Randomized Clinical Trial

Combined Infraclavicular-Suprascapular Nerve Blocks Compared With Interscalene Block for Arthroscopic Rotator Cuff Repair: A Prospective, Randomized, Double-blind, and Comparative Clinical Trial

Joseph Makram Botros, MD, Fatma ElZahraa Omar Mahmoud, MD, Atef Mohamed Mahmoud, MD, Mohamed Ahmed Shawky, MD, Mohamed Safaa ElDin Mohamed Arafaa, MD, and Safaa Gaber Ragab, MD

From: Pain and Intensive Care Medicine, Fayoum University, Fayoum, Egypt

Address Correspondence:
Joseph Makram Botros, MD
Pain and Intensive Care Medicine
Faculty of Medicine
Fayoum University
Fayoum 63512, Egypt
E-mail: dr_jo27@yahoo.com

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 05-14-2023
Revised manuscript received: 06-20-2023
Accepted for publication: 07-19-2023

Free full manuscript: www.painphysicianjournal.com

Background: The gold standard postoperative analgesia protocol for arthroscopic rotator cuff repair procedures is the interscalene block (ISB), which prevents the significant consequences of phrenic nerve block associated with hemidiaphragmatic paralysis (HDP). The infraclavicular brachial plexus block (BPB) combined with the suprascapular nerve block (SSNB) had the same analgesic efficacy as the infraclavicular BPB alone, with no effect on respiration.

Objectives: Therefore, the study aimed to assess the HDP and analgesic efficacy of both approaches in controlling pain following arthroscopic rotator cuff repair surgeries.

Study Design: A prospective, randomized, double-blind, and comparative clinical trial.

Setting: The study comprised 66 patients. They were separated into 2 equal parallel groups 33 patients each: the ISB group and the costoclavicular and suprascapular block (CSB) group.

Methods: The ISB group obtained the ISB followed by the general anesthesia. The CSB group received infraclavicular blockade using the costoclavicular approach and SSNB followed by general anesthesia.

Results: Considering morphine utilization during the first day following the operation, the groups demonstrated an insignificant difference. The CSB group showed a decreased rate of diaphragmatic paralysis.

Limitations: There was no control group. And, the blocks might take a long time to be performed up to 30 minutes. Also, there were no validated criteria to define HDP based on M-mode ultrasound measurements.

Conclusions: The employment of the costoclavicular block in combination with the suprascapular block may provide a comparable analgesic potency to the sole use of the standard ISB with no HDP.

Key words: Interscalene block, costoclavicular block, suprascapular nerve block, hemidiaphragmatic paralysis

Pain Physician 2023: 26:E787-E796

In the first 2 days following arthroscopic rotator cuff repair, the patient experiences considerable pain (1). The gold standard analgesic for this type of surgery is the interscalene block (ISB), which minimizes pain for at least 8 hours and reduces opioid intake for the first 12 hours after surgery (2).

The increased likelihood of ipsilateral phrenic nerve block with subconsecutive hemidiaphragmatic

paralysis (HDP) represents the main drawback of the ISB. The incidence of ipsilateral phrenic nerve block could extend up to 100% according to the concentration, site of local anesthetic (LA) administration, and volume (3). HDP reduces the forced expiratory volume and the vital capacity in the first second and increases the expiratory flow rates leading to a lowering of the respiratory function. These effects could be harmful to people having a low respiratory reserve (4).

For patients undergoing shoulder arthroscopic procedures, in terms of analgesic efficacy, the simultaneous utilization of the suprascapular block (SSB) and conventional paracoracoid infraclavicular block (ICB) was not comparable to the standard ISB 30 minutes after recovery, but had no hemidiaphragmatic (HD) effect (5). The LA is positioned in the lateral infraclavicular fossa dorsal to the axillary artery in the conventional paracoracoid ICB technique (6). The ICB anesthetizes the lateral and subscapular pectoral nerves as well as the axillary nerve; whereas, the SSB anesthetizes the posterior shoulder joint (7).

In ultrasonography, the lateral infraclavicular fossa cords may be found deep, be challenging to identify, and have a variety of anatomic locations surrounding the axillary artery (8). Another approach (costoclavicular) for ICB is blocking the brachial plexus located at the midinfraclavicular fossa positioned beneath the clavicle's midway. The cords of the brachial plexus can be simpler to be visualized, consistently found lateral to the axillary artery in a compact space, and the brachial plexus is superficial, unlike the paracoracoid approach (9).

The current study aimed to compare the HDP and analgesic efficiency of the costoclavicular approach of the suprascapular nerve block (SSNB) and infraclavicular brachial plexus block (BPB) with the standard ultrasound-guided interscalene BPB in patients undergoing arthroscopic rotator cuff repair. We assume that combining ICB-SSB compared with the standard ISB can result in a comparable postoperative analgesic effect with less HDP.

Methods

The current study was approved by The Institutional Review Board and Ethical Committee of Fayoum University Hospitals (D 165). Also, it was registered at ClinicalTrials.gov (NCT03628950). The study duration was 18 months from June 2020 to January 2022. A written and informed consent was taken from every patient in the study. The study included 80 patients of both genders, older than 18, undergoing arthroscopic rotator cuff repair, with the American Society of Anesthesiologists (ASA) physical status classification (I to III). The patients that refused regional anesthesia, had a preexisting obstructive pulmonary disease or a body mass index > 40 kg/m^2, or had contraindications to regional anesthesia were all excluded from the study. Patients with sepsis, severe cardiovascular illness, hepatic or renal dysfunction, chronic pain disorders necessitating opioids, and previous neck or infraclavicular/suprascapular fossa surgery, were also excluded from the trial.

The final analysis comprised 66 individuals divided into 2 groups 33 patients each. The ISB group: The group received ultrasound-guided ISB followed by general anesthesia. And, the costoclavicular and suprascapular block (CSB) group: The group received ultrasound-guided ICB using the costoclavicular approach and ultrasound-guided SSB followed by general anesthesia.

A computer-generated table assigned the patients to one of the groups at random. Sealed opaque envelopes were utilized for keeping the randomization sequence. The trained senior anesthesiologists opened the envelopes shortly after recruitment and admittance to the surgery room. Data collectors and assessors were blinded for the allocations of groups.

Preoperative history taking and physical examination were performed for every patient. Also, investigations were carried out per a local institutional policy for evaluating patients. Liver function tests, creatinine and serum urea, coagulation profile, complete blood count, blood sugar level, and electrocardiogram (ECG) were performed.

After arriving to the induction room, all patients were given intravenous premedication (fentanyl, 50 µg; midazolam, 2 mg), in the upper limb opposite the surgery incision, via a 20-G intravenous catheter, which was inserted previously. Throughout the block procedure time, all patients were given supplemental oxygen (2 L/min-1 via a nasal cannula), as well as routine ASA monitoring (noninvasive blood pressure, 5-lead ECG, and pulse oximetry) and baseline vital data were recorded.

Real-time ultrasound guidance was utilized for completing the blocks (Philips® ClearVue 350, Philips Healthcare, Andover, MA 01810). At first, the patients obtained a superficial cervical plexus block in the operative limb as C4 (one of the origins of supraclavicular nerves) provides nerve supply to the lateral aspect of the shoulder, as well as the acromioclavicular joint. In

a supine position, the block was administered to the patients, with their heads positioned toward the other side. The high-frequency linear array transducer (8-15 MHz) was put across the lateral side of the neck at the midway of the posterior border of the sternocleidomastoid (SCM) muscle after the skin had been cleaned and prepared with antiseptic. The transducer was placed with the SCM's tapering end deposited in the center of the screen. The block needle (22-G, 50 mm, Stimuplex D®; B Braun, Melsungen, Germany) was inserted through the skin and into the platysma muscle, with an LA (10 mL of plain bupivacaine 0.5%) placed slightly behind this landmark (10).

In the ISB patients, in a sterile fashion, the ultrasound transducer was applied on the neck's lateral side at the level of the cricoid cartilage in the ISB group for visualizing the hypoechoic structures that indicated the brachial plexus roots (11). The block needle (22-G, 50 mm, Stimuplex D®; B Braun, Melsungen, Germany) was advanced lateral to the medial and in-plane until its tip was positioned between the 2 most superficial hypoechoic structures under the prevertebral fascia (12). At C5-C6, bupivacaine (0.5%, 10 mL) was injected, and at C7-C8, another bupivacaine (0.5%, 10 mL) was injected.

In the CSB group, the patients were positioned in a supine position with the operative limb in 90° abduction (13). The probe was placed in the medial infraclavicular fossa after being mobilized off the clavicle's inferior border. Beneath the subclavius muscle in the costoclavicular region, the subclavian artery was identified. The 3 cords of the brachial plexus were visible on the lateral side of the artery. After visualizing the cephalic vein or thoracoacromial artery, the ultrasound transducer was tilted slightly cephalad to enable an appropriate sonographic view of the costoclavicular area and provide an access to the brachial plexus cords. The block needle (22-G, 80 mm, Stimuplex D®; B Braun, Melsungen, Germany) was advanced via a cephalad-to-caudate trajectory and an in-plane method till its tip reached the middle of all the 3 cords. In this area, bupivacaine (0.5%, 10 mL) was administered (13). The patients were then positioned in a lateral decubitus position, with the surgical limb on top. To provide a view of the suprascapular fossa, the ultrasound transducer was inserted in a sterile manner cephalad and parallel to the scapular spine. With 3 mL of 1.0% lidocaine, a skin wheal was raised. The block needle (22-G, 80 mm, Stimuplex D®; B Braun, Melsungen, Germany) was advanced by utilizing a lateral-to-medial direction and an in-plane technique until its tip was in the suprascapular fossa's floor ventral to the supraspinatus muscle fascia. This area was injected with 10 mL of 0.5% bupivacaine.

In both groups, after 30 minutes of completing the sensorimotor block assessments, general anesthesia was induced using 1 μg/kg[1] of intravenous fentanyl, 0.5 mg/kg[1] of atracurium, and 1.5-2 mg/kg[1] of propofol, 1.5 % of isoflurane in 2 L/min[1] oxygen-air mixtures (50% 50%), and 0.1 mg/kg[1] of atracurium were used to maintain general anesthesia every 30 minutes. Then, the patients, of both groups, were slowly placed in the beach chair posture for shoulder surgery operations. A 50-μg bolus dosage of fentanyl was provided intraoperatively if the patient's heart rate or blood pressure was > 20% of their preoperative value. The same surgeons conducted the surgical procedures in patients of both groups.

An anesthesiologist who did not conduct the BPB assessed the amount of motor and sensory blockades 30 minutes after LAs were administered. The skin covering the lateral surface of the deltoid and the clavicle (supraclavicular nerves) was utilized to evaluate the sensory blockade via an alcohol swab (axillary nerve) (7). A cold test was used to score each territory on a 3-point scale: 0 indicated no block; 1 indicated analgesia (patient could feel touch but not cold); and 2 indicated anesthesia (patient could not feel touch) (14). External shoulder rotation (SSN) and shoulder abduction (suprascapular and axillary nerves) were used to assess motor function on a 3-point scale: 0 = no block; 1 = paresis; and 2 = paralysis (7). The incidence of entire blocks for 30 minutes after injection was recoded if a global composite score of 6 points (out of a maximum of 8 points) was reached at 30 minutes.

A blinded, trained radiologist evaluated the ultrasound examination of the hemidiaphragm in the supine position. To get an intercostal image, a low-frequency (2 to 5 MHz) curvilinear array transducer was implanted at the midaxillary line in the coronal plane. The liver or spleen was centered with the rib shadows on either side at the level of the eighth to ninth ribs on the left side and the seventh to eighth ribs on the right side. Caudal descent of the liver or spleen precedes descent of the bright pleural line on deep inspiration. To view the pleural line's end-expiratory and end-inspiratory levels marked on the patient's skin, the transducer was moved in cephalad and caudal directions. This process was performed with the patient in the supine position before the chosen regional anesthetic approach and one hour after the surgery after recovery of the

patients in the postanesthesia care unit (PACU). A small change indicated no block, while a decrease in this distance indicated a phrenic nerve block (15,16).

Following the operations, all patients were extubated and brought to the PACU for a 2-hour assessment. In the PACU, the patients received an intravenous infusion of 100 mg ketoprofen and 1 g acetaminophen over 30 minutes. At 2 hours postoperatively, the pain was graded on a Numeric Rating Scale (NRS-11) from 0 (no pain) to 10 (worst imaginable pain), then at 4, 8, 12, and 24 hours postoperatively in the inpatient department. As part of the institution's postoperative pain-control protocol, intravenous injections of 100 mg of ketoprofen every 12 hours and 1 g of acetaminophen every 8 hours were continued for 48 hours. The initial request for analgesia was utilized to determine the period of postoperative analgesia. The period between the analgesic drugs' postoperative delivery and the termination of the LA injection for BPB was recorded as the block anesthesia time. Patients, who had an NRS-11 > 5, received morphine sulfate intravenously in boluses of 2-5 mg in doses up to 20 mg at 24 hours, or 10 mg at 4 hours. In 24 hours, the total and interval amount of morphine consumed were recorded. The cumulative use of morphine on the first day following surgery was the primary outcome.

Secondary outcomes comprised the interval morphine consumption at 2, 4, 8, 12, and 24 hours, assessment of HDP, postoperative static pain at 1, 4, 8, 12, and 24 hours using NRS-11, the incidence of the associated side effects with opioids (e.g., respiratory depression, nausea, vomiting, pruritus, and excessive sedation), incidence of a complete block, percentage of a block with a minimal sensorimotor composite score of 6 points out of 8 points at 30 minutes following injection, operative time, intraoperative opioid (fentanyl) required during general anesthesia, assessment of time to the first rescue analgesia, assessment of the performance time (i.e., duration from skin disinfection till the end of the LA injection), assessment of potential adverse events occurring during and in the first 24 hours following the performance of the blocks, and demographic data.

The G*Power software version 3.1.9.2 was utilized to determine the sample size (Institute of Experimental Psychology, Heinrich Heine University, Dusseldorf, Germany) (17). Based on the findings of Aliste et al (5), sample size calculation revealed that each group should include at least 30 patients, assuming (2 tail) $\alpha = 0.05$, $\beta = 0.1$ (Power = 90 %), and allocation ratio 1:1. The clinical effect size d was 0.88 to identify a difference between the groups equals 6 mg of the cumulative morphine requirements at 24 hours postoperatively (the primary outcome) for patients undergoing shoulder arthroscopic procedures. The authors planned to recruit 33 patients in each group to compensate for the possible protocol violation or data loss.

SPSS Version 20 was used to compare results (IBM Corporation, Armonk, NY). The Shapiro-Wilk test was used to determine the normality of the continuous numerical data distribution. Student's t tests were used for comparing between the groups. Parametric normally distributed numerical data were demonstrated as mean ± SD. The Hodges-Lehmann estimator and Mann-Whitney U test were used for comparing the groups. Median and IQRs were utilized for demonstrating the nonparametric data. Numbers and percentages were used to show categorical data, and the chi-square test or Fisher's exact test was used for intergroup comparison. The results were considered significant when the *P* value was ≤ 0.05, with a 95% confidence level.

Results

The final analysis comprised 66 patients divided into 2 equal groups 33 patients each: ISB group and CSB group (Fig. 1).

When it comes to morphine consumption during the first day following the operation, the groups did not demonstrate significant differences (Table 1). Furthermore, morphine intake at 2, 6, 12, and 24 hours was insignificant. The CSB group had a much-decreased rate of diaphragmatic paralysis (Table 1).

Insignificant differences were observed in the mean heart rate and blood pressure, whether postoperatively or intraoperatively, except at 45 and 60 minutes intraoperatively, which became significantly lower in the ISB group (Table 2).

Significantly lower postoperative oxygen saturation was observed in the CSB group. Also, an insignificant difference was observed in the postoperative readings of respiratory rate except at 24 hours. However, no one needed oxygen supplementation during the postoperative study period, which implies that difference was of no clinical importance (Table 3).

When it comes to the time of the initial request for analgesia, an insignificant difference was observed (Fig. 2). At 2, 6, 12, and 24 hours after surgery, insignificant differences were found between the study methods regarding block performance time, complete block at 30 minutes incidence, intraoperative opioid use, and NRS-11 score (Fig. 3) (Table 1). Also, an insignificant

incidence of side effects was found between the 2 groups with 6 cases (18%) in the ISB group (4 cases of Horner's syndrome, one case of blood aspiration, and one case of paresthesia) compared to 2 cases (6%) one of paresthesia and one case of pleural puncture in the CSB group (P = 0.25) (Table 4).

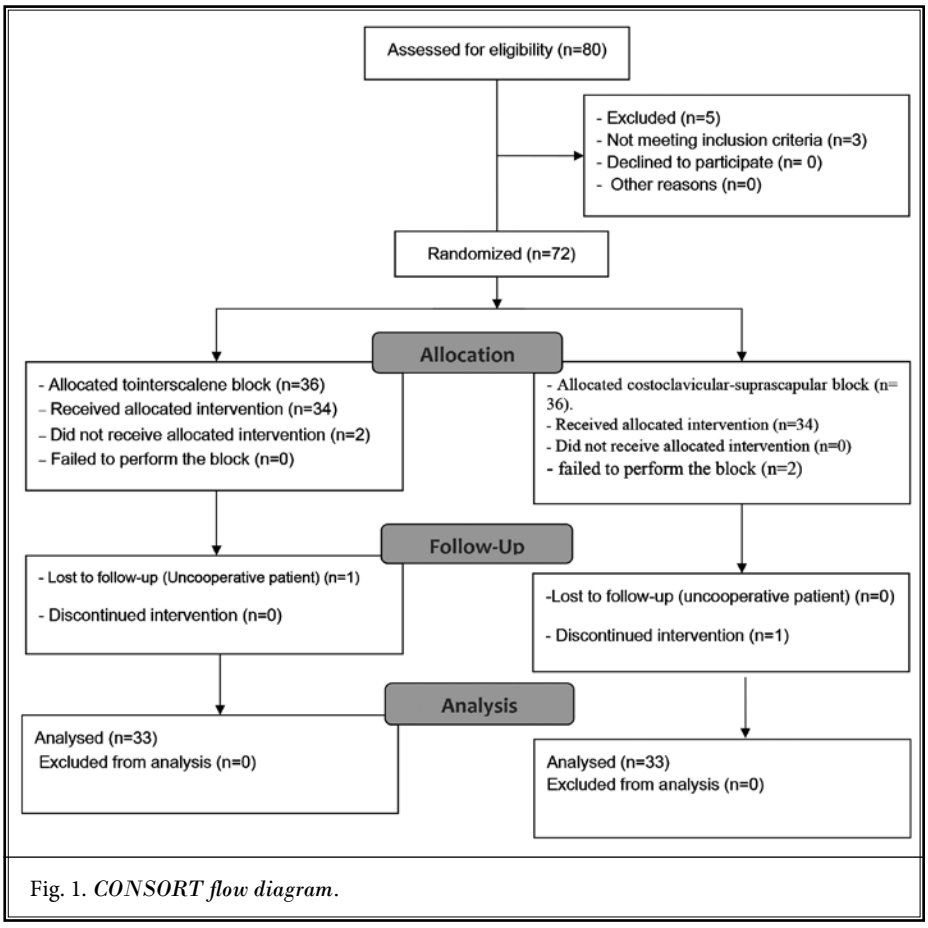

Fig. 1. *CONSORT flow diagram.*

Discussion

Severe pain occurs following arthroscopic rotator cuff repair, especially in 2 days after the surgery (2). The gold standard analgesic for this surgical operation is the ISB, although it has a substantial possibility of ipsilateral phrenic nerve block with subsequent HDP. The employment of the costoclavicular block (CCB) in combination with an SSB may provide comparable analgesic potency to the sole use of the standard ISB with negligible hemidiaphragmatic effects.

The study aimed to determine the effect of combining CCB, as well as SSB to ISB in relieving shoulder pain without the effect of diaphragmatic paralysis.

A nonsignificant difference was found when cumulative morphine was administered in the first 24 postoperative hours (P value = 0.45). These current findings agreed with Aliste et al (18), who observed an insignificant difference between the ISB and CCB groups concerning the median cumulative morphine requirement in the first 24 postoperative hours (P = 0.962).

Another study (19) compared the ISB to the superior trunk block in 126 patients having arthroscopic ambulatory shoulder operations and found insignificant findings in morphine consumption on the first day after surgery (P = 0.15).

Consistent findings were documented by Auyong et al (20,21) in 2 different studies and Trabelsi et al (22). Moreover, Pani et al (23) showed, in their comparison between the ISB and the shoulder block (suprascapular and axillary blocks) on 76 patients scheduled for shoulder arthroscopic surgery, that the total paracetamol consumption was not statistically significant during the postoperative 24 hours.

However, the current study's results were not supported by Aliste et al (5). A possible explanation for this difference might be that Aliste et al (5) performed a paracoracoid approach in an ICB in their study in contrast to the costoclavicular approach in the current study.

Also, Koltka et al (24), who compared SSB and single-shot ISB, demonstrated that the overall morphine utilization during the first day following the operation was 30.6 ± 9.6 mg in the supraclavicular group, while it was 18.95 ± 9.2 mg in the interscalene group (P < 0.001). This may be due to sparing the suprascapular nerve by the supraclavicular block, which contributes to the sensory supply to the shoulder (25).

In a study comparing suprascapular nerve and interscalene brachial plexus blocks in patients undergo-

Table 1. *Demographic and operative data*.

		ISB Group (n = 33)		CSB Group (n = 33)		*P* value	Mean Difference	CI 95%	
								Lower	Upper
Age (y) Mean (SD)		43.8 (16.9)		38 (12.8)		0.11	5.524	-2.083	13.131
Gender						0.159			
Men: n (%)		27 (81.8%)		22 (66.7)					
Women: n (%)		6 (18.2%)		11 (33.3%)					
ASA n %	I	9 (27.3%)		4 (12.1%)		0.252			
	II	16 (48.5%)		17 (51.5%)					
	III	8 (24.2%)		12 (36.4%)					
BMI (kgm^{-2}) Mean (SD)		26 (2.4)		26.78 (2)		0.178			
Incidence of HDP n %		30 (91%)		0 (0%)		0.000*			
Morphine Intake in 24 h (mg)		Median	IQR	Median	IQR	*P* value			
Median (IQR)		6	2 (6-8)	6	5 (6-11)	0.45	-1.061	-2.951	0.829
Block Performance Time (min) Median (IQR)		8	3 (6.5-9.5)	13	5 (10-15)	0.000*	-4.531	-5.634	-3.428
Incidence of Complete Block at 30 min Median (IQR)		6	2 (6-8)	6	1 (6-7)	0.348	0.935	0.394	1.477
Duration of Surgical Anesthesia Median (IQR)		50	12 (48-60)	50	20 (40-60)	0.288	18.430	6.762	30.099
Operative Time (min) Median (IQR)		65	15 (55-70)	65	20 (50-70)	0.974	-0.386	-6.723	5.951
Intraoperative Opioid (fentanyl) (μg) Median (IQR)		50	50 (50-100)	50	50 (50-100)	0.98	0.147	-13.271	13.564

Abbreviations: ISB, interscalene block; CSB, costoclavicular suprascapular block; ASA, American Society of Anesthesiologists; BMI, body mass index; HDP, hemidiaphragmatic paralysis; *, *P* value ≤ 0.05.

ing shoulder arthroscopic operation, Kumara et al (26) mentioned that the SSNB group had higher analgesic requirements than the ISB group (63.3% vs 40.0%) with no significant difference. This difference could be attributed to the pectoral, axillary, subscapular, and supraclavicular nerves' supply of 30% of the sensory input to the shoulder, which was not blocked in the SSB alone. In contrast, it is blocked by combining the CCB with the SSB, as in Leiva et al (27) and our study. Moreover, Desroches et al (28) reported similar results.

Regarding the intervals of morphine doses in 2, 6, 12, and 24 hours, we found a nonsignificant difference between the groups (*P* values at 2, 6, 12, and 24 hours postoperatively were 0.74, 0.71, 0.07, and 0.06, respectively).

For analgesia in arthroscopic shoulder operation on 60 patients, the results of Dhir et al (29), who compared the combined axillary and suprascapular nerve blocks to the ISB, were inconsistent with the current study. They showed that postoperative interval opioid consumption decreased significantly in the ISB (*P* < 0.001) (29). This incongruity could be attributed to performing the SSB with axillary nerve block (ANB) in contrast to our study's combined CSB.

The groups did not demonstrate a significant difference regarding the time to the first analgesic request (*P* = 0.29). This was consistent with Trabelsi et al (22), Pani et al (23), El Sawy et al (30), and Karaman et al (31).

A nonsignificant difference was determined considering the intraoperative opioid dose in the current study. These results match those observed in 2 studies performed by Aliste et al (5,18), either with the paracoracoid approach or the costoclavicular approach of the ICB. Likewise, Auyong et al (21) reported similar results.

A nonsignificant difference was found regarding the NRS-11 score at 2, 6, 12, and 24 hours. In concordance with the present results, Aliste et al (18) demonstrated nonequivalent postoperative pain scores only during the first 30 minutes, and pain scores afterward decreased in the interscalene group, but with a nonsignificant difference. Also, the findings agreed with Lee et al (32), who studied 61 patients having arthroscopic rotator cuff repair divided into 3 groups: patient-con-

Table 2. *Intraoperative and postoperative heart rate and blood pressure in the groups.*

	Group ISB		Group CSB		*P* value	Mean Difference	CI 95%	
	Mean	SD	Mean	SD			Lower	Upper
Heart Rate at Induction (beat/min)	74	8	74	11	0.979	-0.369	-5.114	4.377
After 15 min (beat/min)	70	7	71	7	0.503	-1.506	-5.088	2.075
After 30 min (beat/min)	69	8	70	5	0.585	-0.611	-3.885	2.663
After 45 min (beat/min)	67	5	70	6	0.015*	-3.326	-5.972	-0.679
After 60 min (beat/min)	66	4	69	5	0.007*	-3.068	-5.309	-0.828
	Median	IQR	Median	IQR				
2 h Postoperative (beat/min)	72	7 (67-74)	74	13 (67-81)	0.118	-3.481	-7.048	0.086
6 h Postoperative (beat/min)	70	8 (66-74)	70	8 (67-75)	0.516	-.753	-4.071	2.566
12 h Postoperative (beat/min)	74	13 (67-80)	72	5 (68-73)	0.150	2.459	-0.981	5.899
24 h Postoperative (beat/min)	73	7 (70-77)	73	10 (68-78)	0.903	-0.109	-3.117	2.900
	Mean	SD	Mean	SD				
Blood Pressure at Induction (mmHg)	95	9	95	11	0.903	-1.298	-6.149	3.553
Blood Pressure at 15 min Intraoperative (mmHg)	90	13	93	11	0.421	-3.145	-8.841	2.552
Blood Pressure at 30 min Intraoperative (mmHg)	88	10	93	8	0.071	-4.479	-9.034	0.076
Blood Pressure at 45 min Intraoperative (mmHg)	89	9	93	8	0.023*	-5.464	9.477	-1.452
Blood Pressure at 60 min Intraoperative (mmHg)	90	8	94	8	0.050*	-5.167	-9.398	-0.936
Blood Pressure (mmHg) 2 h Postoperative	94	9	95	10	0.773	-1.150	-6.038	3.739
Blood Pressure at 6 h Postoperative (mmHg)	93	6	95	7	0.330	-1.703	-5.203	1.797
Blood Pressure at 12 h Postoperative (mmHg)	93	8	96	7	0.138	-2.566	-6.219	1.087
Blood Pressure at 24 h Postoperative (mmHg)	96	7	96	7	0.916	-0.019	-3.537	3.500

Abbreviations: ISB, interscalene block; CSB, costoclavicular suprascapular block; *, *P* value ≤ 0.05.

Table 3. *Postoperative oxygen and respiratory rate in the 2 groups.*

	Group ISB		Group CSB		*P* value	Mean Difference	CI 95%	
	Median	IQR	Median	IQR			Lower	Upper
Postoperative Oxygen Saturation at 2 h (%)	98	2 (97-99)	97	2 (96-98)	0.001*	0.013	0.005	0.021
Postoperative Oxygen Saturation (%) 6 h (%)	98	1 (98-99)	98	1 (97-98)	0.000*	0.011	0.004	0.016
Postoperative Oxygen Saturation (%) 12 h (%)	99	1 (98-99)	98	2 (97-99)	0.001*	0.008	0.004	0.012
Postoperative Oxygen Saturation (%) 24 h (%)	99	1 (99-100)	99	1 (98-99)	0.033*	0.004	0.00	0.00802
Postoperative Respirator Rate at 2 h (breath/min)	16	4 (14-18)	16	3 (15-18)	0.736	-0.492	1.779	0.795
Postoperative Respiratory Rate at 6 h (breath/min)	16	3 (14-17)	16	4 (13-17)	0.811	0.133	-1.032	1.298
Postoperative Respiratory Rate at 12 h (breath/min)	16	2 (15-17)	17	3 (15-18)	0.327	-0.778	-1.896	0.340
Postoperative Respiratory Rate at 24 h (breath/min)	16	2 (15-17)	17	3 (15-18)	0.046*	-0.994	-1.877	-0.111

Abbreviations: ISB, interscalene block; CSB, costoclavicular suprascapular block; *, *P* value ≤ 0.05.

trolled analgesia (PCA) alone & PCA+ISB & PCA + SSNB, and ANB. They found that at 8 hours postoperatively, the mean Visual Analog Scale (VAS) score of the PCA with SSNB & ANB group (3.9 ± 2.2) was close to or lower than that of the ISB group (5.2 ± 2.9) with an insignificant difference (32). Similar results were recorded by Trabelsi al (22), Pani et al (23), and Karaman et al (31).

On the other hand, a study conducted by Dhir et al (29) found higher pain scores in the PACU for suprascapular and axillary nerves blocks ($P < 0.001$); whereas, the pain levels in both groups were comparable after 6 hours. Pain management was greater in the SSNB & ANB group than in the interscalene group during the 24-hour follow-up ($P = 0.01$), and this difference from our results could be explained by the combination of the CCB to the SSB (29).

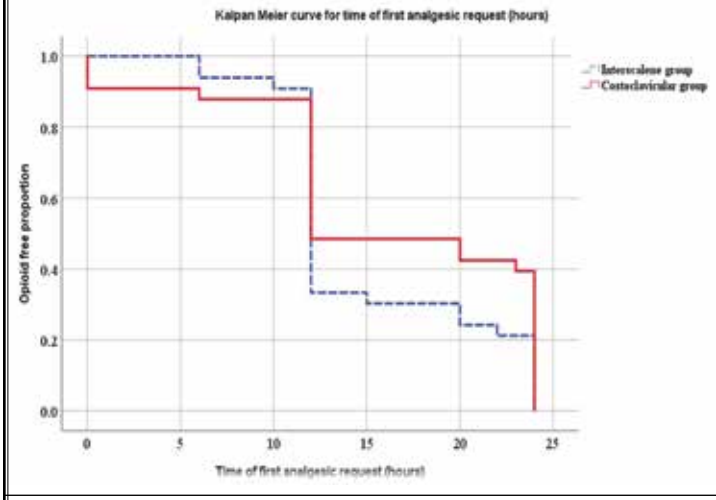

Fig. 2. *Time to first analgesic request.*

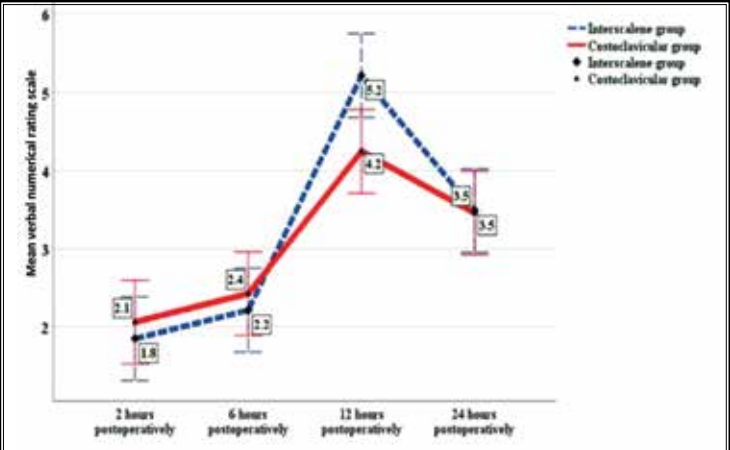

Fig. 3. *Mixed linear model for the NRS-11 during the first 24 postoperative hours for the 2 study groups.*

Table 4. *Comparison of occurrence of potential adverse effects between the groups.*

Adverse Effect	ISB Group (n = 33)	CSB Group (n = 33)	*P* value
No	27 (82%)	31 (94%)	0.25
Yes	6 (18%)	2 (6%)	
Horner syndrome	4 (12%)	0 (0%)	
Blood aspiration	1 (3%)	0 (0%)	
Paresthesia	1 (3%)	1 (3%)	
Pleural puncture	0 (0%)	1 (3%)	

ISB, interscalene block; CSB, costoclavicular suprascapular block

Similarly, Neuts et al (33) compared axillary and suprascapular nerve blocks to ISBs for pain control following an arthroscopic shoulder operation. Their study found that the postoperative pain scores at rest were more variable and elevated for suprascapular and axillary nerve blocks than ISB at most time intervals (33). This difference may be explained by receiving a rotator cuff and an additional supply from other nerves, which are not anesthetized with SSNB and ANB (25).

Similarly, Koltka et al (24) demonstrated that after 4 hours of the surgery, the median VAS scores between the groups were similar; however, at 8, 12, and 24 hours postoperatively, the median VAS scores in the SSB group were higher than those in the ISB group, but the difference was not significant. This difference from our results could be due to the suprascapular nerve-sparing in the supraclavicular block, contributing to the shoulder's sensory supply.

Likewise, Desroches et al (28) demonstrated a nonsignificant difference between the ISB and SSB groups in mean 24-hour postoperative pain, although the ISB group reported less pain in the recovery room. This was due to other nerves than SSN contributing to the nerve supply of the shoulder (28).

In our study, the incidence of the complete block after 30 minutes revealed an insignificant difference between the groups ($P = 0.34$). These findings matched those of a recent study conducted by El Sawy et al (30) and mentioned that there was no difference between 2 blocks completed after 30 minutes ($P = 0.02$), demonstrating a score of at least 6 points.

According to our findings, the ISB led to a higher HDP (91% vs 0%; $P < 0.001$). The findings agreed with Auyong et al (21), who observed when comparing the ISB group to the anterior SSNB group that the ipsilateral diaphragmatic excursion was preserved ($P < 0.001$).

Also, a study carried out by Sivashanmugam et al (34) observed ipsilateral hemidiaphragmatic paresis following a supraclavicular and costoclavicular BPB in 40 patients who underwent right-sided upper extremity surgery. This study showed that the frequency of ipsilateral hemidiaphragmatic paresis increased significantly following the BPB ($P = 0.008$) in the supraclavicular group than in the costoclavicular group came in agreement with our results (34).

In addition, Kim et al (35) found that the frequency of diaphragmatic paresis increased in the interscalene group than in the supraclavicular group significantly at 30 minutes following the block and in the PACU, their study comparing interscalene and supraclavicular blocks on 49 patients scheduled for shoulder surgery.

Furthermore, a significant difference was determined by Taha et al (36) ($P < 0.001$) between the groups regarding phrenic nerve palsy when they evaluated the impact of infraclavicular subomohyoid block with low-volume ISB on 72 patients scheduled for shoulder arthroscopy.

In addition, Kim et al (19) observed increased diaphragmatic excursion reduction in the interscalene group than in the superior trunk group ($P < 0.001$).

As expected, the costoclavicular-suprascapular group, which involved 2 blocks at different sites, required a longer performance time than the interscalene group, with a high statistical significance ($P < 0.001$); these results match with those of Aliste et al (5) and Dhir et al (29).

Concerning the incidence of complications and potential adverse effects, the 2 study groups had non-significant differences. Horner syndrome developed more frequently in ISB than in CSB. Similar findings were documented by Aliste et al (5) and Waleed (37) in their studies. Also, Ryu et al (38) showed similar results.

Limitations

There was no control group, the blocks took a long time to be performed up to 30 minutes, single-center study, and there were no validated criteria to define hemidiaphragmatic paresis or paralysis based on M-mode ultrasound measurements were considered as limitations for the current study.

Conclusions

According to the current study, analgesia supplied by a combination of costoclavicular and suprascapular blocks is noninferior to an ISB regarding preserving pulmonary function.

Acknowledgments

For Dr. Yasser Mostafa Salem, MD for his support and help in editing this manuscript.

References

1. Beals T, Odashima K, Haines LE, Likourezos A, Drapkin J, Dickman E. Interscalene brachial plexus nerve block in the emergency department: An effective and practice-changing workshop. *J Ultrasound* 2019; 11:15.
2. Ullah H, Samad K, Khan FA. Continuous interscalene brachial plexus block versus parenteral analgesia for postoperative pain relief after major shoulder surgery. *Cochrane Database of Systematic Reviews* 2014; 2014:CD007080.
3. Urmey WF, Talts KH, Sharrock NE. One hundred percent incidence of hemidiaphragmatic paresis associated with interscalene brachial plexus anesthesia as diagnosed by ultrasonography. *Anesth Analg* 1991; 72:498-503.
4. Urmey WF, McDonald M. Hemidiaphragmatic paresis during interscalene brachial plexus block: Effects on pulmonary function and chest wall mechanics. *Anesth Analg* 1992; 74:352-357.
5. Aliste J, Bravo D, Finlayson RJ, Tran DQ. A randomized comparison between interscalene and combined infraclavicular-suprascapular blocks for arthroscopic shoulder surgery. *Can J Anaesth* 2018; 1:1-8.
6. Tran DQ, Bertini P, Zaouter C, Muñoz L, Finlayson RJ. A prospective, randomized comparison between single- and double-injection ultrasound-guided infraclavicular brachial plexus block. *Reg Anesth Pain Med* 2010; 35:16-21.
7. Tran DQ, Layera S, Bravo D, Cristi-Sanchéz I, Bermudéz L, Aliste J. Diaphragm-Sparing nerve blocks for shoulder surgery, revisited. *Reg Anesth Pain Med* 2020; 45:73-78.
8. Sauter AR, Smith HJ, Stubhaug A, Dodgson MS, Klaastad Ø. Use of magnetic resonance imaging to define the anatomical location closest to all three cords of the infraclavicular brachial plexus. *Anesth Analg* 2006; 103:1574-1576.
9. Karmakar MK, Sala-Blanch X, Songthamwat B, Tsui BC. Benefits of the costoclavicular space for ultrasound-guided infraclavicular brachial plexus block: Description of a costoclavicular approach. *Reg Anesth Pain Med* 2015; 40:287-288.
10. Ho B, De Paoli M. Use of ultrasound-guided superficial cervical plexus block for pain management in the emergency department. *J Emerg Med* 2018; 55:87-95.
11. Spence BC, Beach ML, Gallagher JD, Sites BD. Ultrasound-Guided interscalene blocks: Understanding where to inject the local anesthetic. *Anaesthesia* 2011; 66:509-514.
12. Franco CD, Williams JM. Ultrasound-Guided interscalene block: Reevaluation of the "stoplight" sign and clinical implications. *Reg Anesth Pain Med* 2016; 41:452-459.
13. Leurcharusmee P, Elgueta MF, Tiyaprasertkul W, et al. A randomized comparison between costoclavicular and paracoracoid ultrasound-guided infraclavicular block for upper limb surgery. *Can J Anaesth* 2017; 64:617.
14. Chan C, Peng P. Suprascapular nerve block: A narrative review. *Reg Anesth Pain Med* 2011; 36:358-373.
15. Zambon M, Greco M, Bocchino S, Cabrini L, Beccaria PF, Zangrillo A. Assessment of diaphragmatic dysfunction in the critically ill patient with ultrasound: A systematic review.

Intensive Care Med 2017; 43:29-38.

16. Sarwal A, Walker FO, Cartwright MS. Neuromuscular ultrasound for evaluation of the diaphragm. *Muscle & Nerve* 2013; 47:319-329.
17. Faul F, Erdfelder E, Lang AG, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods* 2007; 39:175-191.
18. Aliste J, Bravo D, Layera S, et al. Randomized comparison between interscalene and costoclavicular blocks for arthroscopic shoulder surgery. *Reg Anesth Pain Med* 2019; 44:472-477.
19. Kim DH, Lin Y, Beathe JC, et al. Superior trunk block: A phrenic-sparing alternative to the interscalene block: A randomized controlled trial. *Anesthesiology* 2019; 131:521-533.
20. Auyong DB, Yuan SC, Choi DS, Pahang JA, Slee AE, Hanson NA. A double-blind randomized comparison of continuous interscalene, supraclavicular, and suprascapular blocks for total shoulder arthroplasty. *Reg Anesth Pain Med* 2017; 42:302-309.
21. Auyong DB, Hanson NA, Joseph RS, Schmidt BE, Slee AE, Yuan SC. Comparison of anterior suprascapular, supraclavicular, and interscalene nerve block approaches for major outpatient arthroscopic shoulder surgery: A randomized, double-blind, noninferiority trial. *Anesthesiology* 2018; 129:47-57.
22. Trabelsi W, Gabsia AB, Lebbi A, Sammoud W, Labbène I, Ferjani M. Suprascapular block associated with supraclavicular block: An alternative to isolated interscalene block for analgesia in shoulder instability surgery? *Orthop Traumatol Surg Res* 2017; 103:77-83.
23. Pani N, Routray S, Pani S, Mallik S, Pattnaik S, Pradhan A. Post-Operative analgesia for shoulder arthroscopic surgeries: A comparison between inter-scalene block and shoulder block. *Indian J Anaesth* 2019; 63:382.
24. Koltka AK, Büget M, Bingül ES, et al. Postoperative analgesia after arthroscopic shoulder surgery: A comparison between single-shot interscalene block and single-shot supraclavicular block. *Agri* 2017; 29:127-131.
25. Soriano LR, Baixauli PK, Ibañez JDA. ESRA19-0518 strategies to reduce hemidiaphragmatic paresis and related risks after blocks/for shoulder surgery. *Reg Anesth Pain Med* 2019; 44:45-46.
26. Kumara AB, Gogia AR, Bajaj JK, Agarwal N. Clinical evaluation of post-operative analgesia comparing suprascapular nerve block and interscalene brachial plexus block in patients undergoing shoulder arthroscopic surgery. *J Clin Orthop Trauma* 2016; 7:34-39.
27. Leiva A, Campos X, Mistreta D, et al. Hemidiaphragmatic paralysis with continuous interscalene block and diluted solutions of levobupivacaine. *Rev Chil de Anest* 2020; 49:683-690.
28. Desroches A, Klouche S, Schlur C, Bauer T, Waitzenegger T, Hardy P. Suprascapular nerve block versus interscalene block as analgesia after arthroscopic rotator cuff repair: A randomized controlled noninferiority trial. *J Arthros Related Surg* 2016; 32:2203-2209.
29. Dhir S, Sondekoppam RV, Sharma R, Ganapathy S, Athwal GS. A comparison of combined suprascapular and axillary nerve blocks to interscalene nerve block for analgesia in arthroscopic shoulder surgery: An equivalence study. *Reg Anesth Pain Med* 2016; 41:564-571.
30. El Sawy AG, El-Garhy AM, Abd-Elmegeed MM. Interscalene versus combined supraclavicular with suprascapular ultrasound-guided nerve blocks in arthroscopic rotator cuff surgery with levobupivacaine. *Al-Azhar Assiut Med J* 2019; 17:281-287.
31. Karaman T, Karaman S, Aşçı M, et al. Comparison of ultrasound-guided supraclavicular and interscalene brachial plexus blocks in postoperative pain management after arthroscopic shoulder surgery. *Pain Pract* 2019; 19:196-203.
32. Lee SM, Park SE, Nam YS, et al. Analgesic effectiveness of nerve block in shoulder arthroscopy: Comparison between interscalene, suprascapular and axillary nerve blocks. *Knee Surg Sports Traumatol Arthrosc* 2012; 20:2573-2578.
33. Neuts A, Stessel B, Wouters PF, et al. Selective suprascapular and axillary nerve block versus interscalene plexus block for pain control after arthroscopic shoulder surgery: A noninferiority randomized parallel-controlled clinical trial. *Reg Anesth Pain Med* 2018; 43:738-744.
34. Sivashanmugam T, Maurya I, Kumar N, Karmakar MK. Ipsilateral hemidiaphragmatic paresis after a supraclavicular and costoclavicular brachial plexus block: A randomised observer blinded study. *Eur J Anaesthesio* 2019; 36:787-795.
35. Kim BG, Han JU, Song JH, et al. A comparison of ultrasound-guided interscalene and supraclavicular blocks for post-operative analgesia after shoulder surgery. *Acta Anaesthesiol Scand* 2017; 61:427-435.
36. Taha A, Yurdi N, Elahl M, Abd-Elmaksoud A. Diaphragm-Sparing effect of the infraclavicular subomohyoid block vs low volume interscalene block. A randomized blinded study. *Acta Anaesthesiol Scand* 2019; 63:653-658.
37. Waleed A. Postoperative analgesia for postoperative shoulder surgery: Comparison between ultrasound-guided interscalene block and combined suprascapular and axillary blocks. *Ain Shams J Anesthesiol* 2016; 9:536.
38. Ryu T, Kil BT, Kim JH. Comparison between ultrasound-guided supraclavicular and interscalene brachial plexus blocks in patients undergoing arthroscopic shoulder surgery: A prospective, randomized, parallel study. *Medicine* 2015; 94:e1726.