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Original Research Article

A comparison of ultrasound versus paresthesia technique for supraclavicular brachial plexus block

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ABSTRACT

Background: Ultrasonography is a newer tool for identification of nerves in the practice of regional anaesthesia. Visualization of target structures and spread of drugs under direct vision and thus avoiding complications like pneumothorax, accidental intravascular injections are potential benefit of ultrasonography technique. Aim of the study was to examine the usefulness of ultrasound guided brachial plexus block and compare it with paresthesia technique with the believe that ultrasound guidance can shorten the onset as well as increase the duration of blockade..
Methods: Eighty patients of either sex, 18-60 years, posted for upper limb surgery were divided into 2 groups according to the technique used to give block, group US (ultrasound technique) and group PA (paresthesia technique). Both the groups received 0.5 % bupivacaine 20 ml with 8 mg of dexamethasone.
Results: There was notable difference between the patient groups with regard to initiation of motor blockade (10 min group US vs 11.1 min group PA, p <0.0156) and sensory blockade (5.16 min group US vs 6.96 min group PA, p <0.0001) also duration of motor blockade (1272.88 min in group US vs 899.25 min in group PA, p <0.0001) and sensory blockade (1343.88 min in group US vs 996.75 min in group PA, p<0.0001).
Conclusions: Ultrasound guided supraclavicular brachial plexus blocks result in a higher success rate with respect to onset and duration of blockade with less incidence of complications compared to paresthesia technique.

Keywords: Brachial plexus, Motor, Paresthesia, Sensory, Supraclavicular block, Ultrasound

INTRODUCTION

Success of regional anaesthesia depends upon precise identification of nerve plexus, proper techniques of nerve localization and needle placement, accurate deposition of drug around the plexus and at the same time avoiding intravascular or intra-arterial injection and accidental pleural puncture.[1] Brachial plexus block can be given by paresthesia or nerve stimulation or uItrasound technique.[2] In paresthesia technique block needle is placed in proximity to the target nerve or plexus. When a needle makes direct contact with a sensory nerve, paresthesia (abnormal sensation) is elicited in its area of sensory distribution. Ultrasound for peripheral nerve localization is becoming increasingly popular. This technique usually results in a far lower injected volume of local anaesthetic (10-30 mL).[2]

Ultrasonography is the only tool which can satisfy all the criteria of ideal nerve block.[3] As we can deposit the drug around the target under direct vision the success rate of ultrasonography guided block is quite high and at the same time quality of block is excellent. In this prospective, randomized, single blinded study we examined the usefulness of ultrasonography guided brachial plexus block and compare it with paresthesia

technique and evaluate onset time, duration and quality of motor and sensory block, success rate and complications if any noticed.

METHODS

In this randomized, prospective, controlled study 80 patients, aged 18-60 years of either sex posted for routine or emergency unilateral upper limb surgery were included. Patient having hypersensitivity to local anesthetics, coagulopathy, neuropathies and pulmonary pathology were excluded from the study. Written informed consent was obtained from all patients who were undergoing moderate to severely painful procedures. (e. g. fracture radius, ulnar, lower end humerus, below elbow amputation, hand or elbow deformity correction)

Pre-operative checkup was done and all the investigations were noted. On the day of surgery, procedure was explained to the patient. Perioperative pulse rate, blood pressure, SpO_2 were monitored. All patients were premedicated with Inj. Midazolam 0.02mg/kg and Inj. Fentanyl 1 µg/kg. Brachial plexus block was given by supra-clavicular approach. The patients were randomized into two groups, Group US - block given using Ultrasonography and group PA - block given by paresthesia technique. Both the groups received 0.5% bupivacaine 20 ml with 2ml (8 mg) dexamethasone making a total volume of 22 ml. Block was performed in supine position with arm by the side of the patient and head turn to the opposite direction after taking all aseptic and antiseptic precautions.

Group US: A sonosite linear probe (6- 13 MHz) was use to locate the nerve plexus in supraclavicular fossa using in-plane technique in all patients. The brachial plexus, subclavian artery, subclavian vein, first rib and pleura were visualized in coronal oblique plane. Brachial plexus was consistently located superolateral to subclavian artery almost in each case. After anaesthetizing the skin with 2 ml of 1% lignocaine nerve location was performed using a 22 gauze, 5 cm long, short beveled, teflon coated needle. Needle was advanced along the longitudinal axis of the ultra sound transducer from lateral to medial direction so that entire shaft of the needle would lie in the path of the ultrasound beam and both the needle shaft and tip could be visualized. After negative aspiration of air and blood, drug was injected and proper spread of drugs around the plexus is continuously evaluated with ultrasound and needle reposition was done whenever necessary.

Group PA: Brachial plexus blockade was given by classical (Kulenkampff's) approach. Under strict aseptic and antiseptic precautions 1.5 - 2 cm above the mid clavicular point, just lateral to subclavian artery pulsation, 22 gauge 1.5 inch hypodermic needle was introduced and move backward, inward and downward until paresthesia and/or pulsation and/or rib was encountered. Drug was injected after negative aspiration for blood. During the conduct of block and thereafter, the patient was observed vigilantly for any central nervous system and cardiovascular complications.

Onset of sensory blockade was assessed by atraumatic pin prick test in the areas innervated by median, ulnar, and radial nerves and correlated with contralateral limb. Sensory blockade was graded from VAS 10 to 0. (10 – Full sensation, 0 - no sensation, 0 - 4 mild pain, 4 - 7 moderate pain, > 7 severe pain).

Onset time of sensory blockade was considered from injection of drug to complete abolition of pin prick. Duration of sensory blockade was considered as time from total abolition of pin prick to first pain. Duration of effective analgesia was counted as time from injection of drug to VAS score > 4.

Motor blockade was evaluated by weakness of shoulder, elbow or wrist any of the three joints upon trying to perform active movements. It was graded by modified Lovett scale (0 to 6). Onset was considered as time from injection of drug to development of complete paralysis. Duration of motor blockade was considered as time between complete paralyses to modified Lovett rating scale of 6. Block was considered to be successful when there was complete sensory and motor blockade. Block was considered failed if there was absence of complete sensory or motor blockade in at least one dermatome. Patients with unsatisfactory effects of block were supplemented with intravenous sedation or general anesthesia using I-gel or classical LMA.

The sample size was calculated by taking the help of statistician and considering results of initial pilot study on 10 patients, with a goal of clinically meaningful prolongation of motor and sensory blockade of 15 to 20 %, ensuring power of the study being 0.90 with alpha error of 0.05. This results in sample size of 35–38 patients in each group but expecting a 5 % dropout rate, total 80 patients were considered in the study. The patients were randomized into two groups of 40 each, using computer generated random number table. Treatment was randomly allocated to the patients. After collecting all the relevant data from both groups, mean and standard deviation were calculated using MS Excel software for age, sex, type and surgical duration, onset of sensory as well as motor blockade, prolongation of block, duration of effective analgesia, pulse rate, systolic and diastolic pressure. To determine the statistical significance for above mentioned parameters unpaired t-test was applied using SPSS software and p-value was calculated. Qualitative data were expressed by number and percentage. To observe the difference between the proportion, chi square test or Fishers Exact test was used. Quantitative data were presented by mean±SD. Difference between the means were analyzed by repeated ANOVA followed by Post Hoc test. Confidence interval

were calculated and P value <0.05 was considered as significant level.

RESULTS

There was no notable difference between the groups with respect to age, sex, weight, surgical duration and ASA grading (Table 1). Types of surgeries were also not different between the groups (Table 2).

Table 1: Demographic characteristics and duration of surgery.

Variables	Group PA	Group US
Gender (male/female)	31/09	32/08
Age (years) Mean±SD	34.8±11.36	37.92±13.07
Weight (kg) Mean±SD	64.875±4.41	63.85± 4.98
ASA grading (I:II)	08:32	10:30
Duration of surgery (min) Mean±SD	168.87±26.98	173.62±67.71

Group PA-Paresthesia; Group US - Ultrasound; SD - Standard deviation

Table 2: Types of surgery.

Types of surgery	Group PA	Group US
	Number = 40 (50%)	Number = 40 (50%)
Deformity correction-hand/elbow	10 (25 %)	08(20 %)
Radius/ulna nailing/plating	23 (57.5 %)	24 (60 %)
Distal humerus nailing/plating	04 (10 %)	07 (17.5 %)
Tendon repair	02 (5 %)	01 (2.5 %)
Fasciotomy/amputation	01 (2.5 %)	00 (00 %)

Group PA - Paresthesia; Group US - Ultrasound; SD - Standard deviation

Table 3: Success rate between two groups.

Duration (min)	Group PA	Group US
	Number = 40 (50%)	Number = 40 (50%)
Success	35 (87.5%)	39 (97.5 %)
Fail	05 (12.5 %)	01 (2.5 %)

Group PA - Paresthesia; Group US - Ultrasound

47.5% patient in group US had sensory onset time of ≤ three mins compared to 0% patient in group PA. Onset time was 8-11mins in 40% patients in group PA compared to 0% patient in group US (Figure 1).

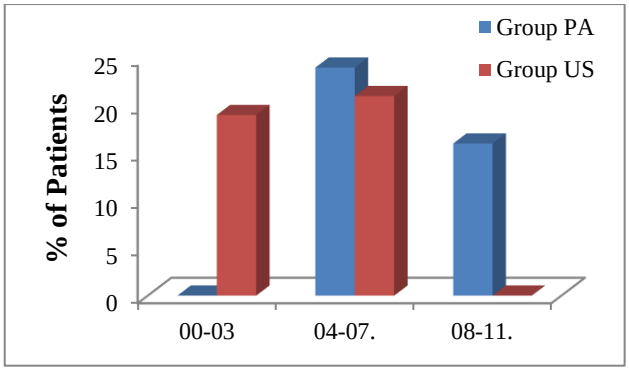

Figure 1: Onset time of sensory blockade.

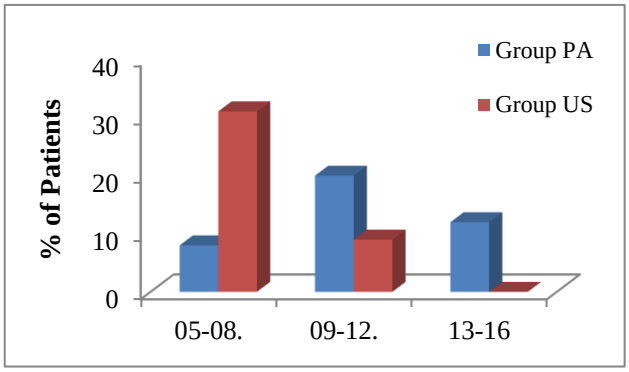

Figure 2: Onset time of motor blockade.

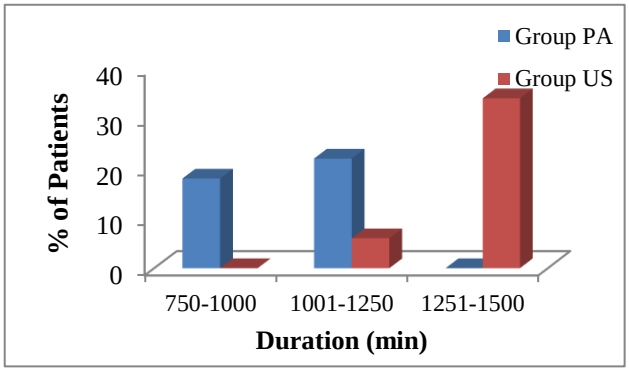

Figure 3: Duration of sensory blockade.

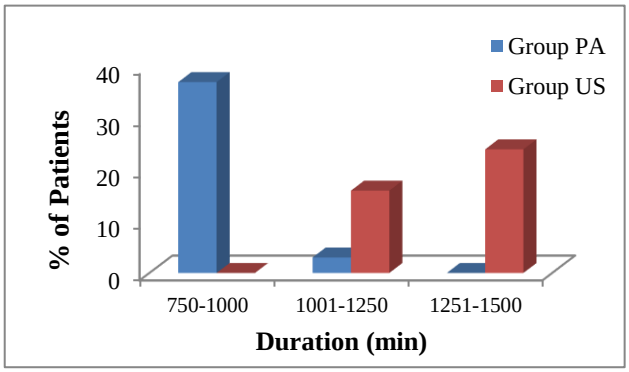

Figure 4: Duration of motor blockade.

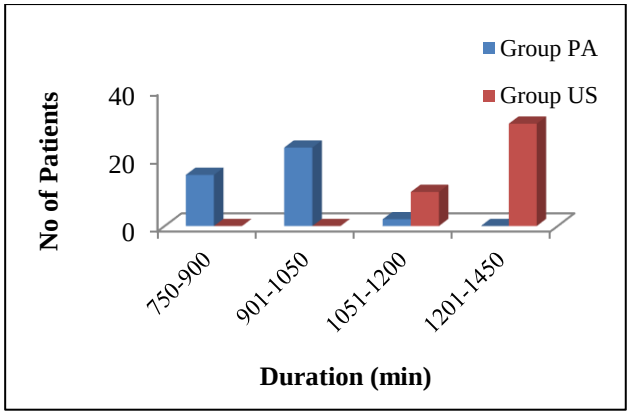

Figure 5: Duration of effective analgesia.

77.5% patient in group US had motor onset time of 5-8 mins compared to 20% patient in group PA. Onset time was 13-16 mins in 30% patients in group PA compared to 0% patient in group US (Figure 2).

In group PA 45% patients had sensory blockade of ≤ 1000 min while 100% of patients from group US had duration of sensory blockade ≥ 1000 min (Figure 3). Mean sensory blockade in group US was significantly prolonged as compared to group PA with p-value of <0.0001.

92.5% patients from group PA had duration of motor blockade ≤ 1000 min while 100 % of patients from group US had duration of motor blockade ≥ 1000 min. (Figure 4) Mean motor blockade in group US was significantly prolonged as compared to group PA with p-value of <0.0001.

100% patients from group PA had duration of effective analgesia ≤ 1200 min while 75% patients from group US had duration of effective analgesia ≥ 1200 min (Figure 5). Mean duration of effective analgesia in group US (1296.25±96.38 min) was significantly prolonged as compared to group PA (934.5±73.65 min) with p-value of <0.0001.

In paresthesia group, there were eight cases of vascular puncture and one case of pneumothorax which required ICD insertion post operatively. Five patient in paresthesia group and one patient in ultrasound group had unsatisfactory effect, required supplementation with general anaesthesia which were considered as failed. With ultrasound technique 97.5% of success rate was achieved (Table 3).

DISCUSSION

Goal of our prospective study is to find out the benefit of ultrasound in supraclavicular brachial plexus block in comparison to paresthesia technique. For successful block one should have the ability to precisely identify the nerve plexus and to deposit required amount of drug around the plexus aiming at complete impregnation of all the branches. Success also depends on the technique, experience, built of the patient, volume, type and the additive drug used. Still today in developing country most popular method of nerve identification is either by elicitation of paresthesia or by motor respond to nerve stimulator by nerve stimulator but both this technique are associated with complications, failure rate and patient dissatisfaction.[1,2] With paresthesia technique, there are increased risk of neuropathy, nerve injury and puncture of blood vessels.[4]

Ultrasonography is a newer tool for easy visualization of target structures leading to precise needle placement and spread and distribution of drugs under direct vision and thus avoiding complications like pneumothorax, accidental intravascular injections etc. Widespread use of ultrasound leads to increasing the success rate, decreasing onset time and even decreasing the total volume of drugs required.[1,2,5,6]

We considered the block to be successful when there is complete blockade of all sensory dermatome and at the same time inability to move any of the upper limb joint. In our study, surgery was performed without general anaesthesia in 97.5% (39 out of 40) in ultrasound group and 87.5% (35 out of 40) in paresthesia group. Results are comparable to those obtained by other studies, who have state that successful block is to carry out the surgery without giving general anaesthesia.[3]

Onset time of sensory as well as motor blockade in ultrasound group was significantly less as compared to paresthesia group which was comparable to the study done by Chan et al.[1] Vincent W. S. Chan, in their study observed that sensory and motor blockade onset time was 5.4±1.8 min. and duration of blockade was 11.4±4.2 hours, with low pain score and high patient satisfaction with ultrasound guided block.[5]

Mean duration of effective analgesia in group US was significantly prolonged as compared to group PA. This was comparatively longer in both the groups in comparison with other similar studies as we were using dexamethasone as additive which itself prolong the block duration.[7,8] Cummings and colleagues found that addition of dexamethasone to bupivacaine and ropivacaine increases the interscalene block duration from 11.8 to 22.2 hours in ropivacaine group and from 14 to 24 hours in bupivacaine group.[7] Williams et al, found that the duration of blockade was 846±531 min in US group without using dexamethasone.[9]

In our study there were eight cases of vascular puncture which was similar to Hickey et al, who mentioned puncturing subclavian artery during subclavian paravascular block in 25.6% cases.[10] Although ultrasound doesn't always prevent intravascular injection in our case it was almost nil.[11] Main benefit of using ultrasound for supraclavicular block is the easy visualization of the tip of the block needle and its relation to pleura, thus

avoiding pneumothorax. By using ultrasound Renes et al, demonstrate that there was no incidence of hemidiaphragmatic paresis.[4]

As we can visualized the nerve plexus directly the requirement of drug was quite less compare to conventional paresthesia technique.[12] Searle et al use only 25.7±5 ml of drug with excellent result which was almost similar to our study.[13] So our study shows that ultrasound had a definite edge over paresthesia technique. But when we look at the studies comparing the benefit of ultrasound over nerve stimulator technique, Chao L et al concluded that supraclavicular brachial plexus blockade by ultrasound or by nerve stimulator technique has similar success rate and produce excellent quality of sensory and motor blockade with fewer side effects.[6] But with respect to procedural time, less time was required for ultrasound guided block compared to nerve stimulator.[6,14]

CONCLUSION

Our study proved the superiority of ultrasound technique over the paresthesia technique with respect to early onset and prolongation of effective analgesia. The ultrasound guided technique always have an edge over the paresthesia technique in view of reducing complications because of direct visualization of target structures although there may be need for larger study to analyze the advantages of ultrasound over traditional paresthesia technique.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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