

Do Articular-Sided Partial-Thickness Rotator Cuff Tears After a First-Time Traumatic Anterior Shoulder Dislocation in Young Athletes Influence the Outcome of Surgical Stabilization?

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Background: Because of the high risk for redislocations after a first-time traumatic anterior shoulder dislocation with conservative treatment, recent publications have recommended early arthroscopic intervention, especially for young athletes. Concomitant rotator cuff tendon damage may occur when the shoulder dislocates; however, its presence and influence on clinical results have not been well described in this patient category.

Hypothesis: In opposition to current opinion, a substantial number of articular-sided partial-thickness rotator cuff tears (APTRCTs) would be found at surgery after a first-time traumatic anterior shoulder dislocation in young athletes. However, the impact of these injuries on 2-year postoperative results would be negligible.

Study Design: Cohort study; Level of evidence, 3.

Methods: Sixteen male patients (mean age, 21 years [range, 16-25 years]) with a first-time traumatic anterior shoulder dislocation without bony Bankart lesions were included in this study. The indications for surgical treatment were age less than 25 years and being active in collision or contact sports at a competitive level. Arthroscopic surgery was performed at a mean 7.8 days (range, 2-14 days) after injury. Rowe and American Shoulder and Elbow Surgeons (ASES) scores as well as range of motion were evaluated at a minimum 2 years after an arthroscopic Bankart procedure, and a comparison of the clinical results between patients with and without APTRCTs was conducted.

Results: An anterior-inferior capsulolabral injury was found in all patients. There were no bony Bankart lesions. An APTRCT was found in 9 of the 16 patients. At 2 years after surgical treatment, there were no significant differences between the patients with and without APTRCTs in terms of the Rowe score (90.0 and 87.1, respectively; $P = .69$) and ASES score (94.6 and 90.4, respectively; $P = .67$).

Conclusion: APTRCTs were found in the superior part of the shoulder joint after a first-time traumatic anterior shoulder dislocation in a majority of young male athletes treated with surgical stabilization. There were no significant differences found between patients with and without APTRCTs in terms of the Rowe and ASES scores at 2 years after surgical treatment.

Keywords: intra-articular damage; rotator cuff; shoulder dislocation; shoulder instability; young athletes

The most common treatment for a first-time traumatic anterior shoulder dislocation is conservative treatment.^{16,27} However, the redislocation rate is very high in the younger population, reportedly ranging from 77% to 94% in young athletes.^{9,17,26,28,33} Recent publications have recommended early arthroscopic intervention for young

and active patients.^{2,11,14} The indications for operative treatment after a first-time anterior shoulder dislocation were reported by Habermeyer et al.⁷

The results of operative treatment depend on the presence of bone defects in the anterior part of the glenoid and the posterior humeral head. However, even in patients without any bone defects, a redislocation rate of 6.5% in young athletes has been reported by Burkhart and de Beer.³

The structures injured in a first-time traumatic anterior shoulder dislocation have been described in previous

The Orthopaedic Journal of Sports Medicine, 6(6), 2325967118781311
DOI: 10.1177/2325967118781311
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studies.^{8,20,32} These studies have focused on anterior capsulolabral complex injuries and Hill-Sachs-type posterior humeral head defects. Reports of rotator cuff tendon damage in young patients after a first-time traumatic anterior shoulder dislocation are rare; however, it has been reported in patients older than 40 years as between 35% and 86%.^{8,19,22}

Considering the mechanism of anterior glenohumeral joint dislocations (ie, that the posterior-superior part of the humeral head engages with the anterior-inferior rim of the glenoid), it is reasonable to assume that superior articular-sided rotator cuff structures may also be damaged in the young population.

The aim of the current study was to identify articular-sided rotator cuff traumatic changes of the glenohumeral joint after a first-time traumatic shoulder dislocation in young athletes and to compare the clinical results in patients with and without such injuries at a minimum of 2 years after surgery. The hypothesis of the study was that, in opposition to current opinion, a substantial number of articular-sided partial-thickness rotator cuff tears (APTRCTs) would be present after a first-time traumatic anterior shoulder dislocation in young athletes. However, the impact of these injuries on 2-year postoperative results would be negligible.

METHODS

A total of 144 patients underwent surgical treatment of shoulder instability between April 2012 and February 2015. Of these patients, 27 had a first-time traumatic anterior shoulder dislocation. Eleven of 27 patients were excluded from the study because of previous subluxation episodes ($n = 7$), generalized hypermobility signs ($n = 3$), or previous surgery on the same shoulder ($n = 1$).

Thus, 16 male patients (mean age, 21 years [range, 16-25 years]) with a unilateral (11 right and 5 left) first-time traumatic anterior shoulder dislocation were included in the study and were prospectively followed; however, the hypothesis was retrospectively implemented. In 7 patients, the nondominant shoulder was affected, and in 9 patients, the dominant shoulder was affected.

The inclusion criteria for surgical treatment were age younger than 25 years and participation in collision or contact sports at a competitive level without any previous symptoms of instability episodes from the affected shoulder, based on patients' subjective reports and official medical charts. Patients also needed to demonstrate no generalized hypermobility signs, more specifically, a

Beighton Hypermobility Score¹ of ≤ 4 , and no sulcus sign in the contralateral shoulder.

In all patients, the traumatic anterior shoulder dislocation was confirmed with radiography. All reductions were performed under intra-articular local anesthesia with 20 mL of 1% lidocaine in the emergency department by a trauma specialist on call. The reduction was confirmed with radiography. The shoulder was immobilized in internal rotation in a sling until surgery. Before surgery, computed tomography (CT) was performed in all patients to identify bone injuries.

Arthroscopic surgery was performed a mean of 7.8 days (range, 2-14 days) after injury. Surgery was performed by one senior surgeon (M.R.) with the patient in the beach-chair position under either general anesthesia or general combined with regional anesthesia. The shoulder joint was inspected through a posterior portal and through an anterior portal using a 4-mm 30° arthroscope. Arthroscopic images of the glenohumeral joint were captured with Olympus VSI media or Synergy^{UHD4} (Arthrex).

During arthroscopic inspection through the posterior portal, anterior-inferior capsulolabral injuries, the anterior glenoid, the rotator interval area, the stability and attachment of the long head of the biceps tendon, the subscapularis tendon, the superior capsulomuscular area, and the glenohumeral cartilage area were visualized, inspected, and palpated with a probe from the anterior portal. Anterior-inferior capsulolabral injuries were recorded using a clockface system. The Hill-Sachs lesions were visualized and checked during arm abduction and external rotation for engagement with the anterior-inferior glenoid. Through the anterior portal, the posterior and posterior-inferior capsulolabral parts of the joint were inspected subsequently.

The Southern California Orthopedic Institute (SCOI) rotator cuff classification system³⁰ was used to classify articular-sided rotator cuff lesions (type A). The different grades of the system are as follows:

Grade 0: Normal rotator cuff

Grade 1: Slight capsular fraying in a small, localized area (usually <1 cm in size)

Grade 2: Fraying or failure of some rotator cuff fibers in addition to a capsular injury (usually <2 cm in size)

Grade 3: Fraying and fragmentation of tendon fibers, often involving the whole surface of a rotator cuff (supraspinatus) tendon (usually <3 cm in size)

Grade 4: In addition to fraying and fragmentation of the tendon, presence of a sizable flap tear and often encompassing more than one tendon

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The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

Ethical approval for this study was obtained from the Tallinn Medical Research Ethics Committee (No. 2952).

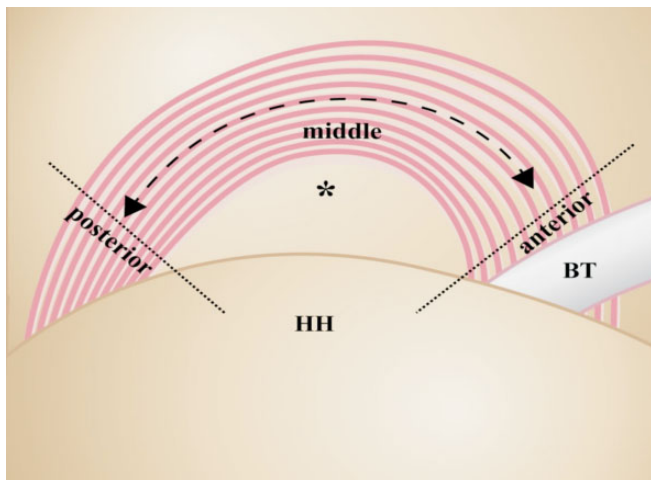


Figure 1. Schematic drawing of 3 zones of the superior intra-articular capsulomuscular area. Anterior, anterior rotator cable attachment area; middle, middle part of rotator cable with rotator crescent; and posterior, posterior rotator cable attachment area. BT, long head of the biceps tendon; HH, humeral head; ◀-----▶, rotator cable; *, rotator crescent.

The SCOI classification system has been shown to have moderate reliability and very good agreement between surgeons to describe partial-thickness rotator cuff tears.¹⁸

The arthroscopic Calandra classification system⁵ was used to classify Hill-Sachs lesions. The different grades of the system are as follows:

- Grade 0: No lesion
- Grade 1: Defect of the articular surface not involving the subchondral bone
- Grade 2: Small defect involving the subchondral bone (≤ 1 cm)
- Grade 3: Large defect involving the subchondral bone (> 1 cm)

During arthroscopic inspection, the superior capsulomuscular part of the glenohumeral joint was divided into 3 zones: the anterior and posterior rotator cable attachment areas and the middle rotator crescent area (Figure 1).

The evaluation and description of the damaged structures were independently performed by 2 experienced shoulder surgeons (M.R. and K.K.). Differences in opinion between the 2 surgeons were resolved by a discussion with clinical anatomy specialists working at the Department of Anatomy of the University of Tartu (E.P. and I.K.).

In all patients, the anterior capsulolabral injury was reapproximated with 2 or 3 bioabsorbable anchors with single or double No. 2 Orthocord sutures (Lupine; DePuy Synthes) to the anterior glenoid without overtensioning of the capsule. Intra-articular rotator cuff injuries were debrided with a shaver. Hill-Sachs lesions were left in situ.

The postoperative rehabilitation program under the guidance of a physical therapist followed the same guidelines for all patients. The arm was immobilized in internal

rotation for 4 weeks. Pendulum exercises were allowed from week 4 and full range of motion (ROM) from week 12, and full return to sports was permitted at the earliest 16 weeks after surgery.

For analysis of the results, the patients were divided into 2 groups: those with and without APTRCTs. A clinical evaluation was performed at a minimum of 2 years after surgery by an independent physical therapist not involved in the rehabilitation of the patients (K.P.) using the American Shoulder and Elbow Surgeons (ASES) score, Rowe score, and ROM measurements. ROM was measured with a goniometer and is reported as the loss of motion in degrees in comparison to the contralateral healthy shoulder. Specific strength measurements not included in the ASES and Rowe scores were not performed. Patients' reports and medical history during the 2-year follow-up were reviewed, and specific interest was paid to frank dislocation and subluxation episodes. The apprehension test was used as a specific tool for predicting recurrent instability, and results were classified dichotomously as positive or negative depending on whether there was a protecting muscular contraction during the test. Return to previous levels of activity was dichotomously classified as "yes" if 90% to 100% (grade 1-2) or "no" if less than 90% (grade 3-5) of the previous level of activity was achieved according the Cho classification system.⁶

This study was approved by the Tallinn Medical Research Ethics Committee, and informed consent was obtained from all patients.

Statistical Analysis

Mean (range) values are presented. The Mann-Whitney *U* test was used for the comparison of the ASES and Rowe scores between the patients with and without APTRCTs. Categorical variables were compared using the chi-square test. A *P* value of $< .05$ was considered significant. The primary variable of the study was the presence of rotator cuff injuries in young athletes. A post hoc power analysis revealed that if 56% (9/16) of patients have this type of injury instead of no patients at all, approximately 18 patients would be required to reach a power of 80%.

RESULTS

All 16 patients had hemarthrosis and anterior-inferior capsulolabral injuries without bony damage on the anterior glenoid. Nine of the 16 patients had APTRCTs in the superior part of the shoulder joint. These injuries were classified as A2 rotator cuff lesions in 3 patients and A1 rotator cuff lesions in 6 patients. The anterior insertion area of the rotator cable was affected in 2 patients, and the posterior insertion area of the rotator cable was affected in 6 patients. An isolated injury of the posterior insertion of the rotator cable was identified in 4 patients. One patient exhibited an osteochondral injury of the posterior insertion of the rotator cable (Figure 2).

The rotator crescent area was damaged in 5 of the 16 patients (Figure 3). Two of these patients also had damage

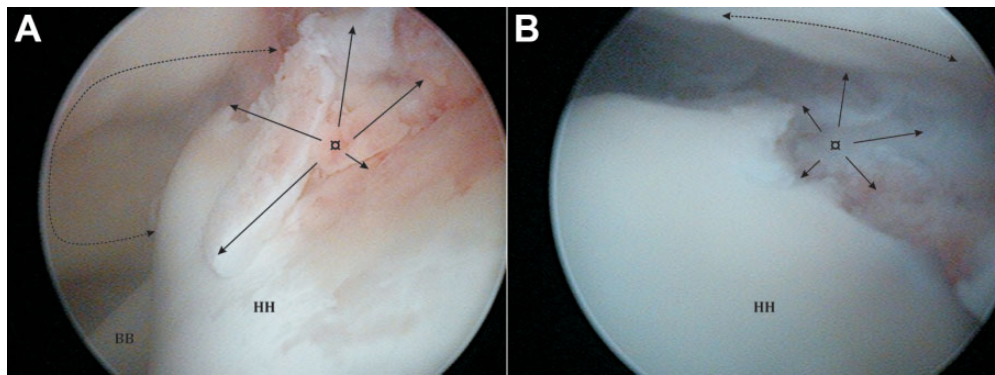


Figure 2. Arthroscopic view of the right shoulder through the posterior portal showing an osteochondral injury of the posterior rotator cable attachment area in patient 4: (A) osteochondral injury on the posterior rotator cable attachment area and (B) posterior rotator cable attachment area after debridement. BB, biceps brachii long head tendon; HH, humeral head; \leftarrow ----- \rightarrow , rotator cable; *, rotator crescent.

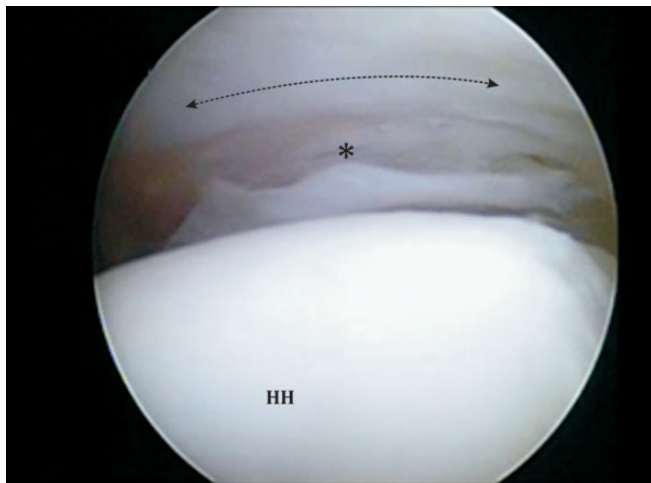


Figure 3. Arthroscopic view of the left shoulder through the posterior portal showing a rotator crescent lesion in patient 8. HH, humeral head; \leftarrow ----- \rightarrow , rotator cable; *, rotator crescent.

to the anterior rotator cable attachment (Figure 4), and 2 had damage to the posterior rotator cable attachment. Hill-Sachs lesions were found in 14 patients at surgery. Seven lesions were grade 1, and 7 were grade 2. These lesions were also observed on CT in 12 of the 14 patients. There were no radiologically engaging Hill-Sachs lesions.

A superior labral anterior posterior (SLAP) type 5 lesion was found in 1 patient; an isolated grade 3 chondral lesion on the middle of the humeral head was found in another patient. Patient demographics and glenohumeral joint findings are summarized in Table 1.

A follow-up was performed at a mean of 32 months (range, 24-38 months) after surgery. Thirteen of 16 patients had returned to their preinjury level of activity at follow-up, and the remaining 3 patients had returned to sports activities at a lower level. There were no significant differences in ASES or Rowe scores between the study groups at

follow-up. Patients who had APTRCTs had a tendency toward greater loss of ROM in abduction/external rotation than patients without APTRCTs (not significant and $P = .05$, respectively) (Table 2). Based on the patients' reports and medical history, no recurrences of frank dislocation and subluxation episodes were registered during the follow-up period.

DISCUSSION

The most important finding in the present study was the presence of articular-sided rotator cuff injuries in the superior part of the glenohumeral joint at index surgery in more than half of the young male athletes evaluated. All APTRCTs were superficial and involved different areas of the rotator cable and rotator crescent.

Arthroscopic studies as well as recent anatomic articles have provided detailed descriptions of the superior glenohumeral joint capsule. Burkhart et al⁴ and Kolts et al¹⁵ described the rotator cable in the superior part of the glenohumeral joint with the anatomic term "ligamentum semicirculare humeri." In an anatomic study, Rahu et al²⁴ found that the superior capsuloligamentous structures were tightly connected to the supraspinatus tendon and could be considered the insertion area for this tendon. In the posterior insertion area, the rotator cable connects the teres minor, infraspinatus, and supraspinatus tendons. Because of these anatomic conditions, it is very difficult to differentiate superficial intra-articular capsular lesions from rotator cuff lesions in the superior area of the shoulder joint.

At present, operative treatment after a first-time traumatic anterior shoulder dislocation focuses on the restoration of anatomic structures in the anterior-inferior part of the joint and fixation of rotator cuff and SLAP lesions, if present. In their clinical study, Burkhart and de Beer³ reported that despite appropriate surgical treatment and rehabilitation, redislocations occurred in 6.5% of patients without any bone defects. One explanation for this finding could be unidentified injuries to the superior structures of

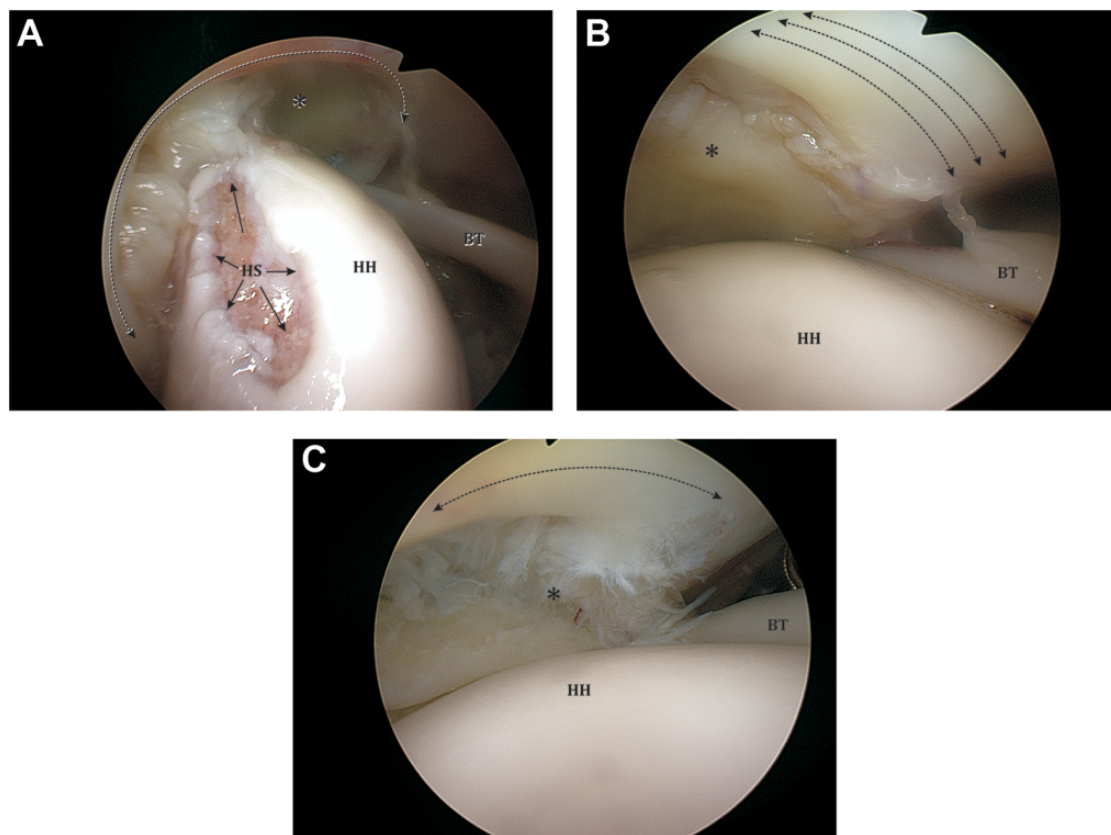


Figure 4. Arthroscopic view of the left shoulder through the posterior portal showing a Hill-Sachs lesion, rotator crescent injuries, and anterior part of the rotator cable injuries in patient 11: (A) Hill-Sachs lesion (grade 2) and rotator crescent injury (A2), (B) rotator crescent and anterior part of the rotator cable injuries, and (C) rotator crescent and anterior part of the rotator cable injuries after partial debridement. BT, long head of the biceps tendon; HH, humeral head; HS, Hill-Sachs lesion; ◀-----▶, rotator cable; *, rotator crescent.

the shoulder joint. However, in the present study, no recurrence of instability occurred during the follow-up period, but 3 patients were not able to return to the same activity level.

In a cadaveric study, Ishihara et al¹⁰ showed that the integrity of the superior capsule significantly affects anterior and inferior translation of the glenohumeral joint. Pinkowski et al²³ showed in another cadaveric study that the rotator cable is important for glenohumeral stability. Specifically, an APTRCT involving the anterior and posterior rotator cable increased anterior and inferior glenohumeral translation by 55.6% at 30° of external rotation and by 46.6% at 120° of external rotation, respectively, compared with the initial capsular cut.

In previous studies, the presence of APTRCTs has not been a common finding after a first-time traumatic anterior dislocation in young patients. Shin et al²⁹ reported that only 1 of 33 patients under the age of 30 years had an APTRCT at surgery after an acute shoulder dislocation. Kim et al¹³ found that 2 of 33 patients aged between 17 and

33 years had an APTRCT involving less than 25% of the rotator cuff.

In the present study, all intra-articular rotator cuff injuries were superficial according to the SCOI classification. Most surgeons likely pay little attention to these lesions, which might therefore be underreported.

In young overhead athletes, internal impingement is regarded as an overuse injury that will lead to an APTRCT. In patients with internal impingement, the APTRCT is located in the posterior rotator cable area. Paley et al²¹ found symptomatic posterior internal impingement in 93% of overhead athletes during arthroscopic inspection of superficial intra-articular rotator cuff tears, with capsulolabral fraying in the affected area.

All patients in the present study were asymptomatic before injury, based on patient reports and medical history. Furthermore, the lesions found at surgery appeared acute, with hematomas or bleeding, and could therefore be distinguished from older overuse injuries. It therefore appears unlikely that the lesions found resulted from internal impingement.

TABLE 1
Patient Demographics and Glenohumeral Joint Findings^a

Patient No.	Sex	Side	Arm Dominance	Age, y	Sports Activity	CT Findings	Time Between Injury and Surgery, d	Location of Capsulolabral Injury, clockface	Hill-Sachs Grade	APTRCT			SCOI Classification	Other Findings
										Anterior	Middle	Posterior		
1	Male	Left	ND	25	Ice hockey	Hill-Sachs	9	2 to 6	1					None
2	Male	Right	D	24	Wrestling	Hill-Sachs	2	2 to 6	2	+	+		A1	None
3	Male	Right	D	23	Motocross	Hill-Sachs	9	2 to 5:30	1					None
4	Male	Right	D	17	Judo	Hill-Sachs	7	2:30 to 6	1	+	+		A2	None
5	Male	Right	D	21	Soccer	Hill-Sachs	8	2 to 5:30	2					HH grade 3 cartilage injury
6	Male	Right	D	18	Judo		3	3 to 6				+	A2	None
7	Male	Left	ND	25	Motocross	Hill-Sachs	8	11 to 5:30	1	+	+		A1	SLAP type 5 lesion
8	Male	Left	ND	19	Judo		4	2:30 to 5:30	1		+		A1	None
9	Male	Left	ND	19	Volleyball	Hill-Sachs	8	2 to 6	2					None
10	Male	Right	D	19	Motocross	Hill-Sachs	11	2:30 to 5:30	1			+	A1	None
11	Male	Left	ND	21	Ice hockey		9	2 to 5:30	1	+	+		A2	None
12	Male	Right	ND	20	Handball	Hill-Sachs	7	3 to 5:30	2			+	A1	None
13	Male	Right	D	21	Soccer	Hill-Sachs	8	2 to 6	2					None
14	Male	Right	D	20	Wrestling	Hill-Sachs	10	2 to 5:30	2					None
15	Male	Right	ND	24	Bicycle motocross	Hill-Sachs	9	2 to 5	2			+	A1	None
16	Male	Right	D	18	Handball		12	2 to 5:30						None

^aAPTRCT, articular-sided partial-thickness rotator cuff tear; CT, computed tomography; D, dominant; HH, humeral head; ND, nondominant; SCOI, Southern California Orthopedic Institute; SLAP, superior labral anterior posterior.

Studies have reported that APTRCTs of less than 50% thickness may be treated successfully with debridement,³¹ which is in line with the approach in the present study. However, theoretically, the complete restoration of all functional structures, including the capsulotendinous integrity of APTRCTs, appears important for normal glenohumeral kinematics. Studies have found that transtendon repair and repair after tear completion achieve similar results for patients with APTRCTs of greater than 50% thickness.^{12,25}

No significant differences were found in the ASES score, Rowe score, or ROM in most dimensions between patients with versus without APTRCTs in the present study. However, the present study was underpowered for these variables.

The major limitation of the present study was the small number of patients, which did not provide adequate power for a proper analysis of loss of ROM, and

even the primary variable, the presence of APTRCTs, also appears underpowered. Furthermore, control groups with either a lack of treatment or repair of APTRCTs were not considered.

A further limitation is that the measurements of ROM were performed by a single experienced physical therapist without interrater reliability testing. The differences of a few degrees of motion between the groups could actually be within an error of measurement, further complicated by the fact that the contralateral shoulder might not be the perfect comparison.

A third limitation of the present study is the lack of a conservatively treated control group. A fourth limitation is that magnetic resonance imaging was not performed preoperatively. Finally, one has to consider the difficulties in assessing a soft tissue injury close to a Hill-Sachs lesion. However, the results of the present study are interesting and could be used as a basis for future research.

TABLE 2

Comparison of Clinical Outcomes in Patients With Versus Without APTRCTs at a Minimum of 2 Years After Surgery^a

Variable	APTRCT	No APTRCT	P
No. of patients	9	7	
Age, y	19.8 (17-25)	21.0 (18-25)	.75
Sex, male/female, n	9/0	7/0	>.99
Arm, dominant/nondominant, n	4/5	5/2	.52
Rowe score, points	90.0 (55-100)	87.1 (50-100)	.69
Excellent (90-100), n	7	5	
Good (70-89), n	1	1	
Fair (40-69), n	1	1	
Poor (<40), n	0	0	
ASES score, points	94.6 (81-100)	90.4 (76-100)	.67
Return to same level of sport, n	8	5	.37
Recurrence of dislocation, n	0	0	
ROM limitation, no/yes, n	4/5	4/3	.61
Loss of ROM compared with contralateral side, deg			
External rotation	8.3	4.3	.56
Internal rotation	0.0	0.0	>.99
Elevation	0.0	0.0	>.99
Abduction/internal rotation	1.7	0.0	.10
Abduction/external rotation	2.8	0.0	.05

^aValues are shown as mean (range) unless otherwise indicated. APTRCT, articular-sided partial-thickness rotator cuff tear; ASES, American Shoulder and Elbow Surgeons; ROM, range of motion.

CONCLUSION

APTRCTs were found in the superior part of the shoulder joint after a first-time traumatic anterior shoulder dislocation in a majority of young male athletes treated with surgical stabilization. At 2 years after surgical treatment of a first-time anterior shoulder dislocation, there were no significant differences found between the patients with and without APTRCTs in terms of the Rowe and ASES scores.

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