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Original article

Study of Infra-clavicular and Supraclavicular approaches to Brachial plexus block using Ultrasound in upper extremity surgeries

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Abstract:

Background and aim : Infraclavicular and supraclavicular brachial plexus blocks are widely used in upper limb surgery. In recent years, real-time ultrasonographic guidance has been introduced for peripheral nerve blocks. In this study, we aimed to compare the efficacy of infraclavicular and supraclavicular brachial plexus block in patients undergoing upper extremity surgery by using ultrasound.

Methods: About Eighty patients of either sex, aged 18–60 years, ASA physical status I and II, and posted for elective surgery of upper limb were included. Patients were randomly divided into two groups; 40 patients in infraclavicular block group (group I) and 40 patients in supraclavicular block group (group S). In both groups, nerves were searched using ultrasound. The two groups were compared with respect to block performance time, onset of sensory and motor blockade, readiness for surgery, success rate and complications. The statistical analysis was performed with Student t-test and Chi-square test.

Results: The block performance time for the infraclavicular group was (10.43 ± 4.16 min), whereas for supraclavicular group, it was (12.33 ± 3.10 min) with success rates (98%) in infraclavicular blocks and (90%) success rate in supraclavicular blocks. Onset of sensory blockade was achieved earlier (7.23 ± 3.41 min) in Group I than Group S (9.25 ± 3.17 min, P = 0.007). The onset of motor blockade was similar in Group I (8.12 ± 3.20 min) and Group S (9.36 ± 4.20 min, P = 0.14). The patient satisfaction score was similar in both the groups. The duration of sensory and motor block were similar in both group with p >0.5

Conclusion: The infraclavicular block is more rapidly executed compared to supraclavicular block with similar success rates in the presence of ultrasound and hence infraclavicular block should be preferred.

Keywords: Brachial Plexus , infraclavicular, supraclavicular, block, upper extremity

INTRODUCTION

Brachial plexus block is an established regional anesthetic technique for upper limb surgeries. It is used as a better alternative to general anesthesia as it not only provides adequate anesthesia but it has many other advantages like avoid complications of general anesthesia, no need for specialized costly equipment, minimal physiological and metabolic alterations, less stress response, minimal monitoring, excellent longer duration of postoperative analgesia, less postoperative nausea & vomiting and shorten stay in the post-anesthesia care unit.[1,2]Upper extremity blocks are more common than lower extremity blocks. The brachial plexus block of is a very effective method for achieving anesthesia for the upper limb which involves shoulder to fingertips. There are various theories and approaches for achieving brachial plexus blockage which varies on the block indication, procedure of surgery being performed, specific patient-body habitus, associated medical comorbidities and anatomical individual variations. [3]

There are essentially four approaches to a brachial plexus block: a) interscalene, b) supraclavicular, c) infraclavicular, d) axillary. Because the brachial plexus is more compact in the upper levels, it is easier to block and therefore supraclavicular and infraclavicular approaches are used more frequently [1,3,4].The supraclavicular brachial plexus block is a popular technique for surgeries below the shoulder because of its quick onset and high success rate.[3] However the major disadvantages are higher incidence of complications such as inadvertent vascular injections, pneumothorax, phrenic nerve palsy and Horner's syndrome. The main advantage of infraclavicular block is less incidences of complications with ultrasound and it is ideal method for catheter insertion techniques. The disadvantage is that plexus are situated very deep at this level and the angle of approach is more acute making synchronised visualisation of the relevant anatomy and needle challenging in inexperienced hands and in obese patients.[5]Both supraclavicular and infraclavicular approaches have similar distributions of anaesthesia. The conventional blind technique depends on subjective response and associated with significant failure rate, injury to nerves, and vascular structures.[6]The advent of ultrasonography in anaesthesia practice has made its a valuable adjunct in peripheral nerve blocks.[7]Nowadays, the ultrasound technique is being used to locate the nerve plexus and its spatial relationship with other surrounding tissues as it provides the real-time view. Ultrasound guidance not only determines the size, depth and exact location of the plexus, but also its neighboring structures and achieves a satisfactory and dense blockade but due to variable user experience, the results may vary.[8]The inherent benefits of direct visualisation of nerves and surrounding anatomy, continual observation of the needle tip and spread of local anaesthetic make ultrasound-guided regional anaesthesia highly appealing. In the present study, we tried to research the two approaches of brachial plexus block, which were supraclavicular block and infraclavicular block approaches and compared them in the terms of the block performance time, onset of motor and sensory block by using the ultrasound technique among patients who were undergoing upper extremity surgery.

MATERIALS & METHODS

After approval by the Institutional Ethical Committee, this study was done in 80 patients undergoing elective upper limb surgeries of the elbow, forearm and hand in a tertiary medical college

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hospital. Patients of the American Society of Anesthesiologists (ASA) Physical status I or II, weighing between 50 and 100 kg and in the age group of 18–60 years were included in the study. Uncooperative patients, patients with significant pulmonary pathology and those who were allergic to the amide local anaesthetics were excluded from the study. Patients with chest deformity, clavicle fracture and pregnancy were not included in this study. A written informed consent for the study was obtained from each patient. The patients were divided to receive either infraclavicular (Group I) or supraclavicular (Group S) blocks. All the blocks were performed by the resident with experience of performing more than 30 blocks using ultrasound under the supervision of an experienced anaesthesiologist. The blocks were performed with 30 mL 0.5% bupivacaine with 10mcg dexmedetomidine. An Ultrasound machine with linear probe with colour doppler was utilised for the study. A 5 cm short beveled, hypodermic, insulated needle was used for the blocks. The patient was given supine position with the head turned to opposite side from the side to be blocked for the infraclavicular block. The skin was disinfected and draped. The transducer of ultrasound machine was held in the parasagittal plane just medial to the coracoid process and inferior to the clavicle and the axillary artery was visualised. The needle was inserted in plane from the cephalic aspect, with the insertion point just inferior to the clavicle. The needle was directed towards the posterior part of the axillary artery as it passes through the pectoralis muscles. The goal was to inject the local anaesthetic until it spread around the artery and not to target individual cords and hand extensions was elicited as the needle was advanced. About 30 mL of 0.5% bupivacaine with 10mcg dexmedetomidine was administered under ultrasound visualisation to achieve a U-shaped spread around the artery. The supraclavicular block was performed with the patient made to lie in supine position and the head turned to the opposite side, and the skin was disinfected and draped. The transducer was placed transversely just superior to the clavicle at approximately its midpoint. The subclavian artery, first rib and pleura were identified along with brachial plexus. The objective was to place the needle in the brachial plexus sheath and inject bupivacaine with dexmedetomidine to visualise the spread within the brachial plexus and the centrifugal displacement of the trunks and divisions. Motor response of the hand was identified to confirm proper needle placement. After confirmation of needle placement, 30 ml of 0.5% bupivacaine with 10 mcg dexmedetomidine was injected. The onset and degree of sensory and motor block was observed every 5 min for 30 min till complete block was achieved. Even if after 30 min complete sensory block was not achieved and patient still complained of pain, then it was a taken as a failed block. If any of single nerve was spared, then a rescue block was given. If more number of nerves were spared, then general anaesthesia was administered. The scoring system adapted from Koscielniak Nielsen et al [9] 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. and Lahori et al[10,11](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

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sensory block was defined as the time elapsed between injection of drug and complete loss of 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. [12]They were asked to mark it as satisfied only if they were happy to accept the same block in further life if required. The performance time for block was defined as the time interval from placement of ultrasound probe to the removal of needle after injection of local anaesthetic. The following adverse effects were observed: accidental vascular puncture, pneumothorax, diaphragmatic paresis and Horner's syndrome. The primary objectives of this study were to compare the block performance time and success rate of supraclavicular and infraclavicular approaches to brachial plexus block using ultrasound guidance. The secondary aims were to compare the onset of sensory and motor blockade, readiness for surgery, patient satisfaction and complications associated with each approach. The block performance time for infraclavicular block was assumed to be 5 min based on performance time in Koscielniak Nielsen et al .[9]
Sample size was calculated based on previous study article of Ranganath et al. [13] Study comparing the two approaches of block and considering the parameter of block performance time, sample size was calculated as 36 in each group. Considering 5 % dropouts the sample size was 40 in each group. The confidence interval of 95% and power of 80% the sample size was calculated. Important data from the study proforma of the individual study subject was entered, compiled in Microsoft office excel sheet and was analysed using statistical package for the social sciences(SPSS) version 21.Various statistical tests including chi square test and student's t test was used.

RESULTS

The block performance time for the infraclavicular group was (10.43 ± 4.16 min) whereas for supraclavicular group it was (12.33 ± 3.10) min with similar success rates (92.6%). Onset of sensory blockade was achieved earlier (7.23 ± 3.41 min) in Group I than Group S (9.25 ± 3.17 min, P = 0.007). The onset of motor blockade was similar in Group I (8.12 ± 3.20 min) and Group S (9.36 ± 4.20 min, P = 0.14). The patient satisfaction score was similar in both the groups. We observed Horner's syndrome in 4 patients and diaphragmatic paresis observed in 1 patient while performing supraclavicular approach blockade while no complication observed in infraclavicular approach blockade.

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TABLE 1: DEMOGRAPHIC PROFILE			
Demographic data	***Group I***	***Group S***	***P***
Age (years	33.53±14.21	32.40±11.25	0.7021
Weight (kg)	67.27±8.77	65.87±10.47	0.09
Sex (male/female)	32/8	32/8	1.000
ASA PS (I/II)	34/6	36/4	0.499
Duration of Surgery(min)	96.41±8.23	99.52±4.84	0.74
Site of surgery (hand/forearm/elbow)	20/17/3	21/14/5	0.66

TABLE 2 : ANAESTHETIC DATA			
Anaesthetic data	**Group I**	**Group S**	***P***
Block performance time (min)	10.43 ± 4.16	12.33 ± 3.10	0.023*
Onset of sensory blockade (min)	7.23 ± 3.41	9.25 ± 3.17	0.007*
Onset of motor blockade (min)	8.12 ± 3.20	9.36 ± 4.20	0.14
Readiness for surgery (min)	7.46±2.98	9.00±3.90	0.05*
Duration of sensory block	586± 19	592±24	0.134
Duration of motor block	527±16	518±21	0.274
Success rate (%)	98%	90%	
Patient satisfaction, *n* (%)	38	37	0.65

**P*-value significant, *P*-value not significant. Values are mean±SD or number of patients, SD – Standard deviation

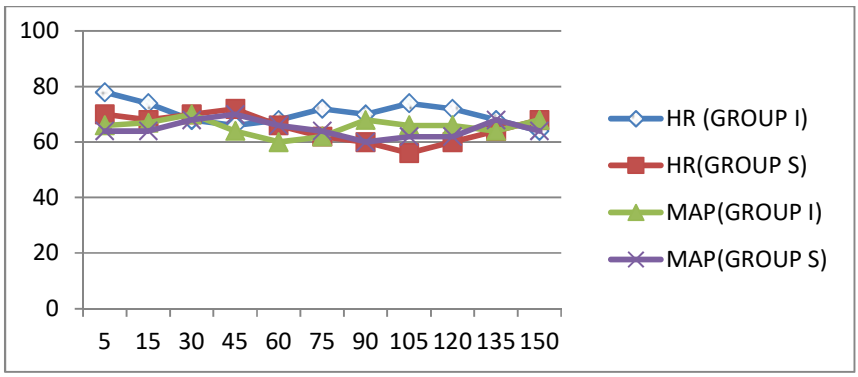

Figure1: Changes in heart rate and MAP during surgery

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DISCUSSION

Brachial plexus block is good alternative or an adjuvant to general anesthesia for surgeries of upper limb. There are important advantages of brachial plexus block, including, that patient being conscious during the surgery, spontaneous breathing of the patient, maintaining airway reflexes, analgesia in the post-operative period and early mobilization of the patient. A brachial plexus block can be performed using multiple different approaches. In our study, we had compared the supraclavicular and infraclavicular approaches using ultrasonography in patients undergoing upper limb orthopedic surgeries.

We had followed the guideline of The New York School for performing both the blocks. The supraclavicular block was performed by administering two aliquots of bupivacaine with dexmedetomidine at two separate locations within the brachial plexus sheath.[14] We performed the infraclavicular block by injecting the local anaesthetic until the U-shaped spread around the artery was documented.[5] The individual cords were not targeted and the needle was aimed towards the posterior cords. However few studies have suggested a single injection technique for the supraclavicular block. [15-17]

The block performance time was less for infraclavicular block than supraclavicular block. The additional minutes required for the supraclavicular block can be because the needle was targeted at two points in supraclavicular block whereas the local anaesthetic was deposited at only one point in infraclavicular block. The mean block performance time of 5.0 min in the infraclavicular group and 5.7 min in the supraclavicular group was reported by Koscielniak-Nielsen ZJ et al,[9]Arcand et al.[12]compared ultrasound guided supraclavicular with infraclavicular blocks and reported no significant difference in the block performance time. In our study the success rate of the brachial plexus block was 98% infraclavicular group vs 90 % in supraclavicular group. Koscielniak-Nielsen ZJ et al in their study reported that success rate was 93% in infraclavicular group vs 78% in supraclavicular group.[9] However, three other studies[15,16-18] found that a success rate of around 95% for ultrasound-guided supraclavicular blocks. Ootaki C et al [19] and Sandhu NS et al [20] quoted a success rate of 90%–95% for ultrasound-guided infraclavicular block. All these findings are similar to the success rate of our study.

In our study, we observed that the onset of sensory blockade as well as motor blockade was slightly earlier in the infraclavicular group than supraclavicular group. Koscielniak et al [9] reported that an ultrasound guided infraclavicular block had a faster onset, better surgical efficacy and fewer adverse events than a supraclavicular block. Koscielniak-Nielsen ZJ et al in their study the sensory block to all seven terminal nerves following brachial plexus block was evaluated, they concluded that supraclavicular block had a significantly poorer block of the median and ulnar nerves but a better block of the axillary nerve.[9] In contrast, Arcand et al[18]reported no significant difference in onset times of blocks and block efficacy.

In this study, there were no significant difference in both groups in terms of duration of sensory block, duration of motor block and post-operative analgesia and hemodynamic parameter. Similar result was observed by Ferlengez AG et al[21] and Sarkar S. et al.[22]Kilka et al[23]and Neuburger et al [24]reported

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adequate surgical analgesia in the infraclavicular approach and this finding are similar to our study. In our study, high incidence of complication was seen with the supraclavicular approach. Horner's syndrome developed in four patients and diaphragmatic paresis was observed in one patient in supraclavicular group and all the patients were managed conservatively. None of any other complication like pneumothorax or vascular puncture were observed in either group. Koscielniak-Nielsen ZJ et al in their study reported Horner's syndrome and diaphragmatic paresis in 20% of patients with supraclavicular block. Neal JM. et al[25]have been reported a 50% incidence of diaphragmatic paresis in supraclavicular block when using more sensitive methods of assessment such as ultrasound, plethysmography and pulmonary function tests. Since we used only clinical assessment and chest X-ray for diagnosis, the incidence was only 2.5% in our study. Williams SR et al [17] reported, 3% incidence of diaphragmatic paresis in supraclavicular block on the basis of clinical diagnosis with breathing difficulties and chest X-ray and this finding correlates with our study. Pneumothorax was reported in two patients (4%) in supraclavicular block performed blindly.[12] Incidence of pneumothorax in our study was nil in both group with the use of ultrasound. The incidence of vascular puncture was nil in both groups in our study. The vascular puncture incidence was reported from 2%[6] to 2.5%[9] in other studies

All the findings of our study support hypothesis that infraclavicular block is safe can be performed faster than supraclavicular block in the presence of ultrasound. There are three limitations in our study. Firstly, though the results were favouring infraclavicular block, still we did not get a significant difference in complication rate and readiness for surgery and the power analysis also showed that much larger number of sample size might be needed to achieve a statistical difference. Second, we did not use catheters for blocks. It was claimed that with infraclavicular block, the catheter can be maintained and secured easily than supraclavicular block.

CONCLUSION

Ultrasound-guided technique resulted in faster performance of infraclavicular block compared to supraclavicular block thus minimizing the rate and occurance of complications with similar degree of surgical anaesthesia observed in both approaches but expertise is needed in infraclavicular approach.

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