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SYMPOSIUM: NEW APPROACHES TO SHOULDER SURGERY

Débridement of Small Partial-thickness Rotator Cuff Tears in Elite Overhead Throwers

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Abstract Elite overhead throwing athletes with rotator cuff tears represent a unique group of patients with an ultimate goal of returning to their previous level of competition. We hypothesized débridement of small partial-thickness rotator cuff tears would return the majority of elite overhead throwing athletes to their previous level of competition. Preoperative and intraoperative findings on 82 professional pitchers who had undergone débridement of partial-thickness rotator cuff tears were evaluated using our database. We obtained return to play data on 67 of the 82 players (82%); 51 (76%) were able to return to competitive pitching at the professional level and 37 (55%) were able to return to the same or higher level of competition. Of the 67 patients, 34 pitchers returned a questionnaire with a minimum followup of 18 months (mean 38 months; range 18 to 59 months). SF-12 scores were above average with a mean PSF-12 and MSF-12 of 55.04 and 56.49 respectively. An Athletic Shoulder Outcome Rating Scale score of greater than 60 was found in 76.5% of pitchers. Débridement of small partial-thickness rotator cuff tears allowed a majority of elite overhead throwing athletes to return to competitive pitching, however, returning to their previous level of competition remains a challenge for many of these players. **Level of Evidence:** Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Elite overhead throwing athletes with rotator cuff tears represent a unique group of patients with a mechanism and disorders that are often different than other individuals with rotator cuff tears. Proposed mechanisms include eccentric tendon failure attributable to overuse [2, 27], secondary impingement from instability [18, 19], and internal impingement of the rotator cuff on the posterior superior labrum [16, 17, 19, 40]. Most likely, these mechanisms overlap and contribute to each individual's rotator cuff injury to differing degrees.

The vast majority of elite overhead throwing athletes have a spectrum of injuries involving a partial-thickness articular-sided rotator cuff tear in the location of the posterior supraspinatus and anterior infraspinatus [2, 24, 29]. There is also typically a disorder of the posterior superior labrum and changes on the posterior humeral head, including an expanded bare area and cyst formation [3, 16, 40]. In addition, most patients are believed to have either a component of anterior microinstability [8, 15, 16], which worsens the internal impingement, or a tight posteroinferior capsule [5] resulting in posterosuperior glenohumeral translation and anteroinferior pseudolaxity.

Because rotator cuff tears are one of the key components of an injured overhead throwing athlete, appropriate

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treatment is critical for proper function. Surgery for partial-thickness rotator cuff tears generally produces favorable outcomes [4, 7,10, 14, 36, 47]. However, most studies have looked at the general population and used rating scales that evaluate typical daily activities. Few studies focus specifically on overhead throwing athletes and the results in these studies have been more variable, especially in baseball players [1, 2,4, 28, 30, 31, 36, 39, 40]. In addition, there has been increased debate between débridement and repair of partial-thickness rotator cuff tears. Although the current general consensus has been to repair tears greater than 50% thickness [6, 12–14, 22, 23, 25, 43, 44, 47], studies to support this have not focused on baseball players. With this in mind, the current study focuses only on baseball players with débridement of partial-thickness rotator cuff tears.

The ultimate goal in treating baseball players and other athletes is to allow them to return to their previous level of competition. This outcome is often more demanding than the goals of the general population, especially at the professional level. Because of the multifactorial etiology and varying degree of injury to the different anatomic structures in the shoulder, as well as considering these extremely high outcome goals, treatment should be tailored to each individual patient.

We hypothesized débridement of partial-thickness rotator cuff tears would allow most elite overhead throwing athletes to return to their previous level of competition. We presumed additional concomitant procedures performed at the time of surgery would influence return to play. In addition, we hypothesized the majority of athletes would have Athletic Shoulder Outcome Rating Scale scores above 60 and above average SF-12 scores.

Materials and Methods

We retrospectively reviewed the records of 82 professional baseball pitchers who underwent arthroscopic débridement of a rotator cuff tear by the senior author (JRA) between April 2002 and September 2005. We included patients if they were an active professional baseball pitcher (major or minor league) at the time of surgery and had undergone arthroscopic débridement of a partial-thickness rotator cuff tear. All patients with partial-thickness tears were included, regardless of depth, as long as the tears were treated with débridement and not repaired. We did not consider concomitant intraarticular disorders a reason for exclusion because the vast majority of these throwers' shoulders do have associated disorders, which is often part of the constellation of findings with a partial-thickness rotator cuff tear in these unique patients. All patients had an unsuccessful course of nonoperative treatment and were at a point where they were unable to perform at a competitive level as a result of shoulder pain and dysfunction. Nonoperative treatment typically consisted of a minimum of 6 to 8 weeks of activity modification followed by a gradual return to throwing with a specific throwing rehabilitation program. Rotator cuff strengthening and stretching, as well as an occasional corticosteroid injection were also typically involved. The minimum time to followup was 18.0 months (mean 39.2 months; range 18.0 to 59.2 months). We received prior Institutional Review Board approval for the study. All investigations were conducted in conformity with ethical principles of research and informed consent was obtained.

The pitchers' mean age at the time of surgery was 25.6 years (standard deviation [SD], 5.5). Before surgery, the median number of years in the major league was 0 years (range, 0–11 years) and minor league was 4 years (range, 0–15 years) with a total median of 5.0 years (range, 1–16 years). Preoperative shoulder range of motion based on our examination under anesthesia showed a mean external rotation of 113.6° (SD, 15.5°) and internal rotation of 50.1° (SD, 13.5°) with the arm abducted 90°. The dominant shoulder was involved in all patients, which included 55 (67%) right and 27 (33%) left procedures. Injuries were chronic (greater than 6 weeks) in 76 (93%) pitchers, subacute (2–6 weeks) in five (6%), and acute (less than 2 weeks) in one (1%) case.

Each patient was treated with an examination under anesthesia, diagnostic arthroscopy, subsequent rotator cuff débridement, and arthroscopic surgical treatment of any concomitant abnormality. This most typically involved labral débridement, labral repair, subacromial decompression (bursectomy and miniacromioplasty), or thermal capsular shrinkage (Tables 1 and 2). The indication for thermal shrinkage was laxity on exam, and the indications for acromioplasty were impingement on exam, responses from subacromial injections previously done, and intraoperative findings.

All patients underwent arthroscopic shoulder surgery in the lateral decubitus position after thorough examination under anesthesia. A standard diagnostic arthroscopy was then performed. The rotator cuff was arthroscopically evaluated from the articular and bursal surfaces. The operating surgeon staged the tears according to depth (less than 25%, 25%–49%, 50%–74%, and greater than 75%). Our technique for evaluating the depth of these tears is not an exact process but basically involves estimating the distance of the intact cuff from the articular surface. We then consider distance as a percentage of 14 mm, which is the size of the average supraspinatus footprint as determined by Dugas et al. [9]. In patients in whom the tear was greater then 50%, a spinal needle was inserted into the tear while visualizing from the articular surface. The area was then carefully probed and evaluated from the bursal side to confirm it was not full thickness. In patients with

Table 1. Preoperative and intraoperative data on professional baseball pitchers who underwent débridement of a partial-thickness rotator cuff tear

Data	Frequency (n = 82; %)
Position	
Pitcher	82 (100%)
Side (all dominant)	
Right	55 (67%)
Left	27 (33%)
Level of play	
Major	37 (45%)
Minor	45 (55%)
Type of injury	
Acute	1 (1.2%)
Subacute	5 (6%)
Chronic	76 (93%)
Rotator cuff tear size	
Less than 25%	61 (74%)
25%–50%	14 (17%)
50%–75%	4 (5%)
Greater than 75%	1 (1.2%)
Unknown	2 (2%)
Additional procedures	
Subacromial decompression	25 (30%)
Labral débridement	21 (26%)
Labral repair	49 (60%)
Thermal shrinkage	27 (33%)
Subacromial space procedures	
Miniacromioplasty	25 (30%)
Coplaning of the distal clavicle	1 (1.2%)
Distal clavicle excision	1 (1.2%)
Excision C-A ligament	6 (7%)
Excise bursitis	31 (38%)
None	49 (60%)
Location of unstable labral tears (n = 49)	
SLAP	36 (73%)
SLAP and anterior	1 (2%)
SLAP and posterior	4 (8%)
Posterior	7 (14%)
Anterior and posterior	1 (2%)
Other procedures	
Capsular release	5 (6%)
Distal clavicle excision	1 (1.2%)
Posterior capsular repair	2 (2%)
Thrower's exostosis excision	1 (1.2%)
Capsular plication/interval closure	1 (1.2%)
Biceps tenodesis	1 (1.2%)
Glenoid OCD débridement	1 (1.2%)

C-A = coracoacromial; SLAP = superior labrum anterior posterior; OCD = osteochondral defect.

partial-thickness rotator cuff tears, the pathologic tissue was débrided with a mechanical shaver. Concomitant disorders were then arthroscopically treated based on a preoperative clinical examination and intraoperative findings. This typically involved mechanical débridement of stable labral tears, repair of unstable labral tears using bioabsorbable suture anchors, subacromial bursectomy with miniacromioplasty, or thermal capsular shrinkage.

As expected, rotator cuff tear size was predominantly small (Table 1). There were 61 (74%) tears less than 25% thickness, 14 (17%) tears 25% to 49% thickness, four (5%) tears 50% to 74% thickness, and one (1%) tear 75% or greater thickness. We could not determine tear sizes in two (2%) patients would take out tear sizes owing to inadequate documentation.

Consistent with the shoulder disorders typically found in overhead throwing athletes, labral disorders were found in 70 (85%) shoulders (Table 1). We judged 49 (70%) of the labral tears unstable and we therefore repaired them. The remaining 21 (30%) labral tears were stable and only underwent débridement. Of the unstable labral tears, 41 (84%) involved the superior labrum. Seven (14%) were isolated posterior labral tears. Subacromial decompression was performed in 25 (30%) shoulders. A thermal capsular shrinkage procedure was performed in 27 (32%) patients. We identified only 3 patients (4%) with isolated

Table 2. Combinations of additional procedures performed on professional baseball pitchers who underwent débridement of a partial-thickness rotator cuff tear

Concomitant procedure in addition to débridement	Frequency of combination (N = 82; %)	Location of labral repair
LR	25 (30%)	S (n = 18), S and P (n = 3), P (n = 2), A and P (n = 1), A and S (n = 1)
LR, TS	15 (19%)	S (n = 11), P (n = 3), S and P (n = 1)
LR, SAD	7 (9%)	S (n = 7)
LD, SAD	7 (9%)	N/A
LD	7 (9%)	N/A
SAD	6 (7%)	N/A
LD, TS	5 (6%)	N/A
None	3 (4%)	N/A
TS	2 (2%)	N/A
LR, TS, SAD	2 (2%)	P (n = 2)
LD, TS, SAD	2 (2%)	N/A
TS, SAD	1 (1%)	N/A

LD = labral débridement; LR = labral repair; TS = thermal shrinkage; SAD = subacromial decompression; P = posterior; S = superior; A = anterior; N/A = not applicable.

partial-thickness rotator cuff tears undergoing débridement with no other concomitant procedure (see Table 2).

Rehabilitation varied depending on the treatment of the concomitant disorders associated with the partial-thickness rotator cuff tear, but typically consisted of an early pain and inflammatory control phase, protection phase, gradual return of range of motion, strengthening, and gradual return to competition. Modifications from the standard rehabilitation protocol for surgical treatment of rotator cuff débridement were made for labral repairs and thermal capsular shrinkage, such as prolonged immobilization and limited active biceps work. These protocols have all been developed by our physical therapist (KW) who works with these high-level elite athletes [45]. All patients had access to highly trained personnel and necessary facilities attributable to their status as professional baseball players.

After review of the records, additional followup data were collected on 34 of the 82 (41%) patients through a mail or e-mail survey distributed to patients after consent was received. The mean age within this group was 26.5 years (SD, 7.3 years). The survey consisted of the SF-12 Patient Questionnaire [41, 42], the Athletic Shoulder Outcome Rating Scale [38], and some additional questions regarding the player's control, velocity, time to return to throwing, time to return to competition, number of seasons played after surgery, and need for additional surgery. Of the remaining 48 patients, 18 were contacted and initially agreed to participate but then did not complete the survey despite repeated attempts to contact them. We were unable to contact the remaining 30 patients. We attempted to determine if any of the 48 players from whom we were unable to obtain a followup survey had been able to return to competition. This was accomplished through an Internet search of three professional baseball web site databases [21, 26, 37]. We were able to determine level of play when returning to competition by looking at season statistics from both major and minor league databases on 33 of these 48 players. This information was unavailable for 15 players.

The SF-12 scores were recorded for each player in an effort to measure overall health and wellness as well as assess any unexpected health effects of our treatment. The SF-12 is a self-administered written survey that was designed to measure general health status from the patient's point of view. Results are expressed in terms of two metascores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). A high score indicates better physical functioning. The PCS and MCS scores have a range of 0 to 100 and were designed to have a mean score of 50 and a standard deviation of 10 in a representative sample of the US population. Thus, scores greater than 50 have above average health status. The SF-12 has been validated in the literature [35, 41, 42]. The patients also completed the subjective portion of the Athletic Shoulder Outcome Rating Scale [38]. We asked them to score their peak recovery or best point after surgery, as well as score their current level at the time of follow up. Although this outcome assessment tool has not been validated in the literature, it was used because of its unique parameters for evaluation of outcome in the athletic shoulder. Typical shoulder outcome scales were developed for the general population and do not accurately assess outcomes in athletes. The subjective part of the Athletic Shoulder Outcome Rating Scale measures shoulder function in athletes based on pain, strength and endurance, stability, intensity, and performance. The individual categories are weighted according to importance to the overall outcome with performance being weighted more than all the other categories combined. The maximum score on the subjective portion of the Athletic Shoulder Outcome Rating Scale is 90 points with results being rated as excellent between 80 and 90, good 60 to 79, fair 40 to 59, and poor less than 40 points [38]. Finally, the participants were asked to provide information on their control, maximum velocity, time to return to throwing, time to return to competition, number of seasons played after surgery, and need for additional surgery.

Descriptive statistics were run on all variables. In addition, chi-squared and Fischer's exact tests were run in an effort to identify any ($p < 0.05$) relationship between having had additional concomitant procedures and returning to play baseball after surgery. Fischer's exact tests were run on variables with expected frequencies of less than five (included: subacromial decompression and thermal capsular shrinkage).

Results

Most players were able to return to professional pitching, but only approximately half were able to return to the same or higher level of competition (major league, minor league, independent league, and so on) as before their injury (Table 3). This return to play information was obtained on

Table 3. Professional pitchers returning to play after rotator cuff débridement*

Level of return	Major league (N = 24)	Minor league (N = 43)	All (N = 67)
Same	9 (38%)	27 (63%)	36 (54%)
Lower	12 (50%)	2 (5%)	14 (21%)
Higher	0 (0%)	1 (2%)	1 (1%)
Did not return to play	3 (13%)	13 (30%)	16 (24%)

* Information regarding return to play could not be obtained on 15 athletes.

Table 4. Relationship between additional procedures and not returning to play*

Statistical category	Labral repair	Labral débridement	Thermal	SAD
Chi-squared value	−0.076	0.008	−0.077	0.13
Significance	0.54	0.94	0.54	0.27

* There are no significant relationships between additional procedures and not returning to play; SAD = subacromial decompression.

67 (34 followup + 33 internet search = 67) of our initial 82 pitchers (81.7%). Fifty-one of the 67 (76%) were able to return to competitive pitching at the professional level. Thirty-six of the 67 (54%) returned to the same level and 14 (21%) returned to a lower level. One pitcher returned to a higher level and made it into the major leagues after having surgery when he was in the minor leagues. Sixteen of the 67 players (24%) were unable to return to pitching at the professional level at the time of followup. Data were unavailable on 15 pitchers. With this in mind, we also determined a worst and best case scenario including these 15 patients in the total. This would ultimately range between 62% and 80% returning to play.

We found no major relationship between the additional procedures performed and not returning to play (Table 4).

The Athletic Shoulder Outcome Rating Scale scores (for the 34 pitchers who returned the survey) showed most pitchers with good to excellent results at their best point after surgery. The best scores were as follows: 18 (52.9%) excellent, eight (23.5%) good, four (11.7%) fair, and four (11.7%) poor. These scores represented the best results they were able to obtain after surgery. When asked about their current status at the time of followup, results were a little lower. Current scores were 13 (39.4%) excellent, six (18.2%) good, eight (24.2%) fair, and six (18.2%) poor. One player with excellent results at his best point postoperatively did not complete his current scores at followup.

Followup SF-12 scores were above average with a mean PSF-12 of 55.04 (SD, 4.48) and a mean MSF-12 of 56.49 (SD, 4.11).

Of the 34 pitchers who returned the survey, 29 (91%) returned to professional pitching. Although most were able to return, their control and velocity diminished. Twenty-two (65%) players did not feel they had the same control of their pitches. Twenty-four (71%) did not have the same velocity. The maximum velocity before injury averaged 94.2 mph (SD, 2.3 mph), while the maximum velocity after surgery averaged 90.1 mph (SD, 4.1 mph). The mean time to return to throwing was 5.6 months (SD, 2.6 months) and time to return to competition averaged 10.7 months (SD, 4.3 months). The median number of seasons played after surgery was 2 years (range, 0 to 4 years). At the time of followup, 18 (53%) pitchers were still playing. Fifteen (44%) were retired. One player did not indicate his employment status. Five (15%) had undergone a second shoulder surgery during the followup period attributable to continued shoulder dysfunction.

Discussion

Elite overhead throwing athletes with rotator cuff tears represent a unique group of patients. The demands placed on the shoulders of these individuals are far beyond that of the general public. When injuries do occur, treatment results are largely evaluated by a player's ability to return to competition. Because partial-thickness rotator cuff tears are very common in an injured overhead throwing athlete, it is critical to evaluate the results of treating these injuries. We performed this study to determine the results of débridement of partial-thickness rotator cuff tears in elite overhead throwing athletes by evaluating their ability to return to their previous level of competition, as well as evaluating Athletic Shoulder Outcome Rating scores and SF-12 scores. We also hoped to determine if additional concomitant procedures performed at the time of surgery would have an effect on return to play.

Our retrospective study is limited by missing information. The percentage of players with followup (41%) is not as high as we would have liked. We found it difficult to contact several players as a result of them being out of town during spring baseball practice and the start of the baseball season. Even after leaving messages with family and directly with their teams, getting them to return calls was a challenge. Some players were currently playing baseball in foreign countries. Other players agreed to participate but never returned their questionnaires despite repeated attempts to contact them. Having a lower percentage of players respond for followup can obviously affect the results. The data also reflect coexisting shoulder disorders in all of these patients. We recognize these associated injuries as a very important limitation to the study when trying to isolate our results from our treatment of rotator cuff tears. As previously mentioned, injury to an overhead throwing athlete often involves several anatomic structures. In fact, our data showed only 3 out of 82 (4%) players had an isolated rotator cuff injury. It is difficult to sort out how each of these contributed to the overall impairment of the athlete. However, based on the limited data we found no relationship with any additional procedures performed and a player's ability to return to competition. If nothing else, the number of other soft tissue procedures performed underscores the complexity of treating these types of injuries. Finally, for comparative purposes we used an older and unvalidated categorical rating in addition to contemporary measures.

Overall, 76% of pitchers who were followed up (76% of the 67 from the overall group of 82) were able to return to competitive pitching at the professional level. This included 55% able to return to the same or higher level of competition. Unfortunately, we were unable to obtain data on 15 patients. Of these 15 patients, at least three players were believed to be pitching competitively in a foreign country. We, however, were not able to directly confirm this and therefore did not include them in our results. Although it is possible all 15 patients were unable to return to play, it is likely some returned to pitching in leagues (foreign, independent, and so on) that were not included in the databases we used. With this in mind, we determined a worst- and best-case scenario including all 15 patients in the total. This would ultimately result in a range of 62% to 80% returning to play.

The Athletic Shoulder Outcome Rating Scale demonstrated 76.5% of professional pitchers have good to excellent results (score > 60) with débridement of partial-thickness rotator cuff tears. These results are consistent with other published studies. Many studies have generally demonstrated favorable outcomes from débridement of partial-thickness rotator cuff tears [4, 7, 10, 14, 33, 36, 47]. However, the vast majority of these studies involved the general population and used rating scales that evaluate typical daily activities. There have been fewer studies focusing specifically on athletes [1, 2, 4, 28, 30, 31, 36, 39, 40]. Overall, results from these studies have been more variable, especially in baseball players (Table 5).

The sizes of tears in our patients were small. Of the 82 pitchers who had undergone débridement of a partial-thickness rotator cuff tear during the time period of this study, 91.5% had tears less than 50% thickness. Of the 34 pitchers who responded, 97.1% had tears less than 50% thickness. This high frequency of small tears is likely a consequence of several factors. First, most tears in these overhead throwing athletes are indeed small. Players often seek medical care before their tears are large because function has already diminished to an unacceptable level. It should also be considered we may have a tendency to slightly underestimate the size of these tears and be somewhat biased when caring for these professional athletes because of their careers. Finally, most tears greater than 50% thickness are now being treated more aggressively by us and around the country. These tears are typically being repaired and, therefore, would not be included in our results. Techniques for arthroscopic repair of partial-thickness tears have been described [6, 20, 46] and are now commonly performed. Several authors have recommended performing a formal repair rather than débriding these tears greater than 50% to 75% thickness [6, 12–14, 22, 23, 25, 43, 44, 47]. Results in professional baseball players with eight of nine (89%) players more than 12 months after surgery returning to the same or higher level of play have been reported [6]. In our study, the followup group of 34 patients had one player with a tear greater than 50% thickness. The player had a fair result at his best point after surgery. At followup, his result had diminished to poor. The player was never able to return to competition in professional baseball. More research is needed regarding the size and depth of tears that are amenable to débridement alone versus repair, especially in the overhead throwing athlete.

Table 5. Summary of literature on débridement of partial-thickness rotator cuff tears involving athletes

Studies on cuff débridement involving athletes	Key data and reported results
Budoff et al. [4]	89% success rate
	31% of athletes continued to have pain
Andrews et al. [2]	85% success rate of returning to a competitive level
	34 total patients (all throwing athletes)
	64% of patients were baseball players, half of these were professional
Snyder et al. [36]	84% success rate
	31 total patients (No high-level overhead throwers)
Altchek and Carson [1]	80% success rate
	50 total patients (all throwing athletes)
Riand et al. [31]	80% success rate
	Mostly overhead throwing athletes, but no baseball players
Payne et al. [30]	72% success rate, but only 51% returned to pre-injury level of competition
	43 total patients (20 baseball/softball players)
Ogilvie-Harris and Wiley [28]	50% success rate
	57 total patients
Tibone et al. [39]	22% returned to same sporting level

The results from the Athletic Shoulder Outcome Rating Scale were encouraging, with 76.5% having good to excellent results. Of those having fair to poor results, we were unable to find any specific factors that would have contributed to their results being worse than the others. We did believe it was important to determine scores for the Athletic Shoulder Outcome Rating Scale at their best point postoperatively in addition to their current status at the time of followup. The results had diminished somewhat at the time of current followup with only 57.6% having good to excellent results. Also, 44% of the pitchers were retired at the time of followup. These results, in addition to the finding that the mean number of seasons played after surgery was only 1.5 years, are noteworthy. This could be explained by the fact that the repetitive forces placed on the

shoulder of a professional baseball pitcher are extreme [11] and the durability of débridement just may not hold up over time. However, it must be considered the mean career length of a professional baseball pitcher is only 4.8 years [34]. In fact, less than half of all professional baseball position players will play 4 years or longer [32]. In this study, the mean number of years of professional competition before surgery was 5.8 years. Obviously, a percentage of these pitchers would be retired from baseball at a followup of 39.5 months regardless of injury or surgery. Also, players are often in the middle of their contracts with teams when they are injured. Regardless of the results from surgery, teams will always look at previous injuries when negotiating new contracts or acquiring new players. If two players have equal ability, the one who has not been injured is possibly more likely signed, forcing previously injured players to retire.

Débridement of small partial-thickness rotator cuff tears in elite overhead throwing athletes will allow most to return to competitive professional pitching; however, only approximately half are expected to return to their previous level of competition. At our institution, we will débride the majority of tears less than 50% thickness. The question still remains as to the appropriate treatment of larger tears. Although we have become much more aggressive and will typically repair tears greater than 50% thickness with an arthroscopic technique, further research is needed to confirm the decision of whether to perform débridement or repair in larger tears. Additional research is also needed to evaluate the treatment of labral pathology in this subset of patients. This is especially relevant in allowing athletes the ability to return to their sports at a competitive level.

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