ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 17, Issue 12, 2024

Online - 2455-3891
Print - 0974-2441

Research Article

A COMPARISON OF ULTRASOUND-GUIDED SUPRACLAVICULAR VERSUS INFRACLAVICULAR BLOCKS FOR HAND AND FOREARM SURGERIES

ANANYA HAGJER*, DEEPANNITA SUTRADHAR, RUPANKAR NATH, SUNEETA DUTTA

Department of Anaesthesiology and Critical Care, Silchar Medical College and Hospital, Silchar, Assam, India.
***Corresponding author: Ananya Hagjer; Email: hagjer13@gmail.com**

Received: 18 September 2024, Revised and Accepted: 10 November 2024

ABSTRACT

Objective: Regional anesthesia, particularly techniques such as supraclavicular (SCB) and infraclavicular (ICB) blocks, is increasingly favored over general anesthesia for upper limb surgeries due to its safety and efficacy, especially with ultrasound guidance.

Methods: A study was conducted at Silchar Medical College and Hospital involving 120 patients undergoing elective hand and forearm surgeries. These patients were randomly divided into SCB and ICB groups. Each block was performed using ultrasound guidance with an 8-MHz ultrasonic linear scanning probe. Patients received pre-medication, including pantoprazole/ranitidine, ondansetron, and midazolam (anxiolytic dose), 15 min before the procedure. The aim of our study was to compare the efficacy of ultrasound guidance in SCB block versus ICB block in terms of sensory and motor block, time taken to visualize structures, block performance time, and observe other parameters such as complications.

Results: Significant differences were observed between the SCB and ICB groups in terms of systolic BP, diastolic BP, and mean arterial pressure (MAP). The SCB group exhibited a higher MAP, whereas the ICB group required more time for structure visualization and block performance. However, the ICB group achieved complete sensory blocks quicker than the SCB group. Needle advancements were more frequent in the SCB group as compared to the ICB group.

Conclusion: The study concluded that while the ICB group had a longer block performance time, it experienced fewer complications, making ultrasound-guided ICB block a more effective option for upper limb surgeries compared to the SCB block.

Keywords: Ultrasound guidance, Upper limb block, Supraclavicular block, Infraclavicular block, Brachial plexus.

 DOI: http://dx.doi.org/10.22159/ajpcr.2024v17i12.52972. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

This is a bit non specific. Either mention the number of surgeries happening per year in india or across the world. An estimated 5000 surgeries are required to meet the surgical burden of diseases of 100,000 people in LIMI countries. These patients are prime candidates for perioperative pain management. Continual perioperative pain relief sans adverse effects has always been an achilles heel for the anaesthesiologist [1]. Hence, there is a continual need for effective perioperative pain management. In patients who are not suitable for general anesthesia, regional anesthesia can be employed as the solitary anesthesia technique, in addition to providing adequate pain relief. Alongside, it helps in avoiding concerns such as polypharmacy, avoiding laryngoscopic stress response, delayed awakening, and prolonged sedation. Regional nerve block reduces the side effects of general anesthesia, laryngoscopic stress reaction, preserving consciousness, avoiding polypharmacy, and also provisions for excellent post-operative analgesia.

Supraclavicular (SCB) and infraclavicular (ICB) approaches for brachial plexus blocks have always been part of the anesthesiologists' armamentarium, and have gained popularity among anesthesiologists following the introduction of ultrasound guidance, owing to proper visualization of the brachial plexus anatomy and increased accuracy in the deposition of local anesthetics which translates into reduced side effects namely failed blocks, intravascular injections, and nerve damage.

We aimed to compare the two established approaches to brachial plexus block by means of this prospective comparative study in terms of the onset of sensory and motor block and the time of achieving complete motor and sensory blockade in the operative limb. We also compared the time taken to identify and visualize the sonoanatomy in each group and the intergroup block performance time.

METHODS

This prospective, interventional, single-centric, double-blind, randomized, parallel-group, Helsinki protocol-compliant, and Ethical Committee-approved clinical study was registered with the Clinical Trial Registry of India. (CTRI/2023/07/055701). Written well-informed consent was obtained from all patients. Patient enrolment commenced in March 2023 and concluded in February 2024. A total of 120 patients were block randomized with 60 patients each allotted SCB group and ICB group. The sample size was calculated based on the study conducted by Koscielniak-Nielsen *et al*. assuming 95% of patients that underwent ICB block and 80% of SCB block had total sensory and motor block [2]. To estimate this difference with 95% confidence limits and 80% power the minimum sample size needed was calculated as 60 patients per group (total 120 patients).

A total of 120 patients with 60 patients in each group. The method of concealment comprised sequentially numbered, sealed, opaque envelopes. The study was participant and the outcome assessor-blinded.

Group-SCB received SCB block through ultrasound-guided technique and Group-ICB received ICB block through ultrasound-guided technique. Patients belonging to ASA grade 1 or 2, undergoing elective hand and forearm surgeries, of either sex aged 18–60 years, of body mass index 18–24 were included in the study. Patients who had an allergy to local anesthetics, parturients, patients with abnormal/difficult anatomy (chest deformity or clavicle fracture), significant

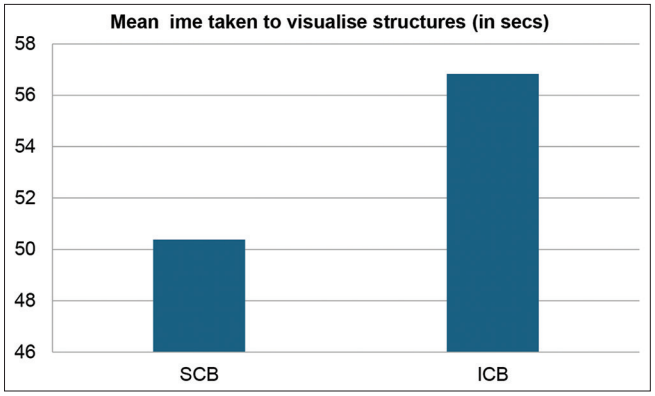

Fig. 1: Mean time taken to visualise structures

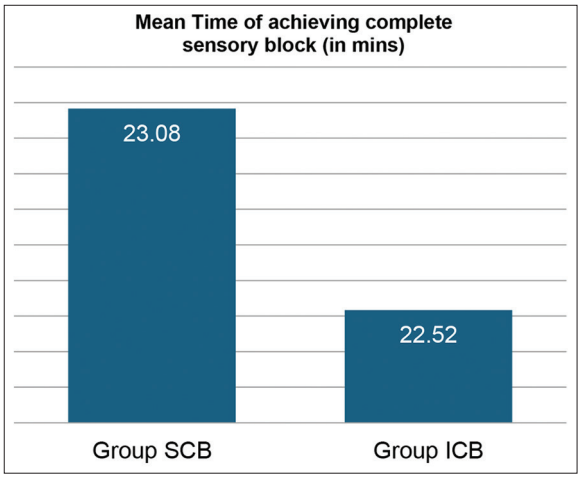

Fig. 2: Time of achieving complete sensory block

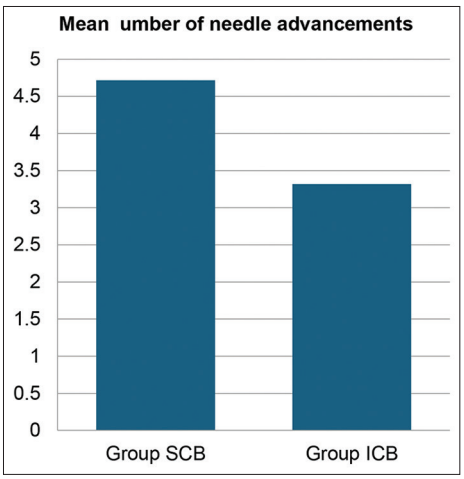

Fig. 3: Number of needle advancements

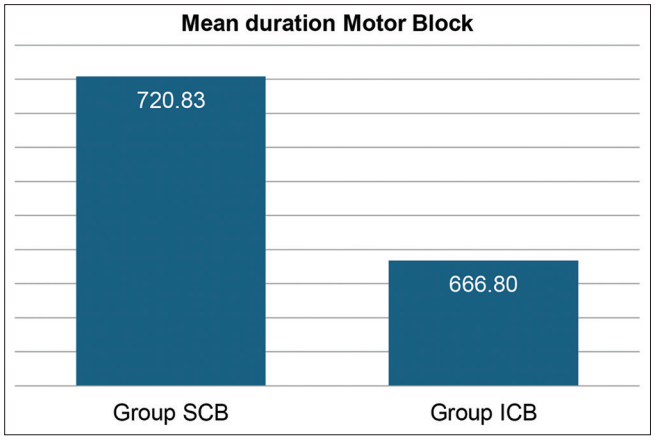

Fig. 4: Duration of Motor Block

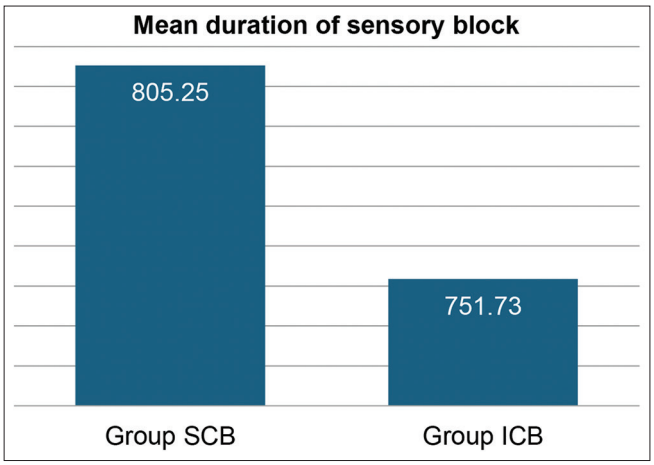

Fig. 5: Duration of sensory Block

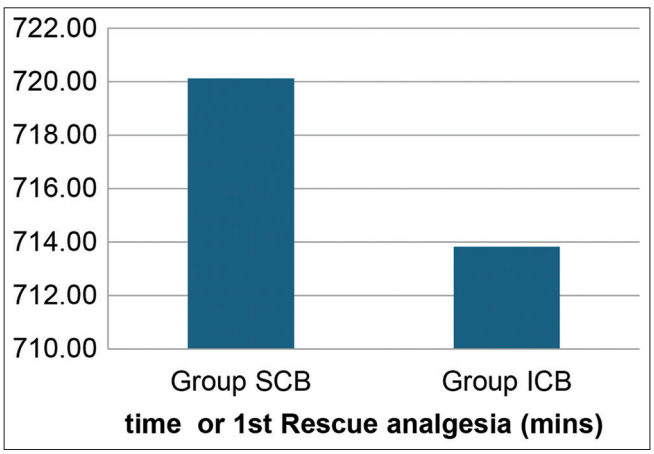

Fig. 6: Time for first rescue analgesia

pulmonary pathology, coagulopathies, pre-existing motor, and sensory deficits in the operative limb, or active infection at the injection site were excluded from the study.

Anesthesia Methods: Standard anesthesia monitors were attached to all patients and 18 gauge intravenous (IV) access was obtained in the pre-operative period before the administration of study blocks. All patients were pre-medicated with an injection of ondansetron 4 mg IV and an injection of pantoprazole (2 mg/kg) intravenous dose according to their weight and an injection of midazolam (0.5–1 mg) was used to provide light anxiolysis 15 min before the procedure. Both block procedures were performed using ultrasound guidance Mindray Z6 POCUS Portable Ultrasound Machine, Color Doppler Velocity, Linear Array (MHz), and 100 mm/22-gauge echogenic needle (Pajunk; Sonoplex stim cannula; Geisingen, Germany) in the supine position. An anesthesiologist proficient in ultrasonography (USG) guided nerve blocks administered the blocks in all patients. All patients in both groups were administered the same local anesthetic mixture (0.75% ropivacaine (3-4 mg/kg) and 2% lignocaine hydrochloride with 1:200,000 epinephrine (5-7 mg/kg) diluted with distilled water). In both techniques, after visualization

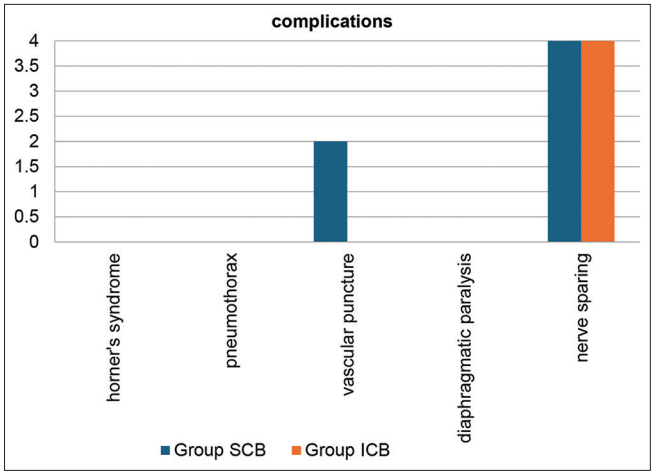

Fig. 7: Complications

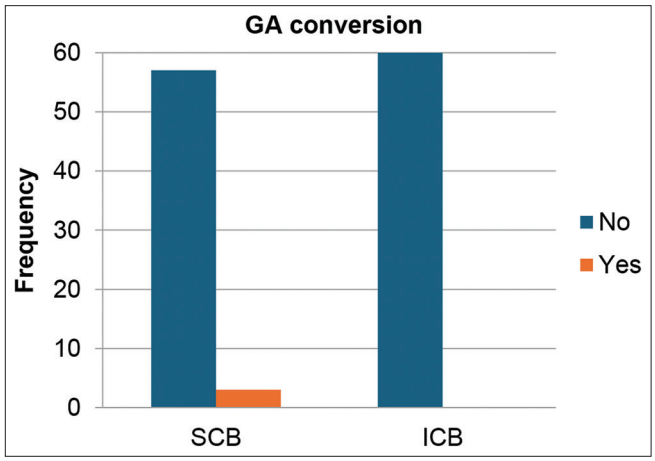

Fig. 8: GA converion rate

of the nervous and vascular structures, the needle was inserted perpendicular to the skin surface. In SCB block, the local anesthetic was spread around the subclavian artery. In the ICB block, a U-shaped distribution of local anesthetic was achieved around the axillary artery at the 6 o'clock position of the axillary artery.

Primary outcome measures included block onset time, duration, and block accuracy for each sensory and motor nerve blockade and the number of needle advancements. Sensory block assessment [4] was done based on pinprick stimulation and graded according to the following score in all four nerve compartments:

Anesthesia (no pain; no touch sensation; and complete sensory block): Grade 2, analgesia (no pain but touch present): Grade 1, and pain (feels pain): Grade 0.

Motor block was assessed and graded according to the Modified Bromage Scale for upper extremities: Paralysis (complete motor block): Grade 2, paresis (partial block): Grade 1, no weakness (no block): Grade 0. [5] We assessed the quality of block in our study from the onset of sensory and motor block till complete sensory block in all the four nerve terminals along with complete motor block in all the major joints of the forearm and hand. We defined the duration of the sensory block as the time between the onset of the sensory block and the complaining of the first post-operative pain. We also defined the duration of the motor block as the time from the onset of the motor block to the complete recovery of motor function in the operative limb. We have defined the number of needle advancements as the total number of times the needle was inserted and moved forward to reach the brachial plexus nerves [6]. Block performance was evaluated based on the time interval between the first insertion of the needle and its removal. Vitals parameters such as systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), and SpO_2 were noted at 0, 5, 10, 15, 20, 25, 30, 40, 50, 60, and 90 min respectively.

Pain scores were measured using the Visual Analog Scale (VAS), VAS score >4 was defined as the need for the first rescue analgesic, and the time for the first rescue analgesic was noted. Additionally, when rescue analgesia was delivered, the Ramsey sedation score was recorded. Secondary outcome measures included adverse events associated with the two nerve block approaches namely Pneumothorax, Horner's syndrome, and unintentional vascular puncture, etc.

RESULTS

The two groups displayed comparable demographic parameters and ASA grading ($p>0.05$). The patients' mean HR, SBP, DBP, MAP, and SPO_2 did not differ statistically significantly between the two groups, with the exception of the 50-min mark, when the SCB group's SBP, DBP, and MAP were determined to be significant, with a $p<0.05$.

The onset for both motor and sensory block as well as the motor and sensory block at the end of 30 min were calculated by the t-test method and both were found to be insignificant ($p>0.05$).

Block performance time

The block performance time for ICB block was found to be significantly longer than SCB block, also done using the Mann–Whitney test. The p-value was again found to be <0.001in this case.

Mean time taken to visualize structures

The mean time taken to visualize structures in the SCB group was 50.38±9.594 s. Moreover, for the ICB group, it was 56.83±8.876 s. The "p" value was observed to be <0.001 which indicated "statistical significance between the two groups" and was determined by the use of the Mann–Whitney test.

Time of achieving complete sensory block

It was observed in group SCB, the mean time of achieving complete sensory block to be 23.0833 min with a standard deviation of 1.47627 and in the ICB group to be 22.5167 min with a standard deviation of 1.57837, the p-value of which is 0.044, which is statistically significant.

Time taken to visualize structures, GA conversion rates, duration of analgesia, and patient satisfaction scores were calculated using the Mann–Whitney test, and the results were all found to be insignificant.

Number of needle advancements

The mean number of needle advancements in the SCB group was five with a standard deviation (SD) of one and in ICB group three with a SD of one. The p-value was <0.001 indicating statistical significance between the two groups.

Total duration of motor block

The mean duration of the motor block in group SCB was 720.8333 min with a standard deviation of 19.06738 and the main duration of the motor block in group ICB was 666.8000 with a standard deviation of 13.04074. The p-value was <0.001 indicating statistical significance between the two groups.

Total duration of sensory block

The mean duration of sensory block in group SCB was 805.2500 min with a standard deviation of 20.97022 and in group ICB was 751.7333 with a standard deviation of 29.39495. The p-value was <0.001 indicating statistical significance between the two groups.

VAS score

The VAS score in group SCB was 3.45±0.72 and for group ICB was 3.57±0.77. The p-value was 0.393 which is statistically not significant.

Time for 1st rescue analgesia

The time noted for the request of 1st rescue analgesia in group SCB was 720.12±75.27 min and for group ICB was 713.83±77.03. The p-value was 0.652 which is statistically not significant.

Ramsay sedation score

The Ramsay Sedation Score in group SCB was 2.3±0.46 and for group ICB was 2.23±0.62. The p was 0.506 which is statistically not significant.

COMPLICATION

In our study, complications such as Horner syndrome, pneumothorax, and diaphragmatic paralysis were not observed in both groups. However, vascular punctures were seen in two subjects from the SCB group, and nerve-sparing was seen equally in four subjects from both groups. The p-values were found to be insignificant.

GA conversion rate

In our study, ultimately three patients from the SCB group needed GA conversion as compared to no conversion from the ICB group. The p-value was 0.079 which is statistically not significant.

DISCUSSION

Ultrasound has revolutionized the field of regional anesthesia. The repeatability, accuracy, and reduced side effects are a testament to the ultrasound efficacy. The aim of our study was to compare the efficacy of ultrasound guidance in SCB block versus ICB block and observe other parameters such as complications.

In our study, we randomly allocated 120 adult patients of age between 18 and 60, of either sex with ASA physical status I and II, to receive either USG-guided SCB block (Group SCB) or USG-guided ICB block (Group ICB). Hence, 60 patients were in Group-SCB and the remaining 60 patients were in the Group-ICB.

The two groups were similar in terms of demographic parameters and hemodynamic parameters and the results of our study were comparable to studies done by Mallik and Chandra, Koscielnak-Nielsen *et al*. which showed no clinically significant difference in block quality, hemodynamic parameters, and respiratory parameters, except a clinically significant difference in the systolic diastolic and MAP at 50 min (Table 1) [2,7].

Time taken to visualize structure was counted from the moment of visualization of all relevant anatomy under ultrasound guidance for either group. In our study, it has been observed that the mean time taken to visualize structures took a significantly longer duration in ICB group 56.83±8.876 s as compared to SCB group which was 50.38±9.594 s (Table 3). The reason could be due to the increased complexity of the target area as the brachial plexus is deeper and surrounded by more structures, making it more challenging to visualize and access this region via the ICB route. Other contributing factors could be due to individual anatomy which differs from person to person.

The mean time of achieving complete sensory block was observed to be statistically significant in our study with group ICB showing faster complete sensory block than group SCB (Table 4). The mean time of achieving complete motor block in our study between the two groups was not significant in our study. While more research is needed in this area, one definitive reason for faster sensory blockade is more direct access to the brachial plexus; reducing the distance of the local anesthetic to reach the nerves [8]. A study done by Minville *et al*. showed that ICB blocks had a faster onset of sensory blockade as compared to SCB blocks whose findings were similar to our study [9]. Their study postulated that the reason for faster blockade could be due to fewer anatomical barriers (e.g., muscles and bones) leading to faster sensory blockade. Comparable results were observed in another study done by Kilka *et al*. showed that the sensory block for ICB block was achieved faster (at 20.4 min) in comparison to SCB block (at 30.8 min) [8].

Table 1: MAP

	SCB	ICB	p-value
MAP_Baseline	86.8±11.9	85.4±10.2	0.502
MAP_5 min	86.3±11.8	86±10.7	0.891
MAP_10 min	86.6±10.8	85.1±10.4	0.434
MAP_15 min	89±9.7	88.5±9.6	0.777
MAP_20 min	90±10.5	88.8±9.9	0.515
MAP_25 min	86.8±8.6	87.3±10.3	0.796
MAP_30 min	87.1±11.8	86.6±10.9	0.791
MAP_40 min	89.7±9.7	87±8.2	0.105
MAP_50 min	90.2±10.4	85.9±9.5	0.019
MAP_60 min	89.4±9.8	88.2±9.5	0.484
MAP_90 min	87.3±10.1	85.2±9.5	0.243

MAP: Mean arterial pressure, SCB: Supraclavicular, ICB: Infraclavicular

Table 2: Block performance time

Groups	SCB	ICB	p-value
Block performance time (Min)	6.0458±0.98292	9.2917±1.62108	<0.001

SCB: Supraclavicular, ICB: Infraclavicular

Table 3: Time taken to visualize structures

Groups	SCB	ICB	p-value
Mean time taken to visualize structures (in sec)	50.38±9.594	56.83±8.876	<0.001

SCB: Supraclavicular, ICB: Infraclavicular

Table 4: Time of achieving complete sensory block

Group	n	Mean time of achieving complete sensory block (in min)	SD	p-value
Group SCB	60	23.0833	1.47627	0.044
Group ICB	60	22.5167	1.57837	

SCB: Supraclavicular, ICB: Infraclavicular, SD: Standard deviation

In our study, the ICB block took longer to perform as compared to the SCB block and showed a significant difference with p<0.001 (Table 2). This is likely because it is a relatively novel technique practiced in our facility. Our findings were similar to Abdalziz *et al*. who also had longer block performance time in ICB group than SCB group [10]. However, multiple previous studies comparing SCB and ICB brachial plexus block ultrasound guided found that there were no significant differences in performance time [12].

Another study done by Abhinaya *et al*. found that block performance took less time in ICB group than in the SCB group [1] They concluded that the SCB block was significantly less effective for blocking the median and ulnar nerves but performed better in blocking the axillary nerve with a faster onset of block in the ICB group.

In our study, the onset of sensory and motor block was counted from the time of needle withdrawal from the skin. Our study revealed no significant differences in onset and our findings were similar to other previous studies as done by El-sawy *et al*., Arcand *et al*., and Yang *et al*. etc. [14-16]. However, a study done by Koscielniak-Nielsen *et al*. which compared ultrasound-guided SCB and ICB blocks for upper extremity

surgery in 120 patients showed that ICB blocks had a faster onset of action and higher surgical effectiveness [2]. They postulated that the poorer efficacy of the SCB blocks in their patients was caused by lower experience with this technique.

We assessed the grade of sensory (in all four nerve components) and motor block (elbow, wrist, and hand) at the end of 30 min and found no significant difference between the two groups. El-Sawy *et al*. found no difference between the SCB and ICB groups at 10 min but found a significantly higher sensory block at 20 and 30 min time intervals in the SCB group than the ICB group [14]. Arcand *et al*. found block quality (in terms of partial or complete sensory block of all nerve territories) tended to be better in the SCB group than in the ICB group, mostly because of radial sparing in the ICB group [15].

Out of a total of 120 patients, 112 patients had complete sensory block (sensory block of score 2 in all four nerve territories), Complete motor block (motor block of score 2 in all three joints motor components), and Effective upper limb block (complete sensory block and complete motor block) [2]. Our study did not show any statistical difference in terms of complete sensory, motor, and effective upper limb block between the two groups. In contrast to our study, previous studies showed a better and faster onset of block in ICB than in SCB block [2,17].

Our study showed a significant difference in the mean number of needle advancements (Table 5) where SCB group showed a mean of 5 which was more than ICB group whose mean was 3. It is likely because SCB block needed drug deposition into the corner pockets instead of a single shot technique as compared to the ICB group. The study done by Kilka *et a*l. showed similar findings to our study where ICB block needed lesser needle insertion than SCB block and provided reasoning that it could be due to easier identification of the musculocutaneous nerves and the lateral cord of the brachial plexus in the ICB region [8].

Although in our study there were no significant findings in the onset of blocks in both the groups, the total duration of motor and sensory blocks was found to be significantly more in SCB group (Tables 6 and 7). The results of our finding were similar to studies done by Malik *et al*., and El-Sawy *et al*. [7,14] However, a study done by Park *et al*. showed no difference between the two groups in terms of duration [12].

Complications such as vascular puncture, diaphragmatic paralysis, Horner's syndrome, and pneumothorax were looked for (Table 11). From the SCB group, two subjects had vascular puncture but it did not affect the quality of the block. Other findings from our study showed 4 subjects to have ulnar sparing from the SCB group and 4 subjects from ICB group to have radial nerve sparing. They received analgesic supplementation with an injection of nalbuphine. Three subjects from SCB group and one subject from ICB group ultimately needed GA conversion in our study (Table 12).

In the study done by Abhinaya *et al*., one patient had pneumothorax and another had ipsilateral diaphragmatic paresis in SCB group but none in ICB group [3]. Three patients developed Horner's syndrome in SCB group and three other patients had vascular punctures in SCB group compared to one patient in ICB group. Their study shows similarity to our study with SCB block having a higher degree of complications than ICB block.

VAS score, time of first rescue analgesia, and Ramsay sedation score were also evaluated in our study, the results of which were insignificant.

Our study had a few limitations such as pain related to injection and satisfaction scores could not be assessed, no catheters were used in the ICB group which could have increased the duration and adequacy of the block, dropout rate was not assessed and our sample size was small.

Table 5: Mean number of needle advancements

Group	n	Mean number of needle advancements	SD	p-value
Group SCB	60	5	1	<0.001
Group ICB	60	3	1	

SCB: Supraclavicular, ICB: Infraclavicular, SD: Standard deviation

Table 6: Total duration of motor block

Groups	n	Mean duration motor block (in mins)	Std. deviation	p-value
Group SCB	60	720.8333	19.06738	<0.001
Group ICB	60	666.8000	13.04074	

SCB: Supraclavicular, ICB: Infraclavicular

Table 7: Duration of sensory block

Groups	n	Mean duration of sensory block (in min)	Std. deviation	p-value
Group SCB	60	805.2500	20.97022	<0.001
Group ICB	60	751.7333	29.39495	

SCB: Supraclavicular, ICB: Infraclavicular

Table 8: Rescue analgesia

Groups	Group SCB	Group ICB	p-value
time for 1st rescue analgesia (min)	720.12±75.27	713.83±77.03	0.652

SCB: Supraclavicular, ICB: Infraclavicular

Table 9: VAS score

Groups	Group SCB	Group ICB	p-value
VAS	3.45±0.72	3.57±0.77	0.393

VAS: Visual analogue scale, SCB: Supraclavicular, ICB: Infraclavicular

Table 10: Ramsay sedation score

Groups	Group SCB	Group ICB	p-value
Ramsay sedation score	2.3±0.46	2.23±0.62	0.506

SCB: Supraclavicular, ICB: Infraclavicular

Table 11: Complications

Groups	Group SCB	Group ICB	p-value
Horner's syndrome	0	0	1.000
Pneumothorax	0	0	1.000
Vascular puncture	2	0	0.1577
Diaphragmatic paralysis	0	0	1.000
Nerve sparing	4	4	1.000

SCB: Supraclavicular, ICB: Infraclavicular

Table 12: GA conversion rate

GA conversion	SCB	ICB	Chi	df	p-value
No	57	60			
Yes	3	0	3.077	1	0.079

SCB: Supraclavicular, ICB: Infraclavicular

CONCLUSION

USG has definitely increased the ease, safety, and efficacy of doing the nerve block procedure and proved to be a safer alternative to general anesthesia due to the lower number of complications and side effects. In our study, we found that although block performance time was longer in the ICB group, achieving complete sensory block in the ICB group was faster than SCB block, and the number of complications was lower than in the SCB group. Although the duration of both motor and sensory block was significantly longer in SCB-group the rate of GA conversion was lesser in ICB group. Given enough time to perfect this technique in our facility, we have found that ultrasound-guided ICB blocks are more favorable from the patient's safety perspective. Hence, we recommend the use of ultrasound-guided ICB blocks owing to its enhanced safety and predictability.

REFERENCES

1. Bhandarkar P, Gadgil A, Patil P, Mohan M, Roy N. Estimation of the national surgical needs in India by enumerating the surgical procedures in an urban community under universal health coverage. World J Surg. 2021 Jan;45(1):33-40. doi: 10.1007/s00268-020-05794-7, PMID 32974741
2. Koscielniak-Nielsen ZJ, Frederiksen BS, Rasmussen H, Hesselbjerg L. A comparison of ultrasound-guided supraclavicular and infraclavicular blocks for upper extremity surgery. Acta Anaesthesiol Scand. 2009 May;53(5):620-6. doi: 10.1111/j.1399-6576.2009.01909.x, PMID 19419356
3. Abhinaya RJ, Venkatraman R, Matheswaran P, Sivarajan G. A randomised comparative evaluation of supraclavicular and infraclavicular approaches to brachial plexus block for upper limb surgeries using both ultrasound and nerve stimulator. Indian J Anaesth. 2017;61(7):581-6. doi: 10.4103/ija.IJA_402_16, PMID 28794531
4. Koscielniak-Nielsen ZJ, Frederiksen BS, Rasmussen H, Hesselbjerg L. A comparison of ultrasound-guided supraclavicular and infraclavicular blocks for upper extremity surgery. Acta Anaesthesiol Scand. 2009 May;53(5):620-6. doi: 10.1111/j.1399-6576.2009.01909.x, PMID 19419356
5. Horlocker TT, Kopp SL, Wedel DJ. Peripheral Nerve Blocks. Miller's Anaesthesia. 8th ed. Philadelphia, PA: Churchill Livingstone; 2014. p. 1721-51.
6. Kapral S, Jandrasits O, Schabernig C, *et al*. Supraclavicular versus infraclavicular brachial plexus block for hand and forearm surgery. Anesthesiology. 1999;91(5):1315-22.
7. Mallik A, Chandra K. A comparative study of quality of ultrasound guided supraclavicular and infraclavicular blocks for upper limb surgery. Galore Int J Health Sci Res. 2020 Oct-Dec;5(4):1-13.
8. Kilka M, Geiger P, Zgaggen W, *et al*. Reg Anesthcular vs supraclavicular brachial plexus block for pain relief after shoulder surgery: A randomized controlled trial. Reg Anesth Pain Med. 2010;35(5):445-51.
9. Minville V, Fourcade O, Bourdet B, *et al*. Supraclavicular versus infraclavicular brachial plexus block: A prospective, randomized, double-blind study. Anesth Analg. 2005;101(3):684-8.
10. Abdalziz AR, Masoud SM, Balata AA, El Harrisi MA. Supraclavicular versus infraclavicular brachial plexus block using two different techniques: Comparative study. Egypt J Hosp Med. 2021 Jul 1;84(1):2108-14. doi: 10.21608/ejhm.2021.180865
11. Stav A, Reytman L, Stav MY, Portnoy I, Kantarovsky A, Galili O, *et al*. Comparison of the supraclavicular, infraclavicular and axillary approaches for ultrasound-guided brachial plexus block for surgical anesthesia. Rambam Maimonides Med J. 2016 Apr 19;7(2):e0013. doi: 10.5041/RMMJ.10240, PMID 27101216
12. Park SK, Lee SY, Kim WH, Park HS, Lim YJ, Bahk JH. Comparison of supraclavicular and infraclavicular brachial plexus block: A systemic review of randomized controlled trials. Anesth Analg. 2017b;124(2):636-44. doi: 10.1213/ANE.0000000000001713, PMID 27828793
13. Hadzic A. Hadzic's Textbook of Regional Anesthesia and Acute Pain Management 2nd ed. The New York School of Regional Anesthesia. Vol. 2017. United States: McGraw-Hill Education; 2017.
14. El-Sawy A, Mohamed NN, Mansour MA, Salem MR. Ultrasound-guided supraclavicular versus infraclavicular brachial plexus nerve block in chronic renal failure patients undergoing arteriovenous fistula creation. Egypt J Anaesth. 2014 Apr;30(2):161-7. doi: 10.1016/j.egja.2013.12.006
15. Arcand G, Williams SR, Chouinard P, Boudreault D, Harris P, Ruel M, *et al*. Ultrasound-guided infraclavicular versus supraclavicular block. Anesth Analg. 2005 Sep;101(3):886-90. doi: 10.1213/01.ANE.0000159168.69934.CC, PMID 16116009
16. Yang CW, Kwon HU, Cho CK, Jung SM, Kang PS, Park ES, *et al*. A comparison of infraclavicular and supraclavicular approaches to the brachial plexus using neurostimulation. Korean J Anesthesiol. 2010;58(3):260-6. doi: 10.4097/kjae.2010.58.3.260, PMID 20498775
17. Fredrickson MJ, Patel A, Young S, Chinchanwala S. Speed of onset of corner pocket spraclavicular and infraclavicular ltrasound guided brachial plexus block: A randomized observer-blinded comparison. J Assoc Anaesth Great Britain Ireland. 2009;64:738-44.