

Intraarticular Abnormalities in Overhead Athletes Are Variable

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Abstract

Background The cause of shoulder pain and dysfunction in the overhead athlete can be variable. Several studies illustrate the wide variety of lesions seen at the time of arthroscopy in overhead athletes who require surgery but it is unclear whether these differ by sport.

Questions/purposes We examined overhead athletes with shoulder dysfunction to determine (1) the range of arthroscopically visualized shoulder abnormalities with specific attention to the posterosuperior glenohumeral joint and the rotator cuff; and (2) the relationship of sport type to these abnormalities.

Methods We reviewed our institution's database for professional and collegiate athletes in overhead sports who, from 1996 through 2010, had diagnostic shoulder arthroscopy for insidious, nontraumatic, persistent pain and inability to participate in their sport. A descriptive analysis of the arthroscopic findings from 51 consecutive patients (33 males, 18 females; mean age, 25 years; range,

15–59 years) was done. We analyzed the arthroscopic findings with respect to sport using analysis of variance and Fisher's exact test.

Results There was a wide range of superior labrum, posterosuperior glenoid, and rotator cuff abnormalities. Overall, the most frequent abnormalities were posterosuperior glenohumeral joint changes. Swimmers had fewer intraarticular abnormalities than baseball players.

Conclusions We found a wide spectrum of intraarticular abnormalities in the shoulder of overhead athletes with shoulder pain requiring surgery. Additional study is needed to determine whether these abnormalities or combinations relate to specific athletic movements.

Level of Evidence Level IV, retrospective case series. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

The causes of shoulder pain and dysfunction in the overhead athlete are controversial [2–4] with several proposed theories, including subacromial impingement [14], occult instability [7, 23], tendon tension overload [19], and internal impingement [12, 28]. In some patients, the shoulder pain and dysfunction cannot be successfully treated nonoperatively, and they require surgery to address the abnormalities presumed to be the cause of their problem. In this population, the most common abnormalities reported at the time of arthroscopy have been superior labrum anterior posterior lesions and partial tears of the rotator cuff [6]. Previous studies that reported the intraarticular abnormalities have been primarily in baseball players [2, 18, 28].

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We noticed at the time of arthroscopic shoulder surgery in high-intensity athletes that the intraarticular abnormalities were highly variable. Specifically, superior labrum lesions were quite varied with fraying, cracking, and even obliteration of the labrum. We also noted that athletes in some sports involving overhead motions who needed surgery often have less severe or fewer intraarticular abnormalities than those involved in other sports. These variations by sport have not been noted in previous studies, so delineating their occurrence may be important in treatment decision-making in the future.

Therefore, the purposes of this study were to (1) identify the spectrum of intraarticular injury observed in high-intensity overhead athletes; and (2) attempt to identify intraarticular injury patterns with respect to sport.

Patients and Methods

We retrospectively reviewed the senior author's (EGM) shoulder surgery database for patients who, from 1996 through 2010, had arthroscopic surgery of the shoulder. Of those 2152 patients, 1437 had diagnostic arthroscopy and 168 were athletes who participated in an overhead sport (baseball, swimming, tennis, volleyball, softball, basketball, weightlifting, racquetball, and gymnastics). We excluded 57 who had a history of remote or recent trauma initiating their symptoms (pain secondary to acute trauma causing a rotator cuff tear, instability, or a fracture) and 60 who were only recreational athletes. Our final study group consisted of 51 overhead athletes, competitive at the professional or collegiate level, who underwent diagnostic arthroscopy (after the failure of nonoperative interventions) for insidious, nontraumatic, persistent pain and inability to participate in their sport. Preoperative diagnosis included shoulder instability, superior labrum anterior and posterior (SLAP) lesion, rotator cuff tear, and internal impingement. The 33 males and 18 females had an average age of 25 years (range, 15–59 years) (Table 1). This study was approved by our Institutional Review Board.

Every patient had completed preoperatively a standardized questionnaire on their initial visit that asked for demographic information and data regarding the mechanism of injury, sports activities, and symptoms. A preoperative physical examination was done by the senior author or under his direct supervision. Because some of the radiographs and MR images (with or without intraarticular gadolinium) had been obtained at other institutions, and thus there was no standardization of the sequences, these imaging studies were not included in our study. These studies were used to determine the final diagnosis and did not have any influence on the intraoperative findings at the time of surgery.

Table 1. Demographics for 51 patients

Characteristic	Number
Mean age \pm SD (years)	25 \pm 1.6
Male gender (%)	65
Dominant arm affected (%)	85
Sport type (%)	
Baseball	45
Swimming	24
Softball	10
Tennis/racquetball	10
Volleyball	8
Basketball	4
Professional level sport (%)	33

All arthroscopic procedures were done by the senior author. All patients had general anesthesia with or without a scalene block and were positioned in a lateral decubitus position with the arm suspended with 10 pounds (4.5 kg) of traction. All shoulders were systematically examined through standard anterior and posterior portals and the implementation of a standardized data sheet [10]. A nerve hook was used to evaluate the labrum through an anterior and, when necessary, a posterior portal. All shoulders were specifically examined for any signs of instability, including Hill-Sachs lesions [21], Bankart lesions [21], anterior ligament periosteal sleeve avulsions lesions [15], glenoid ligament articular damage [16], reverse Bankart lesions [5], and reverse Hill Sachs lesions [21]. A “drive through sign,” a measure of shoulder laxity [11], was assessed in each shoulder with the techniques previously described by Pagnani et al. [17] and McFarland et al. [10]. During the arthroscopy, the rotator cuff tendons were carefully examined for partial- or full-thickness tears. Partial- and full-thickness tears were evaluated to determine if they were in the anterior or posterior aspect of the tendon [23, 27].

Superior labrum abnormality was described using the classification of Snyder et al. [24]: Type I, fraying only; Type II, detachment of the biceps and labrum from the superior glenoid; Type III, a bucket handle tear of the superior labrum; and Type IV, a tear into the body of the biceps tendon. Type II SLAP lesions were further subdivided into the three variants described by Morgan et al. [13]: anterior variant, detachment of the biceps attachment to the superior glenoid tubercle and only the anterior portion of the labrum detached; posterior variant, biceps detached from the superior glenoid tubercle and detached posterior labrum portion; and combined variant, detached biceps attachment to the superior glenoid tubercle and the labrum anteriorly and posteriorly from the superior glenoid.

Some posterosuperior labrum abnormalities did not fit into the Snyder classification but were included in the analysis: fraying only of the posterior labrum, partial detachment of the posterosuperior labrum where there were cracks in the labrum but it was not entirely detached, detachment of the posterosuperior labrum with no detachment of the biceps from the superior glenoid tubercle, and complete loss of the posterosuperior labrum secondary to fragmentation and destruction of the labrum. Note that these descriptions of the posterosuperior labral abnormalities were not mutually exclusive, that is, the posterosuperior labrum could be described as detached and frayed. Lesions of the glenoid, particularly in the superior glenoid, which to our knowledge have not been examined in previous literature regarding shoulder abnormalities of overhead athletes, were documented as (1) glenoid articular cartilage erosions that were not full thickness; or (2) complete loss or eburnation of cartilage, and each was localized according to its respective quadrant on the glenoid.

All patients underwent an examination for internal impingement by placing the arm in abduction and external rotation with the arthroscope viewing the joint from a posterior portal [10]. A positive test was when the rotator cuff was seen to make contact with the posterior and superior labrum and glenoid.

To address our first purpose, we performed a descriptive analysis to determine which abnormalities were seen in overhead athletes with shoulder pain. To determine if sport type had an effect on the presence of SLAP lesions, posterosuperior labral lesions, rotator cuff lesions, or glenoid lesions, we stratified the patients according to sport type designated in the preoperative history and questionnaire. Univariate analyses comparing the proportion of SLAP lesions, posterosuperior lesions, rotator cuff lesions, and glenoid lesions among sports were performed using Fisher's exact test of significance. A standard statistical package (SPSS, Version 17, Chicago, IL, USA) was used for all statistical analyses.

Results

Posterosuperior glenohumeral changes were the most common intraarticular abnormality seen in this patient cohort. In total, 22 patients had a lesion of the posterosuperior labrum. Because several abnormalities in the posterosuperior labrum could coexist, there were 21 with fraying, four with cracking, and nine with detachment of the posterior and superior labrum. Of the nine posterosuperior labrum detachments, five were completely obliterated with no remnant noted. Of the 51 patients, 18 (35%) had partial rotator cuff tears and seven (14%) had full-thickness rotator cuff tears. All rotator cuff tears

involved the supraspinatus. Of the 51 patients, 13 had Type II superior labrum anteroposterior lesions; most (six) of these Type II lesions were the combined lesion variant followed by the anterior lesion variant (four) and posterior lesion variation (three). The glenoid was normal in 37 (73%) patients and abnormal in 14 (27%). Of the glenoid lesions, seven were in the superior quadrant. Of the lesions in the superior quadrant, four were in the posterosuperior quadrant only, two were in the anterior quadrant only, and one was in the posterior and anterior quadrants. Of the five lesions involving the posterior and superior quadrant, two were partial erosions/fissures and three had complete loss of articular cartilage with eburnation of the glenoid. Overall, 11 patients were noted to have Bankart lesions, and five patients had Buford labral variants. There were abnormalities of the superior glenohumeral ligament in four, of the middle glenohumeral ligament in five, and of the inferior glenohumeral ligament in nine patients. We observed five patients with intraarticular loose bodies. With the exception of one patient, all the patients had internal impingement, that is, posterosuperior contact of the humeral head with the glenoid rim in maximal abduction and external rotation.

The types of intraoperative abnormalities varied according to sport type (Table 2). The frequency of rotator cuff tears ($p = 0.009$) and glenoid abnormalities ($p = 0.047$) varied when stratified by type of sport. Individuals who reported swimming or tennis/racquetball had lower rates of rotator cuff abnormalities (8% and 20%, respectively) compared with other overhead athletes (50% for volleyball, 65% for baseball, 80% for softball, and 100% for basketball). Individuals who reported tennis/racquetball or basketball had higher rates of glenoid abnormalities (60% and 100%, respectively) compared with other overhead athletes (0% for softball, 17% for baseball, 25% for volleyball, and 33% for swimming). When comparing type of SLAP lesion or posterosuperior labral lesions by sport type, however, there were no differences ($p = 0.884$ and $p = 0.077$, respectively). Swimmers overall had fewer intraarticular structures affected than did their peers.

Discussion

The causes of shoulder pain and dysfunction in the overhead athlete are variable. Although several studies illustrate the wide variety of lesions seen at the time of arthroscopy in overhead athletes who require surgery, it is unclear whether these differ by sport. We therefore (1) identified the spectrum of intraarticular injury observed in high-intensity overhead athletes; and (2) attempted to identify intraarticular injury patterns with respect to sport.

Table 2. Intra-articular findings of shoulder arthroscopy in overhead athletes by sport

Finding	Baseball (n = 23)	Swimming (n = 12)	Softball (n = 5)	Tennis/racquet-ball (n = 5)	Volleyball (n = 4)	Basketball (n = 2)	Total (n = 51)	p value
Rotator cuff tear (%)								0.009
None	35	92	20	80	20	0	51	
Partial	39	8	80	0	50	100	35	
Full	26	0	0	20	0	0	14	
Posterior superior labral lesion (%)	57	17	80	40	25	0	43	0.077
SLAP lesion (%)								0.883
None	52	83	60	60	100	50	64	
Type I	9	0	20	20	0	0	8	
Type IIA	9	8	0	0	0	50	8	
Type IIB	9	8	0	0	0	0	6	
Type IIC	17	0	20	20	0	0	12	
Type III	4	0	0	0	0	0	2	
Glenoid lesion (%)	17	33	0	60	25	100	27	0.0471

SLAP = superior labrum anterior and posterior.

Our study had several limitations. First, we had no control group of nonathletes for comparison. The ideal control group would be patients of a similar age who underwent surgery for nontraumatic, insidious pain in the shoulder but who did not perform high-intensity sports. Unfortunately, there were not enough patients in our database who would meet these criteria with the same age range and demographics as our cohort. It is possible that some of the lesions seen here were related not to sports activity, but rather to age. Second, we had a relatively small number of patients. After stratification, certain sports had fewer than five individuals. Consequently, the study was underpowered to compare the frequencies of certain abnormalities. Additional study with greater numbers of patients could find differences in the frequencies of intra-articular lesions such as posterosuperior labral lesions that we were unable to detect. Furthermore, given our study design, we were unable to determine the relationship between the variable lesions seen at surgery or the relationship of each lesion type to clinical symptoms.

Our data suggest that a wide range of abnormalities occurs in the shoulders of overhead athletes with shoulder pain and that the varieties are more numerous than previously reported [1, 8, 9, 18, 22, 26, 28] (Table 3). The wide variety of posterior and superior labral abnormalities we describe here are not included in the commonly used Snyder classification [24]. Although Morgan et al. [13] classified Type II SLAP lesions as posterior, anterior, or combined lesions, they did not mention many of the abnormalities we have reported. Morgan et al. [13] reported posterior Type II SLAP lesions comprised 62% of all SLAP lesions in their cohort and found overhead

throwers were three times more likely to have this variant of Type II SLAP lesion than nonthrowers with SLAP lesions. Walch et al. [28] described posterosuperior labral lesions as “degenerative types with irregular scuffing.” However, they neither described nor distinguished their findings from other abnormalities seen in the posterosuperior labrum. Although we found no descriptions in the literature of the variations we observed (fraying, cracking, partial detachment, whole detachment, or obliteration of the labrum), we believe these findings may be clinically important because these abnormalities may influence treatment and surgical result. For example, in our experience, it is simply not possible to repair cracking alone of the labrum with suture repair nor is it possible to repair the labrum when it is totally obliterated, as we describe here.

Similarly, although we found a wide variation in the types of glenoid lesions in this patient cohort, we could not determine the clinical importance of these variations. Ten percent of our patients had posterosuperior glenoid articular cartilage changes that varied from mild chondromalacia to complete cartilage loss. These findings are similar to those reported by Patzer et al. [20], who found 10% of their patients with SLAP lesions had posterosuperior glenoid cartilage changes. However, their study did not include overhead athletes. The cause of these lesions is unknown, although it has been postulated by Walch et al. [28] and Jobe et al. [7] that damage to the posterior and superior labrum is secondary to “internal impingement” of the greater tuberosity of the humerus on the posterosuperior labrum with the arm in an abducted and externally rotated position. It is possible that the same mechanism is responsible for articular cartilage lesions in this area of the glenoid.

Table 3. Summary of published intraarticular findings of shoulder arthroscopy in overhead athletes

Study	Population (number)	Rotator cuff findings	Posterior superior labrum findings	SLAP lesion findings (%)	Glenoid lesion findings
Kaplan et al. [8]	Throwing athletes with internal impingement (9)	11% partial supraspinatus tear,* 22% partial infraspinatus tear*	100% fraying	11	56% posterior glenoid articular cartilage lesions*
Walch et al. [28]	Mostly throwing athletes (one body builder); excluded patients with SLAP and Bankart tears (17)	76% partial rotator cuff tear, 77% supraspinatus, 23% infraspinatus	71% fraying	N/A	59% posterior superior glenoid sclerosis/osteophytes†
Paley et al. [18]	Overhead throwers (41)	93% partial rotator cuff tears	88% fraying	10	10% Bankart
Brushoj et al. [1]	Swimmers (18)	None	Not reported	11	6% Bankart
Levitz et al. [9]	Baseball players (52)	96% posterior partial rotator cuff tears	96% labral injury	Not reported	Not reported
Reynolds et al. [22]	Baseball players with partial rotator cuff tears (82)	100% partial rotator cuff tears	14% labral injury	73	Not reported
Tomlinson and Glousman [26]	Overhead athletes (46)	30% partial supraspinatus tear	76% labral injury, 46% fraying	2	Not reported

* Magnetic resonance imaging results; † computed tomography results; N/A = not applicable; SLAP = superior labrum anterior and posterior.

Although we found baseball players had a greater number of intraarticular abnormalities than did swimmers, the clinical importance of this finding is unknown. For swimmers, our findings are consistent with those of Brushoj et al. [1], who performed arthroscopic surgery for 18 high-level swimmers over an 8-year period and reported that two had SLAP lesions and none had rotator cuff tears. There are multiple studies of baseball players. Levitz et al. [9] reported that of 52 baseball players who had arthroscopy, 50 had posterior rotator cuff tears and labral injury, but there were no details about the location of the rotator cuff tears or of the type of labrum injury. Reynolds et al. [22] operated on 82 professional baseball players (average age, 25.6 years), all of whom had partial-thickness rotator cuff tears, and found 49 shoulders had unstable SLAP lesions. Their study did not describe the variants of superior labrum lesions or whether glenoid lesions were encountered at the time of surgery. Lastly, there are no studies that fully delineate the spectrum of intraarticular abnormalities in tennis players. Sonnery-Cottet et al. [25] studied 28 tennis players who had internal impingement. In their series, all patients showed undersurface supraspinatus tendon tears requiring débridement. No SLAP lesions were detected, but 11 posterosuperior labral lesions were débrided, and another 14 posterosuperior labral lesions were resected. No SLAP lesions were detected. No other statistical analysis of intraarticular abnormalities was shown.

In summary, we found a wide variety of abnormalities in the shoulders of overhead athletes. The posterior and

superior labrum abnormalities can vary from frayed to destroyed, and the articular cartilage in this area can have a variable degree of chondromalacia. Swimmers had fewer intraarticular abnormalities than did baseball players, but larger numbers of athletes in other sports are needed to determine whether the spectrum of changes seen in the shoulder are sport-related. Additional study is needed to verify these observations about the myriad abnormalities in the shoulders of overhead athletes and to determine, with larger cohorts, if the observed abnormalities are clinically important and influence the results of treatment.

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