Comparative evaluation of two approaches of infraclavicular brachial plexus block for upper-limb surgeries

ABSTRACT

Background: Infraclavicular approach is a common technique of brachial plexus block. The main difficulty of ultrasound guided technique is in needle visualization due to deep location of the cords. Hebbard et al described a retroclavicular approach wherein the needle was inserted posteriorly to the clavicle.

Materials and Methods: In this prospective randomized controlled study, we have compared the classical technique with the retroclavicular approach in terms of needle visibility, block success rate, number of needle passes, block performance time, procedure-related pain, complications, patient and operator comfort and satisfaction.

Results: The rate of block success was similar in both the groups. The needle tip and shaft visibility was more in the retroclavicular group (P < 0.05). The number of needle passes was also less in the retroclavicular group. Time for the block procedure was less in retroclavicular group when compared to the classical coracoid group. The patients reported less pain in retroclavicular group (P < 0.05).

Discussion: Retroclavicular approach is a feasible option of infraclavicular brachial plexus block in Indian Subpopulation in terms of needle visibility and block success rate.

Key words: Coracoid approach; needle visibility; retroclavicular

Introduction

Infraclavicular brachial plexus block (IBPB) was introduced in the early 20th century as an alternative to axillary and supraclavicular approaches. The major advantage of this technique is the ease of catheter fixation. Several approaches to IBPB have been described, using various surface landmarks, needle insertions, and recommended needle directions. The most common approach by the landmark technique is the coracoid approach, where the needle is inserted 2 cm medial and 2 cm inferior to the coracoid process. Ultrasound (US) can be used to visualize the cords around the axillary artery and deposit the local anesthetic around the artery. Due to the deep location of the plexus (4.5–7.5 cm) in this region, visualization of the whole length of needle is difficult. Hence, to overcome this problem, Hebbard et al. described US-guided posterior approach to IBPB, wherein the needle was inserted posterior to the clavicle. In this retroclavicular technique, the needle shaft is aligned perpendicular to US beam, making its visibility better. Soon after this, a feasibility study was done by Charbonneau et al. Later, a trial done by Kavrut et al. established its role over classical coracoid approach.

In this prospective randomized controlled study, we have tried to administer this block in Indian population and compare it with classical coracoid technique in terms of...
needle visibility, block success rate, number of needle passes, block performance time, procedure-related pain, complications, and patient and operator comfort and satisfaction. This is the first study done on this technique on Indian subpopulation.

**Statistical analysis**
The study power was based on a study done on the needle tip visibility by Jandzinski et al. With a power of 0.80, an alpha error of 0.05, and a standard deviation of 0.9 on a 5-point visibility scale with a difference of one point being clinically significant; a sample size of 39 was calculated. We increased the sample size to 60 to compensate for dropouts. Statistical analysis was performed using IBM SPSS Statistics version 20 (IBM, Armonk, New York, USA). Continuous variables were analyzed using two-sample t-test, while the Chi-square with Yates’ correction using 2 × 2 contingency table was used to compare the categorical variables. Wilcoxon test was used for nonparametric analysis. \( P < 0.05 \) was considered statistically significant.

Materials and Methods

After clearance from the Institutional Ethics Committee, 134 American Society of Anesthesiologists (ASA) I/II patients scheduled to undergo arm/forearm surgery were screened for this study over 1.5 years. Patients with anatomical abnormality at the clavicular region, local infections, neurological disease, coagulopathy, known allergy to local anesthetics, and with body mass index (BMI) >24 kg/m² were not included in this study. All the patients were explained about the procedure and written informed consent was taken. On shifting to the preoperative holding area, a 20-G intravenous cannula was inserted in the contralateral arm and maintenance fluid started. Standard ASA monitors were attached once the patient was shifted to the operating room. The patients were randomly allocated in either of the groups by computer-generated random numbers and the intervention was done accordingly.

**Retroclavicular technique (Group I and Figure 1)**
The patient was placed in a supine position with head turned on the contralateral side. A high-frequency linear probe (6–13 Hz, SonoSite Turbo M) was placed medial to coracoid process below the clavicle to view the axillary vessels and the cords in the short axis. The lungs and the pleura were visualized and the needle trajectory was kept away from it. Index finger was used to palpate the supraclavicular fossa to ascertain the needle insertion point which is around 2 cm cephalad to the clavicle, medial to the trapezius insertion in the clavicle. Keeping this finger position in mind, the US probe was oriented in such a manner to keep the axillary vessels and cord in view. Under strict aseptic precautions, 20-G 10-cm echogenic needle was inserted parallel and in plane to the probe. An initial blind zone (acoustic shadow of clavicle) was passed. After that, the horizontal trajectory of the needle was traced and the local anesthetic injected in a U-shaped manner around the axillary artery [Figure 2]. Twenty milliliters of 0.5% levobupivacaine was injected in small aliquots with negative aspiration.

**Group II (classical coracoid approach)**
The position of the patient was the same as the previous approach. On the affected side, the high-frequency linear probe was placed parasagittally below the clavicle, medial to the coracoid process. The axillary vessels and the cords were visualized and the echogenic needle was inserted between the probe and the clavicle. The target was caudal to the posterior wall of the axillary artery, where the local anesthetic was deposited in a U-shaped manner in small aliquots. The total volume was 20 ml of 0.5% levobupivacaine. In both the groups, local anesthetic infiltration was done before inserting the block needle. Soon after the procedure, the patients were asked to rate their pain during the procedure using a 10-cm visual analog score (VAS) (0 = no pain and 10 = worst pain imaginable).

Assessment of the block was performed by an anesthesiologist not involved in the procedure. The cutaneous territories corresponding to the various nerves were assessed for sensory loss.

1. Radial (lateral aspect of the dorsum of the hand)
2. Median (volar aspect of the thumb)
3. Ulnar (volar aspect of the fifth finger)
4. Musculocutaneous (lateral aspect of the forearm)
5. And medial cutaneous nerve of the forearm (medial aspect of the forearm).

Sensory score was given as follows: 0 = no loss of sensation, 1 = blunting of sensation, and 2 = complete loss of sensation.

Motor function was assessed (0 = normal strength, 1 = weakness, and 2 = paralysis for the various nerves.

1. Radial: Thumb abduction
2. Median: Thumb opposition
3. Ulnar: Thumb adduction, and
4. Musculocutaneous: Elbow flexion.

Sensory block success was a sensory score of 10 and motor block success was a sensory score of 8 at 30 min. If the patients failed to achieve either of the criteria in the above-mentioned time, it was considered as block failure. Needling time was defined as the time from the beginning of needling until the end of levobupivacaine injection. All
the blocks were videotaped and reviewed by independent anesthesiologists at the end of procedure. A 5-point Likert scale was used to rate the needle visibility: 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = very good. Any complications during the procedure such as vascular puncture, paresthesia, Horner syndrome, and dyspnea were noted. A chest X-ray was done in all patients at 48 h to rule out pneumothorax. All the patients were asked to rate their satisfaction with anesthesia procedure at the end of 24 h.

**Results**

Out of the 134 patients screened, 14 patients did fit the inclusion criteria [Figure 1]. Both the groups were similar in terms of age, sex, ASA, height, and weight [Table 1]. The rate of block success was similar in both the groups. The needle tip and shaft visibility was more in the retroclavicular group \( (P < 0.05) \). The number of needle passes was also less in the retroclavicular group [Table 2]. Time for the block procedure was less in retroclavicular group when compared to the classical coracoid group. The patients reported less VAS during needling in the retroclavicular group. There was no difference in operator comfort levels in both the groups. There were four patients with needle-induced paresthesia and two with vascular puncture in the coracoid group. After 1 week, none of these four patients complained of any remnant paresthesia. Patient satisfaction was higher in the retroclavicular group.

**Discussion**

The present study showed that retroclavicular approach is a feasible option of infraclavicular block in Indian population. In fact, the needle shaft and tip visibility was significantly better with this approach when compared to the classical coracoid approach. The success rate in both the groups was same. The number of needle passes and the time taken for the block procedure were significantly less in the retroclavicular group. Patient satisfaction was also statistically higher in this group.

The advent of US-guided blocks allows the real time visualization of the needle, hence decreasing the complication rates. There are various factors which effect the visualization of the needle, for example, the angle between the US beam and the needle trajectory. In the retroclavicular approach, the angle between the beam and the needle is nearly perpendicular improving its visibility.\(^1\) With the presence of vascular structures such as cephalic vein, artery, and acromial branch of the thoracoacromial artery in this area; this technique proves to be safer.\(^7\)

**Table 1: Demographic parameters**

| Parameters                      | Group R \( (n=60) \) (retroclavicular) | Group C \( (n=60) \) (classical) | \( P \) |
|---------------------------------|----------------------------------------|----------------------------------|--------|
| Age (years)                     | 36.53±8.86 \( (31/29) \)              | 34.55±8.25 \( (32/28) \)        | 0.2067 |
| Sex (male/ female)*             | 39/21 (60/40)                          | 33/27 (50/50)                    | 0.2636 |
| ASA (I/II)                      | 36/24 (60/40)                          | 37/23 (61/39)                    | 0.0822 |
| Weight (kg)                     | 57.75±6.70                             | 59.93±6.94                      | 0.005  |
| Height (meters)                 | 1.67±0.5                               | 1.65±0.9                        | 0.9156 |

\*Two-tailed \( r^2 \) with Yates’ correction using 2 × 2 contingency table. ASA: American Society of Anesthesiologists

**Table 2: Block characteristics**

| Parameters                      | Group R \( (n=60) \) (retroclavicular) | Group C \( (n=60) \) (classical) | \( P \) |
|---------------------------------|----------------------------------------|----------------------------------|--------|
| Needle shaft visibility         | 4 (3-4)                                | 3 (2-4)                          | 0.005  |
| Needle tip visibility           | 4 (3-5)                                | 3 (2-5)                          | 0.014  |
| Number of needle passes         | 1 (1-2)                                | 1 (1-3)                          | 0.004  |
| Block success, \( n \%)*        | 57 (95)                                | 57 (95)                          | 1      |
| Block-related pain on VAS       | 1 (1-2)                                | 2 (1-3)                          | 0.0116 |
| Time for procedure (s)          | 376.93±64.123                          | 401.60±68.88                     | 0.045  |
| Patient satisfaction            | 3 (2-4)                                | 4 (3-5)                          | <0.001 |
| Operator comfort                | 3 (3-4)                                | 3 (3-4)                          | 1.000  |
| Complications                   |                                        |                                  |        |
| Incidence of needle-induced paresthesia | 0                                | 2                                | 0.1639 |
| Vascular puncture, \( n \%)     | 0                                      | 2                                | 0.1639 |
| Horner syndrome, \( n \%)       | 0                                      | 0                                |        |
| Dyspnea, \( n \%)               | 0                                      | 0                                |        |
| Local anesthetic toxicity, \( n \%) | 0                                  | 0                                |        |

\*Two-tailed \( r^2 \) with Yates’ correction using 2 × 2 contingency table (values are the mean±SD, the median (range), or the number and percentage of patients, Wilcoxon signed-rank test with continuity correction was used). SD: Standard deviation; VAS: Visual analogue scale
Retroclavicular approach was first described by Hebbard et al. where they described this technique to improve the needle visibility over the classical technique. Charbonneau et al. did a noncomparative feasibility study in 62 patients with more than 90% sensory and surgical success rate. Our study had similar results with comparable success rate (95%) in both the approaches of block.

Charbonneau et al. claimed that the retroclavicular approach had the added advantage of better needle tip and shaft visibility; this finding was reaffirmed by Kavrut et al. They did a prospective randomized study in 100 patients comparing both the techniques. They concluded that the retroclavicular approach is better in terms of needle tip and shaft visibility, reduced performance time, and fewer needle passes.

Kavrut et al. observed the rate of paresthesia to be as high as 12% during the coracoid approach. This was similar to the rate reported by Frederiksen et al. (17.5%) and Tran et al. (7.5%). We observed a rate of 6.66% in coracoid approach and 1.6% in retroclavicular approach. Hence, the latter approach is safer as the needle trajectory can be better visualized. Our study had similar results. Needle tip and shaft visibility were significantly better ($P < 0.005$) in the retroclavicular group. Charbonneau et al. reported a less VAS score while performing the retroclavicular approach (1.9 ± 1.2). We also had lower pain scores in retroclavicular approach as compared to classical approach ($P < 0.05$). This could be attributed to the fact that we avoided the pectoral muscles, as transmuscular path can be more painful. This might have led to the higher satisfaction levels among patients in the retroclavicular group. External rotation of the shoulder along with abduction of the upper arm is preferred for the coracoid approach of IBPB. This helps in pulling the clavicle cephalad and creating a space for needle insertion and maneuverability. This is not mandatory in retroclavicular approach. Hence, this technique becomes convenient in trauma patients with painful limb.

Another finding was the significantly less time required for the retroclavicular block. This could be related to better visibility of the needle leading to less number of needle passes. Chin et al. earlier stated in their review that good visibility in infraclavicular blocks provides a safer technique with lesser needling time.

In a case series done by Beh et al., they reported technical difficulty in patients with short and thick neck and patients with anatomical variations of the clavicle. We had excluded patients with anatomical variations and BMI > 24; hence, it is difficult to comment on the previous findings. Another limitation could be that a larger sample size might be required to comment on the complications associated with the techniques. Infraclavicular blocks offer the advantage of better catheter fixation. We did not try inserting or fixing catheters in any of the surgeries.

**Conclusion**

The results of this study show that the retroclavicular approach is a good alternative to coracoid technique in the Indian population with normal anatomy. It offers better tip and shaft visibility, lesser needle passes, and shorter performance time and comparable success rate when compared to the coracoid approach. Further studies are required to see its utility in obese patients and patients with anatomical variants.

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**Conflicts of interest**

There are no conflicts of interest.
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