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# Comparative efficacy of ultrasound-guided combined suprascapular and axillary nerve block with suprascapular nerve block alone in patients with frozen shoulder: A prospective, double-blinded randomized, single-centre trial

Sanjay Kumar [a], Sandeep Khuba [a,*], Sujeet Gautam [a], Anil Agarwal [a], Arindam Chatterjee [a], Nitin Goyal [a], Prabhakar Mishra [b]

[a] Department of Anaesthesiology, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India
[b] Department of Biostatistics and Health Informatics, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India

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ABSTRACT

*Background:* Frozen shoulder is a troublesome disease of the shoulder joint. It leads to marked disability because of pain with restriction of active and passive movement of the joint. We aimed to determine and compare the efficacy of combined suprascapular and axillary nerve blocks with suprascapular nerve block alone for the treatment of frozen shoulder pain.

*Methodology:* A total of 61 patients with frozen shoulder included in the study underwent ultrasound-guided combined suprascapular and axillary nerve block (n = 31) and suprascapular nerve block (n = 30). All the patients were assessed for visual analogue scale (VAS) pain (0-10), simple pain score (0-5), total pain score (0-9), range of motion (abduction, external rotation, and internal rotation) of the affected shoulder joint at baseline and post-procedure at 7 days, 1 month, 3 months, 6 months, and 12 months.

*Result:* There was a significant improvement in VAS pain score, simple pain scores, total pain scores and range of motion of the affected shoulder joint in both groups at all time points as compared to the baseline. However, in the combined nerve block group the VAS scores, simple and total pain scores, abduction, and internal rotation were significantly better at 6 months, 3 months, 6 months, and 12 months, respectively.

*Conclusion:* The combined block provided faster and superior pain relief and improvement in function.

## 1. Introduction

Frozen shoulder or adhesive capsulitis is a troublesome disease of the shoulder joint. It leads to marked disability because of pain with restriction of active and passive movement of the joint. Its prevalence is around 2–5% in the general population, more commonly affecting patients with age 40–70 years, diabetes mellitus, stroke, and local shoulder pathology [1,2]. A variety of treatment modalities are offered for pain relief including the use of physical therapy, non-steroidal anti-inflammatory drugs (NSAIDs), intra-articular steroids, manipulation under anaesthesia and surgical capsular repair with limited success [3].

The sensory innervation of the shoulder joint consists of the suprascapular, axillary, lower subscapular, and lateral pectoral nerve [Fig. 1] However, the majority of sensory innervation is provided by the suprascapular and axillary nerve [4]. The blockade of the sensory supply of a chronic painful joint lead to improvement in its pain relief and function. Suprascapular nerve block has been observed to lead to improvement in pain and function of chronic shoulder pain of varied etiology [5]. The various studies reported beneficial effects of suprascapular nerve block for 3–6 months in patients with shoulder pain [6,7]. We hypothesized that the blockade of two nerves innervating a joint is better than a single nerve to improve pain and function. So, the present study aims to determine and compare the efficacy of ultrasound-guided combined suprascapular and axillary nerve block with suprascapular nerve block alone for the treatment of pain and function of the shoulder joint in frozen shoulder patients.

* Corresponding author.
*E-mail address:* sandeepkhuba@gmail.com (S. Khuba).

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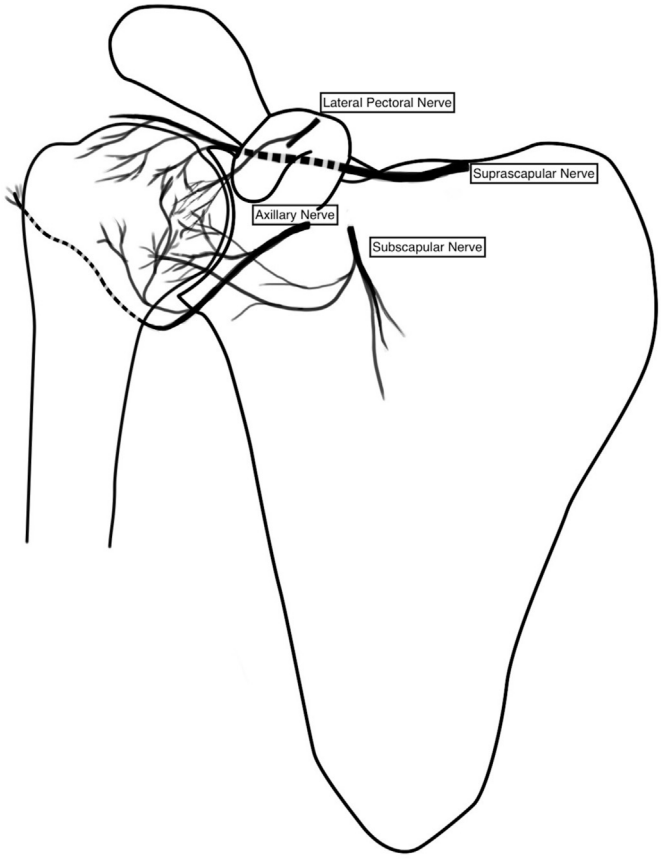


**Fig. 1.** Nerve supply of shoulder joint.

## 2. Materials & methods

### 2.1. Study design and setting

This prospective, double-blinded, randomized, single-center, interventional study was conducted after approval by the institutional ethical committee with reference number PGI/BE/408/2017 dated 11 May 2017. This study is registered with the clinical trial registry of India with registration number CTRI/2018/05/014083. The patients suffering from frozen shoulder attending the Pain Clinic, Department of Anaesthesiology were recruited to the study according to the following inclusion and exclusion criteria.

### 2.2. Inclusion criteria

- Age 18–60 years
- History of complaint >6 weeks
- Second and third stages of shoulder capsulitis
- Restricted shoulder movement in at least 2 planes including abduction, external rotation, and internal rotation.
- Written informed consent obtained.

### 2.3. Exclusion criteria

- Systemic inflammatory disease (including rheumatoid arthritis and osteoarthritis, polymyalgia rheumatica)
- Glenohumeral joint arthritis
- Tumor
- Contraindications to needle insertion like coagulopathy, allergy to local anaesthetic.
- Pregnancy
- Acute trauma, fracture of the shoulder

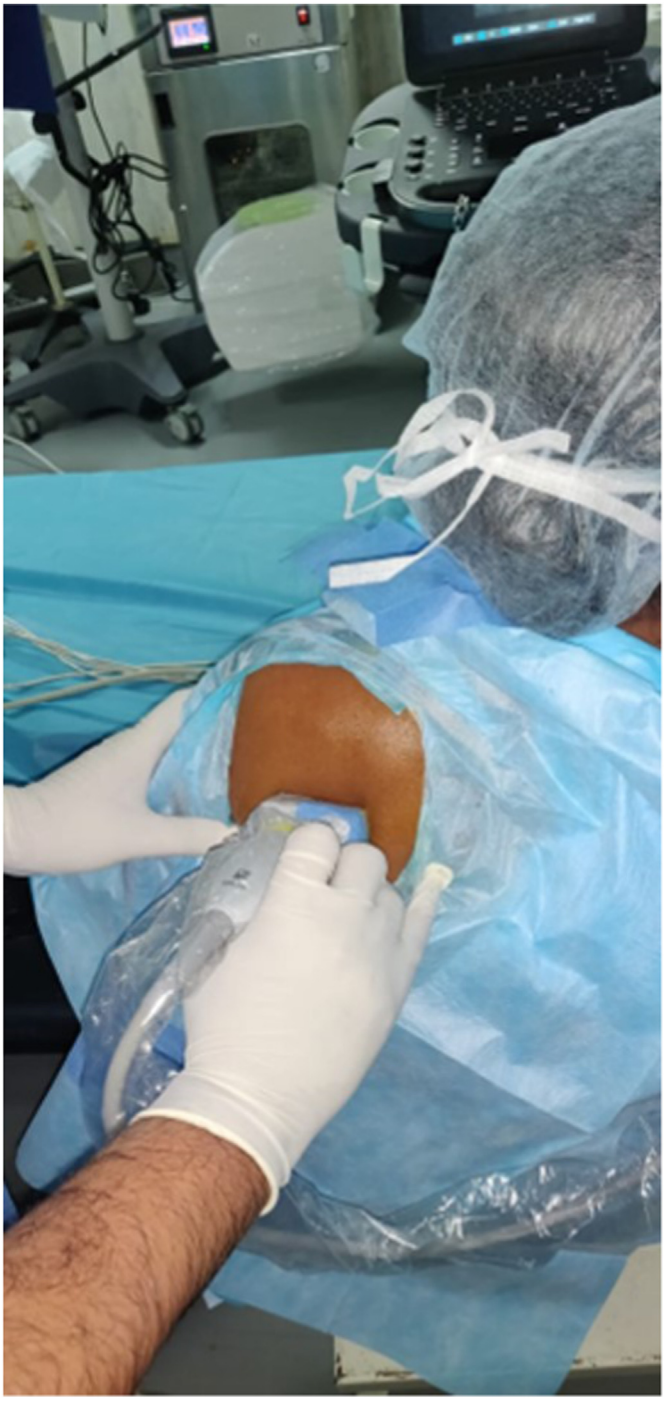

**Fig. 2.** Suprascapular nerve block.

### 2.4. Group allocation

The patients after satisfying the inclusion criteria were allocated to one of two groups according to a computer-generated random number table. The patients were blinded to the group allocation. One group was the “SA” group in which both suprascapular and axillary nerves were blocked. The other group was the “S” group in which only the suprascapular nerve was blocked, and sham needling was done for the axillary nerve.

### 2.5. Trial treatment

A single physician performed the procedures on all the patients.

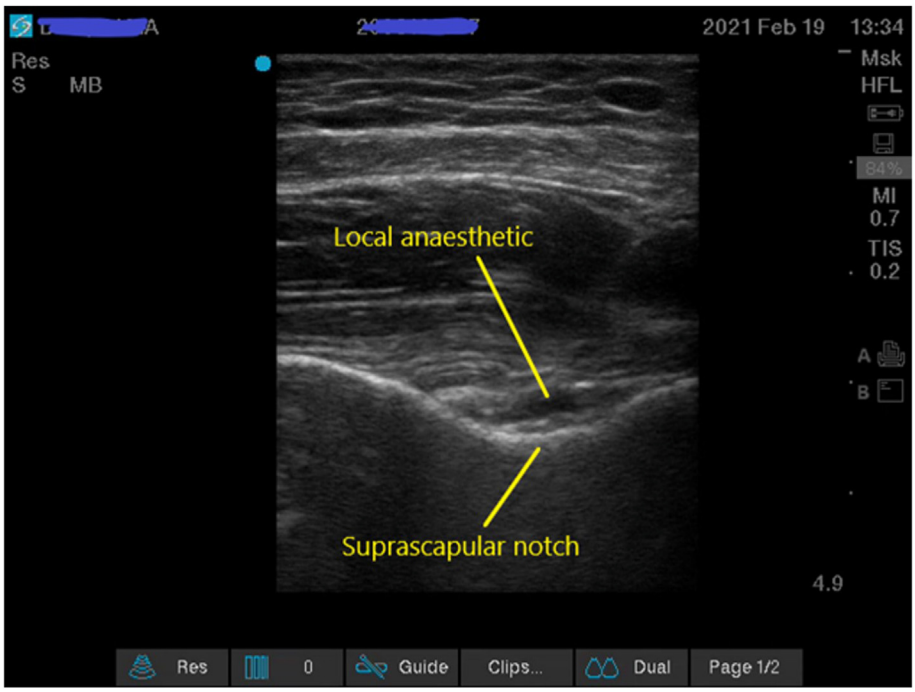


**Fig. 3.** Local Anaesthetic spread.

Written informed consent was taken from all the patients. The procedures were performed under standard American Society of Anesthesiologists (ASA) monitoring. Intravenous access was obtained before beginning the procedure. The procedure was performed with the patient in the sitting position with the clinician standing behind. The shoulder area was prepared aseptically with chlorhexidine and povidone-iodine solution. The high frequency (6–13 MHz) linear probe of the ultrasound machine (M-Turbo, Fujifilm Sonosite, USA) was used for both suprascapular and axillary nerve block.

### 2.6. Suprascapular nerve block technique

The USG probe was placed in a transverse plane to visualize the suprascapular notch [Fig. 2]. The suprascapular artery and the transverse scapular ligament were visualized in the suprascapular notch. A 2–3 ml of 1% lignocaine was infiltrated into the skin and subcutaneous tissue. A 22 G, 10 cm Quincke spinal needle was inserted from medial to lateral direction in the "in-plane technique" towards the suprascapular notch [Fig. 3]. 5 ml of 0.25% bupivacaine along with Triamcinolone acetonide (Kenacort, Abbott, India) (10 mg in SA group and 20 mg in S group) was deposited in the suprascapular notch to block the suprascapular nerve [Fig. 3]

### 2.7. Axillary nerve block technique

The USG probe was placed on the posterior surface of the humerus and scanned in its long axis along a horizontal line that crosses the midpoint of a line joining the anterior aspect of the acromion and the inferior angle of the scapula (Fig. 4). This allowed a short axis view of the circumflex artery and the axillary nerve traversing the posterior aspect of the neck of the humerus (Fig. 5). 5 ml of 0.25% bupivacaine with 10 mg of Triamcinolone acetonide was injected adjacent to the artery in SA group and 5 ml of normal saline in S group (Fig. 6). After the procedure, the patients were shifted to post anaesthesia recovery room. The patients were observed and discharged after 2 h (see ).

### 2.8. Outcome

All the patients were assessed for Pain (VAS), total pain score (combination of simple pain score, radiation, and sleep disturbance score) and active range of movement of the shoulder joint at baseline and post-procedure at 7 days, 1, 3, 6 and 12th months. Patients graded their sleep disturbance and radiation/spread of pain using a nominal scale shown in Table 1. The first column will be the simple pain score and the sum of the 3 columns was recorded as the total pain score [5]. All the assessment was done by a third observer who was blinded to the allocation group of the patients. The active range of abduction, internal rotation and external rotation was measured using goniometry. All the assessment of outcome measures was done by the same physician.

### 2.9. Sample size estimation

Assuming a 35% difference in pain reduction between suprascapular and axillary nerve block (SA) and suprascapular nerve block (S) study groups, pain reduction in SA and S groups was assumed to be 85% and 50%. At minimum two-sided 95% confidence interval and 80% power of the study, the estimated sample size in SA and S groups was 26 (in each group). Finally in this study, 31 and 30 patients were included in SA and S groups respectively. The sample size was estimated using software Power analysis and sample size version −16 (PASS-16, NCSS, LLC, USA).

### 2.10. Statistical analysis

Continuous variables were presented in mean (95% Confidence interval) along with median (interquartile range) whereas categorical variables were presented in frequency and percentage. To compare between SA and S groups, the Chi-square test was used to compare the female proportions whereas the independent samples *t*-test was used to compare the mean age. Mann Whitney *U* test was used to compare the Pain Scores and other quantitative measurements including ordinal data. Friedman test was used to test the change in the repeated scores over the follow-up time. A linear mixed model was used to test the association

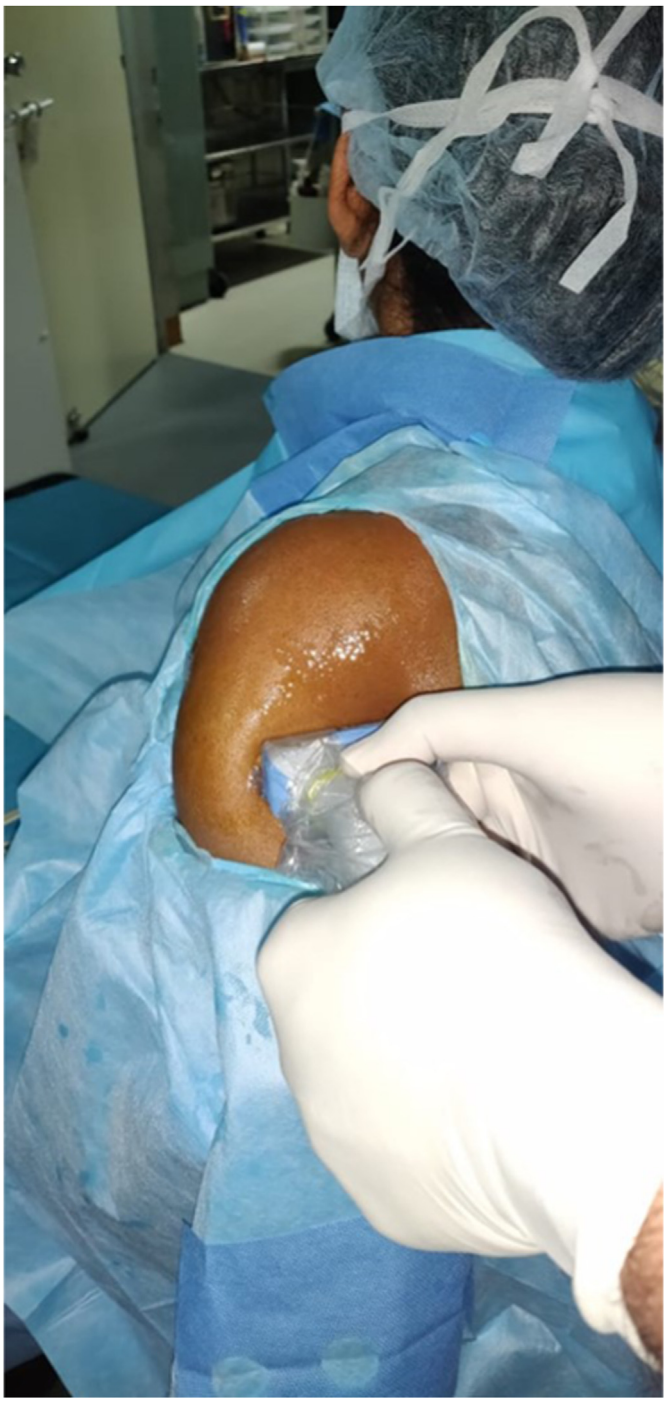

**Fig. 4.** Axillary nerve block.

between study groups (SA and S) and repeated Scores measured at time points (Baseline, 7 days, 1 month, 3 months, 6 months, and 12 months). Adjacent and Cumulative bar diagrams were used to compare the measurements between the groups. P value $< 0.05$ was considered statistically significant. Statistical package for social sciences, version 23 (SPSS 23, IBM, Chicago, USA) was used for data analysis.

## 3. Results

In the present study, 61 patients were included, of them, 31 were in suprascapular and axillary nerve block (SA) and 30 in suprascapular nerve block (S) (Fig. 7). The Mean and median age of the study patients was 53.75 and 52 years (Range: 34-78). 55.7% of the participants were females. There was no significant difference in mean age ($54.32 \pm 11.04$ vs $53.17 \pm 12.04$, $p = 0.697$) and female sex (58.1% vs 53.3%, $p = 0.710$) between SA and S groups.

In both groups (SA and S), the intervention was given and reduction in VAS score, Simple pain score (P) and Total pain score (TP) were measured at Baseline, 7 days, 1 month, 3 months, 6 months and 12 months and association of pain reduction between study groups and time points were assessed.

The VAS score, Simple pain score (P) and Total pain score (TP) showed a reduction over time in both groups. For the VAS score, the reduction was evident in the SA as well as S group but there was a more rapid reduction observed in the SA group as compared to the S group and it was significantly lower at 7 days, 1 month, 3 months and 6 months ($p < 0.05$ each) however, it was statistically equal at baseline and 12 months ($p > 0.05$ each). The linear mixed model showed that there was a significant association between the study groups (SA and S) and the reduction in VAS pain score during the follow-up time ($p < 0.05$). [Table 2, Fig. 8].

For the Simple pain score (P), the more rapid reduction was observed in the SA group as compared to the S group and it was significantly lower at 7 days, 1 month and 3 months ($p < 0.05$ each) but statistically equal at baseline, 6 months, and 12 months ($p > 0.05$ each). The linear mixed model showed a significant association between the study groups and a reduction in pain scores during the follow-up time ($p < 0.05$). [Table 2, Fig. 9].

For the Total pain score, a more precipitous reduction was observed in the SA group as compared to the S group and it was significantly lower at 7 days, 1 month and 3 months ($p < 0.05$ each) but statistically equal at baseline, 6 months, and 12 months ($p > 0.05$ each). The linear mixed model indicated a significant association between the study groups and a reduction in total pain score during the follow-up time ($p < 0.05$). [Table 3, Fig. 10].

Similarly, for the radiation of pain (RAD pain) score and sleep disturbance score (SL), a reduction trend was evident in the SA as well as S groups with almost similar reduction in each of the two groups. RAD score was statistically equal at all time points ($p > 0.05$ each). Similar results were also observed for sleep disturbance score (SL) where except at one month, rest of the time points, score was statistically equal. Linear mixed model showed that there was no significant association between the study groups and reduction in RAD pain score and SL score during the follow up time ($p > 0.05$ each). [Table 4].

Score of the Abduction angle (ABD), Internal rotation angle (IR) and External rotation angle (ER) were assessed at baseline, 7 days, 1 month, 3 months, 6 months, and 12 months. The measurements showed an increasing trend from baseline to all follow up time points. In ABD, score was significantly higher in SA group at 7 days, 1, 3 and 6 months ($p < 0.05$) but statistically equal at baseline and 12 months ($p > 0.05$). [Fig. 11]. In Internal rotation angle (IR), except at baseline rest of the time points, score of SA group was significantly higher as compared to S group. [Fig. 12]. In External rotation angle (ER) group, at the 3 months, score was significantly higher in SA group as compared to S group whereas rest of the time points, score was statistically equal ($p > 0.05$) [Fig. 13]. Linear mixed model showed that there was significant association between the study groups (SA and S) and increment of ABD and IR scores individually (each $p < 0.05$) whereas no association was observed for ER measurements. [Tables 5 and 6].

## 4. Discussion

This study shows that combined suprascapular and axillary nerve block leads to better improvement in pain and function of shoulder joint in initial 6 months than suprascapular nerve block alone. However, after 6 months both combined and suprascapular nerve block are similar in terms of pain relief and functional improvement.

The suprascapular nerve innervates the posterior glenohumeral capsule, subacromial bursa, coracoacromial, and acromioclavicular

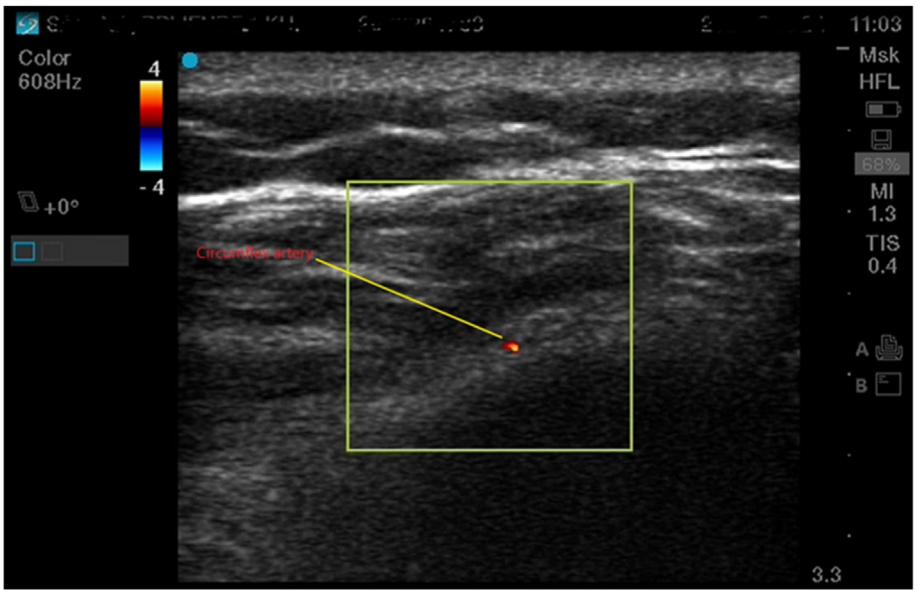


**Fig. 5.** Short axis view of the circumflex artery and the axillary nerve.

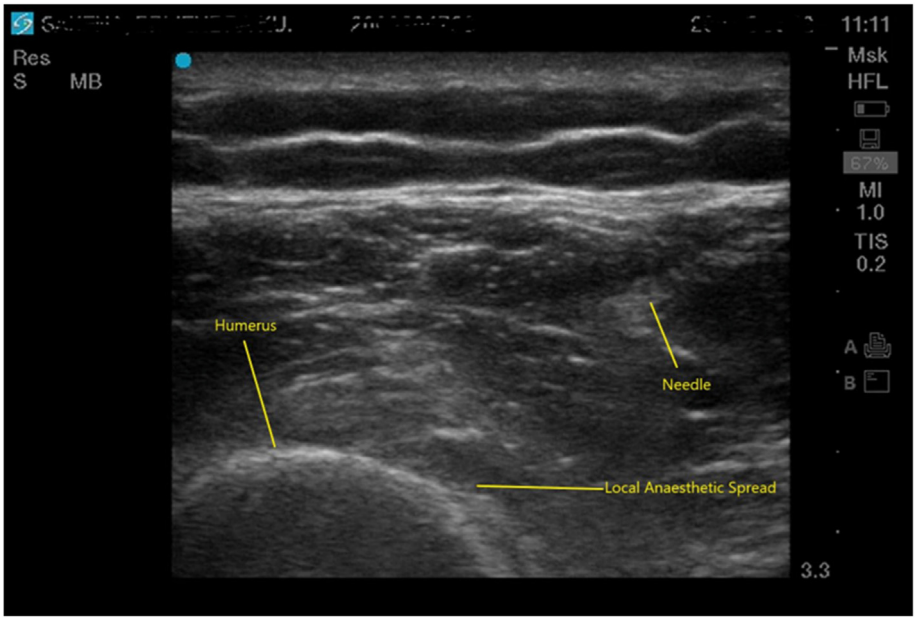


**Fig. 6.** Local anaesthetic Spread.

ligament. The axillary nerve supply sensory innervation to inferior portion of anterior and posterior glenohumeral capsule [8]. The suprascapular nerve block has been observed to lead to improvement in chronic shoulder pain for 3–6 months [5–7]. Consistent with earlier studies, this study observed similar improvement in pain scores for up to 12 months with both combined and suprascapular nerve block. However, the pain relief was significantly better for up to 6 months with combined block. So anaesthetic block of two nerves offers faster pain relief as compared to single nerve block.

We observed significant improvement in sleep at 1 month with combined block than suprascapular nerve block alone. After 1-month similar improvement in radiation of pain and sleep disturbance was there with both combined and suprascapular nerve block over all time periods as compared to the baseline. The pain relief achieved with nerve blocks led to improvement in sleep. Cho et al. [9] observed the association of shoulder pain with sleep disturbance. They found 81.5% prevalence of sleep disturbance in patients with shoulder pain of more than 3 months duration. They also observed that the sleep disturbance co-related with intensity of shoulder pain rather than duration. In our experience, combined suprascapular and axillary nerve block provides faster improvement in sleep as compared to suprascapular nerve block alone.

The normal range of motion of shoulder joint for abduction, internal rotational, and external rotation is 0–180°, 0–90°, and 0–90°, respectively. The frozen shoulder is characterized by pain and stiffness in the shoulder joint. The average range of motion of abduction, internal rotation, and external rotation have been observed to be 98-degree, 18°, and 33° in shoulder joints of patients with frozen shoulder [10]. The baseline average abduction, internal rotation, and external rotation angle of the patients included in this study were observed to be 91.63, 35.57, and 44.42°, respectively. It has been observed that in patients of adhesive capsulitis, external rotation is more severely affected followed by

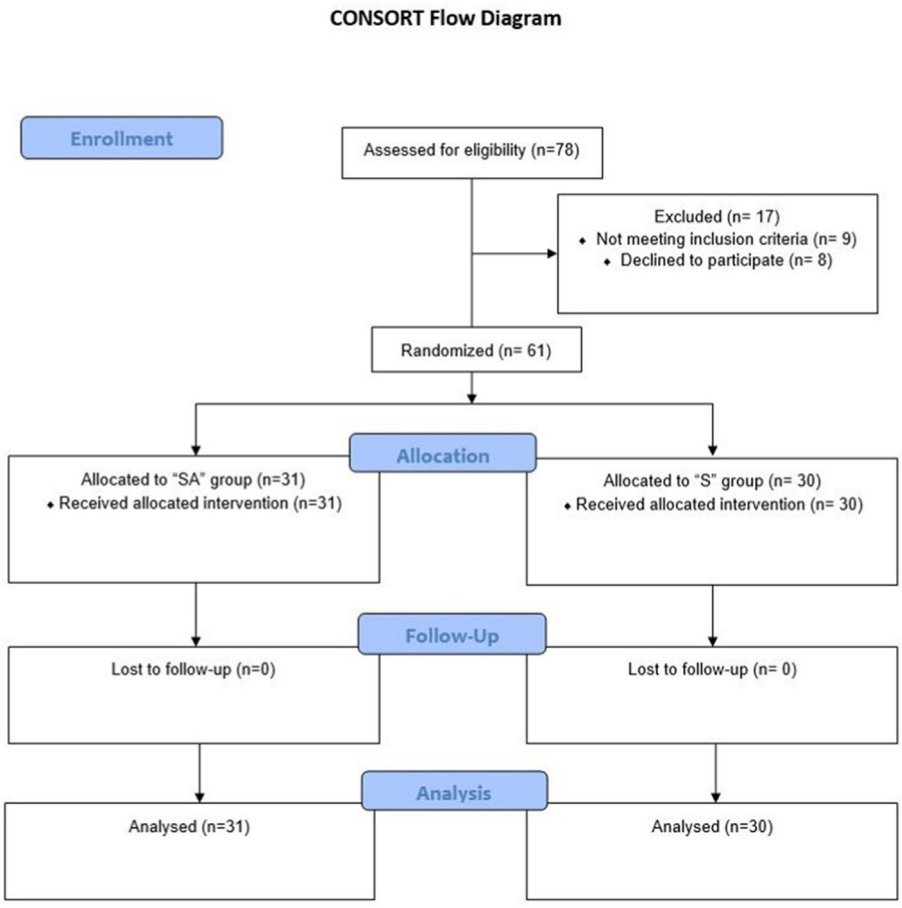


**Fig. 7.** Consort flow diagram.

**Table 1**
Range of scores and corresponding intensity.

| Score | Simple pain score | Radiation | Sleep disturbance |
|---|---|---|---|
| 0 | None | None | None |
| 1 | Mild, intermittent | To elbow | Mild |
| 2 | Mild, constant | To wrist | Moderate |
| 3 | Moderate | To hand | Severe |
| 4 | Severe | | |
| 5 | Very severe | | |

abduction and then internal rotation [11]. We observed significant increase in shoulder movement after combined or suprascapular nerve block alone for up to 12 months as compared to the baseline. In our experience, the combined block provided faster improvement in external rotation, abduction, and internal rotation for up to 3, 6 and 12 months, respectively.

The frozen shoulder is managed conservatively with the use of non-steroidal anti-inflammatory drugs, physiotherapy modalities, exercises, oral or intra-articular corticosteroids and hydrodilatation. The operative treatment involved manipulation under anaesthesia and open or

**Table 2**
Association of the Study Groups and change in Score of VAS and simple pain score between time points.

| Variable's | SA (n = 31) | | S (n = 30) | | P value |
|---|---|---|---|---|---|
| | Mean (95% CI) | Median (Q1, Q3) | Mean (95% CI) | Median (Q1, Q3) | |
| VAS_Baseline (0) | 76.8(73.6,79.8) | 80(70,80) | 77(73.8,80) | 80(70,80) | 0.874 |
| VAS_7 days | 27.7(23.6,31.9) | 25(20,30) | 37(33.7,40.7) | 40(30,50) | **0.001** |
| VAS_1 month | 22.3(19.4,25.2) | 20(20,30) | 33.3(28.3,38) | 30(27.5,50) | **0.001** |
| VAS_3 months | 13.9(11.3,16.5) | 10(10,20) | 24.3(21,27.3) | 30(20,30) | **0.001** |
| VAS_6 months | 4.8(2.9,6.8) | 0(0,10) | 12(9.3,14.7) | 10(10,20) | **0.001** |
| VAS_12 months | 4.2(2.6,6) | 0(0,10) | 6.2(4,8.3) | 7.5(0,10) | 0.244 |
| P_baseline | 4.1(3.9,4.3) | 4(4,4) | 4(3.8,4.2) | 4(4,4) | 0.825 |
| P_7 days | 1.8(1.6,2.1) | 2(1,2) | 2.4(2.2,2.7) | 3(2,3) | **0.003** |
| P_1 month | 1.4(1.3,1.6) | 1(1,2) | 2.1(1.8,2.3) | 2(1,3) | **0.001** |
| P_3 months | 1(0.8,1.1) | 1(1,1) | 1.6(1.4,1.8) | 2(1,2) | **<0.001** |
| P_6 months | 0.5(0.3,0.7) | 0(0,1) | 0.6(0.4,0.7) | 1(0,1) | 0.521 |
| P_12 months | 0.4(0.2,0.5) | 0(0,1) | 0.5(0.3,0.7) | 0.5(0,1) | 0.256 |

CI: Confidence Interval, Q1 = First Quartile, Q3 = Third Quartile.
Linear Mixed model used ($p = 0.001$ for VAS, $p = 0.013$ for P).
Friedman test for repeated measurements ($p < 0.05$ for each measurement of VAS and P). Mann Whitney *U* test between S and SA. $p < 0.05$ significant.
VAS: Visual Analogue Scale.
P: Simple Pain Score.

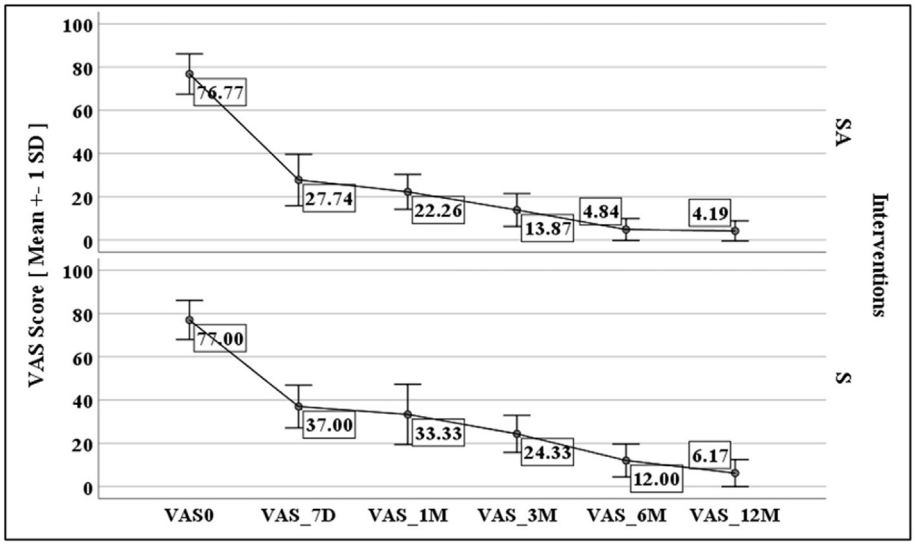


**Fig. 8.** Distribution of the VAS pain score during the follow up between baseline, 7 days, 1 month, 3 months, 6 months, and 12 months.

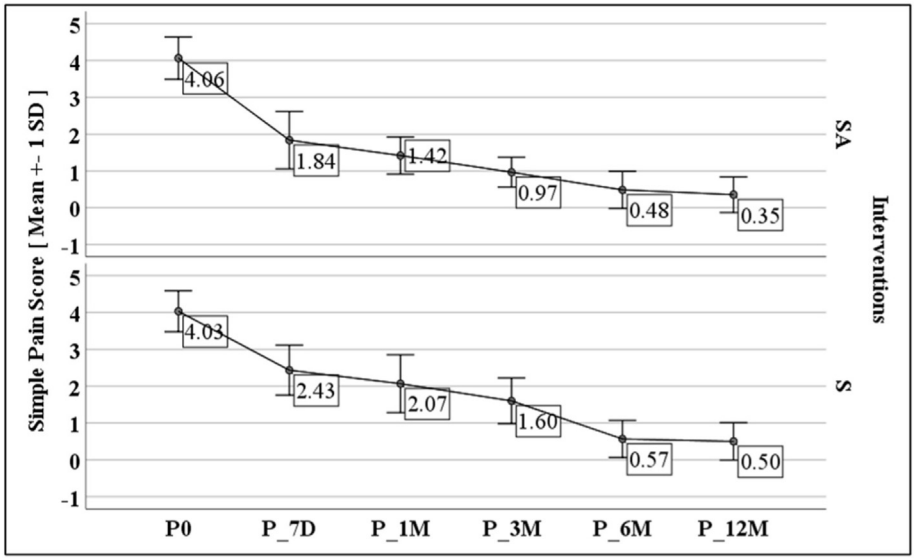


**Fig. 9.** Distribution of the simple pain score during the follow up between baseline, 7 days, 1 month, 3 months, 6 months, and 12 months.

laparoscopic capsular release [12]. The conservative management has been found to be successful in 90% of the patients [13]. The use of intra articular steroid early in the course of the disease has been found to lead to short term improvement in pain relief and function of the shoulder joint [14]. The patients who did not get adequate relief after 3–6 months of conservative management are offered surgical interventions. However surgical interventions have less favorable outcome as compared to conservative management [15]. There is also increased risk of damage to normal tissue as presence of adhesions make it difficult to differentiate between normal and abnormal tissue [16]. There is still disagreement regarding universal treatment for the management of pain and disability of the shoulder in patients of frozen shoulder [17].

The suprascapular nerve block with local anaesthetic with steroid has been shown to lead to improvement in pain and function of the joint in frozen shoulder patients for up to 3 months [5]. The pulsed radiofrequency treatment of suprascapular nerve has also been shown to result in benefit of up to 6 months in patients of chronic shoulder pain [17]. The combined suprascapular and axillary nerve block has been found safe and effective for perioperative anaesthesia and analgesia in patients undergoing arthroscopic shoulder surgery [18]. In a case report described by Rothe et al. [19], the isolated axillary nerve block had resulted in excellent pain relief in chronic shoulder pain after a fracture of tubercle

**Table 3**
Association of the Study Groups and change in TP Score between Six time points.

| Variable's | SA (n = 31) | | S (n = 30) | | P value |
|---|---|---|---|---|---|
| | Mean (95% CI) | Median (Q1, Q3) | Mean (95% CI) | Median (Q1, Q3) | |
| TP_baseline | 8.5(8.1,8.9) | 9(8,9) | 8.6(8.3,8.9) | 9(8,9) | 0.706 |
| TP_7 days | 4.3(3.9,4.7) | 4(3,5) | 4.9(4.5,5.2) | 5(4,6) | **0.023** |
| TP_1 month | 2.7(2.5,3) | 3(2,3) | 3.6(3.3,4) | 3.5(3,4) | **<0.001** |
| TP_3 months | 2.1(1.9,2.3) | 2(2,2) | 2.7(2.5,2.9) | 3(2,3) | **<0.001** |
| TP_6 months | 1.5(1.3,1.7) | 1(1,2) | 1.6(1.4,1.7) | 2(1,2) | 0.521 |
| TP_12 months | 1.4(1.2,1.5) | 1(1,2) | 1.5(1.3,1.7) | 1.5(1,2) | 0.256 |

CI: Confidence Interval, Q1 = First Quartile, Q3 = Third Quartile.
Linear Mixed model used (p = 0.011 for TP).
Friedman test for repeated measurements ($p < 0.05$ for each measurement of TP).
Mann Whitney *U* test between S and SA. $P < 0.05$ significant.

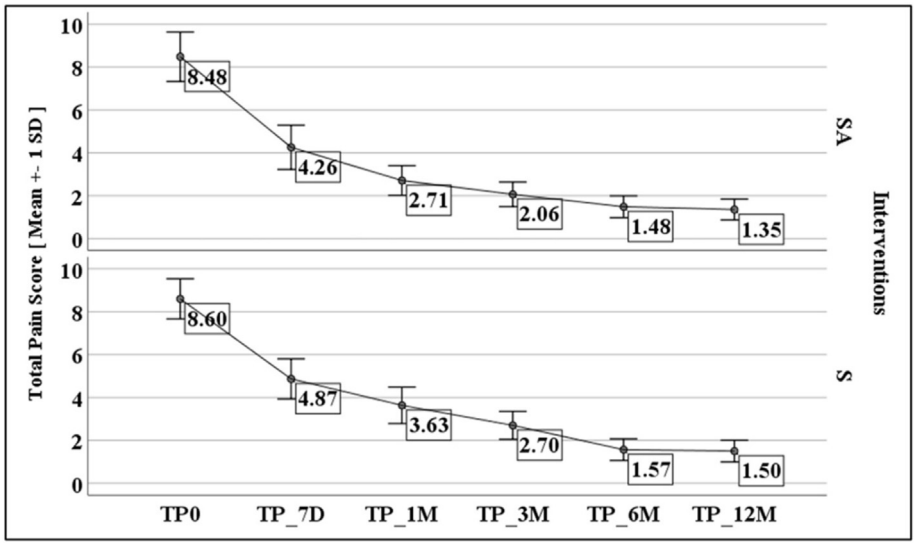


**Fig. 10.** Distribution of the total pain score during the follow up between baseline, 7 days, 1 month, 3 months, 6 months, and 12 months.

**Table 4**
Association of the Study Groups and change in RAD and SL Score between Six time points.

| Variables | SA (n = 31) | | S (n = 30) | | p value |
|---|---|---|---|---|---|
| | Mean (95% CI) | Median (Q1, Q3) | Mean (95% CI) | Median (Q1, Q3) | |
| RAD_baseline | 2.7(2.6,2.9) | 3(2,3) | 2.8(2.7,2.9) | 3(3,3) | 0.593 |
| RAD_7 days | 1.4(1.3,1.6) | 1(1,2) | 1.5(1.3,1.7) | 1(1,2) | 0.712 |
| RAD_1 month | 1.1(1,1.2) | 1(1,1) | 1.1(1,1.2) | 1(1,1) | 0.973 |
| RAD_3 months | 1(1,1) | 1(1,1) | 1(1,1) | 1(1,1) | 0.999 |
| RAD_6 months | 1(1,1) | 1(1,1) | 1(1,1) | 1(1,1) | 0.999 |
| RAD_12 months | 1(1,1) | 1(1,1) | 1(1,1) | 1(1,1) | 0.999 |
| SL_baseline | 1.8(1.6,2) | 2(1,2) | 1.8(1.5,2) | 2(1,2) | 0.956 |
| SL_ 7 days | 1(1,1) | 1(1,1) | 1(1,1) | 1(1,1) | 0.999 |
| SL_1 month | 0.2(0.1,0.4) | 0(0,0) | 0.5(0.4,0.7) | 1(0,1) | **0.014** |
| SL_3 months | 0.1(0,0.2) | 0(0,0) | 0.1(0,0.3) | 0(0,0) | 0.657 |
| SL_6 months | 0(0,0) | 0(0,0) | 0(0,0) | 0(0,0) | 0.999 |
| SL_12 months | 0(0,0) | 0(0,0) | 0(0,0) | 0(0,0) | 0.999 |

CI: Confidence Interval, Q1 = First Quartile, Q3 = Third Quartile.
Linear Mixed model used (p = 0.902 for RAD, p = 0.168 for SL).
Friedman test for repeated measurements ($p < 0.05$ for each measurement of VAS and P). Mann Whitney *U* test between S and SA. $P < 0.05$ significant.

of humerus. In this study we have demonstrated the efficacy of combined suprascapular and axillary nerve block for improvement in pain and function of the shoulder joint in frozen shoulder patients.

This study concludes that the combined suprascapular and axillary nerve block provided better pain relief and functional improvements compared to suprascapular nerve block alone during the initial follow up period of 3–6 months; however, both combined and suprascapular nerve block alone are comparable in the later part of follow up. As the risk associated with an additional ultrasound guided axillary nerve block is minimal, we suggest that both axillary and suprascapular nerve block should be offered to the patients of frozen shoulder for better initial pain management.

## 5. Limitations of the study

We assessed only pain, quality of sleep and improvement in range of motion of the joint. A multidimensional assessment score like the Shoulder Pain and Disability Index (SPDI) would have been much better to assess the quality of the life of the patients. We have included patients up to the age of 60 years only in our study. The inclusion of patients older than 60 years would have enhanced generalizability of our study results. We followed up our patients for up to 12 months so more studies with longer follow up may be done in future to know the long-term benefit of

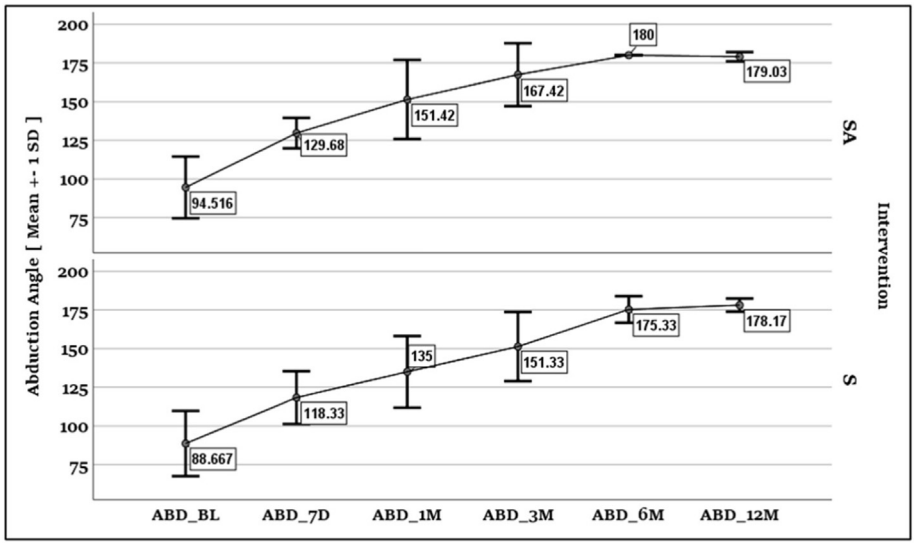


**Fig. 11.** Distribution of the ABD score during the follow up between baseline, 7 days, 1 month, 3 months, 6 months, and 12 months.

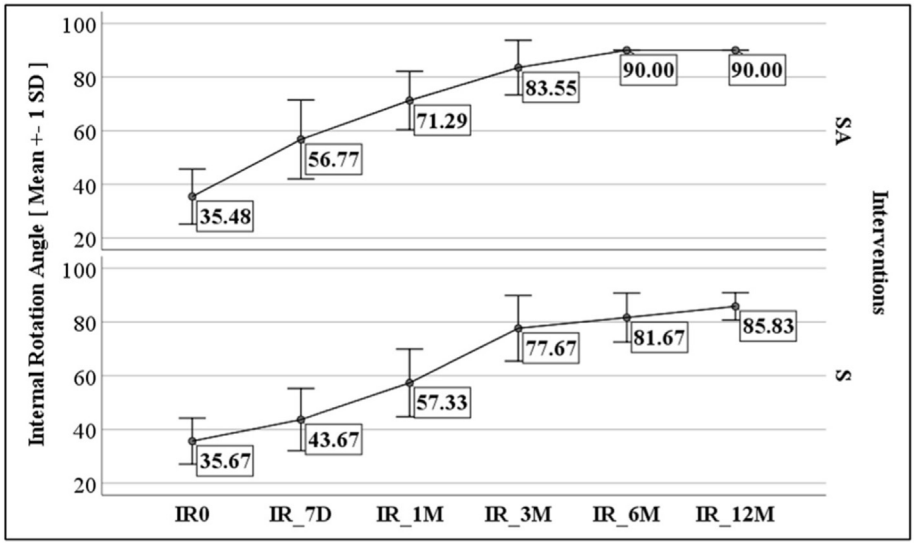


**Fig. 12.** Distribution of the IR score during the follow up between baseline, 7 days, 1 month, 3 months, 6 months, and 12 months.

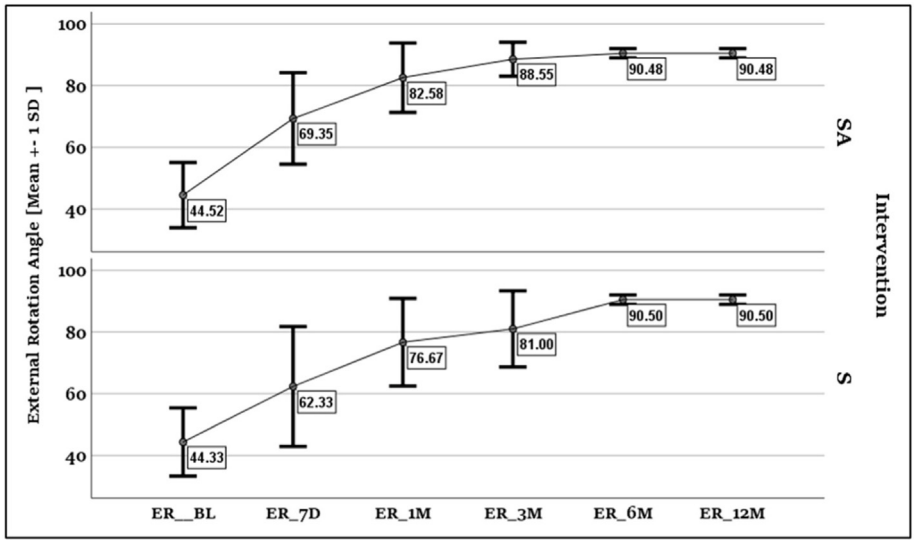


**Fig. 13.** Distribution of the ER score during the follow up between baseline, 7 days, 1 month, 3 months, 6 months, and 12 months.

**Table 5**
Association of the Study Groups and change in ABD and IR Score between Six time points.

| Variables | SA (n = 31) | | S (n = 30) | | |
|---|---|---|---|---|---|
| | Mean (95% CI) | Median (Q1, Q3) | Mean (95% CI) | Median (Q1, Q3) | p value |
| ABD_baseline | 94.5(87.4,101.3) | 100(80,110) | 88.7(81,96.3) | 80(77.5,110) | 0.268 |
| ABD_ 7 days | 129.7(118.6,139.5) | 130(130,130) | 118.3(110.7,126.3) | 120(100,130) | **0.003** |
| ABD_1 month | 151.4(138.1,161.8) | 160(126,180) | 135(127.3,143.3) | 120(120,152) | **<0.001** |
| ABD_3 months | 167.4(159.7,173.9) | 180(160,180) | 151.3(144,159.7) | 150(140,180) | **0.004** |
| ABD_6 months | 180(180,180) | 180(180,180) | 175.3(172,178) | 180(175,180) | **0.005** |
| ABD_12 months | 179.1(178.7,179.5) | 180(180,180) | 178.2(176.5,179.7) | 180(180,180) | 0.402 |
| IR_baseline | 35.5(31.9,39) | 30(30,40) | 35.7(32.7,38.7) | 30(30,40) | 0.945 |
| IR_7 days | 56.8(51.6,61.9) | 60(50,70) | 43.7(39.7,47.7) | 40(30,60) | **0.001** |
| IR_1 month | 71.3(67.4,75.2) | 70(60,80) | 57.3(52.7,61.3) | 60(40,60) | **<0.001** |
| IR_3 months | 83.6(80,86.8) | 90(80,90) | 77.7(73.3,81.7) | 80(70,90) | **0.018** |
| IR_6 months | 90(90,90) | 90(90,90) | 81.7(78.3,84.7) | 80(80,90) | **<0.001** |
| IR_12 months | 90(90,90) | 90(90,90) | 85.8(84,87.5) | 90(80,90) | **<0.001** |

CI: Confidence Interval, Q1 = First Quartile, Q3 = Third Quartile.
Linear Mixed model used ($p = 0.004$ for ABD, $p < 0.001$ for IR).
Friedman test for repeated measurements ($p < 0.05$ for each measurement of ABD and IR). Mann Whitney *U* test between S and SA. $p < 0.05$ significant.

**Table 6**
Association of the Study Groups and change in ER Score between Six time points.

| Variables | SA (n = 31) | | S (n = 30) | | p value |
|---|---|---|---|---|---|
| | Mean (95% CI) | Median (Q1, Q3) | Mean (95% CI) | Median (Q1, Q3) | |
| ER_baseline | 44.5(41,48.1) | 40(40,50) | 44.3(40.3,48.3) | 45(30,50) | 0.952 |
| ER_7 days | 69.4(63.9,74.2) | 70(60,80) | 62.3(56.3,69.3) | 60(40,82.5) | 0.123 |
| ER_1 month | 82.6(78.1,86.4) | 90(70,90) | 76.7(71.7,81.3) | 80(60,90) | 0.080 |
| ER3_3 months | 88.6(86.5,90.3) | 90(80,90) | 81(76.3,85.3) | 90(70,90) | **0.016** |
| ER_6 months | 90(90,91) | 90(90,90) | 90(90,91.2) | 90(90,90) | 0.967 |
| ER_12 months | 90(90,91) | 90(90,90) | 90(90,91.2) | 90(90,90) | 0.967 |

CI: Confidence Interval, Q1 = First Quartile, Q3 = Third Quartile.
Linear Mixed model used (p = 0.087).
Friedman test for repeated measurements ($p < 0.05$ for each measurement of ER). Mann Whitney *U* test between S and SA. $p < 0.05$ significant.

these nerve blocks. This is a single center trial; a multicenter trial may be warranted to confirm the findings of our study. So further studies may be required to improve upon limitations posed by our study.

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## Declaration of generative AI and AI-assisted technologies in the writing process

The authors declare that no artificial intelligence tools were used during preparation of manuscript.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

[1] Manske RC, Prohaska D. Diagnosis and management of adhesive capsulitis. Curr Rev Musculoskelet Med 2008 Dec;1(3–4):180–9.
[2] Hand C, Clipsham K, Rees JL, Carr AJ. Long-term outcome of frozen shoulder. J Shoulder Elbow Surg Am Shoulder Elbow Surgeons 2008;17(2):231–6.
[3] Le HV, Lee SJ, Nazarian A, Rodriguez EK. Adhesive capsulitis of the shoulder: review of pathophysiology and current clinical treatments. Shoulder Elbow 2017 Apr;9(2):75–84.
[4] Tran J, Peng PWH, Agur AMR. Anatomical study of the innervation of glenohumeral and acromioclavicular joint capsules: implications for image-guided intervention. Reg Anesth Pain Med 2019;44:452–8.
[5] Shanahan EM, Ahern M, Smith M, Wetherall M, Bresnihan B, FitzGerald O. Suprascapular nerve block (using bupivacaine and methylprednisolone acetate) in chronic shoulder pain. Ann Rheum Dis 2003;62(5):400–6.
[6] Jones DS, Chattopadhyay C. Suprascapular nerve block for the treatment of frozen shoulder in primary care: a randomized trial. Br J Gen Pract 1999;49(438):39–41.
[7] Sá Malheiro N, Afonso NR, Pereira D, Oliveira B, Ferreira C, Cunha AC. Efficacy of ultrasound guided suprascapular block in patients with chronic shoulder pain: retrospective observational study. Rev Bras Anestesiol 2020;70(1):15–21.
[8] Laumonerie P, Dalmas Y, Tibbo ME, Robert S, Faruch M, Chaynes P, Bonnevialle N, Mansat P. Sensory innervation of the human shoulder joint: the three bridges to break. J Shoulder Elbow Surg 2020;29(12):e499–507.
[9] Cho CH, Jung SW, Park JY, Song KS, Yu KI. Is shoulder pain for three months or longer correlated with depression, anxiety, and sleep disturbance? J Shoulder Elbow Surg 2013;22(2):222–8.
[10] Rundquist PJ, Anderson DD, Guanche CA, Ludewig PM. Shoulder kinematics in subjects with frozen shoulder. Arch Phys Med Rehabil 2003;84(10):1473–9.
[11] Cyriax J. Textbook of orthopedic medicine. In: Diagnosis of soft tissue lesions. seventh ed., vol. 1. New York: Macmillan Publishing; 1978.
[12] Cho CH, Bae KC, Kim DH. Treatment strategy for frozen shoulder. Clin Orthop Surg 2019 Sep;11(3):249–57.
[13] Levine WN, Kashyap CP, Bak SF, Ahmad CS, Blaine TA, Bigliani LU. Nonoperative management of idiopathic adhesive capsulitis. J Shoulder Elbow Surg 2007;16(5):569–73.
[14] Challoumas D, Biddle M, McLean M, Millar NL. Comparison of treatments for frozen shoulder: a systematic review and meta-analysis. JAMA Netw Open 2020;3(12):e202958.
[15] Longo UG, Ciuffreda M, Locher J, Buchmann S, Maffulli N, Denaro V. The effectiveness of conservative and surgical treatment for shoulder stiffness: a systematic review of current literature. Br Med Bull 2018;127(1):111–43.
[16] Grant JA, Schroeder N, Miller BS, Carpenter JE. Comparison of manipulation and arthroscopic capsular release for adhesive capsulitis: a systematic review. J Shoulder Elbow Surg 2013;22(8):1135–45.
[17] Ergonenc T, Beyaz SG. Effects of ultrasound-guided suprascapular nerve pulsed radiofrequency on chronic shoulder pain. Med Ultrason 2018;20(4):461–6.
[18] Checcucci G, Allegra A, Bigazzi P, Gianesello L, Ceruso M, Gritti G. A new technique for regional anesthesia for arthroscopic shoulder surgery based on a suprascapular nerve block and an axillary nerve block: an evaluation of the first results. Arthroscopy 2008;24(6):689–96.
[19] Rothe C, Lund J, Jenstrup MT, Lundstrøm LH, Lange KH. Ultrasound-guided block of the axillary nerve: a case series of potential clinical applications. Acta Anaesthesiol Scand 2012;56(7):926–30.