ORIGINAL ARTICLE

Comparison between ultrasound guided supraclavicular and infraclavicular brachial plexus block to assess the quality of surgical anaesthesia and intraoperative tourniquet pain: A prospective randomized observer blinded study

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Abstract

Background: The brachial plexus block is a reliable technique of regional anesthesia for procedures involving the upper limbs. Both supraclavicular and infraclavicular brachial plexus block techniques are used for brachial plexus blockade. *Aim and Objectives:* The present study compared Supraclavicular Brachial plexus block (SCB) with Infraclavicular Brachial plexus block (ICB) using ultrasonography (USG) in terms of quality and tourniquet pain. *Material and Methods:* Of the 76 subjects scheduled for elective procedures of the upper limb, all were categorized into two groups with computer-based randomization: a supraclavicular group (Group S) and infraclavicular group (Group I). USG was used to perform all the blocks. Both groups were compared in terms of the time taken to perform the block, time taken for sensory and motor block onset, time taken for complete blockade, duration of blockade, intraoperative tourniquet pain, and intraoperative and postoperative complications. Statistical analysis was performed with student unpaired t-test and chi-square test and $p < 0.05$ was considered statistically significant. *Results:* The time taken to perform the block was more in Group I than in Group S. Block onset time and total blockade time of the sensory and motor components were less in Group I than in Group S. Duration of the blockade was longer in Group I than in Group S. The incidence of tourniquet pain was less in Group I. No intraoperative or postoperative complications were observed in either group. *Conclusion*: Onset time for ICB was shorter with a longer duration of the blockade. Incidences of tourniquet pain were also less with a similar rate of success. Therefore, the ICB may be a better alternative to the SCB in upper limb procedures.

Keywords: Brachial plexus block, Ultrasonography, Tourniquet Pain, Postoperative Complications

Introduction

Regional anesthesia prevents unwanted exposure to general anesthesia and airway instrumentation. It also has a rapid recovery period and improved postoperative analgesia. A brachial plexus block is a commonly used regional anesthesia technique for upper-limb surgeries. It is an alternative technique for General Anesthesia (GA) and can be used with GA to achieve ideal operating conditions by providing muscular relaxation, maintaining hemodynamic stability intraoperatively, and providing perioperative analgesia [1]. Apart from sensory supply by intercostobrachial nerve, large part of sensory and motor innervation to the upper limb is provided by the brachial plexus; therefore, blocking it alone is a highly effective method of providing anaesthesia from the shoulder to the fingertips [2-3].

There are different approaches to a brachial plexus block, the most common being the Supraclavicular Brachial (SCB) plexus block. It provides reliable anaesthesia to the entire upper limb and can be used for arm, forearm, elbow, and hand surgeries. It is more easily approachable because it is more

superficial, but adverse events, including pneumothorax, injury to phrenic nerve, and injury to vascular structures are prevalent [3-4].

An alternative technique is needed with same success rate to overcome such complications. Infraclavicular Brachial (ICB) plexus block can be used as an alternative. Ultrasonography (USG) has improved safety, efficacy and decreased the rate of failure of this approach [5]. The incidence of complications is lower in ICB as it is simple and safe block. The major drawback is that they lie deeper so this block is difficult to perform for less experienced anaesthesiologists and in obese patients [6]. The literature has compared the incidence of tourniquet pain in ICB with the axillary brachial plexus block and found that it was less in ICB [7]. Additionally, studies on ICB have found no incidence of tourniquet pain, though they did not compare it with any other block [8]. A literature review did not uncover any study comparing the incidence of tourniquet pain between SCB and ICB.

In the present study, we assessed the quality of surgical anaesthesia and tourniquet pain between USG guided SCB and ICB. The primary objective was to compare the onset and complete blockade of sensory and motor components of brachial plexus and intraoperative tourniquet pain in USG guided SCB and ICB. Secondary objective was to compare the duration of block, block performance time and intraoperative and postoperative complications in USG guided SCB and ICB.

Material and Methods

Institutional ethical clearance was acquired, and the study was registered at Clinical Trials Registry – India (CTRI) (CTRI/2021/03/041992). Informed consent was taken from all participants. Patients were from 18–60 years of age and of either gender belonging to American Society of Anaesthesiologists (ASA) grades I and II with Body Mass Index (BMI) less than 30 who were posted for any elective forearm surgery under USG guided regional anaesthesia. Patients with known coexisting lung disease, chest deformity, allergy to local anaesthetic, and emergency surgeries were excluded. Seventy-six patients enrolled in the study were randomized into two groups via a computer-generated randomization table.

Minimum sample size was calculated using

$$n = \frac{(z_\alpha + z_\beta)^2 (s_1^2 + s_2^2)}{(\overline{X_1} - \overline{X_2})^2}$$

zα- linked with the level of significance

zβ-linked with the power of the test.

For 5% level of the significance zα = 1.96 and

zβ = 0.84 for 80% power of the test.

Mean values for the first group were (9.57) and the second group were (11.53).

s1 is the standard deviation of the first group (3.19) and s2 is the standard deviation of the second group (2.90) [6].

The minimum number of cases in each of the two groups were 38.

Methodology

After a thorough pre-anaesthetic evaluation a day before surgery and confirming the nil by mouth status on the day of surgery, patients were shifted to the operation theatre. Baseline monitors (non-invasive blood pressure, pulse oximeter, and electrocardiogram) were attached, and parameters were noted. Ringer's lactate was started through a wide-bore intra-venous cannula. Under strict asepsis, an initial scan was carried out using the Sonosite ultrasound machine. A 8–15 MHz linear probe (B-probe) was used to perform the block. A 22-gauge 50 mm insulated short bevel needle was used to perform the block. The injection of bupivacaine 0.5% with a dosage of 20 ml was used

for the block. The time between the positioning of the needle and its removal was recorded for every block performed. An experienced anaesthesiologist executed the blocks.

The SCB was carried out with the patient lying supine, head inclined toward the contralateral side, and the arm adducted against the side of the body. The linear probe was placed in the coronal or oblique plane just above the clavicle near the midpoint. Trunk divisions of the brachial plexus were visualized above the first rib lateral to the subclavian artery. The needle was placed in a sheath of the plexus, and the injection bupivacaine 0.5% was injected. The spread of the drug within the brachial plexus and its centrifugal distribution into the trunks and divisions were seen.

The ICB was performed with the patient in a supine position. The transducer was positioned in the deltopectoral groove below the clavicle in the parasagittal plane. The limb that had to be operated on was abducted or placed against the body. After the parts were painted and draped, the needle was pointed toward the target using the in-plane technique. Posterior to the axillary artery, the injection of bupivacaine 0.5% was deposited to attain a U-shaped distribution surrounding the artery. The lateral and medial cord were also infiltrated with the drug using the triple injection technique.

The time between the drug injection and the total loss of pinprick sensation was used to define the start of the sensory block, whereas the time between the drug injection and the full motor block was used to define the onset of the motor block. These were noted at intervals of 5 minutes until 30 minutes and a total blockade was attained.

If total sensory block was not attained after 30 minutes, then it was considered a failed block. The study was abandoned, and the patient was supplemented with adequate analgesia or converted to general anesthesia. The results were determined by an observer who was unaware of how the block was performed. Evaluation of the score for sensory blockade was determined with needle pricks by testing the territories supplied by the brachial plexus. Time taken for loss of pinprick sensations (sensory onset time) and the onset of weakness (motor onset time) were assessed. The quality of sensory blockade was evaluated using the scoring method used by Abhinaya *et al*., (2017) [6]. The time taken to reach a score of 2 was recorded and considered as the time to achieve total blockage. The quality of motor blockade was observed using the four-point rating scale taken from Abhinaya *et al*., (2017) [6]. The time taken to attain a score of 3 was noted and considered the time taken to achieve a complete motor block. Tourniquet pain was assessed 30 minutes after it had been inflated and then at ten-minute intervals until the end of surgery. Patients were questioned for any discomfort. Pain was assessed according to the Numeric Rating Scale (NRS).

NRS

A tool used for assessing tourniquet-related pain was adapted from Brenner *et al*., (2019) [8]. For scores > 5, rescue analgesia of fentanyl c was given with the patient breathing spontaneously. The duration of the block was noted in both groups as the time taken to return from Grade 3 of the motor blockade to Grade 1. The block was considered successful when there was Grade 3 sensory and motor blockage or sparing of a single nerve territory. Failure to carry out the desired surgical procedure while under a block was regarded as a failed block (sparing of greater than one nerve even after 30 minutes of the block), and there was a need to convert into general anaesthesia.

Complications

Patients were monitored for complications such as vascular injuries or the development of hematoma, both during surgery and for 24 hours following surgery. Patients were monitored for injuries to the nerve, pneumothorax, Horner's syndrome, and diaphragmatic paralysis.

Statistical analysis

The current study compared two groups. Mean and Standard Deviation were computed for continuous quantitative data. Continuous variables between groups were compared with suitable statistical tools such as the unpaired student t-test, which is used to compare two quantitative variables in a group. Rates, ratios, and percentages were used to express the categorical data. Using the chi-square test, the relationship between the result, clinical, and demographic factors was examined. The median was used to represent discrete variables. For comparing discrete variables, nonparametric tests were used. The comparison was represented using appropriate graphs. A value of $p < 0.05$ was deemed significant for each test.

Results

A total of 76 patients were recruited and equally allotted in two groups. Age distribution between these groups was comparable. Mean age in the supraclavicular group (Group S) was 38.32, and in the infraclavicular group (Group I) it was 43.79; this age difference was not statistically significant ($p = 0.1080$). In the present study, there was no extreme variation in gender distribution in the two groups. The differences in patient characteristics and demographic profiles between the two groups were not statistically significant (Table 1).

The mean time to perform block in Group I was 11.42 ± 1.78 min which was significantly higher compared to Group S which was 8.26 ± 1.70 min (Table 2). In our institute, ICB is less routinely performed than SCB which could explain the increased time required for the former. The mean time for onset of sensory blockade in Group S was 5.55 ± 0.80 min which was significantly higher than Group I which was 4.47 ± 0.51 min and the mean time of onset of motor blockade in Group S was 6.26 ± 0.92 min which was significantly higher than in Group I which was 4.92 ± 0.88 min (Table 2). Total duration of blockade in Group I was 9.20 ± 0.80 hours which was significantly higher than Group S which was 8.13 ± 0.43 hours ($p < 0.0001$). In Group S, minimum time was 6.5 hours and maximum time was 9 hours while in Group I, minimum time was 7 hours and maximum time was 11 hours (Table 2).

Intraoperative tourniquet pain was assessed in both the groups. The incidence of tourniquet pain and the requirement of rescue analgesia were less in Group I than Group S, which was found to be statistically significant ($p < 0.04$) (Table 3). Injection Fentany 1 mcg/kg was given in patients who experienced tourniquet pain and consumption was more in Group S. There were no intraoperative and postoperative complications in both groups.

Table 1: Demographic data

Parameters	Group S ± SD	Group I ± SD	*p*
Age	38.32 ± 14.61	43.79 ± 14.72	0.2
Weight	63.42 ± 6.72	63.03 ± 6.81	0.8
BMI	22.77 ± 2.34	23.22 ± 2.80	0.4

Table 2: Comparing quality of block in both the groups

Parameters	Group S	Group I	*p*
Block performance time (min)	8.26 ± 1.70	11.42 ± 1.78	**< 0.0001**
Onset of sensory blockade (min)	5.55 ± 0.80	4.47 ± 0.51	**< 0.0001**
Onset of motor blockade (min)	6.26 ± 0.92	4.92 ± 0.88	**< 0.0001**
Total duration of sensory blockade (hour)	8.13 ± 0.43	9.20 ± 0.80	**< 0.0001**
Total duration of Motor blockade (hour)	8.13 ± 0.43	9.20 ± 0.80	**< 0.0001**

Table 3: Comparing intraoperative tourniquet pain in both the groups

Tourniquet	Group S N (%)	Group I N (%)	*p*
Yes	8 (21.1)	2 (5.3)	<0.04
No	30 (78.9)	36 (94.7)	
Total	38 (100)	38 (100)	

Discussion

Brachial plexus block is the most effective substitute for GA in upper limb procedures. It yields a better quality of analgesia and also avoids complications related to GA, such as polypharmacy [1]. The brachial plexus block is a highly convenient alternative for patients with severe respiratory and cardiovascular co-morbidities, in obese patients who have airway difficulties, and in patients with anticipated difficult airways. It is also preferred in patients with co-morbidities like diabetes mellitus by reducing perioperative fasting [1]. With the advent of ultrasound technology, the brachial plexus block has become easier to perform because there are fewer chances of complications like vascular injury and a reduction in the drugs required [2].

The SCB is executed at distal trunks and proximal divisions. At this level the plexus is more superficial, so the block is simpler to carry out. Plexuses at this level are more compact; hence, a modest amount of local anesthetic provides reliable anesthesia [3]. The ICB was performed at the level of cords, and it has the advantages of avoiding complications like pneumothorax, Horner's syndrome, and diaphragmatic paralysis, which are commonly associated with SCB. The onset of ICB is very rapid, and it provides reliable anesthesia similar to SCB [6].

In the present study, we compared USG guided SCB and ICB in 76 patients who were randomly divided into two groups. The mean time to perform the block in Group S was significantly lesser than Group I (p = < 0.0001) which correlates with the findings of María*et al*., (2008) [13] while it contrasts with those of Abhinaya *et al*., (2017) [6], where the time taken to perform the block was found to be

shorter in ICB than SCB. It also deviates from the studies conducted by El-Sawy *et al*., (2014) and Yang *et al*., (2010) which found no statistically significant difference in the time taken to perform the block between the two methods [9-10].

In the present study, onset and total blockade of sensory and motor components occurred earlier in Group I than in Group S, which was found to be highly statistically significant ($p < 0.0001$) (Table 5). This finding aligned with those of Abhinaya *et al*., (2017) [6] and Koscielniak-Nielsen *et al*., (2009) [11] who found that the complete block of sensory and motor components was achieved significantly earlier in ICB. Our findings differ from those of Yang *et al*., (2010) [10] and Arcand *et al*., (2005) [12] who found no statistically significant variation in time of onset and time for total sensory and motor component blockade. Early onset of motor and sensory blockade in our study can be attributed due to triple injection technique in contrast to the above studies where single injection technique was followed.

The duration of action of ICB was significantly more than the SCB, like that of Yang *et al*., (2010) who found that the duration of the action of the ICB was 827 ± 175 min, while that of SCB was 763 ± 202 mins, but this difference was statistically insignificant. These findings deviate from the study by María *et al*., (2008) [13] and the systemic review conducted by Park *et al*., (2017) [7] where they found no difference in the duration of the action of either block. In the above systemic review, they assessed rates of sensory blockade in 4 terminal branches of peripheral nerves between supraclavicular block and infraclavicular block. Study by María *et al*., (2008) was conducted among paediatric patients and because of compact anatomical arrangement of plexus in supraclavicular area, the smaller volume of drug also resulted in prolonged duration. [13]

Chin *et al*., (2010) [14] compared the incidence of tourniquet pain in the ICB with all other brachial plexus blocks and found that it was less in ICB. They inferred that the ICB provides reliable anaesthesia to the musculocutaneous nerve, which helps alleviate tourniquet pain. Similarly, Koscielniak-Nielsen *et al*., (2009) [11] found that patient satisfaction was more in ICB than SCB due to fewer incidences of tourniquet pain, but it was not quantified. However, there is no proper evidence of why the ICB causes less tourniquet pain compared to other blocks.

No intraoperative or postoperative complications were seen in the groups. This finding contrasts with that of Sreelal *et al*., (2020) [15], who found a greater incidence of Horner's syndrome and one case of a puncture of the subclavian artery in SCB while there was no such complications in ICB. They also reported an incomplete blockade of the radial nerve territory in the infraclavicular group. In a systemic review by Kaye *et al*., (2021) [16] comparing various brachial plexus blocks, the authors inferred that the ICB had fewer complications such as pneumothorax and Horner's syndrome than the supraclavicular and interscalene brachial plexus blocks.

Conclusion

Through this study, it may be concluded that the USG guided ICB could be a better alternative to SCB with faster onset of action, greater duration of blockade, and lesser tourniquet pain.

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