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Paracoracoid Subscapularis Plane Block Versus Infraclavicular and Subomohyoid Blocks for Pain Relief in Unilateral Shoulder Surgeries: A Randomized, Double-Blind Comparative Study

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ABSTRACT

Background: The techniques of paracoracoid subscapularis plane, infraclavicular, and subomohyoid blocks are innovative methods used in shoulder procedures to prevent phrenic nerve block and hemi-diaphragmatic paresis, as opposed to using the interscalene block.

Objective: The objective of this study was to evaluate the analgesic efficacy and outcomes of two different blocks in unilateral shoulder surgery.

Patients and Methods: Eighty patients were randomly distributed into two equal study groups: group P was subjected to paracoracoid subscapularis plane block and group ISO to infraclavicular and subomohyoid block. After the conduction of general anesthesia, the two blocks were done by injecting 15 ml of bupivacaine 0.5% under an ultrasound image.

Results: No statistically significant difference was detected in the visual analog scale among the study groups immediately after the operation and up to 8 hours. However, after 12 hours, there was a clear and substantial difference, with the ISO group showing an excellent analgesic effect. The intra-operative heart rate exhibited more stability in group P; this difference. The heart rate exhibited increased stability after 1.5 hours in the ISO group; however, this change was not statistically significant. The intra-operative mean arterial blood pressure didn't exhibit any statistically significant difference among the two groups, except after 1 hour, where the ISO group demonstrated a more pronounced and stable effect. There was a significant statistical difference in opioid intake among the ISO group and the control group.

Conclusion: Paracoracoid subscapularis nerve block is more efficacious in shoulder procedures as it does not damage the phrenic nerve, unlike the subomohyoid block.

Keywords: Paracoracoid subscapularis plane block, Infraclavicular nerve block, Subomohyoid plane block, Shoulder surgeries.

INTRODUCTION

Shoulder surgery is a frequently performed orthopedic operation [(1)]. Typically, it leads to severe pain after surgery, which may necessitate the administration of high amounts of opioids to manage it [(2)].

Regional nerve blocks are employed for the management of postoperative pain. Shoulder surgeries often include the interscalene block (ISB). It improves rehabilitation after surgery and reduces pain by bypassing the brachial plexus (BP). Nevertheless, it leads to the occurrence of phrenic nerve block (PrNB) in addition to hemi-diaphragmatic paresis (HDP), that significantly hinder mechanics of respiration and those with insufficient respiratory reserve may have difficulties in tolerating it [(3)]. There is a need for new and improved approaches to spare the phrenic nerve block, which is more effective than the interscalene block [(2)].

The infraclavicular and subomohyoid (ISO) block is a modern procedure that involves a single puncture to block the brachial plexus cords and the suprascapular nerve. This technique is used to effectively manage pain after shoulder surgery. It is more likely to protect the phrenic nerve in comparison with a low-volume interscalene block [(4)].

Another option is the paracoracoid block, which involves blocking the suprascapular nerve as well as the axillary nerve as they wrap around the neck of the humerus. Studies have observed a positive result despite a less-than-ideal impact, potentially due to the nerves being obstructed after the articular branches had separated from the main bundle [(5)].

This study employed a randomized and double-blind design to compare the impact of paracoracoid subscapularis plane blocks, infraclavicular blocks and subomohyoid blocks in managing postoperative pain following unilateral shoulder surgery. Our hypothesis posits that the paracoracoid subscapularis plane block is more efficacious and less risky when compared to alternative therapies. Our study was conducted to examine the analgesic impacts of ultrasound-guided paracoracoid subscapularis plane block as well as ultrasound-guided ISO block for unilateral shoulder surgery. The assessment included measures such as the Visual Analogue Scale (VAS) for pain, hemodynamic stability, opioid consumption, and the occurrence of complications such as hematoma at the block site and side effects related to opioids.

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PATIENTS AND METHODS

Study design

This study was a randomized, double-blind comparative trial. The study was done at Al Fayoum University Hospital from October 12, 2020, to September 20, 2022. This manuscript complies with the relevant CONSORT criteria.

Study participants

A total of eighty patients, aged from 25 to 65 years old and were chosen for shoulder surgeries based on their American Society of Anesthesiologists (ASA) physical status, which was either I or II. They were randomized to two study groups: group P, which had a paracoracoid subscapularis plane block (n = 40), and group ISO, which received an ISO block (n = 40). Patients suffering from systemic infections, local infections at the block site, those with neurological or psychological disorders, or patients who declined to participate, had histories of local anesthetic allergies, coagulation disorders (defined as a platelet count below 80,000, an INR greater than 1.5%), or a prolonged activated partial thromboplastin time greater than 45 seconds were not included in the study.

Randomization and blinding

The patients were not provided with specific information about the type of block. The anesthesiologist who carried out the procedure had no other roles to do in the research. Researchers who were not involved with the block method assessed the outcome factors. As a result, all participants, except for the anesthesiologist who carried out the intervention, were unaware of the anesthetic technique. An uninvolved research nurse allocated the groups into sealed envelopes that were sequentially labeled with successive numbers. Upon reviewing the participant's signed consent, the study nurse promptly unsealed the envelopes just prior to the nerve block intervention.

Interventions

Preoperative care

Prior to doing a thorough history-taking, comprehensive physical examination, and laboratory tests, all patients were adequately prepared. Additionally, they were instructed on how to quantify their pain levels using the visual analog scale, which involved discussing the various degrees on a scale ranging from 0 to 10. During the surgical procedure, upon entering the surgery room, an intravenous (IV) dose of 0.05 mg/kg midazolam was given. For all patients, standard monitoring was applied, which included a 3-lead electrocardiogram placed over the patient's chest, measuring blood pressure without invasive procedures, in addition to pulse oximetry placed over the arm that was not affected.

Intraoperative and postoperative care

General anesthesia was induced utilizing propofol (1 to 2 mg/kg), atracurium (0.5 mg/kg), as well as fentanyl (1 to 2 µg/kg). Anesthesia was maintained using isoflurane (1–1.5%) and a combination of 60% oxygen along with 40% air. The management of intra- and postoperative hypotension, characterized by a systolic blood pressure below 90 mmHg, involved lowering the administration of inhaled anesthetics and intravenous fluid boluses. If the patient did not respond, we administered a vasopressor, specifically ephedrine, at a dosage of 7–10 mg. Intra- and postoperative bradycardia, characterized by a heart rate below 50 beats per minute, was managed by administering intermittent intravenous doses of atropine exceeding 0.4 mg.

The blocks were performed using an aseptic approach, and 1 ml of 1% lidocaine was applied to the epidermis as well as subcutaneous tissues to numb the skin. A 50 mm 22G block needle was placed utilizing the in-plane technique, while the needle is being inserted, the probe is held in a lateral to medial position. All the interventions were carried out by an anesthesiologist with expertise in ultrasonography. Patients were positioned supine with their shoulders in a neutral alignment and their necks laterally flexed away from the affected shoulder. Each block was created using 15 ml of 0.5% bupivacaine (Marcaine; AstraZeneca, Egypt).

The paracoracoid block, involves the placement of a high-frequency ultrasonic probe (6–13 MHz) (Figure 1-A) in the frontal plane above the shoulder to identify the lesser and greater tuberosity of the humerus. The connection between the subscapularis muscle as well as the lesser tuberosity of the humerus becomes visible when the arm is rotated outward (Figure 1-B). The subscapularis muscle was infiltrated with a local anesthetic solution [6].

Finding the subclavian artery, brachial plexus, as well as inferior belly of the omohyoid muscle is the goal of the subomohyoid block, which is performed with the help of a linear high-frequency (6-13 MHz) ultrasonic probe. To achieve this, the probe is positioned above the supraclavicular fossa. The subomohyoid area (Figure 1-C) is defined by the brachial plexus, subclavian artery, as well as the lower half of the omohyoid muscle. The local anesthetic solution was injected using a needle approach from the side to the middle, beneath the lower part of the omohyoid muscle [7].

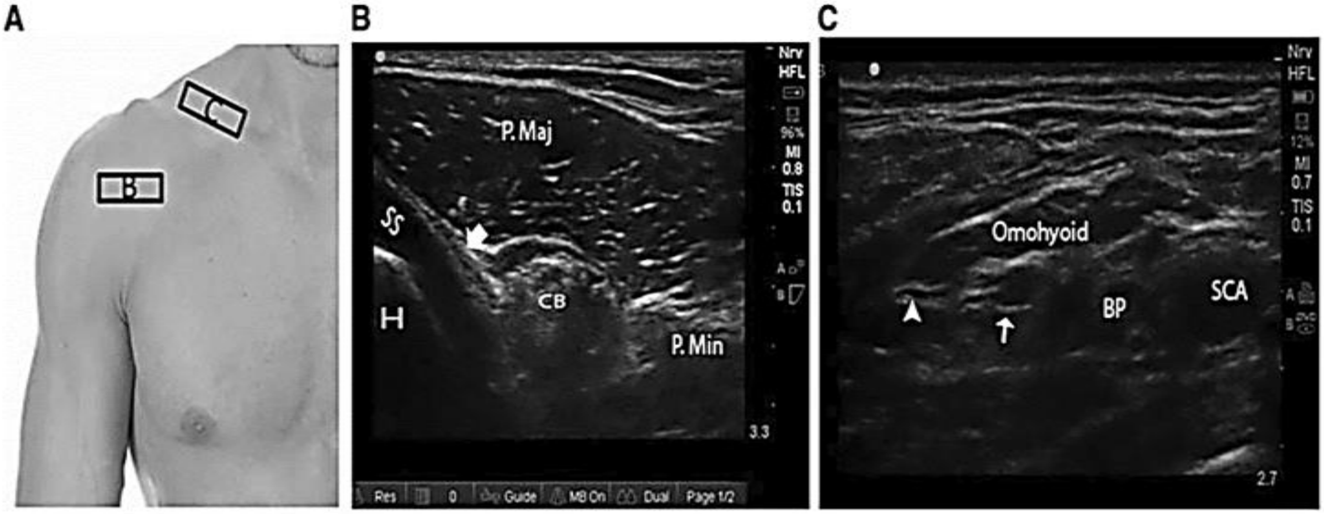

Fig. 1 (**A**) The subomohyoid and subscapularis plane blocks were located using the probe. (B) Subscapularis plane ultrasound imaging displaying the humerus's lesser trochanter (H; laterally), along with the subscapularis tendon (SS) attached above it. The white arrowhead indicates the subscapularis plane. From the coracoid process, which is not visible in this figure, the pectoralis minor (P. Min) along with coracobrachialis (CB) emerge at this level. Just below the skin's surface lies the pectoralis major (P. Maj) muscle. (C) An ultrasound picture taken of the area under the omohyoid bone (omohyoid) and the suprascapular nerve (arrow) that travels parallel to it can be seen on the side opposite the brachial plexus (BP) in the subomohyoid plane. An injection should be administered into the fascial plane beneath the lateral aspect of the inferior aspect of the omohyoid muscle, as indicated by the arrowhead. The image also shows the subclavian artery (SCA) [(7)].

After the treatment was finished, the appropriate doses of neostigmine as well as atropine were administered to alleviate the neuromuscular paralysis. After the patients were extubated, they were moved to the post-anesthesia care unit (PACU). Every patient was successfully removed from the ventilator at the PACU and attended to by a nurse who was unaware of the study's details. The measures in the PACU and later in the hospital ward were collected by a researcher who was unaware of the details of the procedure, 60 minutes after it was over. Upon meeting the criteria for discharge, all patients were transmitted to their respective rooms. The postoperative analgesic regimen was standardized and consisted of frequent intravenous administration of ketorolac (30 mg) on a regular basis during the initial twenty-four hours following surgery. Pain intensity was evaluated using a 10-cm VAS over the period in the PACU until 48 hours postoperatively. A score of 0 cm marked complete absence of pain, but a score of 10 cm marked the most terrible pain one could imagine. A morphine intravenous bolus of 0.05 mg/kg was given to patients who had a VAS score higher than 4 at any point in time.

Outcomes

The primary outcome was the amount of pain that patients reported while at rest, since the surgeons limited the range of motion for the operated shoulder.

One secondary outcome was the amount of time that passed after the local anesthetic was administered until the 1st rescue analgesic, an IV bolus of morphine, was requested. This time correlated to a VAS score greater than 4, which consequently serves as another indicator for the duration that the sensory block lasted. Additionally, data were recorded regarding the quantity of morphine administered and the number of patients who sought IV bolus morphine within the first two days following surgery. Additionally, alterations in hemodynamics throughout the first day after surgery were evaluated. Adverse effects of opioids, such as postoperative depression of respiration, nausea, vomiting, sedation, and pruritus, as well as possible adverse reactions of brachial plexus blocks (such as hoarseness, Horner syndrome, oxygen desaturation SpO_2 <92 postoperative or dyspnea) as well as complications of these blocks (such as persistent paresthesia, tingling, in addition to weakness hematoma across the injection site), were documented. at the conclusion of the1st day following surgery.

Ethical considerations:

This study was performed at Al Fayoum University Hospital after being approved by the Ethical Committee with approval number D229 and retrospectively registered at clinicaltrials.gov with the number NCT05439837. Written informed consent was attained from each participant after providing them with a detailed explanation of the investigation. The research followed all the rules laid out in the Declaration of Helsinki.

Sample Size Calculation and Statistical Analysis:

To determine the proper sample size, we conducted a preliminary study involving 10 patients (5 in each group). This study was done to measure our primary outcome, which was the VAS. Our findings revealed that there was a mean difference of 0.4 among the two groups, as calculated 4 hours after the operation. The standard deviation was 0.7 in one group and 0.5 in the other group, resulting in an effect size of 0.65. The software version 3.1.9.6 of G*Power was developed by Heinrich Heine University in Germany. A sample size calculation was performed using a two-tailed alpha error of 0.05 and a power of 0.80, with an allocation ratio of 1. The calculation determined that an overall of 76 participants are required, with 38 participants in each group. In order to account for potential data loss, we augmented the sample size to include 80 patients, with 40 patients assigned to each group.

Version 22 of IBM SPSS Statistics was used for the data analysis. The normality of quantitative variables was evaluated utilizing the Kolmogorov-Smirnov test with a significance level of 5%. The data were categorized based on their respective types. Qualitative factors were represented using frequency and percentage. When the data were normally distributed, the standard deviation (SD) and mean were utilized to represent them. If the data weren't normally distributed, however, the median as well as interquartile range (IQR) were used instead. Based on the type of qualitative variables, group comparisons were carried out utilizing either the chi-square test or the Fisher exact test.

When comparing numerical variables among the two groups, the independent sample T-test was used for data that were normally distributed, while the Mann-Whitney test was used for data that were not normally distributed. The p-value was set well below the threshold of 0.05. The tests were conducted using a two-tailed approach.

RESULTS

With a p-value greater than 0.05, there was no statistically significant difference between the two groups in terms of the demographic as well as operative data acquired from patients (Table **1**).

Table 1: Demographic and operative data comparison among the two study groups

	Paracoracoid group (n=40)		**Infraclavicular group (n=40)**		***p-value*** #
	Number	**Percentage**	**Number**	**Percentage**	
Sex					
Male	24	60 %	16	40 %	0.074
Female	16	40 %	24	60 %	
ASA					
I	8	20 %	16	40 %	0.051
II	32	80 %	24	60 %	
	Mean	SD	Mean	SD	*p-value*‡
Age (years)	41.80	10.22	46.05	9.75	0.061
Body mass index (kg/m^2)	26	4.3	27.75	5.21	0.106
	Median	**IQR**	**Median**	**IQR**	***p-value***※
Duration of surgery (hours)	4	0	4	1 (3-4)	0.347
Performance time of block (minutes)	15	7.25 (12.25 - 19.5)	15	5.75 (12-17.75)	0.490

ASA: American Society of Anesthesiology, **SD:** standard deviation, **#:** Chi-squared test, **‡:** independent sample t-test, **※:** Mann-Whitney U test.

When comparing heart rates at various time intervals, there was no statistically significant difference among the two groups.

Table 2: Intraoperative heart rate comparison between the two study groups

Heart rate (beat/minute)	**Paracoracoid group (n=40)**		**Infraclavicular group (n=40)**		***p-value*** ‡
	Mean	**SD**	**Mean**	**SD**	
Baseline	82 **(beat/minute)**	8	81 **(beat/minute)**	7	0.549
After 0.5 hour	80 **(beat/minute)**	8	83 **(beat/minute)**	6	0.062
After 1 hour	83 **(beat/minute)**	8	83 **(beat/minute)**	6	1
After 1.5 hours	79 **(beat/minute)**	11	81 **(beat/minute)**	6	0.316
After 2 hours	82 **(beat/minute)**	6	78 **(beat/minute)**	14	0.101

SD: standard deviation, **‡:** independent sample t-test

With p-values > 0.05 at various time points, there was no statistically significant difference among the two groups in terms of heart rate.

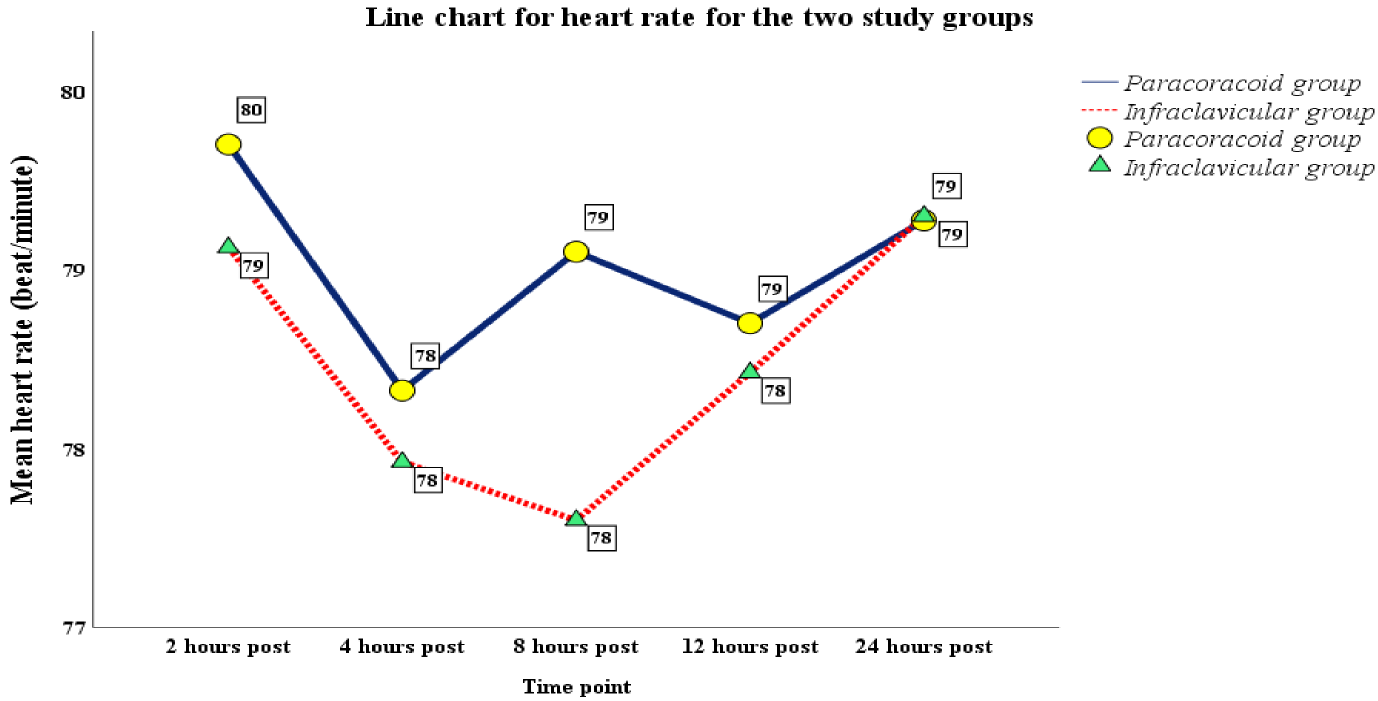

Fig. 2: Line chart for postoperative heart rate for the two study groups.

With p-values > 0.05 at various time intervals, there is no statistically significant difference among the two groups in terms of mean arterial blood pressure.

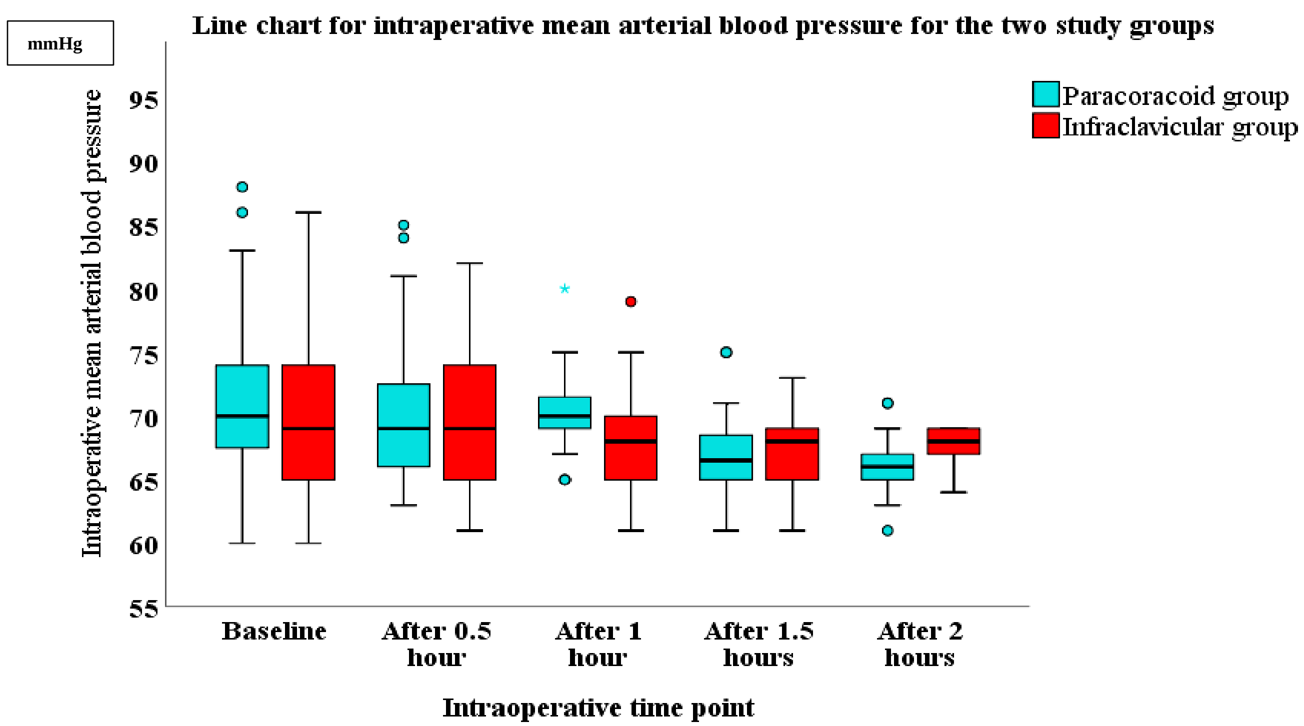

Fig. 3: Line chart for intraoperative mean arterial blood pressure for the two study groups.

When comparing the two groups' mean arterial blood pressure at various time points, a p-value greater than 0.05 indicates that there was no statistically significant difference.

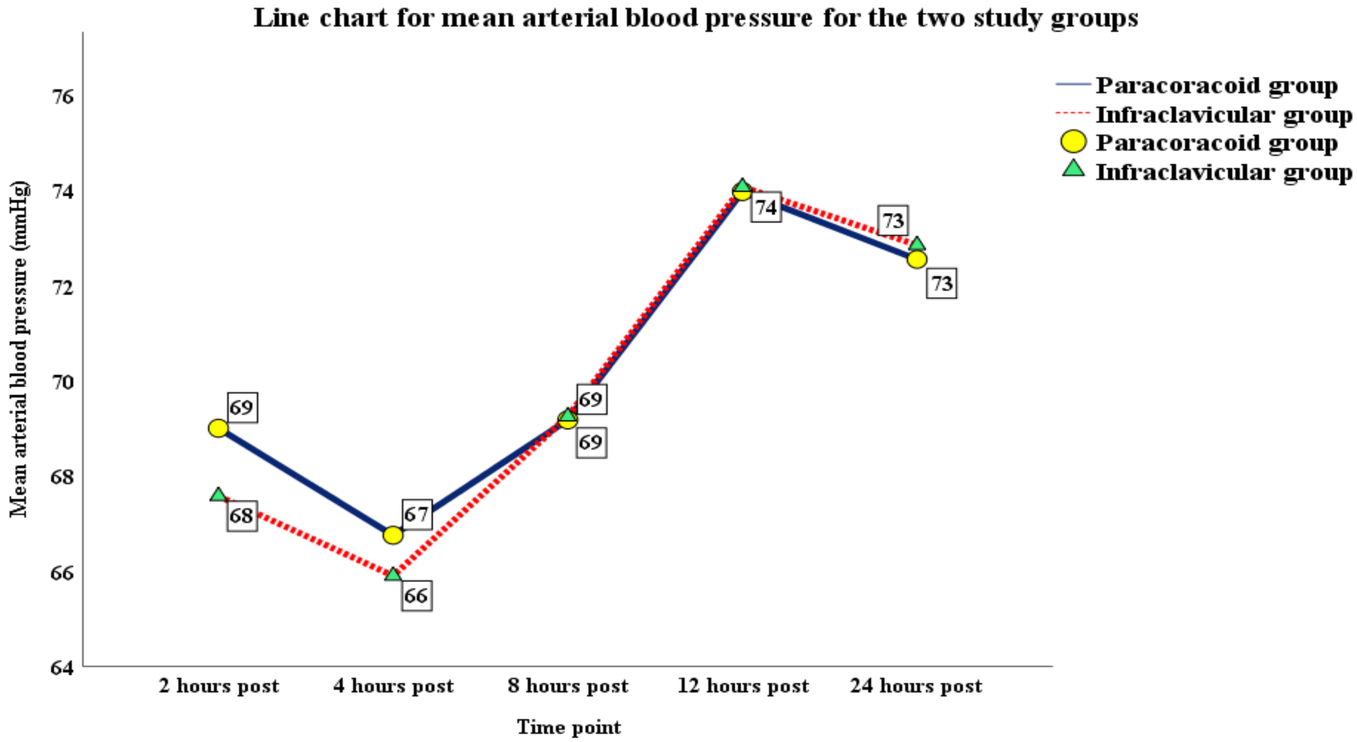

Fig. 4: Line chart for postoperative mean arterial blood pressure for the two study groups.

With p-values > 0.05 at various time intervals, there was no statistically significant difference among the two groups in terms of oxygen saturation.

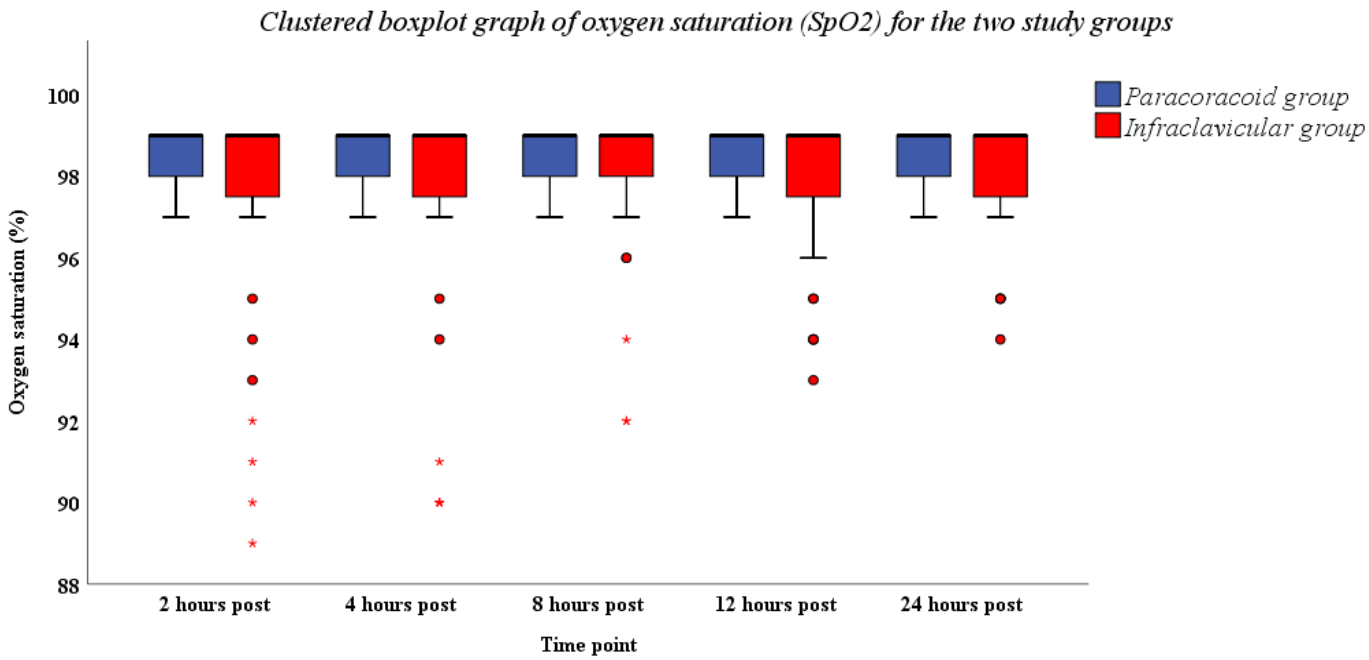

Fig. 5: Clustered boxplot graph of oxygen saturation (SpO_2) for the two study groups.

No statistically significant difference was found between the two study groups concerning postoperative visual analog pain until 8 hours then there was a statistically significant difference after 12 and 24 hours (Table **7**; Fig. **9**).

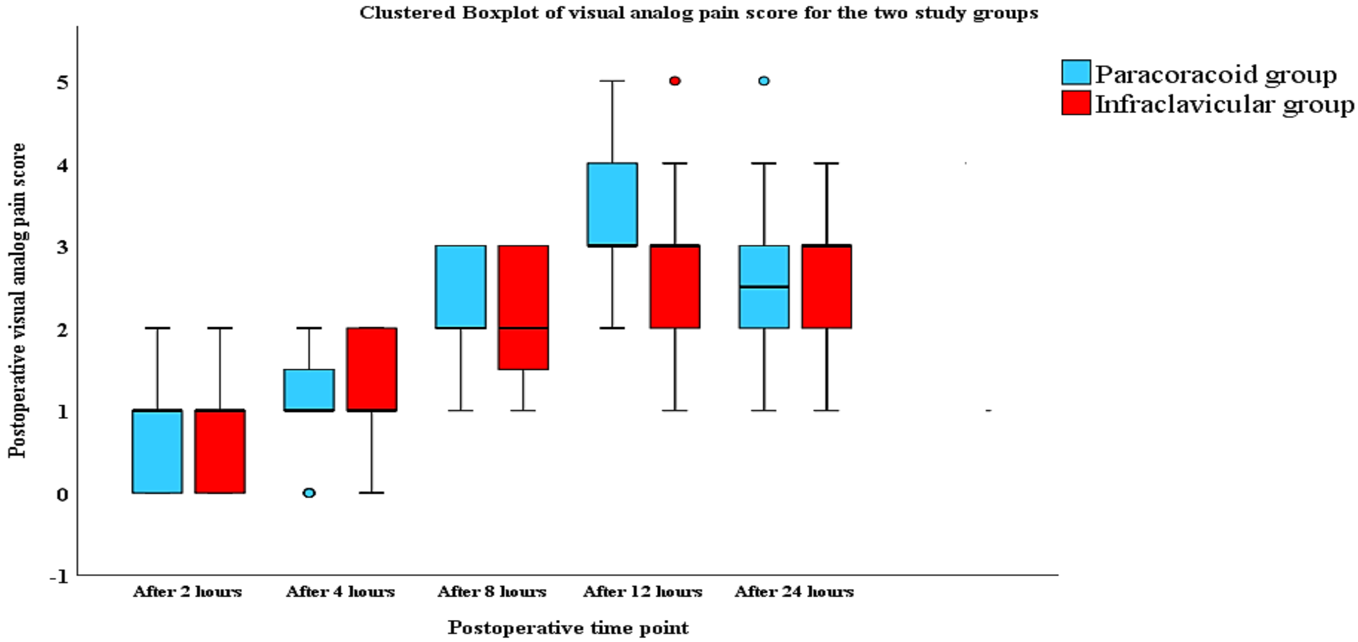

Fig. 6: Clustered boxplot of visual analog pain scale for the two study groups.

*: significant. With a p-value less than 0.001, there was a strong statistically significant difference among the two research groups in relation to the analgesic requirement (Table **8**; Fig. **10,11**).

Table 3: Analgesic requirements comparison between the two study groups

Analgesic requirement	**Paracoracoid group(n=40)**		**Infraclavicular group(n=40)**		**p-value ‡**
	Median	**IQR**	**Median**	**IQR**	
Time of 1st analgesic request	12	4 (8-12)	12	16 (8-24)	0.395
Total opioid consumption	30	5 (30-35)	30	7.5 (26.25-33.75)	0.043*

IQR; Interquartile range**, ‡;** Mann-Whitney U test, ***:** significant

No statistically significant difference was detected among the two study groups concerning postoperative differential opioid consumption at different time points (Table **9**; Fig. **12**)

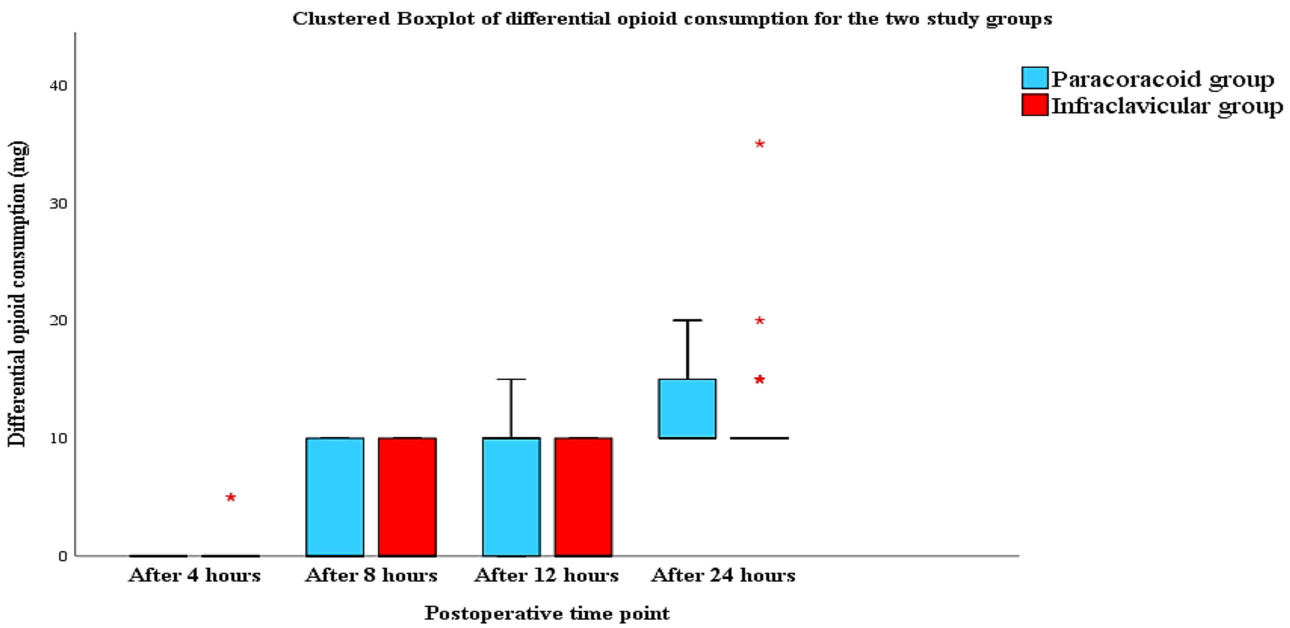

Fig. 7: Clustered boxplot of differential opioid consumption for the two study groups.

The complication incidence was significantly different between the two study groups.

Table 4: Comparison of complication incidence among the two study groups

	Paracoracoid group (n=40)		Infraclavicular group (n=40)		*p-value* #
	Number	Percentage	Number	Percentage	
No	40	100 %	34	85 %	0.026*
Yes (dyspnea)	0	0 %	6	15 %	

ASA: American Society of Anesthesiology, **SD:** standard deviation, **#:** Fisher-exact test, ***:** significant.

DISCUSSION

A substantial number of adult experience significant acute pain following shoulder surgery, with around 45% experiencing severe discomfort immediately after the operation. Given that most of these procedures are carried out in an ambulatory setting, it is crucial to prioritize the provision of appropriate pain relief after surgery to facilitate the faster recovery and rehabilitation of these patients [8].

The ISB is considered the most efficient method for relieving shoulder pain. However, it has its drawbacks. An alternative approach for shoulder pain relief is combined subscapularis plane and subomohyoid injections. This method can be used instead of peripheral nerve blocks and has little effect on phrenic nerve function [7].

When comparing the two groups' heart rates, no statistically significant difference was found. There was no statistical change in preoperative heart rate between groups in an earlier trial conducted in 2020. However, at several time points (skin incision, postoperatively, six hours, twelve hours, eighteen hours, and a whole day), the two groups' heart rates were significantly different from one another [9].

Using a VAS for recording pain levels for up to eight hours after surgery, the present study indicated no statistically significant difference among the two groups. On the other hand, after 12 and 24 hours, the groups differed significantly. For arthroscopic shoulder surgery, a new study compared the efficacy of the subomohyoid anterior suprascapular block with that of the interscalene block. The authors discovered that subomohyoid anterior suprascapular block provided similar pain control to interscalene block at all time points within the 1st 24 hours post the surgery [10].

During the prior investigation, the VAS was measured at specific intervals after the surgery in both groups. During the first 6 hours, the mean VAS scales were higher in the group that was given the ISB compared to the group that was given the suprascapular nerve block (SSB). This difference was statistically significant during the 1st 2 hours. The verbal pain scores demonstrated statistically significant differences between the groups up to a 4-hour interval. At the 6-hour interval, the scales were equal between the groups, and at the 24-hour interval, the scales were nearly the same [11].

A different study found no statistically significant difference among the two groups on the VAS scale when administered in the operating room before surgery, which contradicts our results. When comparing Group 2 with Group 1, the VAS scores in Group 2 were much higher. Following the surgery, a 24-hour period, no statistically significant difference was noted ($P < 0.05$) [12].

Aliste *et al.* [13] discovered that ISB offers superior pain management within the initial 30 minutes, resulting in enhanced pain control. Subsequently, while the pain levels at 1, 2, and 3 hours seemed to be lesser in the ISB group, the highest values within the 99% confidence intervals didn't surpass the predetermined threshold for equivalency.

Given that both the ISB as well as ICB-SSB groups had comparable percentages of patients with fully blocked nerves after 30 minutes (ranging from 95% to 100%), it can be inferred that achieving axillary and suprascapular nerve blocks is possible using either approach. There is some speculation that the early difference in pain reduction among the two groups could be attributed to the fact that ICB-SSB does not fully cover the subscapular as well as lateral pectoral nerves. The axillary nerve as well as the anterior shoulder joint are supplied by a network of nerves that start in the posterior and lateral cords [2]. Further, previous research by **Singelyn *et al.*** [14] found that ISB was superior to SSB.

Also, patients having arthroscopic rotator cuff surgeries reported less pain (for up to one day) and higher levels of satisfaction when axillary block as well as SSB (Supraclavicular Brachial Plexus Block) were used together, as opposed to when SSB was used alone, according to **Lee *et al.*** [15].

Enhanced pain management in the PACU can aid in the patient's discharge and is therefore beneficial for outpatient shoulder surgery. This is because most criteria for PACU discharge include reaching a specific threshold of pain severity on a scale, as well as not relying on systemic analgesics, to determine if the patient is ready to be discharged [8].

However, in certain situations and/or with particular groups of patients, the potential dangers of pulmonary and block-related issues linked to ISB may be greater than the advantages it provides. In these cases, SSNB has the potential to be a better option because it is both safe and efficient [16].

In this study, both groups had a median period of 12 hours after surgery before the first request for pain relief medication. This result came in agreement with previous studies that have also reported the use of pain medication during the first 24 hours after surgery [17-19].

However, a recent study revealed modest evidence suggesting that patients in the suprascapular group experienced a somewhat shorter duration before requesting their first painkiller [10].

According to total morphine consumption, a significant difference was observed among the two study groups concerning analgesic requirements, as total morphine usage in the paracoracoid group had a lesser analgesic requirement than in the subomohyoid group (p = 0.043).

Four clinical investigations have also discovered that ISB appears to decrease postoperative oral morphine usage in the PACU compared to suprascapular block [17-20].

In our study, no statistically significant difference was found among the two study groups concerning the postoperative differential opioid consumption.

In contrast, research conducted by **Price [17], Wiegel *et al.* [18], and Dhir *et al.* [20],** revealed that interscalene nerve blockade (ISB) appeared to decrease postoperative morphine use in the PACU compared to suprascapular nerve block. However, it is important to note that this difference wasn’t shown to be statistically significant.

As regard complications, a significant difference was detected among the two study groups concerning the complication incidence, as six patients in the infraclavicular (subomohyoid) group had oxygen saturation below 92.

Previous studies have also identified respiratory issues in the group receiving suprascapular nerve block (SSNB) in the subomohyoid region. The predominant respiratory consequence noted was a postoperative oxygen saturation < 92, which aligns with our findings [18,21–23].

Patients at high risk for complications during arthroscopic shoulder surgery may benefit from ultrasound-guided CCB instead of ISB, according to a recent study by **Luo *et al.* [24]**.

Prior research has conclusively demonstrated that implementing ISB for individuals undergoing arthroscopic shoulder surgery has several advantages. These include expedited recovery, reduced reliance on opioids for pain management, decreased fluctuations in intraoperative hemodynamics, enhanced patient satisfaction, and minimized adverse effects associated with general anesthesia [8–25].

CONCLUSION

In shoulder surgeries, the paracoracoid subscapularis nerve block is more efficacious in avoiding phrenic nerve involvement in comparison with the subomohyoid block.

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Author contributions

Mohamed Ahmed Shawky Mohamed finished the first draft of the paper. Maged Labib Boules, Joseph Makram Botros, Mohamed Ahmed Shawky Mohamed, and Omar Sayed Farghaly performed nerve blocks. The task of recruiting patients and collecting data was done by Nader Mohammed Nagib Sirry. The data were analyzed and interpreted by Mohamed Ahmed Hamed. The study's general content, design, data analysis, critical revisions for essential intellectual content, as well as final approval were all the responsibility of the authors.

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- **Consent for publication:** Not applicable.
- **Competing interests:** No conflict of interest has been identified by the writers.

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