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ORIGINAL RESEARCH

A comparison of functional outcomes in patients undergoing revision arthroscopic repair of massive rotator cuff tears with and without arthroscopic suprascapular nerve release

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Purpose: This study was designed to compare functional outcomes in patients undergoing revision repair of massive rotator cuff tears (retracted medial to the glenoid) with Goutallier Grade 4 atrophy and concomitant release of the suprascapular nerve to a similar group of patients with Grade 3 atrophy undergoing revision rotator cuff repair (RTCR) without nerve release. We hypothesized that patients undergoing nerve release would have more favorable functional outcomes as measured by the Modified University of California at Los Angeles shoulder rating scale (UCLA).
Patients and methods: Twenty-two patients underwent revision repair of massive rotator cuff tears with release of the suprascapular nerve at the suprascapular notch. We compared total preoperative, postoperative, and change in UCLA score in these patients to a similar group of 22 patients undergoing revision RTCR without suprascapular nerve release. Additionally, UCLA subscores between the two groups were compared preoperatively and at final follow-up.
Results: The average preoperative UCLA score in the nerve-release group was 7.91, and final follow-up average was 27.86; average 3.05 grades of strength were recovered. In the comparison group, average preoperative UCLA score was 11.77, and final follow-up average was 29.09; average 1.32 grades of strength were recovered. The average preoperative UCLA score was significantly worse in the nerve-release group (P=0.007). The average postoperative UCLA score was not significantly different (P=0.590) between the groups, indicating a better improvement in the nerve-release group with significantly greater improvement in active forward flexion, strength, and pain relief.
Conclusion: Patients who underwent concomitant release of the suprascapular nerve during revision RTCR had greater overall improvement as noted in pain relief, active forward flexion, and strength, than a comparable group without nerve release.
Keywords: muscle atrophy, suprascapular nerve release, revision rotator cuff repair, atrophy

Introduction

Controversy has followed the report of Lafosse et al[1,2] regarding arthroscopic release of the suprascapular nerve as an adjunct to rotator cuff repair. Although pathologic entrapment of the suprascapular nerve is relatively uncommon, it has not often been noted as a factor in tearing of the rotator cuff. Since the first reported case of an isolated suprascapular nerve lesion in 1886 by Dörrien,[3] significant progress has been made in understanding the variety of pathologies affecting the suprascapular nerve as well as

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how to appropriately treat them. In 1959, Kopell and Thompson[4] described suprascapular neuropathy at the suprascapular notch, but it was not until 1982 that Aiello et al[5] differentiated entrapment at the suprascapular notch compared to entrapment more distally in the course of the nerve at the spinoglenoid notch. More recently, various etiologies leading to suprascapular neuropathy have been described. These include scapular dyskinesia, traction, repetitive microtrauma either to the nerve itself or indirectly to the blood supply of the nerve,[6] and extrinsic compression of the nerve by ganglion cysts or (less commonly) by tumor.[7] In addition, direct trauma to the nerve as a result of fracture,[8] dislocation,[9] or iatrogenic injury[10] has been described. A variety of surgical techniques for decompression of the nerve have been described, initially utilizing an open approach and more recently utilizing arthroscopic techniques. Multiple published reports have demonstrated that when the nerve is entrapped and subsequently decompressed either at the suprascapular notch, the spinoglenoid notch, or both, satisfactory functional recovery can be expected.[2]

Controversy remains as to how the nerve is affected in the setting of a tear of the rotator cuff and how the nerve responds both anatomically and functionally once the torn rotator cuff is repaired. There is little published information regarding decompression of the nerve as a concomitant procedure during rotator cuff repair. Simply stated, the indications for suprascapular nerve release in the setting of rotator cuff repair are undetermined. We hypothesized that adding suprascapular nerve release to revision rotator cuff repair would improve our functional results as reflected by greater improvement in the Modified University of California at Los Angeles shoulder rating scale (UCLA) score and a higher rate of tendon healing. In order to prove this hypothesis, and after institutional review board approval, we decided to include suprascapular nerve release as a part of our surgical approach in a prospective group of patients who had had failed prior rotator cuff surgery with tears retracted medial to the glenoid and magnetic resonance imaging (MRI)-determined Goutallier Grade 4 atrophy.[11] We then compared this group to a retrospective group of similar revision rotator cuff repair patients with retraction either to or medial to the glenoid rim with MRI-determined Grade 3 atrophy.

Material and methods

Ethical approval for this study was obtained from the institutional review board of Tulane University. We prospectively collected data on all revision rotator cuff tears managed between July 2007 and March 2009 at our facility. We identified 283 patients who had previously underwent revision rotator cuff repair. In order to obtain a baseline on the effectiveness and possible indications for suprascapular nerve release, we arbitrarily decided to perform suprascapular nerve release on patients with Goutallier Grade 4 atrophy and tendon retraction medial to the glenoid as measured on preoperative MRI scanning. The level of atrophy was determined by the senior author prior to the surgery with help from a staff radiologist. Inclusion criteria for our study included: one or more failed primary rotator cuff repair(s) after recurrent massive rotator cuff tear(s) with the lateral tendon edge retracted medial to the glenoid, and Goutallier Grade 4 atrophy. Twenty-two shoulders (six left, 16 right) in 22 patients (eight females, 14 males) with an average age of 58.9 years (range 42–74 years) formed our study group. Prospective data collected included the UCLA with subscores and a visual analog scale (VAS) for pain.

We then retrospectively identified a cohort of 22 shoulders (ten left, 12 right) in 22 additional patients (seven females, 15 males) with an average age of 61.9 years (range 45–88 years) who had undergone revision arthroscopic repair of a massive rotator cuff tear during the same time period (May 2007 to March 2009) without concomitant release of the suprascapular nerve. The authors had determined at the beginning of the study that we would release the nerve in all Grade 4 atrophy patients, but not those with less than Grade 4. We therefore decided to compare the Grade 3 and 4 groups for outcome analysis. These patients also had retraction of the cuff medial to the glenoid but had only Goutallier Grade 3 muscle atrophy as determined by the same senior physician. When selecting the patients for this comparison group, every attempt was made to match each patient in the nerve-release group with a patient of similar age, preoperative functional status, and date of surgery who had not undergone a nerve release. The same UCLA with subgroup score and VAS score were collected in all patients. Postoperative rehabilitation progressed according to an established protocol developed by the senior author and was identical for all patients in both groups.

All 44 patients were then contacted and asked to present to our outpatient clinic for a final follow-up evaluation that included a questionnaire, examination, and ultrasound performed by one of the authors. There were three failures in each group; two of the release group failures and one of the nonrelease group failures declined to come in for re-examination. The exam data from these three patients were instead collected from their last clinic visit. At the time of the follow-up visit, voluntary written informed consent for participation in the study and a self-reported, validated questionnaire regarding pain, daily function, and satisfaction were obtained from each patient. These documents were also sent to the study group patients who did not come back and were completed by two of these three patients. In addition, objective information regarding the current functional status of the operative shoulder repairs was collected by performing a focused physical examination of the extremity. This examination was performed by certified athletic trainers in the clinic in order to have an independent evaluation of the postoperative functional level. Using this subjective and objective data, the "postoperative" UCLA score for each patient was determined.

We then compared the average total UCLA score for the nerve-release group with those of the nonrelease group for both the preoperative and postoperative data sets. The difference between preoperative and postoperative total UCLA scores for each patient was then determined as well as the average difference for each of the two patient groups.

In addition, we analyzed the subscores comprising the total preoperative and postoperative UCLA scores for each patient. An average score for preoperative pain, function, active forward flexion, and strength was calculated for each patient in both groups. The same average was calculated for each patient in both groups with regard to postoperative subscores. Patient preoperative satisfaction was recorded but not analyzed, as all patients were dissatisfied and thus desired surgery. Patient postoperative satisfaction was analyzed. The difference between preoperative and postoperative scores for pain, function, active forward flexion, strength, and satisfaction was determined for each patient in both groups. The average improvement/change was calculated for each subscore in both groups.

Direct comparisons were then made between the two groups in regards to average total preoperative UCLA score, average total postoperative UCLA score, and average total improvement/change in UCLA score. We also compared average preoperative and postoperative UCLA subscores (pain, function, active forward flexion, strength, and satisfaction) between the two groups. Finally, average improvement/change in each subscore was compared between the two groups.

Statistical analysis

Comparisons between groups were made using an independent Student's *t*-test. Within-group comparisons were made using a paired *t*-test. An alpha level of 0.05 was used to determine statistical significance.

Results

In the nerve-release group we were able to re-examine 20 of the 22 patients. One patient, an emergency room physician who was completely noncompliant with postoperative protocol, was contacted by phone and related his functional level and problems but refused to come in for physical examination. Another patient, a physician from another state, had a failure of the repair and his examination was performed by a local athletic trainer based on our guidelines. Each of these patients had additional MRI testing with the results provided to the authors. The average follow-up time for all patients was 28 months (range 18–40 months). The average preoperative total UCLA score for these patients was 7.91. At final follow-up, 19 patients were satisfied and recovered at least two grades of strength (average 3.05) according to the UCLA. The tears in three of these 22 patients failed to heal; two were not satisfied with their functional outcome while, interestingly, the third was satisfied according to the survey he completed at the time of final follow-up. The average total UCLA score at final follow-up was 27.86. The average improvement in total UCLA score for the patients in this group was 19.95.

In the comparison group, 20 of 22 patients (91%) were available for final follow-up. Two patients were unable to return for independent examination, but they did complete the survey and we used the complete physical examination data collected from a recent visit during a different study at the end of 2010 for the purposes of our analysis. The average follow-up time was 28 months (range 18–39 months). The average preoperative total UCLA score for these patients was 11.77. At final follow-up, 19 patients were satisfied and recovered an average 1.32 grades of strength according to the UCLA. In this group, we also had three failed rotator cuff repairs as determined by the ultrasound examinations. The same three patients deemed to have failed repairs were not satisfied with their functional outcome according to surveys completed at the time of final follow-up. The average total UCLA score at final follow-up was 29.09. The average improvement in total UCLA score for the patients in this group was 17.32.

The difference between the average preoperative total UCLA score in the nerve-release group and the equivalent score in the comparison group was 3.86 and significant (P=0.007). The difference between the average postoperative total UCLA score in the nerve-release group and the equivalent score in the comparison group was 1.23 and not significant (P=0.590). The difference in average total UCLA score improvement between the nerve-release group and the comparison group was 2.63 and not significant (P=0.231). These results are summarized in Table 1.

We also compared the preoperative and postoperative subscores comprising the total UCLA score for each patient

Table 1 Average preoperative, postoperative, and change in total UCLA score

	Average preoperative UCLA	Average postoperative UCLA	Average change UCLA
Nerve released	7.91	27.86	19.95
Nerve not released	11.77	29.09	17.32
	P=0.007	*P*=0.590	*P*=0.231

Abbreviation: UCLA, Modified University of California at Los Angeles shoulder rating scale.

across both groups. The average preoperative pain subscore for the nerve-release group was not significantly different than for the comparison group (*P*=0.333). However, the average preoperative subscores for function, active forward flexion, and strength were significantly worse in the nerve-release group compared to the nonrelease group (function *P*=0.022; active forward flexion *P*=0.000; strength *P*=0.000). These results are summarized in Table 2. Comparison of average postoperative subscores for the nerve-release group relative to average postoperative subscores for the nonrelease group revealed no significant differences (pain *P*=0.617; function *P*=0.609; active forward flexion *P*=0.504; strength *P*=1.00; satisfaction *P*=1.00). These results are summarized in Table 3.

Finally, we compared the average preoperative to postoperative improvement in each subscore for both patients undergoing nerve release and patients not undergoing nerve release. This analysis revealed nonsignificant differences in pain (*P*=0.303), function (*P*=0.273), and satisfaction (*P*=1.00). However, significant differences were noted in active forward flexion (*P*=0.000) and strength (*P*=0.000). These results are summarized in Table 4.

Discussion

In this study we proved one hypothesis and disproved another hypothesis. There was no difference in healing rate between the two groups, thus indicating that nerve release did not result in increased healing. The second hypothesis, that suprascapular nerve release would result in improved function over the nonrelease group, was proven true with regard to improvements in flexion, strength, and VAS score, but not proven in terms of overall UCLA score between the two groups. To the best of our knowledge, this study represents the first direct comparison between patients undergoing and not undergoing release of the suprascapular nerve at the suprascapular notch during revision rotator cuff repair, even though both groups were not completely comparable since the control group was retrospective and the nerve-release group

Table 2 Average preoperative UCLA subscores

	Average preoperative pain	Average preoperative function	Average preoperative active forward flexion	Average preoperative strength
Nerve released	2.95	2.59	1.18	1.18
Nerve not released	2.45	3.73	2.68	2.91
	P=0.333	*P*=0.022	*P*=0.000	*P*=0.000

Note: Average preoperative patient satisfaction was not specifically calculated as all patients were deemed "unsatisfied" and thus desirous of surgery.
Abbreviation: UCLA, Modified University of California at Los Angeles shoulder rating scale.

Table 3 Average postoperative UCLA subscores

	Average postoperative pain	Average postoperative function	Average postoperative active forward flexion	Average postoperative strength	Average postoperative satisfaction
Nerve released	7.00	7.73	4.59	4.23	4.32
Nerve not released	7.45	8.09	4.36	4.23	4.32
	P=0.617	*P*=0.609	*P*=0.504	*P*=1.00	*P*=1.00

Abbreviation: UCLA, Modified University of California at Los Angeles shoulder rating scale.

Table 4 Average change in UCLA subscores

	Average change, pain	Average change, function	Average change, active forward flexion	Average change, strength	Average change, satisfaction
Nerve released	4.05	5.14	3.41	3.05	4.32
Nerve not released	5.0	4.36	1.68	1.32	4.32
	P=0.303	*P*=0.273	*P*=0.000	*P*=0.000	*P*=1.00

Abbreviation: UCLA, Modified University of California at Los Angeles shoulder rating scale.

was prospective. To date, the literature on suprascapular nerve pathology and its treatment contains multiple case reports demonstrating the presence of isolated suprascapular nerve entrapment either at the suprascapular notch or the spinoglenoid notch. Various outcome reports have noted excellent patient response following decompression of the nerve with substantial improvement in shoulder function. In addition, multiple techniques describing both open and arthroscopic decompression of the nerve both at the suprascapular notch and at the spinoglenoid notch have been described.[11]

The idea that the anatomical course of the suprascapular nerve and the tension within it is disrupted when the rotator cuff is torn was proposed by Albritton et al in 2003.[12] In this cadaver study, the angle between the nerve and its motor branch to supraspinatus was markedly diminished with increasing degree of medial retraction of the supraspinatus tendon and muscle. In addition, the motor branch was found to be taut in all specimens tested when 2 to 3 cm of retraction was present. The authors concluded[12] that "medial retraction of the supraspinatus tendon drastically changes the course of the suprascapular nerve through the scapular notch, creating increased tension on the nerve". They proposed that this increased tension may explain the various and sometimes significant amounts of atrophy seen in the rotator cuff muscle following tears and subsequent medialization of the rotator cuff tendons from their insertion on the greater tuberosity.

Warner et al[13] performed detailed dissections on 18 cadaver shoulders to demonstrate more precisely the anatomical course of the suprascapular nerve and its branches. The authors concluded that the normal anatomy of the nerve limits lateral advancement of both the supraspinatus and infraspinatus during the standard anterosuperior approach for rotator cuff repair. Goutallier et al[14] seemed to refute these findings several years later by demonstrating that "in most cases no neurological impairment could be observed in surgical practice" in 24 patients undergoing rotator cuff repair using muscular advancement. In Goutallier et al's study, the authors utilized both clinical examination and electromyography findings to inform their conclusions. In a separate study, Greiner et al[15] demonstrated that the most medial motor branches of the suprascapular nerve are tensioned when advancing the supraspinatus muscle 1 cm laterally in the setting of a Debeyre's supraspinatus slide for rotator cuff repair in 24 cadaver shoulders. Additionally, Mallon et al described four patients with suprascapular neuropathy and concurrent massive rotator cuff tears that improved with rotator cuff repair alone.[16]

We propose, that when the course of the suprascapular nerve is disrupted (as the result of both a tear and the subsequent medial retraction of the rotator cuff, after which the tear is not addressed before the muscle and tendon of the rotator cuff begins to scar down in its new abnormal position), the nerve and surrounding soft tissue may become entrapped by local adhesions. This abnormal tissue may not only limit the advancement of the cuff tissue back to its anatomical position at the time of rotator cuff repair, but it may also tether the nerve in an abnormal position when manual advancement of the cuff tissue is performed. This may lead to a great amount of tension within the nerve, which could conceivably lead to suboptimal recovery of shoulder function despite the rotator cuff tendon being returned and anchored to its anatomical insertion.

While surgical indications regarding symptomatic isolated suprascapular nerve entrapment that has failed non-operative management have been described and are generally well accepted, the indications for suprascapular nerve release in the setting of primary and revision rotator cuff repair are undetermined. We chose to initially evaluate this in the most complex setting, ie, revision rotator cuff repair with significant retraction and severe atrophy. We are now conducting a study regarding suprascapular nerve release in two additional groups: in primary repair with Grade 3 or 4 atrophy and in revision repair with Grade 2 or 3 atrophy. We certainly cannot recommend, however, suprascapular nerve release in any group other that those with Grade 4 atrophy with severe retraction during the revision.

Our results demonstrate that statistically significant improvement in flexion, strength, and VAS pain score can be obtained when suprascapular nerve release is added to rotator cuff repair in revision cases with severe atrophy and retraction of the tendon. It does not result in improved healing of the repair. Our first hypothesis was therefore confirmed and our second hypothesis refuted by this study. The greater degree of functional improvement was especially noted in strength, VAS pain score, and active forward flexion. This improvement suggests that release of the suprascapular nerve at the suprascapular notch in the setting of revision rotator cuff repair with severe tissue atrophy allows patients with extremely poor preoperative function to at least attain a similar level of postoperative function as those patients with somewhat better (but still poor) preoperative function when an adequate repair is obtained. This nerve release does not result in an improved rate of healing as determined by postoperative clinical examination or ultrasound.

Several limitations should be noted in our study. In determining our sample size, a power analysis was not performed to determine the optimal number of study participants for the demonstration of statistical significance. Also, the diagnosis of suprascapular neuropathy in the release group was made clinically by the senior author without objective evidence (ie, electromyography/nerve conduction velocity) to support this diagnosis. Additionally, electromyography/nerve conduction velocity was not performed in any patient postoperatively to demonstrate the resolution or improvement of suprascapular neuropathy. In theory, a selection bias could have been present such that the patients who were placed into the nerve-release group were scheduled for concomitant nerve release based simply on especially poor preoperative functional status and clinical suspicion of significant suprascapular nerve compromise.

Conclusion

In the current study, patients undergoing release of the suprascapular nerve at the suprascapular notch at the time of revision repair of a massive rotator cuff tear retracted medial to the glenoid with Goutallier Grade 4 atrophy had significantly better improvement in active forward flexion, strength, and VAS pain scores compared to a similar nonrelease group undergoing the same procedure. Release of the nerve did not improve tendon healing.

Further study is needed, perhaps in the setting of a randomized controlled trial, to validate and expand the meaningful use of the results presented here. Such studies will also help to determine concrete indications for suprascapular nerve release at the suprascapular notch in the setting of primary and revision arthroscopic rotator cuff repair.

Disclosure

The authors report no conflicts of interest in this work. There are no actual or potential conflicts of interest for any of the authors in relation to the content of this manuscript. No external source of funding (financial support) was utilized in the analysis of patient data or in preparation of this manuscript. No financial compensation was offered or made to the patients in exchange for their cooperation in following up for this study.

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