Original Article
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Spontaneous Deltoid Tear in Cuff Tear Arthropathy and Its Effect on the Outcome of Reverse Total Shoulder Arthroplasty: A Comparison Using Propensity Score Matching

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Background: Deltoid function critically influences the results of reverse total shoulder arthroplasty (RTSA), and spontaneous deltoid attrition tears are frequently detected in cuff tear arthropathy (CTA) patients; however, the clinical impacts of these tears on RTSA outcomes are undetermined. Our aim was to determine the effect of spontaneous deltoid attrition tears on postoperative outcomes after RTSA without an additional deltoid procedure.

Methods: Seventy-two patients who underwent RTSA for CTA with preoperative magnetic resonance imaging (MRI) and a minimum clinical follow-up of 1 year (mean, 32 months) were retrospectively reviewed in the study. Patients with a history of previous shoulder surgery or injury were excluded. The presence and location of deltoid attrition tears were determined in preoperative MRI. Propensity score matching (1:1) was performed to construct tear and no-tear groups. Finally, 21 patients, matched with respect to age, sex, hand dominance, symptom duration, medical comorbidity (obesity, diabetes mellitus, and coronary artery disease), Hamada grade, and implant type, were assigned to each group. Clinical outcomes (functional scores, isometric power, and range of motion) in the two groups were compared.

Results: Deltoid attrition tears were detected in 21 of the 72 enrolled cases (29.1%). Anterolateral deltoid was the most frequent location and no tear was detected in the posterior deltoid. The tear rate increased with disease severity (Hamada G2, 4.8%; G3, 23.8%; > G4, 71.4%). No pre- or postoperative clinical variables differed significantly between the tear and no tear groups.

Conclusions: Deltoid attrition tears were detected in 29% of CTA patients who underwent RTSA. The most common site was the anterolateral region and tear prevalence tended to increase with CTA progression. However, RTSA was found to provide satisfactory outcomes regardless of the presence of a deltoid attrition tear.

Keywords: *Deltoid attrition tear, Cuff tear arthropathy, Reverse total shoulder arthroplasty, Clinical outcome*

Reverse total shoulder arthroplasty (RTSA) is gaining popularity and provides acceptable outcomes for those with cuff tear arthropathy (CTA).[1-4] Shoulder reconstruction using a reversed prosthesis is considered to rely on the deltoid as a joint stabilizer and prime mover in abduction and rotation.[1,3] The concept of RTSA that provides a medialized and distalized center of shoulder rotation

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with a constraint fulcrum critically depends on an intact deltoid.[1,5] Therefore, some surgeons have focused on the restoration of deltoid function during RTSA for deltoid impairment based on direct deltoid repair, deltoid flap, deltoid turn down procedures, or rotationplasty.[6-9] However, no consensus has been reached regarding the criteria used to determine eligibility for an additional deltoid procedure during RTSA.[10]

Spontaneous deltoid attrition tears concomitantly found in CTA are not an infrequent phenomenon.[11,12] Although early studies on deltoid tears with no history of surgery or injury reported a low prevalence of 0.3%–9.2%,[13,14] recent studies have revealed that this pathology is more likely to be found among patients with chronic rotator cuff tears.[11,12] This finding indicates a possible association between a chronic rotator cuff and deltoid tears and prompted the suggestion that a superiorly directed humeral head in cases of rotator cuff dysfunction might cause attrition tears due to rubbing at the deltoid undersurface.[15,16] Thus, surgeons might frequently encounter CTA-associated deltoid tears, but evidence is not sufficient to support decision-making regarding the need for an additional deltoid procedure during RTSA.

Little is known about how a spontaneous deltoid attrition tear affects RTSA outcomes. A previous study reported the outcome of RTSA in one CTA patient with a preoperative spontaneous deltoid tear.[17] The authors reported a satisfactory outcome and concluded that force balance between the intact anterior and posterior deltoid functioned properly to restore shoulder movement.[17] However, one case report is insufficient to determine whether RTSA without any additional deltoid procedures is indicated in those with CTA and an accompanying spontaneous deltoid tear.

Accordingly, we conducted this study on spontaneous deltoid attrition tears in a CTA cohort to determine their effect on postoperative outcome after RTSA without an additional deltoid procedure. We hypothesized that the presence of spontaneous deltoid attrition tears would adversely affect postoperative outcomes after RTSA.

METHODS

This retrospective, case-controlled study was conducted using a prospectively collected database. To reduce the possibility of bias, 1-to-1 propensity score matching was conducted. The review of medical records was approved beforehand by the Seoul National University College of Medicine Institutional Review Board (No. H-1906-007-1037). Because of the retrospective nature of this study, informed consent from patients was waived.

Patient Population

From April 2010 to December 2019, primary RTSA was performed on 137 shoulders of 123 patients under a diagnosis of CTA at our institution by a single surgeon (SHK). RTSA was recommended for patients with arthritic changes of at least Hamada grade 2 and considerable discomfort. The study inclusion criteria were as follows: (1) RTSA with a diagnosis of CTA, (2) accessible preoperative plain radiography and magnetic resonance imaging (MRI) images, and (3) a clinical follow-up of ≥ 1 year. The exclusion criteria were (1) a history of shoulder surgery (including open/arthroscopic rotator cuff repair), (2) a history of shoulder trauma, (3) concomitant latissimus dorsi and teres major transfer, and (4) a diagnosis of osteoarthritis, fracture, infection, or inflammatory arthritis. Of 113 CTA patients who underwent RTSA alone and had no history of injury or surgery, 41 were excluded because they did not satisfy the criteria of clinical follow-up. Finally, 72 shoulders of 72 patients (14 men and 58 women) were analyzed. Their mean age at operation was 73 ± 4 years (range, 65–83 years), and mean follow-up was 31 ± 19 months (range, 12–108 months).

Clinical Evaluation

Clinical data were obtained from a prospectively collected database and included sex, age, hand dominance, side of involvement, implant type used, and medical comorbidities (diabetes mellitus [DM], coronary artery disease [CAD], and obesity [body mass index ≥ 25 kg/m^2]). Clinical evaluations were performed using functional scores, isometric strengths, and range of motion (ROM) measurements. All measurements were prospectively performed by an experienced clinical assistant not otherwise involved in the study. Baseline measurements were obtained 1 or 2 days before RTSA, and postoperative measurements at every postoperative outpatient visit. Measurements taken at the latest follow-up visits were included in the analysis as postoperative variables. Isometric forward flexion (FF) strength was measured in 90° flexion, while isometric internal rotation (IR) and external rotation (ER) strengths were measured with arms at sides using a digitalized tensiometer (FGN-100, Nidec-Shimpo Co.). Strengths were measured three times at each follow-up visit, and average values were used in the analysis. Active ROM measurements for FF and ER were taken with arms at sides and for IR with arms at back. IR was assessed using vertebral levels numbered serially as follows: 1-12 for T1-T12, 13-17 for L1-L5, 18 for sacrum, and 19 for buttock. Functional outcome scores were obtained using the Constant-Murley, the American Shoulder and Elbow Surgeons (ASES), and the University of California in Los Angeles (UCLA) scoring systems.

Radiologic Evaluation

All enrolled patients underwent preoperative plain radiography, which included the Grashey view and preoperative MRI performed within 3 months of surgery. Hamada grade was evaluated in the Grashey view to estimate CTA severity (grade 1, an acromiohumeral distance of ≥ 6 mm; grade 2, a distance of < 6 mm; grade 3, acetabulization of the acromion; grade 4, glenohumeral joint space narrowing; grade 5, humeral head collapse).[18] Presence of a greater and/or lesser tuberosity spur was evaluated in shoulder anteroposterior (AP), 30° caudal tilt, supraspinatus outlet, and axial views. Critical shoulder angles (CSAs) were measured in the Grashey view, and CSA was defined as the angle between a line connecting superior and inferior poles of the glenoid and a line crossing the glenoid inferior pole and the most lateral point of the acromion.[19]

The presence of a deltoid tear was evaluated by preoperative MRI on T2 fat suppression images in all three orthogonal planes by a radiologist specializing in musculoskeletal imaging (HJY), and tear thicknesses (partial or full) and sizes (mediolateral [ML] length and AP width) were measured (Fig. 1). A partial-thickness tear was regarded as focal deltoid detachment at the acromion origin with high signal intensity. In case of a full-thickness tear, we could observe a full-thickness defect of the deltoid origin with some retraction in the oblique coronal section. Tear locations were also evaluated using the 7-segment system devised by Sakoma et al.[20] (anterior [A] 1–3, middle [M] 1, and posterior [P] 1–3) (Fig. 2).

To check interobserver reliability, another author (JHN), unaware of the radiologist's results, also checked whether deltoid tears were present or absent. Cohen's kappa for interobserver agreement was 0.89 ($p < 0.001$).

Operational Technique

All operations were performed by a single shoulder surgeon (SHK) using the deltopectoral approach and the beach chair position. Four implant designs were used based on the senior surgeon's decisions. Twenty-five patients were implanted with RSP (DJO Surgical), 11 with Comprehensive (Biomet Inc.), 31 with Aequalis Acend Flex (Wright Medical), and 5 patients with Equinoxe (Exactech Inc.). Baseplate centers were placed 3 mm inferiorly to the glenoid center to avoid scapular notching and inserted with no or slight inferior tilt. Liners were selected based on considerations of optimal soft-tissue tension and joint stability, although in most cases, a standard liner

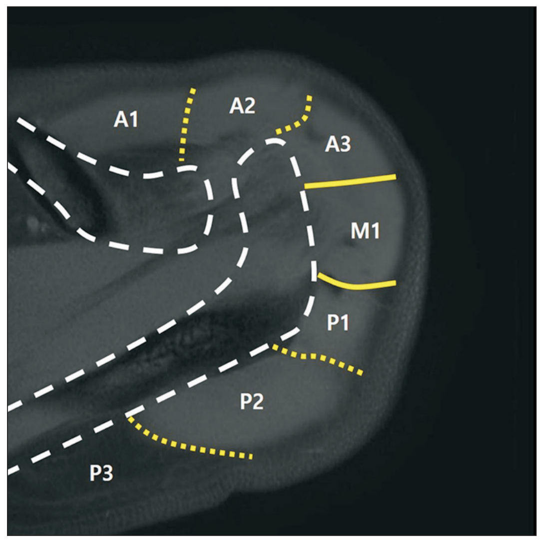

Fig. 2. Definition of the deltoid segment as described by Sakoma et al.[20] The deltoid was divided into 7 segments: 3 anterior segments (A1, A2, and A3), 1 middle segment (M1), and 3 posterior segments (P1, P2, and P3).

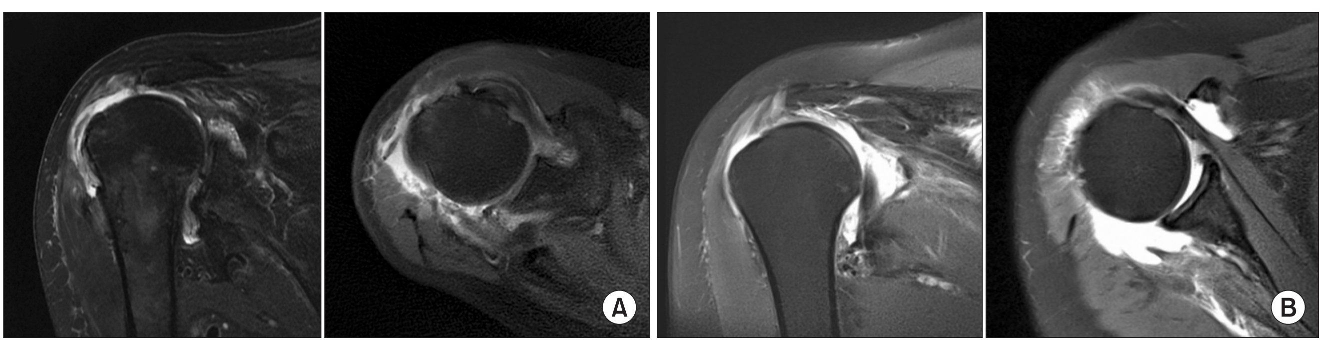

Fig. 1. Preoperative magnetic resonance imaging findings showing spontaneous deltoid attrition tears in cuff tear arthropathy. (A) Full-thickness tear. (B) Partial-thickness tear.

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Table 1. Locations and Extents of Deltoid Attrition Tears

Case number	Tear location*						
	A1	A2	A3	M1	P1	P2	P3
1			—	—			
2			···				
3			—	—			
4			—	—	—		
5	—	—	—				
6			—	—	—		
7		—	—				
8			···				
9			—	—			
10			—	—	—		
11			—	—			
12			···				
13			—	—			
14			···				
15			···				
16		—	—				
17			—	—			
18			···				
19		—	—				
20			···				
21			···				
Involvement (no)	1	4	21	9	3	0	0

Note that a full-thickness deltoid defect is displayed in solid line and a partial-thickness defect in dotted line.
A: anterior segment, M: middle segment, P: posterior segment.
*Tear locations were determined as described by Sakoma et al.[20]

thickness was used. A joint gap of < 5 mm under longitudinal traction was regarded as acceptable because it resulted in no impingement, subluxation, or limitation of motion during full passive ROM. If possible, the subscapularis tendon was repaired, but this was not performed in cases with severe retraction or fatty infiltration of subscapularis muscle. If the long head of the biceps tendon was intact, it was tenotomized and transferred to the conjoint tendon at the end of the procedure. At the end of the surgery, the deltopectoral fascia was repaired by a running locking suture technique using an 1-0 Vicryl (Ethicon Inc.). All patients wore an abduction brace after surgery for immobilization. Active elbow, wrist, and hand motion were encouraged while maintaining the brace, which was removed 3 weeks after surgery when passive ROM exercises were started.

Table 2. Deltoid Tears with Respect to Hamada Grades

Hamada grade	1	2	3	> 4
Intact deltoid	0	11 (21.6)	17 (33.3)	23 (45.1)
Torn deltoid	0	1 (4.8)	5 (23.8)	15 (71.4)

Values are presented as number of cases (%).

Statistical Analysis

Matching was performed 1-to-1 by using the greedy method, propensity score matching with a caliper width of 0.2. This technique minimizes selection bias, which is an inherent drawback of retrospective studies, and enables matching individual characteristics between two groups by logistic regression. Variables used for matching included demographic features (age, sex, and dominance), disease chronicity or severity (onset period, Hamada grade), and factors known to affect RTSA outcomes, that is, DM, CAD, and obesity.[21] Implant types used were also included because the type of lateralization is known to influence deltoid tension and moment arm differently after surgery and possibly to affect RTSA outcomes.[22]

Propensity score matching was performed using SAS ver. 9.4 (SAS Institute), but the analysis was performed using SPSS ver. 25.0 (IBM Corp., Armonk, NY, USA). Reported *p*-values are two-sided, and statistical significance was accepted for *p*-values < 0.05. Interobserver reliabilities were evaluated using Cohen's kappa. The Student *t*-test or the Mann-Whitney *U*-test was used to compare continuous variables, and the Wilcoxon signed-rank test was used for matched comparisons.

Table 3. Patient Characteristics before Propensity Score Matching

Variable	No tear (n = 51)	Tear (n = 21)	*p*-value*	SMD
Sex (male : female)	7 : 44	7 : 14	0.056	0.631
Age (yr)	73 ± 4	72 ± 5	0.826	0.203
Dominant side (dominant : non-dominant)	36 : 15	15 : 6	0.943	0.023
Symptom duration (mo)	37 ± 48	39 ± 39	0.842	0.044
Underlying disease				
DM	42 : 9	20 : 1	0.151	0.802
CAD	42 : 9	20 : 1	0.151	0.802
Obesity	26 : 25	12 : 9	0.634	0.137
Hamada (G2 : G3 : G4 : G5)	11 : 17 : 16 : 7	1 : 5 : 13 : 2	0.085	0.417
Implant type (LGMH : LGLH : MGLH)	16 : 9 : 26	9 : 2 : 10	0.538	0.166
Follow-up period (mo)	32 ± 21	29 ± 13	0.527	0.157

Values are presented as number of cases or mean ± standard deviation.
SMD: standardized mean deviation, DM: diabetes mellitus, CAD: coronary artery disease, G: grade, LGMH: lateralized glenoid medialized humerus, LGLH: lateralized glenoid lateralized humerus, MGLH: medialized glenoid lateralized humerus.
*The values were calculated using *t*-test or chi-square test as appropriate.

RESULTS

Deltoid tears were detected in preoperative MRI images in 21 of the 72 enrolled cases (29.1%). Of these 21 tears, 13 were full thickness (Fig. 1A) and 8 were partial thickness (Fig. 1B). In the cases of full-thickness tears, all segments showed full-thickness deltoid tears. The mean AP width was 30 ± 16 mm (range, 13–71 mm). The mean ML length was 35 ± 16 mm (range,15–82 mm). A3 was the most frequently involved segment followed by M1, A2, P1, and A1. No tear was detected at P2 or P3. The number of tear-involved segments was 1 in 8 cases, 2 in 9 cases, and 3 in 4 cases. All tears involved the A3 segment (Table 1).

Tear rates increased with increasing Hamada grade (G2, 4.8%; G3, 23.8%; > G4, 71.4%) (Table 2). Tuberosity spurs were more frequent in the tear group than in the no tear group (tear group, 18/21 vs. no tear group, 29/51; $p = 0.030$). CSAs were not significantly different between the two groups (tear group, 32.3° ± 6.4° vs. no tear group, 33.5° ± 5.7°; $p = 0.437$).

Deltoid tears were more frequent in men than women, but there was no significant difference. With the exception of sex, no intergroup difference was detected regarding patient characteristics including age, hand dominance, symptom duration, or medical comorbidities, including DM, CAD, and obesity (Table 3).

After 1 : 1 propensity score matching, patient characteristics, type of implant used, and clinical follow-up durations were not different in the tear and no tear groups (Table 4), and no significant difference was observed regarding clinical outcome variables, including functional scores (Constant-Murley, ASES, and UCLA scores), postoperative isometric power, or ROM in FF, ER, and IR (Table 5).

DISCUSSION

The important findings of our study are that spontaneous deltoid attrition tears were detected in 29.1 % of a cohort composed of patients with a diagnosis of CTA that underwent RTSA without an additional deltoid procedure and that clinical functions were similarly improved after surgery in the tear and no tear groups at a mean of 31 ± 19 months postoperatively after propensity score matching. These observations suggest that deltoid attrition tears in CTA have no effect on short- to mid-term outcomes after RTSA and that RTSA is an acceptable treatment option for CTA regardless of the presence of a deltoid tear determined by preoperative MRI.

No previous study has investigated the rate of deltoid tears in CTA patients. However, somewhat surprisingly, the prevalence of deltoid attrition tears detected in our CTA cohort was considerably higher than that previously reported among cohorts in two single-center MRI stud-

Table 4. Study Group Characteristics after Propensity Score Matching

Variable	No tear (n = 21)	Tear (n = 21)	*p*-value*	SMD
Sex (male : female)	4 : 17	7 : 14	0.484	0.416
Age (yr)	72 ± 4	72 ± 5	0.779	0.000
Dominant side (dominant : non-dominant)	14 : 7	15 : 6	0.999	0.123
Symptom duration (mo)	41 ± 41	39 ± 39	0.955	0.050
Underlying disease				
DM	20 : 1	20 : 1	0.999	0.000
CAD	20 : 1	20 : 1	0.999	0.000
Obesity	13 : 8	12 : 9	0.753	0.109
Hamada (G2 : G3 : G4 : G5)	1 : 4 : 13 : 3	1 : 5 : 13 : 2	0.999	0.137
Implant type (LGMH : LGLH : MGLH)	8 : 3 : 10	9 : 2 :10	0.999	0.051
Follow-up period (mo)	34 ± 27	29 ± 13	0.965	0.236

Values are presented as number of cases or mean ± standard deviation.
SMD: standardized mean deviation, DM: diabetes mellitus, CAD: coronary artery disease, G: grade, LGMH: lateralized glenoid medialized humerus, LGLH: lateralized glenoid lateralized humerus, MGLH: medialized glenoid lateralized humerus.
*The values were calculated using *t*-test or chi-square test as appropriate.

Table 5. Matched Comparison of Outcomes of Reverse Total Shoulder Arthroplasty in the Two Study Groups

Variable	No tear (n = 21)	Tear (n = 21)	*p*-value
Functional score			
Pre-CMS	37 ± 20	42 ± 18	0.387
Post-CMS	66 ± 21	62 ± 23	0.563
Pre-ASES	38 ± 16	43 ± 18	0.355
Post-ASES	62 ± 21	67 ± 23	0.602
Pre-UCLA	13 ± 5	15 ± 5	0.499
Post-UCLA	26 ± 5	26 ± 8	0.903
Isometric power (N)			
Pre-FF power	11.9 ± 8.5	8.7 ± 5.3	0.237
Post-FF power	29.5 ± 14.7	25.3 ± 13.6	0.375
Pre-ER power	11.8 ± 5.3	14.1 ± 7.9	0.201
Post-ER power	20.6 ± 8.2	18.8 ± 7.2	0.487
Pre-IR power	36.8 ± 12.8	27.4 ± 10.6	0.113
Post-IR power	39.1 ± 17.9	37.4 ± 15.4	0.702
ROM (°)			
Pre-FF ROM	109 ± 52	109 ± 50	0.836
Post-FF ROM	136 ± 16	128 ± 35	0.442
Pre-ER ROM	31 ± 29	30 ± 25	0.950
Post-ER ROM	26 ± 12	27 ± 12	0.884
Pre-IR ROM	10 ± 3	10 ± 2	0.550
Post-IR ROM	12 ± 3	13 ± 2	0.498

Values are presented as mean ± standard deviation.
Pre: preoperative, Post: postoperative, CMS: Constant-Murley score, ASES: American Shoulder Elbow Surgeons, UCLA: University of California in Los Angeles, FF: forward flexion, ER: external rotation, IR: internal rotation, ROM: range of motion.

ies.[13,14] Lecours et al.[14] reported a prevalence of 9.2% after reviewing 380 consecutive shoulder MRIs of patients who manifested shoulder pain. They suggested the association of deltoid tears with rotator cuff tears. Ilaslan et al.[13] reported a rate of 0.3% in 8,562 consecutive shoulder MRIs with rotator cuff tears. However, since these tear rates were found in patients with shoulder pain or rotator cuff tears, the higher rate found in the present study was not surprising because CTA is considered the most advanced stage of rotator cuff disease. Therefore, surgeons should be careful when investigating the possible presence of attritional tears in CTA patients because they are far more frequent than generally considered and are easily overlooked during radiologic assessments. We suggest a study be undertaken to document its features in clinical practice.

The mechanism of the occurrence of spontaneous deltoid tears in CTA patients has been ascribed to attrition caused by mechanical friction at the deltoid undersurface by a superiorly directed humeral head, which in the case of chronic rotator cuff tears migrates superiorly and laterally.[1,16] Our study results support this theory in some respects. First, tear occurrence increased with the progression of CTA (a higher Hamada grade). Second, all tears involved the anterolateral segment of the deltoid (A3) and then seemed to extend to adjacent segments. Third, tuberosity spurs were significantly more common in the tear group than in the no tear group (tear group, 18/21 vs. no tear group, 29/51; $p = 0.030$), and they were usually found in positions adjacent to tears. Fourth, deltoid tears were more frequent in men than in women, which concurs with previous reports and suggests higher activity levels may have contributed to the pathogenesis of tears.[6] In other words, the presence of an insult (tuberosity spur uncovered to the deltoid through rotator cuff tear site), patient physical activity, and duration of insult (CTA chronicity) may promote the occurrence and progression of tears.

Deltoid function is an important aspect of shoulder biomechanics after RTSA.[1,3] This can be deducted from the theory that medialization of the distalized center of shoulder rotation results in the recruitment of deltoid fibers more in abduction and rotation and lengthens the muscle.[1] For this reason, deltoid impairment is generally regarded as a major contraindication of RTSA.[10] Furthermore, in a recent study, multivariate regression analysis showed that preoperative deltoid volume was the only determinant of clinical satisfaction after RTSA.[23] Several studies have investigated the treatment of CTA with deltoid impairment, and some have addressed the use of RTSA with simultaneous deltoid procedures such as direct deltoid repair, deltoid flap, deltoid turn down, and rotationplasty.[6-9] Although some studies showed shoulder function and ROM were improved after RTSA, no consensus has been reached regarding the merits and demerits of methods and no stratified indication has been proposed for a concomitant deltoid procedure in RTSA with respect to tear severity. We stress that surgeons should be cautious when considering this procedure because most of the procedures are sophisticated and invasive.

We undertook this study, in part, to answer the question whether spontaneous deltoid attrition tears associated with CTA severity should be treated surgically during RTSA. Literature on the topic does not allow this question to be conclusively answered, although a few studies have reported outcomes of RTSA alone in patients with deltoid impairment.[6,10,17] Tay and Collin[17] issued a case report, describing a case of RTSA alone in a CTA patient with an irreparable deltoid and no recent trauma history or previous shoulder surgery. At 1 year after surgery, FF and abduction continued to recover and the shoulder joint functioned well. However, a positive outcome in one case hardly provides sufficient evidence to form a conclusion. Ladermann et al.[10] reported the results of 49 patients with impairment of the deltoid who underwent RTSA. After surgery, forward elevation and Constant-Murley scores improved, but unfortunately in this study, the etiology of deltoid impairment included previous open shoulder surgery, trauma, and spontaneous tears. Furthermore, as it was conducted using a multicenter design, operations were performed by several surgeons using different approaches. On the other hand, a case series reported satisfactory results for RTSA performed in 19 patients after failed deltoid flap surgery for a rotator cuff tear.[24] Since the anterolateral region of deltoid was used as the flap in previous primary surgery rather than rotator cuff repair, defective regions observed during RTSA were consistent with those usually involved (A2, A3) by spontaneous attrition tears, as was observed in the present study. The authors reported that all 19 patients expressed subjective satisfaction and that abduction strengths and Constant scores were improved after RTSA alone. However, a high complication rate (7 of 19 patients) was noted, and revision operations were needed in these 7 patients. Since none of the abovementioned studies was a comparative study and inclusion was not confined to those with a spontaneous tear, their findings provide no basis for evidence-based decision-making.

On the contrary, we do suggest that no additional deltoid procedure during RTSA is needed for patients with a spontaneous deltoid attrition tear. The strength of the present study is that matched comparisons were made between RTSA patients with or without a deltoid tear and that comprehensive data were obtained on perioperative shoulder function and strength, which strengthened our assessment of RTSA outcomes.

To explain why spontaneous deltoid tears had no observed effects on RTSA outcomes, we conjecture that tears usually arise in the A3 segment and then extend to adjacent segments, but do not involve more than 3 segments horizontally and remain isolated in the area between the site of origin on the acromion and the musculotendinous junction vertically or that perhaps tears are confined to the area adjacent to a tuberosity spur, where mechanical friction would be severe. This confined nature of tears in terms of size and extent could explain why deltoid tears had no significant effect on deltoid function after RTSA or on overall clinical outcomes. In agreement with Tay and Collin[17] we suggest that tears and damaged muscles might be well compensated by the resting segment, particularly by the anterior and posterior deltoid. Previous mechanical studies have shown that deltoid fibers in specific regions are vital for normal function after RTSA, especially FF.[25,26] Furthermore, it was suggested in another study that it is not necessary to maintain all deltoid volume to achieve satisfactory outcomes.[10] If remaining deltoid fibers are sufficient to stabilize shoulder mechanics, function and strength can be improved, but it has not been determined what extent of tear represents a threshold for a good outcome or which deltoid sites are more or less vulnerable. However, we emphasize that these suggestions are speculative and that additional studies are required to further characterize the natures of spontaneous tears and their effects on surgical outcomes.

The study has several limitations. First, the relatively short-term follow-up (mean, 31 months) used to determine RTSA outcomes and follow-up losses may have compromised our findings, although the use of propensity score matching strengthened the validity of our analysis. Second, the evaluation of deltoid change after RTSA was not available. Since MRI in the condition of RTSA could get a lot of metal artifacts disrupting proper assessment of the deltoid, change of deltoid tears after RTSA is uncertain at this point. Third, differences in the implant type used might have confounded comparisons to some extent, since deltoid wrapping and lengthening might be dependent on the implant site and degrees of lateralization. However, implant designs were incorporated in the propensity matching, and thus errors may have been minimal. Fourth, we could not find any clinical significance of deltoid tears in RTSA, which may be due to mild deltoid tears. In our study group, there were only 4 patients with a severe deltoid tear. Our results may be limited to mild deltoid tears; however, this represents the extent of tears we commonly see in CTA patients. Therefore, what the authors wanted to convey is that in CTA with spontaneous deltoid tears, we can perform RTSA without great concern. To evaluate the effect of deltoid tear severity on RTSA outcome, further research involving more patients with severe deltoid tears is needed.

Nevertheless, we can draw some conclusions from the current study that might aid surgical decision-making. In particular, there may be no need to repair spontaneous attrition deltoid tears during RTSA when the patient has no previous history of shoulder surgery or trauma. Although studies are needed for further clarification, RTSA in CTA patients with a deltoid attrition tear could be regarded as an acceptable treatment option that provides outcomes similar to RTSA for CTA with an intact deltoid.

In conclusion, a deltoid attrition tear was detected in 29.1% of CTA patients that underwent RTSA. The anterolateral region of the deltoid was the most common site and tear prevalence tended to increase with CTA progression. Furthermore, our results showed RTSA might provide satisfactory outcomes regardless of the presence of a deltoid attrition tear.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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