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A RANDOMIZED CONTROLLED STUDY COMPARING USG GUIDED SUPRACLAVICULAR VS INFRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES

KEYWORDS: Supraclavicular, Infraclavicular, USG Guided, Brachial Plexus Block

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ABSTRACT

Background and goals of study: The aim of the study is to compare the Ultrasound guided supraclavicular block with infraclavicular block for forearm and hand surgeries.

Methods: 120 patients (n=120) were recruited in this study. They were randomly allocated into two groups. Group-S patients (n=60) received ultrasound guided supraclavicular block and Group-I patients (n=60) received USG guided infraclavicular block. The patients were evaluated for 1) sensory block at radial, median, ulnar and musculocutaneous nerve distribution 2) Motor block at the level of elbow, wrist and hand grip 3) Complete sensory block in all four nerve territories 4) Complete motor block in all three joints. 5) Effective upper limb block 6) surgical block 7) Block performance time 8) Requirement of intra operative anxiolytics and opioids and 9) adverse events like a) accidental vessel puncture b) Horner's syndrome and c) Pneumothorax.

Results: The two groups were comparable in terms of age, sex, weight distribution and other demographic parameters. No difference was observed between the two groups in terms of sensory block in the areas distributed by radial, median and musculocutaneous nerves. Group-I patients had a significantly better block in the ulnar nerve distribution than the Group-S patients (p= 0.013). For motor block, no significant results were observed between the two groups at elbow and wrist level. Group-S patients showed poor motor block at hand grip level than Group-I patients ($p<0.05$). Complete sensory block (p=0.013) and complete motor block (p=0.018) were superior in the Group- I. Effective upper limb block was inferior in the Group-S (70%) compared with Group-I (85%). No difference was observed between the two groups for surgical block. Compared with the Group-S, the Group-I had a longer block performance time. Intra operative requirement of anxiolytics and opioids was less in Group-I. There was a higher incidence of accidental vessel puncture in Group-I than in Group-S (36.7 % vs. 11.7 %). Complications like Horner's syndrome and Pneumothorax were not observed in both the groups.

Conclusion: Infraclavicular approach produces better blockade than supraclavicular approach in spite of longer performance time and higher incidence of accidental vessel puncture.

INTRODUCTION:

Surgical procedures involving hand and forearms can be performed under brachial plexus block. Entire sensory and motor blockade of the upper limb can be achieved by blocking the brachial plexus and has stood the test of time for upper limb surgeries. Interscalene, supraclavicular and axillary blocks are routinely used approaches for brachial plexus1. Infraclavicular approach to the brachial plexus block is also commonly used in recent times. Infraclavicular block is considered as effective as supraclavicular block, and is performed at the level of the cords2 whereas supraclavicular approach is used for blocking at the level of trunks and divisions. Infraclavicular approach is supposed to be associated with less incidence of pneumothorax3. This study was planned to compare the clinical efficacy of ultrasonogram guided supraclavicular and infraclavicular approaches of brachial plexus block in forearm and hand surgeries.

Aim of the study is to compare the ultrasound guided supraclavicular block with infraclavicular block for forearm and hand surgeries. Primary objective is to assess the effectiveness of the upper limb block based on the 1) Sensory block over the areas supplied by radial, median, ulnar and musculocutaneous nerve 2) Motor block at the level of elbow, wrist and hand grip 3) Complete sensory block 4) Complete motor block 5) Effective upper limb block and 6) Surgical block. Secondary objective is to assess the Block performance time and to study the incidence of adverse events like pneumothorax, accidental vessel puncture and Horner's syndrome.

METHODOLOGY:

This is a prospective randomized study. 120 adult patients aged between 18 to 50 years, of ASA grade 1 and 2 of either sex undergoing surgeries on the forearm and hand were randomly allocated into two groups, Group- S and Group- I. Each group comprises of 60 patients. Surgery was performed under ultrasonogram guided supraclavicular block in Group-S and Ultrasonogram guided infraclavicular block in Group- I. Following patients were excluded from the study: Patient refusal for the procedure, uncooperative patients, clinically significant pulmonary pathology, pregnant women, known cases of neuropathy involving the forearm and hand, Infection at the needle insertion site and Coagulopathies.

Written informed consent was obtained from all the patients. An 18G IV line was secured on the non-surgical limb. Intravenous fluid in the form of Ringer lactate was started, at the rate of 100ml/hour. The patients were premedicated with 0.025mg/kg of midazolam intravenously 5 minutes before the procedure. Pulse Oximeter, ECG, NIBP monitors were attached to the patient and baseline parameters was recorded. A local anesthetic mixture was prepared with, equal volumes of 0.5% bupivacaine and 2% lignocaine with adrenaline. The local anesthetic mixture was given in a dose of 0.5ml/kg. An ultrasound machine that was equipped with color Doppler and a linear 10-18 MHz probe was used to all patients in both groups.

Ultrasonogram probe jelly was applied over the probe, and the probe was covered with sterile covering. Skin was prepared with povidone iodine solution. The target for group-S is the trunks, divisions of the Brachial plexus and the subclavian artery. The target for group-I is the axillary artery, axillary vein and the cords of brachial plexus.

Supraclavicular group:

In the group-S, the patients was placed in supine position .The operating arm was placed on the side of the body and adduction at shoulder joint and the head was turned away from the side to be blocked with shoulder elevated. Probe placement in group-S was coronal oblique plane, in the supraclavicular fossa just lateral to the clavicular head of the sternocleidomastoid muscle, with the intention of visualizing the subclavian artery, pleura, first rib and the brachial plexus.

After anaesthetizing the skin and subcutaneous tissue with 1- 2 ml of 2% lignocaine, an 8 cm long 18G needle was introduced under the

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probe, along with the probe's long axis (in plane technique). The first 20 ml of the local anesthetic mixture was injected inferolateral/ lateral to the subclavian artery around the plexus and the remaining anesthetic mixture was injected superior to the plexus after repositioning the needle tip.

Infraclavicular group:
With the patient in supine position, the operating arm was placed 90% abduction at the shoulder joint and elbow flexed. Patient's head turned away from side to be blocked.

The pillow was positioned underneath the shoulder blades, so as to extend the both shoulders and therefore to expose the deltopectoral groove. The probe placement in group-I was over the deltopectoral groove in the parasagittal plane with a medial to lateral position with the intention of visualizing the axillary artery, axillary vein and the cords of the plexus. An 8 cm long 22G needle was introduced under the probe, along with the probe's long axis (in plane technique). The first 10ml of the local anesthetic mixture was injected posterior to the artery. Second 10ml of local anesthetic mixture was injected lateral to the axillary artery. The remaining local anesthetic mixture was injected in between axillary artery and axillary vein after repositioning the needle tip.

Outcome measures:
1. SENSORY BLOCK- Sensory block was evaluated by pinprick stimulation at the areas supplied by radial nerve, median nerve, ulnar nerve and musculocutaneous nerve. The assessment of sensory block documented for each nerve as:

a. anesthesia-score 2(no pain ,no touch sensation)
b. analgesia -score1(no pain)
c. pain-score 0 (feels pain)
Sensory block was assessed every 10 minutes after the needle removal for 30 minutes.

2. MOTOR BLOCK- was assessed at the level of wrist, elbow, hand grip.

a. Elbow: by flexion and extension of the elbow
b. Wrist: by flexion and extension of the wrist
c. Hand grip: by flexion of the fingers at the metacarpo phalangeal and interphalangeal joints. flexion and adduction of the fingers and thumb.

Motor function was graded such that,

a. paralysis - score 2(no contraction)
b. paresis –score 1(reduced contraction)
c. no weakness-score 0(normal contraction)

Motor block was assessed at 30 minutes after needle removal.

3. COMPLETE SENSORY BLOCK-is defined as a sensory block of score 2 in all four nerve territories.

4. COMPLETE MOTOR BLOCK - is defined as a motor block of score 2 in all the three joints motor components.

5. EFFECTIVE UPPER LIMB BLOCK- is defined as a complete sensory block (score 2 in all four nerve territories) and complete motor block (score 2 in all three joints motor components).

6. SURGICAL BLOCK- is defined as a sensory score of 1 (analgesia) or score of 2 (anesthesia) in all four nerve territories after 30 minutes of block, irrespective of the motor block.

7. BLOCK PERFORMANCE TIME
Block performance time is defined as the time interval from the time of first insertion of the blocking needle to the time of its removal. Block performance time was recorded by the anesthesia assistant with an electronic stop watch.

8. REQUIREMENT OF INTRAOPERATIVE ANXIOLYTICS AND OPIOIDS
Vide infra

9. ADVERSE EVENTS
The following adverse events were looked for in all the patients.
a. Accidental vessel puncture was identified by the appearance of blood in the syringe.
b. Horner's syndrome can be identified by the appearance of ptosis and miosis.
c. Pneumothorax can be identified clinically by persistent cough, chest pain, difficulty in breathing and shortness of breath within 24 hours after performance of block. It was confirmed by taking chest X-Ray for the clinically suspected patients.

Patients who had an 'effective surgical block' were declared as, ready for the surgical procedure. Intraoperatively patients with score 1 of sensory block was given additional dose of 0.025mg/kg of Inj. Midazolam and 1mcg/kg of Inj. Fentanyl. Patients with score 2 of sensory block, directly go with the surgical procedure.

For anxious patients, additional dose of Inj. Midazolam 0.025mg/kg was given. All patients were supplemented with nasal oxygen 3 – 4 liters/min through face mask intra-operatively. Patient was monitored throughout the procedure. At the end of procedure, patient was transferred to post anesthesia care unit. In the post anesthesia care unit patient was monitored for 24 hours. For all patients inj. Paracetamol 1 gram was given intravenously after 6 hours of the procedure and continued thrice daily for two days.

All the blocks in both the groups were performed by the principle investigator. Outcome measures were assessed by anesthesia resident, except block performance time. Block performance time was recorded by anesthesia assistant.

RESULTS:
Data analysis was done with the help of computer using SPSS software. Data was expressed as mean of Standard deviation. Quantitative Analysis was compared with Pearson Chi-Square, Fishers Exact Test and independent 'S' were used. A 'p' value <0.05 was considered significant.

The two groups were comparable in terms of age, sex, and weight distribution ($p<0.05$). Other demographic parameters such as duration of surgery and surgical area distribution were also comparable with the 'p' value of <0.05.

No difference was observed between the two groups in terms of sensory block in the areas distributed by radial, median and musculocutaneous nerve with the 'p' values of 1.000, 0.315 and 1.000. Group-I patients had a significantly better block in the ulnar nerve distribution than the Group-S patients with the 'p' value of 0.013.

For motor block, no significant results were observed between the two groups at elbow and wrist level with the 'p' value of 1.00 and 0.648. The Group –S patients showed poor motor block at hand grip level than Group-I patients ('p' value 0.013).

Complete sensory block is superior in the I-Group: 91.7% vs. 76.7% in the Group-I with the 'p' value of 0.013.

Complete motor block is also superior in the Group-I: 88.3% vs. 75% in the Group-S with the 'p' value of 0.018.

Effective upper limb block is inferior in the Group-S (70%) compared with Group-I (85%) with the 'p' value of 0.021.

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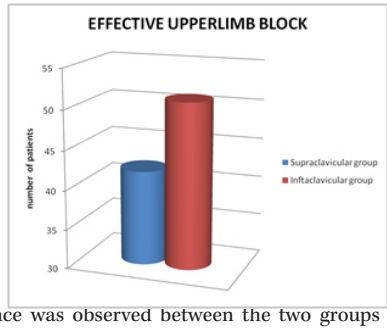
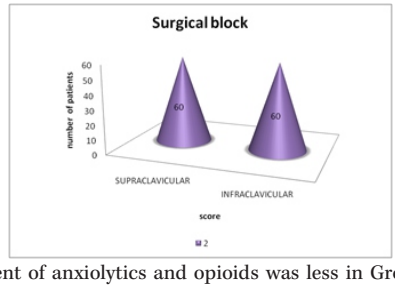
EFFECTIVE UPPER LIMB BLOCK				
	Group S		Group I	
	Number of patients	%	Number of patients	%
Score 2	42	70	51	85
Chi square value	5.089 significant			
'p'value	0.021 significant			



No difference was observed between the two groups for surgical block with the 'p' value of 1.000.

SURGICAL BLOCK				
	Group S		Group I	
	Number of patients	%	Number of patients	%
	60	100	60	100
'p'value	1.000 not significant			



Requirement of anxiolytics and opioids was less in Group-I when compared to Group-S Compared with the Group-S, the Group-I had a longer block performance time (416.48 seconds [SD-20.550] vs. 894.92 [SD- 57.063] with the 'p' value of 0.000.

There was a higher rate of accidental vessel puncture in group-I (36.7 % vs. 11.7 %) than in Group-S with the 'p' value of 0.001.

There was no Horner's syndrome and Pneumothorax in both the groups.

DISCUSSION:

Surgical procedures involving hand and forearms can be performed either with general anesthesia or regional anesthesia techniques. In general anesthesia, patients have the risks of airway manipulation, hemodynamic instability, cognitive dysfunction and post-operative nausea and vomiting[4]. Anesthesia with regional techniques can overcome the complications associated with general anesthesia. Also regional anesthesia techniques have the advantage of decreasing morbidity, mortality, providing superior post-operative analgesia, being cost effective and lower in the rate of serious complications when compared to general anesthesia. Regional anesthetic technique with peripheral nerve block enables the patients to be discharged on the same day, thus facilitating day care surgery.

In upper limb the entire sensory and motor blockade can be achieved by blocking the brachial plexus and has stood the test of time for upper limb surgeries. Interscalene block, supraclavicular block and axillary blocks are routinely performed blocks for upper limb surgeries. Infraclavicular block has been commonly used recently. Among the various approaches of brachial plexus block, supraclavicular block is considered the easiest, and it also provides the most reliable, uniform, predictable anesthesia for upper extremity and blocks at the level of trunks and divisions.

Hence it is one of the most popular techniques used for upper limb surgeries. Recently, infraclavicular block is also considered as effective as supraclavicular block. The cords of the brachial plexus are blocked in infraclavicular approaches[2] when compared with supraclavicular approaches where the block is performed at the level of trunks and divisions. It is an excellent block for providing either surgical anesthesia or postoperative analgesia for all distal upper limb procedures[2,5]. This block is typically performed between the anterior shoulder and chest wall, in the deltopectoral groove[1]. It is considered that, supraclavicular approach is associated with more incidence of pneumothorax. Infraclavicular block is supposed to decrease the risk of pneumothorax[3]. Hence, it is decided to compare the efficacy and complications of supra and infra clavicular approaches of brachial plexus block.

Initially nerve blocks were performed with paraesthesia elicitation technique. The classical approach using paraesthesia technique was a blind, land mark technique and associated with higher failure rates and injury to the nerves and surrounding structures[6]. Later, nerve stimulator was invented for higher success rate and to decrease the complications[7]. This technique ensures a better blockade than conventional paresthesia technique[8]. This landmark and nerve stimulator techniques can cause neurovascular injuries, which will lead to permanent nerve damage[9], injury to the pleura leading to pneumothorax[10] and also had more failure rates.

The problem with designated anatomical landmarks is that they are variable from patient to patient. When searching blindly for the plexus to block, an invasive needle with the sharp edge can damage or pierce the vessels, nerves and other anatomical structures[11]. Ultrasonogram was introduced with real time imaging radiological tool. Working with radiological tool gains more importance than paresthesia and peripheral nerve stimulator technique. The application of ultrasound guided technique for exact localization of nerves/ plexus and vessels has revolutionized the regional anesthesia field, where in ultrasound probes with suitable frequencies have been successfully tried[12]. Due to the advantage of real time visualization, ultrasonogram reduces the number of needle passes to reach the target nerve groups, which in turns can shorten the block performance time, and increases the success rate[13].

Ultrasound for supraclavicular and infraclavicular brachial plexus block has improved the success rate of block with excellent localization as well as improved safety margin[5,14]. Ultrasonogram is better than any other radiological tool for needle guidance in peripheral nerve block. It also pro-vides real time examination of the nerve, and also it provides visualization of the needle manipulation and local anesthetic spread[15]. Disposable sterile 8cm length, 18G needle is used to all the patients of both groups for, local anesthetic administration in our study.

For scanning, 15-18 MHz frequency probe is used for all patients in the supraclavicular group, and 10 to 12 MHz frequency probe is used for all patients in the infraclavicular group.

Sample size: Based on previous literature16 it was assumed that 95% of patients underwent Infraclavicular block and 80% of Supraclavicular block had total sensory and motor block. To estimate this difference with 95% confidence limits and 80% power the minimum sample size needed was calculated as 60 patients per group (total 120 patients).

$n=z^2\{P^1(1-P^1)+P^2(1-P^2)\}/(P^1-P^2)^2$

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P^1=95
P^2=80
=6.18{95 x 5+80 x 20}/ (95-80)^2
~57=60 patients

The drug injection site is inferolateral/lateral and superior to the subclavian artery in group-S. In group-I the drug is injected around the axillary artery, that is posterior, lateral and in between axillary artery and axillary vein.

Comparison of sensory block of four individual nerves in this study reveals that there is no statistically significant difference between both groups for radial, median, and musculocutaneous nerve.

The 'p' values were 1.000 for radial nerve, 0.315 for median nerve, and 1.000 for musculocutane-ous nerve. The sensory block of ulnar nerve was significantly better in group- I with the 'p' value of 0.013. From the above observation it may be concluded that infraclavicular block is better than group-S in our study. This may be due to the fact that we encountered difficulty in reaching the corner pocket between the first rib and the subclavian artery in group S[17]. This is the site where lower trunks are situated. Hence the results of sensory block of ulnar nerve were better with infraclavicular approach than with the group-S. The result obtained in our study was analogues to a previous study[16].

No significant difference was observed for motor block at elbow and wrist in both the groups with the 'p' value of 1.00 for elbow joint and 0.648 for wrist joint. At the hand grip level, group-I recorded better motor block than the group-S with a 'p' value of 0.013.

In our study complete sensory block was better for group-I (91.7%) than group-S (76.7%). One previous study also states that significant difference between supraclavicular and infraclavicular groups for complete sensory block16.

Complete motor block was higher with group-I (88.3%) than group-S (75%) with the significant 'p' value of 0.018. Effective upper limb block was defined, as a complete sensory block (score 2 in all four nerve territories) and complete motor block (score 2 in all three joints motor components).

Our study shows Effective upper limb block was better in group-I (85%) than group-S (70%) with the significant 'p' value 0f 0.021. The results obtained in our study were analogues to the previous study[16].

In our study surgical block was defined as a sensory score of 2 (anesthesia) or sensory score of 1 (analgesia) in all four nerve territories after 30 minutes of block irrespective of the motor block. In our study no significant difference occurred between the two groups for surgical block with 100% success in both groups. One previous study supports the similar results of success rate in our study[16]. Ulnar nerve is better located and reached in the infraclavicular approach. This could be the possible reason for the more effective blockade with the infraclavicular approach.

The block performance time taken by infraclavicular block is much more than supraclavicular block in our study, with the mean time of 416.48 seconds for group-S and 894.92 seconds for group-I. This may be due to the fact that difficulty to reach the posterior cord which is deeply placed in position and also the medial cord which placed in between the axillary artery and the axillary vein.

Out of 60 patients in supraclavicular group 18 patients were supplemented with Injection Midazolam 0.25mg/kg and Injection Fentanyl 1mcg/kg intraoperatively. Four patients were supplemented with Injection Midazolam 0.25mg/kg intra operatively.

In infraclavicular group out of 60 patients 9 patients were supplemented with Injection Midazolam 0.25mg/kg and Injection Fentanyl 1mcg/kg intraoperatively. Seven patients were supplemented with Injection. Midazolam 0.25mg/kg intraoperatively. Hence our study concludes that patients in infraclavicular group require less intraoperative supplementation than supraclavicular group.

Accidental vessel puncture is seen in 7 patients of supraclavicular group (11.7%), and 22 patients in infraclavicular group (36.7%). This may be due to the fact that accidental puncture of the axillary artery occurs when approaching the posterior cord which is deeply placed posterior to the axillary artery. Also the accidental puncture of either axillary artery or axillary vein may occur, while approaching the medial cord which is placed in between the axillary artery and the axillary vein. In our study no patients in both the groups were observed for Pneumothorax and Horner's syndrome. The result obtained in our study was analogues to the previous study. The incidence of pneumothorax is high in supraclavicular approach while using landmark technique or Nerve stimulation techniques. Since the localization of brachial plexus is more accurate with ultra-sonogram technique, pneumothorax is not seen in both the groups.

Ultrasound guided peripheral nerve blocks have a higher rate of success for achieving surgical anesthesia. Our study showed 100% success rate for both the groups in view of surgical anesthesia. In spite of taking longer time for block performance and higher incidence of accidental vessel puncture, group-I is better than the group-S, for complete sensory, complete motor and effective surgical block .Because the sensory block in ulnar nerve distribution and motor block at the hand grip level were better with group-I. Other than accidental vessel puncture in group-I, complications like Horner's syndrome and pneumothorax were not observed in both the groups.

CONCLUSION:

Infra clavicular approach of brachial plexus block produces better blockade than supra clavicular approach in spite of longer performance time and higher incidence of accidental vessel puncture.

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