ORIGINAL ARTICLE

Infraclavicular brachial plexus block: Comparison of posterior cord stimulation with lateral or medial cord stimulation, a prospective double blinded study

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ABSTRACT

Background: Infraclavicular approach to the brachial plexus sheath provides anesthesia for surgery on the distal arm, elbow, forearm, wrist, and hand. It has been found that evoked distal motor response or radial nerve-type motor response has influenced the success rate of single-injection infraclavicular brachial plexus block. **Aim:** We conducted this study to compare the extent and effectiveness of infraclavicular brachial plexus block achieved by injecting a local anesthetic drug after finding specific muscle action due to neural stimulator guided posterior cord stimulation and lateral cord/medial cord stimulation. **Methods:** After ethical committee approval, patients were randomly assigned to one of the two study groups of 30 patients each. In group 1, posterior cord stimulation was used and in group 2 lateral/medial cord stimulation was used for infraclavicular brachial plexus block. The extent of motor block and effectiveness of sensory block were assessed. **Results:** All four motor nerves that were selected for the extent of block were blocked in 23 cases (76.7%) in group 1 and in 15 cases (50.0%) in group 2 (*P*:0.032). The two groups did not differ significantly in the number of cases in which 0, 1, 2, and 3 nerves were blocked (*P*>0.05). In group 1, significantly lesser number of patients had pain on surgical manipulation compared with patients of group 2 (*P*:0.037).**Conclusion:** Stimulating the posterior cord guided by a nerve stimulator before local anesthetic injection is associated with greater extent of block (in the number of motor nerves blocked) and effectiveness of block (in reporting no pain during the surgery) than stimulation of either the lateral or medial cord.

Key words: *Infraclavicular brachial plexus block, lateral/medialcord, neural stimulator, posteriorcord*

INTRODUCTION

Infraclavicular approach to the brachial plexus block, first described by Labet in 1922, provides anesthesia for surgery on the distal arm, elbow, forearm, wrist, and hand.[1] Numerous modifications of this technique have been developed to improve the success rate and risk of complications.[2-6] With the advent of nerve stimulator, the regional block has become more popular because of its advantage of minimal discomfort to patient, lesser chances of nerve damage, and improved success rate in contrast to the 'paresthesia technique'.[7-11] In infraclavicular brachial plexus block, it has been found that evoked distal motor response or radial nerve-type motor response has influenced the success rate of single-injection infraclavicular brachial plexus block. It has been observed in a nonrandomized observational study that the infraclavicular block after localizing the posterior cord would place the needle centrally within the infraclavicular portion of the brachial plexus and allow an even spread of the local anesthetic compared with localizing the lateral/medial cord.[12]

The present randomized prospective study was conducted to evaluate the extent and effectiveness of infraclavicular brachial plexus block achieved by injecting drugs after

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stimulating the posterior cord and comparing the same with the block achieved by injecting drugs after stimulating the lateral or medial cord with the help of a neural stimulator.

METHODS

This randomized, prospective, parallel group, double-blinded study was conducted after obtaining the approval of the institutional ethical committee. Patients were blinded about the groups to which they belong and investigators performing the block were allowed to select patients in a particular group based on muscle activity without specifically searching for a cord; hence, they too were blinded. Sixty patients in the age group 18-65 years of either sex and the American Society of Anesthesiology (ASA) physical status one or two undergoing elective surgery below or at the elbow (hand, wrist, forearm, or elbow) were recruited for the study. An informed and written consent was taken from all the patients. Patients with a history of brachial plexus surgery or injury, previous adverse reaction to amide local anesthetic, infection at the site of puncture, coagulopathy, and pregnant patients were excluded from the study. Patients were evaluated preoperatively and the procedure was explained to them for the brachial plexus block.

Patients were randomized using computer-generated random number table to one of the two groups: Group 1 (n=30): Infraclavicular brachial plexus block given with posterior cord stimulation; and Group 2 (n=30): Infraclavicular brachial plexus block given with lateral or medial cord stimulation. Regional anesthesia technique was standardized in both groups.

Anesthetic technique: After placement of an intravenous catheter, all patients received intravenous midazolam (1 mg). Patients were placed supine with the arm abducted to 90 degree. The coracoid process was palpated and a point 2 cm inferior and 2 cm medial to the process identified. The skin overlying this point was cleaned and infiltrated with 1% lidoocaine (2 ml). A 50 mm short-bevel insulated needle connected to a neural stimulator was than inserted perpendicular to the skin. The stimulator was set to deliver rectangular direct current impulses with a frequency of 2 Hz and pulse width of 100 ms. The initial stimulating current was set at 1.0 mA. Once proximity to a cord was identified by visible contraction of an appropriate muscle group, the current was incrementally reduced to 0.3 mA or less, and the needle slowly inserted until muscle activity resumed. The cord was identified by observing the specific muscle responding: Lateralcord–coracobrachialis (elbow flexion); Medialcord–flexor carpi ulnaris (wrist flexion); Posteriorcord–triceps (elbow extension).

25 ml of 0.5% bupivacaine was injected at that site after electrical stimulation of the cord with respect to muscle contraction. Patients were observed for any complication during the block procedure. The block was evaluated for motor and sensory functions after 15 min and 30 min of full dose of local anesthetic, respectively. For motor block evaluation, the following nerves were assessed: Radial nerve (push–assessed by elbow extension against resistance), median nerve (flexion of the distal interphalangeal joint of the second finger keeping the proximal interphalangeal joint steady), ulnar nerve (abduction of the middle and ring fingers), and musculocutaneous nerve (pull–elbow flexion against resistance). Motor block grading was performed using the following scale: 0=normal contraction, 1=reduced contraction (paresis), and 2=no contraction (paralysis). Nerves with motor blockage grade 1 or grade 2 were considered as motor blockage. For sensory block evaluation, the following nerves were assessed: Radial nerve (dorsum of hand, over the second metacarpophalangeal, lower lateral part of the arm, posterior aspect of the arm and forearm), median nerve (thenar eminence and the first three finger palmer aspect), ulnar nerve (medial side of hand, palmer and dorsal aspect and little finger), medial cutaneous nerve of the arm and forearm (medial side of the arm and forearm, respectively), intercostobrachial nerve (skin distal to axillary hair patch), musculocutaneous nerve (lateral side of the forearm), axillary nerve (upper lateral side of the arm) using a blunt-tip needle for pin prick. At 30 min after block placement, any patient with a block that was inadequate for surgery was offered general anesthesia.

The outcome of block was measured in the form of extent of block and effectiveness of block. For the extent of block, the following nerves were assessed: Radial nerve, median nerve, ulnar nerve, and musculocutaneous nerve. The extent of block was assessed in the form of the number of motor nerves blocked in each case: 0 nerve blocked-1 nerve blocked-2 nerves blocked-3 nerves blocked-4 nerves blocked.[12] For effectiveness of the block, the ability to tolerate surgical incision or manipulation was assessed in the following way: 2=no pain, 1=wincing, which may or may not require sedation, and 0=unbearable pain.

Any complication, including bleeding from subclavian vessel puncture, local anesthetic toxicity, and pneumothorax during the block procedure and during surgery, was recorded.

Statistical analysis

The sample size of 60 patients in the two groups was based on an assumed difference of 20% in the success rate of the block. Data was presented in terms of descriptive statistics for continuous variable and the proportion

for categorical variable. Two-sample *t*-test was used for comparing demographic characteristics. The Chi-square test/Fisher-exact tests were used to compare the categorical variable (extent of block and effectiveness of block). $P<0.05$ was taken as a level of significance.

RESULTS

Sixty-eight patients were recruited for the study, but only 60 patients were randomized because the rest did not meet the inclusion/exclusion criteria. Patients in both groups were comparable with regard to sex, age, weight, ASA physical class, and region of surgery [Table 1].

Significantly more number of patients in group 1 had the entire 4-nerve region blocked compared with patients of group 2 (*P*:0.032) [Table 2].

Significantly lesser number of patients in group 1 had pain on surgical manipulation compared with patients of group 2 (*P*:0.037) [Table 3].

Hemodynamic parameters including pulse rate, mean blood pressure, and respiratory rate were comparable in the two groups ($P>0.05$). In both groups no complications were observed.

Table 1: Demographic characteristics in the two groups

	Group 1 (*n*=30)	Group 2 (*n*=30)	*P* value
Sex (M:F) (*n*)	26:4	26:4	1
Age (years), mean±SD	33.13±9.62	35.43±14.25	0.467
Weight (kg), mean±SD	65.50±4.24	63.47±4.86	0.090
ASA 1:11 (*n*)	24:6	25:5	0.739
Region of surgery-hand and wrist: Forearm: Elbow and surrounding area (*n*)	8:17:5	7:16:7	0.806

ASA – Anaesthesiology

Table 2: The extent of block as assessed by the motor block in the number of nerves

Extent of motor nerve block	Group 1 (*n*=30)	Group 2 (*n*=30)	*P* value
0 Nerve blocked	1 (3.3)	5 (16.7)	0.085
1 Nerve blocked	1 (3.3)	4 (13.3)	0.161
2 Nerve blocked	2 (6.7)	2 (6.7)	1.000
3 Nerve blocked	3 (10.0)	4 (13.3)	0.688
4 Nerve blocked	23 (76.7)	15 (50.0)	0.032*

Number of patients (percentage); *(Statistical Significant)

Table 3: The effectiveness of block-sensory block in the two groups

	Group 1	Group 2	*P* value
2=No pain	26 (86.7)	19 (63.3)	0.037*
1=Wincing which may or may not require sedation	2 (6.7)	4 (13.3)	0.389
0=Unbearable pain	2 (6.7)	7 (23.3)	0.071

Number of patients (percentage); *(Statistical significant)

DISCUSSION

The results of the present study indicate that stimulating the posterior cord of brachial plexus during infraclavicular brachial plexus block provides greater extent and effectiveness of block, compared with stimulating the lateral/medial cord of brachial plexus.

Our results reaffirm the outcome of the study conducted by Lecamwasam *et al.*, where they reported that stimulating the posterior cord before local anesthetic injection is associated with increased success rate for infraclavicular brachial plexus block than stimulation of the medial or lateral cord.[12] However, their study was limited by the fact that it was a non-randomized observational study and specific cord identification was not attempted, which is in contrast to our study. Sebastien Bloc studied the success rate of single-injection infraclavicular plexus block by using electrically evoked radial, ulnar, or median nerve-type distal motor response to guide the injection of local anesthetic solution.[13] They found that the success rate was significantly higher when the injection was performed on a radial nerve-type response (90%) compared with the median (74%) or ulnar (68%) nerve distal motor-type response. Recently, similar results have been reported even with ultrasound-guided block. Bowens *et al.* studied the success rate of infraclavicular block after ultrasound and neurostimulation-guided injection of local anesthetic either centrally (posterior cord) or peripherally (medial or lateral cord). They observed a significantly higher success rate of block when the drug was placed centrally.[14] Li *et al.* conducted a study to compare the difference in the efficacy of infraclavicular brachial plexus block by stimulating different cords of the infraclavicular brachial plexus, with Wilson's approach guided by a nerve stimulator. They found that stimulating the posterior cord provided complete blockade in 78.9% and stimulating the lateral cord provided complete blockade in 53.1%; this shows that stimulating the posterior cord increases the efficacy of infraclavicular brachial plexus block compared with stimulating the lateral cord.[15] Porter *et al.* carried out ultrasound-guided coracoid infraclavicular brachial plexus block to allow visualization of the needle in addition to the observation of local anesthetic spread on injection. They stated that the injection of local anesthetic after obtaining proximal muscle stimulation was associated with local anesthetic spread between the axillary artery and pectoral muscle.

This resulted in block failure. When local anesthetic was injected after distal muscle stimulation as the needle reaches posterior to the axillary artery, it leads to the spread of local anesthetic solution posterior to the axillary artery and increases the possibility of successful block because of the anatomical location of the brachial plexus at this level.[16]

In the present study, no complications were reported during the block procedure and during the surgery in both groups. In the present study, a nerve stimulator and an insulated needle were used for identification of cords of the brachial plexus. It makes it easier to locate the cord, thereby reducingthe chances of trauma due to repeated puncture for identification of the cord. In the literature it has been mentioned that infraclavicular brachial plexus can avoid neurovascular structure of the neck, minimize the risk of pneumothorax, and does not produce a reduction in pulmonary functions.[17-21]

To conclude, stimulating the posterior cord guided by a nerve stimulator before local anesthetic injection is associated with a greater extent of block (in the number of motor nerves blocked) and effectiveness of block (in reporting no pain during the surgery) than stimulation of either the lateral or medial cord.

Limitations

In this study, we did not specifically search for individual cords by manipulating the needle direction; however, we formed groups based on finding specific muscle activity, which increased the study time in selecting patients for groups. In the future, we could select patients in a particular group beforehand and then search for the cord of that group, which will help us in identifying a specific direction for that brachial plexus cord. We have also not compared the complications between the two groups.

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