

Arthroscopic Release of Suprascapular Nerve Entrapment at the Suprascapular Notch: Technique and Preliminary Results

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Purpose: We describe a novel all-arthroscopic technique for suprascapular nerve (SSN) decompression and present our preliminary results for this procedure. **Methods:** A prospective series of 10 patients with preoperative electromyographic findings consistent with chronic SSN compression, posterior shoulder pain, and subjective weakness were treated with arthroscopic SSN decompression. There were 8 men and 2 women, with a mean age of 50 years. The mean follow-up was 15 months (range, 6 to 27 months). In 8 of 10 patients, we performed an electromyographic examination postoperatively to evaluate nerve recovery after decompression. The clinical outcomes measures used to assess preoperative and postoperative function were the visual analog scale for pain, the Constant score, strength testing of the supraspinatus and infraspinatus, and a subjective satisfaction questionnaire. In all patients preoperative and postoperative computed tomography arthrograms were obtained to document the absence of a rotator cuff tear. **Results:** There were no complications resulting from SSN decompression. Of 10 patients, 8 had postoperative electromyography at a mean of 6 months after SSN release and 2 refused to undergo this study after surgery. Of the 8 postoperative electromyograms, 7 had complete normalization of the latency in the motor fibers of the SSN and normalization of the voluntary motor action potential for the supraspinatus and infraspinatus muscles. Two of the electromyograms showed evidence of partial recovery. The preoperative and postoperative Constant scores for these patients were 60.3 and 83.4, respectively ($P < .001$). All patients returned to their normal work and sports activity at a mean of 3 weeks (range, 2 days to 3 months). The abduction and external rotation strength also significantly improved. At the time of last follow-up, 9 patients graded their clinical outcome as excellent and responded that they had complete relief of pain. One of the study subjects reported a satisfactory result with moderate relief of pain. **Conclusions:** Arthroscopic release of the SSN can be performed safely and effectively. All of the patients in this preliminary study had improvement in their postoperative electromyographic findings and had marked improvement in pain relief and function. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** Arthroscopy—Endoscopy—Suprascapular nerve—Suprascapular notch—Subacromial impingement—Rotator cuff—Shoulder portals.

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The authors report no conflict of interest.

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0749-8063/07/2301-4306\$32.00/0*

doi:10.1016/j.arthro.2006.10.003

Suprascapular nerve (SSN) entrapment occurring at the transverse scapular notch was first described by Thompson and Kopell.^{1,2} Numerous authors have reported a variety of causes for SSN entrapment, including transverse scapular ligament (TSL) anomalies,³ compression from adjacent ganglia,⁴⁻⁷ abnormal osseous morphology of the suprascapular notch,^{8,9} direct trauma or traction injury,^{10,11} rotator cuff rupture,^{12,13} and trauma.¹⁴ Isolated SSN compression is a relatively rare phenomenon and, as such, is easily misdiagnosed. As a result, many patients with SSN compression present with more than 6 months of chronic pain and weakness.

If a patient has chronic pain and electrodiagnostic

evidence of SSN compression refractory to conservative management, then surgical release of the nerve is indicated. Open surgical release is an accepted method of treatment.¹⁵⁻¹⁸ The open technique for decompression uses a superior incision that may be extended posteriorly if the SSN at the spinoglenoid notch also requires release. This superior approach either detaches the trapezius from its insertion along the scapular spine or uses muscle-splitting. Superior access to the transverse scapular notch is technically difficult because the operative field is relatively narrow and deep and the SSN is as small as 1 mm in diameter.⁸ The purpose of this report is to describe a new all-arthroscopic method for surgical decompression of the SSN resulting from entrapment at the transverse scapular notch and report our preliminary results with this technique in 10 patients.

METHODS

Patient Selection and Evaluation

Between January 2003 and December 2004, 10 consecutive patients (Table 1) who presented to the senior author (L.L.) with clinical and electrodiagnostic findings confirming chronic SSN entrapment were identified. Each patient was treated with arthroscopic SSN release, and none had a prior history of attempted SSN decompression via an open technique. There were 8 men and 2 women, with a mean age of 50.4 years (range, 36 to 73 years). The mean clinical follow-up was 15 months (range, 6 to 27 months). The left shoulder was involved in 4 patients. Nine cases occurred in the dominant arm. All had pain felt in the posterior aspect of the shoulder present at rest and exacerbated by overhead use of the arm for at least 6

TABLE 1. Demographics and Laterality of 10 Patients in Study

Patient No.	Age (yr)	Side	Follow-Up (mo)
1	46.8	R	21
2	45.5	L	27
3	49.2	R	24
4	56.2	R	19
5	35.7	R	15
6	39.6	L	14
7	45	L	6
8	58	R	9
9	73	L	7
10	54.6	R	7
Mean	50.36		14.9

TABLE 2. Summary of Preoperative and Postoperative Results in 10 Patients With Arthroscopic SSN Decompression

	Preoperative	Postoperative	P Value
Pain	7	14.5	<.001
FCT (out of 20)	10.6	18.5	<.001
MOB (out of 40)	38.4	39.6	.051
Strength (out of 15)	4.3	10.8	<.001
Constant score	60.3	83.4	<.001
Supraspinatus strength (kg)	2.4	4.6	<.001
Infraspinatus strength (kg)	2	4.3	<.001
Supraspinatus latency (ms)	4.5375	3.175	.002
Infraspinatus latency (ms)	5.14375	3.53125	.002
Supraspinatus amplitude (mV)	0.6	1.0125	.279
Infraspinatus amplitude (mV)	1.0125	1.225	.428

Abbreviations: FCT, function; MOB, mobility.

months before surgery. A course of conservative management, which included physiotherapy, had failed in all patients, and one had a subacromial injection without improvement in symptoms. Three of these patients had associated symptomatic acromioclavicular joint arthritis, which was treated by arthroscopic distal clavicle resection at the time of arthroscopic SSN decompression. All of the patients in this series had visible and palpable atrophy of the supraspinatus and infraspinatus muscles and had weakness of abduction and external rotation without a limitation in active forward flexion. The preoperative and postoperative clinical examinations consisted of manual muscle testing on a scale ranging from 0 to 5 (where 5 indicates normal force) by use of the Jobe test for the supraspinatus and forced external rotation with the arm in a neutral position for testing of the infraspinatus. Preoperative and postoperative pain scores were generated by use of a visual analog scale and were used to calculate preoperative and postoperative Constant scores (Table 2). All patients also had computed tomography (CT) or magnetic resonance arthrography preoperatively to assess the degree of fatty infiltration and muscle atrophy, as well as to define any other concomitant pathology (Figs 1 and 2).

Electromyographic (EMG) evaluation was performed on all patients preoperatively and repeated at 6 months after arthroscopic release of the SSN in 8 of 10 cases. Two patients refused repeat evaluation with electromyography postoperatively. Nerve conduction velocity was evaluated by analyzing the latency of the muscle response on the electromyogram and the am-



FIGURE 1. Magnetic resonance image showing atrophy of infraspinatus muscle without fatty degeneration (arrow).

plitude of the muscle contraction to determine the degree of nerve compression proximal and distal to the compressive lesion (Tables 3 and 4). The values for conduction velocity, distal latency, and amplitude in the contralateral unaffected shoulder were used as controls. The EMG parameters acquired from the unaffected extremity were normal in all 10 patients. With regard to SSN decompression, an excellent result was considered to be present when normalization of the conduction velocity, distal latency, and amplitude was achieved. A good result was defined as improvement in the 3 parameters after surgical decompression without complete normalization. Failure was defined as no postoperative improvement in the conduction velocity, distal latency, and amplitude.

Surgical Technique

The patients were placed in the beach-chair position with the arm held in flexion and with 3 kg of longitudinal traction (Fig 3). This setup optimizes arthroscopic visualization by distracting the humerus from the acromion so that the potential space about the transverse scapular notch is maximized. An interscalene block with general anesthesia and muscle paralysis was used in the first 6 cases, and only an interscalene block for anesthesia was used in the remaining 4.

The portals used to perform surgery (Fig 4a-c) were the standard posterior “soft spot” portal (A) typically used to visualize the glenohumeral joint and the sub-

acromial space, a lateral subacromial portal (C), and an anterolateral portal (D). We describe a new portal (G), the SSN portal, which is positioned between the clavicle and the scapular spine approximately 7 cm medial to the lateral border of the acromion. This portal is approximately 2 cm medial to the Neviaser portal. Warner et al.¹³ found that the suprascapular notch is 4.5 cm (± 0.5 cm) from the posterolateral acromion. This portal is created under direct visualization via an outside-in technique.

Meticulous hemostasis is required to safely perform the arthroscopic SSN release. This is achieved by maintaining an adequate pump pressure of 50 mm Hg and a systolic blood pressure of less than 120 mm Hg at all times.

After inspection of the glenohumeral joint by use of the posterior portal, the arthroscope is introduced into the subacromial space through the lateral portal. A shaver and radiofrequency device are used through the posterior portal to remove the anteromedial bursa and provide access to the suprascapular notch. Because swelling during the procedure adds significantly to the difficulty of gaining adequate exposure to the TSL, if a distal clavicle resection or subacromial decompression is to be performed, it is done after the SSN decompression. Once the anteromedial bursectomy has been completed, the arthroscope is switched to the lateral portal. The anterolateral portal is made at the anterolateral corner of the acromion. This portal is

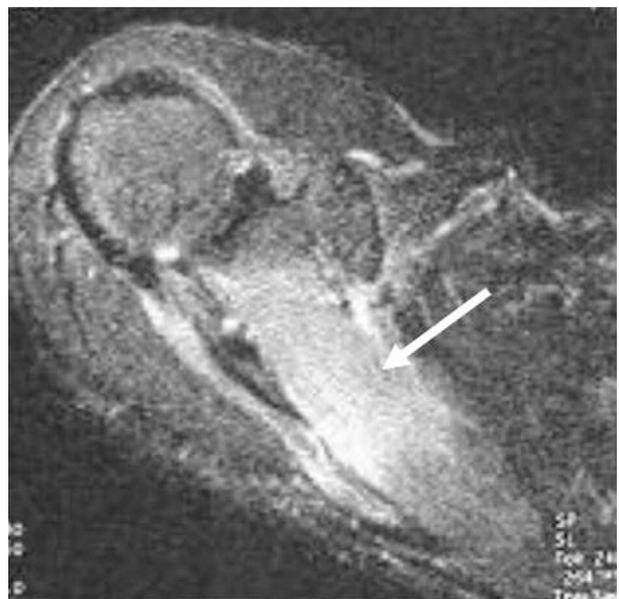


FIGURE 2. Magnetic resonance image showing atrophy of supraspinatus muscle without fatty degeneration (arrow).

TABLE 3. Preoperative and Postoperative Latency From EMG Analysis

Patient No.	Latency (ms)					
	Supraspinatus			Infraspinatus		
	Preoperative	Postoperative	Change	Preoperative	Postoperative	Change
1	4.60	3.40	1.20	6.80	3.40	3.40
2	5.45	3.20	2.25	3.95	3.40	0.55
3	4.40	3.20	1.20	3.80	3.45	0.35
4	6.30	3.50	2.80	7.60	4.30	3.30
5	11.65	—	—	8.60	—	—
6	4.90	3.90	1.00	4.55	3.15	1.40
7	3.65	2.35	1.30	3.75	2.85	0.90
8	4.00	—	—	3.65	—	—
9	3.10	2.75	0.35	3.70	2.85	0.85
10	3.90	3.10	0.80	7.00	4.85	2.15
Mean	5.2	3.2	1.4	5.3	3.5	1.6

optimal for completing the dissection of the transverse scapular notch by use of the shaver and radiofrequency devices. First, the coracoacromial ligament is identified, and its course is followed to the base of the coracoid. Next, the coracoclavicular ligaments (conoid and trapezoid) are identified by carrying the dissection posteriorly and medially. The medial border of these ligaments at the base of the coracoid defines the lateral insertion of the superior TSL. The TSL is identified as the medial continuity of the conoid ligament above the scapular notch (Fig 5). Once visualization of the TSL is adequate, an 18-gauge spinal needle is used to guide the placement of the new (SSN) portal through the trapezius at an angle

orthogonal to the suprascapular fossa and slightly anteriorly toward the transverse scapular notch. If the spinal needle is oriented correctly, the tip of the needle should be visualized immediately anterior to the anterior border of the supraspinatus muscle. Placement of this portal should not endanger the spinal accessory nerve as it traverses near the medial border of the scapula because the portal should be more than 5 cm medial to the SSN. Once the spinal needle has been appropriately positioned, a knife is used to incise the skin, and all dissection through the trapezius and surrounding soft tissues en route to the SSN is performed bluntly by use of a trocar. The blunt trocar is used to dissect the fatty tissues that surround the SSN within

TABLE 4. Preoperative and Postoperative Muscle Contraction Amplitude From EMG Analysis

Patient No.	Amplitude (mV)					
	Supraspinatus			Infraspinatus		
	Preoperative	Postoperative	Change	Preoperative	Postoperative	Change
1	0.10	0.20	0.10	0.50	0.90	0.40
2	0.60	0.60	0.00	0.20	0.70	0.50
3	0.20	0.60	0.40	0.70	1.70	1.00
4	0.10	0.10	0.00	0.70	0.70	0.00
5	0.30	—	—	0.40	—	—
6	1.60	4.40	2.80	1.90	3.20	1.30
7	0.10	0.40	0.30	1.40	1.10	-0.30
8	0.30	—	—	1.00	—	—
9	0.80	0.40	-0.40	1.10	0.60	-0.50
10	1.30	1.40	0.10	1.60	0.90	-0.70
Mean	0.5	1.0	0.4	1.0	1.2	0.2

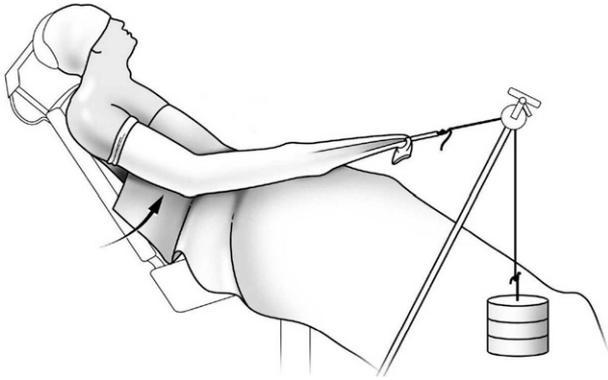


FIGURE 3. Beach-chair position and weight traction.

the transverse scapular notch and to further clarify the borders of the TSL. The suprascapular artery is easily visualized superior to the ligament, and the SSN is identified as it travels underneath the ligament (Fig 6). If necessary, the radiofrequency and shaver devices may be used to enhance the dissection as long as the instruments remain superior to the supraspinatus muscle belly in the area posterior and lateral to the coracoid ligament insertion at the base of the coracoid so that inadvertent injury to the suprascapular artery is avoided. Once the ligament and nerve are identified, the blunt tip of the trocar is positioned lateral to the SSN within the transverse scapular notch to protect the SSN during transection of the ligament. To perform the ligament release, a second portal approximately 1.5 cm lateral to the SSN portal is used to introduce the arthroscopic scissors so that the TSL may be released (Fig 7). After release of the TSL, the decompression should be assessed by use of gentle manipulation of the SSN within the scapular notch. If there is residual compression of the nerve, usually resulting from bony hypertrophy within the suprascapular notch, a notchplasty should be performed along the lateral border of the suprascapular notch with a bur. To complete the procedure, the portals are closed with an absorbable subcutaneous suture.

Postoperative Care

All patients in this series were discharged on the day of surgery. Patients are instructed to wear a sling for the first 48 to 72 hours for comfort, although there is no structural reason to restrict their activity. Pendulum exercises and active motion are encouraged on the first postoperative day, and patients are permitted to progress their activity without restrictions thereafter. All patients were seen at 6 weeks and 6 months after

surgery for clinical examination and evaluation. At 6 months after surgery, 8 of 10 patients underwent repeat electromyography to assess SSN function.

RESULTS

There were no complications in this series due to nerve injury, bleeding, or infection. All patients had a significant improvement in their pain after SSN release. The mean preoperative pain score was 7.0 (range, 5 to 10; $P < .05$), and the mean postoperative pain score was 14.5 (range, 10 to 15; $P < .05$).

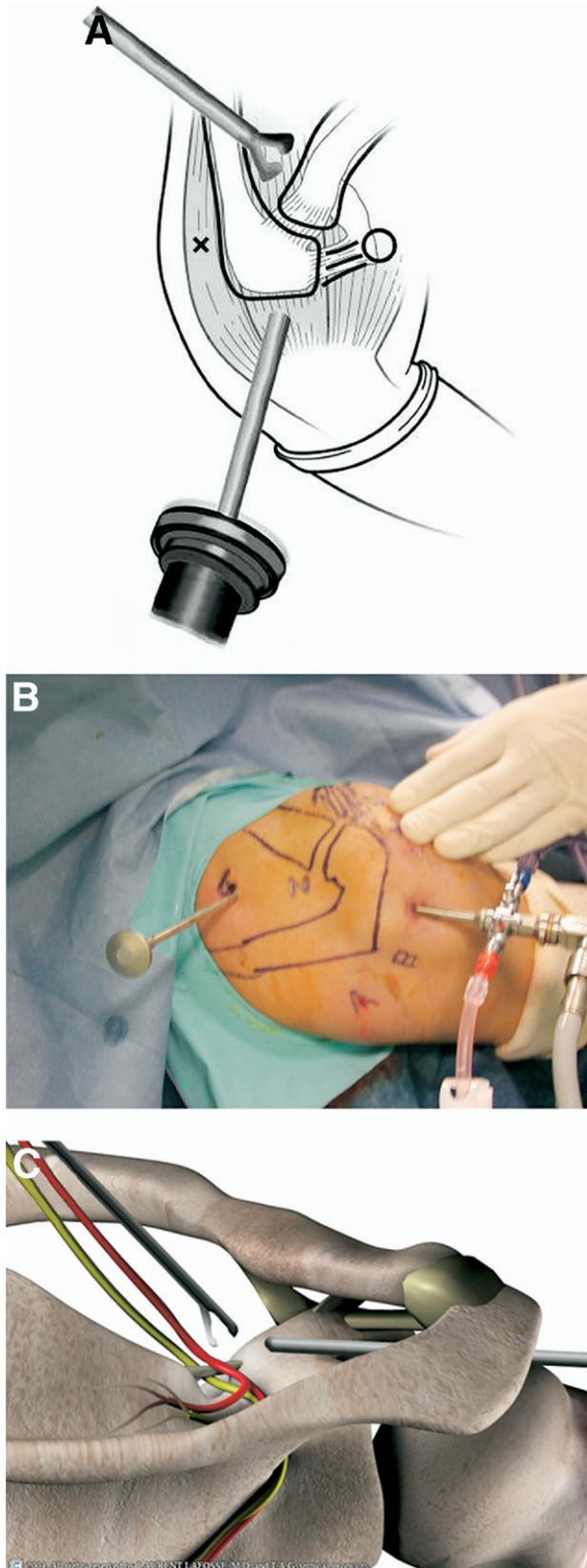
Of the 8 patients who had postoperative electromyograms, 7 had complete normalization of the conduction velocity, distal latency, and amplitude (Table 3). Each of these 7 patients also had normalization of the voluntary motor action potential for the supraspinatus and infraspinatus (Table 4). Of the 8 patients who had postoperative electromyography, 1 showed only partial improvement in these parameters although he had nearly complete resolution of his pain.

The Constant score also significantly improved after SSN release in these patients. The mean Constant score was 60.3 points preoperatively (range, 59 to 66 points; $P < .05$) and increased to 83.4 points after surgery (range, 72 to 87; $P < .05$) (Table 2). All of the patients in this series had evidence of persistent muscle atrophy at the time of last follow-up; however, each of them had significant gains on strength testing after surgery. The mean preoperative strength for the supraspinatus and infraspinatus was 2.4 kg and 2.0 kg (range, 2 to 3 kg; $P < .05$), respectively (Table 5). The mean postoperative strength was 4.6 kg for the supraspinatus (range, 4 to 5 kg; $P < .05$) and 4.3 kg for the infraspinatus (range, 2 to 5 kg; $P < .05$).

No pathology other than subacromial bursitis was identified during diagnostic arthroscopy.

DISCUSSION

The anatomy of the SSN has been well described.¹³ It originates as a sensorimotor nerve from the upper trunk of the brachial plexus distal to Erb's point and passes under the TSL at the suprascapular notch, sending 2 motor branches to the supraspinatus muscle. Before innervating the supraspinatus and infraspinatus, it courses deep to the trapezius and omohyoid muscles and then follows the course of the suprascapular artery to the suprascapular notch. The artery passes over the TSL, whereas the nerve passes underneath this ligament and then into the supraspinatus fossa deep to the supraspinatus before continuing



through the spinoglenoid notch and terminating in the muscle belly of the infraspinatus within the infraspinatus fossa.

Most cases of SSN compression occur at the suprascapular notch, which we believe is likely the result of nerve tethering about the TSL, as do other investigators. Traction injuries or osseous stenosis at the suprascapular notch can also further contribute to SSN compression by the TSL.^{5,9} In addition, ossification of the TSL has also been described, on rare occasion, to be a potential contributing factor to SSN compression.⁶ Although the TSL is most often responsible for SSN entrapment, the spinoglenoid notch has been shown to be the primary contributor to SSN nerve compression in as many as 14% of cases.⁶ None of the patients in this preliminary series had compression as a result of bony abnormalities or compressive ganglia within the notch as documented by preoperative magnetic resonance or CT arthrography.

In our series of 10 patients we carefully documented compression at the suprascapular notch by preoperative electromyography. The results convincingly showed that SSN decompression via the arthroscopic technique described in this report resulted in a significant improvement in nerve conduction velocity and shortening of the distal latency in every study subject (Table 3). The results also show that nerve recovery was correlated with the increasing magnitude of the compound motor action potential amplitude. Three cases did not show improvement in the compound motor action potential amplitude for the infraspinatus on postoperative electromyography whereas the amplitude of the infraspinatus improved (Table 4). Interestingly, 2 patients did not show complete normalization of their electromyograms until 1 year after SSN decompression. Hence, 6 months may not be enough time to analyze the physiologic outcome of this procedure by use of electromyography.

FIGURE 4. (A) Superior view of portals for SSN decompression. The arthroscopic scissars are introduced through the SSN portal approximately 2 cm medial to the Neviaser portal. The arthroscope is visualizing through the lateral portal. (x, standard posterior portal.) (B) Portals on right shoulder. The arthroscope is placed in the lateral portal, and the trocar shows the position of the SSN portal medial to the Neviaser portal used to dissect the SSN and protect it during ligament release. A portal approximately 2 cm lateral to the SSN portal (N) and very close to the Neviaser portal is used to transect the TSL by use of arthroscopic scissars. (C) Portals and instrument positioning. Viewing through the lateral portal, all other devices are passed through the SSN portal.

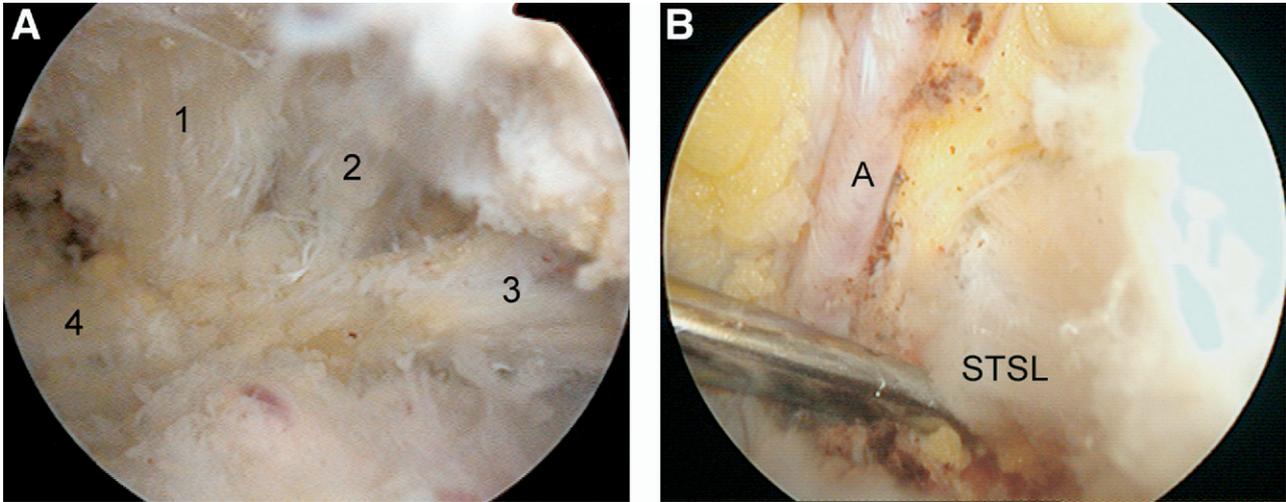


FIGURE 5. (A) Right shoulder, lateral view: (1) conoid and (2) trapezoid coracoclavicular ligaments, (3) coracoacromial ligament, and (4) superior TSL (STSL). (B) Suprascapular artery crossing STSL (right shoulder, lateral view). (A, suprascapular artery.) The device is inserted via the SSN portal.

The prevalence and potential importance of SSN entrapment have yet to be established and require further study. Warner et al.¹³ have shown that lateral reduction of rotator cuff tears during reconstruction may result in significant tension on the SSN and entrapment by the TSL. In fact, 3 patients not included in our series had persistent pain after rotator cuff repair and each had neurophysiologic evidence of SSN entrapment. The structural integrity of their rotator cuff reconstructions based on analysis of the supraspinatus and infraspinatus footprints from their

CT arthrograms was completely intact. Each of these patients had an arthroscopic SSN release with normalization of their electromyograms, resolution of their posterior shoulder pain, and overall excellent clinical results. We are engaged in a prospective study of SSN entrapment after rotator cuff repair, which will include these 3 patients.

This study has several limitations including a short period of follow-up, the fact that it is a single-surgeon series, the absence of a comparative group, and the small number of patients. Therefore validation of

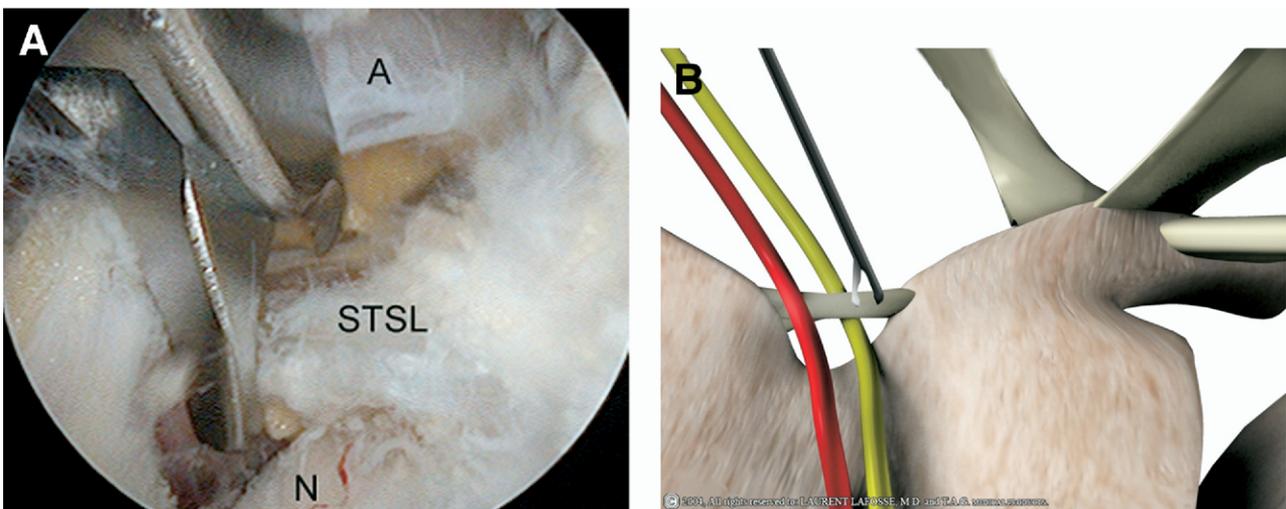


FIGURE 6. (A) Cutting of superior TSL (STSL) (right shoulder, lateral view). (A, suprascapular artery; N, SSN.) The device is inserted via the SSN portal. (B) Schema of endoscopic view.

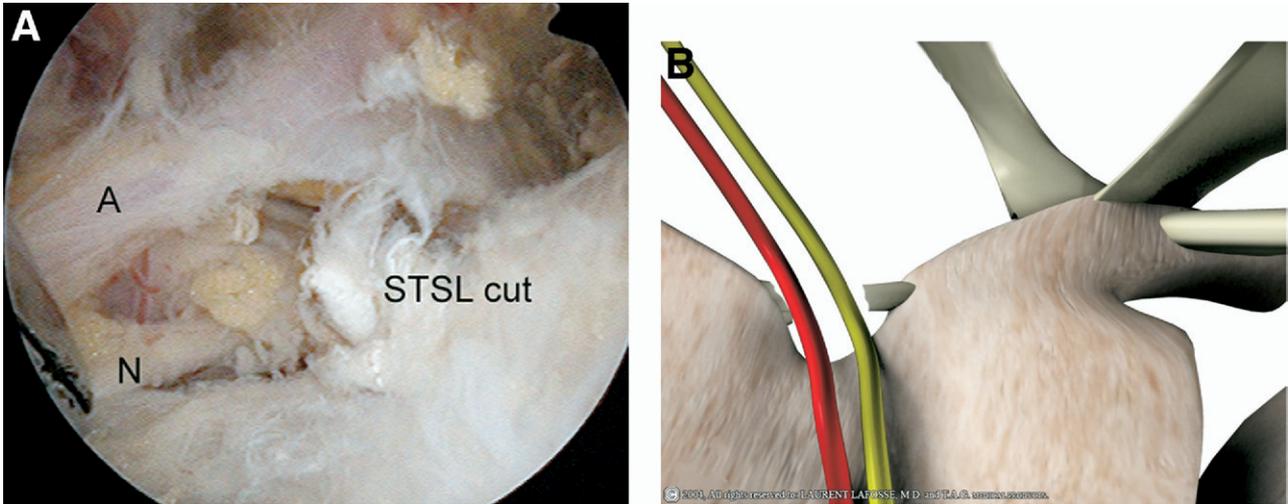


FIGURE 7. (A) Cut STSL with SSN (N) and artery (A) (right shoulder, lateral view). (B) Schema of endoscopic view.

these findings with appropriate controls is necessary in the future.

The technique for arthroscopic release of the SSN confers 3 distinct advantages over the traditional open technique. First, it provides superior visualization of the neurovascular structures and the TSL. The SSN is as small as 2 mm and is therefore sometimes difficult to appreciate via open exposures.¹³ This difficulty may result in inadvertent injury to the SSN during dissection toward the transverse scapular notch. The small diameter of the SSN is easily visualized with the magnification afforded by the arthroscope and permits a safer and arguably more facile nerve release. The spinal accessory nerve is also not at significant risk during the arthroscopic procedure because the SSN

portal is less than 5 cm medial to the SSN.¹³ Second, arthroscopic release of the SSN is significantly less invasive and does not involve detachment of the trapezius insertion. Hence, most patients have significantly less pain than with the open procedure, as evidenced in our preliminary data analysis showing that all but 1 patient no longer required narcotic pain medication only 72 hours after the procedure. Third, all of these procedures are performed as outpatient surgeries and in a significantly shorter time than can be achieved with the open technique. The operative time for the first arthroscopic SSN releases was approximately 1 hour, and the learning curve has enabled us to increase our efficiency significantly so that most of these cases now take less than 10 minutes.

TABLE 5. Preoperative and Postoperative Suprascapular and Infraspinatus Muscle Strength

Patient No.	Preoperative Strength		Postoperative Strength	
	Suprascapular	Infraspinatus	Suprascapular	Infraspinatus
1	3	2	5	5
2	3	2	5	5
3	2	0	4	2
4	2	2	5	4
5	2	2	5	4
6	2	2	4	4
7	3	3	4	4
8	2	2	5	5
9	3	3	4	5
10	2	2	5	5
Mean	2.4	2	4.6	4.3

CONCLUSIONS

This report describes an all-arthroscopic technique for release of the SSN at the transverse scapular notch and shows that this procedure can be performed safely and effectively. Our early results have shown that neurophysiologic findings indicative of nerve entrapment normalize after release of the TSL and clinical results in the short term are excellent and promising. Long-term studies evaluating the clinical outcomes of this procedure are needed. Further prospective controlled studies are also required to determine the prevalence and role of SSN entrapment in patients with shoulder pain especially after failed rotator cuff reconstruction.

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