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Efficacy of suprascapular nerve block compared with subacromial injection: a randomized controlled trial in patients with rotator cuff tears

Joseph A. Coory, MBBS, BSc(Anat)[a,*], Adam F. Parr, MBBS, FRACS[a], Matthew P. Wilkinson, MBBS, FRACS[a], Ashish Gupta, MBBS, MSC, FRACS[a,b]

[a]*Townsville Hospital, Douglas, QLD, Australia*
[b]*Greenslopes Private Hospital, Brisbane, QLD, Australia*

Hypothesis: We aimed to compare the clinical efficacy of a suprascapular nerve block (SSNB) versus subacromial injection (SA) for outpatient treatment of patients with symptomatic rotator cuff tears in a double-blinded, randomized controlled trial using sealed-envelope randomization.

Methods: A total of 42 participants with symptomatic partial- and full-thickness rotator cuff tears quantified by ultrasound or magnetic resonance imaging received either an ultrasound-guided SSNB or SA. The primary outcome measure was shoulder function measured by the modified Constant-Murley (CM) score and the secondary outcome was the pain score measured by a visual analog scale at 2, 6, and 12 weeks after injection.

Results: We analyzed 43 shoulders (27 in male patients, 62.2%). The mean age was 65.2 years (standard deviation [SD], 11.9 years). Of the shoulders, 22 (51.2%) underwent SAs and 21 (48.8%) underwent SSNBs. Continuous variables were analyzed by an independent *t* test (2 tailed), and nominal data were analyzed by the Fisher exact test (1 sided). At 6 weeks, the mean change from the baseline CM score was significantly higher in the SSNB group than in the SA group (14.3 [SD, 18.1] vs 3.0 [SD, 12.8]; $P = .048$). At 12 weeks' follow-up, the SSNB group had a significantly higher CM score than the SA group (57.6 [SD, 10] vs 44.6 [SD, 16]; $P = .023$) and greater improvement from the baseline CM score (23.4 [SD, 17.5] vs 7.8 [SD, 16.5]; $P = .014$). At 12 weeks, the visual analog scale score was significantly better in the SSNB group than in the SA cohort (9.9 [SD, 3.3] vs 7.3 [SD, 4.3]; $P = .03$).

Conclusions: This study demonstrates that an SSNB resulted in better pain and functional results than an SA at 6 and 12 weeks for symptomatic rotator cuff tears.

Level of evidence: Level II; Randomized Controlled Trial; Treatment Study

Keywords: Shoulder; rotator cuff; anesthesia; pain management; suprascapular nerve block; subacromial injection; nonoperative management

The Townsville Hospital ethics board approved the study protocol (approval No. HREC/14/qths/11, SSA/14/qths/96).

*Reprint requests: Joseph A. Coory, MBBS, BSc(Anat), 100 Angus Smith Dr, Douglas, QLD 4810, Australia.
E-mail address: jcoory@gmail.com (J.A. Coory).

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Rotator cuff tears are among the most common musculoskeletal disorders and are a substantial cause of disability in the adult population.[25] Treatment of rotator cuff tears depends on the morphology of the tear and the age and comorbidities of the patient. Commonly, a trial of nonoperative management including activity modification, nonsteroidal anti-inflammatory drugs (NSAIDs), physiotherapy, and subacromial injections (SAs) is attempted.[12,15,30] SAs are used as part of the nonoperative management process to relieve pain and allow early mobilization and physiotherapy to retrain the remainder of the rotator cuff. The evidence to support the efficacy of SAs varies.[5,9]

The suprascapular nerve (SSN) is the dominant motor supply to the supraspinatus and infraspinatus. The SSN provides the major sensory supply to the superior part of the shoulder. Anatomic studies have demonstrated that the SSN sensory branches supply the acromioclavicular joint, subacromial space, rotator cuff, peri-coracoid region, and part of the superior labral complex.[4,34] The inferior part of the shoulder capsule receives sensory branches from the axillary and subscapular nerves. It has been postulated that SSN traction (contributing to perineural inflammation) may be a cause of neurogenic pain and reduced function in patients with rotator cuff tears.[6] Full-thickness rotator cuff tears cause traction and tension on the nerve, which has been shown to be dynamic with range of movement and increase with tear size.[2,27] Suprascapular neuropathy is the most severe clinical manifestation of this and is associated with large to massive rotator cuff tears.[7,26] The suprascapular nerve block (SSNB) has been shown to be an effective form of pain relief in patients with a broad range of shoulder pathologies.[10] Vecchio et al[33] demonstrated that SSNBs improved shoulder pain and abduction in patients with rotator cuff tears.

The use of corticosteroid injections in shoulder pathology has been widely studied. There are multiple systematic reviews of their use for rotator cuff tears. Overall, the literature has shown a small benefit in pain and function from SAs measured at 4 to 6 weeks.[9] When compared with the use of NSAIDs alone, SAs are superior in improving shoulder function but not in reducing pain.[31] There is limited evidence to suggest SAs have an effect beyond 6 weeks.[5,9,16,31] The injection of a corticosteroid into the subacromial space also increases the risk of infection if early operative intervention is required.

The SSN is the major sensory nerve supply to the superior part of the shoulder, and rotator cuff tears have been shown to cause varying degrees of traction to the SSN. The perineural inflammation due to the compression should respond to a local anesthetic and corticosteroid injection similarly to nonoperative intervention for carpal tunnel syndrome or a spinal nerve root. There are no published randomized controlled trials comparing SAs with SSNBs.

The purpose of our study was to compare SSNBs with SAs in the nonoperative management of rotator cuff tears. Our hypothesis was that SSNBs would be more effective than SAs in restoring function and reducing pain at 3 months.

Materials and methods

Study design

At a single tertiary orthopedic referral center, from February 2014 to December 2015, patients with symptomatic rotator cuff tears were enrolled in a double-blind, randomized controlled trial comparing SSNBs with SAs. An independent safety monitoring board was appointed to monitor the trial. Written informed consent was obtained from each participant.

Study population

We assessed the eligibility of patients in the outpatient referral database at our institution. The inclusion criteria included patients older than 45 years with symptomatic partial- and full-thickness rotator cuff tears of all sizes, confirmation of the diagnosis by magnetic resonance imaging or ultrasound (3 patients were unable to undergo magnetic resonance imaging), and willingness to participate in 3 months' follow-up. We excluded patients who had signs of adhesive capsulitis, who had glenohumeral joint osteoarthritis (Samilson-Prieto grade 3 or greater), who had medical contraindications to injection of a local anesthetic and corticosteroid, who received previous local anesthetic and corticosteroid injection (HCLA) within 3 months, who underwent prior shoulder surgery on the affected side, who were taking oral corticosteroids or disease-modifying antirheumatic drugs, who were unable to reliably perform a visual analog pain assessment, or who were unable to consent. All rotator cuff tears at our institute undergo a 3-month nonoperative rehabilitation trial period. Patients with large acute traumatic rotator cuff tears are advised to undergo an acute repair. During the trial, no patient was offered surgical intervention. At the completion of the study, patients were re-evaluated and given the choice to either proceed with surgery or continue a nonoperative treatment course.

Randomization

Patients were randomly assigned to the SSNB or SA group in a 1:1 ratio by use of an intention-to-treat principle. Randomization was carried out with a sealed-envelope technique. The envelopes were prepared by a research assistant with either an SA or SSNB injection request inside. The envelope was darkened to maintain blinding of the prescribers. When a patient was enrolled in the study, an envelope was selected and taken to the radiology department by the research assistant. The injections were then performed by 1 of 2 trained interventional radiologists with an interest in musculoskeletal interventions.

Study intervention

Patients in the SSNB group received an ultrasound-guided SSNB via the technique popularized by Harmon and Hearty.[18] This approach targets the SSN at the suprascapular notch, and its accuracy has been documented in clinical and cadaveric studies.[28] The SA group received an ultrasound-guided SA via a standard posterior approach. In both groups, we administered 9 mL of 1% ropivacaine and 1 mL of betamethasone.[14] Care was taken in the SSNB cohort to ensure the injectate was directed medially toward the suprascapular

notch and brachial plexus to limit extravasation into the subacromial space.

Each participant received standard advice regarding activity modification and rotator cuff tear Murdoch protocol physiotherapy. Patients were permitted to take NSAIDs on an as-required basis.

Power analysis

From previous research into SAs, it was decided that a change in the pain score from baseline of 0.2 and a standard deviation (SD) of 0.22 would be used.[9] By use of a 2-sided significance level of 5% and 90% power, it was shown that 25 patients would be required per group. The minimal clinically important change for the Constant-Murley (CM) score in patients with rotator cuff tears or subacromial bursitis has been shown to be 10.[19,22] Post hoc power analysis demonstrated that with a CM score difference of 10 ($\alpha = .05$, $\beta = .2$), we achieved a power of 0.9 with 42 patients.

Initial assessment

The following information was collected by an orthopedic surgeon at entry of patients into the study: age, sex, smoking status, height, weight, medical comorbidities, medication history, side of tear, duration of tear (acute or chronic), previous shoulder injections, and activities of daily living (independent, assisted, or dependent). In addition, the baseline modified CM score[11] and visual analog scale score were recorded.

Patient follow-up

The patients and the orthopedic surgeon performing the follow-up assessments were blinded to the intervention the patients had received. The patients were followed up by an orthopedic surgeon at 2, 6, and 12 weeks after injection. At each appointment, patient assessment was carried out by the same observer. The primary outcome measured was the modified CM score.[11] Strength was measured using a fixed spring balance method at 90° of scapular abduction with the wrist in full pronation, with the score being the highest value obtained from 3 maximal effort attempts, as has been described previously.[3,11] The secondary outcome was pain as assessed on a visual analog scale. Data were recorded on a hard copy and later transferred to a deidentified database by the research assistant.

We recruited 48 shoulders in 42 patients into the study. Of the patients, 5 were not included in the final analysis because of loss to follow-up (3 patients did not attend any follow-up after injection [2 with SSNB and 1 with SA], whereas 1 patient [with SSNB] was reviewed at 2 weeks after injection with a CM score of 66 and 1 patient [with SA] was reviewed at 6 weeks after injection with a CM score of 27 but did not attend the 12-week follow-up). An attempt was made to contact each patient who was lost to follow-up by telephone, and a letter was sent to each patient. For analysis, we had a complete data set for baseline characteristics and preoperative and 12-week CM scores.

Statistical analysis

Statistical analysis was carried out using SPSS software, version 15.0 (IBM, Armonk, NY, USA), as well as version 24.0 for Windows for further analysis. Initially, continuous variables were assessed using the Kolmogorov-Smirnov test, histograms, and normal quantile-quantile plots, which demonstrated that CM scores at 12 weeks were evenly distributed ($P = .028$). Continuous variables were analyzed by an independent t test (2 tailed), and nominal data were analyzed by the Fisher exact test (1 sided).

Results

We analyzed 43 shoulders (27 in male patients, 62.2%). The mean age was 65.2 years (SD, 11.9 years). Of the shoulders, 22 (51.2%) underwent SAs and 21 (48.8%) underwent SSNBs (Fig. 1). Of the patients, 3 received simultaneous bilateral injections; each shoulder was randomized independently. Baseline characteristics were similar between the SA and SSNB groups, except for hypertension, which was overrepresented in the SA cohort. Pre-intervention CM scores were similar between groups (Table I).

At 2 and 6 weeks' follow-up, no difference in CM scores was found between the 2 cohorts (Table II). However, at 6 weeks, the mean change from the baseline CM score was significantly higher in the SSNB group than in the SA group (14.3 [SD, 18.1; 95% confidence interval (CI), 6.56-22] vs 3.0 [SD, 12.8; 95% CI, –2.35 to 8.35]; $P = .048$). At 12 weeks' follow-up, the SSNB group had a significantly higher mean CM score than the SA group (Fig. 2) and greater improvement from the baseline CM score (23.4 [SD, 17.5; 95% CI, 15.9-30.9] vs 7.8 [SD, 16.5; 95% CI, 0.91-14.7]; $P = .014$). The difference in CM scores was accounted for by significant differences in the visual analog scale score, range of motion, and power between the SA and SSNB groups at 12 weeks (Table II).

Discussion

The main finding in this randomized, double-blinded, controlled trial in 42 patients with rotator cuff tears was the superiority of SSNBs over SAs at 12 weeks. The CM score was selected as our primary outcome measure as it has good interobserver reliability and has been widely used in the published literature on SAs.[3,11,36] The study enrolled a representative group of symptomatic rotator cuff tears and used the intention-to-treat principle to increase the external validity of our data. We achieved the minimal clinically important change from baseline in both the SA and SSNB groups.[19,22] The SSNB group outperformed the SA group at 12 weeks. On subgroup analysis of the strength component of the CM score, this component was found to be superior in the SSNB group.

The SSN plays an important role in the motor and sensory innervation of the shoulder. The SSN is a branch of the brachial plexus from which it receives contributions from the C5, C6, and more variably, C4 nerve roots.[1] Its motor supply is to the supraspinatus and infraspinatus muscles. In addition, it supplies 70% of sensation to the shoulder joint,

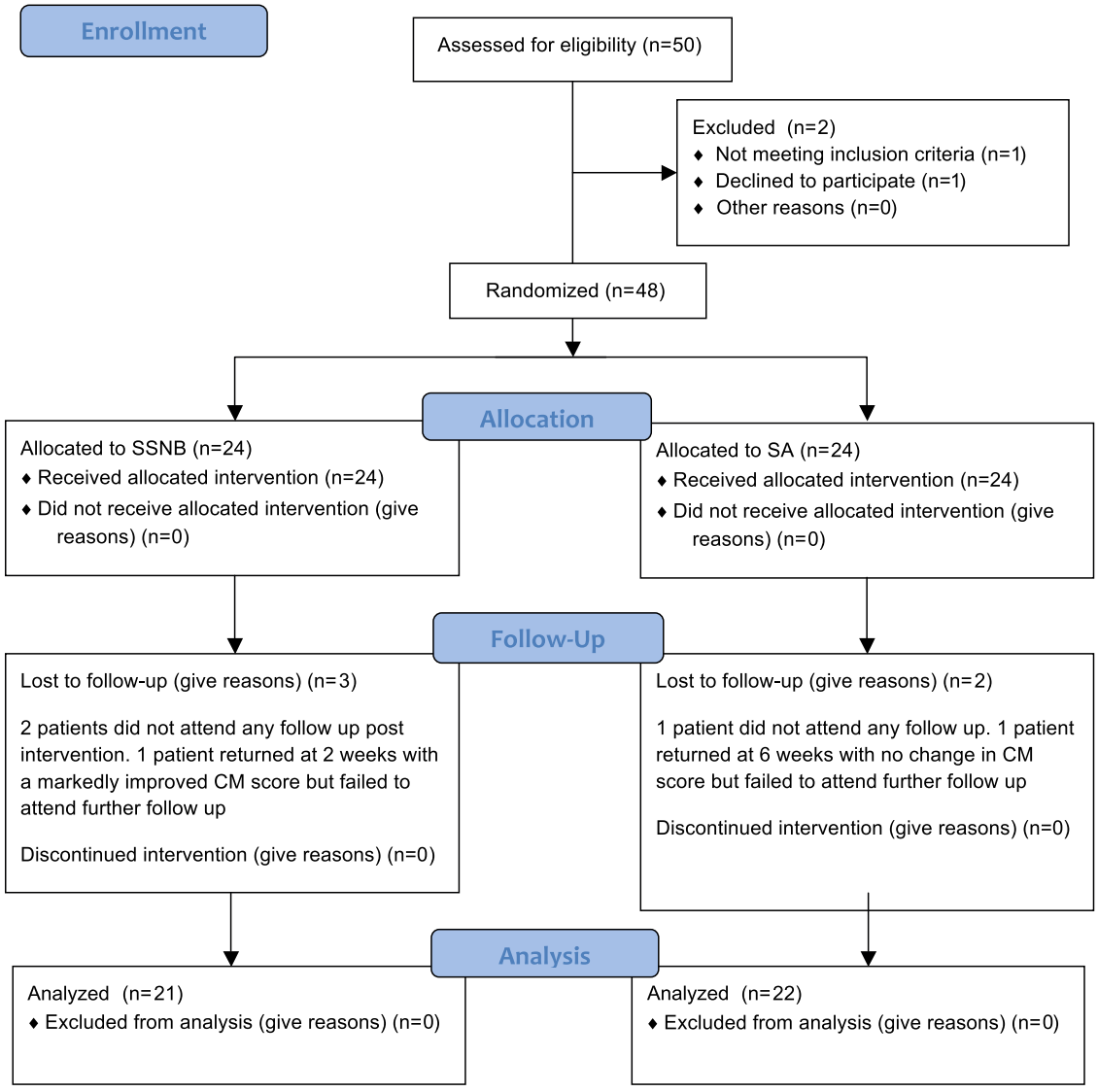

Figure 1 Consolidated Standards of Reporting Trials (*CONSORT*) flow diagram. *SSNB*, suprascapular nerve block; *SA*, subacromial injection; *CM*, Constant-Murley.

acromioclavicular joint, coracoclavicular ligaments, coracohumeral ligament, and SA bursa.[29,34]

The anatomy of the SSN puts it at risk of traction and compression at the suprascapular and spinoglenoid notches. The SSN enters the supraspinatus fossa at the suprascapular notch, where it is tethered beneath the transverse suprascapular ligament.[4,17,35] The nerve then runs obliquely in the supraspinatus fossa before passing through the spinoglenoid notch to innervate the infraspinatus muscle.[4] The suprascapular notch is an important anatomic structure. The variability in shape of the notch as well as its relationship with the superior transverse scapular ligament has been implicated in impingement

Table I Baseline characteristics comparing SSNB and SA

Variable	SA (n = 22)	SSNB (n = 21)	*P* value
Age, yr	65.5 (45-85)	70.0 (43-85)	.141
Male sex	13 (59.1%)	14 (66.7%)	.422
Ex-smoker or current smoker	12 (54.5%)	7 (33.3%)	.137
Height, cm	167.5 (7.7)	166.9 (8.3)	.794
Weight, kg	85.2 (12.2)	78.0 (14.3)	.082
Body mass index	30.5 (5.0)	28.2 (5.7)	.156
Right-sided tear	15 (68.2%)	11 (52.4%)	.398
Degenerative tear	15 (68.2%)	16 (76.2%)	.404
Full thickness	14 (63.3%)	18 (85.7%)	.162
Partial thickness	8 (36.7%)	3 (10.5%)	
Previous shoulder injection	6 (27.2%)	10 (47.6%)	.144
Independent with activities of daily living	17 (77.3%)	15 (71.4%)	.598
Dyslipidemia	9 (40.9%)	12 (57.1%)	.224
Hypertension	15 (68.2%)	8 (38.1%)	.047
Diabetes mellitus	7 (31.8%)	4 (19.0%)	.272
Chronic obstructive pulmonary disease	3 (13.6%)	3 (14.3%)	.645
Chronic kidney disease	1 (4.5%)	1 (4.8%)	.744
Constant-Murley score	37.6 (15.0)	35.3 (12.8)	.606

SSNB, suprascapular nerve block; *SA*, subacromial injection.
Continuous variables are presented as mean (standard deviation), and categorical data are presented as number (percentage). Nominal data were analyzed by the Fisher exact test (1 sided), and continuous data were analyzed by an independent *t* test (2 tailed).

Table II Constant-Murley scores throughout study comparing SSNB and SA

	SA	SSNB	Significance (*P* value)
Before injection	n = 22	n = 21	
Activity and positioning	7.4 (4.0)	7.8 (4.2)	.753
Visual analog scale score	5.7 (4.7)	5.1 (4.8)	.663
Range of motion	21.9 (8.5)	20.8 (8.5)	.661
Power	2.6 (3.3)	1.8 (3.1)	.399
Constant-Murley score	37.6 (15.0)	35.3 (12.8)	.606
2 weeks	n = 20	n = 19	
Activity and positioning	6.0 (3.2)	6.4 (2.5)	.600
Visual analog scale score	9.1 (4.7)	8.6 (3.4)	.784
Range of motion	25.6 (9.8)	27.8 (8.2)	.433
Power	3.6 (3.5)	4.0 (3.2)	.749
Constant-Murley score	44.2 (15.9)	47.5 (11.1)	.456
6 weeks	n = 18	n = 17	
Activity and positioning	5.3 (3.1)	6.0 (3.1)	.497
Visual analog scale score	7.3 (4.6)	9.5 (3.9)	.139
Range of motion	24.9 (8.7)	29.4 (9.3)	.146
Power	3.4 (3.7)	5.4 (4.0)	.151
Constant-Murley score	40.9 (14.8)	49.7 (13.8)	.080
12 weeks	n = 22	n = 21	
Activity and positioning	6.6 (3.0)	7.5 (3.3)	.315
Visual analog scale score	7.3 (4.3)	9.9 (3.3)	.030
Range of motion	26.6 (8.9)	32.5 (5.9)	.014
Power	4.2 (3.7)	7.7 (3.1)	.002
Constant-Murley score	44.6 (16.0)	57.6 (10.0)	.003

SSNB, suprascapular nerve block; *SA*, subacromial injection.
Data are presented as mean (standard deviation). Significance was tested using an independent *t* test (2 tailed). Power was measured in pounds in the scapular plane.

of the SSN.[13] As the SSN is tethered at both the suprascapular and spinoglenoid notches, it is susceptible to traction and compression at these landmarks.

Although small numbers negated the possibility of performing a subgroup analysis, the data showed a greater number of full-thickness tears in the SSNB cohort. Despite this high number, the patients in the SSNB group had a better CM score at 12 weeks than those in the SA group. We hypothesized that SSNBs would result in improved function by reducing pain, particularly in large to massive rotator cuff tears, which have been shown to place traction on the nerve. In addition, rotator cuff tears and other causes of scapular dyskinesia result in protraction of the scapula, which may lead to traction of the SSN and its impingement under the transverse scapular ligament.[23] This can be clinically tested by the SSN stretch test.[24] Moreover, this chronic compression is seen surgically as perineural oedema and erythema during SSN release.[24] This is quite similar to the observations made during decompression of the median nerve or the ulnar nerve for entrapment syndromes. SA has been associated with a higher incidence of postoperative infection if surgery is undertaken in the 6 to 12 weeks after injection. This risk may be avoided if the SSN is used instead because the corticosteroid is injected away from the operative site.

Suprascapular neuropathy in patients with full-thickness rotator cuff tears is a well-defined clinical entity, occurring in 8% to 27% of patients.[8,32] We believe that suprascapular neuropathy is the most severe form of a spectrum of SSN dysfunction caused by traction on the nerve resulting in inflammation, particularly in full-thickness tears.[21] In addition, the deltoid may be dysfunctional secondary to a reflex inhibitory pain arc mediated by traction on the SSN during forced abduction, as evidenced by the improved power scores in participants receiving SSNBs (from 1.8 [SD, 3.1] to 7.7 [SD, 3.1]; $P = .002$). A single study has noted an association between deltoid atrophy and large to massive rotator cuff

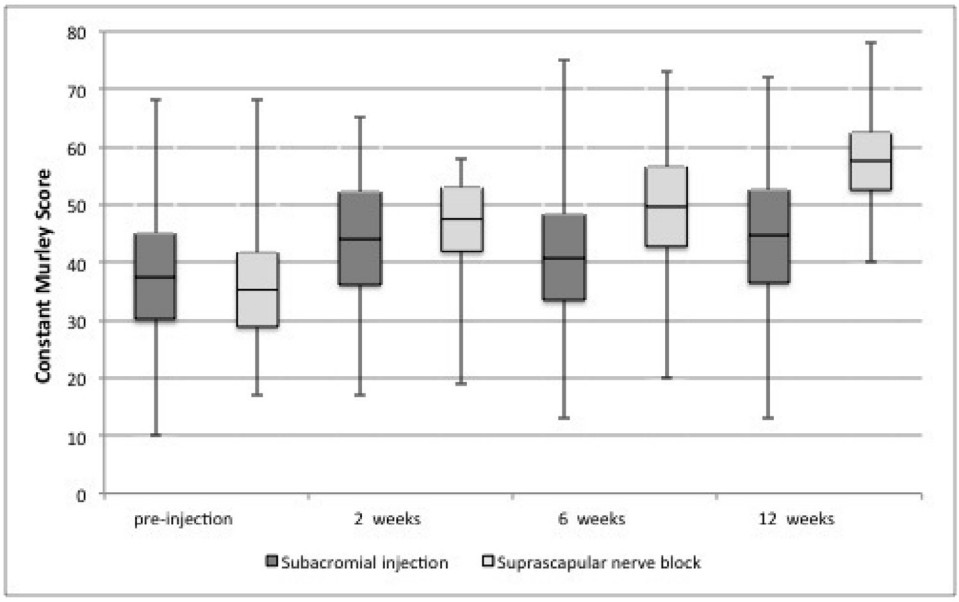

Figure 2 Box-and-whisker plot displaying Constant-Murley scores for subacromial injections and suprascapular nerve blocks before injection and at 2, 6, and 12 weeks after injection. Constant-Murley scores are presented as mean, standard deviation, and range.

tears.[20] This is an area of weakness in the current published literature and an area in which future research is needed.

There are several limitations to our study: The sample size did not enable us to perform subgroup analysis of rotator cuff morphology. In addition, given that the SSNB group was still improving at the 3-month mark, the duration of the effect of these injections is unknown. Our follow-up period of 3 months was guided by results of previous trials on SAs in which little improvement was seen at 3 months.[9] In the 3 patients (6 shoulders) receiving bilateral injections, there may be more systemic absorption of the corticosteroid, potentially providing benefit to the contralateral shoulder. Although the trial design was double blinded, we recognize that educated patients may be able to identify the type of injection owing to the location of the needle; however, both SAs and SSN injections were performed through a posterior approach using an aseptic draping technique as per the patient information handout. Finally, the administration of an ultrasound-guided SSNB is a subspecialty skill requiring an experienced operator, and such an operator may not be readily available.

Conclusion

We found that SSNBs outperform SAs in patients initially receiving nonoperative management of symptomatic rotator cuff tears. This study has shown that an SSNB is an alternative to an SA for nonoperative management of rotator cuff tears, particularly full-thickness tears. Future research should be directed to the length of therapeutic effect of SSNBs and their utility in identifying a subset of patients who would benefit from SSN release.

Disclaimer

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