A COMPARATIVE STUDY BETWEEN ANATOMICAL LANDMARK AND NERVE STIMULATOR GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR NEUROVASCULAR VARIATIONS IN TOPOGRAPHIC ANATOMY OF BRACHIAL PLEXUS.

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ABSTRACT

A comparative study between anatomical landmark and nerve stimulator guided supraclavicular brachial plexus block for neurovascular variations in topographic anatomy of brachial plexus.

In the backdrop of our country, nerve stimulator is still not available in many centres and many anesthetists do not yet have the proper expertise and experience in giving nerve stimulator guided brachial plexus blocks as compared to their performance of anatomical landmark guided brachial plexus block. Study revealed that anatomical landmark guided brachial plexus block is as good a method as the nerve stimulator guided technique and there is no added advantage that the nerve stimulator guided method will have over it.

However, supraclavicular brachial plexus block for neurovascular variations in topographic anatomy may not be benefited from the performance of anatomical landmark guided block as literature revealed no specific established neurovascular variation in topographic anatomy in respect to age sex, race, body weight in living subjects.. No anatomical variation in the brachial plexuses under study could be found out since direct visualisation of the brachial plexus was not possible from either of the methods.. The aim was to compare between percentage of patients successfully completing the surgical procedure using anatomical landmark guided supraclavicular brachial plexus blocks versus nerve stimulator guided supraclavicular brachial plexus blocks in order to delineate the anatomical variation of brachial plexus. In this prospective, randomised, open level parallel group study and onset of sensory blockade was judged by pin-prick, temperature testing, motor blockade--by 'push, pull, pinch, pinch'. Percentage of patients successfully completing the surgical procedure using anatomical landmark guided supraclavicular brachial plexus blocks versus nerve stimulator guided supraclavicular brachial plexus blocks were determined . Incidence of failure of block were noted in both the methods . All the results were statistically analysed. Success rate of patients underwent supraclavicular brachial plexus block, taking the number of patients completing operation without conversion to general anaesthesia as the parameter, is 80.39 % in patients given anatomical landmark guided supraclavicular brachial plexus block and 78.43 % in patients given nerve stimulator guided supraclavicular brachial plexus block .Thus in patients with anatomical variations of brachial plexus, identification of surface landmarks for the purpose of giving blocks is not fruitful. It was concluded that the anatomical methods are not a reliable technique. Direct visualization of the brachial plexus by newer methods is needed for 100% success.

Key Words: Anatomical Landmark, Nerve Stimulator Guided Block, Brachial Plexus Block, Neurovascular Variations, Topographic Anatomy.

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INTRODUCTION

Patients requiring upper extremity surgery are seen more or less frequently in the orthopaedic , plastic surgery and emergency operation. theatres . In each case it is always a critical question for the anaesthesiologists to choose between general and regional anaesthesia.

According to Philip (1992), regional blocks can offer many advantages by restricting the anaesthetized area to the surgical site while limiting common side effects of general anaesthesia, example. – nausea, vomiting, dizziness and lethargy. Moreover, Mingus (1995) and Bridenbaugh (1983) stated that they improve recovery and decrease the need for post anaesthesia nursing care. In totality, they are claimed by Mingus (1995) to be also the most cost- effective method.

Supraclavicular brachial plexus blocks provides anaesthesia and is preferred in the most consistent, time efficient manner. In addition to the classical technique of performing supraclavicular brachial plexus blocks as a blind procedure keeping in mind the underlying anatomy of the region, another commonly used method requires the use of nerve stimulator.

A technique employing a nerve stimulator and an insulated needle was used for supraclavicular brachial plexus block with a success rate of 98%. However, in another study success rates as low as 79 % had been reported ⁷. A previously done study also reported a success rate of only 72 % despite the necessity of a nerve stimulator and doppler probe to perform the technique of supraclavicular brachial plexus block as described.

In the backdrop of our country where nerve stimulators are not freely available in many centres this study aims to compare the efficacy of supraclavicular brachial plexus block using the anatomical landmark and by using nerve stimulator so as to determine the effectiveness of each technique and the better option between both though neurovascular variations in topographic anatomy of brachial plexus may exist. Therefore ,aim of this study is to compare_between percentage of patients successfully completing the surgical procedure using anatomical landmark guided supraclavicular brachial plexus blocks versus nerve stimulator guided supraclavicular brachial plexus blocks in order to delineate the anatomical variations of brachial plexus.

Objectives of the study were threefold, namely,

Determination of

- 1. Onset of nerve blockade.
- 2. Percentage of cases revealed inadequate block which required supplementation due to complaint of pain within one hour of onset of
- supplementation due to complaint of pain within one hour of onset of block.
- 3. Incidence of failure of block by both the methods .

All the results were statistically analysed.

MATERIALS AND METHODS

After approval of the Institutional Ethical Committee and written, informed consent, this prospective, randomized, open-level, parallel group study was carried out among one hundred and two patients with ASA physical status I and II inpatients aged between 18 and 40 years scheduled to undergo brachial plexus block for upper extremity surgery. Patients with respiratory or cardiac disease, diabetes, or peripheral neuropathy, as well as those receiving chronic analgesic therapy, were excluded.

No premedication was given until the completion of all measurements. After a 20-gauge intra-venous cannula was inserted in the forearm, all patients had received a 5 mL / kg/ h infusion of lactated Ringer's solution. Standard monitoring was used throughout the study, including noninvasive arterial blood pressure, heart rate, and end-tidal CO2 and pulse oximetry. All the patients were provided conscious sedation using midazolam (1mg) and fentanyl ($25 \mu g$). Ramsay Sedation Scale was used (*), where a sedation score of < 3 was used for this study.

Keeping all resuscitative measures ready, nerve block was performed with and without the aid of a nerve stimulator (Plexival, Medival, Italy) using a short-beveled, Teflon-coated stimulating needle (Locoplex,

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Vygon, France) (3.5 cm long, 25 gauge). The stimulation frequency was set at 2 Hz, and the intensity of stimulating current was initially set to deliver 1 mA, then decreasing gradually to <0.5 mA.

All the patients were randomized through a computer generated random number in a sealed envelope to receive brachial plexus block using anatomical land mark (n=51) and using the aid of a nerve stimulator (n=51).

Sterile syringes containing the local anesthetic solution were prepared in a double-blinded fashion by one of the investigators, who had not taken part in the further management of the patients.

All baseline vital parameters were measured immediately before block injection (baseline). At the same time, onset of nerve blockade was judged by sensory blockade- pin-prick, temperature and motor blockade- 'push, pull, pinch, pinch.

The start time for clinical assessments started from the completion of the local anesthetic injection. Motor function was tested by asking the patient to abduct the arm at the shoulder joint against gravity and to flex the forearm at the elbow. Sensory block was assessed using pinprick . The onset of surgical anesthesia (ready for surgery) was defined as the loss of pinprick sensation at the skin dermatomes involved in the surgical field and inability to abduct the arm at the shoulder joint against gravity. All measurements were made with the patient lying in a 30° head-up, supine position. Immediately after block placement, patients were evaluated every 1 min, by an anaesthesiologist unaware of the injected solution, to determine loss of shoulder abduction as evidence of a successful motor blockade. In addition, sensory block were assessed by pinprick every 1 min in the C5-6 dermatomes. Failure to lose shoulder abduction was considered to be due to inadequate block. These patients were reblocked or supplemented by other anaesthetics at the discretion of the attending anesthesiologist and were omitted from statistical analysis. All episodes of local anesthetic toxicity or haemodynamic change requiring anesthesiologist intervention (increased IV fluids or ionotropes) were recorded as adverse events. After evidence of a successful sensory and motor block, the patients were taken to the operating room for surgery.

2ml/kg body weight of 0.25 % injection bupivacaine was given to produce the supraclavicular brachial plexus block. The patients were studied in two groups . First group [Group A , n=51] was given supraclavicular brachial plexus block based on anatomical landmark of this region[palpation of subclavian artery pulsation in the supraclavicular fossa] .Second group [Group B , n= 51] was given supraclavicular brachial plexus block guided by nerve stimulator.

The onset of the block was determined by sensory blockade [which was tested by pin prick , temperature] and by motor blockade which was tested by 'Push' [extend arm with triceps to check radial nerve] ,' Pull' [flex arm with biceps to check musculocutaneous nerve] ,' Pinch' [fifth digit to check ulnar nerve] , 'Pinch' [index finger to check median nerve] . Success of the technique was considered as surgery without patient discomfort and need for supplementation of block within one hour of onset of block .

At the end of operation pain was assessed using visual analogue scale. Operationally, a visual analogue scale was use, and patients with visual analogue scale < 3 was considered with no pain at the end of operation.

The following parameters were followed in this study:

Number of patients completed surgery under supraclavicular brachial plexus block as the sole anaesthetic technique between the two groups, one where anatomical landmark guided block was given and the other where nerve stimulator guided block was given.

Onset of nerve blockade was judged by:

Sensory blockade- pin-prick, temperature.

Motor blockade- 'Push' : extend arm with triceps to check radial nerve,

'Pull' : flex arm with biceps to check musculocutaneous nerve,

' Pinch' :pinch fifth digit to check ulnar nerve,

'Pinch' : pinch index finger to check median nerve .

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Success of the technique was considered by:

- > Adequate nerve block : neither sedation nor analgesics required to complete operation.
- Inadequate block : operation started successfully after block but required supplementation due to complaint of pain by patient within 30 minutes of performance of block.
- ➤ Failed block : general anaesthesia required to complete surgery .

Study tools used:

- Adult patients admitted to the in-patient departments of surgery & orthopaedics for upper extremity surgery.
- 0 0.25% Injection bupivacaine [2 ml/ kg body wt] for production of block.
- Nerve stimulator.
- o Monitor with NIBP.
- o Statistical tools & software for analysis and comparison of data
- o Cotton wool with spirit to check temperature [cold sensation] for onset of sensory blockade.

Sample size calculation was assumed from a previously done pilot study showing success rate of supraclavicular brachial plexus block, guided solely by anatomical landmarks to be 70%. It was calculated from that study that 47 subjects would need to be recruited per group in order to detect a difference of 25% improvement in success rate (i.e. from 70% to 95%) with 90% power and 5% probability of Type I error. We aimed to recruit 52 subjects per group to leave a 10% margin for non-evaluable cases.

Statistical Analysis

All relevant data were recorded and statistically analyzed.

All the data were expressed as Mean \pm S.D with 95 % confidence interval. Student – t test or Fisher's exact test was used for statistical comparison . p value < 0.05 was considered as statistically significant.

RESULTS AND DISCUSSION

This study was carried out among one hundred and two patients brachial plexus block for upper limb surgeries with ASA physical status I and II and aged between 18 and 40 years. Descriptive statistics – Group 1 [A] : Patients undergoing supraclavicular brachial plexus block.

Group 2 [B] : Patients undergoing nerve stimulator guided brachial plexus block.

Table	1:	Showing	comparison	of	numerical	variables	between	the	two	groups	by	Student's
unpair	ed	t test.										

	Mean 1	Mean 2	t-value	Df	Р	Valid N	Valid N	Std.Dev 1	Std.Dev2
Age	37.7451	35.0392	0.89253	100	0.374252	51	51	15.08223	15.53314
Weight	57.1373	56.451	0.61897	100	0.537341	51	51	5.74811	5.44542
OpDur	169.7647	121.8627	3.47967	100	0.000745*	51	51	85.22337	49.0098
PR_Pre	82.3922	84	-0.77896	100	0.437842	51	51	10.5737	10.27035
PR_15	86.8235	89.7451	-1.15965	100	0.248951	51	51	12.83231	12.61086
PR_30	82.3659	85.8462	-1.43686	78	0.154758	41	39	11.06968	10.56942
SBP_Mean	122.6667	124.1373	-0.57377	100	0.567413	51	51	12.16169	13.67921
DBP_Mean	80.7255	80.3725	0.18858	100	0.850804	51	51	8.59553	10.23516
RR_Mean	22.4902	21.7647	0.98055	100	0.32918	51	51	3.96672	3.49049

significant p- value : \Box

OpDur - Duration of Operation; PR_Pre - Pulse rate prior to giving block; PR_15 - Pulse rate 15 minutes after giving block; PR_30 - Pulse rate 30 minutes after giving block; SBP_Mean - Mean Systolic Blood pressure; DBP_Mean - Mean Diastolic Blood pressure; RR_Mean - Mean Respiratory rate

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From Table 1 it is seen that among all the numerical variables compared by the Student's unpaired t test between the groups of patients undergoing supraclavicular brachial plexus block by anatomical landmark guided method & nerve stimulator guided method only the duration of operation bears a significant p-value of 0.000745 (that is , p value <0.05).

Comparison of categorical variables between groups - Fisher's exact test

Table 2: Comparison of Ramsay's sedation score, sex distribution and conversion to general anaesthesia between patients of Group 1 (A) patients of Group 1 (A) & Group 2 (B).

~	RSed				GA Convert		GA Convert	
Group	Score	RSed Score	Sex	Sex				Row
						Yes		
	2	3	F	Μ	No	Immediate	After 30 minutes	Totals
1	32	19	20	31	41	10	•	51
	62.75			60.78				
Row %	%	37.25%	39.22%	%	80.39%	19.61%	•	
2	38	13	13	38	40		11	51
	74.51			74.51				
Row %	%	25.49%	25.49%	%	78.43%		21.57%	
	•					·		

Fisher's exact test 2-tailed Fisher's exact test 2-tailed Fisher's exact test 2-tailed p value 1.000 p value 0.286 p value 0.204

RSedScore: Ramsay's Sedation Score F: Female M: Male GAConvert : Conversion to general anaesthesia

From Table 2, demographic profile shows that comparison of sex, Ramsay's Sedation Score and patients converted to general anaesthesia between the two groups by Fisher's exact test did not reveal any significant p- value (that is p- value > 0.05). At the same time, it was seen that among those converted to general anaesthesia ,percentage of failed blocks (that is , those who required immediate conversion t o general anaesthesia) were 19.61% and percentage of inadequate blocks (that is, those who required conversion t o general anaesthesia after 30 minutes) were 21.57% .

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Table 3: shows comparison of pain free 30 mins of patients , Visual Analogue Scale , sensory and motor blockade between Group 1 (A) & Group 2 (B).

Group	Pain Free 30m	Pain Free 30m	Block Sen	Block Sen	Block Mot	Block Mot	VAS	VAS	Row
	Yes	No	Yes	No	Yes	No	Yes	No	Totals
1	41	10	41	10	41	10	41	10	51
Row %	80.39%	19.61%	80.39%	19.61%	80.39%	19.61%	80.39%	19.61%	
2	40	11	40	11	40	11	40	11	51
Row %	78.43%	21.57%	78.43%	21.57%	78.43%	21.57%	78.43%	21.57%	

Fisher's exact test 2-tailed p value 1.000

Pain Free30m :No pain complained by patient 30 minutes after onset of block. BlockSen : Sensory block BlockMot : Motor block

VAS : Visual Analogue Scale

From Table 3 demographic profile shows that among the two groups ,comparison of absence of complaint of pain by patients 30 minutes after onset of block , Visual Analogue Scale , Sensory and Motor blockade by Fisher's exact test did not reveal any significant p-value (that is p-value > 0.05).

The classical supraclavicular brachial plexus block was found to be acceptable, effective by Pande, R. 1; Pande, M. 1; Bhadani, U. 2; Pandey, C. K. 2; Bhattacharya, A. 3, ⁹ with the success rate of anatomical landmark guided block being 80.39 % and from this study too, it has been found out that the success rate of anatomical landmark guided brachial plexus block was quite close to the success rate of nerve stimulator guided supraclavicular brachial plexus block (78.43 %). But disadvantages of anatomical land mark guided supraclavicular block included requirement for elicitation of paraesthesia to attain a reliable rapid onset block ., ¹⁰, which was very much subjective and moreover blind.

The nerve stimulator guided supraclavicular block reported high success rates though success rates as low as 79 % have also been reported . ¹¹ This present study reports the success rate of nerve stimulator guided brachial plexus block to be 78.43% .

This present study was undertaken among 102 adult patients scheduled to undergo upper limb surgeries .In the first group (anatomical landmark guided), 10 out of 51 patients (19.61 %) were noted to have failed blocks and in the second group (nerve stimulator guided) 11 out of 51 patients (21.57 %) experienced inadequate brachial plexus blocks where patients needed supplementation within 30 minutes . Failed block was considered as patient complaining of discomfort and the need for supplementation of block to start with the incision .It could be attributed to the individual differences in the pharmacokinetic handling of bupivacaine which was used as the local anaesthetic to perform the blocks. These differences could be due to various factors of which relevant in this study were the differences in age , sex ,body size and genetic factors . Also to be taken into account was the fact that the blocks were performed without the use of any pre- medication or adjuvant which would be another cause of block failure .The demographic profile of the present study revealed no significant difference with respect to age, sex, body weight, the type and dose of the drug.

An issue frequently raised against the use of regional anesthesia in general is that, even in experienced hands, the success rate is rarely 100%. One of the reasons for this is that

the anatomy of the human body is variable and these variations are unrecognizable during the performance of either a paraesthesia or peripheral nerve stimulator technique, both of which depend on

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surface landmarks and blind needle insertion. With respect to this study, no onset of block could be termed as the cases where anatomical variations could be considered.

Study of Fazan Valéria Paula Sassoli; Amadeu André de Souza; Caleffi Adilson L.; Filho Omar Andrade Rodrigues revealed that, anatomical variation of brachial plexuses were not found and sex, color or side of the body had not much influence upon the presence of variations.

During routine dissection of a 55-year old male cadaver, multiple anomalies were observed in the brachial plexus .The subclavian artery entered scalenus anterior muscle while the roots C8-T1 of the brachial plexus passed behind scalenus medius. The anterior divisions of upper and middle trunks united to form the lateral cord lateral to the axillary artery. The anterior division of the lower trunk ran as the medial cord medial to the axillary artery. Suprascapular nerve did not arise from the superior trunk; it arose from the root of C5. Superior subscapular, thoracodorsal and inferior subscapular nerves arose from the posterior division of the upper trunk . Afterwards, the posterior cord continued as axillary and radial nerves. The musculocutaneous and ulnar nerves had their normal courses.

A 57-yr-old man presented for elective tenolysis and reconstruction of the left hand following a previous crush injury with open fractures several months earlier. Upon scanning the brachial plexus in the left supraclavicular fossa, it was discovered that at the level of the first rib, the superior trunk was medial to the subclavian artery whereas the middle and inferior trunk was in the usual location lateral to the subclavian artery . A more comprehensive scan revealed an anomalous course of the C5/C6 roots and superior trunk of the brachial plexus. The C5 root was located just lateral to the internal jugular vein, and medial to the anterior scalene muscle (ASM); the C6 root lay slightly more lateral, but still inferomedial to the superior trunk . A similar anatomic pattern was seen on the right side. Performance of either an interscalene block or a supraclavicular block in this patient using an anatomical surface landmark-guided technique would almost certainly have resulted in sparing of the C5 and C6 dermatomes.

Therefore awareness of the topographic anatomy of various neurovascular variations in the triangles of the neck may serve as a useful guide for radiologists, anesthesiologists and surgeons. It can help to prevent diagnostic errors, influence surgical and interventional procedures and avoid surgical complications during head and neck surgeries. The detailed case report with review of the literature of a 55-year-old formalin fixed male cadaver was presented showing an unusual loop formation from the three main branches of supraclavicular nerve around the external jugular vein and the transverse cervical artery on the right side of the neck. Such a loop may lead to neurovascular symptoms. Cases bearing this kind of variations should be managed carefully during surgical and/or electrophysiological procedures.

Another study involving dissection of twenty-three brachial plexus (13 women and 10 men, fresh or injected by formalin) was carried out to find out the brachial plexus anatomic variations and its relations . Anatomic variations were noted at different levels of the brachial plexus .Relevant to the supraclavicular part of brachial plexus , is the finding of variation in the brachial plexus tract in 1 case (4.3 %) and the frequency of 4th cervical root (C4) participation in brachial plexus. Kerr found 65.9%. It was 30.4% of C4 participation in brachial plexus in this series. In 5 cases no abnormalities were found . These brachial plexus variations could fail the brachial plexus loco-regional anaesthesia.

In a prospective observational study by Kessler and Gray, 23 adultvolunteers underwent head and neck examination by use of a linear 14-MHz ultrasound probe (15L8; 26 mm footprint) and an Acuson Sequoia C256 system (Siemens Medical Solutions, Mountain View, CA). Anatomic

variations were detected in 6 of 46 (13%) examined brachial plexuses. Three C5 ventral rami were seen passing over and 3 passing through the anterior scalene muscle. A high incidence of scalene muscle abnormalities was detected with sonography. These anomalies could potentially restrict the distribution of local anesthetic injections and produce inferior trunk sparing. In the supraclavicular region, neural elements were located inferiorly to thes ubclavian artery in two volunteers.

The anatomical pathway to reach the brachial plexus is diverse. Since the first report on the variation of the brachial plexus over a 100 years ago to more recent cadaver autopsies showing cord level variations in

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up to 12.8% of cases ¹⁷, acknowledge the diverse range of variations associated with the brachial plexus which could not only play a definite role in the failure of brachial plexus blocks, but could also increase the rate of complications due to multiple punctures when using the nerve stimulator, which in turn made the usefulness of ultra-sonography more valid.

From this study it was seen that the success rate of patients underwent supraclavicular brachial plexus block , taking the number of patients completing operation without conversion to general anaesthesia as the parameter ,was 80.39 % in patients given anatomical landmark guided supraclavicular brachial plexus block and 78.43 % in patients given nerve stimulator guided supraclavicular brachial plexus block .Since the p- value comes to 1 .00 , therefore it can be said that there was no significant difference in the success rate of patients undergoing supraclavicular brachial plexus block by either of the techniques.

Especially in patients with anatomical variations and also where identification of surface landmarks for the purpose of giving blocks is difficult, a recent method known as ultrasound guided supraclavicular brachial plexus block was very useful since direct visualization of the brachial plexus was possible in this technique. Therefore this technique had been associated with decreased time to perform the block, decreased onset time and increased success rates as compared to both anatomical landmark guided and nerve stimulator guided brachial plexus blocks¹⁹. Finally, the study did not show variations of age, sex ,bodyweight ,which would matter a little, if any, that is influence upon the presence of anatomical variations upon which the 100% success depends in case of this type of blind procedures.

Therefore, to conclude ,nerve stimulator is still not available in many centres and many anesthetists do not yet have the proper expertise and experience in giving nerve stimulator guided brachial plexus blocks as compared to their performance of anatomical landmark guided brachial plexus block. This was because from this study it was revealed that anatomical landmark guided brachial plexus block was as good a method as the nerve stimulator guided technique. Moreover, due to presence of neurovascular variations of topographic anatomy of brachial plexus , identification of surface landmarks for the purpose of giving blocks was not considered a reliable technique .Newly evolving techniques showing direct visualization of the brachial plexus mandates 100% success of supraclavicular brachial plexus block.

ACKNOWLEDGEMENTS

This work would be incomplete without a word of thanks to the surgeons and anaesthetists of I.P.G.M.E&R for their co-operation and Dr. Abhijit Hazra ,Associate Professor ,Department of Pharmacology , I.P.G.M.E &R for his acumen in dealing with all statistical issues of this work .Finally , we would like to thank our families for their unconditional love and support throughout the entire course of this work .

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