Journal of Shoulder and Elbow Arthroplasty
Volume 3: 1–6

DOI: 10.1177/24715492198611 85
journals.sagepub.com/home/sea
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Clinical and Radiological Evaluation of Subscapular Suture Integrity in Reverse Shoulder Arthroplasty

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Abstract

Objective: The aim was to establish a correlation between the integrity of a suture made in the subscapular tendon (SST), as assessed by an ultrasound examination, and its functionality, as assessed by clinical tests during the postoperative period following reverse shoulder arthroplasty (RSA). A secondary goal is to evaluate the presence and viability of the sutured SST.
Methods: This is a retrospective study of 18 RSA patients in whom the SST was repositioned to the anterior face of the humeral osteotomy. The median time of the postoperative evaluation was 31 months. The clinical evaluation consisted of the Gerber lift-off test, the internal rotation (IR) lag sign test, and the abdominal compression test, as well as forward flexion (FF), external rotation (ER), and IR. All patients underwent shoulder ultrasounds to evaluate the SST presence and viability.
Results: The SST was visualized in 13 patients (72.2%; 95% confidence interval [CI], 51.5–92.9). Of these 13 patients, the SST presented an altered fibrillar pattern in 5 patients (38.4%; 95% CI, 12.0–64.9) and was considered nonviable. There were no associations between SST viability and a positive Gerber's lift-off test ($P = .480$), a positive IR lag sign test ($P = .480$), or a positive abdominal compression test ($P = .618$). There were no significant differences in FF ($P = .104$), ER ($P = .196$), or IR ($P = .374$) mobility between patients with viable SSTs and those without viable SSTs.
Conclusion: It was not possible to demonstrate a correlation between the integrity of the SST repair based on the ultrasound and its functionality as assessed by clinical tests in the postoperative period following an RSA. The SST repair has a high failure rate, as demonstrated by the high incidence of nonviable or absent tendons.

Keywords

Reverse shoulder arthroplasty, subscapular tendon

Date received: 9 March 2018; revised: received 4 June 2019; accepted: 10 June 2019

Introduction

Reverse shoulder arthroplasty (RSA) is considered to be a safe and effective procedure.[1] The RSA concept was introduced in the mid-80s[2] and was initially indicated for elderly patients (>70 years old) with rotator cuff arthropathy who presented with pain and loss of upper limb (UL) forward flexion (FF) capacity.[3,4] In recent decades, indications have also been expanded to other pathologies.[5]

Despite the increasing familiarity of surgeons with the use of RSA, there are still some divergences regarding the surgical technique.[1,6] One point of disagreement among surgeons is whether the restoration of the subscapular tendon (SST) at the end of the surgical procedure is necessary.[5,7–10]

The controversy regarding SST fixation is frequently discussed.[5,7–14] Some authors argue that the reintegration of the SST may improve anterior stability,[5,7–10]

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whereas other surgeons do not report any correlation between pain, movement, and stability scores regardless of whether patients are submitted to SST repair.[15–19] Routmann et al.,[15] concluded that, in certain RSA models, the reintegration of the SST might have negative biomechanical consequences.

Suturing the SST at the end of the RSA procedure can add a small amount of time to the surgery; however, SST repair increases the postoperative recovery time. Therefore, it is important to determine whether the SST repair is worth the increased recovery time. The primary objective of this research is to establish a correlation between the integrity of the SST repair, as assessed by an ultrasound examination, and its functionality, as assessed by clinical tests administered during the postoperative period following an RSA. As a secondary objective, we will attempt to evaluate the presence and viability of the repaired SST.

Methods

The current study was retrospective. During the period from September 2011 to March 2016, a group of 19 patients were submitted to RSA procedures where it was possible to repair the SST at the end of the surgical procedure.

The surgeries were performed in the "beach chair" position through deltopectoral access. All arthroplasties used the Equinoxe Shoulder System® (Exactech), with a cervico-diaphyseal angle of 132.5° and a metaglen fixed with 4 locking compression screws. The mobility of the SST was tested, with the aim of moving the tendon to the border of the humeral osteotomy without excessive tension. The SST was attached to the border of the humeral osteotomy with 3 or 4 trans-osseous nonabsorbable sutures.

All patients were immobilized for 30 days and provided with a sling containing a neutral rotation cushion for the UL. After this period, active-assisted FF, external rotation (ER), and internal rotation (IR) exercises were initiated. After 60 postoperative days, exercises designed for the isometric reinforcement of the deltoid and the isotonic reinforcement of the scapular stabilizers were started.

Loss of follow-up occurred for 1 patient (5.2%) from the initial sample. The median age of the 18 remaining patients in the study was 74 (95% confidence interval [CI], 68.25–75.50) years, and 3 (16.6%) were men and 15 (83.3%) were women. The right side was affected in 10 patients (55.5%), and the left side was affected in 8 patients (44.4%). The dominant side was affected in 10 (55.5%) patients.

Postoperative evaluations were performed a median of 31 (95% CI, 20.5–48.0) months after the procedure, with a minimum of 12 months and a maximum of 79 months (Table 1).

The complication rate was 38.8% (7 cases). There were 3 cases with neuropraxias, 2 of the axillary nerve, and 2 of the median nerve. All cases were spontaneously resolved between 3 and 6 months after the operation.

Table 1. Characteristics of Patients.

Patient	Evaluation	Age	Sex	Pathology	PreOP FF	PreOP ER	PreOP IR	Compl.
1	68	75	M	CTA	50	30	L5	No
2	79	75	M	CTA	80	30	L5	Axillary nerve praxia
3	54	65	F	CTA	80	45	Zero	No
4	24	82	F	CTA	45	40	L5	No
5	48	69	F	A W/out Cuff	40	−30	Zero	Median nerve praxia
6	48	77	F	CTA	30	Zero	Zero	No
7	34	80	F	CTA	45	40	L5	Humeral Fx
8	33	77	F	CTA	90	Zero	L2	No
9	38	70	F	CTA	45	30	T12	No
10	38	74	F	CTA	30	Zero	Zero	Acromial Fx
11	29	74	F	CTA	30	Zero	Zero	Metallic head dissociation
12	27	64	M	CTA	Zero	−30	Zero	No
13	24	74	F	A W/out Cuff	45	Zero	Zero	Median nerve praxia
14	22	75	F	CTA	80	Zero	Zero	No
15	13	75	F	CTA	30	10	Zero	No
16	16	66	F	CTA	30	45	T12	No
17	12	74	F	A W/out Cuff	80	10	T12	No
18	12	65	F	CTA	45	Zero	L5	Humeral Fx

Abbreviations: A W/out Cuff, arthritis without cuff integrity; Compl., complication; CTA, cuff tear arthropathy; F, Female; M, male; PreOP ER, preoperative external rotation of the superior limb, in degrees; PreOP FF, preoperative forward flexion of the superior limb, in degrees; PreOP IR, preoperative internal rotation of the superior limb.

Evaluation is shown in months; age is shown in years.

One case with a fracture of the acromion and 1 case with a traumatic fracture of the middle third of the humerus were treated conservatively. One case with an incomplete humeral fracture distal to the cementless stem was diagnosed on a postoperative radiography and required no special treatment. The only complication that required reintervention was the dropping of the metallic glenosphere at 6 months postoperative. It was returned to its position and fixed with a new screw.

All patients received an informed consent information package that was approved by the ethics committee of the institution where the work was performed.

Clinical and ultrasonographic evaluations were performed at the same time and by the same observers; an orthopedist, who performed the specific SST tests and evaluated the range of movement for the UL, and a radiologist, who performed and analyzed the ultrasound images, were also constant.

The clinical evaluation included the Gerber's lift-off test, IR lag sign during the Gerber's lift-off test, and the abdominal compression test.

During Gerber's lift-off test, the patient placed the back of the hand at the L5 lumbar spine level and actively moved it away from the lower back by rotating the arm internally. The test was considered positive when the patient was unable to perform the maneuver.[18–20]

The presence of positive IR lag sign during the Gerber's lift-off test was verified when the patient was unable to maintain the hand away from the lower back, even when assisted by the examiner.[18–20]

The abdominal compression test was performed by asking the patient to press the abdomen with the palm of the hand while maintaining the arm at the maximum IR and maintaining the wrist in neutral flexion. The test was considered positive when the elbow moved posteriorly.[11,18–20]

The evaluations of FF and ER mobility were performed by goniometry.

The IR evaluation was scored as one of the following: the absence of IR was indicated by the inability of the patient to place the affected hand in the region corresponding to the spinous process of lumbar L5; regular IR was indicated by the ability of the patient to place the affected hand in the spinous process of lumbar L5; and normal IR was indicated by the ability of the patient to place the affected hand in the lower thoracic region (T10 to L1).

All patients were subjected to an ultrasound of the operated shoulder, performed by the same radiologist. The equipment used was a Toshiba Applio 300 brand ultrasound with a linear 18 MHz high-resolution transducer. Upon ultrasound examination, the presence of the SST that was inserted on the anterior border of the humeral osteotomy was evaluated; its viability was also assessed, taking into account the thickness and the usual fibrillar pattern of the SST. When the SST was visible, the thickness of the muscular–tendon transition was measured using the lateral end of the coracoid process as a reference.[12,13,21] This measurement was performed in the plane perpendicular to the SST fibers, drawing a line 1 cm lateral to the coracoid process (Figure 1).

In addition to tendon thickness and integrity, the usual ultrasound fibrillar pattern of the SST was also evaluated. A tendon was considered to have a normal ultrasound pattern when the presence of parallel longitudinal hyperechogenic fibers separated by a hypoechoic substrate that were all oriented in the same direction was observed. The intact tendons that presented the fibrillar pattern described above and a thickness measurement starting at 0.5 cm[13,21] were considered to be viable.

The variables studied included the following: age, sex, operated side, dominance, a positive Gerber's lift-off test, the presence of positive IR lag sign during the Gerber's lift-off test, a positive abdominal compression test, the FF mobility of the UL, the active ER mobility of the UL, the IR of the UL, and the presence of an SST with a viable ultrasound appearance, as verified through measurements of tendon thickness and the fibrillar pattern.

A 1 decimal precision is used in the presentation of the data, except for the P value, which uses 3 digits. The original data were retained for analysis. The categorical variables are presented as percentages. Quantitative variables with Gaussian distributions are represented by their means and respective standard deviations, and the variables with asymmetric distributions are represented by their respective medians and interquartile ranges. As the sample presented a nonsymmetric distribution, a nonparametric Mann–Whitney U test was used for bivariate comparative analyses. The χ^2 test and, where necessary, the Fisher's exact test were used when the variables were categorical. An α of 5% ($P = .05$) and a β of 90% were considered statistically significant.

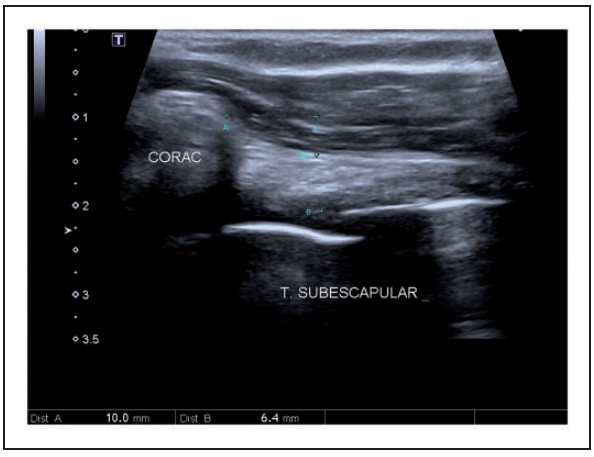

Figure 1. Photo of the ultrasound measurement.

For data storage and analysis, the database and statistical packages Excel (Microsoft, USA) and SPSS 20.0 (IBM SPSS Inc., 2011) were used.

Results

The study evaluated a total of 18 patients. No cases of arthroplasty dislocation were reported, although there was a case where the metallic glenosphere dropped.

Ultrasounds were able to visualize the SST in 13 (72.2%; 95% CI, 51.5–92.9) patients and were unable to visualize the SST in 5 patients (27.7%). Among the 13 patients in whom the SST was visualized, an altered fibrillar pattern was observed in 5 patients (38.4%; 95% CI, 12.0–64.9).

Gerber's lift-off test was considered positive in 10 (55.5%) patients. The IR lag sign during the lift-off test was considered positive in 8 (44.4%) patients. The abdominal compression test was considered positive in 14 (77.7%) patients.

The median FF was 105° (95% CI, 90–120). The median ER was 25° (95% CI, 10–30). The IR was considered to be normal in 8 patients (44.4%), regular in 6 patients (33.3%), and absent in 4 patients (22.2%).

There was no association between the viability of the SST and a positive result from the Gerber's lift-off test ($P = .480$).

There was no association between the viability of the SST and a positive IR lag sign result during the Gerber's lift-off test ($P = .480$).

There was no association between the viability of the SST and a positive abdominal compression test ($P = .618$).

There were no significant differences ($P = .104$) in FF mobility between patients with viable SSTs and patients with SSTs that could not be visualized or were considered nonviable during the ultrasound evaluation.

There were no significant differences ($P = .196$) in ER mobility between patients with viable SSTs and patients with SSTs that could not be visualized or were considered nonviable during the ultrasound evaluation.

There were no significant differences ($P = .374$) in IR mobility between patients with viable SSTs and patients with SSTs that could not be visualized or were considered nonviable during the ultrasound evaluation.

Discussion

The RSA procedure has been shown to be safe and to deliver satisfactory results; however, some controversial issues remain. The positive and negative effects of the reinsertion of the SST at the anterior border of the humeral osteotomy is one major issue. When the osteotomy is performed at an intertuberosity level, the trapezoidal anatomical site of SST insertion is partially removed.[22] When the osteotomy is performed at an infratuberosity level, the insertion site of the SST is removed in its entirety.[22] Regardless of the height of the osteotomy, the reinsertion of the SST is distal to the anatomical insertion point, positioning the tendon with a different force vector from the original one.[9,22]

Some authors defend the repair of the SST during RSA procedures,[7,8] whereas others have demonstrated that there is no relationship between SST reinsertion and the end result of the surgical treatment.[1,10,14,15]

The literature has suggested that the primary reasons for not repairing the SST at the end of the RSA procedure include the following: delay in the rehabilitation process,[5] high percentage of nonhealing,[9] and possible restriction of ER.[23]

When comparing the results between patients with and without SST repair at the end of the RSA procedure, some authors have reported no differences in the range of motion, strength, or presence of pain.[1,5,9,10] These results suggest that there is no justification for repairing the SST and consequently subjecting patients to a longer rehabilitation period characterized by temporary immobilization and the progressive gain of movement through physiotherapy. De Boer et al.,[1] evaluated RSA patients with ultrasonography, compared the mobility and muscle strength between patients with intact SSTs and patients with ruptured SSTs, and found no difference between the groups. Clark et al.[5] evaluated the range of motion and reported similar results. Our findings were similar, as patients with viable SSTs according to the ultrasonography results did not have a better range of motion than patients with nonviable or ruptured SSTs.

Boileau et al.[9] suggested that the reinsertion of the SST into the RSA might be difficult due to the distalization of its original insertion site, leaving the SST elongated and with an oblique force vector, which would make healing difficult. In his work, Boileau does not cite his SST cicatrization failure rate.[9] In our study, the ultrasound examination was unable to verify the presence of the tendon at the SST insertion site in one-third of the patients (27.7%). However, of the 72.2% of tendons observed, approximately half (38.4%) had an inadequate fibrillar pattern, suggesting a nonviable or nonfunctioning tendon. We therefore suggest that all patients with an inadequate fibrillar pattern should be classified as failure to heal.

Boulahia et al.[14] demonstrated that patients with unrepaired SSTs presented greater ER of the UL and that a healed SST could exert a tenodesis effect and hamper the ability of the deltoid to perform ER in RSA patients. A larger ER arc in RSA patients with an unrepaired SST than those with repaired SSTs was also verified by Miller et al.[24] The same tenodesis effect, resulting in increased strength requirements for the posterior deltoid and external rotators, was also suggested

in a cadaver study conducted by Hansen et al.[23] A healed SST appears to produce unfavorable biomechanical conditions for the ER movement of the UL.[23] In our study, patients with healed and viable SSTs, according to the ultrasonography results, did not present a smaller ER arc than patients with nonviable SSTs.

The reasons given for repairing the SST at the end of the RSA procedure include the following: better IR mobility of the UL[10] and more stability for the arthroplasty.[8] Authors who argue in favor of SST repair have also suggested that the repaired SST does not limit the ER triggered by the posterior deltoid.[10]

Wall et al.[10] demonstrated greater IR mobility in patients with repaired SSTs, likely due to the maintenance of tendon integrity and functionality. In our study, there was no significant difference in the quality of IR movements between patients with viable and unviable SSTs, as assessed by ultrasound evaluations.

Oh et al.,[8] in a biomechanical study of cadavers, demonstrated that the integrity of the repaired SST generates requirement for increased force to cause anterior dislocation. Edwards et al.[7] reported that patients who underwent RSA procedures where it was not possible to repair the SST experienced double the frequency of arthroplasty dislocations. However, Clark et al.[5] did not find a difference in the incidence of dislocation in RSA patients with and without SST repairs. As of now, in our study, no patient has presented with postoperative dislocation.

Some studies have evaluated the viability of SSTs sutured after shoulder arthroplasties.[1,24] De Boer et al.[1] performed an ultrasonographic study of the SST in patients who underwent RSA procedures where the reinsertion of the SST was performed, with a mean follow-up of 30 months, and found the SST to be present in only 40% of the patients. In their study, they clarify that it is not possible to determine whether the loss of SST viability is due to traumatic-functional ruptures or nonhealing. In our study, we were also unable to identify factors that suggest traumatic ruptures of the SST.

The literature does not define a thickness at which the SST should be considered feasible, as this can vary according to the biotype of the patient. In our study, we considered an SST to be viable when it had a thickness greater than 0.5 mm and the fibrillar pattern was adequate. The SST was visualized in 13 patients (72.2%) and was considered viable in only 8 (44.4%). The presence of a viable SST was not associated with a greater gain of IR mobility or with negative semiological tests that are specific for this tendon.

Dedy et al.[25] evaluated the integrity of the SSTs in a group of patients with RSAs using ultrasonography. They found better IR mobility in patients with intact SST repairs, although they did not have access to the preoperative mobility data of the patients and included different brands of arthroplasties.

Clinical tests to examine the shoulder joint facilitate the diagnosis of functionality for joint structures. The literature details diverse tests with different sensitivities and specificities. A meta-analysis[26] suggests that the performance of clinical tests alone is limiting, even for the physical examination of nonoperated shoulders. We were unable to identify studies that compare the results of semiological test for the SST during the postoperative period following an RSA. In our study, we used the following studies for the clinical evaluation SST functional integrity: the Gerber's lift-off test, the presence of IR lag sign during the Gerber's lift-off test, and the abdominal compression test. There were no correlations between the results of these clinical tests and the feasibility of the SST, according to the ultrasonography examination, demonstrating that these tests are not appropriate for the determination of SST repair functionality after an RSA.

This study is limited by the small number of patients. Another limitation of this study is that ultrasonography is an imaging examination that is dependent on the examiner, unlike magnetic resonance imaging, which is considered to be a superior method for evaluating tendons and muscle. Although we were careful to evaluate all patients with the same radiologist and to use the same equipment, this remains a limitation.

Conclusions

It was not possible to demonstrate a correlation between the integrity of the SST repair, as assessed by ultrasound, and its functionality, as assessed by clinical tests during the postoperative period following an RSA.

SST repairs performed at the end of the RSA procedure have high failure rates, as demonstrated by the high incidence of nonviable or absent tendons.

A larger series of patients or randomized studies performed in the future may clarify whether it is worth submitting RSA patients to postoperative SST repairs.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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