



# Ultrasound guided suprascapular and costoclavicular nerve block versus interscalene nerve block for postoperative analgesia in arthroscopic shoulder surgery: A randomized non-inferiority clinical trial

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## ABSTRACT

**Background:** Suprascapular nerve block (SSB) with costoclavicular nerve block (CCB) could be an ideal hybrid block for arthroscopic shoulder surgery in comparison to interscalene nerve block (ISB) regarding postoperative analgesia.

**Methods:** Fifty adult patients scheduled to undergo elective arthroscopic shoulder surgery under general anesthesia were equally randomized and enrolled in this study in a 1:1 ratio either to ISB group or diaphragm sparing block DSB (received combined SSB plus CCB blocks). The first numeric pain score (NRS) on awakening was recorded (1), then every 15 minutes over 3 hours. The time to 1st rescue analgesia and the number of patients who required nalbuphine to decrease pain scores below 4/10 were recorded. The incidence of persistent pain after 1 month was recorded as well.

**Results:** Pain NRS was significantly lower in ISB than DSB group during the early 3 hours postoperatively ( $p < 0.001$ ). The time to rescue analgesia was significantly longer in group ISB than group DSB ( $179.50 \pm 40.9$  versus  $57.38 \pm 19.57$  min, respectively, with  $p = 0.013$ ). The number of patients who required postoperative nalbuphine was significantly fewer in group ISB than group DSB (8 versus 19, respectively, with  $p = 0.004$ ). The incidence of persistent pain after 1 month was insignificant between the two groups.

**Conclusions:** SSB with CCB offered lower analgesia quality compared to ISB in shoulder surgery.

## ARTICLE HISTORY

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## KEYWORDS

Suprascapular nerve block; costoclavicular nerve block; interscalene nerve block; postoperative pain; shoulder arthroscopy; rescue analgesia

## 1. Introduction

Shoulder arthroscopy is a common outpatient operation with an increasing number of indications and complexity [1, 2]. On the other hand, pain management in the early postoperative period remains a challenge [3]. Tachycardia, tachypnea, hypoventilation, sleep disturbances, and the emergence of chronic pain are among the physiologic repercussions of pain [4]. In addition, inadequate pain management has been also linked to an increased risk of thromboembolic events, pulmonary problems, chronic pain syndromes, as well as an increased length of hospital stay [5].

Multimodal pain management is indicated for early postoperative pain control in shoulder surgery. Regional anesthesia (RA) is preferred as an effective method of administering anesthetic and postoperative analgesia [6]. Interscalene brachial plexus blocks (ISB), continuous ISB blocks (CISB), suprascapular nerve blocks (SSB), supraclavicular nerve blocks (SCB), local infiltration, and ISB with adjuvants are common for shoulder surgery procedures [7]. ISB is a frequent analgesic technique; however, it carries some side effects such as

phrenic nerve paralysis, dyspnea, and Horner syndrome [8]. One of the common regional nerve blocks for arthroscopic shoulder surgery is SSB [9].

We hypothesized that combined SSB and costoclavicular cord nerve blocks (CCB) could provide comparable analgesia to ISB with less complications. The primary outcome of this study was to compare the effects of combined SSB and CCB to ISB on postoperative numerical pain rate scale (NRS). Secondary outcome included postoperative 24 h nalbuphine consumption, time to the first postoperative analgesic request, time of awakening and extubation, hand grip strength before discharge from the post-anesthesia care unit (PACU), patient satisfaction, dyspnea score in PACU, and the incidence of persistent pain after 1 month.

## 2. Materials and methods

This is a prospective randomized single-blind clinical trial. It was approved by the Institutional Ethics Board (17,200,124) and registered at [clinicaltrials.gov](http://clinicaltrials.gov)

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(NCT04224766). Fifty adult patients scheduled to undergo elective arthroscopic shoulder surgery under general anesthesia were enrolled in this study from April 2021 to April 2022. Patients were screened in the pre-anesthesia clinic; the entire study protocol and orientation of numerical rate scale (NRS) of pain was explained. Patients were asked to complete an informed written consent form. Inclusion criteria were ASA physical status I or II, and age of 18 to 60. Exclusion criteria included significant cardiovascular disease, pulmonary disease, coagulation abnormalities, patient refusal, anatomical abnormalities, neuropathic pain, body mass index more than 40, history of substance abuse, use of psychotropic and/or narcotic medications on a regular basis, allergy to any drug used in this study, infection at the site of regional blocks, and cognitive dysfunction. Patients were also excluded if they experienced nerve block failure when evaluated in the preoperative regional block room (i.e., lack of loss of sensation to the ice cube placed at the shoulder incision level). The study was conducted and adherent to the CONSORT guidelines and to the regulations and amendments of the Helsinki Declaration.

Randomization was done via a website randomizer-built table. The participants were randomized in a 1:1 ratio into one of the two following groups after taking 1–3 mg midazolam for sedation as needed.

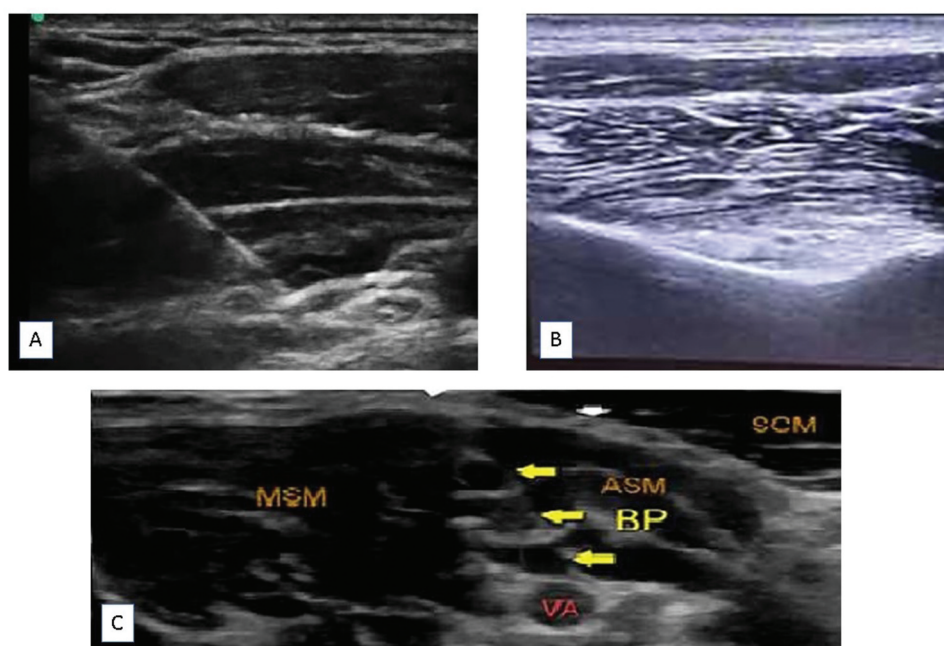
ISB group: received 15 mL of 0.5% bupivacaine through a single-dose of ultrasonographic (US)-guided interscalene brachial plexus block between scalenus anterior (ASM) and scalenus medius muscle (MSM).

DSB group: received a single shot US-guided suprascapular nerve block with 5 mL 0.5% bupivacaine. The goal is to first inject local anesthetic deep to the fascia

of the suprascapular muscle, followed by a single shot US-guided costoclavicular block (the space between the clavicular head of the pectoralis major and the subclavius muscle anterior and the posterior surface of the clavicle and the second rib, posteriorly) with 10 mL 0.5% bupivacaine. Test was done to evaluate the nerve block-induced loss of sensation to ice prior to entering the operating room (OR). [Figure 1](#) demonstrates ultrasonographic views of the blocks.

Basic anesthesia monitoring was established including ECG, heart rate, SPO<sub>2</sub>, and non-invasive blood pressure, end tidal CO<sub>2</sub>, temperature. Fentanyl 1mcg/kg iv bolus was given then Propofol (1.5–2.5 mg/kg IV), and cisatracurium (0.1 mg/kg IV) was used to induce general anesthesia and endotracheal intubation. Anesthesia was maintained with isoflurane 1–2% in the air-oxygen mix at a 1:1 ratio. Four mg dexamethasone I.V. was administered after induction of general anesthesia. Increments of fentanyl bolus (0.5 mcg/kg) were given whenever heart rate or mean arterial blood pressure was increased by 10–20% above the baseline values. Emergence and extubation were attained in the operative room.

The first pain score (NRS) on arrival to PACU was recorded, then pain scores every 15 minutes (using the NRS, where 0 = no pain and 10 = worst possible pain) over 3 hours. The time for 1st rescue analgesia, which means the time from the block to the time of the first postoperative analgesic request in the form of ketorolac 30 mg iv injection, and the number of patients who required nalbuphine injection to decrease pain scores below 4/10 were recorded. The score of dyspnea with a score of 0–10 (using NRS score, where 0 = no dyspnea and 10 = worst dyspnea and



**Fig. 1** Ultrasonographic views of the different blocks used in the study. A: Costoclavicular approach of infraclavicular block, B: Suprascapular nerve block, C: Interscalene brachial plexus block.

discomfort) was recorded. For hand grip strength score, the test was completed using a dynamometer which measures grip strength in kilograms before nerve blockade and before PACU discharge was also recorded [10,11]. The duration of the motor block, as determined by the time it takes to reach normal hand grip strength, was also recorded. Any adverse effects or complications were recorded and treated accordingly. Time to extubation and time to modified Aldrete score >9 were recorded as well (11). Outcome assessing physician was kept blind to the grouping of the patients as the physician in PACU was not aware to which group the patient was included. Complications related to procedures were recorded as well as two of our patients explained severe hypotension which required 60 mg ephedrine after induction of anesthesia and one of our patients explained hoarseness of voice after recovery which need just observation.

### 3. Statistical analysis

Based upon previous studies, Wilson et al., Lee et al., and Casati et al., the sample size was suggested for a total of 50 patients [12,13]. Data were presented as mean  $\pm$  standard deviation (SD) or standard error (SE), number (percentage), median (range) as appropriate to its type. Firstly, data were analyzed by Kolmogorov–Smirnov test to assess the type of distribution. Categorical data were analyzed by Chi-square test. Comparison between the two groups of continuous numeric data was established by unpaired t-test (for parametric data) or Mann Whitney U-test (for nonparametric data). The nonparametric data analysis within the same group was done by the Kruskal Wallis H tests. Based on the p-value <0.05, we have considered that the results were of statistical significance. Data were analyzed through the SPSS Statistics for Windows, Version 23.0 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM).

### 4. Results

A total of 70 patients were assessed for eligibility. Twelve patients did not consent, and eight patients had their operations canceled. Finally, 50 patients were randomized equally between the two groups as shown in the CONSORT chart (Figure 2). Regarding the demographic, clinical, and surgical data, there was no significant difference between the two groups as shown in Table 1.

The numerical pain scores showed significant differences between the two groups during the whole study period with lower scores recorded in the ISB group than DSB group as shown in Figure 3. Total intraoperative fentanyl consumption was insignificant between the two groups. Postoperatively, the number of patients

who received nalbuphine was significantly fewer in group ISB than DSB group. The time to rescue analgesia was longer in group ISB compared to group DSB. The incidence of persistent pain after 1 month was insignificant between the two groups (Table 2). The time to extubation and time to modified Aldrete score >9 showed insignificant difference between groups (Table 1).

Regarding the dyspnea score, there were significant differences between the two groups during all post-operative times, with lower scores noted in group DSB in comparison to ISB group as shown in Table 3. The handgrip score showed insignificant difference between the two groups during the whole study period (table 4). Group ISB recorded a significantly higher satisfactory score than the DSB group (Table 3). No complication related to procedures was recorded in this study.

### 5. Discussion

Early postoperative discomfort and pain after shoulder surgery are a major source of anxiety and distress for both patients and physicians. All aspects of the patient's recovery require adequate pain control. Our results showed that patients undergoing arthroscopic shoulder surgery with ISB have experienced statistically significant lower levels of pain and opioid consumption in PACU than those who have received combined SSB and CCB. However, the dyspnea was less experienced in the combined DSB group.

The suprascapular nerve innervates the infraspinatus and supraspinatus muscles and delivers 70% of sensory input to the glenohumeral joint [14]. Based on this anatomical basis, the SSB has been proposed as an alternative to the ISB for better appropriate analgesia after shoulder surgery [15]. Patients with morbid obesity, obstructive sleep apnea, and severe chronic obstructive pulmonary disease seem to be suitable candidates for the SSB [16–18]. The infraclavicular nerve block (ICB) anesthetizes the axillary nerve (which supplies the anterior and posterior shoulder joints) as well as the subscapular and lateral pectoral nerves (both of which supply the anterior shoulder joint), whereas the SSB anesthetizes the posterior shoulder joint. While combined ICB-SSB has been successfully employed for proximal humeral surgery, its benefits for shoulder surgery need to be investigated further [19].

Our results are in line with the study done by Abdallah et al., who found that ISB in shoulder surgery provided excellent postoperative analgesia, reduced pain scores, and opioid consumption for at least 8–12 hours. However, ISB carries a significant risk of temporary and long-term respiratory problems such as phrenic nerve paresis and unilateral diaphragmatic

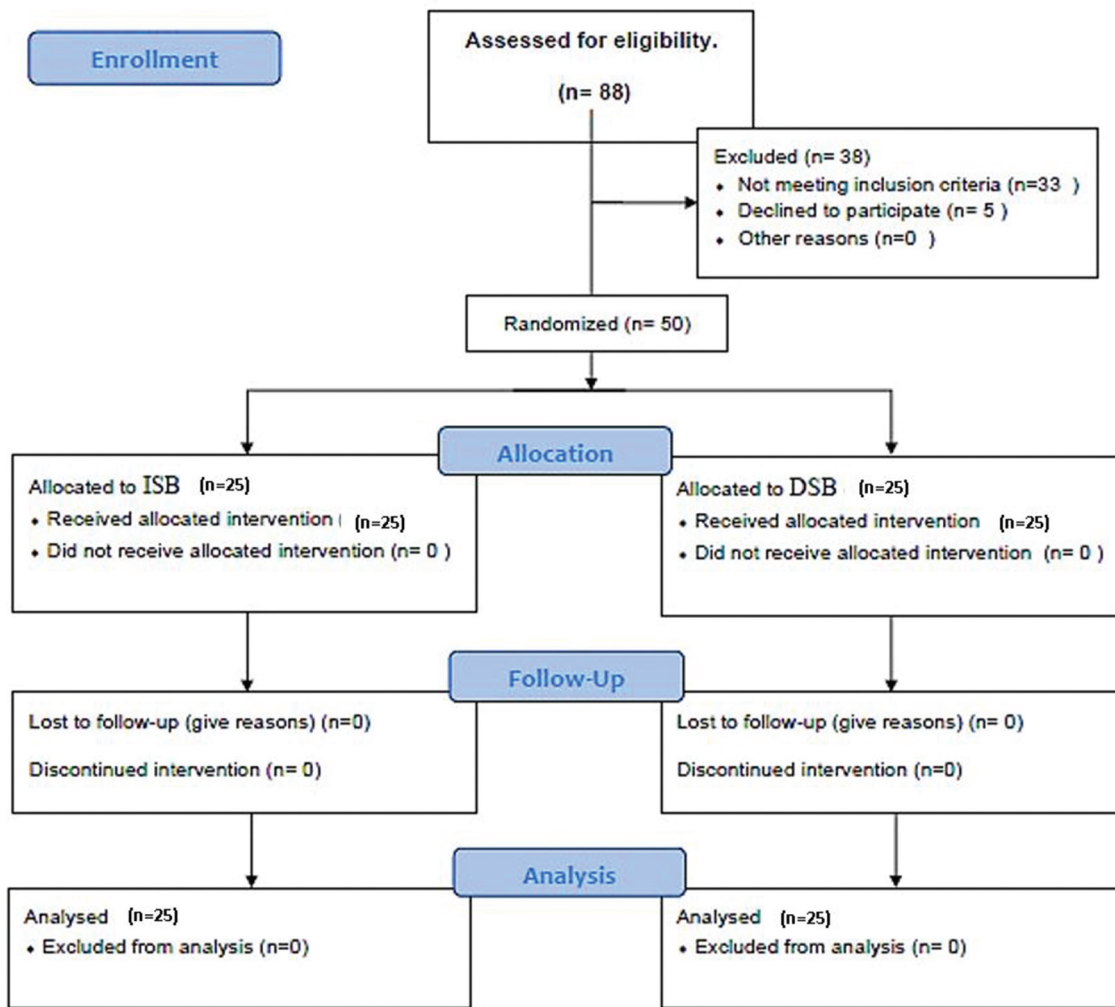


Figure 2. CONSORT- flow chart of the participants.

Table 1. Demographic, clinical, and surgical data.

Variables	ISB (n = 25)	DSB (n = 25)	P-value
Age (years)	42.56 ± 13.51	43.20 ± 11.78	0.85
Sex			
Male	12 (48%)	13 (52%)	1
Female	13 (52%)	12 (48%)	
Body mass index (kg/m <sup>2</sup> )	28.3 ± 2.6	27.4 ± 2.5	0.17
Hypertension	4 (16%)	4 (16%)	0.94
Diabetes mellitus	2 (8%)	3 (12%)	0.50
<b>Operative details</b>			
• Duration (minutes)	88.7 ± 11.7	84.46 ± 13.97	0.25
• Two incisions	8 (32%)	7 (28%)	0.50
• Three incisions	17 (68%)	18 (72%)	
• Extubation time after stoppage of anesthesia (minutes)	8.60 ± 1.2	12 ± 1.7	0.112
• Time to Aldrete score >9 in minutes mean (SD)	126.6 ± 22.5	124 ± 25.6	0.727

Date are expressed as mean ± standard deviation or standard error, frequency (percentage). COPD obstructive pulmonary disease. ISB interscalene block, DSB diaphragmatic sparing block. P value is significant if <0.05.

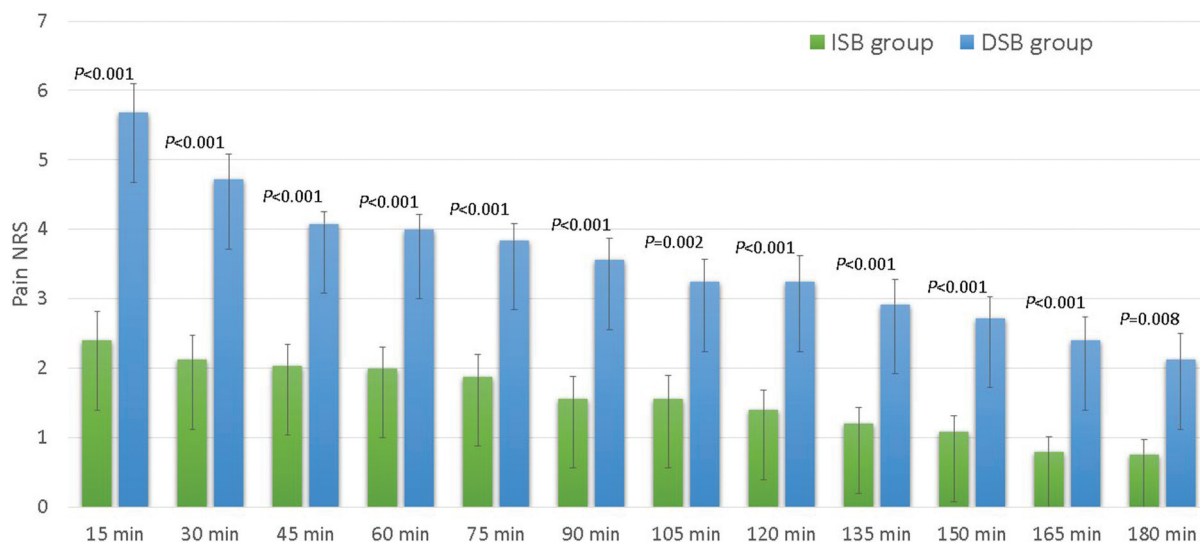
paralysis. Moreover, they had reported that ISB’s analgesia was limited to 8–12 hours postoperatively as determined by reduction in pain and narcotic consumption. They found higher intraoperative opioid consumption

and lower patient satisfaction at 6 hours in patients who received axillary nerve block (AXB) combined with suprascapular nerve block compared to ISB group [20].

Contrary to our results, Hussain et al. found that pooled data from 16 studies (1,152 patients) who received either interscalene or suprascapular block were not different regarding the 24-h morphine consumption. Compared with suprascapular block, interscalene block reduced postoperative pain but not opioid consumption during recovery room stay by a weighted mean difference (95% CI) of 1.5 cm (0.6 to 2.5 cm; *P* < 0.0001). Pain scores were not different at any other time [21].

Indeed, Singelyn et al. concluded that the SSB is inferior to ISB [22]. In addition, Lee et al. found that combining AXB with SSB resulted in lower pain levels up to 24 hours and greater satisfaction in individuals following arthroscopic rotator cuff repair when compared to SSB alone [23]. Even though ICB-SSB should give superior coverage of the lateral pectoral and subscapular nerves than AXB-SSB, more research is needed to compare these two diaphragm-sparing techniques.





**Figure 3.** Numerical rating scale of pain among studied groups. **Capture:** Data are expressed as mean  $\pm$  standard error. NRS, numerical rating scale. ISB, interscalene block group, DSB, diaphragmatic sparing block group. *P* value is significant if  $<0.05$ .

**Table 2.** Intraoperative and postoperative analgesia.

Variables	ISB (n = 25)	DSB (n = 25)	<i>P</i> -value
Intraoperative total fentanyl ( $\mu$ g)	68.75 $\pm$ 25.9	65.78 $\pm$ 23.8	0.776
Time to 1 <sup>st</sup> rescue analgesia (minutes)	179.50 $\pm$ 40.9	57.38 $\pm$ 19.57	0.013
Number of patients received postoperative nalbuphine	8 (32%)	19 (76%)	0.004
24 <sup>th</sup> hours patient satisfaction score	80 (10)	50(35)	0.006
Persistent pain after 1 month	4 (16%)	4(16%)	-

Date are expressed as mean  $\pm$  standard deviation or standard error, frequency (percentage), median (IQR) interquartile range. PACU post anesthesia care unit. ISB interscalene block, DSB diaphragmatic sparing block. *P* value is significant if  $<0.05$ .

**Table 3.** Dyspnea score among studied groups.

Variables	ISB (n = 25)	DSB (n = 25)	<i>P</i> -value
DS 15 minutes	4.72 $\pm$ 0.534 (4)	00(0)	< 0.001
DS 30 minutes	0.30 $\pm$ 0.544 (5)	00(0)	< 0.001
DS 45 minutes	0.84 $\pm$ 0.495 (4)	00(0)	< 0.001
DS 60 minutes	4.40 $\pm$ 0.434 (3)	00(0)	< 0.001
DS 75 minutes	4.08 $\pm$ 0.454(3)	00(0)	< 0.001
DS 90 minutes	4.00 $\pm$ 0.444 (2)	00(0)	< 0.001
DS 105 minutes	3.92 $\pm$ 0.444(2)	00(0)	< 0.001
DS 120 minutes	3.92 $\pm$ 0.444(2)	00(0)	< 0.001

Date are expressed as mean  $\pm$  standard error and median (IQR) interquartile range. DS dyspnea score. ISB interscalene block, DSB diaphragmatic sparing block. *P* value is significant if  $<0.05$ .

**Table 4** Hand grip score.

Variables	ISB (n = 25)	DSB (n = 25)	<i>P</i> -value
HG 15 minutes	29.48 $\pm$ 2.7530(20)	22.84 $\pm$ 2.8526(21)	0.196
HG 30 minutes	29.48 $\pm$ 2.7530(20)	22.84 $\pm$ 2.8526(21)	0.196
HG 45 minutes	29.48 $\pm$ 2.7530(20)	22.84 $\pm$ 2.8526(21)	0.196
HG 60 minutes	29.48 $\pm$ 2.7530(20)	22.84 $\pm$ 2.8526(21)	0.196
HG 75 minutes	29.48 $\pm$ 2.7530(20)	22.84 $\pm$ 2.8526(21)	0.196
HG 90 minutes	29.48 $\pm$ 2.7530(20)	22.84 $\pm$ 2.8526(21)	0.196
HG 105 minutes	49.88 $\pm$ 3.5950(23)	46.32 $\pm$ 3.4550(30)	0.483
HG 120 minutes	49.88 $\pm$ 3.5950(23)	46.32 $\pm$ 3.4550(30)	0.483

Date are expressed as mean  $\pm$  standard error and median (IQR) interquartile range. HG hand grip. ISB interscalene block, DSB diaphragmatic sparing block. *P* value is significant if  $<0.05$ .

Leurcharumee et al. showed higher pain scores and opioid intake in patients who received costoclavicular block (CCB) compared to those who received infraclavicular block (ICB) [24]. As a result, we reasoned that if AXB-SSB beats SSB, then ICB-SSB will as well. Hence, we erred on the side of caution regarding optimal analgesia in this research and chose to compare ISB with ICB-SSB rather than SSB alone. In terms of intra and postoperative analgesia with better maintenance of respiratory function, Vittorio et al. discovered that combining a peripheral nerve block (ICB-SSB) seemed to be helpful. Avoidance of diaphragmatic dysfunction after shoulder surgery is important in patients with limited pulmonary reserves such as those with chronic respiratory disorders and/or obesity [25].

To the best of our knowledge, this is the first study to compare the effect of ISB versus combined suprascapular and costoclavicular blocks on persistent pain after 1 month. Our clinical implications for anesthesiologists to reserve SSB-CCB for high-risk patients with chronic pulmonary diseases. Future researchers should try adjuvants to SSB and CCB to extend the duration of action and improve the outcome. Our study's limitations include the fact that we used the pain numeric rating scale as an endpoint, which is inherently subjective because it is based on patients' individual perceptions of pain. Second, because it is a single surgeon sequential series in a single institution with no control group, our findings may have been influenced by selection bias. We recommend a longer term of the chronic pain follow-up period.

In conclusion, in patients undergoing arthroscopic shoulder surgery, combined suprascapular and costoclavicular blocks provide lower analgesia quality and dyspnea index during the early postoperative period compared with ISB.

The authors declare that there is no conflict of interest. The authors also denote that the study has used local departmental resources with no external fund.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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