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ORIGINAL PAPER

Arthroscopic rotator cuff repair with or without suprascapular nerve decompression in posterosuperior massive rotator cuff tears

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Abstract

Purpose The purpose of this study was to compare clinical outcomes of the arthroscopic rotator cuff repair (ARCR) in posterosuperior massive rotator cuff tears with or without arthroscopic suprascapular nerve (SSN) decompression in terms of arthroscopic release of the transverse scapular ligament.

Methods Patients with a minimum follow-up of 24 months who underwent complete repair of torn rotator cuff involving a complete full-thickness tear of the supraspinatus and the infraspinatus were retrospectively evaluated. A total of 31 patients were treated with SSN decompression (group 1), and 36 patients were treated without SSN decompression (group 2). The clinical and functional outcomes were evaluated using the University of California, Los Angeles (UCLA) score, active range of motion (flexion and external rotation), and a visual analog scale (VAS) for pain. Repair integrity and fatty infiltration of the repaired cuff were examined by MRI.

Results There was no significant difference between both groups across all measured at final follow-up: UCLA scores were 30.8 in group 1 and 30.8 in group 2 ($p = 0.58$); VAS scores were 14 mm and 13 mm, respectively ($p = 0.35$); active flexion angle were 149° and 153°, respectively ($p = 0.35$); and external rotation angles were 41° and 42°, respectively ($p = 0.85$). There were no significant differences in the re-tear rate (42% in group 1 and 33% in group 2, $P = 0.75$) and post-operative fatty infiltration scores of supraspinatus ($P = 0.28$) and infraspinatus ($P = 0.37$) in both groups.

Conclusions The functional outcomes and healing rate did not differ significantly between the groups with or without SSN decompression treated with arthroscopic cuff repair for massive RCT. At the short-term follow-up, SSN decompression was not found to have significantly affected the outcome of ARCR for posterosuperior massive RCT.

Keywords Suprascapular neuropathy · Rotator cuff tears · Fatty infiltration

Neuropathy of suprascapular nerve (SSNN) related to rotator cuff tears (RCT) has garnered significant attention in recent years [1–18]. Several clinical and basic studies have demonstrated that SSNN may occur in patients with RCT, suggesting that unrecognized SSNN may adversely affect (pain, range of motion, or healing status of repaired tendon) the treatment of massive RCT. SSNN may also be the causative factor of fatty degeneration of the rotator cuff, lower healing rate in repairing massive RCT, and poor clinical outcomes after cuff repair. Clinical and anatomical studies suggested a relationship between fatty infiltration (FI) in massive RCT and SSNN [19, 20]. Rowshan et al. examined a rabbit subscapularis tenotomized model and concluded that FI of the muscle occurs with chronic RCT, which may be explained by nerve injury [19]. Liu et al. demonstrated significant and consistent muscle atrophy and FI in the rotator cuff muscles after the transection of the rotator cuff tendon [20]. The authors found that denervation significantly increased the amount of muscle atrophy and FI after RCT.

The proposed mechanism of SSNN in relation to RCT is that torn and medially retracted rotator cuff (supraspinatus and infraspinatus) tethers the suprascapular nerve (SSN), which is relatively fixed at a point where it passes through the suprascapular notch [1, 3–12]. More extensive retraction causes increased nerve traction [7, 9, 11, 21, 22]. Mallon et al. reported two of four patients with massive retracted RCT and SSNN, who demonstrated reinnervation potentials after partial

Level of Evidence: Level III, retrospective comparative study.

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arthroscopic rotator cuff repair (ARCR) [9]. Costouros et al. found that all six patients with pre-operative electrodiagnostically confirmed SSNN and showed nerve recovery after partial or complete rotator cuff repair [11]. The extensive advancement of torn rotator cuff, which occurs in cases of massive RCT, was also concerned. Several authors have confirmed that the lateral advancement of the supraspinatus muscle causes compression of the nerve and should therefore be limited to 1 cm only or else the branches of the SSN may get damaged [21, 22].

These evidences suggest that SSN injury may be a part of the disease spectrum of the rotator cuff tear pathology and that SSN decompression accompanied with ARCR may improve the clinical outcomes. Savoie et al. reported patients who underwent concomitant release of SSN during a revision cuff repair and showed greater overall improvement, such as pain relief, active forward flexion, and strength, than a comparable group without nerve release [23]. However, the existence of SSNN in relation to RCT remains controversial [16, 17, 24] or, even if it exists, whether SSN decompression improves the surgical outcomes remains debatable. We had combined arthroscopic SSN decompression as an adjuvant procedure to ARCR in the posterosuperior massive cuff tear; however, we have stopped combination of the nerve decompression because there did not appear to be an apparent superiority. The purpose of this study was to compare the minimum two year clinical outcomes with or without arthroscopic SSN decompression in the posterosuperior massive RCT. Our hypothesis was arthroscopic SSN decompression by releasing the transverse scapular ligament (TSL) did not improve the clinical outcomes of ARCR in posterosuperior massive RCT.

Materials and methods

A retrospective analysis of the medical records was performed (Fig. 1). Between January 2011 and December 2015, all patients with a minimum follow-up of 24 months who underwent arthroscopic repair of the posterosuperior massive RCT involving a complete full-thickness tear of the supraspinatus (SSP) tendon and a full-thickness tear of the infraspinatus (ISP) with pre- and post-operative MRI evaluation were identified from a surgical registry. The exclusion criteria included incomplete repair (partial repair), paralabral cyst, fracture, infection, or revision cases. Post-operative MRI was eligible only when they were taken between the 12 and 24 months post-operatively.

A total of 31 patients (mean age: 66.6 years; male 18, female 13) were treated by SSN decompression (group 1), and 36 patients (mean age: 67.8 years; male 21, female 15) were treated without SSN decompression (group 2). The same surgeon performed all surgical procedures. An act of adopting or rejecting SSN decompression was determined by the time frame. Between January 2011 and April 2013, SSN decompression was combined with the ARCR, whereas between May 2013 and December 2015, SSN decompression was not combined. The clinical and functional outcomes were evaluated with reference to the University of California, Los Angeles (UCLA) score, active range of motion (flexion and external rotation), and a visual analog scale (VAS) for pain.

Surgical technique

A single surgeon performed all surgical procedures under general anaesthesia. The patients were positioned in the beach-chair position, with the arms held in flexion and with 1–3 kg of longitudinal traction, depending on the patient's body weight. Diagnostic arthroscopy was performed, and the torn rotator cuff was repaired with suture anchors. The number of anchors and the repair configuration (single-row, double-row, or suture-bridging double row) were decided according to the mobility of the torn rotator cuff and the extension of the tear. In case where the long head of the biceps was present, tenotomy or tenodesis was performed. The arthroscopic SSN decompression was performed after completion of the ARCR without arthroscopic subacromial decompression [24].

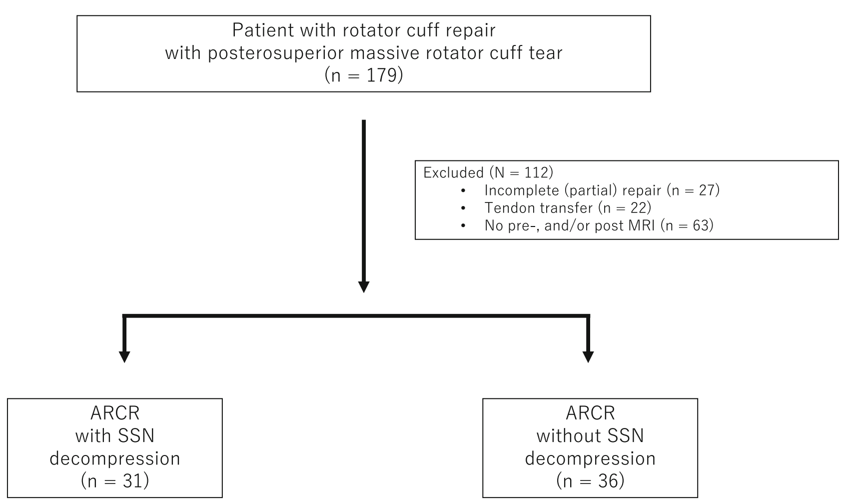

Fig. 1 Flowchart of the study protocol

Viewing from the lateral portal, the TSL was identified medial to the coracoclavicular ligament. The TSL was demarcated from the surrounding soft tissue using the switching rod inserted from the SSN portal, which was created at the middle of the intersection line connecting the medial edge of the scapular spine and the anterolateral acromion. By retracting the SSN medially using the switching rod, the TSL was divided with a pair of arthroscopic scissors. If the TSL was fully ossified (Rengachary type 6), it was removed with a micro Kerrison Rongeur.

All patients were subjected to the standard rehabilitation protocol. An abduction brace was applied for six weeks, active exercise was allowed after six weeks, and muscle strengthening exercise was started after 12 weeks.

Radiographic evaluation

Imaging studies were interpreted by a single musculoskeletal radiologist blinded to the operative findings and an orthopaedic shoulder surgeon.

A standard set of radiographs consisting of true anteroposterior, lateral scapular, and axillary views were obtained.

The tendon retraction grade was analyzed by MRI according to the Patte classification [25]: stage 1, proximal stump close to the bony insertion; stage 2, proximal stump at the level of the humeral head; and stage 3, the proximal stump at the level of glenoid. Subscapularis involvement was graded as intact, partial tear, superior subscapularis tear, and superior and inferior subscapularis tears [26].

FI of the cuff muscles (supraspinatus and infraspinatus) was assessed by MRI, according to the Fuchs modification of the Goutallier classification [27, 28]. This classification system is based mainly on the fatty degeneration percent of the involved muscle: grade 0, normal muscle; stage 1, some fatty streaks; stage 2, more muscle than fat; stage 3, as much fat as muscle; and stage 4, more fat than muscle.

Suprascapular notch morphology was evaluated with 3D reconstructed, unenhanced computed tomography (CT) according to the Rengachary classification [29] (type 1, a wide depression; type 2, a wide V-shaped notch; type 3, a symmetrical U-shaped notch; type 4, small V-shaped notch; type 5, partially ossified; and type 6, completely ossified).

Repair integrity was determined according to the Sugaya classification [30], which distinguishes five repair categories with the use of oblique coronal, oblique sagittal, and transverse T2-weighted images. The type 1 indicates a repaired rotator cuff that has sufficient thickness, with homogeneously low intensity on each image; type 2, sufficient thickness with a partial high-intensity area; type 3, insufficient thickness without discontinuity; type 4, the presence of a minor discontinuity in more than one slice of each image; and type 5, the presence of a major discontinuity on each image. The structural integrity was graded as healed (types 1, 2, and 3) or re-tear (types 4 and 5).

Statistics

The patients' demographic data for age, the UCLA score, and the active range of motion were compared by using unpaired *t* test, along with the χ^2 analysis for sex ratio, side, retraction of torn rotator cuff (Patte stage), and re-tear rate. The VAS score, repair configurations, suprascapular notch shape, FI grade, and the repair integrity (Sugaya grade) were analyzed by the Mann–Whitney *U* test. Statistical significance was set at $P < 0.05$. Statistical analyses were performed with Microsoft Excel software (Microsoft, Redmond, WA, USA).

Results

No significant differences in the patient demographics and pre-operative functional scores and imaging characteristics (i.e., age, sex, affected side, suprascapular notch shape, subscapularis tear involvement, UCLA score, pain-VAS scale, active range of motion, and fatty infiltration of supraspinatus/infraspinatus) were noted; however, the repair configuration with a single-row repair was significantly higher in group 2 (Tables 1 and 2). No significant differences on the follow-up period: the mean follow-up was 28.1 months (range, 24–43 months) in group 1 and was 25.9 months (range, 24 to 38 months) in group 2 (Table 1).

The clinical outcome measures significantly improved in both groups post-operatively (Tables 1 and 3): the mean UCLA score significantly improved from 14.3 pre-operatively to 30.8 post-operatively in group 1 ($P < 0.0001$) and from 15.9 pre-operatively to 30.8 post-operatively in group 2 ($P < 0.0001$); the mean flexion improved from 88° to 149° in group 1 ($P < 0.0001$) and from 108° to 153° in group 2 ($P < 0.0001$); the mean external rotation improved from 30° to 41° in group 1 ($P = 0.0040$) and from 33° to 42° in group 2 ($P = 0.0019$); and pain-VAS scale improved from 61 to 14 mm in group 1 ($P < 0.0001$) and from 56 to 13 mm in group 2 ($P < 0.0001$). There was no significant difference between the groups across all measured parameters at the final follow-up: UCLA score, $P = 0.92$, 95% confidence interval (CI) [−2.5, 2.7]; active flexion angle, $P = 0.35$, 95%CI [−16, 6]; active external rotation, $P = 0.85$, 95%CI [−8, 9]; and pain-VAS scale, $P = 0.35$, 95%CI [−9, 2]. There were no significant differences in the re-tear rate and the pre- and post-operative FI scores of supraspinatus and infraspinatus in both the groups (Tables 2 and 4).

Table 1 Pre-operative demographic and clinical data of the two study groups

Variable[a]	Group 1: ARCR with SSN decompression (*n* = 31)		Group 2: ARCR without SSN decompression (*n* = 36)		*P* value
Age (year)	66.6(7.0)		67.8(6.2)		0.25
Gender					0.82
Male	18		21		
Female	13		15		
Dominant side	68%		75%		0.7
Follow-up, month	28.1(7.0)	24–43	25.9(3.4)	24 to 38	0.086
ROM (active)					
Forward flexion	89(51)	15 to 170	108(49)	15 to 170	0.14
ER at side	30(20)	0 to 65	33(21)	0 to 70	0.56
UCLA score	14.3(4.8)	6 to 24	15.9(6.1)	4 to 27	0.26
VAS (pain), mm	61(22)		56(27)		0.62
Retraction of rotator cuff					0.45
Patte stage 2	15		19		
Patte stage 3	16		17		
Subscapularis involvement					0.99
No to partial tear	20		21		
Superior SSc	11		14		
Superior and inferior SSc	0		1		
Teres minor involment	2(6%)		3(8%)		0.57
Suprascapular notch shape					0.54
Rengachary type 1	0		1		
Rengachary type 2	4		7		
Rengachary type 3	19		18		
Rengachary type 4	3		7		
Rengachary type 5	3		2		
Rengachary type 6	2		1		
Rotator cuff repair configuration					< .001
Single-row	12		30		
Double-row	2		0		
Suture-bridge	17		6		

[a] Continuous data are presented as the mean ± standard deviation (range) or as indicated, and categoric data as number (%) or number. Values are expressed as mean (SD)

ARCR arthroscopic rotator cuff repair, *SSc* subscapularis, *SSN* suprascapular nerve, *UCLA score* University of California Los Angeles score, *VAS* visual analog scale

Table 2 Fatty infiltration of the supraspinatus and infraspinatus

Variable[a]	Group 1: ARCR with SSN decompression (*n* = 31)	Group 2: ARCR without SSN decompression (*n* = 36)	*P* value
Supraspinatus			
Pre-operative	1.8 (0.92)	1.5 (0.65)	0.2
Post-operative	1.7 (1.0)	1.4 (0.60)	0.14
Infraspinatus			
Pre-operative	2.1 (0.9)	1.6 (0.9)	0.28
Post-operative	2.2 (1.0)	1.9 (1.1)	0.37

[a] Values are expressed as mean (SD)

ARCR arthroscopic rotator cuff repair, *SSN* suprascapular nerve

Table 3 Comparison of the clinical and functional outcomes of the two study groups at the final follow-up

Variable[a]	Group 1: ARCR with SSN decompression ($n = 31$)		Group 2: ARCR without SSN decompression ($n = 36$)		*P* value
ROM (active)					
Forward flexion, °	149 (23)	75 to 175	154 (21)	55 to 175	0.35
ER at side, °	41 (18)	0 to 80	40 (17)	5 to 70	0.85
UCLA score	30.8 (5.0)	18 to 35	30.8 (5.4)	14 to 35	0.92
VAS (pain), mm	18 (28)		14 (22)		0.35

[a] Continuous data are presented as the mean ± standard deviation (range) or as indicated, and categoric data as number (%) or number

Values are expressed as mean (SD)

ARCR arthroscopic rotator cuff repair, *SSN* suprascapular nerve, *UCLA score* the University of California Los Angels score, *VAS* visual analog scale

Discussion

The functional outcomes did not significantly differ between the groups with or without SSN decompression treated with arthroscopic cuff repair. There was no difference in the healing rate between the two groups, which indicated that the nerve release did not induct better cuff healing. FI (SSP and ISP) did not recover in both the groups, and there was no difference between the groups (Table 4). There supposed to be no evidence to support the routine combination of SSN decompression.

The possible reasons for the lack of effect of SSN decompression on the final outcome were as follows: (1) SSN was strongly damaged and did not respond to nerve decompression, (2) sufficient decompression of SSN was achieved by rotator cuff repair, or (3) SSNN was rare and not associated with RCT in majority of the cases.

It seemed unlikely that SSN was strongly damaged before the ARCR. At the final follow-up, FI of both the muscles (SSP and ISP) showed no significant deterioration in both the groups, indicating that the SSN had not been totally damaged. It was equally unlikely that SSN was sufficiently decompressed by reduction of medially shifted torn cuff as a result of repair and there was small effect on TSL release. In our study, re-tear of the repaired cuff was observed in 13 of the 31 patients (42%) in the SSN decompression group and in 12 of the 36 patients (33%) in the control group, leaving torn supraspinatus muscle medially. Massimini et al. showed that the course of SSN did not change after transosseous double row repair of the torn rotator cuff at the suprascapular notch [31]. It was assumed that the correcting effect of SSN due to rotator cuff repair was less significant. According to these assumptions, it was thought that SSN decompression did not significantly alter the clinical outcome because SSNR with massive RCT was rare. Collin et al. prospectively evaluated the SSN for pre-operative neurodiagnostic abnormalities in the shoulders with massive RCT by electromyography/nerve conduction and demonstrated that SSNN was rare (1 in 49 shoulders) [17]. Massimini et al. evaluated the anatomical course of SSN in a cadaver model and found that the SSN translated 3.5 mm medially at the spinoglenoid notch as compared to the anatomic SSN course; however, no change in the nerve course was observed at the suprascapular notch [31]. Sasaki et al. created a SSNN model using rat and demonstrated that the mechanical properties of the paralytic group were significantly lower than those of the control group, suggesting that neuropathy was a cause of RCT [32]. This reversal idea of cause–effect association may explain the association of some RCT with SSNN as well as the low prevalence of SSNN in the massive RCT population. However, further studies are warranted to confirm these findings.

Table 4 Post-operative MRI findings of the two study groups

Variable[a]	Group 1: ARCR with SSN decompression ($n = 31$)	Group 2: ARCR without SSN decompression ($n = 36$)	*P* value
Sugaya classification			0.45
Type 1	9	13	
Type 2	6	6	
Type 3	3	5	
Type 4	2	3	
Type 5	11	9	
Re-tear rate	42% (13 cases)	33% (12 cases)	0.75

ARCR arthroscopic rotator cuff repair, *SSN* suprascapular nerve

Limitation

This study has several limitations. First, this was a non-randomized retrospective series with a relatively small sample size and a short follow-up time. Second, the repair technique was not standardized (a single-row, double-row, or suture-bridging, and single-row repair was significantly higher in group 2 (without SSN decompression). Third, the current study showed no significant benefit of SSN decompression for the massive rotator cuff repair, which, however, did not imply that massive RCT is not the cause of SSN neuropathy. Further studies are, however, necessary to confirm these findings.

Conclusions

The functional outcomes and healing rate did not differ significantly between the groups with or without SSN decompression treated with arthroscopic cuff repair for massive RCT. At the short-term follow-up, SSN decompression was not found to have significantly affected the outcome of ARCR for posterosuperior massive RCT.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This study was approved by the Institutional Review Board.

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