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Original Research

A Randomised Comparative Evaluation of Supraclavicular and Infraclavicular Approaches to Brachial Plexus Block for Upper Limb Surgeries using Ultrasonography

[1]Dr. Mahendra Ekka, [2]Dr. Ratikanta Sahoo, [3]Dr. Sheela Ekka, [4]Dr. Sucharita Panda, [5]Dr. Dulal Kishun Soren, [6]Dr. Pankaj Verma.

[1]Associate Professor, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.
[2]Senior Resident, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.
[3]Associate Professor, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.
[4]PG Resident, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.
[5]Professor, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.
[6]Associate Professor, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.

Corresponding Author
Dr. Mahendra Ekka
Associate Professor, Department of Anaesthesiology and Critical Care, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.

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ABSTRACT

Introduction: Anaesthesia is distributed similarly in the supraclavicular and infraclavicular brachial plexus blocks, and both are useful for procedures involving the upper limb.

Aim: The aim of this study was to compare the ultrasound-guided supraclavicular and infraclavicular approaches of brachial plexus blocks.

Materials and methods: Two groups were randomly assigned to 166 adult patients who were scheduled for elective upper limb surgery of the elbow and/or below: the supraclavicular Group (S) and the infraclavicular Group (I). Ultrasound guidance was utilized during the execution of each and every block. The block performance time, number of needle advancements, surgical preparedness, success rate, and complications were compared between the two groups. The Student t test and Chi square test were used for the statistical analysis.

Results: The infraclavicular group's block performance time was (11.50 ± 1.76) minutes, while the supraclavicular group's was (4.96 ± 0.32). The infraclavicular group had 3.01± 0.74 needle advances, compared to 1.88± 0.39 for the supraclavicular group. The supraclavicular group showed two incidences of ulnar nerve sparing, whereas the infraclavicular group showed equivalent effectiveness in both procedures. In Group S, there were two incidences of phrenic nerve palsy and one patient had developed Horner syndrome.

Conclusion: The effectiveness of supraclavicular and infraclavicular block is comparable. While the infraclavicular block was more difficult to perform and required more needle advancements which can be reduced with regular practice and experience but it avoided complications associated with the supraclavicular approach. The supraclavicular block was easier to perform but was associated with complications like Horner syndrome (2 cases), Phrenic nerve block (1 case), and Ulnar nerve escape (2 cases).

Keywords: Ultrasonography, Supraclavicular Block, Infraclavicular Block and Brachial Plexus Block.

INTRODUCTION

Regional nerve blocks are superior to other anaesthetic techniques because they avoid stress of general anaesthesia procedures especially tracheal intubation and laryngoscopy, along with the adverse impacts of general anaesthetic medications.[1] It reduces

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requirement for anaesthetics, reduces intraoperative and postoperative pain by minimizing the stress reaction. Patients of various cardiorespiratory co-morbidities benefit from these.

For upper limb procedures, brachial plexus block offers an excellent substitute for general anaesthesia. By providing comprehensive and sustaining pain relief, muscle relaxation, intraoperative stable hemodynamic and effective sympathetic block, it creates an ideal operating condition. Vasospasm, oedema and perioperative stress are all reduced by the sympathetic block.

Due to its blind nature, the traditional landmark-oriented approach may damage vascular and nerve structures.[2] Many techniques and approaches were suggested to lessen these issues. Out of all of these, ultrasound imaging of anatomical structures is the only technique that provides a safe block of the best quality through precise needle placement and real-time drug disposition visualization.

Ultrasound has a higher success rate, better safety margin, and good localization. Using ultrasound guidance, supraclavicular and infraclavicular brachial plexus blocks have proven to be quite successful for upper extremity surgery. Due to its rapid onset and high success rate, the supraclavicular brachial plexus block is the most often used block for procedures performed below the shoulder. The main disadvantages, yet, include an increased risk of Horner syndrome, pneumothorax, phrenic nerve palsy, and accidental vascular injections. The advent of ultrasonography renewed the interest in the infraclavicular block.

The primary benefit of infraclavicular block is its excellent suitability for catheter techniques and lower incidence of ultrasound-related problems. The drawback is that in obese patients synchronized visualization of the pertinent tissue and needle may be difficult due to the plexus's deeper location and more acute approach angle.

Anaesthesiologists frequently prefer supraclavicular blocks over infraclavicular blocks, despite the fact that both can be used for upper limb procedures. This is because the latter is more technically challenging and can result in more difficulties due to its blind approach. Since its introduction into the field of anaesthesia, ultrasonography has shown to be a useful supplement to peripheral nerve blocks. Ultrasound guided regional anaesthesia is very appealing due to its built-in advantages, which include direct visualization of the nerves and surrounding anatomy, continuous inspection of the needle tip, and the diffusion of local anaesthetic.[3] This study aims to compare the block performance time, overall effectiveness, commonly escaping nerves, and incidence of adverse effects between the supraclavicular and infraclavicular brachial plexus block using ultrasound guidance.

MATERIALS AND METHODS

Following approval from the VIMSAR Medical College, Burla institutional ethical committee (registration number: ECR/861/Inst/OR/2016, CTRI no-038711), 166 ASA I and ASA II patients (ages 18 to 60) undergoing elective upper limb procedures participated in the study. Two groups, consisting of eighty-three individuals each, were divided and labelled infraclavicular block (IC) and supraclavicular block (SC). All patients received details about the procedure prior to their inclusion in the trial. Both the patient and their attendants had signed written informed consent. Using a prepared proforma, result values were recorded.

Inclusion Criteria

1. ASA grade 1/2
2. Elective upper limb surgeries
3. Patients aged 18 to 60 years of either sex

Exclusion Criteria

1. Patient refusal
2. A person with peripheral neuropathy or coagulopathy
3. An allergy to local anaesthetics
4. psychiatric patients
5. Patients with neuromuscular disorder

Using computerized random numbers, each patient was randomly assigned to one of the two groups consisting of 83 patients each.

Group SC: Ultrasound guided supraclavicular brachial plexus given.

Group IC: Ultrasound-guided infraclavicular brachial plexus block given. In all groups, block was carried out using 30 ml of local anaesthetic (20 ml of 0.5% bupivacaine and 10 ml of distilled water).

Ultrasound, Group SC[2,3,4]

Following real-time imaging of the pleura, first rib, arteries, and nerves in group SC, a "in-plane approach" block was carried out. An ultrasonogram device with a 4–12 MHz transducer and a 20G, 10-cm ultrasound-compatible needle was used for this procedure. After sterile preparation of the skin and ultrasound probe, the procedure site was draped. By positioning the transducer in the supraclavicular fossa, behind the middle third of the clavicle, in the sagittal plane, the brachial plexus was seen.

The brachial plexus can be seen in the supraclavicular region in two different ways: either as a grape like cluster of five to six hypoechoic circles, lateral and superior to the subclavian artery between the anterior and middle scalene muscles at the lower cervical region, or as three hypoechoic circles with hyperechoic outer rings. Real-time observation of the needle movement was conducted after inserting a 20 G 10 cm USG compatible needle from the transducer's lateral to medial direction.

A predetermined volume of 30 ml of local anaesthetic solution (20 ml of 0.5% Bupivacaine and 10 ml of distilled water) was administered around the brachial plexus sheath after negative blood aspiration to prevent

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an unintentional intravascular needle puncture. The local anaesthetic drug was seen to be spreading in tissue planes. When injecting a local anaesthetic solution, the needle was initially inserted deeply into the more caudal portions of the plexus, causing the brachial plexus to ascend closer to the skin's surface.

The proper distribution of the local anaesthetic solution around the targeted nerves was constantly checked under sonographic vision, and the injection site was frequently adjusted with minor movements.

Ultrasound Guidance, Group IC [2,3,4]

In group IC, after a real-time visualization block was performed. An ultrasonogram machine with a 4-12 MHz transducer was used for this technique, employing the "in-plane approach" with a 20 G 10cm sonoplex needle. The arm is abducted to 90-degree angle, the forearm is supinated and the elbow is flexed 90 degrees. By reducing the space between the skin and the plexus, this technique facilitates visualization of the pectoralis muscles and the brachal plexus cords.

Scanning generally starts just inferior to the clavicle and medial to the coracoid process after the region has been cleaned and draped. The procedure aims to inject the local anaesthetic until ultrasound evidence of its dissemination surrounding the artery is obtained. It's not necessary to locate and focus on specific cords. Alternatively, it is sufficient to block all three cords by injecting the local anaesthetic in a U-shaped arrangement around the artery (cephalad, posterior, and caudal).

The brachial plexus's hyperechoic cords are recognized when the transducer is positioned in the parasagittal plane to identify the axillary artery, which can be made between 3-5 cm.

A 10 ml disposable syringe with the local anaesthetic solution (20 ml of 0.5% bupivacaine and 10 ml of distilled water) was attached to a 20 G 10cm USG compliant needle. The location of insertion was slightly inferior to the clavicle and needle was placed "in-plane" from the cephalad aspect. 1-2 ml of local anaesthetic were injected, after verifying proper needle placement, by aiming the needle towards the posterior aspect of the axillary artery crossing the pectoralis group of muscles and carefully aspirating. 30 ml of local anaesthetic were then spread to block all three cords.

Assessment of Parameters

All the patients were monitored for

- Procedure time
- Number of needle advancements
- Block effectiveness overall
- Success rate
- Frequently escaped nerves
- Complication rate

Duration of the Procedure

The procedure takes the same amount of time for both groups, measured from the moment of needle insertion until it was removed.

Assessment of Sensory Blockade

To assess sensory blockage, Hollmen's sensory scale was applied:

The four major nerves (ulnar, radial, median, and musculocutaneous) supply the skin dermatomes where sensory block was assessed by pin pricking with a 23 G hypodermic needle once per minute for the first five minutes, then every two minutes for the next ten minutes, and finally every five minutes until the onset of desired sensory block.

1. The typical pin prick feeling
2. The pinprick felt weaker than the area in the opposing limb, but it was still sharp and pointed.
3. Pinprick identified as touch with a blunt object
4. No perception of pinprick

Motor Blockade Assessment

The motor blockade was evaluated using modified Bromage scale.

- GRADE 0-Able to raise the extended arm to 90 degrees for a full two sec-NIL (0%)
- GRADE I-Able to flex the elbow and move the fingers but unable to raise the extended arm-Partial Block (33%)
- GRADE II-Unable to flex the elbow but able to move the fingers-Almost complete block (66%)
- GRADE III: Complete block (100%)-unable to move the arm, elbow or fingers

Efficacy of the Block

1. Effective: no sedation was required during the entire surgical procedure. For statistical ease, Hollmen's sensory scale of 3 or 4 in areas supplied by all four major nerves of the upper limb after 30 minutes of the procedure was considered an effective block.
2. Failed block: When a surgical procedure cannot be performed under the block and need to be converted to general anaesthesia. A block was considered unsuccessful if Hollmen's sensory scale was less than or equal to 2 in more than two significant distribution locations, even after 30 minutes of the procedure.

Success Rate

In this study, every completely effective block was labelled a successful block.

Complications: Patients were observed intra operatively and 24 hours postoperatively for complications.

Intraoperative Complications

1. Vessel puncture and hematoma formation
2. Any toxic or allergic reaction to the drug

Postoperative Complications

1. Injury to the nerves
2. Pneumothorax
3. Phrenic nerve block
4. Horner's syndrome
5. Recurrent laryngeal nerve block

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Throughout the surgical process, oxygen and intravenous fluids were given to each patient.

RESULTS

166 ASA I and II patients of either sex, ages 18 to 60, underwent upper limb procedures under ultrasound guidance for supraclavicular and infraclavicular brachial plexus blocks. This was a prospective single-blind randomized controlled trial.

Patients who had upper limb elective procedures were included in the study. In terms of demographics, the two groups were comparable. [Table 1]

Demographic Data	S	I	P Value
Gender(M/F)	53/30	49/34	
Weight (kg)	56.06 ± 4.17	55.90 ± 3.81	0.55

Table 1: Demographic profile

	S	I	P Value
Time taken for Procedure	4.96 ± 0.32	11.50 ± 1.76	0.01
No. of Needle Advancement	1.88 ± 0.39	3.01 ± 0.74	0.01
Effectiveness of Block (Effective/Failed)	80/3	79/4	0.50(T-Test)
Success Rate	96%	95%	0.69(Chi -Square
Conversion to GA (Failed/Total Blocks)	3/83	4/83	0.50
Duration after which 1st Dose of Post OP Analgesia Requirement	7.43 ± 0.73	7.44 ± 0.87	0.502

Table 2: Ease of technique, Effectiveness, Success rate and GA conversation rate

Group S (4.96 ± 0.32 min) had a block performance time that was comparatively faster than Group I (11.50 ± 1.76 min) (P = 0.01). [Table 2]. In group S, the success rate was 96%, while in group I, it was 95% (P = 0.69). Group I had higher needle advancements (3.01±0.74), while group S had less needle advancements (1.88 ±0.39) with a P value of 0.01. Group S experienced three block failure incidents, whereas group I experienced four cases that converted to GA. In both groups, the duration of the first postoperative analgesic dose was the same.

Nerves	Supraclavicular Block	Infraclavicular Block
Axillary nerve	No	No
Ulnar nerve	2	No
Radial nerve	No	No
Median nerve	No	No
Medial cutaneous nerve of arm	No	No
Medial cutaneous nerve of forearm	No	No

Table 3: Commonly escaped nerves

Complications	Supraclavicular	Infraclavicular
Vessel puncture	No	No
Phrenic nerve block	2	No
Horner syndrome	1	No
Recurrent laryngeal nerve injury	No	No
Pneumothorax	No	No
Nerve injury	No	No

Table 4: Complications

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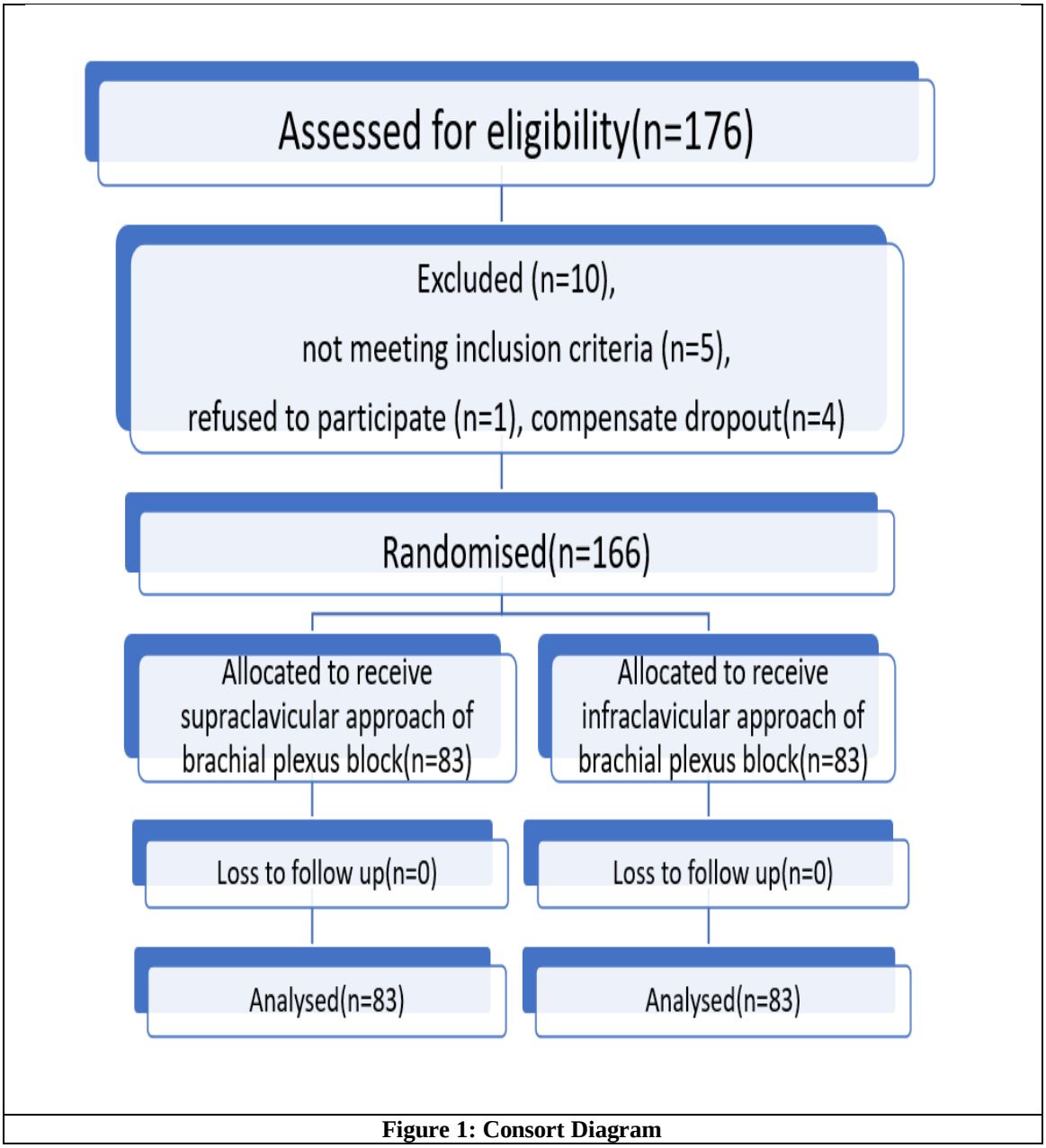

Figure 1: Consort Diagram

No patient in Group S and Group I developed pneumothorax. One patient in Group S developed Horner's syndrome against none in Group I, managed conservatively [TABLE 4].with reassurance, and recovered well within 24 hours. Two of these patients of group S also developed an injury to the phrenic nerve and clinically significant diaphragmatic paralysis which was confirmed with a chest X-ray. The patient was having breathing difficulty and a room air saturation of 92%. The patient was managed conservatively using oxygen by the face mask and observed continuously. The patient recovered well in 24 hours. There were no cases of vascular puncture in both groups.

DISCUSSION

Both general anaesthesia and regional anaesthesia can be used for surgical operations involving the hand and forearm. Patients under general anaesthesia suffer the risk of hemodynamic instability, post-operative nausea and vomiting, postoperative airway manipulation, and post-operative cognitive dysfunction. The drawbacks of general anaesthesia can be avoided with regional anaesthesia procedures. In addition, compared to general anaesthesia, regional anaesthetic procedures have the benefit of reduced morbidity and mortality, greater postoperative analgesia, cost-effectiveness, and a decreased incidence of significant complications.

Peripheral nerve block combined with regional anaesthesia allows the patients to be discharged on the same day, thus facilitating daycare surgery. In the upper limb, the entire sensory and motor blockade can be achieved by blocking the brachial plexus and has stood the test of time for upper limb surgeries. Interscalene blocks, supra clavicular blocks and axillary blocks are routinely performed blocks for upper limb surgeries.

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Interscalene Block[4,5]

Interscalene nerve block is one of the most clinically applicable nerve block techniques. With proper training, equipment, and monitoring precautions, the technique results in a predictable success rate, excellent anaesthesia, and superb postoperative analgesia**.**

Complications

- Diaphragmatic paralysis -commonly present
- Horner syndrome
- Nerve injury
- Local anaesthetic toxicity
- Vascular puncture

Supraclavicular[4,5]

Advantages

- It consistently produces forearm and upper arm anaesthesia. The inferior trunk/ulnar nerve component is typically escaped.
- It can be performed without moving the arm.

Disadvantages

- It is associated with a small incidence of pneumothorax (0.5%), Although Ultrasound guidance may reduce this, it can also create a false sense of security.
- In order to prevent pneumothorax cases using the US-guided approach, proper needle visualization is essential
- It is also associated with some cases of phrenic nerve palsy and may not be the best choice for those with significant pulmonary disease.

Axillary Block[4,5]

Advantages

- Safe, dependable with several injections, ultrasound-assisted quick onset.
- Easy to learn.

Disadvantages

- Few like accidental intravascular injection, hematoma, and nerve injury.
- Technically difficult with limited shoulder abduction.

Infra Clavicular Block[4,5]

- It has been used recently after the use of ultrasound in regional anaesthesia.
- The infraclavicular brachial plexus blocks are an alternative to axillary blocks for anaesthetizing the elbow, forearm, and hand when positioning is compromised by limited abduction at the shoulder, for example, rheumatoid arthritis or an immobilized/traumatized arm.
- It is also an alternative to a supraclavicular block for anaesthetizing the upper arm.
- For people with respiratory compromise, it might be a better option because of the low risk of pneumothorax or phrenic nerve paresis with ultrasound.
- Complications are rare and less frequent than in the supraclavicular approach.
- Can be regarded as a feasible routine substitute in skilled hands.

Among the various approaches of brachial plexus block, the supraclavicular block is considered the easiest, and it also provides the most reliable, uniform, predictable anaesthesia for upper extremity and blocks at the level of trunks and divisions. The success rate of both types of brachial plexus blocks has been improved by ultrasound with perfect localization as well as an appreciable safety margin. Ultrasonography is better than any other radiological tool for needle guidance in peripheral nerve blocks. It also provides real-time examination of the nerve, and also it provides visualization of the needle manipulation and local anaesthetic spread.

Dose of the Drug

We have used 30ml of local anaesthetics solutions (20 ml of 0.5% bupivacaine and 10 ml of distilled water) for both groups.[6,7,8]

Block Performance Time:

In our study, block performance time for ultrasound-guided supra clavicular block was lesser when compared with the time taken for ultrasound-guided infraclavicular block.[8]

Commonly Escaped Nerves

In our study, we encountered sparing of the ulnar nerve in 2 patients in the ultrasound-guided supra clavicular block.[9]

Overall Effectiveness of Block[10,11,12]

Out of the 83 cases studied under the ultrasound-guided supraclavicular group, 80 were totally effective and 3 failed blocks. Thus, 96% attained complete block and 4% failed block.

Out of the 83 cases studied under an ultrasound-guided infraclavicular group, 79 blocks were totally effective and 4 failed blocks. Thus 95% attained complete block and 5% failed block. This was statistically analysed and Fischer's exact p-value was 0.50 (not significant).

Both the Supraclavicular and infraclavicular groups are equally effective.

Conversion to General Anaesthesia

In our study, in ultrasound-guided supra clavicular groupOut of 83,3 patients having Hollmen's sensory scale less than or equal to 2 in more than 2 major distribution areas even after 30 minutes of the procedure were considered as failed blocks and required conversion to general anaesthesia.

4 patients in the ultrasound-guided infraclavicular group having Hollmen's sensory scale less than or equal to 2 in more than 2 major distribution areas even after 30 minutes of the procedure were considered as failed block, and required conversion to general anaesthesia. This was statistically analysed, p Value 0.50 [not

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significant].In our study, conversion rates to general anaesthesia were equal in both groups.

Complications[13,14]

In our study out of 83 patients in the supraclavicular group, 2 cases of phrenic nerve block and 1 case of Horner syndrome were found. No complications were found in the infraclavicular group.

Duration after which the First Dose of Post-OP Analgesia Required

In our study of 83 patients of the supraclavicular group, the mean time for the first dose of post-op analgesia requirement was 7.43 Hours.

In 83 patients of the infraclavicular group, the mean time for the first dose of post-op analgesia requirement was 7.44 Hours. These data were statistically analysed p-value 0.50[statistically not significant]

CONCLUSION

The effectiveness of both supraclavicular and infraclavicular blocks is the same. Although supraclavicular procedure is simpler to execute, it is associated to risks like Horner syndrome (two cases), Phrenic nerve block (one case), and Ulnar nerve escape (two cases). Although infraclavicular surgery is more complex to execute and requires a greater number of needle advancements but can be reduced with experience and regular practice-it avoids the complications associated with supraclavicular surgery. Through consistent practice, the Infraclavicular method can be a safe alternative for the supraclavicular approach, hence circumventing the drawbacks of the other brachial plexus block technique used in forearm surgeries.

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Conflicts of Interest

There are no conflicts of interest.

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