Randomized Trial

Comparison of Spinoglenoid Versus Suprascapular Notch Approaches for Ultrasound-Guided Distal Suprascapular Nerve Blocks for Shoulder Pain: A Prospective Randomized Trial

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Background: Distal suprascapular nerve blocks (SSNB) can be performed at the level of the suprascapular notch (the preferred site) or at the level of the spinoglenoid notch.

Objectives: To compare the efficacy and safety of spinoglenoid versus suprascapular notch approaches for ultrasound (US)-guided distal SSNB in patients with chronic shoulder pain.

Study Design: Prospective randomized controlled trial.

Setting: Outpatient physical medicine and rehabilitation outpatient clinic of a tertiary center.

Methods: Eighty patients with chronic unilateral shoulder pain were included in this study. Patients were randomized into 2 groups: group 1 (SSNB at the level of the spinoglenoid notch) and group 2 (SSNB at the level of the suprascapular notch). The patients were evaluated for pain according to the Shoulder Pain and Disability Index (SPADI) and a secondary visual analog scale (VAS), as well as for the outcome measures of range of motion (ROM) and pain pressure threshold (PPT) at baseline and at one, 4, and 12 weeks after the injection.

Results: Statistically significant improvement was observed in the SPADI and VAS scores and ROM measurements, and the PPT measurements were similar at all post-injection follow-ups in both groups. Changes in outcome measures were similar between the groups, except for some ROM measurements at the post-injection follow-ups.

Limitations: Heterogeneity of shoulder pain etiologies.

Conclusion: Both distal SSNB approaches significantly improved pain and disability scores in patients with chronic shoulder pain, with no observable differences in the short-to-medium term. SSNB performed at the level of the spinoglenoid notch is therefore not inferior in efficacy and safety to SSNB performed at the level of the suprascapular notch.

Key words: Shoulder pain, suprascapular nerve block, spinoglenoid notch, suprascapular notch, ultrasound

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Shoulder pain is a common musculoskeletal complaint in the general population and tends to be chronic in nature (1). The problem is usually caused by pathological conditions that directly affect key shoulder-related structures, such as bones, joints, tendons, muscles, bursae, and ligaments, and is

classified as "chronic secondary musculoskeletal pain" by the International Association on the Study of Pain (IASP) (2,3). However, a relationship between pain and any abnormal finding(s) on diagnostic imaging cannot always be clearly demonstrated, especially in older patients (4). Nevertheless, the characteristics and intensity of shoulder pain are among the primary determinants of the associated disease burden in most patients. One of the characteristics that requires particular clinical awareness is central sensitization, which elicits pain hypersensitivity, and its presence is associated with increased pain catastrophizing, kinesiophobia, and disability in patients with chronic shoulder pain (5,6).

One widely applied treatment option for patients with chronic shoulder pain is the suprascapular nerve block (SSNB), which provides pain relief and functional improvement for up to 12 weeks (7). In addition, when added to physical therapy designed to eliminate the cause of shoulder pain, SSNB can also provide positive synergistic effects on clinical outcomes (8). Moreover, pulsed radiofrequency of these patients' suprascapular nerves has been shown to provide more than 12 weeks of pain relief and reduce the need for medication (9).

The suprascapular nerve, which provides the transmission of pain perception, is responsible for about 70% of the sensory innervation of the shoulder (10). Although anatomical variations exist are encountered, the sensory branches of the distal suprascapular nerve depart from its portion between the proximal region of the suprascapular notch and the distal region of the spinoglenoid notch (11) (Fig. 1). The literature contains reports of distal SSNB techniques performed at 2 different parts of the nerve: the suprascapular notch, which is the most commonly preferred site, and the spinoglenoid notch, which is a lesser-known site (12,13). To our knowledge, no studies have directly compared these 2 distal SSNB approaches.

Chansoria et al (13) reported significant improvement in short-term pain and function in patients with chronic shoulder pain who underwent SSNB at the level of the spinoglenoid notch. The researchers also claimed that, compared to SSNB performed at the level of the suprascapular notch, their technique had no risk of pneumothorax. However, their study presented important limitations, including its short follow-up period and the absence of a control group. The described blind SSNB technique at the level of the spinoglenoid notch was also relatively difficult.

The aim of the present study was to test the efficacy and safety of ultrasound (US)-guided SSNB at the level of the spinoglenoid notch as a treatment for chronic shoulder pain. Considering the sensory innervation of the suprascapular nerve, we hypothesized that SSNB at the level of the spinoglenoid notch would not result in inferior clinical outcomes when compared to SSNB at the level of the suprascapular notch.

Methods

Study Design and Patients

The present study was conducted in a prospective, randomized, double-blind fashion at a tertiary-care university hospital in Kayseri, Turkey, from June 2021 to August 2022. The Consolidated Standards of Reporting Trials (CONSORT) guidelines were used as the reference for the standardization of the data reported in this study. Ethical approval for the study was obtained from the Erciyes University Clinical Research Ethics Committee (approval date: May 05, 2020; approval number: 2021/353). The study was also registered at ClinicalTrials.gov (NCT04938037). The research adhered to the Ethical Principles for Medical Research Involving Human Subjects outlined in the World Medical Association's Declaration of Helsinki, as revised in 2013. A written informed consent form approved by the ethics committee was signed by each participant who agreed to participate in the study.

All patients over the age of 18 who had chronic shoulder pain of any specific etiology (duration > 3 months), had a visual analog scale (VAS) score above 4 despite conservative treatment, and gave informed written consent were screened for eligibility for the study. Exclusion criteria were previous fractures or surgery around the shoulder, receipt of any injections to the affected shoulder in the last 3 months, chronic pain due to other diseases such as malignancy, cervical radiculopathy, hemiplegia, or uncontrolled diabetes or hypertension, coagulopathies, local infection of the shoulder region, and allergy to local anesthetics.

The clinical diagnosis of chronic shoulder pain for each included patient was determined by physical examination and radiologic imaging techniques (magnetic resonance imaging [MRI] or US).

Patients were randomized into 2 groups: group 1 received SSNB at the spinoglenoid notch level, while group 2 received SSNB at the suprascapular notch level. Stratified randomization was performed in 4 blocks based on age and gender. Group allocations were made

(using sealed envelopes) by our medical secretary. The assigned numbers were presented to the physician at the time the procedure was performed. The patients and the physician assessing the outcomes were blinded to the group assignments, but the physician who performed the injections could not be blinded.

Procedures

All injections were administered by a single experienced physician specializing in musculoskeletal injections, who used the linear transducer (LA3-16AD) of the Samsung HM70A with Plus™ US device. The same injection solutions, which were prepared for both groups, consisted of 1 mL of methylprednisolone acetate (40 mg/mL) and 5 mL of 0.5% bupivacaine for the SSNB.

For SSNB at the level of the spinoglenoid notch, the patients were positioned on a stretcher in the lateral decubitus position between the US device and the physician. The patient's injection-side hand was placed on the contralateral shoulder. The transducer was positioned on the glenohumeral joint, parallel to the inferior border of the spina scapula, and then shifted medially to visualize the spinoglenoid notch. After sterile prep, a 20 g 3.5-inch needle was advanced, using an in-plane technique, into the spinoglenoid notch. A lateral-medial needle insertion was used so that the intended target of the final needle tip was at the medial wall of the spinoglenoid notch (Fig. 2).

For SSNB at the level of the suprascapular notch, the technique described by Harmon et al (12) was used. In brief, the patient was positioned seated between the physician and the US equipment. The patient's injection-side hand was placed on the shoulder on the opposite side. To view the suprascapular notch, the physician positioned the transducer above the acromion, parallel to the spina scapula, and then gently adjusted the transducer medially. After sterile prep, a 20 g 3.5-inch needle was advanced into the suprascapular notch.

One week after the injection, all patients received a prescribed exercise regimen to perform in their own homes. The exercise routine encompassed self-stretching, joint mobility exercises, and strength-building activities. A designated physical therapist demonstrated the exercises to each patient individually, and an exercise booklet was provided to assist them.

Finally, the patients were advised to use acetaminophen (500 mg) and/or naproxen (750 mg), if necessary. They were asked not to take analgesics at the follow-up points or 1 day before them, as doing so could affect the clinical outcome measures.

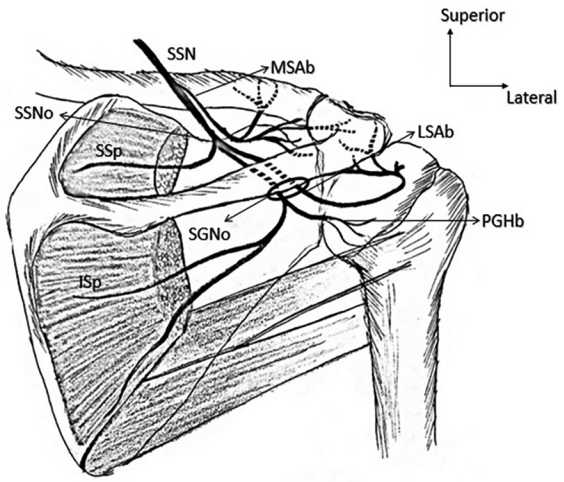

Fig. 1. *Sensory and motor branches of the suprascapular nerve.*
SSN: Suprascapular nerve; SSp: branch to supraspinatus muscle; ISp: branch to infraspinatus muscle; MSAb: medial subacromial branch; LSAb: lateral subacromial branch; PGHb: posterior glenohumeral branch; SSNo: suprascapular notch; SGNo: spinoglenoid notch.

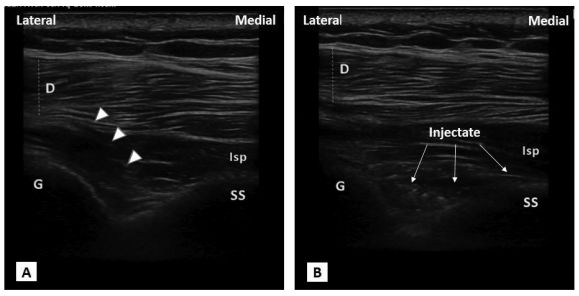

Fig. 2. *Ultrasonographic image of the SSNB at the level of the spinoglenoid notch. (a) Imaging the advanced needle toward the spinoglenoid notch using a latero-medial insertion and in-plane technique. (b) Imaging of the distribution of the injection solution after the procedure.*
SSNB: suprascapular nerve block; D: deltoid muscle; Isp: infraspinatus muscle; G: glenoid; SS: spina scapula; Arrowheads: the needle tip.

Outcome Measures

All patients were evaluated for primary and secondary outcome measures before injection (baseline) and at one, 4, and 12 weeks after injection by an investigator blinded to the injections. The primary outcome measure of the study was the Shoulder Pain and Disability Index (SPADI) score, while the secondary outcome measures were VAS scores, active range of

motion of the shoulder (ROM), pressure pain thresholds (PPT), and treatment satisfaction. All adverse events that occurred during the procedure and at a follow-up visit were recorded.

Primary outcome measure: The SPADI is a shoulder-specific index consisting of 13 items that assess shoulder pain and disability on 2 different scales. Each item is scored between 0 and 10, and the resulting score is converted into a 100-point scale separately for pain, disability, and total score. Increased SPADI scores indicate an increase in patients' shoulder-related pain and disability. Patients with a reduction in the total SPADI score of 18 points or more from the baseline to week 12 (the last follow-up) were considered treatment successes (14). The SPADI has been shown to be valid and reliable in Turkish (15).

Secondary outcome measures: The VAS (0–10 range) was evaluated in each patient for night and activity. An additional VAS assessment was performed one hour after the injection. The patients' active shoulder ROM measurements were taken using a standard manual goniometer. Measurements were made in the supine position, and active forward flexion (FF), abduction (Ab), internal rotation (IR), and external rotation (ER) were measured. The IR and ER measurements were made with the shoulder abducted at 90°. The PPT measurements were obtained over the middle deltoid, upper trapezius, infraspinatus, and tibialis anterior muscles using a 1 cm diameter probe from an electronic digital display algometer (Commander Echo® Algometer, JTECH Medical). Measurements were taken directly on the skin and vertically, and the patient was instructed to stop when the feeling of pressure first turned into pain and discomfort. Three measurements were taken from each region, and the average of the last 2 measurements was recorded. The PPT values were expressed as kilograms per square centimeter (kg/cm^2). A low PPT value represents a decrease in the pain threshold and, therefore, increased sensitivity. A 5-point Likert scale was used to evaluate the patients' overall satisfaction with the treatment (1 = extremely dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, and 5 = extremely satisfied).

The patients' compliance with the exercise program was queried at the fourth and 12th weeks after the injection. The patients were asked to choose among "Never did," "I did it occasionally," and "I did it regularly." Finally, they were asked how much they used the acetaminophen (500 mg) and naproxen (750 mg) that had been sent home with them after the injection at the 1st, 4th, and 12th weeks. The total amount of drugs used was recorded.

Statistical Analyses

The sample size required for the research was calculated via a Web site (http://statulator.com/SampleSize/ss2M.html). In a previous study, the Minimal Clinically Important Difference (MCID) value for SPADI ranged from 8 to 13 points (14). We established our research hypothesis that the clinical results of SSNB at the level of the spinoglenoid notch would not be noninferior to SSNB at the level of the suprascapular notch. Accordingly, when the noninferiority margin is -9 and the standard deviation is 15.3, with 80% power and type 1 error 0.05, 36 patients in each group should be recruited. Because we assumed a 10% dropout rate, 40 patients were planned for each group.

The collected data were statistically analyzed using IBM SPSS™ ver. 22.0 (IBM Corp). All analyses were performed according to the "intention to treat" principle, and the missing data were completed using the single imputation method. The Shapiro-Wilk test, as well as histograms and QQ plots, were used to test whether the data were normally distributed. Analysis results were presented as mean ± SD for numerical data and as numbers and percentages for categorical data. For numerical data, the differences between groups were compared using the independent samples t test or the Mann–Whitney U test. Categorical data were analyzed using chi-square tests or Fisher's exact test. In addition, the differences (Δ) between the baseline values of the outcome measures and the values at the follow-up time points were calculated and included in the intergroup comparison. The Friedmann test was used for intragroup comparisons of the changes in outcome measures from the baseline to follow-up times. The post hoc Dunn-Bonferroni test was then used for pairwise comparisons of follow-up times. A *P* value of less than 0.05 was considered statistically significant.

Results

A total of 112 patients were screened for eligibility. After we excluded 32 patients who met the exclusion criteria or refused to participate, 80 patients were randomized to receive SSNB at the level of the spinoglenoid notch (group 1; n = 40) or SSNB at the level of the suprascapular notch (group 2; n = 40). During the follow-up, 4 patients from group 1 and 3 patients from group 2 dropped out of the study (Fig. 3).

Of the patients included in the study, 51 had partial rotator cuff tears, 8 had total rotator cuff tears, 23 had bicipital tendinitis, 21 had adhesive capsulitis, 11 had acromioclavicular (AC) joint disease, and 5 had subacromial impingement syndrome (SIS). The number of patients with adhesive capsulitis was statistically higher in group 2 than in group 1 ($P = 0.005$). The patients' other clinical and demographic characteristics were similar in both groups (Table 1).

No significant difference was detected between the groups' baseline SPADI, VAS, or PPT scores ($P > 0.05$ for all). However, the means of all ROM measurements at the baseline were significantly lower in group 2 than in group 1 ($P < 0.05$ for all) (Table 2).

Both groups showed significant improvements from their baseline SPADI and VAS scores at all follow-up points ($P = 0.001$ for all). The changes from the baseline SPADI and VAS scores at weeks one, 4, and 12 after the injection were similar between the 2 groups ($P > 0.05$ for all). In addition, no difference was noted between the groups in the change in VAS activity scores measured at one hour compared to the baseline ($P = 0.379$) (Table 3).

Statistically significant improvements from the baseline were observed in all ROM measurements in both groups at all follow-up appointments ($P < 0.05$ for all). The changes in FF and IR were significantly higher in group 2 than in group 1 at all follow-up appointments ($P < 0.05$ for all) (Table 4).

For both groups, no statistically significant change

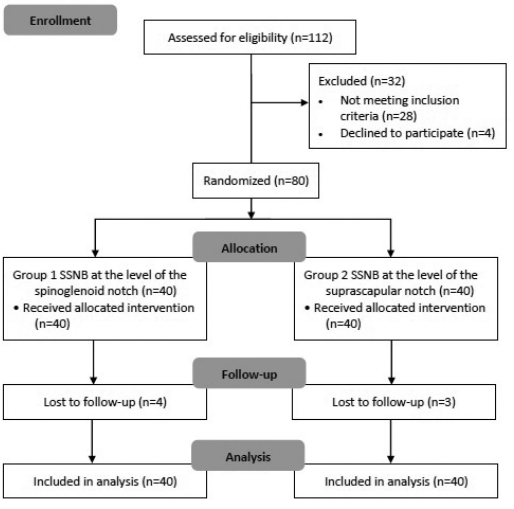

Fig. 3. *CONSORT guideline flow diagram for the study.*
CONSORT: Consolidated Standards of Reporting Trials; SSNB: suprascapular nerve block.

Table 1. *Comparison of the demographic and clinical characteristics of the 2 groups.*

	Group 1 (n = 40)	Group 2 (n = 40)	*P* value
Age, years	57.1 ± 9.3	57.2 ± 8.2	0.959
Gender, male/female	11/29	13/27	0.626
BMI, kg/cm^2	29.2 ± 5.6	30.0 ± 5.1	0.489
Affected shoulder, right/left	26/14	24/16	0.644
Symptom duration, months	14.2 ± 9.5	15.6 ± 12.3	0.826
Diagnosis, n (%)			
Partial-thickness rotator cuff tears	27 (67.5)	24 (60)	0.485
Full-thickness rotator cuff tears	3 (7.5)	5 (12.5)	0.712
Bicipital tendinitis	14 (35)	9 (22.5)	0.217
Adhesive capsulitis	5 (12.5)	16 (40)	0.005*
AC joint patology	4 (10)	7 (17.5)	0.330
Subacromial impingement syndrome	4 (10)	1 (2.5)	0.359

Data are given as mean ± SD or n (%).
*Statistically significant
Abbreviations: BMI: body mass index; SD: standard deviation; AC: acromioclavicular.

Table 2. *Comparison of baseline (pre-injection) SPADI, VAS, ROM, and PPT scores.*

	Group 1 (n = 40)	Group 2 (n = 40)	*P* value
SPADI			
Pain	75.8 ± 13.8	70.0 ± 18.7	0.168
Disability	64.3 ± 16.8	63.9 ± 21.4	0.939
Total	68.4 ± 13.6	66.3 ± 19.5	0.624
VAS			
Activity	7.1 ± 1.7	7.0 ± 1.8	0.655
Night	7.5 ± 1.8	6.8 ± 2.5	0.265
Active ROM, degree			
Forward flexion	152.4 ± 28.4	130.1 ± 38.5	0.008*
Abduction	142.3 ± 38.0	122.6 ± 38.4	0.030*
Internal rotation	63.3 ± 13.4	52.1 ± 20.8	0.007*
External rotation	72.6 ± 21.7	58.4 ± 27.4	0.013*
PPT, kg/cm^2			
Upper trapezius	5.3 ± 2.0	5.6 ± 2.3	0.459
Middle deltoid	5.3 ± 1.9	5.6 ± 2.4	0.624
Infraspinatus	5.6 ± 1.7	5.8 ± 2.3	0.672
Tibialis anterior	8.2 ± 1.8	8.4 ± 2.4	0.619

Data are given as mean ± standard deviation.
*Statistically significant
Abbreviations: SPADI: Shoulder Pain and Disability Index; VAS: visual analog scale; ROM: range of motion; PPT: pain pressure threshold.

Table 3. *Intergroup comparison of the changes (differences) in SPADI and VAS scores from the baseline at the post-injection follow-ups.*

	Group 1 (n = 40)	Group 2 (n = 40)	*P* value
SPADI (pain)			
T0 vs T1	25.9 ± 22.2	27.5 ± 24.4	0.760
T0 vs T2	29.4 ± 24.1	37.6 ± 21.7	0.114
T0 vs T3	30.3 ± 26.0	35.7 ± 28.6	0.380
SPADI (disability)			
T0 vs T1	20.3 ± 20.3	24.8 ± 24.5	0.370
T0 vs T2	26.0 ± 22.3	35.8 ± 23.8	0.062
T0 vs T3	29.6 ± 22.1	33.0 ± 29.2	0.558
SPADI (total)			
T0 vs T1	22.1 ± 20.3	25.9 ± 23.7	0.442
T0 vs T2	27.0 ± 22.2	36.6 ± 22.0	0.057
T0 vs T3	29.4 ± 23.0	34.1 ± 28.1	0.411
VAS (activity)			
T0 vs T*	2.3 ± 3.2	2.6 ± 2.0	0.379
T0 vs T1	2.2 ± 2.5	2.8 ± 2.5	0.232
T0 vs T2	2.8 ± 2.7	3.7 ± 2.4	0.124
T0 vs T3	2.9 ± 2.7	3.5 ± 2.9	0.320
VAS (night)			
T0 vs T1	3.2 ± 2.6	3.0 ± 2.9	0.786
T0 vs T2	3.4 ± 2.6	3.9 ± 2.4	0.388
T0 vs T3	3.1 ± 2.7	3.3 ± 3.2	0.760

Data are given as mean ± standard deviation.
Abbreviations: SPADI: Shoulder Pain and Disability Index; VA: visual analog scale; T0: baseline; T*: 1st hour after injection; T1: 1st week; T2: 4th week; T3: 12th week.

Table 4. *Intergroup comparison of the changes (differences) in ROM measurements from the baseline at the post-injection follow-ups.*

	Group 1 (n = 40)	Group 2 (n = 40)	*P* value
Forward flexion			
T0 vs T1	-3.9 ± 16.0	-9.6 ± 14.0	0.047*
T0 vs T2	-8.6 ± 18.3	-18.6 ± 21.2	0.007*
T0 vs T3	-8.8 ± 18.1	-20.5 ± 22.2	0.010*
Abduction			
T0 vs T1	-4.8 ± 14.4	-9.6 ± 16.1	0.140
T0 vs T2	-14.1 ± 24.9	-23.9 ± 30.1	0.106
T0 vs T3	-13.0 ± 27.7	-26.0 ± 29.1	0.098
Internal rotation			
T0 vs T1	0.9 ± 4.7	-4.5 ± 9.7	0.001*
T0 vs T2	-0.9 ± 3.2	-7.5 ± 11.8	0.001*
T0 vs T3	-2.4 ± 7.0	-8.6 ± 12.2	0.004*
External rotation			
T0 vs T1	-2.5 ± 6.9	-6.8 ± 17.3	0.080
T0 vs T2	-6.0 ± 8.9	-10.9 ± 16.01	0.097
T0 vs T3	-8.5 ± 12.3	-10.0 ± 20.3	0.554

Data are given as mean ± standard deviation.
*Statistically significant
Abbreviations: T0: baseline; T*: 1st hour after injection; T1: 1st week; T2: 4th week; T3: 12th week.

Table 5. *Comparison of the treatment satisfaction between the 2 groups.*

	Group 1 (n = 40)	Group 2 (n = 40)	*P* value
Patient satisfaction. n (%)			
Extremely dissatisfied	3 (7.5)	2 (5)	0.074
Dissatisfied	8 (20)	1 (2.5)	
Neutral	3 (7.5)	6 (15)	
Satisfied	12 (30)	11 (27.5)	
Extremely satisfied	14 (35)	20 (50)	

Data are given as frequency (%).

from the baseline PPT measurements was evident at any follow-up point ($P < 0.05$ for all). The PPT measurements between the 2 groups also did not differ at any follow-up point ($P > 0.05$ for all).

At 12 weeks after the injection, treatment success according to SPADI was detected in 27 (67.5%) and 28 (70%) patients in group 1 and group 2, respectively ($P = 0.809$). When satisfaction with their treatment was evaluated, 26 (65%) patients in group 1 and 31 (77.5%) patients in group 2 responded that they were "satisfied" or "extremely satisfied" ($P = 0.074$) (Table 5).

Nonserious adverse events occurred after injection in both groups. All of these adverse events were transient and self-limited. In group 1, post-injection presyncope developed in one patient and redness and swelling at the injection site in another patient, while motor block developed in 2 patients. In group 2, one patient developed motor block, and another developed presyncope, while 2 patients developed headaches after injection.

Comparison of the 2 groups' exercise compliance revealed no differences at either one–4 weeks or one–12 weeks ($P = 0.591$ and $P = 0.900$, respectively). In addition, no difference was observed between the total amount of acetaminophen 500 mg and naproxen 750 mg used by the patients in each group ($P > 0.05$ for all).

Discussion

This prospective, double-blind, randomized con-

trolled study compared the efficacy and safety of US-guided SSNB techniques performed at the level of the spinoglenoid notch and those performed at level of the suprascapular notch in patients with chronic shoulder pain. Our hypothesis was that the clinical outcomes of SSNB at the level of the spinoglenoid notch and SSNB at the level of the suprascapular notch would be similar. Our findings indicate that distal SSNB blocks performed at these 2 different anatomical localizations both provide similar significant improvements in pain and function in patients with chronic shoulder pain from the baseline to week 12, but neither has an effect on mediating the pain hypersensitivity caused by central sensitization. Another important finding of the study was that injection-related adverse events were mild and transient in both groups. Therefore, both block techniques applied under US guidance can be deemed effective and safe. To our knowledge, this study is the first to compare the efficacy of US-guided SSNB performed at the level of the spinoglenoid notch with SSNB performed at the level of the suprascapular notch as a treatment for shoulder pain.

In a study by Chansoria et al (13), one group of 40 patients (n = 40) with shoulder pain who underwent blinded SSNB at the level of the spinoglenoid notch showed a statistically significant improvement in VAS scores and in pain, disability, and total SPADI scores up to one month after injection. The new technique described by those authors (13) involved inserting the needle parallel to the skin from the suprascapular fossa and then advancing it up to the spinoglenoid notch. With the help of a high-volume (i.e., 10 mL) solution, the injectate solution was spread along the floor of the suprascapular fossa and indirectly blocked the distal and proximal branches of the suprascapular nerve. In our study, the suprascapular nerve was directly blocked at the spinoglenoid notch with the US in the patients forming group 1. Thus, the technique we used in this study differs significantly from the SSNB technique used at the level of the spinoglenoid notches described by Chansoria et al (13). First, we performed US-guided SSNB at the level of the spinoglenoid notch while the patients were in the lateral decubitus position to prevent possible vasovagal syncope. Second, by using US, we were able to easily visualize the scapula spine and then the spinoglenoid notch. The in-plane technique ensured the correct placement of the needle tip according to the localization of the suprascapular nerve and artery (using the Doppler scan) in the spinoglenoid notch. Afterward, the free dissemination of a mixture of steroid and local anesthetic (a minimal amount) sufficient for the block was visualized in the spinoglenoid notch. A technique similar to our study's US-guided SSNB block technique at the level of the spinoglenoid notch was previously described by Messina et al (16). In addition, we compared the SSNB technique at the level of the spinoglenoid notch with the frequently used SSNB technique at the level of the suprascapular notch. Our findings, beyond those of the study by Chansoria et al (13), showed that SSNB at the level of the spinoglenoid notch and SSNB at the level of the suprascapular notch had similar efficacy in improving shoulder pain and functions up to week 12.

In the present study, the increments in the abduction and external rotation ROM were similar between the 2 groups at all post-injection follow-ups, while increments in the FF and internal rotation ROM were significantly greater in group 2 than in group 1. We suspect that this difference reflects the significantly lower number of patients diagnosed with adhesive capsulitis in group 1 than in group 2 rather than a difference in the efficacy of the 2 distal blocks. The 2 groups' baseline ROM measurements also showed this difference between them. SSNB is an effective treatment modality, as confirmed by the results of a recent meta-analysis, because the procedure provides significant improvements in pain, function, and ROM in patients with adhesive capsulitis (17). The authors also claimed that SSNB performed at the level of the spinoglenoid notch, considering the innervation of the suprascapular nerve, may be a more advantageous treatment method for patients with adhesive capsulitis. In our study, we could not perform a subgroup analysis due to the small number of patients diagnosed with adhesive capsulitis and the imbalance in the distribution between the groups. However, a future study planned on patients with adhesive capsulitis may better document the effects of these 2 distal block techniques on treatment outcomes.

After massive tears to the rotator cuff tendons, the retracted tendon and muscle tissue can create a traction effect on the suprascapular nerve. The nerve is especially tractioned in the suprascapular notch and spinoglenoid notch, which are 2 anatomical locations where the nerve's mobility is limited, the risk of entrapment is highest, and neuropathy occurs (18). Coory et al (19) compared SSNB at the suprascapular notch level and subacromial injection in patients with shoulder pain caused by rotator cuff tear. After 12 weeks of follow-up, patients who underwent SSNB at the level

of the suprascapular notch had a significantly greater improvement in their Constant-Murley scores than did patients who received a subacromial injection. In fact, SSNB may be more effective than subacromial injection in reducing pain, because pain is also associated with increased traction on the nerve in the presence of massive rotator cuff tears. Meanwhile, the spinoglenoid notch may be a suitable target for SSNB in shoulder pain caused by rotator cuff tears, considering that the spinoglenoid notch level is one of the regions in which the suprascapular nerve is most frequently subjected to traction and compression forces.

A previous review demonstrated the presence of peripheral and central sensitization, as assessed by PPT and other somatosensory tests, in patients with shoulder pain (20). Previous studies have also argued that one of the mechanisms of action of SSNB is to reduce peripheral nociceptive inputs, thereby causing a decrease in central and peripheral sensitization (21,22). However, to the best of our knowledge, no study in the literature has yet used tests to evaluate peripheral and central sensitization after SSNB in patients with shoulder pain. In our study, the changes in central and peripheral pain sensitivity after SSNB were tested by evaluating the patients' PPT values with an algometer before the injection and at the first, fourth, and 12th weeks after the injection. No significant changes were noted from the baseline in the PPT values in the affected shoulder and distal region at any of the follow-up points up to 12 weeks after the 2 distal SSNB procedures. Our findings show that SSNB has no effect on central and peripheral pain hypersensitivity until week 12 in patients with chronic shoulder pain. This result highlights the need for additional interventions for centrally mediated pain hypersensitivity in patients with chronic shoulder pain.

In our study, transient adverse events, including a vasovagal reaction in 2 patients, motor block in 3 patients, headache in 2 patients, and redness at the injection site in 1 patient, were observed in the 80 patients who underwent SSNB. No significant difference in the occurrence of adverse events was detected between the 2 groups. A study by Shanahan et al (23) reported that 6 patients experienced an adverse event after 1005 SSNBs were applied for the treatment of chronic shoulder pain. Three of these adverse events were temporary dizziness, 2 were temporary weakness in the arm, and one was a nonserious side effect, such as facial flushing. The risk of pneumothorax in SSNB at the suprascapular notch level is one of the serious complications that still exists (24,25). Previously, US-guided and blinded SSNB techniques have been shown to have similar clinical outcomes (26). However, to the best of our knowledge, no case of pneumothorax after US-guided SSNB has been reported in the literature. Therefore, US-guided SSNB at the level of the suprascapular notch is also safe, and we believe that this procedure should now be the minimal approach. SSNB at the level of the spinoglenoid notch poses no risk of pneumothorax (13).

Physiotherapy interventions after SSNB usually include shoulder exercises that patients perform at home by following written and/or verbal instructions. However, no standard exists for these exercise programs, and whether they improve long-term results is unknown (27). In our study, all patients were given a standard exercise program to do at home in the first week after the injection, and their compliance with this program was followed. Both groups were similar in terms of compliance with the exercise program, which might have resulted in slightly higher ROM gains in group 2 than in group 1 due to the greater number of patients with adhesive capsulitis.

This study had some limitations. First, our patients were assigned to groups using the block randomization method, but the causes of chronic shoulder pain (in the diagnostic context) were not considered in the randomization. This omission led to differences in the distribution of some outcome measures between the groups. Second, chronic shoulder pain is a clinical spectrum that includes a heterogeneous group of diagnoses. Although the distribution of clinical diagnoses was balanced between the groups, except for adhesive capsulitis, the efficacy of the 2 different SSNB methods in specific diagnosis groups could vary. Finally, since this study compared 2 different injection techniques, the physician who performed the injections was not naturally blinded to the groups. However, the strengths of our study are that it is the first one to compare US-guided SSNB at the level of the spinoglenoid notch with SSNB performed at the level of the suprascapular notch and that it has used a double-blinded (i.e., patient and outcome assessor), prospective, and randomized controlled design to investigate chronic shoulder pain.

Conclusion

This study showed that US-guided SSNB techniques conducted at the level of the spinoglenoid notch and the suprascapular notch in patients with chronic shoulder pain provided major improvements in pain and disability scores in the short-to-medium term, with no

significant difference between them. Injection-related adverse events were all mild and transient in both groups. These findings show that SSNB at the level of the spinoglenoid notch is not inferior to SSNB at the level of the suprascapular notch in terms of efficacy and safety.

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