Randomized Controlled Trial

Comparison of the Efficacy of Ultrasound-Guided Suprascapular Nerve Blocks and Intraarticular Corticosteroid Injections for Frozen Shoulder: A Randomized Controlled Trial

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Background: The current mainstream treatment for frozen shoulder is a combination of physiotherapy and intraarticular corticosteroid injections (IACIs). Recently, the ultrasound-guided suprascapular nerve block (SSNB) has developed as a notable alternative option to the mainstream treatment.

Objective: We aimed to compare ultrasound-guided SSNBs' effectiveness to IACIs' as treatments for frozen shoulder.

Study Design: This study was conducted as a prospective single-blind, randomized controlled trial.

Setting: Department of Physical Medicine and Rehabilitation, Shin Kong Wu Ho-Su Memorial Hospital, a medical center in Taipei, Taiwan.

Methods: Patients with frozen shoulder (n = 76) were enrolled as participants and allocated to either an SSNB group (n = 38) or an IACI group (n = 38). Both groups received 2 injections of 20 mg of triamcinolone and 3 mL of 1% lidocaine at 2-week intervals and underwent the same physiotherapy protocol for 3 months. The primary outcome measure was the Shoulder Pain and Disability Index (SPADI). The secondary outcome measures were the Shoulder Disability Questionnaire (SDQ), the active and passive range of motion (ROM) of each patient's affected shoulder, and the 36-item Short Form Health Survey (SF-36). Evaluations were performed at baseline and at 4 and 12 weeks after starting treatment.

Results: Both groups achieved significant improvements in all outcome measures, except the general health subscale of the SF-36 at 4 and 12 weeks after starting treatment. For time and group interaction, the results for the SDQ ($P = .047$) and SF-36 (bodily pain, $P = .025$) indicated significant differences that favored IACIs. Additionally, the IACI group achieved more favorable outcomes than did the SSNB group on the SPADI ($P = .094$) and in ROM (i.e., abduction [$P = .190$] and external rotation [$P = .081$]) as well as on 2 subscales of the SF-36: bodily pain ($P = .059$) and role-emotional ($P = .072$).

Limitations: Our study is limited by the lack of participant stratification based on the stages of frozen shoulder and the 12-week follow-up period.

Conclusions: A combination of ultrasound-guided IACIs and physiotherapy should be attempted first as a frozen shoulder treatment.

Key words: Frozen shoulder, adhesive capsulitis, shoulder pain, intraarticular corticosteroid injection, suprascapular nerve block, ultrasound-guided intervention, physiotherapy, pain management

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Frozen shoulder, also known as adhesive capsulitis of the shoulder, is a common clinical problem that causes pain and the loss of both the passive and active range of motion (ROM) of the glenohumeral joint. These conditions can lead to functional limitations and quality of life deterioration (1). Primary frozen shoulder develops without any obvious connection to any other condition, whereas secondary frozen shoulder is related to specific medical problems, such as an injury to or surgery on the shoulder.

The prevalence of frozen shoulder, generally ranging from 2% to 5%, is notably elevated in women and middle-aged individuals (2); moreover, among patients with diabetes, it reaches 13.4%, surpassing the general population's incidence rate (3).

The treatment options for frozen shoulder include physiotherapy, oral medication administration (nonsteroidal anti-inflammatory drugs or corticosteroids), intraarticular corticosteroid injections (IACIs), hydrodilatation, suprascapular nerve blocks (SSNBs), manipulation under anesthesia, and operative intervention (arthroscopic release or open release). Notably, operative intervention is implemented only for refractory cases (4,5). A combination of physiotherapy and IACIs is a common conservative treatment for frozen shoulder (6,7). IACIs can rapidly relieve pain, reduce inflammation, and improve ROM, all of which can increase a patient's adherence to exercise therapy. Physiotherapy can relieve a patient's pain and improve their ROM and muscle strength (8).

The SSNB is a new treatment option for frozen shoulder, and the landmark-guided injection technique was first described by Dangoisse et al (9). Because of advancements in radiology techniques, ultrasound-guided SSNBs are becoming increasingly popular; this method is a cost- and time-effective technique for infiltrating the target nerve accurately without injuring nerves or vessels (10). Some studies have reported that landmark-guided SSNBs are more effective in achieving pain control and functional improvement than are placebos or intraarticular injections (11-14). In the present study, we compared the effectiveness of ultrasound-guided SSNBs and IACIs in treating frozen shoulder because very few studies to date had explored this topic. We hypothesized that more favorable pain control and functional improvement outcomes could be achieved through ultrasound-guided SSNBs than through IACIs.

Methods

Study Design

This prospective, single-blind randomized controlled trial was approved by the Institutional Review Board of Shin Kong Wu Ho-Su Memorial Hospital (approval number: 20170915R). The present study was prospectively registered on ClinicalTrials. gov (registration number: NCT03515278) and financially supported by Shin Kong Wu Ho-Su Memorial Hospital (grant number: 2018SKHADR029); Shin Kong Wu Ho-Su Memorial Hospital was responsible for the integrity and conduct of this study. The study was conducted between February 13, 2018, and December 31, 2019.

Patients

Patients were eligible for participation in the present study if they: 1) had unilateral shoulder pain with a visual analog scale (VAS) score of ≥ 3; 2) experienced a ≥ 50% loss of passive ROM (abduction or external rotation) in the glenohumeral joint relative to the unaffected side; 3) had been experiencing the related symptoms for ≥ 3 months; and 4) were aged ≥ 20 years. Patients were excluded if they: 1) had undergone manipulation of the affected shoulder with or without anesthesia; 2) had a systemic disease, severe degeneration, or trauma involving the shoulder (e.g., osteoarthritis, rheumatoid arthritis, history of labrum or articular cartilage injuries, or malignancies in the shoulder region); 3) had neurological diseases such as stroke or peripheral nerve neuropathy that were already affecting shoulder activity; 4) had pain in or disorders of the cervical spine, elbow, wrist, or hand; 5) had a history of allergies to local anesthetics or corticosteroids; 6) were pregnant or lactating; or 7) had been taking corticosteroids or receiving intraarticular injections of hyaluronic acid to the affected shoulder during the 4 weeks preceding the time of enrollment (15). Before the enrolled patients were randomized, we collected their basic data, which comprised their ages, their genders, their employment statuses, their sports and leisure activities, the durations of their symptoms, their treatment histories, and their medication histories as they pertained to pain control. We also documented each participant's comorbidities, current treatments, and medication use.

Interventions

SSNB Group: In this group, all patients underwent an ultrasound (18-5 MHz linear probe, MyLab™ Class C, Esaote)-guided SSNB, which involved the administra-

tion of 20 mg of triamcinolone and 3 mL of 1% lidocaine twice at a 2-week interval (Fig. 1). The procedure for administration was implemented per the protocol used by Harmon et al (16). We first positioned the probe used for injection parallel to the scapular spine so we could identity the suprascapular notch, after which we performed an in-plane injection at one cm from the medial side of the probe. We used a 23-gauge, 3-inch needle for infiltration. Color Doppler was performed to avoid causing needle-induced trauma to the suprascapular artery or vein. The procedure was performed by a senior physiatrist who was a board-qualified musculoskeletal ultrasonographer and had extensive experience administering ultrasound-guided injections to the shoulder.

IACI Group: The patients in the IACI group received ultrasound-guided IACIs containing 20 mg of triamcinolone and 3 mL of 1% lidocaine. The procedure for administration was performed using the posterior approach, and the shoulder joint injection technique used by Chen et al was applied (17). The patients received the injections while sitting on a chair. Specifically, the probe used for injection was positioned along the musculotendinous junction of the infraspinatus muscle to visualize the posterior labrum and humeral head, and the lateral approach was used. The injection site was at the joint capsule, slightly lateral to the posterior labrum (Fig. 2).

Physiotherapy: All patients from both groups participated in a physiotherapy program that began after the first injection. The physiotherapy program comprised several physical modalities (heat and electric therapies) and therapeutic exercises (mobilization, stretching, ROM exercises, and strength training), and physiotherapy sessions were conducted 3 times a week for 12 weeks or until full symptom relief was achieved.

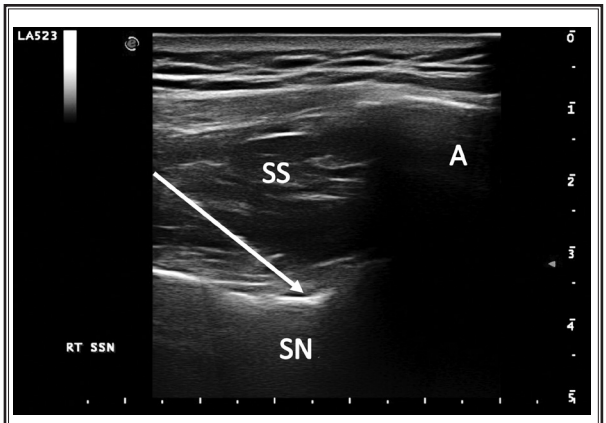

Fig. 1. *Image of ultrasound-guided SSNB.*
Arrow, needle trajectory of injection; SS, supraspinatus muscle; A, acromin; SN, suprascapular nerve.

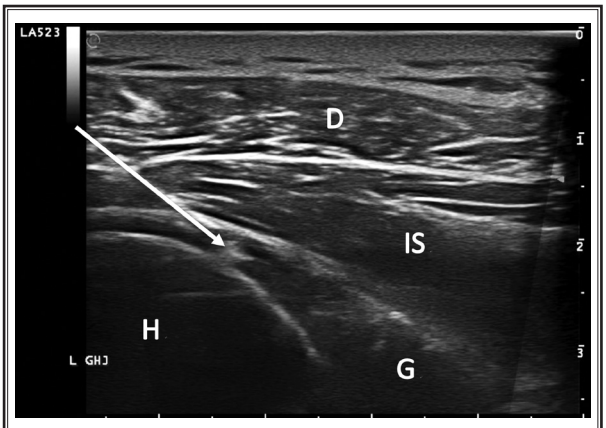

Fig. 2. *Image of ultrasound-guided IACI.*
Arrow, needle trajectory of injection; D, deltoid muscle; IS, infraspinatus muscle; G, glenoid; H, humeral head.

Outcomes

All outcome measures were completed by a trial-blinded assistant. The patients were evaluated before treatment and at 4 and 12 weeks after starting treatment.

Primary Outcome Measure

The primary outcome measure was the Shoulder Pain and Disability Index (SPADI). The SPADI is a self-reported questionnaire that evaluates the pain and disability associated with shoulder diseases. This questionnaire comprises 2 subclasses (pain and disability) with 13 items (5 items in the pain domain and 8 items in the disabilities domain). The SPADI is scored between 0 and 100, and a SPADI score is calculated by averaging the scores from the 2 subclasses. A higher SPADI score indicates more severe symptoms and a greater level of disability. The minimal clinically important difference for the SPADI and the intraclass correlation coefficient was 0.89, indicating the SPADI had good construct validity (18).

Secondary Outcome Measurements

Shoulder Disability Questionnaire: Patients' physical functional performance was measured using the Shoulder Disability Questionnaire (SDQ) (19), which comprises 16 items for assessing whether patients with

shoulder injuries and disorders are experiencing shoulder disorder-related symptoms in common situations. The response options for these items are "yes," "no," and "not applicable." The final SDQ score, ranging from 0 (no disability) to 100 (the worst possible condition), is derived by dividing the number of positively scored items by the total number of applicable items and then multiplying the result by 100.

Active and Passive ROM: We measured all 4 planes of the ROM, namely abduction in the frontal plane, forward flexion, internal rotation, and external rotation, while keeping the arm at a 0° abduction angle. We used a conventional goniometer to measure the ROM, and a trained research assistant served as the examiner to ensure consistency of measurements.

36-Item Short Form Health Survey: The 36-item Short Form Health Survey (SF-36) is commonly used to measure quality of life. The test comprises 8 subscales: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. Each subscale is scored from 0 to 100, with a higher score indicating a more favorable condition. In the present study, we used a Chinese-language version of the SF-36 (20).

Sample Size

Using the G*Power software version 3.1.9.4 (Heinrich Heine Universität Düsseldorf), we determined the required sample size for conducting a repeated measures analysis of variance and achieving an effect size of 0.3. Because our study involved obtaining 3 sets of measurements from 2 groups, a total sample size of 70 patients was determined to provide 85% power for detecting this effect with a 2-sided α of 0.05. Predicting a dropout rate of 10% during follow-up, we enrolled 38 patients in each group.

Randomization

In our study, we employed block randomization with a block size of 4. The allocation was carried out by a researcher, ensuring that both the patients and the assessor remained blinded. The patients were randomly assigned to either the SSNB group or the IACI group; those in the SSNB group underwent a combination of SSNB and physiotherapy, whereas those in the IACI group received IACI and underwent physiotherapy. The assignment scheme was created by utilizing a table of computer-generated random numbers, which were then sealed within opaque envelopes.

When a patient was enrolled, an envelope was opened, and the patient was allocated to one of the 2 groups, depending on the envelope's contents. All measurements were taken by an assessor who was blinded to the group allocation process.

Statistical Analysis

A Shapiro–Wilk test was performed to ensure that all calculated variables followed a normal distribution. Subsequently, a 2 × 3, 2-way mixed-model analysis of variance with a between-subjects factor (group: SSNB and IACI) and a within-subjects factor (evaluation time: pretreatment, 4 weeks after starting treatment, and 12 weeks after starting treatment) was performed. Pairwise comparisons of the 2 groups were performed using an independent t-test when a significant interaction was identified; otherwise, only main effects were reported. When a time effect was identified, post hoc analysis was conducted by performing a polynomial test to determine whether the trend was linear or quadratic. All significance levels were set at $\alpha < 0.05$, and SPSS® version 15.0a (IBM®) was used to perform all statistical analyses.

Results

A total of 87 patients were initially recruited from multiple clinics. However, 7 patients failed to meet the inclusion criteria, and 4 patients subsequently declined to participate. Thus, 76 patients (38 in each group) with frozen shoulder successfully completed the study without any loss to follow-up (Fig. 3). In the SSNB group, the average age was 65.8 years, the ratio of female patients was 68.4% (26/38), and the average duration of frozen shoulder was 5.2 months. In the IACI group, the average age was 66.1 years, the ratio of female patients was 68.4% (26/38), and the average duration of frozen shoulder was 5 months. No significant difference in demographic data, SPADI scores, SDQ scores, the ROM of the affected shoulder, or SF-36 scores was identified between the 2 groups (Table 1).

As for outcomes, significant gradual improvements were identified for all measures, with the exception of the SF-36's general health subscale, in both groups at 4 and 12 weeks after starting treatment (Fig. 4, Tables 2,3). For time and group interactions, only the results for the SDQ ($P = 0.047$) and SF-36 (bodily pain only; $P = 0.025$) indicated significant differences favoring IACIs, and the IACI group tended to achieve more favorable outcomes on the SPADI ($P = 0.094$), in ROM (abduction [$P = 0.190$] and external rotation [$P = 0.81$]), and on 2 subscales of the SF-36 (general health [$P = 0.059$] and role-emotional [$P = 0.072$]).

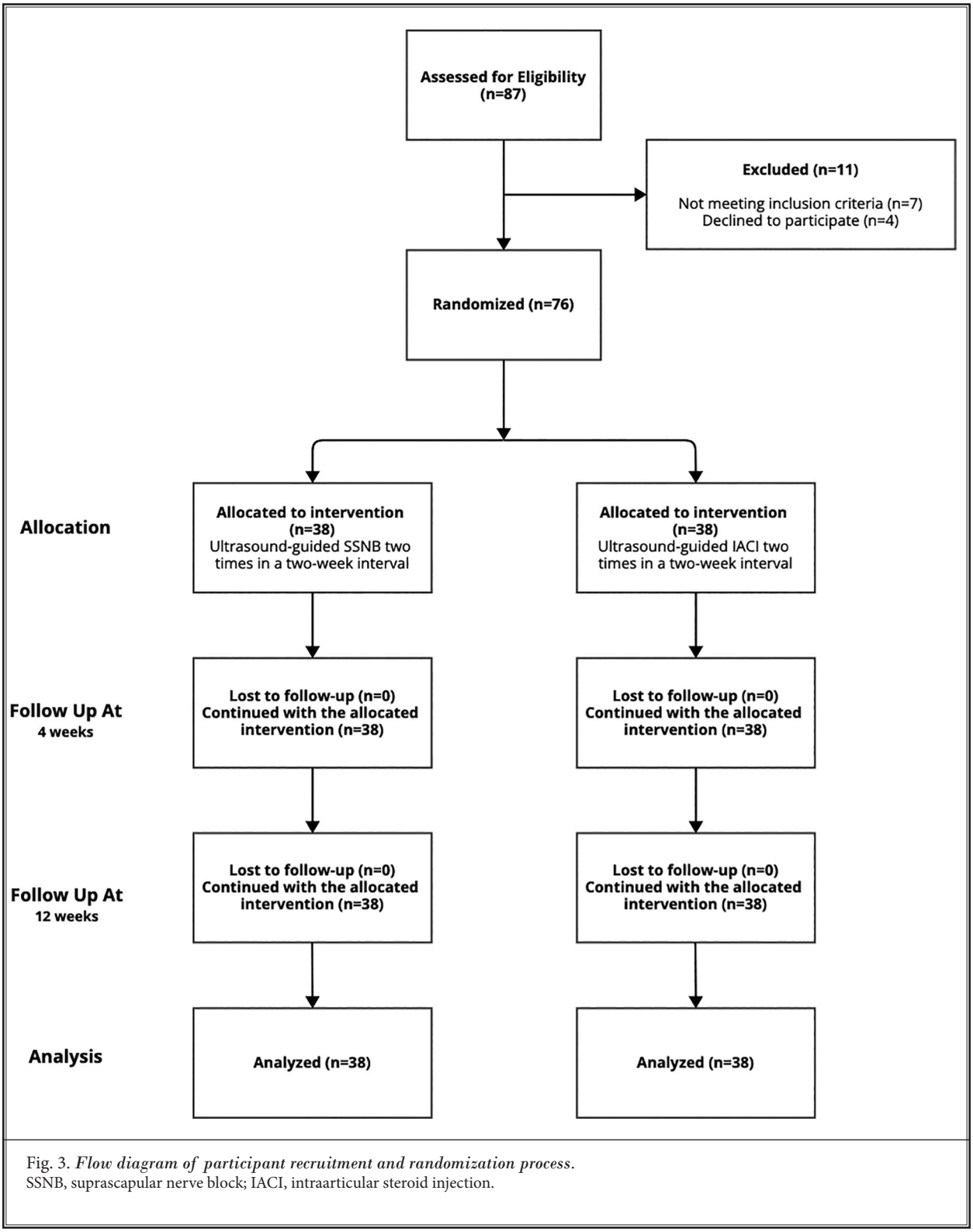

Fig. 3. *Flow diagram of participant recruitment and randomization process.*
SSNB, suprascapular nerve block; IACI, intraarticular steroid injection.

Table 1. *Demographic and clinical characteristics of patients (n = 76).*

Characteristics (n, %)(a) Scale (mean ± SD)(b)	SSNB Group (n = 38)	IACI Group (n = 38)	*P* value
Age (year)	65.8 ± 8.3	66.1 ± 7.2	0.266
Gender			
Men	12 (31.6)	12 (31.6)	1.000
Women	26 (68.4)	26 (68.4)	
Height (cm)	62 ± 11.4	60.6 ± 9.0	0.371
Weight (kg)	162 ± 7.6	163.5 ± 6.3	0.811
BMI	23.6 ± 3.8	22.6 ± 2.8	0.442
Exercises			
No	19 (50)	20 (52.6)	1.000
Yes	19 (50)	18 (47.4)	
Pain duration (month)	5.2 ± 3.1	5 ± 3.4	0.656
SPADI score			
Pain	54.5 ± 22.0	61.7 ± 20.3	0.194
Disability	46.7 ± 21.3	50.3 ± 20.6	0.391
Total	50.6 ± 19.9	56 ± 19.0	0.277
SDQ	39.6 ± 8.8	40 ± 8.3	0.905
AROM			
Flexion	136.7 ± 23.3	134.5 ± 16.3	0.306
Abduction	110.6 ± 30.8	108.2 ± 26.0	0.835
External rotation	31.1 ± 24.2	27.5 ± 16.4	0.851
Internal rotation	38.2 ± 19.7	43.6 ± 19.1	0.195
PROM			
Flexion	138 ± 24.2	135.2 ± 16.2	0.268
Abduction	111.5 ± 31.6	108.8 ± 26.0	0.856
External rotation	32.1 ± 24.7	28.3 ± 16.4	0.897
Internal rotation	39.6 ± 20.2	45.7 ± 19.5	0.170

Values are expressed as means ± SDs or numbers (%).
Abbreviations: SSNB, suprascapular nerve block; IACI, intraarticular steroid injections; SPADI, Shoulder Pain and Disability Index; SDQ, Shoulder Disability Questionnaire; AROM, active range of motion; PROM, passive range of motion.
*Statistical significance level set at $P < .05$; (a) chi-square test or Fisher's exact test; (b) Mann-Whitney U test.

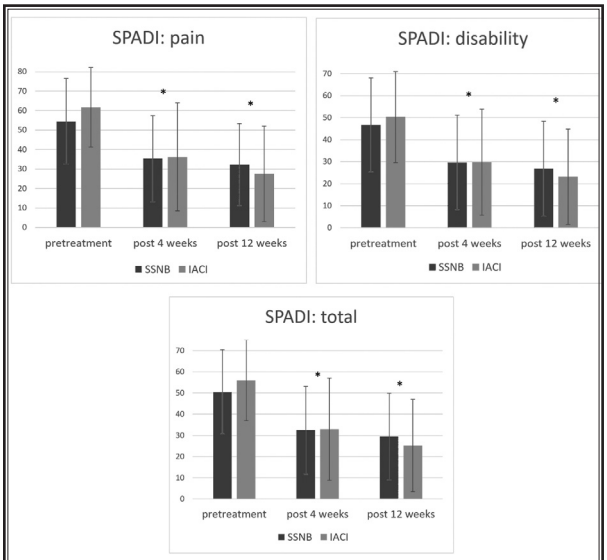

Fig. 4. *Change in SPADI scores (primary outcome).* Asterick, significant improvement compared with pretreatment measurement; SPADI, Shoulder Pain and Disability Index; SSNB, suprascapular nerve block; IACI, intraarticular steroid injection

At no point throughout the study did any patient experience complications or side effects. Although pneumothorax is a possible side effect of SSNBs, it did not affect any of our patients.

Discussion

The results of this single-blind randomized controlled study suggest that a combination of physiotherapy and ultrasound-guided SSNBs or IACIs is safe and effective for patients with frozen shoulder. However, in the present study, ultrasound-guided SSNBs did not provide significantly more beneficial outcomes in pain, disability, ROM, or quality of life than ultrasound-guided IACIs did. Furthermore, IACIs led to a more favorable pain control outcome than did SSNBs.

In other studies, the injectates of SSNBs were the investigated variables. Most studies that have investigated adhesive capsulitis have used only local anesthetics (11,21-24). By contrast, researchers who have studied other chronic shoulder pain conditions have combined local anesthetics with corticosteroids (10). In an SSNB, the mechanism of pain control achieved through steroid administration remains unclear. Corticosteroids have been speculated to prolong the duration of nerve conduction block treatments and produce a local anti-inflammatory effect. In our study, triamcinolone was combined with local anesthetics in SSNBs not only to prolong analgesic effects but also to ensure that the 2 groups were exposed to the same injectates.

Landmark-guided SSNBs typically require higher volumes of injectate than do other treatments to ensure that the desired effects are achieved (21), and during the performance of an SSNB, the needle tip should touch the bone to ensure the patient's safety. Several complications may develop during landmark-guided SSNBs, including vascular injury, peripheral nerve injury, pneumothorax, and systemic toxicity (be-

Table 2. *Effects of time and group on SPADI, SDQ, AROM, and PROM measurements.*

Measurement	Group	Evaluation Time			Time Effects	Group Effects	Time & Group Interactions
		Pretreatment	4-week	12-week	*P*-value	*P*-value	*P*-value
SPADI							
Pain	SSNB	54.5 ± 22	35.3 ± 22.1	32.3 ± 21.1	< 0.001	0.811	0.094
	IACI	61.7 ± 20.4	36.2 ± 27.7	27.5 ± 24.6			
Disability	SSNB	46.7 ± 21.4	29.7 ± 21.5	26.8 ± 21.6	< 0.001	0.994	0.281
	IACI	50.3 ± 20.6	29.8 ± 24.1	23.2 ± 21.6			
Total	SSNB	50.6 ± 19.9	32.5 ± 20.7	29.5 ± 20.4	< 0.001	0.895	0.149
	IACI	56 ± 19.1	33 ± 24.1	25.3 ± 21.8			
SDQ	SSNB	39.6 ± 8.8	27.8 ± 12.7	29.7 ± 13.9	< 0.001	0.113	0.047
	IACI	40 ± 8.4	23.7 ± 16.8	21.3 ± 17.8			
AROM							
Flexion	SSNB	136.7 ± 23.3	146.9 ± 19.7	152.2 ± 21.3	< 0.001	0.966	0.415
	IACI	134.5 ± 16.3	149.3 ± 18.6	152.6 ± 20.4			
Abduction	SSNB	110.6 ± 30.8	124 ± 33.1	133.3 ± 36.4	< 0.001	0.443	0.190
	IACI	108.2 ± 26.1	134.1 ± 36.2	140.4 ± 35.5			
External rotation	SSNB	31.1 ± 24.2	41.5 ± 28.1	45.3 ± 29.5	< 0.001	0.449	0.081
	IACI	27.5 ± 16.5	50.4 ± 27.1	51.2 ± 27.3			
Internal rotation	SSNB	38.2 ± 19.8	49.6 ± 21.5	53.9 ± 23.9	< 0.001	0.343	0.854
	IACI	43.6 ± 19.1	53.9 ± 22	56.3 ± 24.3			
PROM							
Flexion	SSNB	138 ± 24.2	148.3 ± 20.5	153.5 ± 20.7	< 0.001	0.987	0.375
	IACI	135.2 ± 16.2	150.4 ± 18.8	154 ± 20.7			
Abduction	SSNB	111.5 ± 31.7	125.2 ± 34	133.7 ± 36.2	< 0.001	0.369	0.137
	IACI	108.8 ± 26	136.5 ± 36.9	142.5 ± 35.6			
ER	SSNB	32.1 ± 24.7	42.3 ± 28.4	46.5 ± 30.3	< 0.001	0.487	0.080
	IACI	28.3 ± 16.5	50.9 ± 27	52.2 ± 27.2			
IR	SSNB	39.6 ± 20.3	50.8 ± 22.2	55.5 ± 24	< 0.001	0.192	0.975
	IACI	45.7 ± 19.6	56.9 ± 23	60.5 ± 25.8			

Values are expressed as means ± standard deviations (SDs).
Abbreviations: SSNB, suprascapular nerve block; IACI, intraarticular corticosteroid injection; SPADI, Shoulder Pain and Disability Index; SDQ, Shoulder Disability Questionnaire; AROM, active range of motion; PROM, passive range of motion; ER, external rotation; IR, internal rotation.

cause of the necessarily higher volume of injectate). Through ultrasound guidance, we were able to inject medication precisely around the nerves by monitoring the procedure in real time through imaging technology. Additionally, we administered the same volume of anesthetics and steroids to both study groups, thereby reducing the treatment variability and bias among the patients.

Studies have reported differing outcomes regarding SSNBs' effectiveness versus IACIs' in treating frozen shoulder. Sonune et al (24) reported that compared to intraarticular injections, nerve block treatments led to more favorable pain control outcomes within the first 3 weeks of treatment but did not produce more favorable results in ROM or SPADI scores. Haque et al (21) demonstrated that higher SPADI scores were achieved with SSNBs than with intraarticular injections at 12 weeks after starting treatment but not at one or 6 weeks after starting treatment. Verma et al (22) achieved similar pain and functional improvements through SSNBs and IACIs. Because all related studies have used only anesthetics for nerve block treatments, the effects of said treatments are unlikely to persist over the long term. Sheikh et al (25) reported that com-

Table 3. *Effects of time and group on SF-36 measurements.*

Measurement	Group	Evaluation Time			Time Effects	Group Effects	Time & Group Interactions
		Pretreatment	Post 4 weeks	Post 12 weeks	*P*-value	*P*-value	*P*-value
SF-36 PF	SSNB	71.8 ± 16.1	81.8 ± 12.9	79.9 ± 13	< 0.001	0.557	0.127
	IACI	71 ± 20.8	76.3 ± 18	80.3 ± 17.5			
SF-36 RP	SSNB	30.4 ± 40.9	52 ± 43.1	48 ± 42.2	< 0.001	0.948	0.174
	IACI	28.8 ± 38.7	42.3 ± 44.1	57.7 ± 41.4			
SF-36 BP	SSNB	43 ± 17.2	60.2 ± 20.5	62.5 ± 19.4	< 0.001	0.900	0.025
	IACI	37.8 ± 17	57.4 ± 22	69.1 ± 20			
SF-36 GH	SSNB	53 ± 14.3	56.9 ± 12.4	54.2 ± 12.6	0.105	0.995	0.059
	IACI	53.5 ± 10.5	54 ± 12.6	56.7 ± 11.7			
SF-36 VT	SSNB	51.5 ± 18.3	60.4 ± 18	61.6 ± 16.8	< 0.001	0.898	0.550
	IACI	52.2 ± 18.3	59 ± 17.8	63.7 ± 16.5			
SF-36 SF	SSNB	72 ± 22.3	77.4 ± 16.9	78 ± 20.1	0.020	0.193	0.758
	IACI	67 ± 23	70.5 ± 19.8	74.4 ± 20.7			
SF-36 RE	SSNB	52.3 ± 44.1	73.9 ± 39.4	61.3 ± 44.1	0.009	0.608	0.072
	IACI	53.8 ± 43.7	58.1 ± 44.4	62.4 ± 43.4			
SF-36 MH	SSNB	58.4 ± 17.2	62.3 ± 16.4	62.5 ± 16.3	0.002	0.772	0.965
	IACI	57.5 ± 16.9	60.8 ± 17.2	61.7 ± 15.7			

Values are expressed as means ± standard deviations (SDs).
Abbreviations: SSNB, suprascapular nerve block; IACI, intraarticular corticosteroid injection; SPADI, Shoulder Pain and Disability Index; SDQ, Shoulder Disability Questionnaire; AROM, active range of motion; PROM, passive range of motion; SF-36, 36-item Short Form Health Survey (PF, physical functioning; RP, role-physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role-emotional; MH, mental health).

bining corticosteroids with anesthetics for nerve block treatments led to improved pain and ROM outcomes at every follow-up time point until 12 weeks after starting treatment; however, they did not analyze the group or time interactions.

In the past, 2 studies compared the treatment effects of combining SSNBs with IACIs to those of IACIs alone, but the results did not reach a consensus. Jung et al showed that the combination of SSNBs and IACIs was associated with greater improvement in shoulder disability and pain during activity at 2 months and one year than were IACIs alone (26). However, Gencer Atalay et al (27) found no significant differences in either the short-term or long-term follow-up. This discrepancy could be related to the inclusion of steroids in SSNBs, as mentioned above, or it could be attributed to the additional use of steroids in SSNBs, which might have led to variations in the outcomes.

Frozen shoulder can be divided into the freezing phase, frozen phase, and thawing phase, based the symptoms and course of the condition (28). SSNBs and IACIs may exhibit different levels of efficacy during different phases, which may contribute to the variability in the outcomes reported by various studies. In an observational study that investigated patients in the freezing phase (at least 3 months since onset), SSNBs produced more favorable pain control and function-related outcomes than did IACIs even at 12 weeks after starting treatment (29). The author of that study attributed this result to a decrease in central sensitivity and the reduced release of substance P after the SSNB (30). By contrast, Schiltz et al (23) reported that SSNBs were not associated with superior effects to those of saline injections during the subacute freezing phase (2 weeks to 6 months since onset), and the authors attributed this finding to inflamed tissue's poor response to anesthetic blocks. During the frozen phase, an SSNB provides quicker pain relief, and the resulting effect lasts for at least one month, increasing the tolerability of subsequent interventions (e.g., hydrodilatation, manual therapy, and exercise) (30). In summary, a consensus has yet to be reached regarding the treatment superiority of SSNBs or IACIs during each phase of frozen shoulder. Furthermore, definitions of stages are based not only on duration but also on symptoms and functional limitations. Future studies should compare

SSNBs' effects on patients to IACIs' during different phases and under different conditions to minimize the variability of the results.

Exercise is the mainstay of treatments for frozen shoulder. A conventional exercise program for frozen shoulder typically includes wall exercises, ROM exercises, stretching and strengthening exercises for the muscles of the shoulder girdle, muscle energy techniques, and scapulothoracic exercises (31). A treatment program that includes the aforementioned multimodal exercises can reduce pain and increase ROM and physical function (31). Among these exercises, static stretching leads to greater improvements in active ROM, and muscle energy techniques lead to more favorable physical function outcomes (31). In a review of treatments for patients with frozen shoulder (28), combinations of early intraarticular steroid injections and various exercises led to outcomes more favorable for short-term ROM and functional improvement than the outcomes that occurred in the absence of treatments or after placebo treatments. Early management of shoulder pain is believed to increase patient adherence to physiotherapy and functional exercise programs. Furthermore, preventing chronic pain is crucial. Kinesiophobia, fear avoidance, and hypersensitivity due to chronic pain may lead to recalcitrant pain, impaired ROM, disability, and reduced adherence to exercise programs (32). Early pain control through SSNBs may be considered an alternative to IACIs because of the former technique's similar treatment effect and reduced chondrotoxicity.

Limitations

The present study has several limitations. First, we did not subdivide our patients by phase. Thus, future studies should consider recruiting patients experiencing different stages of frozen shoulder. Second, we followed the patients for only 12 weeks. Therefore, a trial with a long-term follow-up (e.g., 6 months or one year) should be performed in the future.

Conclusion

Physiotherapy combined with either ultrasound-guided IACIs or SSNBs is safe and effective for patients with frozen shoulder. Because of safety considerations and several evaluation items' associations with more favorable outcomes, we suggest attempting intraarticular injections first for frozen-shoulder patients.

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