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Predictive factors for failure of conservative management in the treatment of calcific tendinitis of the shoulder

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Background: Calcific tendinitis of the shoulder is a painful condition characterized by the presence of calcium deposits within the tendons of the rotator cuff (RTC). When conservative management fails, arthroscopic surgery for removal of the calcium may be considered. Surgical removal is often followed by RTC repair to address the resulting tendon defect. This study was performed to assess predictive factors for failure of conservative management and to characterize the rate of RTC repair in the setting of calcific tendinitis. We hypothesize that larger calcific lesion would have a higher likelihood to fail conservative treatment.

Methods: A retrospective review of patients who were diagnosed with calcific tendinitis at our institution between 2009 and 2019 was performed. Demographics, comorbidities, pain score (visual analog scale), American Shoulder and Elbow Surgeons score, range of motion, and patient-reported quality of life measures were recorded and analyzed. All patients underwent a radiograph and magnetic resonance imaging. Size of the calcific lesion was measured based on its largest diameter on magnetic resonance imaging. Statistical analysis included chi-square test, independent t-test, and analysis of variance.

Results: Two hundred thirty-nine patients were identified in the study period; 127 (53.1%) were women. The mean age was 54 years, and body mass index was 29.2 with a mean follow-up of 6 months. One hundred and sixty had an intact RTC (67.2%) and 78 had a partial RTC tear (32.8%). Ninety-three of 239 (38.9%) patients failed conservative treatment after an average of 4.4 months, necessitating surgical management. Among patients who underwent surgery, the majority of patients (77 of 93 [82.8%]) required a concomitant RTC repair. Subanalysis demonstrates that calcific lesions >1 cm was significantly associated with failure of conservative treatment (odds ratio = 2.86, 95% confidence interval 1.25-6.29, $P < .05$). All patients who underwent surgery demonstrated significant improvements in pain scores (6.3 to 2.3 visual analog scale), American Shoulder and Elbow Surgeons score (47.9 to 90.49), forward flexion (133° to 146.8°), and external rotation (49.2° to 57.6°) ($P < .05$) postoperatively.

Conclusion: Patients with calcific lesions >1 cm had a 2.8× increased likelihood to undergo operative treatment in the setting of calcific tendinitis of the shoulder. Most patients who undergo surgical management for removal of the calcific deposit required a concomitant RTC repair and had significant improvements in shoulder pain and function. This information can be helpful to guide orthopedic surgeons on preoperative planning and discussion when treating calcific tendinitis of the shoulder.

Calcific tendinitis (CT) of the shoulder is a common painful condition characterized by the presence of calcium deposits within the tendons of the rotator cuff (RTC). CT affects between 3% and 7% of adults in the general population[3] and has been found to account for 7% of all presentations of shoulder pain.[9] Individuals between the ages of 30-60 years are most likely to be affected, with women more at risk than men.[3,7,9] Although the etiology of CT remains unknown, an association with diabetes and thyroid disorders has been identified.[10] In 1997, Unthoff and Loehr[20] proposed a four-stage progression model to describe the pathogenesis of this disorder, with distinct clinical findings corresponding to each stage. This model remains accepted; however, the duration and severity of symptoms vary greatly among patients.

CT can often be managed through conservative treatment options including glucocorticoid injections, physical therapy (PT), and

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rest. Alternative options such as ultrasound-guided barbotage or aspiration and extracorporeal shock wave therapy are also used across centers.[2,14,19] Arthroscopic surgery for removal of the calcification is often performed as a last resort in the setting of failed conservative treatment.

The surgical approach to CT may involve a range of procedures in addition to calcium removal. Acromioplasty and bursectomy may be performed to relieve pain due to impingement or inflamed bursa. An RTC repair may be necessary to address the tendon tear that results from the removal of the calcium deposit. The significance of this resulting tear has been debated in the literature, as RTC tears and repairs are generally associated with increased pain and longer recovery periods.[16] Some authors have reported improved postoperative results after partial as opposed to complete deposit removal, with remaining calcium not having a significant effect on clinical outcomes.[12] Others describe excellent outcomes and earlier pain relief after complete deposit removal followed by RTC repair.[15,21]

The aim of this retrospective study was to assess possible predictive factors for failed conservative management, indicated by the need for surgical treatment. An additional aim was to characterize the rate of RTC repair in the setting of surgical intervention for CT. We hypothesized that larger deposit size, decreased range of motion (ROM), and lower self-reported quality-of-life assessment scores would be predictive of failed conservative treatment.

Methods

This investigation was designed as a retrospective, single-center study. Institutional review board approval was obtained before beginning of the project. The institutional database was queried for all diagnosed cases of CT in the shoulder presenting between 2009 and 2019. The exclusion criteria were a lack of radiographic images (x-ray or magnetic resonance imaging [MRI]) of the shoulder and prior surgical treatment of RTC CT.

From the medical record, basic demographic information was recorded, including sex, age at diagnosis, and hand dominance. Relevant comorbidities—body mass index (BMI), current smoking status, diabetes, and thyroid conditions—were extracted. ROM at the initial visit was recorded for forward flexion, external rotation, and internal rotation. Patient-reported outcomes such as pain and American Shoulder and Elbow Surgeons (ASES) scores as well as quality of life metrics such as Patient Reported Outcome Measurement Information System (PROMIS) global and mental were noted as well.

A routine standard set of radiographs including anteroposterior in internal and external rotation, scapular Y view, and axillary view of the shoulder was obtained for all subjects. The radiographs were assessed by a musculoskeletal radiologist. Data collected included calcification size, localization, and morphology. However, to avoid magnification error, we based our calcification lesion measurements on MRI (Fig. 1).

MRI studies were performed with the patient in supine position. The shoulder was immobilized in neutral or slight external rotation with the palms facing up. The images were then evaluated by the musculoskeletal radiologist to assess RTC tear integrity as well as the location and size of the calcific deposit. Calcification lesion size was measured at its greater diameter on any of the available images and classified as less or greater than 1 cm (Fig. 1). Tearing of the RTC was indicated by a hyperintense signal within the tendon on T2-weighted, fat-suppressed, and gradient echo sequences. RTC status was recorded as intact, partially torn, or completely torn. If a tear was present, classification was determined based on location and size.[6]

All patients underwent initial conservative management. The chosen method of treatment—PT/observation in isolation or combined with glucocorticoid injection and/or ultrasound-guided aspiration—was recorded. The cohort was "post hoc" analysis divided in 2 groups, based on their response to nonoperative management. A successful nonoperative treatment was defined by the resolution of symptoms without surgery, and failure of conservative treatment was defined by the need for surgical removal of the calcific lesion to alleviate symptoms. Group 1 was defined as our nonoperative cohort and includes patients who were successfully treated nonoperatively, and group 2 was defined as our operative cohort and included patients who failed conservative treatment and required surgery. Statistical analysis was then performed to identify potential predictive factors for failure of conservative treatment for CT. Subanalysis was also performed to identify success and failure rates for each of the nonoperative treatment modalities.

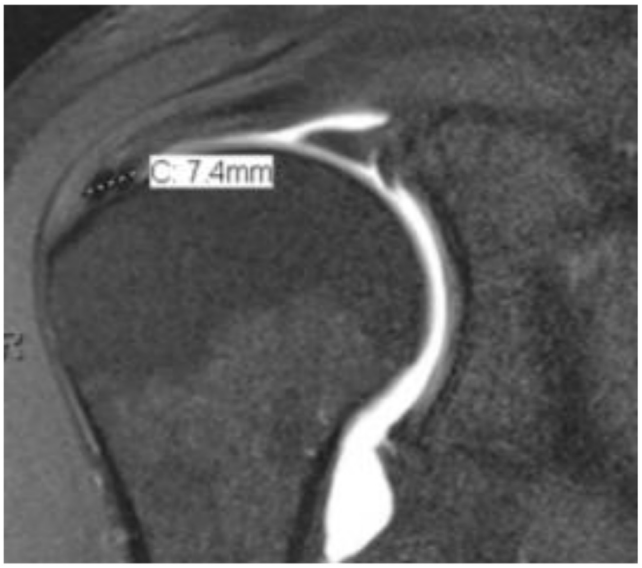

Figure 1 Right shoulder MRI with the measurement method. *MRI*, magnetic resonance imaging.

Finally, each patient's chart was abstracted for eventual surgical intervention. The date of surgery and additional procedures performed—acromioplasty, bursectomy, or RTC repair—were extracted. Complete removal of calcium was performed. Tendon defects after calcium removal that resulted in high-grade tears (>50% of footprint involvement) to full-thickness tears were addressed with concomitant RTC repair. The rate of concomitant procedures was calculated, and visual analog scale (VAS) for pain, ASES score, and ROM were recorded preoperatively and postoperatively.

Descriptive statistics were used to report continuous data. A 1-way analysis of variance and independent t-test were used to compare the means between groups. The chi-square test was performed for all categorical variables, and likelihood was calculated by odds ratio. All statistics were performed using SPSS software (IBM Corp. Released 2016. IBM SPSS Statistics for Macintosh, Version 24.0; IBM Corp, Armonk, NY, USA). Two-tailed P values < 0.05 were considered statistically significant.

Results

Demographics

Two hundred thirty-nine patients were identified in the study period; 127 (53%) were women. The mean age was 54 years, and the BMI was 29.2 with a mean follow-up of 6 months. The

preoperative pain score was 6.3, and the ASES score was 47.9. The majority of patients (160) had an intact RTC (67.2%), and 78 had a partial RTC tear (32.8%). The calcific lesion was located in the supraspinatus in 148 patients (63.8%), infraspinatus in 32 patients (13.8%), subscapularis in 9 patients (3.9%), teres minor in 1 patient (0.4%), and combined tendons in 42 patients (18.1%) (Table I).

Nonoperative treatment group

Most patients did not come to surgical treatment to alleviate symptoms. The success rate of nonoperative treatment was 61.1% (146 of 239). Forty-five of 239 patients (30.8%) underwent successful PT in isolation, 54 of 239 (37%) underwent a successful PT combined with subacromial steroid injection, and 47 of 239 (32.2%) underwent successful PT and ultrasound-guided aspiration of the calcific lesion ($P = .81$) (Table II).

PT only

PT in isolation was performed in 71 of 239 patients. The success rate was 63.3% (45 of 71) for nonoperative management. The failure rate for PT in isolation was 36.6% (24 of 71) (Table II).

PT + subacromial steroid injection

Subacromial steroid injection combined with PT was performed in 79 of 239 patients. The majority had a successful outcome, 54 of 79 (69.4%), defined by the resolution of symptoms without surgery. The failure rate was 31.6% (25 of 79), defined by the need for surgical removal of the calcific lesion to alleviate symptoms (Table II).

PT + ultrasound-guided aspiration

Seventy-one patients underwent PT + ultrasound-guided aspiration for the calcific lesion. The success rate was 66.2% (47 of 71). The failure rate was 33.8% (24 of 71) (Table II).

Operative treatment group

Ninety-three of 239 (38.9%) patients came to operative treatment despite initial attempt of conservative treatment consisting of PT, corticosteroid injection, and/or ultrasound-guided aspiration after an average of 4.4 months. Among patients who underwent surgery, the majority of patients (77 of 93 [82.8%]), underwent a concomitant RTC repair. All patients who underwent surgery demonstrated significant improvement in pain scores (6.3 to 2.3 VAS), ASES (47.9 to 90.49), forward flexion (133° to 146.8°), and external rotation (49.2° to 57.6°) ($P < .05$) postoperatively (Table II).

Comparison between nonoperative vs. operative treatment

Age, female sex, BMI, diabetes, thyroid disease, vitamin D deficiency, hand dominance, pain, ASES, RTC status, and location of the calcific lesion were not predictive for failure of conservative treatment. The nonoperative treatment group (group I) had decreased forward flexion (ROM vs. ROM, *P* value), external rotation, and PROMIS mental health scores compared with the surgical group (group 2). The only predictive factor for failure of conservative treatment was calcific lesions >1 cm (odds ratio = 2.86, 95% confidence interval 1.25-6.29, $P < .05$) (Table III).

Discussion

The major finding of this study is that larger calcification size was correlated with operative treatment for CT of the shoulder.

Table I
Demographics.

Age	54 (27-86)
Female	112/239 (53.1%)
BMI	29.24 (15-57.95)
Diabetes mellitus	31/239 (31%)
Thyroid disease	25/239 (10.5%)
Vitamin D deficiency	61/239 (25.5%)
Dominant side involved	120/239 (50.2%)
Preoperative scores	
Pain	6.3
ASES score	47.9
Forward flexion	133°
External rotation	49.2°
Rotator cuff	
Intact	160/239 (67.2%)
Partial tear	78/239 (32.8%)
Calcific lesion location	
Supraspinatus	148/239 (63.8%)
Infraspinatus	32/239 (13.8%)
Subscapularis	9/239 (3.9%)
Teres minor	1/239 (0.4%)
Combined	42/239 (18.1%)

BMI, body mass index; *ASES*, American Shoulder and Elbow Surgeons.

Table II
Operative treatment group.

Operative treatment group (n = 93)		Failure rate	*P* value
Type of previous nonoperative treatment		38.9% (93/239)	.81
PT only (n = 71)		36.6% (26/71)	
PT + subacromial steroid injection (n = 79)		31.6% (25/79)	
PT + ultrasound-guided injection (n = 71)		33.8% (24/71)	
Concomitant procedure			
Rotator cuff repair		77/93 (82.8%)	
Outcomes	**Preoperative**	**Postoperative**	***P* value**
Pain VAS	6.3	2.3	.01
ASES score	47.9	90.5	.01
Forward Flexion	133°	146.8°	.01
External rotation	49.2°	57.6°	.01

ASES, American Shoulder and Elbow Surgeons; *PT*, physical therapy; *VAS*, visual analog scale.

Specifically, deposits larger than 1 cm measured on the x-ray were less susceptible to treatment with PT, corticosteroid injection, and ultrasound-guided aspiration and were 2.8× more likely to require surgical intervention. A recent study by Brinkman et al[4] did not find calcification size to be a prognostic factor for preoperative RTC tears. However, our study suggests that size is predictive of failed conservative management and eventual surgical intervention.

Ogon et al[13] reported bilateral calcific deposits, localization near the anterior portion of the acromion, medial extension, and high volume of calcific deposits to be prognostic factors for failed conservative treatment; however, they did not specify the amount of volume of calcific deposition. In our series, we did not find bilateral calcific deposits or area of involvement to be a predictive factor for failure of conservative treatment, but we did find size to be an important predictive factor. Bosworth et al[3] have classified calcifying tendinitis of the shoulder based on size. They described 3 subtypes: small <0.5 cm, medium 0.5-1.5 cm, and large >1.5 cm. In our series, we initially stratified our cohort as per the Bosworth classification, but we were not able to find any prognostic value. However, when a threshold value was lowered to 1 cm in size, a large statistical significance was reached. The great range in size from 0.5 to 1.5 cm of the medium type with the Bosworth classification may be the reason why we did not find statistical significance initially. These findings support our hypothesis that larger calcium deposit size is a predictive factor for failure of conservative treatment.

Table III
Comparison between nonoperative treatment vs. operative treatment.

	Nonoperative group	Operative group	*P* value
Age	54 ± 10	54 ± 10.6	.90
Female	77/146 (52/7%)	50/93 (53.8%)	.87
Diabetes mellitus	19/146 (13%)	12/93 (12.9%)	.98
Thyroid disease	15/146 (10.3%)	10/93 (10.8%)	.92
Vitamin D deficiency	39/146 (26.7%)	22/93 (23.7%)	.59
Dominant side involved	81/146 (55.4%)	41/93 (44.1%)	.24
Pain	6.27 ± 2.6	6.34 ± 2.5	.87
ASES score	52.07 ± 22	42.39 ± 13	.14
PROMIS mental health	13.81	16.56	.01
Forward flexion	124.29° ± 55	133° ± 44	.01
External rotation	44° ± 25	49.2° ± 25	.01
Rotator cuff:			
Intact	103/146 (70.5%)	57/93 (61.3%)	
Partial tear	41/146 (28.1%)	31/93 (33.3%)	.17
Calcific lesion location			.39
Supraspinatus	83/146 (56.8%)	65/93 (69.9%)	
Infraspinatus	25/146 (17.1%)	7/93 (7.5%)	
Subscapularis	6/146 (4.1%)	3/93 (3.2%)	
Teres minor	1/146 (0.7%)	-	
Combined	26/146 (17.8%)	16/93 (17.2%)	
Calcific lesion size			.01
<1 cm	78/144 (54.2%)	22/86 (23.7%)	Odds ratio: 2.86
>1 cm	65/144 (45.1%)	64/86 (68.8%)	

ASES, American Shoulder and Elbow Surgeons.

Decreased ROM and lower self-reported quality-of-life assessment scores were not predictive for failure of conservative treatment as hypothesized. In fact, we found the opposite. Increased ROM and higher PROMIS scores were correlated with surgical intervention. We surmise that patients with increased pretreatment ROM and higher PROMIS scores were possibly more functionally active with higher expectations which may explain the higher failure rate of conservative treatment. Therefore, based on our findings, a threshold value of 1 cm may be an important consideration for counseling patients on the likelihood of success with conservative treatment, particularly in individuals with a baseline higher activity level.

The majority of the surgical cases in our study (82.8%) required an RTC repair in addition to removal of calcium. However, only 33% of patients had preexisting tears on MRI. Previous studies have demonstrated a higher incidence of preexisting RTC tears in this patient population.[4] Brinkman et al reported the pre-existing RTC tear rate to be as high as 56%; however, in their series, the mean age (60.6 years) was older than the mean age in our cohort (54 years). The association between RTC tear and increasing age has been well established[8,18] and may explain this difference. In fact, our results suggest that surgical repair may be needed regardless of the presence of such tears preoperatively. This is an important consideration for surgeons discussing the procedure with their patients, as RTC repair may carry additional implications for postoperative recovery as opposed to calcium debridement alone.

Conservative treatment was effective for resolution of symptoms in most cases of CT of the shoulder. Our study also demonstrated that regardless of the modality of nonoperative treatment used, whether a subacromial steroid injection, PT, or ultrasound-guided aspiration, the success rate is not statistically different. These findings are in agreement with the literature.[1,5,11,17] However, we found approximately a third of patients will fail nonoperative management necessitating surgical intervention. If surgery was warranted, however, successful outcomes can be achieved as we identified improvements in VAS, ASES, and ROM at the last follow-up, when compared with the preoperative visit. This suggests overall reduction in pain and improvement in function for most patients. This is consistent with findings from other similar studies.[15,21] Our findings support that arthroscopic debridement followed by RTC repair, if necessary, is an effective method for treating CT in patients who fail conservative treatment.

The strength of our study is the reasonable number of shoulder CT cases, which help to support our findings. Our study, however, is not without limitations. First, we did not record patient-reported outcomes for patients who successfully underwent conservative treatment; this did not allow for final comparison between nonoperative vs. operative treatment functional outcomes at the last follow-up. Second, although all patients had significantly improved pain and function after 6 months of surgical intervention, this is relatively a short-term follow-up.

Conclusion

Patients with calcific lesions >1 cm had a 2.8× increased likelihood to undergo operative treatment in the setting of CT of the shoulder. Most patients who undergo surgical management for removal of the calcific deposit required a concomitant RTC repair and had significant improvements in shoulder pain and function. This information can be helpful to guide orthopedic surgeons on preoperative planning and discussion when treating CT of the shoulder.

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