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A study on comparison between ultrasound guided technique and peripheral nerve stimulator guided technique in performing brachial plexus block (supraclavicular approach) for upper limb surgeries

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Abstract
Background: The use of a peripheral nerve stimulator (PNS) has been considered the 'gold standard' for performing peripheral nerve blocks for the last two decades and has been shown to be a highly effective technique for determining adequate needle placement to produce regional anaesthesia/ analgesia. However, with recent developments in high-frequency imaging, the use of ultrasound (US) technology has significantly increased for nerve localization.
Aim: To assess and compare between ultrasound guided technique and peripheral nerve stimulator technique for performing brachial plexus nerve block through supraclavicular approach.
Materials and Methods: A prospective randomised study was conducted at Meenakshi Mission hospital and research centre for a period of one year between Nov 2015 and Oct 2016. A total of 60 patients were included in the study and by using a single blinded technique they were randomised into two groups. Group A (n=30) patients received US guided technique for brachial plexus block and group B (n=30) received brachial plexus block through PNS technique. Procedure time, block start time (needle insertion), time to achieve complete sensory blockade, motor blockade, and duration of surgical procedure and duration of analgesia were recorded. Complications occurred if any were also noted.
Results: The mean time required for performing ultrasound guided technique was 2.58 mins and for PNS it was 5.82 mins and the difference was found to be statistically significant. Similarly the time required for achieving the complete nerve blockade was much less among the US guided group in comparison to the PNS group. None of the patients in the ultrasound guided technique required a supplementation of analgesics for the maintenance of anaesthesia, whereas 5 patients in the PNS group had received supplementary analgesia. Moreover none of the patients in the US guided technique group had developed any complications, whereas four patients in the PNS technique group had developed vascular complications.
Conclusion: The present study concludes that US guided technique was superior to PNS technique with respect to procedural time, achievement of complete nerve block and incidence of vascular complications for performing brachial plexus block.

Keywords: peripheral nerve stimulation, ultrasound guided, brachial plexus block

Introduction

Peripheral nerve block anesthesia offers many clinical advantages that contribute to both an improved patient outcome and lower overall healthcare costs. Peripheral nerve blocks provide excellent anesthesia and postoperative pain relief, fewer side effects when compared to general anesthesia. The use of nerve blocks had also led to reduced use of opioids for postoperative pain, fewer postoperative complications and earlier discharges [1]. Regional anesthesia is particularly desirable and effective in elderly and high-risk patients undergoing a wide variety of surgical procedures, particularly upper limb and lower limb surgeries [2].

Both the axillary and supraclavicular approaches for percutaneous brachial plexus blockade was introduced by Hirschel in 1911 [3] and later on Kulenkampff wrote his first article on the brachial plexus in 1928 [4] demonstrating that supraclavicular approach for brachial plexus blockade provides a more consistent and effective regional anesthesia for upper extremity anesthesia than other approaches and this approach was widely during World War II due to the many upper extremity injuries.

The use of electrical stimulation to locate peripheral nerves was introduced in 1962 [5]. Several advantages have been claimed with this technique, including a higher success rate, the avoidance of vascular injury, and the avoidance of paresthesias and associated neurological injury [6-8]. The use of a peripheral nerve stimulator (PNS) has been the 'gold standard' for performing peripheral nerve blocks for the last two decades and has been shown to be a highly effective technique for determining adequate needle placement to produce regional anaesthesia/ analgesia. However, with recent developments in high-frequency imaging, the use of ultrasound (US) technology has significantly increased for nerve localization [9, 10].

The US-guided technique offers reported additional advantages, including avoidance of intraneuronal / intravascular injection, faster onset times, improved block quality, decreased pain from muscular contractions, prolonged postoperative analgesia, and decreased need for rescue analgesics [11-13].

Evaluating ultrasound guidance for interscalene and axillary brachial plexus blocks, it is reported that using ultrasonography (USG) significantly improved the onset and

completeness of sensory and motor blocks as compared with an immobile needle single injection technique with PNS [14]. Significant improvement is seen in the overall success rate of axillary block with ultrasound guidance as compared with a transarterial technique [15].

However very few Indian studies had been conducted to compare the anaesthetic effects between ultrasound guided technique and PNS and so this prospective study was conducted to assess the beneficial effects between these two procedures.

Aim

To assess and compare between ultrasound guided technique and peripheral nerve stimulator technique for performing brachial plexus nerve block through supraclavicular approach.

Methodology

A prospective randomised study was conducted at Meenakshi Mission hospital and research centre for a period of one year between Nov 2015 and Oct 2016. A total of 60 patients were included in the study and by using a single blinded technique they were randomised into two groups. Group A (n=30) patients received US guided technique for brachial plexus block and group B (n=30) received brachial plexus block through PNS technique. Patients belonging to ASA 1 or 2 grades and presenting for elective upper limb surgeries in the age group of 18 – 70 years were included for the study. The study was started after getting the clearance from the institutional ethical committee and the informed consent from the individual patients. We used 20 ml of local anesthesia for both the groups which was a 50:50 mixture of 2% lignocaine with adrenaline and 0.5% bupivacaine

PNS technique was performed by placing the needle which was connected to nerve locator by the electrodes and it was properly grounded with the help of ECG leads. We started the nerve stimulation with an intensity of 2.0 mA and a pulse width of 100 μs. Once the desired response was obtained (i.e. a muscle twitch of the fingers that is clearly visible), we started decreasing the current gradually to 0.5mA.

In ultrasound guided technique we used a 5cm, 22-G, insulated needle. This was a superficial block for which a linear high frequency US probe (M turbo 11mm broad band linear array, 6-14MHz Sonosite Bothell Washington, USA) was used. The probe was moved laterally to visualize the plexus as it passes over the 1st rib. After taking all aseptic precautions the needle is advanced in plane, from lateral to medial, the entrance point was located at about 1 cm away from the probe to decrease the angle of insertion and improve needle visualization. The local anaesthetic is seen as a hypoechoic (dark) shadow projecting from the tip of the needle. Procedure time, block start time (needle insertion), time to achieve complete sensory blockade, motor blockade, and duration of surgical procedure and duration of analgesia were recorded. Complications occurred if any were also noted.

Statistical analysis was done with SPSS software version 21 using Student's unpaired t test, Chi-square test, Fisher's exact test, wherever appropriate and p value <0.05 was considered statistically significant.

Results

Table 1 shows the age wise distribution of the study population among both the groups. The minimum age was 18 and the maximum age was 68 years and the mean age was 34.5 years among group A and 36.2 years among group B and majority of patients were in the age group of 30 – 40 years and there was no statistical significant difference in age between the two groups. Of the 60 patients only 10 were females and it was almost equally distributed between the two groups. Among the various departments 95% of the patients were posted for surgery from orthopaedic department and the remaining 5% from the plastic surgery and surgery departments. The mean time required for performing ultrasound guided technique was 2.58 mins and for PNS it was 5.82 mins and the difference was found to be statistically significant (P<.05) (table 2). It proves that US guided technique is much faster than the PNS technique. Similarly the time required for achieving the complete nerve blockade was much less among the US guided group (mean =6.15 mins) than the patient who had undergone peripheral nerve stimulation technique (mean =16.14 mins) and the difference was found to be statistically significant (p<.05) (table 3). None of the patients in the ultrasound guided technique required a supplementation of analgesics for the maintenance of anaesthesia, whereas 5 patients in the PNS group had received supplementary analgesia and this difference was found to be statistically significant (p<.05) (table 4). The analgesics which were used for supplementation were inj.fentanyl 2mcg/kg and inj.midazolam 0.05 mg/kg. None of the patients in the US guided technique group had developed any complications, whereas 4 patients in the PNS technique group had developed vascular complications and the difference was found to be statistically significant (table 5).

Table 1: Age wise distribution of the study subjects

Age (in years)	Group A (US guided)		Group B (PNS guided)		P-value
	frequency	%	frequency	%	
10-20	0	0	1	3.33	0.932
20-30	8	26.67	8	26.67	
30-40	10	33.33	11	36.67	
40-50	8	26.67	5	16.67	
50-60	3	10.00	4	13.33	
60-70	1	3.33	1	3.33	
Total	30	100	30	100	

Table 2: Time taken for performing the procedure between the two groups

Time taken for perform to blockade	Group A (US guided)		Group B (PNS guided)		P-value
	Frequency	%	Frequency	%	
2 – 4 mins	28	93.3	3	10	<.001
4.1 – 6 mins	2	6.6	20	66.6	
>6 mins	0	0	7	23.3	
Mean ± SD	2.58 ± 0.65		5.82 ± 0.84		

P value derived by applying unpaired student T test

Table 3: Time taken for achieving the complete nerve blockade between the two groups

Time taken for achieving the complete nerve block	Group A (US guided)		Group B (PNS guided)		P-value
	Frequency	%	Frequency	%	
5 – 10 mins	28	93.3	3	10	<.001
10.1 – 15 mins	2	6.6	25	83.3	
15.1 – 20 mins	0	0	2	6.6	
Mean ± SD	6.15 ± 1.25		16.14 ± 3.42		

P value derived by applying unpaired student T test

Table 4: Distribution of the study subjects based on the need for supplementing analgesics

Need for supplementing analgesics	Group A (US guided)		Group B (PNS guided)		P-value
	Frequency	%	Frequency	%	
Yes	0	0	5	16.6	.0316
No	30	100	25	83.3	
Total	30	100	30	100	

P value derived by applying chi-square test

Table 5: Complications occurred during the procedure among the two groups

Complications	Group A (US guided)		Group B (PNS guided)		P-value
	Frequency	%	Frequency	%	
Vascular puncture	0	0	4	13.3	.0436
No complications reported	30	100	26	86.6	
Total	30	100	30	100	

P value derived by applying chi-square test

Discussions

In recent years peripheral nerve blocks had gained a lot of interest among the anaesthetist community, as it is associated with good regional anaesthesia, lower complication rate and better postoperative analgesia [16, 17]. Efforts were still made to improve upon the technique of these nerve blocks. Mechanical nerve stimulation and electric stimulation were steps in this direction and more recently advances in imaging its wider availability had made application of USG in PNBs. It is a guided technique which helps in performing PNB by direct visualisation.

In our study both groups were comparable with respect to age, gender, weight and ASA grade of the patients and there was no significant difference found between the two groups and this helped us to alleviate confounding factors like age, gender and ASA which would indirectly have an effect on drug distribution, metabolism and excretion.Weight and BMI among the two groups in our study subjects showed a statistical insignificant which had helped us to alleviate a point of controversy as obesity as well as cachexia has clinically significant effect on the action of drug. Similar type of demographic results was found in the study done by Singh G *et al*. [18] In the present study we found predominance in both the groups. This could be because of more number of male patients had undergone surgery in our institution in this study period. However this male preponderance had no clinical relevance on the results of the study.

In the present study mean time required for performing ultrasound guided technique was 2.58 mins and for PNS it was 5.82 mins and the time difference in performing these two techniques was found to be statistically significant. The results of our study was well supported by the study done by conducted by Krutika B Rupera *et al*. [19], where she quoted the mean procedure time for USG guided group was 4.55 min and it was 5.71 min for PNS group patients, in another study done by Leslie C. Thomas *et al*. [20] the time taken for performing PNS (mean = 10 mins) was much higher than the USG guided technique (mean = 4.3 mins). The possible reasons for the less time taken in performing USG guided technique could be due to direct visualisation of the structures, confidence and accuracy of needle placement and reduction in number of attempts of needle insertion as supported by Vincent W. S. Chan *et al*. [21] The mean time taken for onset of blockade among the USG guided group was 2.58 mins, whereas it was 6.42 mins in the PNS group and the difference between both the groups was found to be statistically significant and our results were almost in par with the studies done by Leslie C. Thomas *et al*. [20], Peter Marhofer *et al*. [22], Stephan Kapral *et al*. [23], Beyazit Zencirci *et al*. [24] and Krutika B Rupera *et al*. [19] Similarly the mean time to achieve complete motor blockade in group A was 6.15±1.25 mins and it was 16.14±4.88 mins among people who had PNS technique and the difference was found to be statistically significant. The similar finding was also stated in studies conducted by Leslie C. Thomas *et al*. [20], Peter Marhofer *et al*. [22], Beyazit Zencirci *et al*. [24] and Krutika B Rupera *et al*. [19] In a study done by Beyazit Zencirci *et al*. [24], 86.67% of the cases in PNS group developed complete sensory block and only 76.67% of these formed a complete motor block within the first half an hour, whereas among the USG guided group complete sensory and motor block was achieved in 100% of the cases. Similar results were obtained from our study also in which complete motor blockade could not be achieved in 6.67% (2 out of 30) of patients belonging to group B in whom sensory block was successful and we completed the surgery by giving supplemental analgesics (inj.fentanyl 2 mcg /kg I.V and inj.midazolam 0.05mg/kg I.V) in those patients.

In group A patients no complications had occurred whereas among group B patients 13.3% (4 out of 30) had accidental vascular puncture showing a statistically significant difference between them proving it that there is more chance of vascular puncture in PNS guided patients when compared

with USG guided patients and it is supported by Beyazit Zencirci *et al*. [24] study.

Conclusion

Procedure time, onset of nerve block and time to achieve complete block were found significantly shorter in US group than PNS group and similarly the duration of nerve block was found significantly more in US group than the PNS group, and finally the incidence of vascular complications like artery puncture was seen more in PNS guided technique than US group. So, ultrasound guided technique was found significantly better than PNS for supraclavicular brachial plexus block.

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