Clinical Features of the Different Types of SLAP Lesions

An Analysis of One Hundred and Thirty-nine Cases

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Background: Previous studies have suggested that SLAP (superior labrum anterior posterior) lesions are a distinct clinical entity. The goals of this study were to define the prevalence, associated pathological findings, and clinical features of the different types of SLAP lesions with use of a common classification system.

Methods: Five hundred and forty-four patients undergoing shoulder arthroscopy for a variety of diagnoses were prospectively included in this consecutive case series. SLAP lesions were grouped with use of the Snyder classification. Demographic data, clinical data, and arthroscopic findings in the groups with SLAP lesions were compared with those in a control group with no SLAP lesion.

Results: Of 544 shoulder arthroscopy procedures, 139 (26%) demonstrated a SLAP lesion. One hundred and three (74%) of the SLAP lesions were Type I, twenty-nine (21%) were Type II, one (0.7%) was Type III, and six (4%) were Type IV. Most (123) of the SLAP lesions were found to be associated with other intra-articular lesions. Multivariate analysis revealed that a positive Speed test and a supraspinatus tear were significantly associated with Type-I lesions ($p = 0.012$ and $p = 0.001$, respectively). The findings associated with Type-II lesions differed according to the patient's age: Type-II lesions in patients who were forty years of age or younger were associated only with a Bankart lesion, whereas those in patients older than forty years of age were associated with a supraspinatus tear and osteoarthritis of the humeral head. Type-III and Type-IV lesions were associated with a high-demand occupation and a Bankart lesion.

Conclusions: This study demonstrated that the prevalence, associated pathological findings, and clinical features of the different types of SLAP lesions vary with the patient population that is studied. Also, the clinical features and pathological findings associated with the different types of SLAP lesions often overlap. Isolated SLAP lesions with no associated pathological findings are uncommon, and care must be taken when ascribing symptoms to a SLAP lesion when other lesions are present.

Level of Evidence: Diagnostic study, Level IV-1 (case-control study). See p. 2 for complete description of levels of evidence.

Snyder et al.[1] coined the term *SLAP lesion* for lesions of the superior aspect of the glenoid labrum that extend anteriorly and posteriorly to the biceps insertion. They divided SLAP lesions into four types on the basis of the morphologic pattern: Type I indicated degenerative fraying with no detachment of the biceps insertion; Type II, detachment of the biceps insertion; Type III, a bucket-handle tear of the superior aspect of the labrum with an intact biceps tendon insertion to bone; and Type IV, an intrasubstance tear of the biceps tendon with a bucket-handle tear of the superior aspect of the labrum. Other patterns of labral lesions that included the superior part of the labrum were described by Maffet et al.[2]. Morgan et al.[3] further divided Type-II SLAP lesions into three subtypes depending on whether the detachment of the labrum involved the anterior aspect of the labrum alone, the posterior aspect alone, or both aspects.

The incidence and etiology of SLAP lesions remain uncertain. Snyder et al.[4] reported that, of 2375 arthroscopic procedures, 140 (6%) revealed a SLAP lesion. Maffet et al.[2] reported that 84 (12%) of 712 patients examined arthroscopically had a SLAP lesion, and Handelberg et al.[5] reported that thirty-two (6%) of 530 patients had such a lesion. Snyder et al.[1,4] described a variety of mechanisms that could result in a SLAP lesion, including a fall on an outstretched arm, instability, and overhead work. They reported that a fall on an outstretched arm was the most common mechanism, whereas Maffet et al.[2] suggested that the most common etiology was traction on the biceps tendon. Andrews et al.[6] noted an association between overhead athletic

activity and superior labral lesions. They postulated that SLAP lesions in athletes are caused by tension on the biceps tendon. Other authors have demonstrated an association between posterior-superior labral lesions and contact of the rotator cuff with the arm in a cocked position[7,8]. Burkhart and Morgan[9] and Morgan et al.[3] suggested that the posterior Type-II lesion may be caused by a "peel-back" of the superior aspect of the labrum when the biceps insertion is twisted as the arm is brought into abduction and external rotation.

The exact contribution of SLAP lesions to glenohumeral instability has been controversial. Rodosky et al.[10] and Pagnani et al.[11] found that the superior aspect of the labrum and the biceps anchor contribute to shoulder stability. An electromyographic study by Sakurai et al.[12] suggested that the long head of the biceps can act as a humeral head stabilizer in superior and anterior directions. Several previous studies have suggested that some superior labral lesions should be repaired to restore stability to the shoulder[3,9,13]. Morgan et al.[3] reported that stabilization of the detached biceps anchor in shoulders with a Type-II SLAP lesion provided satisfactory clinical results and eliminated the drive-through sign[14]. However, the relationship between a physical finding of laxity or instability and a superior labral lesion has not been fully elucidated. Likewise, the relationship of the arthroscopic drive-through sign to laxity and instability remains controversial[14,15]. In addition, several investigators have questioned the role of SLAP lesions in shoulder stability. Some have reported that SLAP lesions occur without associated glenohumeral instability[16-19]. One electromyographic study showed no relationship between biceps activity and active shoulder motion, suggesting that biceps muscle activity does not contribute to shoulder stability[18].

SLAP lesions can occur in association with diagnoses other than instability[1,2,5,16,20-22]. The goal of the present study was to define the prevalence, concomitant pathological findings, and clinical features of the different types of SLAP lesions in a cohort of patients who were undergoing shoulder arthroscopy for a variety of diagnoses. We compared the patients with the different types of SLAP lesions with a group of patients with a similar diagnosis but no SLAP lesion.

Materials and Methods

From 1992 to 2000, 544 patients who were undergoing shoulder arthroscopy were entered into this study. Those for whom the arthroscopy was a revision procedure were excluded. Eleven patients underwent a separate surgical procedure on both shoulders on two different occasions, and each of these shoulders was included in the analysis as an independent case. There were 309 male patients (57%) and 235 female patients (43%) ranging in age from twelve to eighty-six years (mean, 44.2 years). The study was approved by the Institutional Review Board.

Preoperatively every patient completed a standardized questionnaire that asked for demographic information as well as data regarding the mechanism of injury, sports activities, level of sports participation, and symptoms[15]. Symptoms were evaluated with use of a 100-point visual analog scale. A comprehensive physical examination was performed[23], and the findings were recorded on a data-collection sheet[24].

All patients had general anesthesia with or without a scalene block. Intraoperative physical assessment included laxity testing with use of the anterior and posterior drawer tests as described by Gerber and Ganz[25]. Translation of the humeral head on the glenoid was assessed with use of a modified Hawkins scale, in which Grade I indicates that the humeral head translates to the glenoid rim, Grade-II means that it translates over the rim, and Grade III means that the humeral head is locked out[23]. A sulcus sign was observed with use of standard methods and graded as I (<1.0 cm), II (1.0 to 2.0 cm), or III (>2.0 cm)[26,27].

All arthroscopic procedures were performed with the patient in a lateral decubitus position and with use of an armholder and 10 lb (4.5 kg) of traction. The diagnostic arthroscopy was performed through a posterior portal, and a standardized data sheet was used to record the findings in every patient. Intra-articular lesions were identified and recorded[15]. Humeral head and glenoid osteoarthritis were defined as degenerative changes of the articular cartilage with a grade higher than II according to the system described by Outerbridge[28]. In every case, the labrum was probed through an anterior portal. Any labrum with a frayed edge was débrided and probed with a nerve-hook to better define the pathological findings. The labral lesions were classified according to the system of Snyder et al.[1].

The primary diagnoses, made on the basis of the history, physical examination, and arthroscopic findings for every patient[15,24], included rotator cuff disease, glenohumeral instability, acromioclavicular arthritis, frozen shoulder, and others (e.g., glenohumeral arthritis and paralabral cyst). Rotator cuff disease included impingement syndrome without a rotator cuff tear, impingement syndrome with a partial rotator cuff tear, and a full-thickness rotator cuff tear.

For statistical analysis, the SLAP lesions were divided into three study groups: Type I, Type II, and Types III and IV. Type-III and Type-IV lesions were combined because there were only a small number of them. The patient groups were then compared with a group of patients who did not have a SLAP lesion. For the purpose of analysis, we dichotomized all categorical variables. In the initial analysis of the data, univariate analysis was performed with use of a two-sample Student t test or analysis of variance for continuous variables and with a chi-square or Fisher exact test for categorical variables. For the variables that were found to be significant in these initial analyses, we calculated odds ratios and the 95% confidence intervals of the odds ratios with an alpha of 0.20. While controlling for potential confounding variables, we used stepwise logistic regression analysis to derive adjusted odds ratios and 95% confidence intervals with the method of maximum likelihood. Variables with a p value of <0.20 in the univariate analysis were chosen as candidates for the multivariate model. Independent variables were considered significant in the multivariate model when the 95% confidence interval around the odds ratio did not include the number one and the p value was ≤0.05. Statistical analysis was performed with an SPSS software package (version 9.0; SPSS, Chicago, Illinois).

TABLE I Univariate Logistic Regression Analysis of the Different Types of SLAP Lesions in Comparison with the Group Without a SLAP Lesion (Control)*

	Univariate Comparison								
	Control vs. Type I			Control vs. Type II			Control vs. Types III-IV		
Variable	Odds Ratio†	95% Confidence Interval	P Value	Odds Ratio†	95% Confidence Interval	P Value	Odds Ratio†	95% Confidence Interval	P Value
Demographic Data									
Age (per year)	1.02	1.00-1.03	**0.012**			>0.2	0.97	0.92-1.01	0.160
High-demand occupation			>0.2			>0.2	8.66	1.89-39.75	**0.006**
Participation in overhead sports			>0.2	2.52	1.15-5.55	**0.022**			>0.2
High-level sports activity	0.50	0.22-1.14	0.099			>0.2			>0.2
Symptom onset during sports activity			>0.2			>0.2	9.70	1.85-50.88	**0.007**
Symptoms									
Night pain (per point)	1.01	1.00-1.02	0.131			>0.2			>0.2
Overhead pain (per point)	1.01	1.00-1.03	0.074			>0.2			>0.2
Sense of instability (per point)			>0.2			>0.2	0.97	0.93-1.01	0.102
Physical findings									
Hawkins impingement test (positive)	1.57	0.98-2.54	0.062			>0.2			>0.2
Speed test (positive)	2.02	1.26-3.26	**0.004**			>0.2			>0.2
Active compression test (positive)	1.47	0.88-2.46	0.146			>0.2			>0.2
Apprehension test (positive)	0.58	0.32-1.06	0.078			>0.2			>0.2
Laxity tests under anesthesia									
Anterior translation (higher than Grade I)	1.64	0.91-2.93	0.098			>0.2			>0.2
Arthroscopic findings									
Contact of rotator cuff with superior aspect of glenoid in flexion			>0.2	5.41	0.71-41.34	0.103			>0.2
Supraspinatus tear	2.11	1.33-3.37	**0.001**			>0.2			>0.2
Bankart lesion			>0.2			>0.2	9.52	1.81-50.09	**0.008**
Hill-Sachs lesion			>0.2			>0.2	3.60	0.79-16.38	0.098
Humeral head osteoarthritis	1.78	1.05-3.04	**0.034**	2.64	1.15-6.08	**0.023**			>0.2
Glenoid osteoarthritis	1.58	0.87-2.84	0.132			>0.2			>0.2
Primary diagnosis									
Rotator cuff disease	1.78	1.14-2.79	**0.012**	1.82	0.85-4.01	0.138			>0.2
Glenohumeral instability	0.58	0.34-0.99	**0.045**			>0.2	6.01	1.15-31.4	**0.034**

*The variables with a p value of <0.2 are included in this table. The p values indicating a significant variable ($p < 0.05$) are shown in bold.
†An odds ratio of >1.0 means a positive association between the independent variables and the dependent variable, and an odds ratio of <1.0 means a negative association.

Results

Descriptive Data

One hundred and thirty-nine (26%) of the 544 patients had a SLAP lesion. One hundred and three (74%) of the lesions were Type I, twenty-nine (21%) were Type II, one (0.7%) was Type III, and six (4%) were Type IV.

Descriptive data are summarized in the Appendix. Rotator cuff disease was the most common primary diagnosis in the 103 patients with a Type-I lesion (diagnosed in sixty-seven of those patients) and in the twenty-nine with a Type-II lesion (diagnosed in nineteen of those patients). Glenohumeral instability was the most common diagnosis in the patients with a Type-III or IV lesion; it was the diagnosis in five of those seven patients. Eighty-eight percent (123) of the 139 SLAP lesions were associated with other intra-articular abnormalities. Fourteen Type-I lesions and two Type-II lesions were not associated with any other intra-articular abnormality.

Univariate Analysis

Univariate analysis revealed a significant association between

Type-I lesions and age (odds ratio = 1.02 per year, p = 0.012), a positive Speed test[23] (odds ratio = 2.02, p = 0.004), a supraspinatus tear (odds ratio = 2.11, p = 0.001), osteoarthritis of the humeral head (odds ratio = 1.78, p = 0.034), and a primary diagnosis of rotator cuff disease (odds ratio = 1.78, p = 0.012) or glenohumoral instability (odds ratio = 0.58, p = 0.045) (Table I). Type-II SLAP lesions were associated with participation in overhead sports (odds ratio = 2.52, p = 0.022) and osteoarthritis of the humeral head (odds ratio = 2.64, p = 0.023). There was a significant association between Type-III and IV lesions and a high-demand occupation (odds ratio = 8.66, p = 0.006), a sports-related injury (odds ratio = 9.70, p = 0.007), a Bankart lesion (odds ratio = 9.52, p = 0.008), and a primary diagnosis of glenohumeral instability (odds ratio = 6.01, p = 0.034).

Because it is well known that age influences the prevalence and prognosis of various shoulder conditions, especially rotator cuff disease and shoulder instability[29,30], we divided the twenty-nine patients with a Type-II SLAP lesion into two age-groups: those older than the age of forty (sixteen patients) and those forty years old or younger (thirteen patients). Type-II lesions in patients older than forty years of age were associated with a supraspinatus tear (odds ratio = 7.18, p = 0.010), osteoarthritis of the humeral head (odds ratio = 4.56, p = 0.004), and a primary diagnosis of rotator cuff disease (odds ratio = 6.69, p = 0.013). In contrast, Type-II lesions in patients forty years old or younger were associated with participation in overhead sports (odds ratio = 3.54, p = 0.027) and a Bankart lesion (odds ratio = 6.68, p = 0.003).

Multivariate Analysis

On the basis of the factors that were found to be significant in the univariate analysis, a stepwise multivariate logistic regression analysis was performed to isolate variables of independent significance. The variables that were found to be significantly associated with Type-I SLAP lesions were a supraspinatus tendon tear (adjusted odds ratio = 2.28, p = 0.001) and a positive Speed test (adjusted odds ratio = 1.88, p = 0.012). Type-II lesions were associated with participation in overhead sports (adjusted odds ratio = 2.52, p = 0.022) and osteoarthritis of the humeral head (adjusted odds ratio = 2.69, p = 0.021), and Type-III and IV lesions were associated with a Bankart lesion (adjusted odds ratio = 6.70, p = 0.030) and a high-demand occupation (adjusted odds ratio = 4.96, p = 0.048). Analysis of Type-II lesions in patients older than forty years of age revealed two significant independent variables: a supraspinatus tendon tear (adjusted odds ratio = 5.81, p = 0.023) and osteoarthritis of the humeral head (adjusted odds ratio = 3.27, p = 0.026). Type-II lesions in patients forty years old or younger were associated with a Bankart lesion (adjusted odds ratio = 6.68, p = 0.003).

Discussion

This study demonstrated that different types of SLAP lesions have different clinical features and associated intra-articular lesions. Type-I lesions are typically associated with rotator cuff disease, whereas Type-III and IV lesions are associated with traumatic instability. The clinical features of Type-II lesions differ according to the patient's age. Type-II lesions in older patients have clinical features similar to those of Type-I lesions, whereas Type-II lesions in younger patients have clinical features that are closer to those of Type-III and IV lesions.

This study also suggests that the prevalence, clinical manifestations, and associated pathological findings vary with the patient population that is studied. Our statistical analysis was performed by comparing patients with a SLAP lesion with a group of patients who did not have a SLAP lesion. Ideally, the study would have included an additional control group made up of healthy subjects without shoulder symptoms[31]. The prevalence of SLAP lesions in our study was higher than those in some previous reports, in which the rates have ranged from 1.2% to 23%[1,2,4,5,32,33]. This difference might be due to several factors. First, the prevalence of SLAP lesions and the distribution of patient diagnoses vary from physician to physician depending on the patient population that they serve. The distribution of SLAP lesions in our study closely approximates that in the study by Tomonobu et al.[33], who evaluated the type of SLAP lesions seen in patients with rotator cuff disease. If we eliminated the Type-I SLAP lesions from our study, then the prevalence of SLAP lesions (Types II, III, and IV) would be 6.6% (thirty-six of 544), and this rate approximates those of other studies. In addition, the spectrum of patients who were operated on in our study may have influenced the finding that sports activity was the most common cause of all SLAP lesions (it caused 25% [thirty-five] of the 139 lesions). In our study, five of the seven Type-III or IV SLAP lesions were associated with a sports injury (odds ratio = 9.70, p = 0.007).

Second, the results of this study may have been influenced by the variability of the anatomy of the biceps and the superior part of the glenoid labrum[21,34,35]. The variable attachment of the biceps anchor may make it difficult to differentiate detachment of this anchor from a normal meniscoid labrum with a sublabral recess. It can be particularly difficult to determine if the biceps anchor is detached when there is a sublabral hole or Buford complex (the combination of an absent anterosuperior portion of the labrum and a cord-like middle glenohumeral ligament)[36]. Previous authors have noted that there are variants of SLAP lesions that are not easily classified into one group or another[2,37]. In our study, only one physician (E.G.McF.) graded the SLAP lesions, which should have provided some consistency in diagnosis. Different surgeons may not agree on the type of a given SLAP lesion, and, in most studies in the literature, cases from multiple physicians were pooled. We are not aware of any studies that addressed the issue of interobserver or intraobserver variability in the diagnosis or typing of SLAP lesions.

Our study demonstrated many of the difficulties involved in understanding the etiology and treatment of SLAP lesions. The prevalence, associated pathological findings, and clinical features of the different types of SLAP lesion can vary with the patient population studied. There is also a wide variation in the types of pathological findings, and any one surgeon may not acquire substantial experience with every type

of SLAP lesion. The rarity of Type-III and IV SLAP lesions limits statistical evaluation of some factors that might be important in understanding the pathophysiology of those lesions. It may be difficult to determine the clinical relevance of a SLAP lesion when there are other, coexisting lesions in the shoulder. Consequently, when a SLAP lesion coexists with other clinical syndromes or anatomical pathological entities, it is difficult to know if the success or failure of a given treatment is due to the management of the SLAP lesion or to the management of the other pathological entities. This study does not answer the question of whether Type-II SLAP lesions are a cause or result of instability. Additional biomechanical and clinical analyses are needed to understand the pathophysiology and treatment of these lesions.

Appendix

eA Tables presenting a descriptive summary of the demographic data, subjective symptoms, physical findings, and arthroscopic evaluations as well as a comparison of the Type-II lesions subgrouped by age are available with the electronic versions of this article, on our web site at www.jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

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The authors did not receive grants or outside funding in support of their research or preparation of this manuscript. They did not receive payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or associated.

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