Original Article

A Comparison of the Effect of Supraclavicular and Infraclavicular Approaches to Brachial Plexus Block Using Neurostimulation

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Abstract

Background: Various approaches, such as the Interscalene approach, supraclavicular approach, infraclavicular approach, and Axillary approach, are used to block the brachial plexus. This study aimed to compare the effects of supraclavicular and infraclavicular approaches using neurostimulation. **Material and Methods:** This prospective observational study was conducted at GMERS Medical College and General Hospital, Himmatnagar, in patients undergoing upper limb surgeries/procedures (wrist, hand, forearm, elbow, mid-arm). After getting Ethical committee approval, patients undergoing upper limb surgeries were allocated into SCB (Supraclavicular) and ICB (Infraclavicular). Informed consent was obtained from the participants. The two approaches of the peripheral nerve stimulator-guided brachial plexus block were compared for quality, performance time, ease of doing, degree of motor and sensory blockade, hemodynamic variability, and duration of post-op analgesia. **Results:** Onset of sensory block was 6.10±0.94 mins in the SCB group, while 6.45±1.69 mins in the ICB group (p=0.3176). Onset of motor block time was 10.77±1.59 mins in the SCB group, while 10.71±2.76 mins in the ICB group (p=0.9148). Duration of sensory block was 399.68±68.24 mins in SCB, while 379.19±88.38 mins in ICB group, and onset of motor block time was 344.68±64.00 mins in SCB group, while 326.77±79.89 mins in ICB group. Mean duration of post-op analgesia (mins) in SCB and ICB group was 396.29±67.49 and 375.32±87.01, respectively (p=0.2933). The need for supplementation for block failure remained at 1(3.23%) patient in each, either with analgesics or GA. The overall success rate of the block was 30 (96.77%) for each group. **Conclusion:** The present study concluded that both supraclavicular and infraclavicular approaches to brachial plexus block for upper limb surgeries are reliable and effective ways of providing anaesthesia. Both approaches showed similar success rates with almost similar complications, intra-operative vitals fluctuations, and the need for rescue analgesia.

Keywords: Supraclavicular, infraclavicular, brachial plexus, neurostimulation.

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INTRODUCTION

Local anaesthetics for peripheral nerve blockade offer favourable surgical conditions for patients undergoing upper limb procedures. Owing to advancements in facilities and the availability of several long-acting local anaesthetic agents with reduced adverse effects, peripheral nerve blocks have become increasingly popular. Surgical interventions on the hand and forearm can be performed using either general anaesthesia or regional techniques. However, general anaesthesia carries potential risks such as airway manipulation, hemodynamic fluctuations, postoperative cognitive impairment, and nausea or vomiting. Anaesthesia with regional techniques can overcome all the complications associated with general anaesthesia and has the advantage of reduced morbidity, mortality, superior post-operative analgesia, cost effectiveness, and a lower rate of serious complications. Among regional anaesthesia techniques, the peripheral nerve block is frequently practiced.[1-5]

The brachial plexus is a somatic nerve plexus formed by intercommunications among the ventral rami of the lower four cervical nerves (C5-C8) and the first thoracic nerve (T1). The plexus is responsible for motor innervation in all the upper limb muscles, except for the trapezius and levator scapulae.[6] The brachial plexus begins in the prevertebral portion; it leaves this space and enters the posterior cervical space just lateral to the anterior scalene muscles.[6] There are various approaches, like the Interscalene, supraclavicular, infraclavicular, and Axillary, for blocking the brachial plexus. The supraclavicular approach targets the brachial plexus at the level of its trunks and divisions. This block may be performed using paraesthesia, nerve stimulation, or ultrasound guidance, which is preferred in current practice. Although several surface landmarks have been proposed, the plumb bob technique remains the most widely employed. When using nerve stimulation, currents between 0.9 and 0.5 mA produce comparable onset times, block duration, and overall success rates. Under

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ultrasound guidance, the "eight ball, corner pocket" method—where local anaesthetic is deposited at the junction of the first rib and subclavian artery—is a reliable approach for achieving brachial plexus blockade. Compared to neurostimulation, ultrasound provides equivalent efficacy with a reduced risk of phrenic nerve involvement.

The infraclavicular approach provides anaesthesia of the brachial plexus at the lateral, posterior, and medial cords level, and may be performed using either nerve stimulation or ultrasound guidance. Studies comparing nerve stimulation and ultrasound guidance have reported inconsistent outcomes. Two trials comparing single-stimulation infraclavicular block with single or multiple-injection ultrasound-guided block found similar rates of surgical anaesthesia and onset times. Peripheral nerves may be localised using paraesthesia, nerve stimulation, or ultrasound guidance.

In the present study, electrical nerve stimulation was utilised to identify the nerves and ensure safe needle placement outside the intraneural space. The study used nerve stimulation to compare the effectiveness of the supraclavicular and infraclavicular approaches to brachial plexus blockade.

Materials and Methods

Study type: A hospital-based prospective study.

Study Site: Department of Anaesthesiology at GMERS Medical College and General Hospital, Himmatnagar.

Study duration: August 2022 to January 2024

Study Population: The study population was randomly selected according to the number of patients getting operated on for upper limb surgeries daily in the Department of Anaesthesiology/Orthopaedics/Surgery at GMERS Medical College and General Hospital, Himmatnagar, with upper limb surgeries (mid-arm, elbow, forearm, wrist, and hand).

Inclusion criteria

Patients undergoing upper limb surgeries/procedures (wrist, hand, forearm, elbow, mid-arm), irrespective of age and gender, in ASA grade I and II, both elective and emergency, who were willing to participate in the study were included.

Exclusion criteria

Patients with infection at the puncture site, history of coagulopathy, history of allergy to amide/ester group of local anaesthetic, pregnant women, severe pulmonary pathology, mental incapacity or language barrier, anatomical variation, BMI more than 35 kg/m2, pre-existing motor or sensory deficit in the operated limb and patients with previous contralateral pulmonary puncture were excluded out from the study.

Group Allocation: After getting Ethical Committee approval, patients undergoing upper limb surgeries were allocated into SCB (Supraclavicular) and ICB (Infraclavicular). Informed consent was obtained from the participants, and confidentiality was maintained throughout. Each group comprises 31 patients. Surgery was done under the Supraclavicular-subclavian perivascular approach of Brachial plexus block in group SCB and the Infraclavicular-VIB (Vertical Infraclavicular Brachial plexus block) approach in group ICB, and was evaluated clinically.

Block Procedure: Standard monitoring was applied; an IV line was secured. To perform the brachial plexus block using PNS, the patient was informed about the procedure first, and written informed consent was obtained. The patient was prepared by exposing the area required for block, and painting and draping were done with aseptic and antiseptic precautions. Emergency drugs—including atropine, epinephrine, phenylephrine, ephedrine, propofol, midazolam, succinylcholine, and Intralipid—were readily available, along with laminated guidelines for managing local anaesthetic toxicity. A 22-gauge, 50-mm insulated short-bevel needle connected to a nerve stimulator was used for both blocks. The initial current was set at 1.5 mA with a 0.1 ms pulse duration.

Adequate needle placement was confirmed by wrist or finger extension with thumb abduction, visible at a maximum current of 0.4–0.5 mA. 30 mL of local anaesthetic (15 mL 0.5% bupivacaine + 15 mL 2% lignocaine) was injected slowly over 60 seconds with intermittent aspiration every 4–5 mL.

Group SCB: With the patient supine and head turned contralaterally, the interscalene groove was traced to its lowest point posterior to the subclavian pulse near the clavicle midpoint, where supraclavicular artery pulsations were palpated. The needle insertion site was then marked 1.5 cm caudal and 1.5 cm lateral to this landmark. A 22G 50mm needle connected to a nerve stimulator was directed just above and posterior to the subclavian artery pulsations. After eliciting the end motor response, the drug was injected slowly. Minor cranial and caudal adjustments were done if the jerk was not elicited.

Figure 1: Supraclavicular brachial plexus block

Group ICB: With the patient in the supine position with the arm adducted and elbow flexed over the abdomen, the midpoint of the line joining the jugular fossa and ventral apophysis of the acromion was marked just below the clavicle. The needle was inserted vertically into the skin at the entry point, and an end motor response was elicited. Correction was needed for the entry point for smaller patients; shift the entry points 0.2 cms laterally from the midpoint for each 1 cm distance between the jugular fossa and acromion process measured less than 22 cms.

Figure 2: Infraclavicular brachial plexus block

Every patient was given a detailed history of pre-anaesthetic assessment, followed by a thorough clinical systematic examination. The two peripheral nerve stimulator-guided brachial plexus block approaches were compared regarding block quality, performance time, ease of administration, extent of motor and sensory blockade, hemodynamic stability, and duration of postoperative analgesia. The patient's data were collected and evaluated to conclude. Results were recorded in a pre-designed proforma.

Statistical analysis: Descriptive statistics for categorical data were expressed as numbers and percentages, while mean±SD was used to express continuous data based on normal distribution. After appropriate data filtration from Microsoft Excel, the datasheet was analysed using IBM SPSS software version 28. Quantitative variables were compared between the study groups using the unpaired Student's t-test or ANOVA, while categorical variables were analysed using the Chi-square or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Results

In the present study, the variation in the age of patients ranged from 11 to 72 years. The mean age of patients was 40.34±15.14 years. Among 62 patients of this study, 64.52% were male and 35.48% were female. Male: Female ratio in the SCB group was 21:10, while in the ICB group, it was 19:12. Mean weight in the SCB and ICB groups was 65.16±17.35 and 66.39±14.06 kgs, respectively, with a p value of 0.7602. Preoperative heart rate was 80±13.98 beats/min in the SCB group and 80±11.96 beats/min in the ICB group, with a p-value of 1.000. [Table 1]

Table 1: Block characteristics between both the groups (n=31 in each group)

Parameter	SCB (Mean ± SD)	ICB (Mean ± SD)	P value
Time to perform Block (min)	3.69 ± 0.76	3.79 ± 1.56	0.7494
Onset of Sensory Block (min)	6.10 ± 0.94	6.45 ± 1.69	0.3176
Onset of Motor Block (min)	10.77 ± 1.59	10.71 ± 2.76	0.9148
Duration of Sensory Block (min)	399.68 ± 68.24	379.19 ± 88.38	0.3110
Duration of Motor Block (min)	344.68 ± 64.00	326.77 ± 79.89	0.3339
Depth of Needle Insertion (cm)	4.05 ± 0.57	3.93 ± 0.34	0.3181
Duration of Post-operative Analgesia (min)	396.29 ± 67.49	375.32 ± 87.01	0.2933

Depth of needle insertion in the SCB group was 4.05±0.57 cms; in the ICB group, it was 3.93±0.34 cms (p=0.3181). Overall time to perform block in group SCB was 3.69±0.76 mins while it was 3.79±1.56 mins in group ICB (p=0.7494). Onset of sensory block was 6.10±0.94 mins in SCB while 6.45±1.69 mins in the ICB group (p=0.3176). Onset of motor block time was 10.77±1.59 mins in the SCB group, while 10.71±2.76 mins in the ICB group, which was statistically insignificant (p=0.9148). Duration of sensory block was 399.68±68.24 mins in SCB, while 379.19±88.38 mins in ICB group, and onset of motor block time was 344.68±64.00 mins in SCB group, while 326.77±79.89 mins in ICB group. The mean duration of post-op analgesia (mins) in the SCB and ICB group was 396.29±67.49 and 375.32±87.01, respectively, with a p-value of 0.2933, which was statistically insignificant. [Table 1]

Table 2: Comparison of intra-operative heart rate variability in both groups at time intervals

Time Interval (min)	SCB (Mean ± SD)	ICB (Mean ± SD)	P-value
5	73.81 ± 11.24	76.77 ± 10.96	0.2980
15	74.35 ± 10.41	76.06 ± 9.64	0.5048
30	75.42 ± 9.84	75.16 ± 9.06	0.9142
60	75.55 ± 11.00	75.35 ± 9.40	0.9389
120	78.06 ± 11.02	78.06 ± 11.03	1.0000
180	77.74 ± 12.66	78.58 ± 11.16	0.7826

Intraoperatively, heart rate was normal at various time intervals in both groups with no significant difference at any time (p>0.05). [Table 2]

Table 3: Analgesic supplementation, complication rate, and conversion to general anaesthesia (success rate) in both groups

Parameter	Category	SCB N (%)	ICB N (%)	P-value
Analgesic supplementation	Yes	2 (6.45%)	4 (12.90%)	>0.05
	No	29 (93.55%)	27 (87.10%)	
Complications	Nil	30 (96.77%)	30 (96.77%)	>0.05

	Block failure	0	1 (3.23%)	
	Patchy effect / Vessel puncture	1 (3.23%)	0	
Conversion to General Anaesthesia (Success Rate)	Yes	1 (3.23%)	1 (3.23%)	>0.05
	No	30 (96.77%)	30 (96.77%)	

2 patients (6.45%) from the SCB group, while four (12.90%) from the ICB group required rescue analgesia. One patient (3.23%) had a vessel puncture at the time of giving SCB, while one patient (3.23%) from the ICB group had a complete block failure. The need for supplementation for block failure remained at 1(3.23%) patient in each, either with analgesics or GA. The overall success rate of the block was 30 (96.77%) for each group. [Table 3]

Discussion

Brachial plexus block has become a preferred alternative to general anaesthesia for upper limb surgeries and is often referred to as the "spinal anaesthesia of the upper limb." This study used the Winnie and Collins subclavian perivascular approach to perform the supraclavicular block. In contrast, the infraclavicular block was performed via the Vertical Infraclavicular Block (VIB) technique after identifying Kilka's point under peripheral nerve stimulator guidance.

In the present study, the variation in the age of patients ranged from 11 to 72 years. The mean age was 40.34 years. In Narayanan et al.'s study, patients aged between 20 and 60 years undergoing elective surgical procedures of the upper limb, with a mean age of 39.10±16.88 years in the SCB group and 31.60±14.17 years in the ICB group.[11] Another study conducted by Abhinaya et al had an age of 33.53±14.21 years in group ICB, while in group SCB, it was 32.40±11.25 years, with a p-value of 0.733.[12] Similar age incidence was found in a study by Arcand et al.[13]

In the present study, a slightly more male-dominant population was found because of a higher chance of trauma/accidents to the male population compared to females. In a study by De Jose et al, the male: female ratio also showed male predominance.[14] Another survey by Arcand et al. also emphasised male dominance by the M: F ratio in group S, which is 29/11, while in group I, it is 27/13.[13] In Abhinaya et al.'s study, the same result was also shown as in our study, with 22 males compared to 8 female patients in both groups I and S.[12] This gender difference in the study could be because of gender bias in India, which suggests that male patients are more often encouraged to visit the hospital than female patients.

In the present study, weight distribution is important in calculating the local anaesthetic drug dose for the appropriate weight. Mean weight in group SCB and ICB was 65.16±17.35 and 66.39±14.06 kg, respectively. Abhinaya et al.'s study showed similar results compared with our study, having a weight distribution in Group I of 67.27±8.77 while 65.87±10.47 kgs in Group S, with a p-value of 0.577.[12] Another study by Narayan et al also showed almost similar results, matching our study, that in group SC, the weight distribution was 64.50±8.29, while in group IC, it was 61.30±8.11, with a p-value of 0.334.[11] Arcand et al. studied, and Yang et al. showed similar results.[13,15]

Vital parameters, including heart rate, blood pressure, and oxygen saturation, were monitored and compared between the two groups during surgery, with no statistically significant differences observed. There was also no significant difference between the needle insertion depths in both groups. Although the present study calculated this parameter, no relevant literature showed this comparison.

In the present study, group SCB block performance time was 3.66±0.77 min while in group ICB it was 3.82±.55 min. A survey by Abhinaya et al. reported that the block performance time was shorter in the infraclavicular group (9.57 ± 3.19 min) compared to the supraclavicular group (11.53 ± 2.90 min), with both groups showing similar success rates (93.3%). The onset of sensory blockade was faster in the infraclavicular group (6.43 ± 2.61 min) than in the supraclavicular group (8.45 ± 2.87 min, p = 0.006). The onset of motor blockade did not differ significantly between the infraclavicular (7.32 ± 2.90 min) and supraclavicular groups (8.68 ± 3.50 min, p = 0.121). Patient satisfaction was comparable in both groups. Another study by Narayan et al,[11] had motor blockade in group SC, 9.95±3.17 min, while in group IC, it was 14.75±2.85 min, with a p-value of <0.001. The latter group, which underwent Infraclavicular plexus block, showed slightly more block performance time than the group undergoing supraclavicular plexus block, suggesting a technically challenging procedure. A study done by De Jose et al,[14] showed that the mean time to perform the block in group I was 13 min (range 5–16), and in group S was 9 min (range 7–12), with a p-value less than 0.05.

The present study showed the onset of sensory blockage in SCB and ICB was 6.03±0.80 min and 6.52±1.75 min, respectively, with a p value of 0.1614, while the onset of motor blockage in SCB and ICB was 10.84±1.55 min and 10.65±2.69 min, respectively, with a p value of 0.7345. Similar results were also observed in a study by Abhinaya et al, showing the onset of sensory blockage in SCB and ICB was 8.45±2.87 min and 6.43±2.61 min, respectively, with a p value of 0.006, and the onset of motor blockage in SCB and ICB was 8.68±3.5 min and 7.32±2.9 min, with a p value of 0.121.[12] Another study by Narayan et al observed the onset of analgesia in the SC and IC groups, 9.68±1.85 and 12.30±2.82, respectively.[11]

The duration of motor and sensory blockage in the present study was also considered. It was found that the duration of sensory blockage in group SCB and ICB was 406.45±53.51 min and 372.42±96.04 min, respectively, with a p value of 0.0900, while the duration of motor blockage in group SCB and ICB was 351.13±51.55 min and 320.32±86.58 min, respectively, with a p value of 0.0939. Another study by Arcand et al. and Yang et al. also showed results similar to those of the present study.[13,15] A De Jose et al. study showed similar results in line with the present study.[14]

One vessel puncture was seen in the SCB group, while one patient was having complete block failure in the ICB group. One patient in the ICB group suffered complete block failure, which required conversion to GA, and one patient in the SCB group had a patch effect due to vessel puncture and inadvertent spread of LA, which resulted in block failure that required conversion to GA with analgesic supplementation. A study by Arcand et al observed that surgical anaesthesia without supplementation was achieved in 80% of patients in group I compared with 87% in Group S (P=0.39).[13] Supplementation rates were significantly different only for the radial territory. The study by Yang et al. reported that both supraclavicular and infraclavicular approaches provided comparable outcomes regarding complete sensory block rates and block quality, with 82% of patients in each group achieving complete analgesia across all territories at 50 minutes. Kilka et al. observed adequate surgical analgesia in 95% of patients at 30 minutes using the vertical infraclavicular approach with 40 mL of 1.5% prilocaine and 10 mL of 0.5% bupivacaine. Neuburger et al. reported sufficient surgical anaesthesia in 87% and 88% of patients, although the timing of assessment was not specified. Franco et al. documented a 97.2% success rate in the supraclavicular block in 1,001 patients using the subclavian perivascular technique.

The overall success rate of the block was 96.77% for each group in the present study. Possible reasons for the lower success rate observed in both groups include the inadequate spread of the local anaesthetic drug to the desired site, the operator's inexperience, the difference in the batch of local anaesthetics used, and the difference in the potency of local anaesthetics based on storage conditions or the definition of success.

Conclusion

The present study concluded that both supraclavicular and infraclavicular approaches to brachial plexus block for upper limb surgeries are a reliable and effective way of providing anaesthesia. The supraclavicular approach demonstrated a slight advantage, showing shorter block performance time, earlier onset of motor and sensory blockade, and a longer duration of postoperative analgesia. While the infraclavicular approach had less depth of needle insertion, suggesting less discomfort at the time of procedure, a lower incidence of complications, such as pneumothorax, and a prolonged motor and sensory blockade duration. Both approaches showed similar success rates with almost identical complications, intra-operative vitals fluctuations, and the need for rescue analgesia.

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Conflicts of interest

There are no conflicts of interest.

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