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Original Research Article

A Comparative Study to Evaluate the Efficacy of Ultrasound Guided Supra Clavicular and Infra Clavicular Approaches to Brachial Plexus Block for Elective Upper Limb Surgery

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Conflict of interest: Nil

Abstract:

Background: Ultrasound guidance (USG) for brachial plexus blocks has been described for the supraclavicular, infraclavicular and axillary approaches. These reports have shown that USG guided brachial plexus blocks have high success rates and few complications. Compared with the axillary approach, the brachial plexus block at the level of the clavicle can anaesthetize all four distal upper extremity nerve territories without the requirement for a separate block of the musculocutaneous nerve.

Aim and Objective: The aim of the study was to compare the effect of both supraclavicular and infraclavicular brachial plexus blocks in terms of time taken for onset, duration, block performance, and block success and incidence of adverse events.

Materials and Methods: This study conducted on patients of age group between 18 - 60 years of either sex belonging to ASA Grade 1-3 with BMI<35 in patients undergoing elective upper limb surgery. 60 patients were randomised into two groups. Supra clavicular (group S) and infra clavicular (group I). All the patients were given 25 ml of 0.5% ropivacaine (p) as local anesthetics. The block performance time, time taken for onset of sensory and motor blockade, total duration of block, and hemodynamic parameters were observed. The block performance times and the onset of the sensory blockade were the primary outcomes while the duration of the block, success of block, patient satisfaction and hemodynamic parameters were secondary outcomes.

Results: The block performance time for the infraclavicular group was 16.1 ± 3.17 min, whereas for supraclavicular group, it was 10.53 ± 2.80 min with similar success rates . Onset of sensory blockade was achieved earlier (8.31 ± 1.23 min) in Group I than Group S (14.20 ± 1.50 min, P = 0.041). The onset of motor blockade was similar in Group I (11.22 ± 1.20 min) and Group S (16.52 ± 28.42 min, P = 0.462). The duration of action, block success and patient satisfaction were similar in both the groups. Adverse events are more in Group S.

Conclusion: Ultrasound-guided infraclavicular block is a relatively safer technique when compared to the supraclavicular technique with faster onset, better patient satisfaction and fewer complications.

Keywords: Efficacy, Brachial Plexus Block, Infraclavicular Block, Supraclavicular Block and Ultrasound.

Introduction

Ultrasound guidance (USG) for brachial plexus blocks has been described for the supraclavicular infraclavicular and axillary approaches. These reports have shown that USG brachial plexus blocks have high success rates and few complications. [1,2]

Brachial plexus blocks used as a better alternative to general anesthesia in most of the patients who are undergoing upper limb surgeries because of having advantages like minimal preoperative preparation, no need for specialized costly equipment, minimal physiological and metabolic alterations, less stress response, minimal monitoring, longer duration of postoperative analgesia, less post operative nausea & vomiting, decreased incidence of deep vein thrombosis, low burden on hospital management.[3]

The supraclavicular approach has an additional anatomical advantage of a blockade at a level where the brachial plexus elements are tightly grouped, which facilitates a single point injection and is believed to result in very rapid onset.[4]

Anatomically, the infraclavicular approach should be feasible in almost all patients. It also has the theoretical advantages of both the supraclavicular and axillary approaches: a compact anatomical distribution of plexus structures allowing single injection of local anaesthetics and a reduced risk of pneumothorax.[5,6]

Both supraclavicular and infraclavicular approaches have similar distributions of anaesthesia.[4]

Although both supraclavicular and infraclavicular blocks can be utilised for upper limb surgeries, anaesthesiologists often have an inclination for supraclavicular over infraclavicular block because of the technical difficulty and increased complications with the blind approach in the latter. The advent of ultrasonography in anaesthesia practice has made it a valuable adjunct in peripheral nerve blocks.[5,6]

The aim of the study was to compare the effect of both supraclavicular and infraclavicular brachial plexus blocks in terms of time taken for onset, duration, block performance, and block success and incidence of adverse events .[1,7,8]

We hypothesized that, Ultrasound-guided infraclavicular block is a relatively safer technique when compared to the supraclavicular technique with faster onset ,better patient satisfaction and fewer complications .

Material and Methods

This prospective, a randomized, double-blind study was carried out in 60 patients in the Department of Anesthesiology, Gandhi Medical College and Associated Hospitals, Bhopal, M.P.

After thorough pre-anesthetic evaluation patients were included or excluded according to following criteria: aged 18 to 60 years, scheduled for elective upper limb orthopedic surgeries mainly hand, wrist, forearm, and elbow with ASA physical status 1-3, and a BMI of ≤35 kg/m2.The exclusion criteria include patient's refusal, presenting contraindications to regional anesthesia, previous nerve injury, history of drug allergy to local anesthetics, history of drug abuse/dependence, currently consuming analgesics and sedatives., currently on anticoagulants, history of bleeding disorders, psychiatric illnesses, uncooperative patients, any major systemic illness, and lactating mother. The patients were randomized to receive either an infraclavicular brachial plexus block (group I, n=30) or supraclavicular plexus block (group S, n=30). All the patients were assured and explained about the procedure to be performed and informed written consent was obtained before performing the block.

A standard regional anesthesia trolley was prepared. Resuscitation equipment was kept ready. Those enrolled in Group S received 25 mL 0.5% ropivacaine (p), while those in Group I received 25 mL 0.5% ropivacaine (P). Standard monitoring for heart rate, ECG, systolic and diastolic blood pressure, peripheral oxygen saturation was established and baseline vital parameters were recorded. Ondansetron 0.08 mg/kg and midazolam 0.02 mg/kg were given as intravenous premedication 15 minutes before induction.

The brachial plexus blocks were administered using a linear ultrasound probe (SonoSite® 7-12 MHz linear array transducer) by an experienced anesthesiologist. For the supraclavicular brachial plexus block, the ultrasound probe was placed in the frontal plane in the fossa above the clavicle and a short axis view of the subclavian artery was obtained.[1] The needle was then advanced in the plane with direct visualization from the lateral aspect until the tip of the needle was located closer to the subclavian artery. After thorough negative aspiration, the drug was injected into the brachial plexus along with slight manipulation of the needle tip ensuring proper spread of the drug among all compartments of the plexus.[2]

In the infraclavicular brachial plexus block, the ultrasound probe was placed in the para-sagittal plane inferior to the clavicle obtaining a short axis view of the axillary artery. The needle was inserted and advanced in-plane technique until the tip of the needle was located just posterior to the axillary artery in the midst of chords of the brachial plexus [1,2]. After confirmation of the appropriate needle tip position and negative aspiration, the local anesthetic was administered.

The onset and degree of sensory and motor block were observed every 5 min for 30 min till complete blockade was achieved. If after 30 min complete sensory blockade was not achieved and patient perceived pain, then it was a taken as a failed block. If the single nerve was spared, then a rescue block of the concerned nerve at appropriate level was given. If more than one nerve was spared, then general anaesthesia was administered. The sensory score was assessed using needle-prick method by testing the five individual nerves median nerve, radial nerve, ulnar nerve, musculocutaneous nerve and medial cutaneous nerve of the forearm. The scoring system adapted from Koscielniak-Nielsen et al.[6]was followed for checking sensory block (0 – sharp pain, 1 – touch sensation only and 2 – no sensation). The quality of motor block was observed on a four-point scale and was adapted from Lavoie et al.[8] and Lahori et al.[9]: 0-Flexion and extension in both the hand and arm against resistance, 1-Flexion and extension in both the hand and arm against gravity but not against resistance, 2-Flexion and extension movements in the hand but not in the arm and 3-No movement in the entire upper limb. The onset of sensory block was defined as the time

elapsed between injection of drug and complete loss of pinprick sensation, whereas onset of motor blockade was outlined as the time elapsed from injection of drug to complete motor block. The patients were asked for their satisfaction level during the performance of block and surgery by the two point assessment scale 0-unsatisfied and 1-satisfied.[10] They were asked to mark it as satisfied only if they will be happy to accept the same block in future. The block performance time was defined as the time interval from placement of ultrasound probe to the removal of needle after injection of local anaesthetic. The time patient was ready for surgery was taken as the time after completing the block to the achievement of complete sensory and motor blockade. The following adverse effects were observed: accidental vascular puncture, pneumothorax, diaphragmatic paresis and Horner's syndrome.

The primary objectives of this prospective, randomised and observer-blinded study were to compare the block performance time and success rate of supraclavicular and infraclavicular approaches to brachial plexus block using ultrasound-guided neurostimulation. The secondary aims were to compare the onset and duration of sensory and motor blockade, patient satisfaction and complications associated with each approach.

Data were entered in MS-Excel spreadsheet and were analysed using the statistical package for social sciences version 20 (trial version). Descriptive statistics including proportions, measures of central tendency and measures of dispersion were used to describe the data. Further, Student's t-test was used to compare means between the groups and Chi-square test was used to compare proportions. A $P < 0.05$ was considered to be statistically significant.

Result

Table 1: Patient demographic characteristics

Parameter	Supraclavicular block	Infraclavicular block	P Value
Age (Years)	50.51 ± 7.60	49.10± 4.80	0.621
Weight (Kg)	72.26 ± 6.13	74.30± 4.03	0.723
Height (cm)	170.2 ± 1.54	172.8 ± 2.43	0.533
BMI (kg/m2)	29.13 ± 1.08	28.84 ± 2.01	0.342
Duration of surgery (min)	108.29 ± 12.36	102.29 ± 14.09	0.428
ASA grade 2/3	25/5	23/7	0.412

Demographic data such as age, Height, weight, BMI, duration of surgery and ASA grading were analysed and it was found that statistically insignificant with P value > 0.05.

Table 2: The block parameters during the study

Parameter	Supraclavicular block	Infraclavicular block	P Value
Block performance time (min)	10.53±2.80	16.1 ± 3.17	0.041
Onset of sensory block (min)	14.20 ± 1.50	8.31 ± 1.23	0.036
Duration of sensory block (min)	556.57 ± 18.28	581 ± 45.70	0.367
Onset of motor block (min)	16.52 ± 28.42	11.22 ± 1.20	0.462
Duration of motor block (min)	523.34 ± 13.78	532.57 ± 38.80	0.521
Rescue analgesia (min)	556.57 ± 18.28	581 ± 45.70	0.367

We found that, Onset of sensory block (min) mean 14.20 & 8.31 supraclavicular and infraclavicular block respectively with p value< 0.05.

Table 3: Adverse effects

Parameter	Supraclavicular block	Infraclavicular block	P Value
Horner syndrome	6 (20%)	1 (3.3%)	0.032
Pneumothorax	2 (6.6%)	0 (0%)	0.064
Vascular puncture	8 (26.6%)	2 (6.6%)	0.042

We found that, Horner syndrome 20%, & 17.1% supraclavicular & infraclavicular block group respectively and Pneumothorax 6.6% & 0% supraclavicular and infraclavicular block group respectively.

Table 4: Block success rate in both groups

Parameter	Supraclavicular block	Infraclavicular block	P Value
Complete failure	2(6.66%)	1(3.33%)	0.217
Unsatisfactory block	4(13.33%)	4(13.33%)	0.921
Satisfactory block	24(80%)	25(83.33%)	0.692

Table 5: Patient satisfaction of block in both groups

Patient satisfaction	Supraclavicular block	Infraclavicular block	P Value
Unsatisfied	2(6.66%)	2(6.66%)	0.342
Satisfied	28(93.33%)	28(93.33%)	0.80

Block success rate and patient satisfaction of block were comparable in both groups with p value > 0.05.

Discussion

Ultrasound guided brachial plexus block is used widely nowadays, owing to its multiple advantages when compared to landmark guided and nerve stimulation brachial plexus block techniques as USG guided brachial plexus blocks have high success rates and few complications. There is increasing evidence showing that regional anaesthesia for upper limb surgeries produces a good reduction in postoperative pain, side effects, and intraoperative and postoperative morbidity, which in turn results in shorter stays in postoperative anaesthesia care compared to general anesthesia.[1,4]

In our study, a comparison of the supraclavicular and infraclavicular approach to the brachial plexus was carried out to compare both techniques in terms of onset, duration, block performance, and block success, patient satisfaction and incidence of adverse events.

In our present study, Demographic data such as age, ASA grading, Height, weight, BMI and duration of surgery were analysed and it was found that statistically insignificant with P value> 0.05.

Vital parameters like BP, HR SpO2 and RR were analysed at regular intervals of 15 min, 30 min,1 hr, 2 hr and 4 hr and found that statistically insignificant with P value > 0.05.

The block performance time for the supraclavicular block was less compared to the infraclavicular block. This is due to the unfamiliarity of the methodology and inexperience in performing infraclavicular brachial plexus block. Moreover, the infraclavicular brachial plexus block was not routinely practiced in our institution. This finding contrasts with the studies conducted by Abhinaya et al.[5], Koscielniak-Nielsen et al.[6] and Gurkan et al.[7],in which they reported that block performance time was less in the infraclavicular block when compared to the supraclavicular block. However, a study conducted by Sarkar et al.[3] reported similar findings as our study [1,3-5]. Studies conducted by Arcand et al.[2] , Satani et al.[4], Park et al.[10], and Yang et al.[14] reported that there was no difference in block performance time between the two types of block. But the majority of the above studies were done using a landmark-guided technique or a nerve stimulator technique and it would be unwise to generalize the findings for Ultrasound guided regional anesthesia.

The onset of motor block was similar in both groups, whereas the onset of sensory blockade was earlier in infraclavicular block as compared to supraclavicular block and it was found to be statistically significant ($p<0.001$). In contest to our study, Bharti N et al.[11] and Kapral S et al.[12] found that onset of sensory and motor block were comparable in both groups.

The similar results found from the study conducted by Abhinaya et al.[5] and Koscielniak-Nielsen et al.[6], in which the onset of sensory blockade was faster in infraclavicular block. These findings support the hypothesis that an infraclavicular block is safe and can be performed faster than a supraclavicular block in the presence of ultrasound.[1]

Motor blockade was also assessed simultaneously according to the modified Lovett scale, in the four nerve areas. At five minutes, a motor blockade was achieved earlier in the infraclavicular group for all the motor nerves studied and it was statistically significant. These findings may be attributed to the traditional mantle and core hypothesis in a local anesthetic spread in regional anaesthesia [15]. In the upper limb neuraxial anatomy, the neurons supplying the distal part of the upper limb are located more in the centre of the nerve compared to the nerves supplying the proximal areas. The level of block in the supraclavicular approach is comparatively high in the brachial plexus anatomy; hence, there is a delay in diffusion of local anesthetic for the neurons supplying below elbow level. These results were similar to the study carried out by Yang et al.[14] However, there was no difference in the duration of the blockade, both motor and sensory blockade, which is similar to studies conducted by Abhinaya et al.[5], Satani et al.[4] and Bharti et al.[11]

The incidence of complications like horner syndrome, vessel puncture and pneumothorax were more in supraclavicular block group compared to infraclavicular block group. The plumb-bob and subclavian perivascular approaches were designed in part to reduce the risk of pneumothorax and horner syndrome.[1,12]

The percentage of block success and patient satisfaction were comparable in both groups with p value > 0.05.

The limitations of our study are- 1) sample size of the study is considered small for generalising findings across broader patient populations. 2) we excluded emergency cases. 3) The study was

conducted at single centre which may limit the acceptance of findings to other populations.

Conclusion

In conclusion, these results suggest that both the supraclavicular and infraclavicular approach to the brachia plexus had similar clinical efficacy including onset of motor block, duration of sensory and motor block, block success and patient satisfaction but the supraclavicular block caused a pneumothorax and vessel puncture. These results suggest that the infraclavicular approach might be preferable for hand, forearm, and/or elbow surgery for ease of technique, patient satisfaction and low rate of complications. However, more large scale studies will be needed to compare the supraclavicular block with the infraclavicular block using ultrasound.

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