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Original Article

Ultrasound or Nerve Stimulator Guided Interscalene Brachial Plexus Block: A Clinical Comparative Study Using 0.5% Levobupivacaine

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Abstract

Objective: *A clinical study to decide whether ultrasound or nerve stimulator guided Interscalene Brachial Plexus Block is the superior method.*

Material and Methods: *A single blind controlled study was done on 60 patients between the age group of 18-60 years of ASA grade I or II undergoing upper limb surgery. Group A received Interscalene Brachial Plexus Block with 30ml of 0.5% Levobupivacaine using nerve stimulator alone, whereas group B received the same using two-dimensional ultrasonic image, with the secondary use of nerve stimulator after securing a correct needle position. Onset, duration and quality of both sensory and motor blockade were studied in both the groups.*

Results: *The time spent for detecting the brachial plexus, attempts in needle positioning and time taken in injecting the local anaesthetic was not significantly different between the groups. There was no significant difference in onset of sensory and motor blockade between two groups. The only significant difference was in the duration of the sensory and motor blockade. The mean duration of sensory blockade was 520.83 ± 11.60 minutes in group A and it was 585.96 ± 6.24 minutes in group B. Similarly the mean duration of motor blockade in group A was 415.6 ± 10.72 minutes and it was 474.6 ± 20.63 minutes in Group B.*

Conclusion: *It was concluded that ultrasound guidance in administering Interscalene Brachial Plexus Block prolongs the duration of sensory and motor blockade without any hemodynamic disturbances if the blocks are performed by anaesthesiologist who are experienced in both techniques.*

Keywords: *Levobupivacaine, Nerve Stimulator, Ultrasound, Interscalene brachial plexus block, Sensory and motor blockade.*

Introduction

Our aging population presents with an increasing range of co-morbidities, demanding surgical anesthesia. Options include the use of a variety of regional techniques in conjugation with general anesthesia to optimize clinical care and reduce the risk of complications. Regional anaesthesia can reduce or avoid the hazards and discomforts of general anesthesia including sore throat, airway trauma, haemodynamic consequences[1] and muscle pain, and at the same time it also offers a number of advantages to outpatients undergoing surgery. These techniques provide analgesia without sedation, prolonged postoperative analgesia and allow earlier patient's discharge.

Brachial plexus block was first accomplished by William Stewart Halsted [1] in 1884, in New York City at St. Luke's Roosevelt Hospital Centre when he freed the cords and nerves of the brachial plexus after blocking the roots by direct injection with cocaine solution. In 1887, Crile[2] disarticulated the shoulder joint after rendering the arm insensitive by blocking the brachial plexus using direct intraneural injection of each nerve trunk with 0.5% cocaine under direct vision.

The first percutaneous brachial plexus block was performed independently in 1911 by Hirschel [3] through the axillary approach. Kulenkampff [4] introduced the supraclavicular brachial plexus block a few months after Hirschel's description of the axillary approach. He injected his own plexus with 10 ml of procaine at the midclavicular position lateral to the subclavian artery that resulted in complete anaesthesia of the arm. The technique was published later in 1928, by Kulenkampff and Persky. Infraclavicular approaches to the brachial plexus were first described by Bazyand Pauchet in 1917[5].

Interscalene Brachial Plexus Block (ISBPB) is a well-established technique in regional anaesthetic practice with high success rate. Its first description by Winnie[6] was in 1970. The block is effectively used for anaesthetic and analgesic purposes for shoulder and upper arm surgeries. Winnie originally placed the puncture at the level of the laryngeal prominence on the lateral border of the sternocleidomastoid with the needle in a perpendicular direction which led up to major complications. The technique was later modified by Meier and colleagues[7] in 2001, who used a more cranial puncture site with a more tangential orientation of the needle as per Marhofer *et al* [8].

Different technical modalities are being used for identifying and locating the brachial plexus in the interscalene area. Conventional methods include electric stimulation and patient-reported paraesthesia which rely on identification of surface landmark in a semi-blind manner. The exciting recent technological advance in this field has been the introduction of anatomically-based ultrasound imaging. The introduction of this technology represented the first time in nearly 100 years of practice of regional anaesthesia that an operator has been able to view an image of the target nerve [9].

Ultrasound guidance has improved the success and decreased the complication rate in regional anaesthesia in general. Modern ultrasound machines are capable of imaging individual roots to their cords in the infraclavicular region. The sonographic image can be used to guide the injection needle while minimizing the risk of injury of adjacent structures [10].

Material and Method

The study was conducted on 60 patients who came for shoulder surgery (of clavicle, shoulder joint and upper arm) in one year of study period (November 2016 to October 2017) belonging to American Society of Anesthesiologists grade I or II, adults of either sex, between the age group of 18-60 years, in the department of anesthesia & critical care, Rohilkhand Medical College & Hospital, Bareilly. The patients were randomised using "computer generated random number table" to one of the following groups:

•Group A nerve stimulator (NS) (n=30): ISBPB using nerve stimulator alone (conventional landmark-guided interscalene block).

•Group B ultrasound (US) (n=30): ISBPB guided by two-dimensional ultrasonic image, with the secondary use of nerve stimulator after securing a correct needle position.

After approval from institutional ethical committee, informed written consent was taken from all the patients and they were informed about the procedure. Thorough PAC was done one day before the surgery. Patients were advised to stay nil per oral for 8 hours before surgery. All the patients were pre-medicated with tablet alprazolam 0.25 mg and tablet ranitidine 150 mg in the night before surgery. Before shifting the patient to the operation theatre, an intravenous access was obtained and Intravenous fluid was started. Premedication with Inj. midazolam 2 mg intravenous was done. Patient was made to lie supine on the OT table with the head of the bed elevated 30 degrees and routine monitoring leads were applied. Baseline values of pulse rate, blood pressure, SpO2, ECG and respiratory rate were recorded. The patients were then randomly assigned to receive the Interscalene Brachial Plexus Block guided by nerve stimulator (NS Group) or by ultrasound (US Group).

NS Group

The functional safety of the peripheral nerve stimulator was verified. The skin electrode, placed on the ipsilateral arm approximately 6 inches away, was connected to the electrode cable using the red alligator clip (anode). After scrubbing up and wearing gloves the anaesthesiologist prepared the supraclavicular region of the patient with chlorhexidine (savlon), spirit and betadine. The area was then properly draped. The ipsilateral arm was abducted. The interscalene groove was palpated at its lowest point and the point of maximum intensity of subclavian artery was also located. The patient was then instructed to say ‘yes’ and not to move as soon as he felt tingling, shooting or burning pain (like electric shock), radiating down the arm or hand on insertion of the locater needle. He was also advised not to move during the procedure. ISBPB represents the most cranial approach to the brachial plexus. This technique has a risk of inadvertent vessel puncture (of the vertebral artery), production of high spinal or epidural anaesthesia but creates more favorable conditions for catheter placement for continuous block technique. The needle was inserted in interscalene space at the level of cricoids cartilage, Once the desired twitch was obtained, the needle was carefully manipulated, whilst reducing the current until the muscle contractions occur at a lower current level. Persistence of contraction with a stimulator voltage decreased to 0.5 mA was taken as the confirmation of the proximity to the brachial plexus. The needle was then held immobile and 1ml of the local anaesthetic solution after careful aspiration was injected. At this point the twitching should disappear. The mechanism for the immediate disappearance of the twitching is not a result of the local anaesthetic blocking the nerve, but the mechanical displacement of the nerve away from the needle tip[11].

The aspiration test was done for blood to avoid the intravascular injection of drug. Then 30 ml of the 0.5% Levobupivacaine was injected at this point in all the directions by rotating the needle. The aspiration test was done after every movement of the needle as a precaution during the injection of the drug.

US Group

Patient positioning was done. Sterile precautions were followed. In these cases, a long sterile sheath covering the probe and the cord and a sterile conducting gel were used. Transverse and longitudinal views are most commonly used for nerve imaging. Nerves have different degrees of echogenicity. For example, nerve roots and trunks of the brachial plexus in the interscalene and supraclavicular regions appear mostly hypoechoic, while peripheral branches of the brachial plexus and the sciatic nerve are largely hyperechoic.

In the interscalene region, the cervical roots forming the brachial plexus are located between the anterior and middle scalene muscles. They were best visualized when scanned in the lateral aspect of the neck in an axial oblique plane. After sonographic identification of the brachial plexus, we fixed the needle not to move. Nerve stimulation was then switched on looking for the designated muscle response in the same way used in Group NS patients in order to confirm that the bundle visualised in ultrasound is definitely neural and not vascular. Then 30ml of 0.5% Levobupivacaine was administered in 5ml aliquots. Deposition and spread of anaesthetics was also appreciated with real-time imaging during injection.

After administration of drug via both the procedures pulse and blood pressure was recorded preoperatively and immediately after giving the block. Thereafter pulse and blood pressure was recorded every at 5, 10, 15, 30, 45, 60, 90, 120,150, 180, 240, 360, 480 and 720 minutes after the block. Onset and duration of sensory and motor blockade and onset of analgesia was observed every 2 minutes and compared with the corresponding areas of the other arm. The regression of block was similarly observed till complete recovery. Side effects and complication during injection, during operation and postoperatively were properly recorded and treated accordingly.

Results and Observations

Both the groups were comparable in the terms of age, sex, body mass index, ASA grade, type of surgical procedure and mean duration of surgery and no statistically significant difference was found.(Table :1)

There was also no significant difference in the duration of performing the block and number of attempts made in needle positioning.

In our study, the mean onset time of sensory blockade in group A was (6.77 ± 5.30) minutes and in group B it was (5.37 ± 2.34) minutes. The difference between the two groups was statistically insignificant (p = 0.190) even though the onset time of sensory blockade was comparatively faster in US group.

The onset time of complete motor blockade was more than 15 minutes in 22 patients from the NS group. Whereas, 26 patients in the US group required less than 14 minutes for onset of complete motor blockade. In group A, the mean time of onset of motor blockade was (16.72 ± 5.30) minutes and in group B it was (12.54 ± 2.34) minutes. Although the onset of motor blockade was faster in the US group in comparison to the NS group, the difference in onset time of motor blockade between the two groups was statistically insignificant (p =0.097).

In the comparison of mean duration of sensory blockade between the two groups, the mean duration of sensory blockade for group A was 520.83 ± 11.60 minutes and for group B it was 585.96 ± 6.24 minutes. The difference in duration of analgesia, was longer in the US Group and it is statistically significant with a p-value of <0.001(Figure:1).

In case of comparing means of duration of motor blockade between the two groups, the mean duration of motor blockade for group A was 415.6 ± 10.72 minutes and for group B, it was 474.6 ± 20.63 minutes. As we can see there was a longer duration of motor blockade in the US group, and the difference was statistically significant with a p-value of <0.001 (Figure: 2).

Mean pulse rate and mean arterial blood pressure was also comparable in both the groups (Figure: 3 and 4).

When the NS group and the US group were compared in the light of patient satisfaction, quality of block and adverse effects, the difference between the two groups was insignificant.

Table 1: Demographic Profile.

Parameters	Group A (n=30)	Group B (n=30)	*p*-value
Age (Years)	34.8±11.5	37.1±10.4	0.419
BMI(Kg/M^2)	21.4±1.5	21.3±1.6	0.939
Gender (M/F)	22/08	20/10	0.317
ASA (I/II)	20/10	23/07	0.738
Duration of surgery (Min.)	124.7±21.9	133.9±19.3	0.089

Figure 1: Comparison of duration of sensory blockade between the NS and US groups.

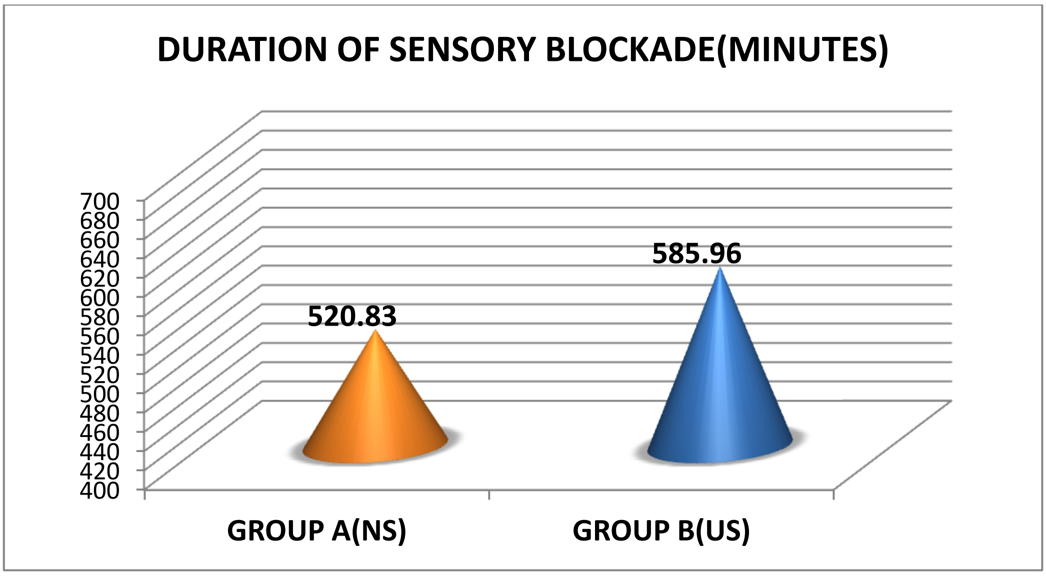


Figure 2: Comparison of duration of motor blockade between the NS and US groups.

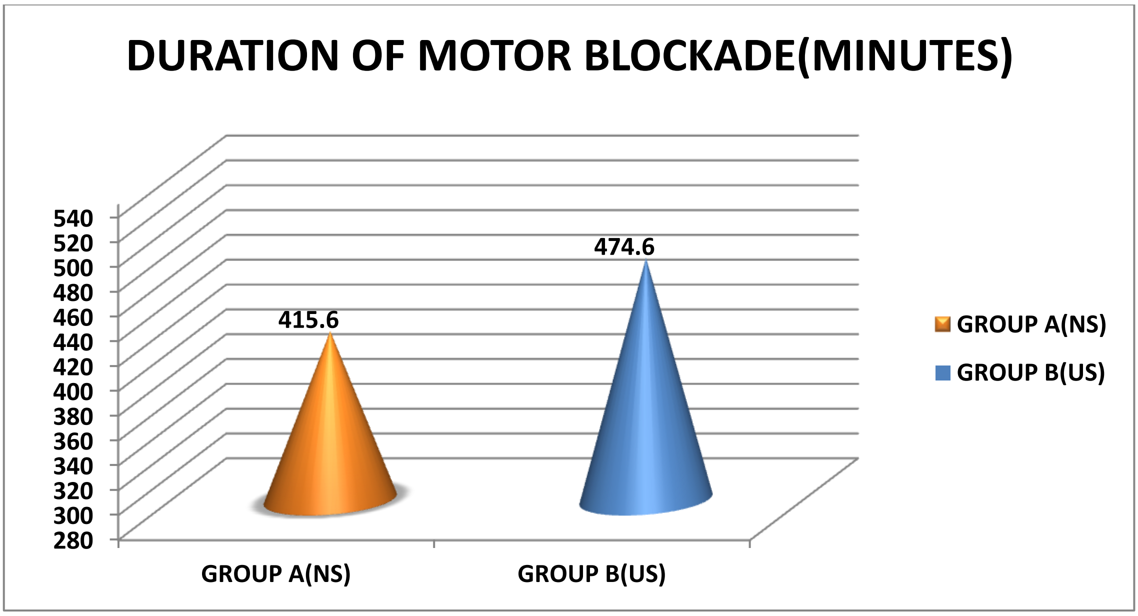


Figure 3: Comparing the mean pulse rate between the NS and US groups.

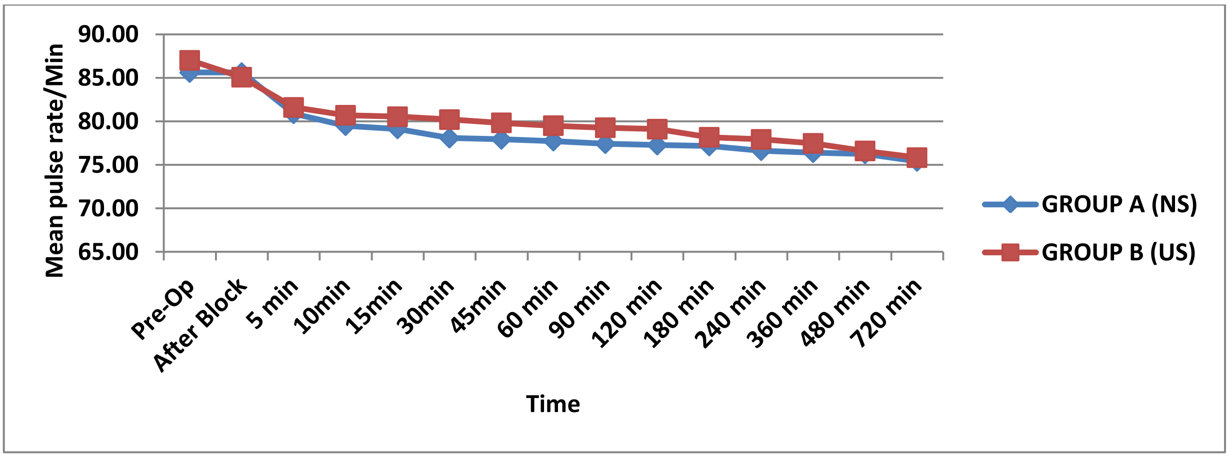
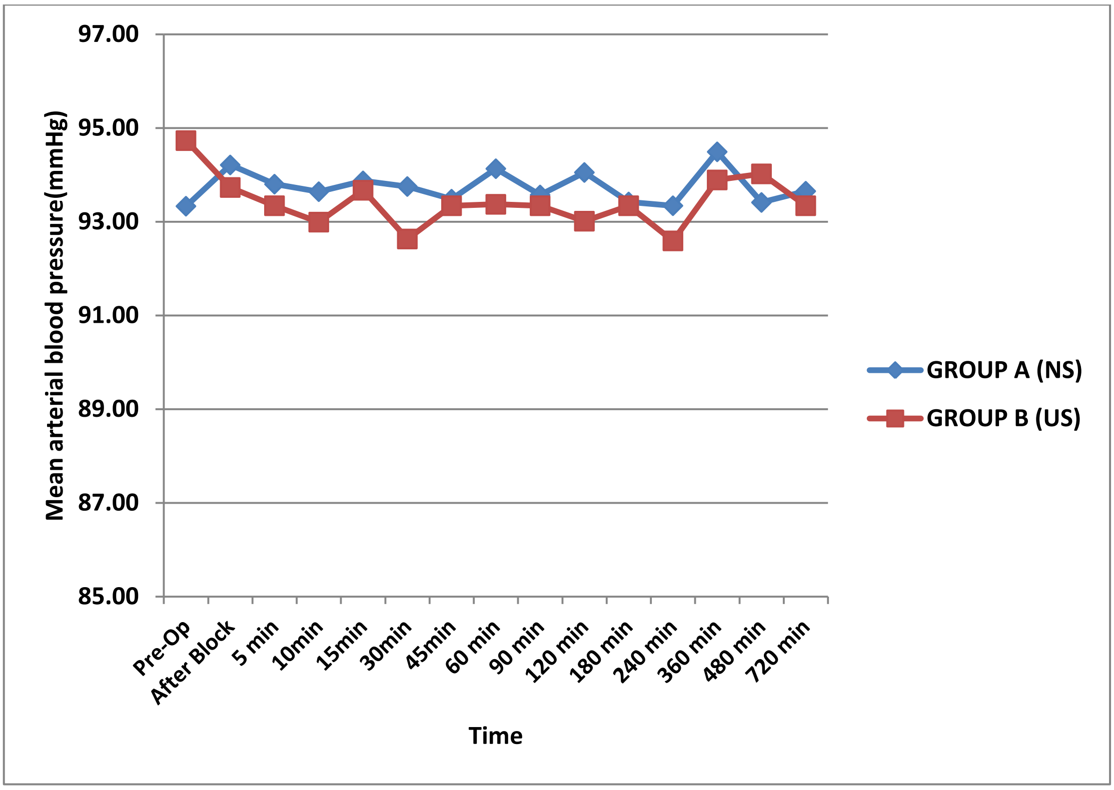


Figure 4: Comparing the mean arterial blood pressure between the NS and US groups.



Discussion

In recent years, interest in the practice of regional techniques is growing and, in particular, peripheral nerve blocks for surgical anaesthesia and postoperative analgesia. The development of local anaesthetic agents with lower toxicity and long duration of action is contributing to this change. Compared with general anaesthesia, regional anaesthesia is associated with multiple benefits including reduced morbidity and mortality[12,13], superior postoperative analgesia[14,15], cost-effectiveness[16] , and a lower rate of serious complications[17,18]. As such, the practice of regional anaesthesia have gained popularity worldwide [19]. One of the principle challenges in regional anaesthesia is the unreliability of conventional modalities like electric stimulation and patient-reported paraesthesia for confirming precise nerve localization. Despite the time-tested record of safety of these “blind” techniques, an inherent rate of block failure exists. Nerve stimulator is also not helpful in avoiding puncture of blood vessels, the pleura, and other vulnerable structures, and complications including local anaesthetic toxicity due to intravascular injection and nerve damage from the mechanical trauma and or intraneural injection have been reported[20].

The problem with designated anatomical landmarks is that they are variable from patient to patient and do not always correlate with the location of the underlying nerve or plexus. In addition, landmark measurements are often complicated and inaccurate.

Imaging guidance for nerve localization holds the promise of improving block success and decreasing complications. Ultrasonography is such a method for providing a “sufficient close examination of anatomy”[21]. It is non-invasive, causes no radiation exposure, is more affordable and portable compared to other imaging techniques, requires little preparation for immediate use, and can be taught and learned with relative ease. Perhaps the most significant advantage of ultrasound technology is the ability to provide anatomic examination of the area of interest in real-time [22].

Brull *et al.*[19] emphasized that there are two predominant advantages of ultrasound-guided peripheral nerve blocks. First, ultrasound enables the operator to manipulate the needle under direct vision to ensure close proximity of the needle tip to the target nerve. Secondly, deposition and spread of local anaesthetic are readily appreciated with real-time ultrasound imaging during injection. Experience with US-imaging has revealed that nerves are often displaced by injection of local anaesthetics. Ultrasound allows the operator to confidently advance or reposition the needle after administering an initial injection of local anaesthetic.

Stephen R. Williams *et al.*[23] in their study found out that ultrasound guidance allowed statistically and clinically significant reductions in the procedure times and provided better block quality than a neurotransmitter guided subclavian perivascular approach.

Most studies comparing ultrasound imaging and nerve stimulation techniques for upper extremity plexus anaesthesia have demonstrated the superiority of ultrasound with respect to block completeness at 30 minutes, overall block success (surgical anaesthesia), rapid block performance, shorter onset times, prolongation of block and reduced complications.

To conclude, our results showed the similarity in time to perform interscalene brachial plexus block and the onset of complete block as well as the success rate, patient satisfaction, incidence of complications and the postoperative pain relief in both groups. We found statistically significant differences in the duration of the sensory and motor blockade between peripheral nerve stimulation and ultrasound guided techniques. Interscalene brachial plexus block seemed to be highly effective using either technique but ultrasound guided block came out as the superior one over all due to providing a better overall duration of blockade.

Conclusion

Interscalene brachial plexus block is nearly equally high effective using either electric nerve stimulation or ultrasound-guidance. Based on our study the only advantage which could be attributed to ultrasound guided technique was that it gives a significantly longer duration of sensory and motor blockade when compared to peripheral nerve stimulator guided technique if the blockades are performed by anaesthesiologists who are experienced in both techniques. As we found out that an ultrasound guidance assisted by peripheral nerve stimulator resulted in superior blockade rather than peripheral nerve stimulator alone, we recommend that peripheral nerve stimulation and ultrasound guidance should be regarded as complementary to each other, rather than alternative tools.

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