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Research Article

COMPARISON OF TWO TECHNIQUES FOR SUPRACLAVICULAR NERVE BLOCK ULTRASOUND GUIDED VERSUS NERVE STIMULATOR BLOCK

Abhinav Tewari[1], Mukesh Kumar[2], Ajit Kumar Singh,[3]* Dr Archana Singh[4] and Dr Gagandeep Singh[5]

[1,2]Asst Prof & Classified Specialist (Anaes & Pain Relief) Department of Anesthesiology and Intensive Care Military Hospital Jalandhar, Punjab, India
[2]Assoc Prof & Sr Advisor (Anaes & Pain Relief) Command Hospital Western Command, Chandimandir
[3]Assoc Prof & Officer Commanding SHO Chandimandir Command Hospital Western Command, Chandimandir
[4]Asst Professor Dept of Surgery Military Hospital Jaipur, Rajasthan, India

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ABSTRACT

Background: Providing adequate intraoperative anesthesia and postoperative analgesia in orthopedic patients has been a challenge for the anesthesiologists, keeping a choice between GA and RA. In case of RA blocks by landmark technique eliciting paresthesia has been associated with higher failure rates and complications. Brachial plexus block can be performed easily with use of nerve stimulators and with ultrasound guidance. The present study was conducted to compare the difference between the two techniques in patients undergoing upper limb surgeries with brachial plexus block.
Methods: Total 100 patients enrolled and randomly allocated into N and U groups of 50 each, undergoing upper limb surgery. Supraclavicular Brachial Plexus Block, was administered using nerve stimulator in N Group and ultrasound guidance in U group. A 1:1 mixture of 0.5% Bupivacaine (up to a maximum of 2mg/kg body weight) and 2% Lignocaine (up to a maximum of 5mg/kg body weight) was used for achieving the block. Data collected and analyzed using relevant stastical tests.
Results: There was significant difference in time taken for performance of block and onset time between in U group as compared to the N group. The need for supplementation and complications were more in case of N group as compared to U group. There was no significant difference between the duration of sensory block in the two groups.
Conclusion: The results suggest that ultrasound guided brachial plexus block by supraclavicular approach are superior to NS guided blocks in terms of faster localisation ,onset of action, lesser complications and overall success rate of block.

INTRODUCTION

Pain has existed ever since life came into existence and the highest evolved organism man feels pain the strongest and hence it has been human endeavor to treat pain as effectively as possible.[1] to alleviate this pain has been the main concern of anesthesiologists. Many methods (e.g. General anaesthesia, TIVA, MAC, Neuraxial blocks, Paravertebral blocks, BEIR's block etc.), many drugs and many routes have been tried for this purpose. The basic to modern neural blockade is the concept that pain is a sensory warning conveyed by specific nerve fibre which is amenable to modulation or interruption anywhere in its course.[2]

Regional anaesthesia provides better pain management, disturbs minimal haemodynamics, provides early ambulation and cost effectivenes. Nerve block requires lot of practice, experience, perseverance and enthusiasm of the anaesthetist practicing regional anaesthesia.[3]

With the advancements in the field of anaesthesia recovery after surgery has been rapid and smooth. Regional anaesthesia is a preferred technique for day care surgeries avoiding the problems associated with GA and early ambulation reduces atelectasis, ileus, dehydration, and deep vein thrombosis.[4] There is a reduced requirement of opioids, hence lesser Post anaesthetic nausea & vomiting .[5] The aim of regional anaesthesia technique to deposit the local anaesthetic nearest the target nerve without minimizing risk of nerve damage or any other structure and electrical stimulation helps in identifying the proximity of the needle to the nerves objectively.[6]

Brachial plexus block has developed into an important and safe substitute to general anaesthesia for surgeries of upper limb and relief of pain peri-operatively and post operatively. Introduced by William Steward Halsted in 1885, performed the block by exposing the roots after that it has undergone many changes and modification.[4]

Corresponding author:* **Ajit Kumar Singh
Assoc Prof & Officer Commanding SHO Chandimandir Command Hospital Western Command, Chandimandir

Supraclavicular approach to brachial plexus block produces the most complete limb block. The axillary approach does not affect the shoulder and interscalene often misses the ulnar aspect of the hand and forearm.

The success of brachial plexus block depends on precision of localisation of neural structures. Historically, done by eliciting of one or more paraesthesia. Paraesthesia indicates the closeness of the needle to the nerve bundle and is a warning of impending mechanical contact in case of further needle manipulation in the same direction.

Success of brachial plexus block depends on correct localization of the nerve, placement of needle, and injection of drug. All the techniques incidentally, are "blind" techniques their reliability being dependant on the correct identification of anatomical landmarks before inserting the needle and eliciting of paraesthesia or nerve-stimulated muscle twitch after inserting the needle.[8]

The nerve stimulation technique is based on the use of electric current (upto2.5ma) for a short duration (0.05-1ms) with an insulated needle to elicit motor stimulation of nerves for confirming presence of needle near the nerves. Only issue with identification of nerves is patient feels unpleasant, when the nerve is stimulated to elicit a motor response (twitch). But nerve stimulation also helps in performing blocks under general anaesthesia in children.[7]

The use of Ultrasound guided blocks has enhanced the success and reduced the complication in regional anaesthesia as a whole, due to direct visualization of the nerve bundles and the spread of anaesthetic drug solution, hence reducing number of multiple punctures and complications. Sonographic image helps to visualise the direction of the needle and helps in manipulating it towards the nerve bundles and also avoiding injury to the nearby vessels and other structures.[9, 10]

Brachial plexus blocks with help of Ultrasound guidance leads to an increase in success rates and reduction in complication rates. Use of ultrasound helps in localizing the bundles of brachial plexus with increased precision and thus guiding needle manipulation towards the target nerves. [8]

This study was designed to assess whether ultrasound technique is better than nerve stimulator in supraclavicular approach of brachial plexus block for patients undergoing surgeries of upper limb.

MATERIAL AND METHODS

After proper approval from the Hospital ethics committee, a randomized controlled trial was carried out on patients undergoing upper limb surgery requiring Supraclavicular Brachial Plexus Block. The study was conducted on 100 patients of ASA Gd I and II with patients randomly allocated into two groups of 50 patients each in Base Hospital Delhi Cantt. 1:1 mixture of 0.5% Bupivacaine (up to a maximum of 2mg/kg body weight) and 2% Lignocaine (up to a maximum of 5mg/kg body weight) was used for achieving the block. The patients were divided into two study groups U & group N. In Group N, Peripheral nerve stimulator guided nerve block alone whereas in Group U Ultrasound guided nerve block alone was given.

The study population included ASA grade I II patients from both sexes and all age groups. Patients who were excluded from the study included ASA Grade III and IV patients. Patients with any preexisting neuropathy, clinically significant coagulopathy, obese patients with(BMI of >35), chronic obstructive pulmonary disease, renal or hepatic failure, known allergies to local anesthetic drugs and any prior surgeries in supraclavicular region and pregnancy.

Patients were given premedication in the form of tab ranitidine 150 mg, metoclopramide 10mg and lorazepam 1mg one night preceding the surgery and 2hrs before surgery. After shifting to the operation theatre patients were put on routine monitoring such as ECG, NIBP, and pulse oximetry. Block was given in supine position with patient's head turned towards the opposite side , the operator was positioned on the ipsilateral side and the ultrasound machine was positioned on the opposite side,a roll was placed under operative shoulder to allow better access with needle , the arm was pulled downwards to depresss the clavicle and make the supraclavicular fossa prominent.Needle, transducer and monitor were kept ready. IV access was established in the opposite (non-operative) limb and site of injection for block was prepared using aseptic techniques. Nerve block was given using Ultrasound guided (Sonosite ultrasound machine with a 4cm linear transducer having a frequency of 5-10MHz). A nerve block needle of 20 G along with extension tubing was used for injecting the drug.

A linear, high frequency probe was used to scan Supraclavicular Fossa in a coronal-oblique plane, parallel and immediately posterior to clavicle, to obtain a short axis view of the neurovascular structures. Brachial plexus was identified as a compact group of nerves located over the first rib, laterally and posterior to Subclavian Artery. The skin was infiltrated with 1ml of 2% lignocaine. After identification of the needle on the screen it was slowly advanced keeping subclavian artery as the landmark, 2ml of saline was injected and it's spread was noted after confirming by negative aspiration that the needle is not intravascular the local anesthetic solution was injected around the plexus in two different needle positions. (Refer figure 1& 2)

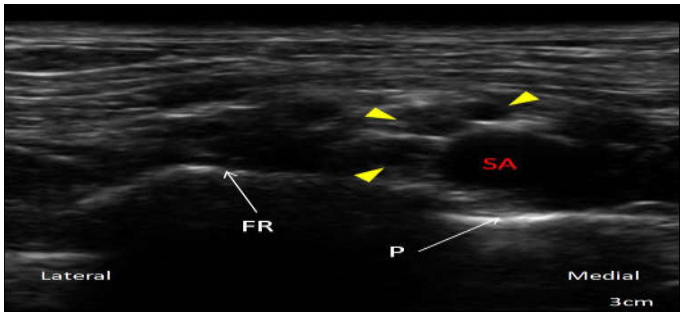

Figure 1 Right supraclavicular brachial plexus (yellow arrows). Note supraclavicular artery (SA) lying on FR=first rib (white arrows). P=pleura.

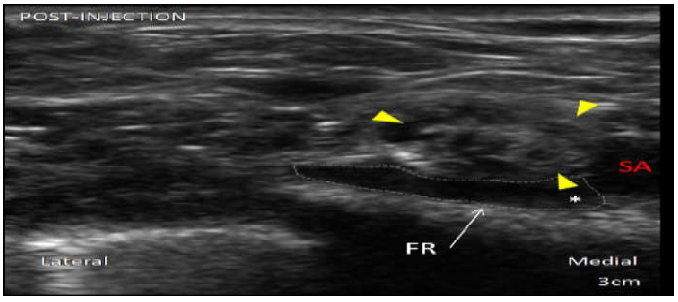

Figure 2 Right supraclavicular brachial plexus (yellow arrows).

Local anesthetic solution (dashed lines) has been deposited in the 'corner pocket' (*). Note the nerve bundles, now appear to

be floating on the anesthetic solution. FR=first rib, SA=subclavian artery

Patients in Group N were given a block using a nerve stimulator device. The positive electrode of nerve stimulator was connected to a 20G insulated needle. After skin infiltration with 1ml of 2% lignocaine skin puncture was made after palpation of subclavian artery, the nerve stimulator was set to deliver1.5-2mA current at1 Hz frequency. the upper trunk was identified the needle was then advanced caudally in slight posterior orientation to bring needle close to lower trunk, identified by flexion/ extension of the fingers. The intensity of stimulation was reduced to <0.5mA maintaining proper twitch, at this point 5ml of drug was injected and disappearance of twitch was noticed after which full dose was given.

Following parameters were studied and recorded in the Performa: Time to localization , time to onset of block, time to peak of block, total time to perform the procedure, regression time ,Accuracy of block ,Density of block , Optimal dosage of LA solution, Need for reinforcement of technique, Need for conversion of technique and Complications of technique. Apart from this number of skin punctures and any intravascular punctures were also noted

The success of block was tested by pin prick test in the central sensory supply area of particular nerve. Normal sensation was taken as partial or failed block and no pain was taken as successful block. Motor block was tested by loss of muscle power with no loss of power counted as failure of block and inability to overcome gravity as complete block. In case any supplementation with IV analgesics was required it was counted as failure of block. In case there was partial block it was decided that LMA would be used to complete the surgery. Collected data was subjected to analysis. The statistical analysis was carried out using SPSS version 20 a Statistical Analysis Software. Data was expressed as mean and SD. Variable data (mean +/- SD) was compared using ANOVA (analysis of variance) with Bonferroni test, whereas Categorical data were compared using Chi-Square/ Fisher's exact test. Any probability value (p) <0.001 was considered statistically significant.

RESULT

In our study 100 patients of either sex had participated. Study was divided into two Study groups of 50 each which were Group N and Group U. Demographic profile of the two groups like gender distribution, Age and Weight on comparison revealed no statistically significant difference among groups. (Refer Table1)

Table 1 Demographic data

	Ns group	Us group	P - value
Mean Age(years)	35.93	34.23	0.207
Mean Weight	67.36	67.54	0.094
Male	8	42	0.787
Female	10	40	

In our study mean number of attempts taken and time to localizing the nerve bundle was less in U group (4.30 ±1.02 min) compared to N group (10.57± 8.79 min). In addition mean Injection time was less in U group (2.67 ± 0.48 min) as compared to N group (3.37± 0.81 min). Further from point of completion of injection of local anaesthetic to Onset of block was faster in group U (7.53 ± 0.68 min) compared to group N (8.63±0.93 min). Intergroup comparison revealed statistically significant difference in onset of block after completion of injection (p value was < 0.001).(Refer Table 2)

Table 2 various parameters studied in US and NS guided blocks

	Ns group	Us group	P - value
Number of attempts taken to locate supraclavicular brachial plexus;mean±SD	5.56±1.18	1.33±0.54	<0.001
Mean Localizing time	10.38±8.36	4.34±1.08	<0.001
Mean injecting time	3.38±0.80	2.64±0.48	<0.001
Mean start to onset time	21.58±8.11	14.26±0.80	<0.001
Mean injection to onset time	8.62	7.48	<0.001

In our study success of sensory block was demonstrated by pin prick test in radial, musculocutaneous, ulnar and median dermatomes. Success of motor block was checked by loss of muscle power and peak effect of motor block was achieved faster in group U (34.76 ±1.46 min) compared to group N (35.37±0.83 min). (Refer Table 3)

Table3

Mean Onset time of Dermatome block	Ns group	Us group	P- value
Mean sensory block onset time; mean±SD in musculocutaneous dermatome	20.30 ± 0.72	19.59 ± 1.05	0.003
Mean sensory block onset time; mean±SD in Radial dermatome	10.26 ± 0.75	9.86 ± 0.35	0.017
Mean sensory block onset time; mean±SD in Ulnar dermatome	30.32 ± 0.82	29.57 ± 1.07	0.009
Mean sensory block onset time; mean±SD in Median dermatome	35.30 ± 0.80	34.71 ± 1.49	0.157
Mean motor block onset time	21.58±8.11	14.26±0.80	<0.001

Intergroup comparison of onset of sensory block and motor block in various dermatomes revealed no statistically significant difference between the groups. Further intergroup comparison revealed no statistically significant difference in peak effect of motor block (p value 0.129).In our study mean lag time from start of procedure to onset of peak sensory and motor block was assessed. Inter group comparison of lag time among the groups revealed no statistically significant difference (p value 0.049).

Supplementation was required in total 24 patients either in the form of General Anesthesia, Total Intravenous Anesthesia or Repeat Block. This was required in 16 patients in group N and while 02 patients in group U.03 patients required GA in group N compared to 01 patient in group U. Repeat block was given in 04 patients in group N while no patient in group U. 09 patients in group N were supplemented by TIVA while 01patient in group U required TIVA. (Refer Figure 3)

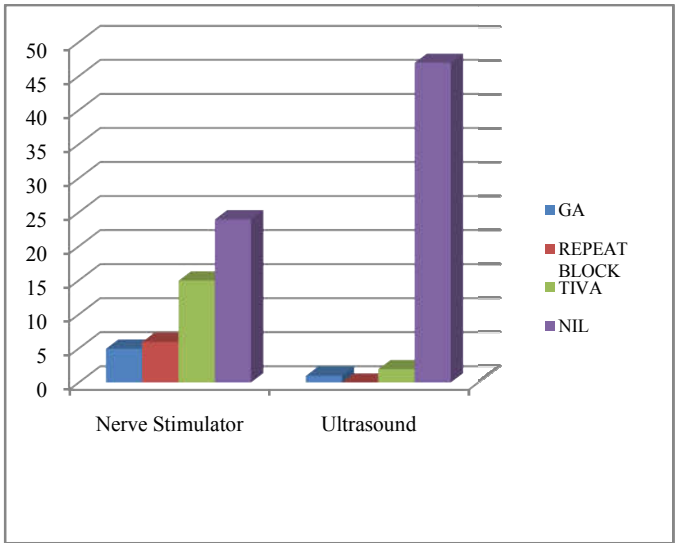

Figure 3 Supplementation method and frequency in block failure

Regarding complications shivering was more common in group N as compared to group U. 7 patients in group N complained of nausea, but none in group U.

Post op bruising was observed in 4 patients in group N and nil in group U, Vascular puncture in 2 patients in group N, but none in group U. No incidence of bradycardia, hypotension, respiratory depression, desaturation, and pneumothorax or hematoma formation in any of the patients of study group. (Refer Table 4)

Table 4 Comparison of Incidence of Complications in both groups

Complications	Nerve Stimulator		Ultrasound		p-value
	Freq.	%	Freq.	%	
Shivering	16	32	5	10	0.024
Nausea	11	22	0	0	0.001
Postop Bruising	7	14	0	0	0.015
Vascular Puncture	4	8.	0	0	0.129

DISCUSSION

William Halsted in 1884 used first brachial plexus block and in 1887 George Crile exposed the plexus under to inject cocaine in a 12 year old boy under vision.[11] First percutaneous brachial plexus block was performed using axillary approach by Hirschel in the 1911. Kulenkampff performed the block via supraclavicular approach whereas Bazy and Pauchetin1917 used infraclavicular approach.[12] The block continued to be performed by the landmark and parasthesia technique.

Perthes in 1912 devised and described the use of electrical nerve stimulator. In 1955 Pearson who introduced the concept of insulated needles for locating the nerve bundles.[13]

In 1978 La Grange *et al* performed the first ultrasound guided supraclavicular block by using a Doppler US blood-flow detector by identifying the subclavian artery and vein. Abramowitz *et al*. in 1981 using Doppler US used axillary artery approach for performing brachial plexus block.[14]

In Past few years an increase interest in peripheral nerve blocks for intraoperative anesthesia as well as postoperative analgesia is noticed due to its added benefits in comparison to general anesthesia.

Success of a block is dependent on delivery of the accurate dose and location. Anatomical landmarks have individual variability and the underlying nerve or plexus location may vary. This challenge leads in unreliability, when block is performed by conventional method using landmarks and parasthesia. Multiple attempts by the needle can be frustrating for the operator, painful to the patient and time consuming. Inaccurate positioning and local anesthetic leads to patchy block or block failure. Trauma by needle for locating the nerve plexus can cause nerve damage, pleural and vascular complications. All of these techniques have a low sensitivity for detection of needle to nerve bundle contact.[15]

Localizing nerves with help of imaging helps to improve success rate of block and decrease the complications. Different modalities such as computed tomography (CT), magnetic resonance imaging (MRI) and fluoroscopy were used. These had limitations as regards space and costs. Ultrasonography is noninvasive, with no exposure to radiation, affordability and portability and also its ability to provide real-time view of the area being scanned.

Studies have emphasized that the direct visualization of the needle tip helps in locating the nerve to be blocked. Real-time visualization helps in the drug infiltration around the nerve bundle, thus distributing the drug solution uniformly around the nerve bundles. This results in quicker onset, enhanced duration, and better quality block with less local anesthetic dosage as compared with blocks given by the parasthesia elicitation or with nerve stimulator. Lastly since vessels and nerves are visualized in real time there are less chances of intravascular or intraneural injection of local anesthetic.[16]

Studies comparing use of nerve stimulator and ultrasound for upper extremity nerve plexus block have established the dominance of ultrasound block in terms of visualization, localization, onset of block, overall success rate of block and decrease incidence of complications. In another study the authors concluded that with experienced anesthetists, nerve stimulator and ultrasound-guided blocks provided similar results as regards success of block, onset, incidence of complications and patient satisfaction in both groups.[17]

In a study the “five Ps” for Ultrasound usage is emphasized. The “five Ps” are position, probe, placement, plane, and picture. Firstly proper probe position to have proper exposure and manipulation, second proper frequency range of probe, proper placement of probe, scanning plane and proper knowledge of area to be scanned. [18]

This was supported by Study by metanalysis by Qin Q *et al* in meta-analysis carried out in the Anesthesiology Department of the Affiliated Hospital of Soochow University, Suzhou, Jiangsu Province, China. [19]

Our results also showed that supraclavicular brachial plexus block under ultrasound guidance has significantly better than nerve stimulator group in terms of shorter time of localisation (4.30min vs. 10.57min), mean injection time (2.67vs 3.37), onset of block (14.27vs21.80), completion of injection to onset of block (7.53 vs. 8.63), better success rate of (92% vs. 48%), lesser complications like vascular puncture and bruising lesser and better satishfaction.

There was no statistically significant difference in the onset of sensory and motor block in both groups.

CONCLUSION

The use of ultrasound has a learning curve which involves appreciation of the sonoanatomy of the part being studied also

coordination of hands and eye for positioning the needle accurately and performing a successful block. At the same time chances of success of nerve stimulator guided block depend on the fact that we still get a twitch at threshold current of 0.5 mA. USG guided technique helps in better direct visualization of neural structures, the needle placement in proximity to nerve bundle and better dispersion of drug.

Recommendations

We recommend that ultrasound guided brachial plexus block using supraclavicular approach are safer and more successful in comparison to nerve stimulator. Although more number of prospective trials are required to further ascertain the USG guided brachial plexus blocks safety and efficacy.

Conflicts of Interest

Nil

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