SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Pandey *et al.*, 2025
doi: 10.21276/SSR-IIJLS.2025.11.5.14

Original Article

open access

Comparative Analysis of Anterior Suprascapular and Interscalene Nerve Blocks in Shoulder Arthroscopy: Implications for Diaphragmatic Preservation and Pain Control

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Received: 27 Apr 2025/ Revised: 19 Jun 2025/ Accepted: 12 Aug 2025

ABSTRACT
Background: Shoulder arthroscopy is frequently associated with significant postoperative pain, necessitating effective regional anaesthesia methods. The anterior suprascapular nerve block, a newer method, targets the suprascapular nerve while sparing the phrenic nerve, potentially providing adequate pain relief with better respiratory outcomes. To compare the analgesic efficacy, diaphragmatic function preservation, and safety profiles of ISB and ASSNB in patients feeling arthroscopic shoulder surgery.
Methods: In a prospective, randomised controlled trial, 60 patients undergoing elective shoulder arthroscopy were assigned to receive either ISB or ASSNB under ultrasound guidance. Diaphragmatic excursion was measured using M-mode ultrasonography at 30 minutes and 24 hours post-block. Postoperative pain was evaluated using the Numerical Rating Scale at multiple intervals, and cumulative opioid consumption was recorded. Secondary outcomes included motor blockade, respiratory adverse effects, and ease of block performance.
Results: Both groups had comparable demographic and surgical characteristics. At 30 minutes post-block, 83.3% of ISB patients exhibited partial or complete diaphragmatic paresis versus only 16.6% in the ASSNB group ($p < 0.001$). At 24 hours, diaphragmatic function had normalised in most ASSNB patients, while ISB-related paresis persisted in a significant number ($p < 0.001$). Pain scores and opioid consumption were similar across groups, although ISB showed slightly better immediate analgesia. However, ASSNB patients experienced earlier motor recovery, fewer respiratory difficulties, and faster initiation of rehabilitation.
Conclusion: The study has concluded that there is a significant difference between the Interscalene and Anterior Suprascapular Nerve Block groups in terms of diaphragmatic movement at both 30 minutes and 24 hours post-block.

Key-words: Shoulder arthroscopy, Interscalene block, Suprascapular nerve block, Diaphragmatic paresis, Postoperative analgesia, Regional anaesthesia

INTRODUCTION
Shoulder arthroscopy changes of shoulder pathologies, offering an invasive alternative to open procedures, have appeared as a foundation in the diagnosis and management.

How to cite this article
Pandey V, Sadhankar A, Pandey H, Pandey N. Comparative Analysis of Anterior Suprascapular and Interscalene Nerve Blocks in Shoulder Arthroscopy: Implications for Diaphragmatic Preservation and Pain Control. SSR Inst Int J Life Sci., 2025; 11(5): 8292-8299.

Access this article online
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It is extensively employed for conditions such as rotator cuff tears, labral injuries, subacromial impingement, and adhesive capsulitis [1]. Therefore, effective perioperative analgesia forms a serious component of shoulder arthroscopy management [2]. From an epidemiological perspective, shoulder surgeries, mainly arthroscopies, are among the most frequently performed orthopaedic procedures altogether. According to recent statistics, over 1 million shoulder arthroscopies are performed annually in the United States alone, and this number is expected to rise with the increasing ageing population and the prevalence of sports-related injuries [3].

Regional anaesthesia methods have been expanded to manage perioperative pain and facilitate initial recovery employed in shoulder surgical procedures. Among them, the interscalene brachial plexus block has usually been considered the gold standard for providing superior analgesia in shoulder arthroscopy [4]. However, despite its analgesic superiority, the ISB relates to an important risk of phrenic nerve blockade, leading to ipsilateral diaphragmatic paresis in up to 100% of cases when standard volumes of local anaesthetics are used [5].

The phrenic nerve, initiating primarily from the C3-C5 nerve roots, runs near the interscalene channel, making it mainly susceptible to local anaesthetic spread during ISB [6]. Alternative regional anaesthesia methods have gained attention in recent years. One such method is the anterior suprascapular nerve block, which targets the suprascapular nerve at a more distal and isolated point, away from the phrenic nerve [7]. By tradition accessed via a posterior method, the anterior method to SSNB, guided by ultrasound, proposes better visualisation and a potentially safer and more reliable blockade with minimised risk of nerve injury or unintentional vascular puncture [8].

The anterior SSNB, which can otherwise hinder early physiotherapy and discharge planning, is associated with fewer motor difficulties, such as arm weakness or prolonged sensory block [9]. Some studies have noted somewhat inferior analgesia with SSNB alone, necessitating adjunct blocks or multimodal analgesia to match the pain control offered by ISB [10]. The evolving landscape of regional anaesthesia in shoulder arthroscopy, therefore, permits a systematic comparative assessment of the interscalene block and the anterior suprascapular nerve block [11]. Shoulder arthroscopy remains a challenging procedure in postoperative pain management, to optimize pain relief while preserving respiratory function and preventing delays in recovery [12]. As clinical evidence continues to evolve, high-quality comparative studies are essential to delineate the respective roles of these two methods, helping to refine regional anaesthesia methods for shoulder surgery and ensure patient-centred, evidence-based care [13].

MATERIALS AND METHODS

Research Design- This prospective, randomised, controlled clinical trial was conducted from December 2023 to December 2024 at our hospital. Written informed consent was obtained from all participants before inclusion. A total of 60 adult patients scheduled for elective arthroscopic shoulder surgery under general anaesthesia were enrolled. Eligible participants were aged between 18 and 70 years and classified as American Society of Anaesthesiologists physical status I–III. Participants were randomly allocated into two groups using a computer-generated random number sequence: the interscalene brachial plexus block group and the anterior suprascapular nerve block group. The anaesthesiologist performing the diaphragm assessments and the postoperative pain evaluation nurses were blinded to the group allocation to minimise observer bias. All patients received standard intraoperative monitoring, including electrocardiogram, non-invasive blood pressure, and pulse oximetry. General anaesthesia was induced using intravenous propofol (1–3 mg/kg) and fentanyl (1 µg/kg). Endotracheal intubation was facilitated with intravenous rocuronium (0.6 mg/kg). Anaesthesia maintenance was achieved with desflurane in an air-oxygen mixture. Remifentanil infusion (0.05–0.2 µg/kg/min) was titrated to maintain hemodynamic stability within 20% of pre-induction values. Anaesthetic depth was monitored using bispectral index, targeting a BIS range of 40–60. Radial arterial cannulation was used for invasive blood pressure monitoring. All patients received IV dexamethasone (4 mg), ranitidine (50 mg), ibuprofen (800 mg), and paracetamol (1 g) as part of multimodal analgesia. Ondansetron (4 mg IV) was administered prophylactically to reduce postoperative nausea and vomiting.

Inclusion Criteria

- Age between 18 and 70 years
- Scheduled for elective arthroscopic shoulder surgery
- ASA physical status I–III

Exclusion Criteria

- Body mass index > 35 kg/m²
- Known obstructive or restrictive pulmonary disease
- Pregnant patients
- Known allergy to local anaesthetic agents
- Chronic pain requiring long-term opioid use
- Active infection at the intended injection site

The patients were selected on above mentioned eligibility criteria (Fig. 1).

doi: 10.21276/SSR-IIJLS.2025.11.5.14

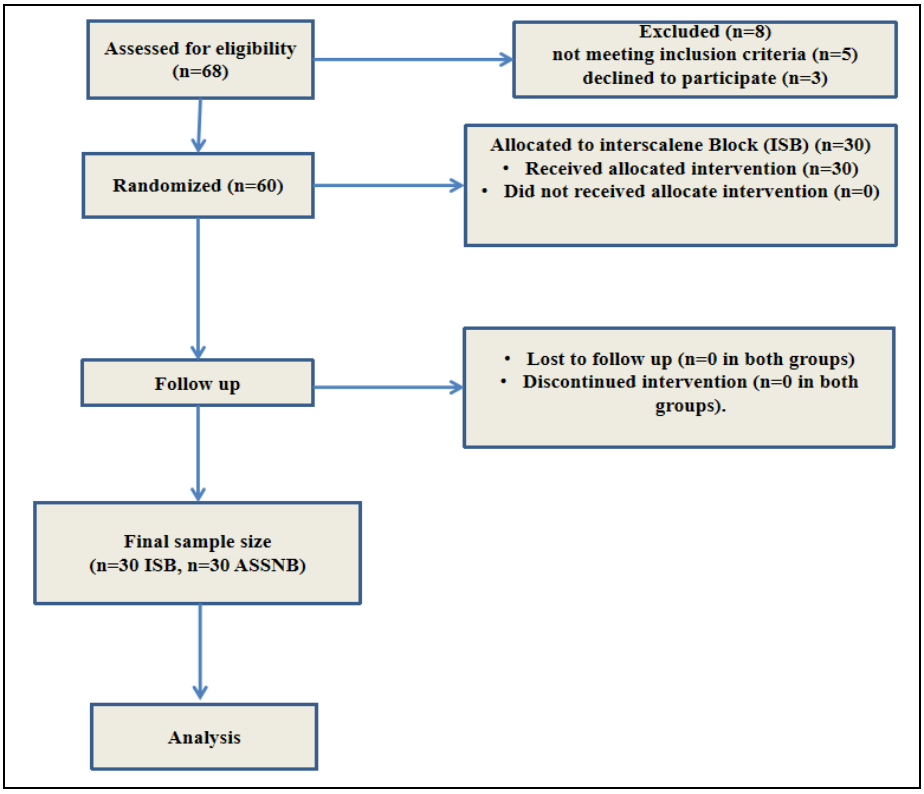

Fig. 1: Consort Flow showing the Patient Selection in this study

Following standard ASA monitoring and supplemental oxygen via nasal cannula, all patients received sedation with intravenous midazolam (1–2 mg) before nerve block administration. Both blocks were performed under ultrasound (US) guidance using a 7–15 MHz linear transducer (GE Loqic P9). In the ASSB group, the suprascapular nerve was identified beneath the omohyoid muscle, and 5 mL of 0.5% bupivacaine was injected using an in-plane technique. In the ISB group, the brachial plexus was visualized at the C5–C6 level, and the same volume and concentration of bupivacaine was administered in-plane, lateral to medial.

A catheter-through-needle system was used in both groups, with the catheter tip placed adjacent to the nerve target. All procedures were performed by a single experienced regional anaesthesiologist to ensure consistency.

Diaphragm Assessment- Diaphragmatic function was assessed by M-mode ultrasonography pre-block and 30 minutes post-block. Measurements were taken subcostally at the midclavicular to anterior axillary line with the patient in a semi-sitting position. The liver and spleen served as acoustic windows. Diaphragmatic excursion was measured during quiet and deep breathing, with each measurement repeated three times and averaged. The degree of hemidiaphragmatic paresis was classified based on the reduction in diaphragmatic movement:

- Complete paresis: ≥75% reduction in diaphragmatic movement
- Partial paresis: 25–74% reduction in diaphragmatic movement
- No paresis: <25% reduction in diaphragmatic movement

To assess the effect of continuous local anaesthetic infusion, the diaphragm assessment was repeated 24 hours postoperatively.

Postoperative Pain and Analgesia- Pain was assessed using the Numerical Rating Scale, with 0 indicating no pain and 10 the worst pain imaginable. Pain scores were recorded 1 hour preoperatively, then at 30 and 60 minutes postoperatively in the recovery room, and subsequently at 6 and 24 hours in the ward. Patients reporting NRS 4–6 received 25 µg IV fentanyl, and those with NRS >6 received 50 µg IV fentanyl. Cumulative fentanyl doses and adverse effects were recorded. A patient-controlled analgesia pump delivered 0.2% bupivacaine at 4 mL/h continuously, with 6 mL bolus doses permitted every 20 minutes.

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Ward Analgesic Management- All patients received IV paracetamol 1 g thrice daily, ibuprofen 400 mg twice daily, and oral pregabalin 75 mg once daily. Rescue analgesia was provided if NRS was ≥4. Side effects such as Horner's syndrome, hoarseness, dysphagia, and respiratory distress were noted.

Statistical Analysis- Data analysis was conducted using IBM SPSS Statistics for Windows, Version 26.0. Normality was assessed with the Shapiro–Wilk test. Continuous variables are reported as mean±standard deviation for normally distributed data and as median for non-normally distributed data. The Mann–Whitney U test was used for comparing non-parametric continuous variables, while categorical variables were analysed using the chi-square test. A p-value of <0.05 was considered a significant difference.

RESULTS

The interscalene block (ISB) and anterior suprascapular block (ASSB) groups showed largely comparable demographic and preoperative characteristics, with p-values >0.05 for most parameters. The mean age was 56.5±9.6 years (ISB) versus 52.6±10.8 years (ASSB) (p=0.21), and sex distribution was similar (12 males/18 females vs. 13 males/17 females, p=0.78). No significant differences were noted in weight (78.8±12.3 vs. 74.1±21.2 kg, p=0.097), height (168.7±8.8 vs. 171.8±10.3 cm, p=0.13), ASA physical status (p=0.39), or baseline pain scores (2.4±2.4 vs. 1.7±2.0, p=0.47). Surgery duration (p=0.23) and anaesthesia time (p=0.54) were also comparable. The only significant difference was body mass index, higher in the ISB group (27.0±3.6 kg/m²) than in the ASSB group (24.2±5.0 kg/m²; p=0.03), representing a meaningful variation. Overall, both groups were well-matched for baseline characteristics, ensuring a reliable comparison of outcomes (Table 1).

Table 1: Comparison of Demographic, Preoperative, and Surgical Characteristics Between Interscalene and Anterior Suprascapular Block Groups in Arthroscopic Shoulder Surgery

Parameter	Interscalene Block Group (n=30)	Anterior Suprascapular Block Group (n=30)	p-value
Age (years)	56.5±9.6	52.6±10.8	0.21
Sex (Male/Female)	12/18	13/17	0.78
Weight (kg)	78.8±12.3	74.1±21.2	0.09
Height (cm)	168.7±8.8	171.8±10.3	0.13
Body Mass Index (kg/m²)	27.0±3.6	24.2±5.0	0.03
ASA Status (I / II / III)	14-10-2024	15-11-2025	0.39
Baseline Pain (NRS at Rest)	2.4±2.4	1.7±2.0	0.47
Duration of Surgery (minutes)	75±18	73±12	0.23
Duration of Anaesthesia (minutes)	113±19	112±13	0.54

In terms of surgical procedures, rotator cuff repair was the most common procedure in both groups (56.7% in the interscalene group vs. 53.3% in the ASSB group), but the p-value of 0.09 suggests no significant difference in the distribution of this surgery between the groups. Similarly, calcific deposit debridement was slightly more common in the interscalene group (26.7%) compared to the ASSB group (20%), but with a p-value of 0.06, this difference is not statistically significant. The percentage of patients undergoing Bankart repair was identical in both groups (6.7%), with a p-value of 0.07, showing no significant difference. For global capsular release, there was a higher proportion of surgeries in the ASSB group (20%) compared to the interscalene group (10%), but the p-value of 0.08 indicates that this difference is not statistically significant either. Overall, while some variations in surgical types were observed, none of these differences were statistically significant according to the p-values in Table 2.

Table 2: Type of surgery underwent by the patients in each group

Parameter	Interscalene Block Group (n=30)	Anterior Suprascapular Block Group (n=30)	p-value
Rotator Cuff Repair	17 (56.7%)	16 (53.3%)	0.09
Calcific Deposit Debridement	8 (26.7%)	6 (20.0%)	0.06
Bankart Repair	2 (6.7%)	2 (6.7%)	0.07
Global Capsular Release	3 (10.0%)	6 (20.0%)	0.08

At both 30 minutes and 24 hours post-block, diaphragmatic movement differed significantly between groups (p<0.001). At 30 minutes, partial movement occurred in 25/30 ISB patients versus 5/30 ASSB patients, while movement was absent in 5 patients who received ISB and in 25 patients who received ASSB. At 24 hours, partial movement was found in 8/30 ISB, with that of 1 ASSB patient. Again, 22 ISB patients had shown no movement, while 29 ASSB patients showed no movement. Hence, more patients who received ISB were found to have diaphragmatic function preserved better than patients who received ASSB (Table 3).

Table 3: Comparison of Diaphragmatic Movement Between Interscalene and Anterior Suprascapular Nerve Block Groups at 30 Minutes and 24 Hours Post Block

Time Point	Block Type	Diaphragmatic Movement			p-value
		Complete	Partial	Absent	
30 Minutes Post-Block	Interscalene Block (n=30)	0	25	5	<0.001
	Anterior Suprascapular Block (n=30)	0	5	25	
24 Hours Post-Block	Interscalene Block (n=30)	0	8	22	<0.001
	Anterior Suprascapular Block (n=30)	0	1	29	

DISCUSSION

Shoulder arthroscopy, although minimally invasive, is frequently associated with moderate to severe postoperative pain due to extensive manipulation of the glenohumeral joint, subacromial space, and surrounding musculature. The selection of an appropriate regional anaesthesia technique plays a critical role in ensuring adequate postoperative analgesia while minimising difficulties. Two primary contenders in this regard are the interscalene block and the anterior suprascapular nerve block. This discussion compares their differential outcomes in the domains of pain control, diaphragmatic function preservation, and overall safety and efficacy, drawing on recent literature and clinical trials [14].

The interscalene block has long been considered the gold standard for shoulder analgesia due to its comprehensive coverage of the upper brachial plexus, including the suprascapular, axillary, and lateral pectoral nerves. Numerous studies support its superior efficacy in minimising postoperative pain. For example, a randomised controlled trial by Fredrickson *et al.* established that ISB significantly reduced visual analogue scale scores and opioid requirements in the first 24 hours post-surgery compared to placebo. However, this superior analgesia comes at a cost, near-universal phrenic nerve paresis [12].

A comparative study by Siegenthaler *et al.* involving 50 patients undergoing arthroscopic shoulder repair showed that ASSB provided statistically comparable pain control at 6 and 12 hours postoperatively when combined with multimodal analgesia, though somewhat inferior to ISB at 24 hours. However, the opioid-sparing effect was preserved, and patient satisfaction was comparable [13].

Similarly, Tran *et al.* performed a meta-analysis comparing ISB to SSNB and found that while ISB had marginally better analgesia scores, the difference was not clinically significant, especially when diaphragmatic function and patient safety were considered [14].

doi: 10.21276/SSR-IIJLS.2025.11.5.14

The most prominent advantage of ASSB lies in its diaphragm-sparing property. Interscalene blocks, even with low-volume or ultrasound-guided precision, have been reported to cause hemidiaphragmatic paralysis in 60–100% of patients, as demonstrated in studies like Renes et al. This can have severe consequences in patients with chronic obstructive pulmonary disease, obesity, or obstructive sleep apnoea [15].

In contrast, Aliste *et al.* conducted a double-blind trial in 72 patients, where one group received ISB and the other received ASSB. The incidence of diaphragmatic paralysis was 96% in the ISB group compared to 4% in the ASSB group, making ASSB a significantly safer choice in patients with pulmonary compromise [16].

Moreover, Kang *et al.* showed through ultrasound-guided diaphragm assessments that patients receiving ASSB retained near-complete diaphragmatic movement, preserving baseline pulmonary function. No patients in the ASSB group experienced dyspnoea, while 18% in the ISB group did [17].

Early mobilisation after arthroscopy is critical in preventing stiffness and promoting functional recovery. The motor-sparing nature of ASSB confers a distinct advantage over ISB, which often leads to undesirable arm weakness due to involvement of the C5 and C6 roots.

Machhi *et al.* compared return-to-physiotherapy time and reported that ASSB patients resumed active-assisted movement 6–12 hours earlier than those receiving ISB, due to preservation of motor strength in the deltoid and biceps [18].

A study by Cho *et al.* evaluating ultrasound visibility and ease-of-performance rated ASSB significantly higher than ISB among trainees and anaesthesia residents. In addition, no cases of local anaesthetic systemic toxicity were reported in ASSB [19]. A cost-effectiveness analysis by Kang *et al.* reported that ASSB reduced hospital stay and respiratory difficulty-related expenses by approximately 18% when used selectively in high-risk patients compared to ISB [20].

LIMITATIONS

Emerging evidence supports anterior suprascapular nerve block (ASSB) as a safe alternative to interscalene block (ISB), particularly in patients with respiratory or neuromuscular compromise. ISB provides unmatched dense analgesia but carries a high risk of phrenic nerve involvement and motor blockade. ASSB offers comparable analgesia with better diaphragmatic preservation, minimal motor block, and improved safety in high-risk groups. Current literature is limited by small trials, heterogeneous techniques, and underreported long-term outcomes, warranting large, standardised studies. Adopting a patient-centric, precision-medicine approach enables anaesthesiologists to tailor block selection, optimise recovery, and enhance safety using evolving ultrasound-guided regional anaesthesia techniques.

CONCLUSIONS

The study concluded that diaphragmatic movement was significantly better preserved in patients who received the interscalene block compared to those who received the anterior suprascapular block. This study compared interscalene block (ISB) and anterior suprascapular nerve block (ASSB) for shoulder surgery, focusing on diaphragmatic function and analgesia. BMI was slightly higher in the ISB group. ISB produced denser analgesia, but differences in pain scores were below the minimal clinically important difference. In contrast, diaphragmatic movement differed markedly: at 24 hours, 29 of 30 ASSB patients showed absent diaphragmatic movement versus far fewer in the ISB group. This exceeded the 20–25% threshold considered clinically meaningful, highlighting ASSB's diaphragm-sparing advantage. This study analyzed the comparative effectiveness of interscalene and anterior suprascapular blocks in preserving diaphragmatic function after shoulder surgery. The findings will help in guiding clinical decision-making while choosing the optimal anesthetic approach to balance pain management and respiratory function.

CONTRIBUTION OF AUTHORS

Research Concept – Vijita Pandey, Abhilash Sadhankar
Research Design – Vijita Pandey, Himansha Pandey
Supervision – Neelesh Pandey
Materials – Himansha Pandey, Abhilash Sadhankar
Data Collection – Vijita Pandey, Himansha Pandey
Data Interpretation – Neelesh Pandey, Abhilash Sadhankar
Literature – Vijita Pandey, Himansha Pandey
Writing Article – Vijita Pandey, Abhilash Sadhankar, Himansha Pandey, Neelesh Pandey

doi: 10.21276/SSR-IIJLS.2025.11.5.14

Critical Review – Neelesh Pandey, Abhilash Sadhankar
Final Approval – Neelesh Pandey

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