five percent confidence intervals (CIs) were reported for all odds ratios in the logistic regression analysis. The level of significance for all tests was $P < .05$. SAS software (SAS Institute, Cary, NC, USA) was used for all statistical analysis.

**Results**

**Descriptive statistics for part A**

From 2002 to 2009, in the New York SPARCS database, there were 1.45 million orthopaedic surgery ambulatory procedures reported. Of these, 11,549 were SLAP repair procedures. In 2002, there were 678 SLAP repairs among 108,707 orthopaedic surgery ambulatory procedures (0.6%). Table I summarizes SLAP repair cases in the SPARCS database from 2002 to 2009. On the basis of New York census data, the population incidence of SLAP repair procedures in 2002 was 3.54 per 100,000 population. In 2009, there were 2,128 SLAP repairs among 245,579 orthopaedic surgery ambulatory procedures (0.8%). The population incidence of SLAP repairs in 2009 was 10.89 per 100,000 population. In 2009, the number of SLAP repair procedures performed in New York increased by 238% (Fig. 1). In comparison, the volume of all orthopaedic surgery ambulatory procedures only increased by 125%.

**Multivariate logistic regression analysis for part A**

In the multivariate logistic regression model, SLAP repair was the response variable and the explanatory variables of the model were procedure year, age, sex, race, ethnicity, and payer. The SLAP repair logistic regression model had a percent concordance of 60.1 and c value of 0.696, which support the model is an acceptable fit. The following variables had a significant effect on the likelihood of having a SLAP repair procedure compared with all other orthopaedic surgery ambulatory procedures: sex, race, payer, age, and procedure year. Men were 2.7 times more likely (95% CI, 2.582-2.885) to have a SLAP repair than women ($P < .0001$). Non-Hispanic patients were 1.2 times more likely (95% CI, 1.132-1.284) to have a SLAP repair than Hispanic patients ($P < .0001$). Patients receiving workers’ compensation were 3.4 times more likely (95% CI, 3.213-3.606) to have a SLAP repair compared with all other insurance types ($P < .0001$). Patients with Medicare were 63.3% less likely (95% CI, 0.313-0.430) to have a SLAP repair compared with all other insurance types ($P < .0001$). Patients with Medicaid were 65.6% less likely (95% CI, 0.264-0.448) to have a SLAP repair compared with all other insurance types ($P < .0001$). For every additional year of age, a patient was 0.5% more likely (95% CI, 1.004-1.007) to have a SLAP repair ($P < .0001$). For every additional year of study duration, a patient was 6.8% more likely (95% CI, 1.050-1.087) to have a SLAP repair compared with all other orthopaedic procedures ($P < .0001$).

**Descriptive statistics for part B**

From 2005 to 2009, in the California OSHPD database, there were 1.99 million orthopaedic surgery ambulatory procedures reported. The number of orthopaedic surgery ambulatory procedures increased from 397,124 in 2005 to a peak of 415,954 in 2007; the number then decreased to 342,944 in 2009. Of the 1.99 million total orthopaedic surgery ambulatory procedures, 28,657 were SLAP repair procedures. Table II summarizes SLAP repair cases in the OSHPD database from 2005 to 2009. In 2005, there were 4,587 SLAP repair procedures (1.16% of all orthopaedic surgery ambulatory procedures). On the basis of California census data, the population incidence of SLAP repairs in 2005 was therefore 12.78 per 100,000 population. In 2009, there were 5,512 SLAP repairs among 342,944 orthopaedic surgery ambulatory procedures (1.61%). The population incidence of SLAP repairs in 2009 was 14.88 per 100,000 population. The population incidence of SLAP repairs was actually at a high in 2007, at 17.83 per 100,000 population. The population incidence of SLAP repairs was 14.88 per 100,000 population. The population incidence of SLAP repairs was actually at a high in 2007, at 17.83 per 100,000 population. The numbers of SLAP repair procedures as a percentage of all orthopaedic surgery ambulatory procedures were stable, around 1.6%, from 2007 to 2009. Comparing the year 2005 with the year 2009, the raw number of SLAP repair procedures performed in California increased by 20.17% (Fig. 2). In comparison, the volume of all orthopaedic surgery ambulatory procedures in California actually decreased by 13.64%. A decrease in the population incidence of all orthopaedic surgery ambulatory procedures also occurred when we compared 2005 and 2009 (1,106.4 procedures per 100,000 population and 927.8 procedures per 100,000 population, respectively).
In the multivariate logistic regression model, SLAP repair was the response variable and the explanatory variables of the model were procedure year, age, sex, race, ethnicity, and payer. The SLAP repair logistic had a percent concordance of 67.2 and c value of 0.706. The following variables had a significant effect on the likelihood of having a SLAP repair procedure compared with all other orthopaedic surgery ambulatory procedures: sex, race, payer, age, and procedure year. Men were 2.5 times more likely (95% CI, 2.328-2.617) to have a SLAP repair than women (\(P < .0001\)). White patients were 1.4 times more likely (95% CI, 1.281-1.544) to have a SLAP repair than nonwhite patients (\(P < .0001\)). Non-Hispanic patients were 1.5 times more likely (95% CI, 1.393-1.656) to have a SLAP repair than Hispanic patients (\(P < .0001\)). Patients receiving workers’ compensation were 2.2 times more likely (95% CI, 2.055-2.383) to have a SLAP repair compared with all other insurance types (\(P < .0001\)). Patients with Medi-Cal (California Medicaid) were 87.9% less likely (95% CI, 0.171-0.286) to have a SLAP repair compared with all other insurance types (\(P < .0001\)). For every additional year of age, a patient was 1.2% less likely (95% CI, 1.094-1.137) to have a SLAP repair (\(P < .0001\)). For every additional year of the study duration, a patient was 11.5% more likely (95% CI, 1.094-1.137) to have a SLAP repair compared with all other orthopaedic procedures (\(P < .0001\)).

### Descriptive statistics for part C

From 2003 to 2010, there were 686,391 orthopaedic surgery procedures submitted to the ABOS by 5,322 candidates taking part II of the orthopaedic surgery board examination. Of these, 6,501 were SLAP repairs. When we analyzed only cases submitted by candidates who had reported at least 1 SLAP repair procedure, the results were similar. In 2003, the 195 candidates who submitted cases that included at least 1 SLAP repair reported a mean (\(\pm\)standard deviation) of 3.9 \(\pm\)4.6 SLAP repair procedures per candidate and 137.7 \(\pm\)65.4 orthopaedic surgery procedures per candidate. In 2010, the 204 candidates who performed at least 1 SLAP repair submitted 3.2 \(\pm\)3.3 SLAP repair procedures per candidate and 123.8 \(\pm\)56.9 orthopaedic surgery procedures per candidate (Fig. 3). Over a period of 8 years, the mean volume of SLAP repair procedures per candidate decreased by 17.67%. In comparison, the mean volume of all orthopaedic surgery procedures decreased by only 10.07%. When we examined cases submitted by candidates performing at least 1 SLAP repair, the highest mean number of SLAP repair cases per candidate occurred in 2006 (4.1 cases per candidate), followed closely by 2008 (4.0 cases per candidate).

### Univariate logistic regression analysis for part C

The ABOS database did not contain variables that would allow for the creation of a multivariate logistic regression model, so a simple univariate logistic regression model was
created with SLAP repair as the response variable as a function of procedure year. Among candidates performing at least 1 SLAP repair, there was no statistically significant difference to have performed a SLAP repair (95% CI, 0.973-1.003) in 2010 compared with 2003 ($P > .10$).

**Discussion**

Successful identification and treatment of pathology of the superior labrum have been challenging for orthopaedic surgeons since the initial recognition and description of SLAP tears in the late 1980s and early 1990s.\textsuperscript{1,38,39} In the face of these challenges and with an increasing foundation of knowledge, the rates at which SLAP tears are being treated surgically is increasing in the United States. This report shows that the incidence of SLAP repairs consistently increased between 2002 and 2009 based on information from the New York SPARCS and California OSHPD databases. However, despite the overall national increase in the incidence of SLAP repairs by orthopaedic surgeons, the incidence among candidates sitting for the ABOS oral examination during the same period remained largely stable. These demographic data suggest that SLAP tears may have been over-treated in the past in general practice and that surgeons who are undergoing part II of the board examination, and are thus required to self-monitor their case selection and be more conservative, perform SLAP repairs for more appropriately narrow indications.

Although controversial questions remain about the diagnosis and appropriate treatment of SLAP lesions, trends in the literature are beginning to emerge and provide preliminary answers. A correct diagnosis of a SLAP tear based solely on a patient’s history and physical examination findings has been notoriously elusive. However, surgeons are appreciating specific diagnostic hallmarks both on history and on physical examination. A history of trauma—whether an isolated event or repetitive injury from overhead athletic or laboring activities—is a key finding in the history of symptomatic SLAP tears.\textsuperscript{31,36} In the absence of some variant of a traumatic history, a surgeon should be wary of attributing physical examination or radiographic findings to a SLAP tear. Historically, physical examination findings for symptomatic SLAP tears have been plagued by poor sensitivities and specificities.\textsuperscript{13,42,47} However, recent literature suggests that the active compression/O’Brien test\textsuperscript{23} and labral shear test\textsuperscript{19} may be superior to other

### Table II

Demographic data for ambulatory SLAP repair procedures by year in California (OSHPD database)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
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<tr>
<td>SLAP repair (No. of procedures)</td>
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<td>5,685</td>
<td>6,517</td>
<td>6,356</td>
<td>5,512</td>
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<td>Mean age (y)</td>
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<td>Male (%)</td>
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<td>40.9</td>
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<td>Race (%)</td>
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</tr>
<tr>
<td>White</td>
<td>35.6</td>
<td>36.4</td>
<td>36.5</td>
<td>39.0</td>
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<tr>
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<tr>
<td>Hispanic</td>
<td>3.5</td>
<td>3.3</td>
<td>3.5</td>
<td>3.9</td>
<td>3.9</td>
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<tr>
<td>Payer (%)</td>
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<td>Medicare part A</td>
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<td>2.5</td>
<td>3.2</td>
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</tr>
<tr>
<td>Medicare part B</td>
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<td>2.7</td>
<td>2.1</td>
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<td>1.0</td>
<td>1.2</td>
<td>2.3</td>
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<td>Blue Cross</td>
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<td>15.6</td>
<td>18.1</td>
<td>18.7</td>
<td>16.6</td>
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<tr>
<td>Workers’ compensation</td>
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<td>26.1</td>
<td>21.2</td>
<td>20.8</td>
</tr>
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**Figure 2** Line graphs with linear regression showing volumes of SLAP repairs (left) and all other orthopaedic ambulatory procedures (right) by year in California.
maneuvers and more reliable than previously acknowledged. Although magnetic resonance imaging is the radiographic study of choice for detecting SLAP tears, the diagnostic accuracy of this modality—either with or without intra-articular contrast—is also plagued by variations in sensitivity and specificity. Nevertheless, current literature suggests that protocols that position the affected extremity in abduction and external rotation can improve diagnostic accuracy, and magnetic resonance imaging remains a critical component of the evaluation of a patient suspected of having a SLAP tear.

The other significant trends that have emerged from the literature involve the treatment of SLAP tears. First, throwing athletes who undergo arthroscopic SLAP repair can expect different functional outcomes than other patients who undergo the same operation. Using contemporary arthroscopic techniques and fixation implants, authors have generally reported positive outcomes after SLAP repair. However, outcomes in overhead athletes have been more negative in terms of return to previous level of athletic and functional performance. Age has also been shown to have an effect on outcome after SLAP repair. Although some studies have shown equivalent results for patients regardless of age, most studies suggest that younger patients show improved outcomes. More importantly, some authors suggest a “critical age” between 35 and 50 years; though imprecisely defined, the consensus is that patients who are younger than this critical age and have a symptomatic SLAP tear are best treated with SLAP repair, whereas patients older than this critical age are best treated with biceps tenodesis. The final trend that has emerged involves the rate of complications. Problems such as stiffness, loose implants, osteoarthritis, and persistent pain have been shown to be significant. Given these potential problems, a surgeon is ill-advised to perform indiscriminate repair of a superior labral lesion.

When viewed in light of the history of SLAP lesions and current trends in the literature, the findings of this study suggest that SLAP tears have been over-treated with surgery over the past decade. Despite the considerable attention paid to the superior labrum in the literature, true superior labral pathology that requires surgical treatment is rare; the seminal reports on the incidence of SLAP tears put the incidence of this lesion in the practices of shoulder surgeons in the single to low-double digits. It is difficult to extrapolate the incidence of SLAP tears in the general population from these data; however, SLAP tears are clearly uncommon injuries. More importantly, the gold-standard diagnostic tool of arthroscopic visualization has shown poor interobserver and intraobserver reliability. However, this persistent diagnostic ambiguity has been accompanied by a progressive improvement in surgical instrumentation and technique. The enhanced reproducibility and reliability of these techniques have allowed the superior labrum to be treated more easily. Thus, diagnostic uncertainty coupled with technical advances has created a situation in which superior labrum “lesions” that did not require an operation were treated with surgical fixation. This is not insignificant because the unnecessary treatment of superior labrum lesions can be associated with significant complications.

This report showed differences in the rate of SLAP repairs being performed based on race, sex, and payment source. The reasons for these differences are unclear.

In both the SPARCS and OSHPD databases, it was shown that men, non-Hispanics, and patients not receiving Medicaid were more likely to have a SLAP repair performed than women, Hispanics, and patients receiving Medicaid, respectively. These differences likely reflect multiple phenomena involving complex socioeconomic, demographic, and systems-based factors. The etiology of these differences could be an area of potential future research.

There are several limitations to this study. As with any study using national databases, this study is dependent on the quality of the databases themselves. Data are subject to inaccuracies in reporting and coding in the respective databases. Even though the SPARCS database has been previously examined and validated, the enhanced reproducibility and reliability of the techniques have allowed the superior labrum to be treated more easily. Thus, diagnostic uncertainty coupled with technical advances has created a situation in which superior labrum “lesions” that did not require an operation were treated with surgical fixation. This is not insignificant because the unnecessary treatment of superior labrum lesions can be associated with significant complications.

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statewide databases, and although their stable case numbers may not have been the driving force during board certification collection periods, it is impossible to track the change in their individual volume after board certification. Second, the treatment of superior labral lesions with SLAP repair is affected by multiple patient-driven, surgeon-driven, and systems-based variables. The data included in this study cannot account for or explain each of the multiple individual variables in this complex situation. Third, data regarding practice patterns and frequency for New York and California may not be generalizable nationally to the population at large. The frequency of SLAP repair in 2 coastal states with numerous large urban populations may differ from other states with different demographic compositions.

Conclusions

There has been an increase in the overall volume and population-based incidence of SLAP repairs in community-based state databases. No such increases were seen in the cases reported to the ABOS by surgeons who had recently finished academic surgical training. When viewed in the context of contemporary literature on lesions of the superior labrum and SLAP repairs, these findings suggest that lesions of the superior labrum have been over-treated with SLAP repair over the past decade but also that surgeons are becoming more aware of the need to narrow indications for this procedure.

Disclaimer

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