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Ultrasound versus nerve stimulation technique for interscalene brachial plexus block: A randomized controlled trial

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Abstract

Introduction and Aims: Peripheral nerve block techniques have evolved over time with the advent of peripheral nerve stimulator and ultrasonography. We intend to compare these two techniques in this study with respect to their efficacy, reliability and safety.

Materials and Method: Prospective, randomized, observer-blinded study was conducted on 60 ASA I-II patients posted for surgery of shoulder, clavicle or proximal humerus. They were randomly allocated in to two groups to receive either ultrasound guided (USG group) or peripheral nerve stimulator guided (PNS group) interscalene brachial plexus block with 20 ml of local anaesthetic solution (2% lignocaine with adrenaline 10ml + 0.5% bupivacaine 10 ml). We compared the procedure time, time for adequate sensory and motor block, duration of block, block failure rate, complications and patient satisfaction.

Result: Ultrasound significantly reduces the time to conduct the block as compared to PNS. The onset of block was earlier and duration was significantly prolonged (p=0.0001) in USG group. The success rate was 100% and patient satisfaction was significantly better in USG group compared to PNS group.

Conclusion: Ultrasound guided technique for interscalene brachial plexus block provides a block which is faster in onset, has prolonged duration, higher success rate and better patient satisfaction compared to PNS guided nerve block.

Keywords: Interscalene brachial plexus block, Local anaesthetic, Peripheral nerve stimulator, Technique, Ultrasound.

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Introduction

Interscalene brachial plexus block (IBPB) is commonly used for the orthopaedic surgery of proximal humerus and shoulder joints. It provides excellent intra-operative anaesthesia, muscle relaxation, better recovery and post-operative analgesia.[1] It can be used as an alternative or an adjunct to general anaesthesia. Brachial plexus blockade can be performed by several standard techniques like conventional landmark technique; peripheral nerve stimulator (PNS) or ultrasound guided technique (USG).[2] Since past two decades, the electrical nerve stimulator has been gold standard for nerve localization in regional anaesthesia.[3,4] Due to recent developments in high frequency imaging, the ultrasound has proved beneficial to localize the nerve during peripheral nerve bloks.[5,6,7] Its advantages are direct visualization of nerves to be blocked and the needle tip, as well as the spread of local anaesthetic drug (LA) in desired location. Hence it significantly reduces the chances of injection into the nerve or vessel, and provides earlier onset and better quality of block, with lower drug volumes, due to targeted drug deposition. In addition, as ultrasound does not require elicitation of muscle contractions for nerve localization, the pain is considerably less.[8,9]

There are limited studies in which these two techniques (USG and PNS) for IBPB have been compared. We conducted this prospective, randomized observer-blinded study to test the hypothesis that USG technique shortens the onset and prolong the duration of IPBP as compared PNS guided nerve localization. Primary aim of the study was to assess the efficacy, accuracy and reliability of USG and PNS guided techniques for IBPB. And secondary aim was to study failure rate and complications if any.

Materials and Method

After obtaining approval of the institutional ethical committee, 60patients were included in our study. It was a prospective, randomized and observer blinded study. Considering standardized effect size of 0.75 and 80% power (β), the sample size for each group came out as 30.

Patients of ASA grade I/II, of either sex in the age group16 - 60 years who were posted for surgery of proximal humerus, shoulder and clavicle under IBPB were enrolled.

Patients with coagulation abnormalities, local infection at block site, those allergic to study drug, severe pulmonary and cardiac pathology, neurodeficit in the limb to be operated and subjects with body mass index>35 Kg/m^2, were excluded.

Routine pre-operative assessment and review of investigations were done. The anaesthesia technique was explained to the patients. Informed valid consent was obtained. All the patients were kept starving

overnight preoperatively and were pre-medicated with tab. Alprazolam 0.25mg at the hour of sleep (HS).

In the operation theatre, intravenous access was secured and multipara monitor (Electrocardiograph, pulse oximeter, and Noninvasive blood pressure) was attached. The patients were randomly allocated into the two groups by a computer-generated random number list and envelop method. In both the study groups, the IBPB was performed by the experienced anaesthesiologist.

The patient was placed in the supine position with the head turned away from the operating side to be blocked. Under all the aseptic precautions, proposed site of block was prepared and draped. After correct placement of the needle, 20 ml local anaesthetic mixture (2% lignocaine adrenaline 10ml and 0.5% bupivacaine 10 ml) was injected in 5-10 ml aliquots after negative aspiration and with continuous monitoring.

In the USG group the side of neck to be blocked was scanned using high-frequency US probe (Nanomaxx - Sonosite – 03R9L2, 13.6 MHz probe, Bothell, WA, USA) and the brachial plexus was identified in the interscalene groove. A 2-inch, 22-gauge, Stimuplex insulated needle (B. Braun, Germany) was placed in the interscalene groove using an "in-plane" approach so that the entire course of the needle can be visualized. Local anesthetic was injected after confirming the position of needle tip. The needle was redirected if required to ensure homogenous spread of the anesthetic.

In the PNS group the interscalene groove was palpated on the side to be blocked. A 2-inch, 22-gauge, Stimuplex insulated needle (B. Braun, Germany) was connected to the nerve stimulator (Stimuplex Dig RC, B. Braun, Melsungen AG). The current intensity was initially set at 1mA and advanced until motor response was elicited in the distribution of median, ulnar, radial, axillary or musculotaneous nerves. The current was then gradually reduced to 0.3 to 0.4 mA and the local anesthetic was injected if there was persistent motor response.

An observer, who was unaware of group assignment, collected and analysed the data.

Block procedure time was defined as follows:

In USG group, it was defined as the time from the initial scanning to the removal of the block needle while in PNS group it was the time from the insertion of the block needle to its removal.

The time to adequate sensory block was considered as the time from removal of the block needle to the time of progressive loss of sensation.

Time to adequate motor block was considered as the time from removal of the block needle till the time of inability to move the blocked arm.

Patients with block failure were given general anaesthesia and the surgery was commenced.

Patient satisfaction score was noted at the end of surgery. Score was graded as 5-very satisfied,4-satisfied, 3- neutral, 2- dissatisfied and 1- very dissatisfied.

Postoperatively, the rescue analgesic was administered at VAS >4 and the time were considered as duration of block.

Statistical Analysis: The data was entered in Microsoft Excel and was analyzed using the Software Statistical Package for Social Science, Version 20 (IBM, SPSS, Chicago, USA) and Epi info (Public domain software by Centre of Disease Control and Prevention, Atlanta Georgia, USA) version 7.2.4. Levene's test for Equality of Variances was used and equal variances was assumed within the groups.

Independent sample test (Unpaired t-test) was used to test equality of means. Chi-square test was used for qualitative variables. Mann-Whitney U test was used to test the significance between sample medians. Post-hoc analysis was done using Tuckey's test by considering 5% margin of error (α), $p < 0.05$ was considered as significant.

Results

In the present study 60 patients were enrolled. They randomly received interscalene brachial plexus block either by ultrasound guidance (USG group) or by peripheral nerve stimulator guidance (PNS). The demographic profile was comparable in both groups (Table 1).

Table 1: Demographic distribution

Parameter	USG - Group (n=30) Mean ±SD	PNS -Group (n=30) Mean ±SD	p value
Age (yrs)	43.33±12.39	38.10±12.25	0.105
BMI(Kg/m^2)	24.16±3.74	22.67±2.87	0.089
Gender(M: F)	18:12	19:11	0.791

(USG = Ultrasonograph, PNS = peripheral nerve stimulator, BMI = body mass index, SD – standard deviation)

Out of 30 patients in USG group, 4 patients were operated for fracture clavicle, 24 patients were operated for fracture proximal humerus, and 2 patients were operated for shoulder dislocation surgery. The distribution was 6, 22 and 2 patients respectively in PNS group. There was no statistically significant difference in both groups.

In USG group, we achieved 100% successful block while in PNS 3(10%) patients had failed block and required general anaesthesia to undergo surgery. However, the difference was comparable within two study groups (p 0.076) (Table 2).

While performing the procedure, the median of number of needle pricks in USG group was significantly lower as compared to PNS group (p 0.030). Similarly, the attempts of needle redirection were also less in USG group. The difference in both the study group was statistically significant (p 0.0001) (Fig. 1).

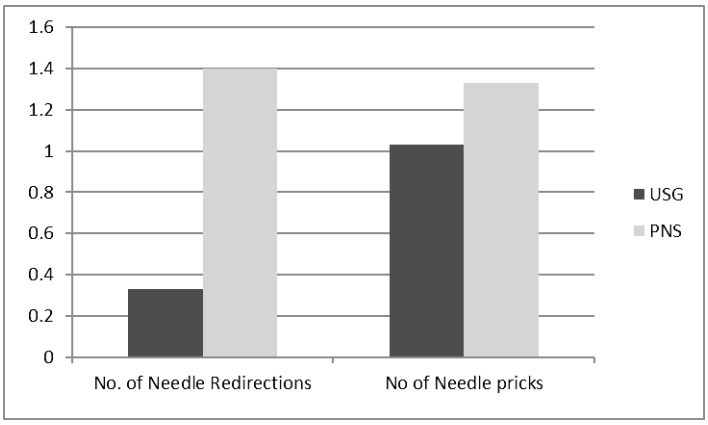

Fig. 1: Comparison of mean number of needle pricks and needle redirections
(USG = Ultrasonograph, PNS = peripheral nerve stimulator)

The time required for IBPB in USG group was 6.43±0.473 minute while in PNS group it was 9.88±0.773 minute. The difference in the time to perform the block was significant statistically (p 0.0001) (Table 2).

Table 2: Comparison of block characteristics

Parameters	USG -Group (n=30) Mean ±SD	PNS- Group (n=30) Mean ±SD	p value
Block procedure time (min)	6.43±0.473	9.88±0.779	0.0001
Time to first rescue analgesia (min)	226±7.81	187.96 ±7.8	0.0001
Patient satisfaction score	4.67±0.479	3.54±1.071	0.0001

(SD= standard deviation, USG = ultrasonograph, PNS = peripheral nerve stimulator, min- minute)

The mean onset time of both sensory and motor block in both the study group is shown in Fig. 2. It was faster in USG group in comparison with PNS group and the difference was statistically significant (p 0.0001).

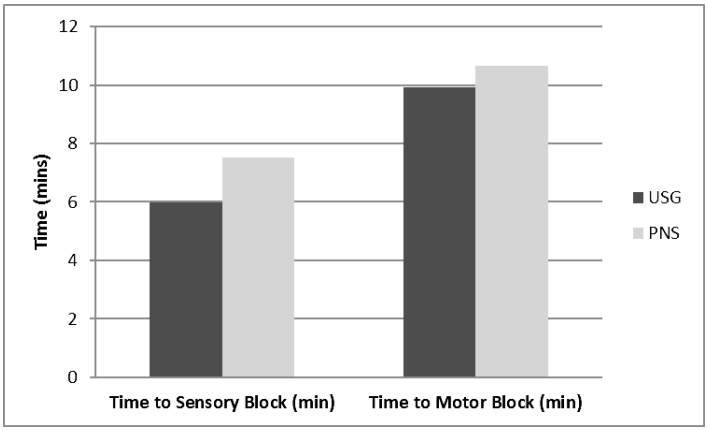

Fig. 2: Comparison of time to adequate sensory and motor block (USG = ultrasonography, PNS = peripheral nerve stimulator, min = minutes)

The time to first dose of rescue analgesic, that is the duration of analgesia was significantly lower in PNS group (187.96±7.8minute) compared to patients in USG group (226±7.81minute) (p 0.0001) (Table 2).

Perioperative mean heart rate (HR) in USG group was 76.10±8.91 per minute while in PNS group was 76.77±8.76 per minute. The difference was clinically and statistically not significant (p 0.7713). Perioperative mean of the mean arterial pressure (MAP) was 92.04±7.14 millimeter of mercury and 91.2±6.62 millimeter of mercury respectively in USG and PNS group. The difference in perioperative mean MAP was statistically not significant (p 0.6366). We did not observe hypotension, hypoxemia, hypoventilation or seizure during procedure. However, only one patient in PNS group had vascular puncture.

Discussion

We observed that USG increased the frequency of successful interscalene brachial plexus block. Also, the block was qualitatively better and more intense as compared to PNS. (p 0.000)

The success of peripheral nerve block depends on precise identification of the nerves and placement of LA around them. It is also dependant on technique used, the experience of the anaesthetist, volume and type of LA injected.[10] Peripheral nerve stimulation technique is still a blind, landmark-based procedure. It is not possible to directly visualize the nerves and hence the spread of LA.[11]

Various important, vulnerable structures are in close proximity to the brachial plexus. So, the serious complications like nerve injury, intravascular injection of LA and hence the systemic toxicity of LA, total spinal anaesthesia or pneumothorax can occur.[12]

Since last few years, real-time ultrasound guided peripheral nerve blocks have been evolving and have gained popularity. USG helps to secure accurate needle position, allows to monitor the spread of LA and hence it improves the onset, quality, duration of nerve block and overall success of peripheral nerve block compare to PNS guided block.[6,13] For both the techniques, experienced anaesthetist is required.

In our study, 100% patients in USG group had block success while only 3 patients in PNS group had block failure. The difference was statistically not significant (p = 0.075). The time for adequate sensory and motor blockade was significantly less in USG group compared to PNS group.

Our results are consistent with Lie et al. They have compared the use of conventional blind (CB), USG and PNS guided IBPB. They found that block execution time was significantly less in USG group (5.26±1.05 minute) than the PNS group 9.19±1.4 minute) and CB group (9.4±1.4 minute).[9]

In our study, duration of analgesia that is the time of requirement of first dose of rescue analgesia was significantly longer in USG group (226±7.81minute) compared to PNS group (187.96±7.8 minute).This could be because of accurate deposition of LA closer to brachial plexus.[14,15] Our results are comparable with the Singh S et al.[16] A systematic review and meta-analysis study done by Abrahams MS et al observed that USG group has combined mean increase in block duration of 25% when compared with PNS group.[10]

Nowadays regional anaesthesia is very demanding as it provides intra-operative anaesthesia and peri-operative analgesia. Survey result indicate that patient prefer general anaesthesia over regional anaesthesia and have phobia of needle pricks, while the surgeons concerns are a failed or inadequate block and increased nonsurgical times.[17] In the present study, mean needle pricks and number of needle redirections were significantly lower in USG group, with 100% block success. Results of present study are consistent with the various authors who have worked in this field and concluded that introduction of real image ultrasound guided nerve location improves the success rate of block.[16,18,19]

Small sample size is one of the limitations of our study. Multicenteric studies with large sample size are required to promote this technique as a part of multimodal approach of post-operative analgesia. Also, patient blinding was not possible as the two techniques are different.

To increase the safety of IBPB, further study with reduced drug volume under USG guidance is recommended. Kumar A et al, in their study compared two techniques that are USG and PNS guided axillary plexus block. They concluded that with the help of USG, 20 ml volume of 0.5% bupivacaine is enough to achieve successful block if one can identify and block the nerve separately.[4,20]

Conclusion

Use of ultrasound for performing interscalene brachial plexus block ensures a block that is faster in onset, superior in quality and of prolonged duration and hence provides longer duration of analgesia, as against that performed by PNS means. This has reflected as a significant reduction in block failure, lesser complications, and better patient satisfaction.

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