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RESEARCH

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Ultrasound-guided combined intra-articular corticosteroids injection and suprascapular nerve block for pain control in patients with frozen shoulder

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Abstract

Background Frozen shoulder is an incapacitating disease that causes pain and limitation in the shoulder joint functional capacity. This work aimed to assess the efficacy of ultrasound-guided combined intra-articular corticosteroids (CS) injection and suprascapular nerve block (SSNB) in pain control in patients with frozen shoulders.

Results Our prospective study included 40 patients, equally divided into two groups: group A; managed with combined ultrasound (US) guided intra-articular corticosteroids injection (IACSI) and SSNB, and group B patients managed with US-guided SSNB. The visual analog scale score statistically significantly improved after both injections. This success was maintained and showed mild improvement at 8-week intervals (with increased patient capability to do physiotherapy after pain control). Similarly, improvement in the functional capacity of the shoulder joint was identified and assessed by the Oxford shoulder score (OSS) in both groups. Mean OSS was statistically significantly higher at 4-week intervals than before the nerve block for groups A and B. At 8 weeks interval, this favorable result was sustained ($p < .001$).

Conclusions US-guided SSNB is an effective, radiation-free method to alleviate frozen shoulder-related pains. However, US-guided combined SSNB and IACSI was more effective than SSNB alone in both pain alleviation and improved shoulder joint function.

Keywords Frozen shoulder, US-guided, Combined intra-articular injection, Suprascapular nerve block

Background

Frozen shoulder is an incapacitating condition. Shoulder pain, as well as restrictions on both active and passive range of motion in all directions. Because of fibrosis, thickness of the joint capsule, and adhesion to the head of the humerus, the glenohumeral joint's range of motion is restricted. In almost all circumstances, frozen shoulder is self-limiting [1]. Before resolution, the natural course lasts 12–42 months. Chronic loss of shoulder mobility results in long-term impairment for 15% of the patients [2, 3].

Uncertainty surrounds the pathophysiology of frozen shoulder. According to a widely accepted idea, fibrosis results in the glenohumeral joint capsule thickening and tightening. The axillary fold is eliminated, joint volume is decreased, there is little synovial fluid present and

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glenohumeral movement is restricted as a result of the capsule's adhesions to the neck of the humerus [2].

Several treatment plans have been used as rest, non-steroidal anti-inflammatory drugs (NSAIDs), physiotherapy by active and passive mobilization, suprascapular nerve block (SSNB), intra-articular corticosteroid injection (IACSI), and surgical options like manipulation under anesthesia and capsular release either open or arthroscopic [2].

The aim of the current work was to assess the efficacy of US-guided combined IACSI and SSNB in pain control in patient with frozen shoulder.

Methods

Study population

This ethically approved prospective study was conducted from May 2020 to July 2022 on 40 patients, aged < 18 years old, both sexes having painful frozen shoulder due to the presence of diffuse shoulder pain of more than 4 weeks duration as well as decreased shoulder movement in all directions. Exclusion criteria included focal shoulder pain due to bicipital tendinopathy or rotator cuff tear (radiologically proven by MRI), shoulder pain following surgery, fractures, or recent trauma, serious neurological or psychiatric disorders, anticoagulant medication use, and patients with radiologically proven neoplasms.

Patients were equally categorized into two groups: patients in group A received combined US-guided IACSI and SSNB block, while patients in group B received US-directed SSNB block only.

All patients were subjected to: detailed history taking, personal and surgical history, adequate clinical examination by a physical medicine consultant, plain X-ray of the shoulder joint (AP view), and laboratory tests including bleeding profile and complete blood picture. A written consent was obtained from the patients or their relatives.

Visual analog scale (VAS) [4]

The pain was evaluated by VAS score (0 = no pain; 10 = severe pain). The baseline data were recorded. Pain relief was classified as "excellent" if the pain is completely resolved or has decreased by 75% or more, "good" for a decrease of 50–74%, "fair" for a diminution of 25–49%, or "poor" for diminution of less than 25% or an increase in pain.

Oxford shoulder score (OSS) [5]

An established scoring system was employed to evaluate the level of discomfort and disability brought on by shoulder pathology. It is composed of 12 questions and has five possible responses. The scoring method for the OSS had several modifications, the last one was in 2009, which stated that the 12 items are graded on a scale of 0 (worst/most severe) to 5 (best/fewest symptoms). Consequently, the overall score is between 48 and 0, with a lower score suggesting a greater level of disability.

US assessment: was done for all cases before interventional procedures by two radiologists with five and ten years' experience in musculoskeletal US to rule out possible shoulder pathologies which can mimic frozen shoulder pain as bursitis, tendinous tears, acromioclavicular osteoarthritis and joint effusion and a consultant of interventional radiology.

Before each procedure, shoulder pain severity assessment was determined using VAS, and shoulder joint function capacity was done using OSS score; baseline values were recorded, twenty patients were subjected to combined US-guided SSNB and IACSI, and another twenty patients were subjected only to US-guided SSNB. Allocation of the cases was done by simple randomization by computer-generated random numbers. Follow-up at 4 and 8 weeks after the procedure using (VAS) and (OSS), the outcome measures the improvement in the level of pain and function as measured by VAS and OSS respectively from the baseline.

Interventional procedures

SSNB

The technique was performed under US guidance. The patient was placed in a sitting position with the hand resting on the opposite shoulder. A full sterile technique was performed. The skin was cleaned and draped in a normal sterile fashion. A 7–12 MHz high-frequency linear transducer was inserted into a sterile sheath. A small layer of sterile gel was placed between the draped ultrasound transducer and the skin. The ultrasound transducer was placed parallel to the scapular spine such that the scapular spine was visualized. The suprascapular fossa was located by moving the transducer cephalad. The suprascapular notch was located by slowly moving the ultrasound transducer laterally (while keeping the transducer in a transverse position) to visualize the supraspinatus muscle and the bone fossa underneath [6, 7]. The suprascapular nerve was visualized as a round hyperechoic structure with an approximate diameter of 2 mm, detected at 4 cm depth beneath the transverse scapular ligament in the suprascapular notch and seen adjacent to suprascapular artery which was identified by the color Doppler. [7]. Then, after skin anesthesia with lidocaine 1%, a 22-gauge, 3.5-inch, spinal needle was introduced at the selected, well-designed point of entry, along the ultrasound beam's longitudinal axis. Due to its clear ultrasound visibility, this needle was selected. The entire route of the needle was shown [8]. The endpoint for injection was the needle tip close to the suprascapular

nerve in the suprascapular notch and adjacent to the suprascapular artery (confirmed by color Doppler). Aspiration was performed to check that the needle wasn't in a minor vascular branch then a mixture of levobupivacaine 0.5% (6 ml), triamcinolone (TA) (40 mg) and lidocaine 1% (2 ml) was injected. The injection and spread of local anesthetic were visualized subsequently. The injection was performed carefully to avoid reflux along the needle with real-time sonographic visualization of the distention of the suprascapular fossa [8, 9]. The needle was removed, and the field was cleaned with a small bandage placed on the puncture site Fig. 1.

Intra-articular injection

For the IACSI injection, the patient laid in a semi-prone position with the painful shoulder up. A 7–12 MHz linear transducer was aligned along the axis of the musculotendinous junction of the infraspinatus muscle to visualize the posterior glenoid rim along with the posterior glenohumeral joint line. The transducer was adjusted to clearly display the humeral head and posterior glenoid labrum and rim outlines. A spherically curved echogenic line could be seen which was the articular cortex of the humeral head. Just medial to this line, a triangular echogenic structure which was the posterior glenoid rim. The cartilaginous posterior glenoid labrum appears as a triangular structure of high echogenicity with proper transducer angulation. Following local anesthetic infiltration and skin antisepsis, a 22-gauge spinal needle was aseptically inserted under ultrasound guidance as it passed obliquely from the skin's surface to the glenohumeral joint. Optimally, the needle's bevel entered the joint space transverse to the humeral head's curve and immediately deep to the Labrum's free margin. After inserting the needle tip into the glenohumeral joint, an instantaneous sensation of capsular resistance was felt, followed by the perception of a space devoid of resistance. A 6 ml mixture of TA (40 mg) (1 ml) and lidocaine 1% (5 ml) was injected. There was little to no resistance to injection when the needle tip was positioned correctly. Toward the end of a successful glenohumeral joint injection, the posterior recess of the glenohumeral joint began to distend,

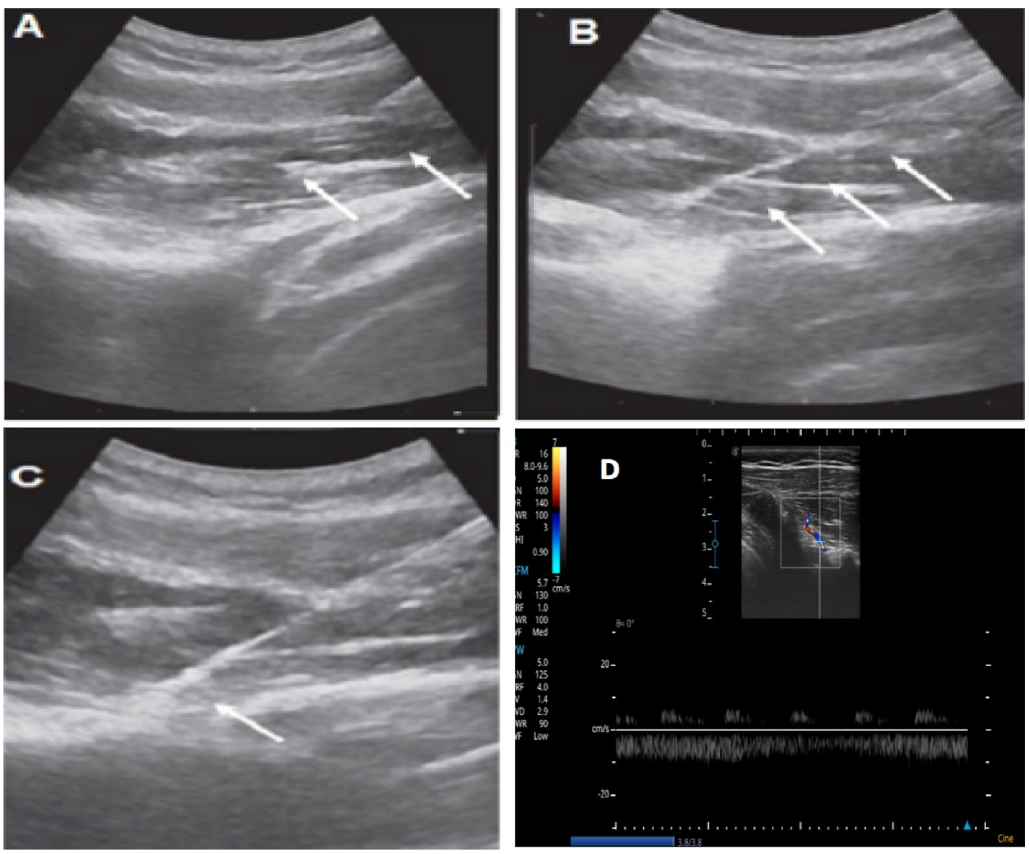

Fig. 1 **A** Ultrasound posterior view of the suprascapular fossa (arrow). The tip of the 22-gauge spinal needle is advanced with its tip seen in the trapezius muscle (arrow). **B** Introduction of the spinal needle (white arrows) through the trapezius muscle then supraspinatus till it passes through transverse scapular ligament with tip seen in the suprascapular fossa. **C** Injection of the drug mixture and distention of the fossa (white arrow). **D** color Doppler image demonstrating suprascapular artery which is adjacent to suprascapular nerve

multiple high-level echoes around the humeral head, and the joint capsule displaced away from the humeral head. Another indicator of successful intra-articular injection was direct visualization of the long head biceps tendon, being intra-articular, with free-flowing of fluid around it [10]. Finally, the field was cleaned with a small bandage placed on the puncture site Fig. 2.

Statistical analysis

Statistical analysis was performed using SPSS v28 (IBM©, Armonk, NY, USA). Shapiro–Wilk test and histograms were used to assess the normality of the data distribution. Quantitative parametric data were given as mean and standard deviation (SD) and analyzed by unpaired t-test. Quantitative nonparametric data were expressed as the median and interquartile range (IQR) and analyzed by Mann–Whitney test. Qualitative variables were estimated as frequency and percentage (%) and analyzed by Chi-square test or Fisher's exact test. ANOVA was used with repeated measures to compare more than two dependent groups, followed by adjusted post hoc pairwise comparisons for the significant repeated measures comparison. *P* value was considered statistically significant at < 0.05.

Results

Demographics data

The 40 patients included with agonizing frozen shoulder symptoms in our study showed no statistically significant differences between groups A and B regarding demographic data, duration, shoulder injected, and major predisposing factors. Details are shown at (Table 1).

Clinical success in terms of patients' pain scores according to VAS before injection, 4- and 8-week postinjection was achieved and showed statistically significant improvement after both injections ($P < 0.001$). The baseline mean VAS score was 8.43 ± 0.59 and 7.85 ± 0.86 for group A and group B; respectively and decreased to 3.63 ± 0.39 and 4.30 ± 0.64; respectively for both groups at 4 weeks intervals. This success was maintained and showed mild improvement at 8-week intervals (with the increased patient capability to do physiotherapy after pain control) to reach a mean of 3.53 ± 0.44 and 4.23 ± 0.68 for both groups; respectively Table 2.

Similarly, the functional capacity of the shoulder joint was assessed by OSS in both groups before injection, 4 weeks, and 8 weeks postinjection. Mean OSS was statistically significantly higher ($p < 0.001$) at 4-week intervals (38.50 ± 1.54) and (37.35 ± 1.09) than before the nerve block (25.40 ± 1.88) and (26.60 ± 1.31) for group A and B; respectively. At 8 weeks interval, this favorable result was sustained ($p < 0.001$) and showed mild improvement to reach mean (41.65 ± 1.18) and (37.80 ± 0.89); respectively with more pain control achieved (allowing more compliance for physiotherapy) Table 2).

Pain improvement represented by a decrease in VAS score showed statistical significance between both groups from baseline ($p < 0.001$ at 4- and 8-week intervals). Group A showed a mean reduction of 4.8 and 4.9 points at 4 and 8 weeks respectively compared to 3.55 and 3.63 points in group B Table 3, Fig. 3A.

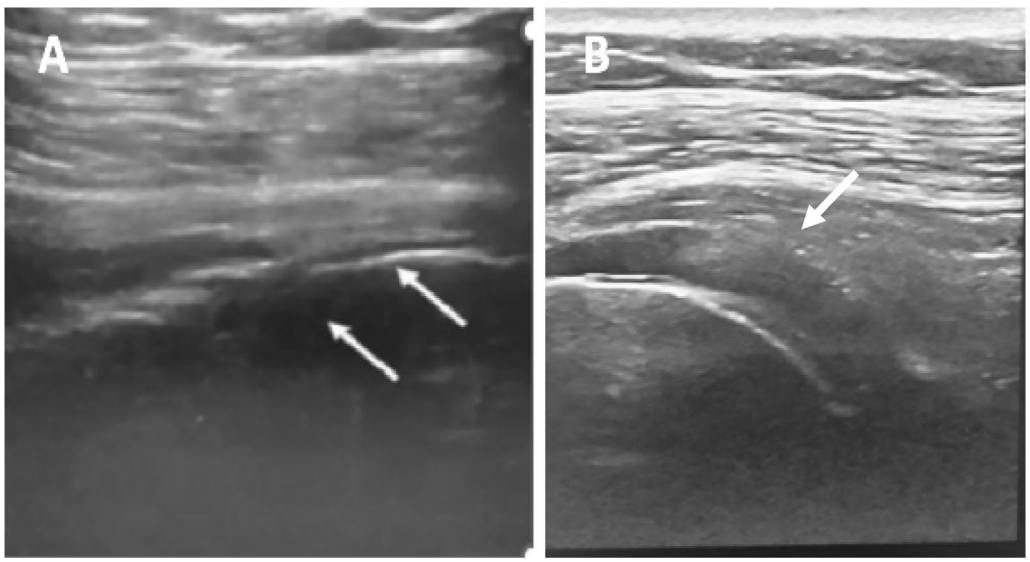

Fig. 2 **A** posterior view of the glenohumeral joint with introduction of the needled tip intra-articular with in the joint cavity (white arrows). **B** Anterior view of glenohumeral joint post injection of the drug mixtures with distention of the joint cavity (white arrow)

Table 1 Comparison of demographic data, duration, shoulder injected, and major predisposing factors between the two groups

		Group A combined ($n=20$)	Group B SSNB ($n=20$)	*P*
Sex	Male	5 (25.0%)	8 (40.0%)	0.311
	Female	15 (75.0%)	12 (60.0%)	
Age (years)	Mean ± SD	48.85 ± 4.30	54.35 ± 7.85	0.025
	Median (IQR)	49.5 (46.5–51.0)	55.0 (49.0–59.0)	
Duration (months)	Mean ± SD	6.95 ± 1.28	6.65 ± 0.88	0.391
	Median (IQR)	7.0 (6.0–8.0)	7.0 (6.0–7.0)	
Side injected	Right	11 (55.0%)	12 (60.0%)	0.749
	Left	9 (45.0%)	8 (40.0%)	
Major predisposing factors	DM	5 (25.0%)	3 (15.0%)	$^{FE}p=0.695$
	Heavy shoulder duty	14 (70.0%)	15 (75.0%)	0.723

SSNB suprascapular nerve block, *IQR* interquartile range, *DM* diabetes mellitus

Table 2 The improvement in VAS and OSS before and 4 and 8 weeks after injection

		VAS			*P*
		Before	1 Month	2 Month	
Combined (Group A) (n = 20)	Mean ± SD	8.43 ± 0.59	3.63 ± 0.39	3.53 ± 0.44	< 0.001*
	Median (IQR)	8.50 (8.0–9.0)	3.50 (3.50–4.0)	3.50 (3.0–4.0)	$p1<0.001^*$
					$p2<0.001^*$
SSNB (Group B) (n = 20)	Mean ± SD	7.85 ± 0.86	4.30 ± 0.64	4.23 ± 0.68	< 0.001*
	Median (IQR)	8.0 (7.50–8.0)	4.50 (4.0–4.75)	4.25 (3.50–4.75)	$p1<0.001^*$
					$p2<0.001^*$
OSS					
Combined (Group A) (n = 20)	Mean ± SD	25.40 ± 1.88	38.50 ± 1.54	41.65 ± 1.18	< 0.001*
					$p1<0.001^*$
	Median (IQR)	25.0 (24.0–27.0)	38.5 (37.0–40.0)	42.0 (40.0–42.5)	$p2<0.001^*$
SSNB (Group B) (n = 20)	Mean ± SD	26.60 ± 1.31	37.35 ± 1.09	37.80 ± 0.89	< 0.001*
	Median (IQR)	27.0 (25.5–28.0)	37.5 (37.0–38.0)	38.0 (37.5–38.0)	$p1<0.001^*$
					$p2<0.001^*$

SSNB suprascapular nerve block, *IQR* interquartile range, *VAS* visual analog scale, *OSS* oxford shoulder score. *p1 p* value for comparison between Before injection and 1 Month, *p2 p* value for comparison between Before injection and 2 Month

*: significant *P* value

Functional capacity improvement was represented by an increase in OSS in both groups from baseline. Similarly, at OSS, both groups showed significantly better results (the mean was 13.1 and 16.25 in group A and 10.75 and 11.2 in group B) at 4 and 8 weeks respectively along the study interval. ($p<0.001$ at all periods) Table 3, Fig. 3B.

Discussion

Frozen shoulder is an incapacitating condition that causes pain and limitation in the shoulder joint. In 1934, "Frozen Shoulder" phrase was coined by Codman. He spoke of a gradually developing shoulder condition that was uncomfortable, stiff, and made sleeping on the affected side difficult [11].

The aim of this work was to test the efficacy of ultrasound-guided combined intra-articular corticosteroid injection and suprascapular nerve block in pain control of frozen shoulder.

In our study, we preferred to use US to guide our procedures over fluoroscopy for different reasons. First, all studies showed no significant privilege for fluoroscopy over ultrasonography in image guidance for shoulder injections. Moreover, fluoroscopy would be time-consuming and carries radiation exposure. Furthermore, as mentioned before ultrasound has diagnostic potential

Table 3 Comparison between combined IACSI and SSNB and SSNB groups according to decrease in VAS from baseline and increase in OSS from baseline

		Group A combined ($n=20$)	Group B SSNB ($n=20$)	*P*
Decrease in VAS from baseline				
Baseline-4 weeks	Mean ± SD	4.80 ± 0.55	3.55 ± 0.90	< 0.001*
	Median (IQR)	5.0 (4.50–5.0)	3.50 (3.0–4.25)	
Baseline-8 weeks	Mean ± SD	4.90 ± 0.53	3.63 ± 0.92	< 0.001*
	Median (IQR)	5.0 (4.50–5.25)	4.0 (3.0–4.25)	
Increase in OSS from baseline				
Baseline-4 weeks	Mean ± SD	13.10 ± 2.22	10.75 ± 1.37	< 0.001*
	Median (IQR)	13.50(12.0–14.50)	10.0 (10.0–12.0)	
Baseline-8 weeks	Mean ± SD	16.25 ± 2.07	11.20 ± 1.40	< 0.001*
	Median (IQR)	17.0 (15.0–17.0)	11.0 (10.0–12.0)	

SSNB suprascapular nerve block, *IQR* interquartile range, *VAS* visual analog scale, *OSS* oxford shoulder score. *p1 p* value for comparison between Before injection and 1 Month, *p2 p* value for comparison between Before injection and 2 Month

*significant *P* value

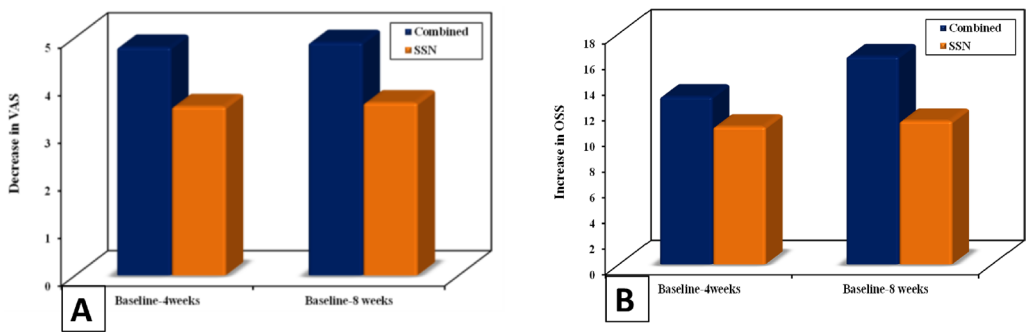

Fig. 3 Bar Chart: comparison between combined IACSI and SSNB and SSNB groups according to decrease in VAS (**A**) and increase in the OSS (**B**) from baseline (at 4- and 8-week intervals)

for frozen shoulder and is readily available and easily accessible.

Numerous studies have shown that combining corticosteroids with local anesthetics may be beneficial to elongate the efficacy of nerve blockage up to 2 times and significantly decrease pain scores [12, 13]. We performed SSNB with a mixture of levobupivacaine 0.5% (7 mL), triamcinolone (40 mg), and lidocaine 1% (2 ml). The study demonstrated the efficacy of this combination conducted by Jung et al. [14] who used a similar mixture of 9.5 ml bupivacaine and 0.5 ml triamcinolone injection. They preferred to use bupivacaine due to its superior effectiveness, prolonged effect, and milder motor blockage.

Despite being the most often used long-lasting local anesthetic, bupivacaine has been linked to some cardiac and central nervous system toxicities [15, 16]. Recently, compared to bupivacaine, ropivacaine has been touted as a potential medication with fewer side effects on the cardiovascular and nervous systems [17]. However, in the current study, no cardiovascular adverse effects were encountered as we were cautious to do aspiration before all injections to make sure the needle bevel wasn't in a minor vessel which is the main cause of such possible complications.

A randomized, double-blind clinical study by Mardani-Kivi et al. [18] revealed that at one-month interval adhesive capsulitis pain was successfully reduced with bupivacaine SSNB. These results agreed with our findings in improvement in patients' pain and functional capacity represented as improvement in OSS and VAS scores at 4 and 8 weeks interval in SSNB group.

Intra-articular corticosteroid injection had been used as a conventional therapy for symptoms control in adhesive capsulitis patients [10]. Intra-articular corticosteroid injection was usually carried out without image guidance; however, Soh et al. [19] in a study carried out in 2011 showed that, when compared to blind (landmark-based) injections, and individuals who had image-guided US injections experienced a statistically significantly higher improvement in shoulder discomfort and function at six

weeks. Better soft tissue infiltration and intra-articular medication administration were possible with image-guided (ultrasound) corticosteroid injections.

However, we performed IACSI on the glenohumeral joint under ultrasound guidance and through a posterior approach. In the same manner as the SSNB injection, we combined a corticosteroid and a local anesthetic. The benefits of local anesthetic include rapid pain relief from intra-articular pathology, dilution of the steroid drug, and reduction or avoidance of the postinjection flare [20, 21]. Jorgensen Jørgensen et al. [22] revealed an additional positive benefit of combining the steroids with local anesthetic for intra-articular injection, who demonstrated considerable instant pain improvement that was maintained for two weeks.

Intra-articular corticosteroid injection short-term effectiveness was primarily supported by previous systematic assessments of their utilization. Koh [23] showed that corticosteroid injection was more effective than physical therapy and watchful wait in the short term (up to 8 weeks).

In the current study, we assessed the effect of combined treatment techniques and we found that both SSNB and IACSI are effective methods in pain control and adhesive capsulitis' functional results. When comparing the results obtained after the combined technique and SSNB alone, we found that the application of the combined technique (SSNB and IACSI) was significantly more effective than SSNB alone in improving pain and functional status as measured by OSS and VAS ratings at 4-week and 8-week follow-ups.

To the best of our knowledge, the outcomes of SSNB alone and SSNB paired with IACSI have not been explicitly compared in the literature. Jung et al. [14] concluded that combining SSNB and IACSI treatment led to greater improvements in function visual analog scale (FVAS) and American Shoulder and Elbow Surgeons score compared with IACSI alone, and this favorable result was maintained up to 10 months post-intervention.

In our study, we found that patients who gained the benefit most were those who performed injections in the early stage or freezing phase of the disease, in cases where pain was the main symptom. This will provide early and better resolution of the symptoms, prior to engaging in physical treatment or home exercise. Thus, helping the patient to be pain-free during physiotherapy, subsequently yields more discipline in exercises and better long-term outcomes.

During the current study, throughout the procedure and the whole follow-up period, neither group experienced any notable side effects.

In several researches, the detrimental clinical consequences of intra-articular glenohumeral steroid injections were extensively examined. Transient pain following injection made up the majority of the local side effects (11.7% of corticosteroid injections) [24].

The second-most often reported negative effects were skin shrinkage and depigmentation (4%). Although the majority of the side effects are extremely rare and temporary, atrophic skin changes and depigmentation can sometimes be permanent, and the patient must be informed before performing the procedure. Although tendon ruptures following steroid injections have been clinically documented, this side event was not recorded in any studies [25].

Gas gangrene is a rare but serious complication. Yangco et al. [26] disclosed a case of gas gangrene brought on by an intra-articular steroid injection. The causative organisms in this instance were Escherichia coli and Clostridia species.

Facial flushing, inhibition of the hypothalamic–pituitary–adrenal axis, and higher blood glucose levels as a result of enhanced hepatic gluconeogenesis are examples of possible systemic side effects [27].

Septic arthritis is the most worrisome complication related to intra-articular corticosteroid injections. A study conducted by Geirsson et al. [28] in Iceland between 1990 and 2002, found a 2 to 1 male-to-female ratio and a mean age of 70 years. Uncontrolled diabetes, immunosuppression, rheumatic, and osteoarthritis are significant risk factors.

Some laboratory studies show that CS and local anesthetics may have chondrotoxic effect when used alone and when used in combination. According to clinical data, chondrolysis resulting from intra-articular local anesthetic use was reported mostly after shoulder surgery and resulting from continuous infusions into the glenohumeral joint however, no sufficient available data about long-term side effects of single intra-articular steroid injection [29].

Limitations

First, there are still a limited number of patients enrolled, which may have impacted the statistical power. Second, the majority of our patients had varying levels of education, socioeconomic status, and concomitant conditions like thyroid insufficiency and stroke, which could have affected their subjective perception of pain relief.

Conclusions

US-guided SSNB with a mixture of CS and local anesthetic is an effective, radiation-free method to alleviate frozen shoulder-related pains. When compared, combined SSNB and IACSI is more effective than SSNB alone in both pain alleviation and improved shoulder joint function.

Abbreviations

CS	Corticosteroids
SSNB	Suprascapular nerve block
IACSI	Intra-articular corticosteroids injection
VAS	Visual analog scale
OSS	Oxford shoulder score
NSAIDS	Nonsteroidal anti-inflammatory drugs
MRI	Magnetic resonance imaging
TA	Triamcinolone
AUC	Area under the curve
IQR	Interquartile range

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Not applicable

Author contributions
The study's design was settled down by all authors, and they all were involved in the writing process and revisions on the initial drafts of the paper. EHA and MME designed the work, acquisition, and data analysis. Material preparation, data collection, and analysis were done by SED, EHA, OEE, and RE. All authors read, revised, and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Approval was obtained for this prospective study from the institutional review board and the Research Ethics Committee of the faculty of Medicine, Alexandria University.

Consent for publication
An informed written consent was obtained from all patients included in this study.

Competing interests
The authors declare that they have no competing interests.

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