"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES."

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Endorsement

This is to certify that the dissertation entitled **"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES."** is a bonafide research work done by **(REG NO. BA0116005).**

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LIST OF ABBREVIATIONS USED

ASA	-	American Society of Anaesthesiologists
C	-	Cervical
T	-	Thoracic
mcg	-	Microgram
cc	-	Cubic centimeter
CNS	-	Central nervous system
CSF	-	Cerebrospinal fluid
CVS	-	Cardiovascular system
DBP	-	Diastolic blood pressure
ED	-	Effective dose
FDA	-	Food and Drug Administration
GA	-	General Anaesthesia
HCO_3	-	Bicarbonate
HR	-	Heart rate
bpm	-	Beats per minute
IV	-	Intravenous
kg	-	Kilogram
L	-	Lumbar
m	-	Meters
MAP	-	Mean arterial pressure
mg	-	Milligram
v/s	-	Versus
MHz	-	Megahertz
Mins	-	Minutes

ml	-	Millilitre
NIBP	-	Non invasive blood pressure
NS	-	Not significant
O_2	-	Oxygen
$PaCO_2$	-	Partial pressure of carbon dioxide
PNB	-	Peripheral Nerve Blocks
PNS	-	Peripheral Nerve Stimulator
SAB	-	Subarachnoid block
SBP	-	Systolic blood pressure
SD	-	Standard deviation
Sec	-	Second
SpO_2	-	Peripheral saturation of oxygen
α	-	Alpha
β	-	Beta
δ	-	Delta
μ	-	Micro
cm	-	centimeter
G	-	Gauge
mEq	-	milliequivalents
Lt	-	litre
Dl	-	deciliter
USG	-	Ultrasound
V_{max}	-	maximum initial velocity or rate of a reaction

ABSTRACT

Introduction: In conventional techniques of performance of brachial plexus bock the search for target nerves remains “blind”; leading to prolonged time for nerve localization. Blind techniques cause patient discomfort, increased incidence of complications and require multiple needle attempts.

Ultrasound (USG) imaging ensures accurate needle positioning and monitors the distribution of local anesthetic in real time. Thus, improving the quality of block and increasing chances of successful nerve block.

In patients with distorted anatomy, obesity and in inexperienced hands USG can be difficult to perform leading incomplete blocks or failure. Nerve stimulation can be used to assist ultrasound guidance to achieve more efficient nerve localization.

Objective: Our study aims to compare USG guided and nerve simulator assisted USG guidance for supraclavicular brachial plexus block in patients undergoing upper limb surgeries for

1. Time for the onset and duration of sensory and motor blockade.
2. Time taken for performance of block.

Method: After obtaining approval of the Ethical committee and written informed consent, 70 ASA I-II patients aged between 18-60 years posted for elective upper limb surgeries under supraclavicular brachial plexus block were included in the study. Patients were randomly divided into two groups of 35 each by computer generated table.

- Group A –Supraclavicular brachial plexus block under ultrasound guidance.
- Group B – Supraclavicular brachial plexus block under nerve stimulation assisted ultrasound guidance.

Student's 't' test was used to compare quantitative variables in both groups. $P<0.05$ was considered statistically significant.

Result: In our study the mean time taken for performance of block was 10.22±2.11 minutes in group A and 5.87 ±1.07 minutes in group B. The onset of sensory block 9.28±1.86 minutes in group A and 6.79±1.04 minutes in group B. The mean time of onset of motor block was 17.69±1.45 minutes in group A and 14.56±2.53 minutes in group B. The results were statistically significant with a $p<0.001$.

The mean time for duration of sensory block was 297.29±47.79 minutes in group A and was 396±37.57 minutes in group B. The mean time for duration of motor block was 225.94±42.72 minutes in group A and 245.60±42.82 minutes in group B. These results were not statistically significant.

The haemodynamic changes between the two groups were both comparable and were statistically and clinically not significant.

Conclusion: In conclusion, the use of nerve stimulation along with ultrasound guidance significantly reduces the time taken for the performance of the block, the onset of sensory and motor block compared to ultrasound guidance alone in patients undergoing supraclavicular brachial plexus block.

Keywords: supraclavicular brachial plexus block, peripheral nerve stimulator, ultasound

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INTRODUCTION

Regional anaesthesia offer many advantages over general anaesthesia which result in better patient outcome and lower overall healthcare costs. It provides excellent anaesthesia and post-operative pain relief, which facilitate early physical activity. It is associated with the reduced use of opioids with fewer peri-operative complications and earlier discharges. Regional anaesthesia is therefore acceptable and preferred especially in elderly and high risk patients[1].

The key to the practice of regional anaesthesia is a thorough knowledge of the anatomy and approach to the block. The success depends on the accuracy of needle placement, nerve localization, and delivering the right dose of local anaesthetic to the target nerve[2].

Surgeries on the upper limb have traditionally been done under general anaesthesia. However this has its own demerits like airway instrumentation, exposure to multiple drugs[1] and chances of aspiration in presence of inadequate nil per oral status. The most common surgeries on the upper limb include orthopedic and plastic reconstructive procedures. These procedures can be long and painful and sometimes requiring long operative time and adequate post operative analgesia.

Brachial plexus block has become a viable alternative to general anaesthesia as it provides excellent intra operative and post-operative analgesia and adequate muscle relaxation without any significant complications.

The brachial plexus block is one of the most widely performed blocks for the upper extremity[3].There are various approaches which have been developed for

blocking the desired parts of the upper extremity namely interscalene, supraclavicular, infraclavicular and axillary. The supraclavicular approach is the most preferred as it is performed at the level of the trunks of the brachial plexus where almost the entire motor, sensory, and sympathetic innervation of the upper extremity is carried in three nerve structures confined to a very small surface area. Consequently, typical features of this block include rapid onset, predictability, and dense anesthesia[3].

There are different methods of performing brachial plexus block from blind parasthesia technique to ultrasound guidance.

Conventional techniques of nerve localization depend on surface anatomical landmarks for identifying the location of brachial plexus. However, at the time of needle insertion, the search for target nerves remains “blind”; thus, nerve localization can be frustrating and time consuming and most often imprecise needle placement resulting in failure of blocks[4].

Blind techniques have an increased incidence of complications such as pneumothorax, horner syndrome and neuropathy; patient discomfort, and long procedure times[3]. The trial-and-error approach to nerve localization often requires multiple needle attempts, leading to patient anxiety and operating room delay.

In order to overcome these factors and improve the success rate, peripheral nerve stimulator (PNS),an important tool is commonly used for assistance during the performance of peripheral nerve block. However, one of the major disadvantages with peripheral nerve block is the method of elicitation of the motor twitch leading to patient discomfort as well as increased latency of the block. In recent years, there has been growing interest in the development of image-guided brachial plexus blocks.

Portable and high resolution ultrasound has become an integral component in present day practice of anesthesia. Ultrasound guided nerve blocks have been described in the literature since 1978. Ultrasound imaging techniques enable the anesthesiologists to secure an accurate needle position and monitor the distribution of local anesthetic in real time with the potential advantage of shortening the latency, improving the quality, and reducing the minimum drug volume required to obtain a successful nerve block. The inherent safety of this technique is the continuous visualization of the needle tip during needle advancement.

However, in patients with distorted anatomy, obese patients and in inexperienced hands ultrasound guided blocks can be difficult to perform and can lead to increased latency, incomplete blocks or failure.

Nerve stimulation can be used to assist ultrasound guidance to achieve more efficient nerve localization. Thereby reducing the number of needle attempts and increasing the success rates. This dual guidance also lowers the risk of pneumothorax as the skin to pleura distance can be measured under USG prior to insertion of the needle. The responses to PNS can be useful for confirmation of needle proximity to the separate trunks.

There are very few studies in literature about the use of PNS assisted ultrasound guidance for brachial plexus block. Hence an attempt has been made to compare ultrasound guided and nerve simulator assisted ultrasound guidance for supraclavicular brachial plexus block in patients undergoing upper limb surgeries.

OBJECTIVE

The objectives of the study were:-

To compare:

1. Onset and duration of sensory and motor blockade.
2. Time taken for performance of block

Between ultrasound guided and nerve stimulator assisted ultrasound guided supraclavicular brachial plexus block in patients posted for elective upper limb surgeries.

REVIEW OF LITERATURE

The idea of reducing noxious stimuli during operative procedure has been present since the earliest surgical documentations. But the research and development of a local anaesthetic for this purpose started in the 1800s.A breakthrough in this regard came with the introduction of ether local spray in 1846 by Benjamin Richardson. In 1884 Hall injected 4% cocaine (15mg) into his forearm and theorised that it blocks neural transmission in cutaneous nerves. This knowledge was then applied to other nerve blocks.

William Halstead performed the first brachial plexus block in the year 1885. Crile in 1897 first exposed the plexus under local anaesthesia with a technique similar to Halstead and then injected cocaine under direct vision to anesthetise the nerve roots. This technique was then utilized for the surgeries on the upper limb[3].

The first percutaneous brachial plexus block was done by G Hirschel in 1911 following which D. Kullenkampff performed the supraclavicular block in 1912. M.Kulenkampff's familiarity with brachial plexus anatomy allowed him to recognize that "the best way to reach the trunks was in the neighborhood of the subclavian artery over the first rib." His technique was also simple;" “all the branches of the plexus could be anesthetized through one injection." These two assertions are still valid today[3].

Kappis in 1912 performed the brachial plexus block through a posterior para vertebral approach to reduce the incidence of pneumothorax, a common complication of the supraclavicular block. This posterior approach was associated with failures and thus others like J.Etienne and V.Pauchet attempted anterior approaches. Ohen Labat

used axillary approach in 1922 and then described interscalene approach too in 1927. These techniques were modified by Murphy in 1944 by using the clavicle, subclavian artery, scalene muscles and 1st rib as land marks[3].

Modern modifications of supraclavicular block include Winnie and Collins's subclavian perivascular technique and the "plumb-bob" technique of Brown and collaborators. The former is more a concept than a radically different technique, stating that plexus anesthesia is performed around a main vessel (perivascular) and within the confines of a sheath. This technique is similar to Murphey's, who in 1944 described a single-injection technique performed just lateral to the anterior scalene muscle directing the needle caudad.

The paresthesia-seeking technique has a long, successful history as a simple technique that requires little specialized equipment. A paresthesia is elicited when a needle makes direct contact with a nerve. These techniques are reliant on patient cooperation and participation to guide the local anesthetic injection accurately. Paresthesia techniques have been criticized for causing patient discomfort, although clinical studies have not shown a significant increase in neurologic complications with this technique. This technique was slowly replaced by many in the 1980s when peripheral nerve stimulation was introduced.

The peripheral nerve stimulator was invented in the 19th century, which made the localisation of nerves better[5].PNS use in regional anaesthesia was first demonstrated in 1984 by Pither, Raj and Ford. Though the invention of nerve stimulator provided the advantage of localizing nerves, regional anaesthesia still remained a blind procedure[6].

With the advent of ultrasound guided block, better localisation of nerves due to direct visualization of nerve bundles and needle during insertion has been made possible. This has helped in reducing nerve trauma and other complications.

The use of USG for performance of supraclavicular brachial plexus block was described for the first time in 1978. The introduction of ultrasound guidance to regional anesthesia in the last decade has resulted in significant renewed interest in the clinical application of the supraclavicular block, as well as a greater understanding of its mechanics.

In 2003 A. Perlas et al conducted a volunteer study in which 15 volunteers underwent brachial plexus examination and localization with the use of nerve stimulator assisted ultrasound guidance.

An insulated block needle was advanced under direct ultrasound guidance to target nerves before confirmation by electrical nerve stimulation in fifteen volunteers. The quality of brachial plexus images, anatomic variations, and the technique of needle advancement for nerve localization were recorded. The brachial plexus components were successfully identified in the transverse view as round to oval hypoechoic structures with small internal punctuate .

The technique of advancing the needle in-line with the ultrasound beam allowed moment-by-moment observation of the needle shaft and tip movement at the time of nerve localization. Hypoechoic structures were stimulated electrically and confirmed to be nerves. They concluded that dual guidance helped in more accurate and consistent localization of the Brachial plexus[7].

In another study conducted by Andrea Casati et al in 2007, 60 ASA I-III patients were randomly allocated to receive either nerve stimulation (NS group) or ultrasound guidance (US group) for nerve location during brachial plexus block.

The median (range) number of skin punctures was 2 (1–2) in group US and 2 (2–3) in group NS (P = 0.94). Group US required fewer needle passes [4 (3–8)] than group NS [8 (5–13)] (P = 0.002). The onset of sensory block was faster in group US than in group NS, but no differences were observed in the onset of motor block or readiness to surgery No differences in the median (range) degree of anesthesia-related pain were reported between group US [1 (0–8) cm] and group NS [3 (0–8) cm] (P = 0.11); however, 24 patients in group US (80%) reported no procedure-related pain as compared with only 15 patients in group NS (52%) (P = 0.028)[8].

In another study conducted by Orebaugh et al in 2007 an existing de-identified database was used for retrospective analysis of resident performance of nerve blocks, by peripheral nerve stimulator guidance alone and by nerve stimulator aided by ultrasound. The primary variable examined was the time required to perform the block. Others variables included number of needle insertions; proportion of blocks in which there was a blood vessel puncture; and block efficacy.

The ultrasound aided blocks took less time to perform (median of 1.8 mins) compared to nerve stimulator alone (median of 6.5 mins). Fewer needle insertions were required to perform the ultrasound-guided blocks (median= 2) as compared to nerve stimulator alone (median =6) , and there were fewer blood vessel punctures when ultrasound was used[9].

In 2007 Chan et al divided patients undergoing elective hand surgery to one of three groups namely nerve stimulator group (NS), ultrasound group(US) and combined ultrasound and nerve stimulation in the USNS Group. Following administration of a standardized solution containing 2% lidocaine with 1:200,000 epinephrine and 0.5% bupivacaine (total 42 mL), sensory and motor functions were assessed by a blinded observer every five minutes for 30 min. One hundred and eighty-eight patients completed the study. Block success rate was higher in Groups US and USNS (82.8% and 80.7%) than Group NS (62.9%) (P = 0.01 and 0.03 respectively). Fewer patients in Groups US and USNS required supplemental nerve blocks and/or general anesthesia. Postoperatively, axillary bruising and pain were reported more frequently in Group NS. This study demonstrated that ultrasound guidance, with or without concomitant nerve stimulation, significantly improves the success rate of axillary brachial plexus block[10].

In 2007 Digimans et al conducted a prospective randomized study, on 72 patients who were to undergo forearm surgery. They compared the quality and speed of execution of infraclavicular block with either USG alone (Group U) or USG combined with neurostimulation (Group S). In Group U, local anesthetic was deposited posterior and to each side of the axillary artery. In Group S, a single injection was made after obtaining a distal motor response with a stimulating current between 0.3 and 0.6 mA. 0.5 mL/kg of lidocaine 1.5%, bupivacaine 0.125%, and epinephrine 1:200 000 were used. Procedure times were significantly shorter in Group U compared with Group S (3.1 +/- 1.6 min and 5.2 +/- 4.7 min, respectively; P = 0.006).

Thirty minutes after the injection, 86% of patients in Group U had complete sensory block in the musculocutaneous, median, radial, and ulnar nerve territories compared with 57% in Group S (P = 0.007). Patients blocked in Group U with a single injection had the same rate of complete block (86%) as those blocked with more than one injection (86%). Block supplementation rates were 8% in Group U versus 26% in Group S (P = 0.049). Block failure occurred in one patient in Group S because of an inability to obtain a distal stimulation after 20 min. They concluded that USG infraclavicular block is more rapidly performed and had higher success rate when visualization of local anesthetic spread is used as the end point for injection[11].

In the year 2009, Shreshtha et al carried out a prospective randomized comparative study on 70 ASA I and II patients requiring upper arm surgery under axillary block. The study comprised of two groups: ultrasound with nerve stimulation group (n=35) and nerve stimulation group (n=35). 24 ml of Bupivacaine 0.5% with injection Dexamethasone 4 mg was used to block the individual four nerves with 6 ml of the local anaesthetic solution per nerve namely ulnar, radial, median and musculocutaneous. The data were recorded by blinded observer. In case of partial block or block failure, the patients were supplemented with Fentanyl or subjected to laryngeal mask placement[4].

It was demonstrated that the onset of sensory and motor block was faster with nerve stimulator assisted ultrasound guidance than with nerve stimulator alone[5].The onset of complete sensory block was earlier and the onset of motor block was faster in ultrasound with nerve stimulation group than in sole nerve stimulation group (p=0.001). Ultrasound guidance decreased the number of skin puncture during the nerve stimulation, p= 0.02. The incidence of paresthesia was encountered during

nerve location (14%), which could be minimized using ultrasound (7%). The success rate of the block was 93% with ultrasound assistance. The procedure time was not different in both techniques. In conclusion this study shows the onset of sensory and motor block is faster with ultrasound guided nerve stimulation[4].

In 2009 Sites et al carried out a study to assess the effect of nerve stimulation while performing an ultrasound guided block. 107 patients undergoing unilateral total knee arthroplasty were randomly divided into two groups, one group received a US-guided femoral nerve block (FNB) (group US) and the other received a US-guided FNB with nerve stimulation (group USNS). 30 ml of bupivacaine 0.5% was injected in both groups. At intervals of 10, 20, 30, and 40 minutes, blinded motor and sensory examinations were conducted. Time to perform the block, the number of needle redirections, and 24-hrs intravenously administered morphine were also assessed.

They found no significant difference in the proportion of patients with either a partial or complete block. 95.7% of the USNS subjects had a partial or complete sensory block of the femoral nerve (complete in 71.7% and partial in 24%) compared with 88.1% of US subjects (complete in 69% and partial in 19.1%; odds ratio, 2.97; P = 0.19). There were more needle redirections in group USNS (4.1 vs 1.1, P < 0.001), with a higher percentage of patients requiring 2 or more needle attempts (44.2% vs 18.9%, P < 0.01). The time to perform the block in group USNS was longer (188 vs 148 seconds, P = 0.01. They concluded that nerve stimulation added to a US-guided FNB did not change preoperative block efficacy[12].

In 2010, Gurkan et al conducted a study to evaluate the influence of ultrasound guidance alone versus nerve stimulation and ultrasound guidance techniques on block performance time and block success rate for the lateral sagittal infraclavicular block

(LSIB). After randomisation 110 adult patients scheduled for distal upper limb surgery were divided into two groups namely the US or the NSUS groups. In the US group, a local anaesthetic (LA) was administered only with US guidance to produce a 'U' shaped distribution around the axillary artery. In the NSUS group, LA was administered under US guidance only after nerve stimulation was used to locate one of the median, ulnar or radial nerve type responses. A total of 30ml of LA was injected in both groups. Sensory block was tested at 10min intervals for 30min. Successful block was defined as analgesia or anesthesia of all five nerves distal to the elbow. Block success rate was 94.5% in both groups. Block performance time was significantly shorter in the US than the NSUS group (157 ± 50 vs. 230 ± 104s) (*P*=0.000). Block onset time was similar in both groups (12.5 ± 4.8 in the US vs. 12.8 ± 5.4min in the NSUS groups). There were two arterial punctures in the NSUS group. US guidance alone produces block success rate identical to both US and NS guidance yet with a shorter block performance time[13].

In 2014 LI Ming et al compared the visualization rate, the recognition rate, target completion rate, nerve block and block effect and safety between ultrasound guidance combined with nerve stimulator (UN) and single nerve stimulator (N) developing orientation for interscalene brachial plexus block. Eighty patients undergoing upper limb operation were randomly divided into UN group and N group. The two groups were given 1% lidocaine +0.375% ropivacaine 20-30 mL. In UN group, the visualization rate of three branches of nerves in brachial plexus, the recognition rate, block rate were higher than N group, the nerve sensory block and intraoperative score was better than that of N group. The incidence of complications of N group was higher than that in UN group ($P < 0.05$). They concluded that ultrasound combined with nerve stimulator for interscalene brachial plexus block

anesthesia, can accurately monitor and recognize the plexus, has good effect in assisted identification of unclear image of nerve, good block effect and less complications.[14]

In 2015, Luo et al devided 90 patients randomly to a modified double-injection group (MDI group) or a traditional double-injection group (DI group). All patients received 23 ml of a 1:1 mixture of 2% lidocaine and 1% ropivacaine during ultrasound-guided supraclavicular brachial plexus block. In the MDI group (n = 45), half the volume was deposited within the brachial plexus sheath guided by ultrasound, next to the inferior trunk and verified by nerve stimulation; the remaining volume was deposited in the main neural cluster. In the double-injection group (n = 45), the first half volume was deposited on ultrasound guidance alone.

Sensory–motor blockade of the musculocutaneous, median, radial, ulnar nerves and surgical anaesthesia, performance time, number of needle passes and complications were recorded. They concluded that the MDI technique had a higher success rate for complete sensory block of the ulnar nerve within 15 min of local anaesthetic injection[15].

In 2016 Arnuntaspakul et al compared ultrasound with nerve stimulation and ultrasound alone in the performance of lumbar plexus block. A total of 110 patients undergoing knee surgeries were given lumbar plexus block for post-operative analgesia. They measured the total anaesthesia time, success rate, number of attempts, block related pain, cumulative opioid consumption and adverse events. The combined modality blocks had significant reduction in anaesthesia time (p=0.005) and onset of block (p=0.004). There was not much variation in the opioid consumption between the two groups[16].

In 2017, Zhi-Xue Wang et al carried out a meta-analysis wherein they searched the EMBASE, PubMed, Medline, the Cochrane Central register of Controlled trials and clinicaltrials.gov, which included 15 randomized trials. Their analysis indicated that ultrasound and nerve stimulator used in combination had favorable effects on overall block success rate and block onset time when compared to ultrasound alone. However, the combined technique had a longer procedure time[17].

In 2018, Bomberg H et al conducted a retrospective analysis comparing the risks and benefits of ultrasound, nerve stimulation, and their combination for guiding peripheral nerve blocks. They used a large registry to analyze whether there are differences in vascular punctures, multiple skin punctures, and unintended paresthesia.

Twenty-six thousand seven hundred and thirty-three cases were extracted from the 25-center German Network for Regional Anesthesia registry between 2007 and 2016 and grouped into ultrasound-guided puncture (n = 10,380), ultrasound combined with nerve stimulation (n=8173), and nerve stimulation alone (n = 8180). The primary outcomes of vascular puncture, multiple skin punctures, and unintended paresthesia during insertion were compared.

Propensity matching successfully paired 2508 patients with ultrasound alone, 2508 patients with a combination of ultrasound/nerve stimulation, and 2508 patients with nerve stimulation alone. After matching, no variable was imbalanced (standardized differences <0.1). Compared with ultrasound guidance alone, the odds of multiple skin punctures (2.2 [1.7-2.8]; P < .001) and vascular puncture (2.7 [1.6-4.5]; P < .001) were higher with nerve stimulation alone, and the odds for unintended paresthesia were lower with nerve stimulation alone (0.3 [0.1-0.7]; P = .03).

The combined use of ultrasound/nerve stimulation showed lower odds of unintended paresthesia (0.4 [0.2-0.8]; P = .007) compared with ultrasound alone. Comparing the combined use of ultrasound/nerve stimulation with ultrasound alone, the odds for vascular puncture (1.3 [0.7-2.2]; P = .4) did not differ significantly. They concluded that the combined use of ultrasound and nerve stimulator reduced the odds of vascular and multiple skin punctures and paresthesia[18].

BASIC SCIENCES

ANATOMY OF BRACHIAL PLEXUS [19]

To administer successful regional anesthesia for the upper limb surgeries, a thorough knowledge about the anatomy of brachial plexus i.e. its formation, muscular and cutaneous distribution and surface anatomy is paramount for the anaesthesiologist

FORMATION OF THE BRACHIAL PLEXUS

This plexus is formed by joining of the ventral rami of the C5,C6,C7,C8 nerves and the first thoracic(T1)nerve with variable contributions from C4 and T2.

If the C4 contribution is large then the plexus is termed “prefixed” whereas if the contribution from the thoracic T2 is large then the plexus is termed “post fixed”.

These variations are more commonly seen in presence of a cervical rib or first rib anomaly. The plexus is composed of roots,trunks, divisions, cords and branches

Roots:-

They are made by the anterior primary rami of C4-C8 and T1 nerves. After they exit from the foramina they join to form the trunks

Trunks:-

There are three trunks in the brachial plexus. The “upper trunk” is formed by union of C5 and C6 at the lateral border of the scalenus medius muscle. Behind the scalenus anterior C8 and T1 rami fuse to form the “lower trunk” whereas the C7 ramus continues as the “middle trunk”.

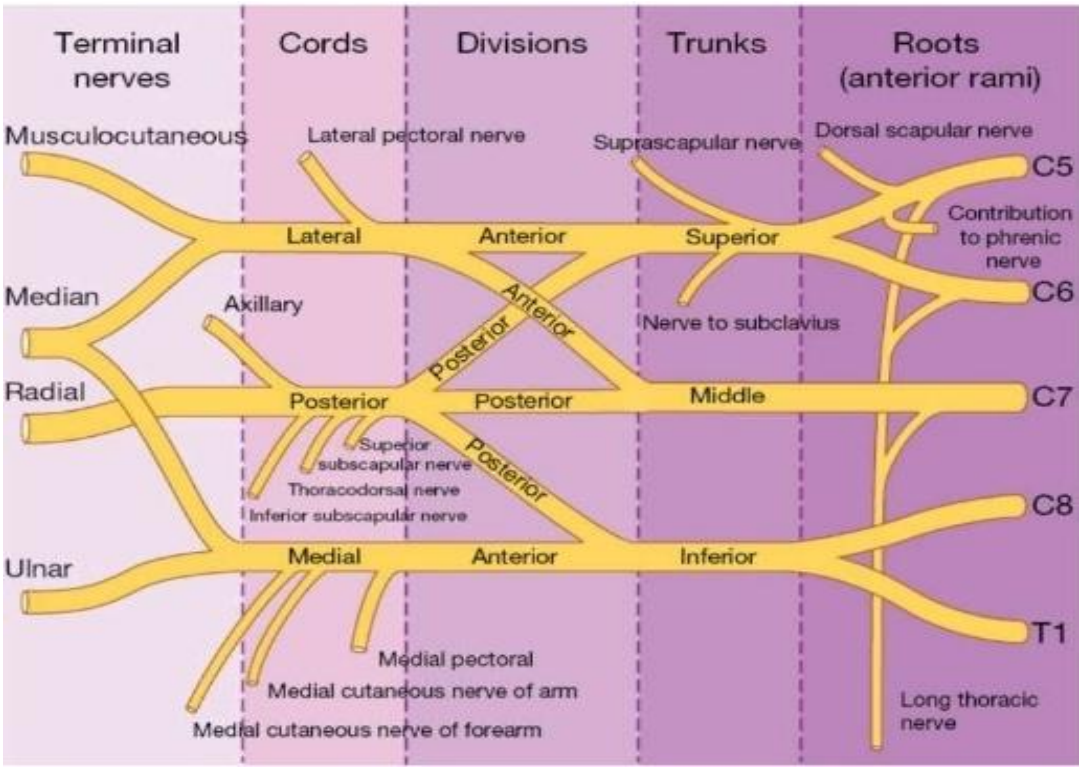


Figure 1.Formation of brachial plexus

Divisions:-

These three trunks travel inferiorly and behind the clavicle each of them gets bifurcated into anterior and posterior divisions

Cords:-

These divisions rejoin to form the cords. Anterior divisions of the upper and middle trunks join to form the “lateral cord” which lies lateral to the axillary artery. On the medial side of the axillary artery the anterior division of the lower trunk continues as the medial cord. Posterior divisions of all three trunks join to form the “posterior cord”, behind the axillary artery.

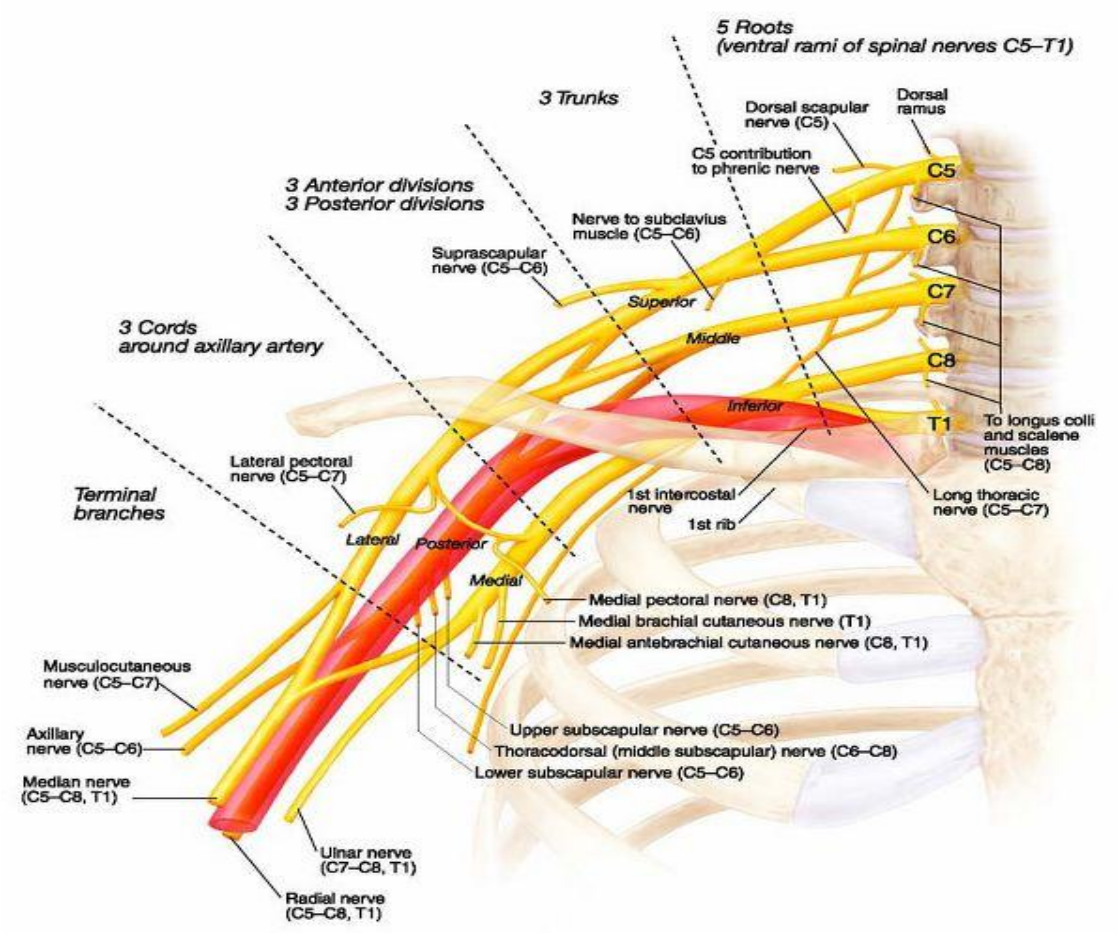


Figure 2.Relations of brachial plexus

In the neck:-

Here the plexus is located in the posterior triangle between the clavicle and lower posterior border of sternocleidomastoid. It exists between the scalenus anterior and medius muscle and passes posterior to the medial two thirds of the clavicle and the suprascapular vessels.

The proximal part of the plexus is superior to the third part of the subclavian artery.

In the axilla :-

Here the lateral and the posterior cords lie lateral to the first part of the axillary artery while the medial cord is present behind it . In the lower axilla cords divide into nerves for the upper limb.

Branches of brachial plexus:-

They are divided into supraclavicular and infraclavicular branches Supraclavicular branches include

From the Roots:-

a) Nerves to scalene and longuscolli- C5,6,7,8
b) Dorsal scapular nerve – C5
c) Branch to phrenic nerve – C5
d) Long thoracic nerve – C5,6,(7)

From the trunks :-

a) Nerve to subclavius – C5,6
b) Suprascapular nerve – C5,6

Infraclavicular branches include

Medial cord :

a) Medial pectoral nerve – C8,T1
b) Ulnar nerve – C7,T1
c) Medial cutaneous nerve of arm – C8
d) Medial cutaneous nerve of forearm – C8,T1
e) Medial root of median nerve – C8,T1

Lateral cord :

a) Lateral pectoral nerve C5,6,7

b) Musculocutaneous nerve – C5,6,7

c) Lateral root of median nerve C5,6,7

Posterior cord :

a) Upper scapular nerve – C5,6

b) Thoracodorsal nerve – C6,7,8

c) Axillary nerve – C5,6

d) Radial nerve – C5,6,7,8,T1

e) Lower scapular nerve – C5,6

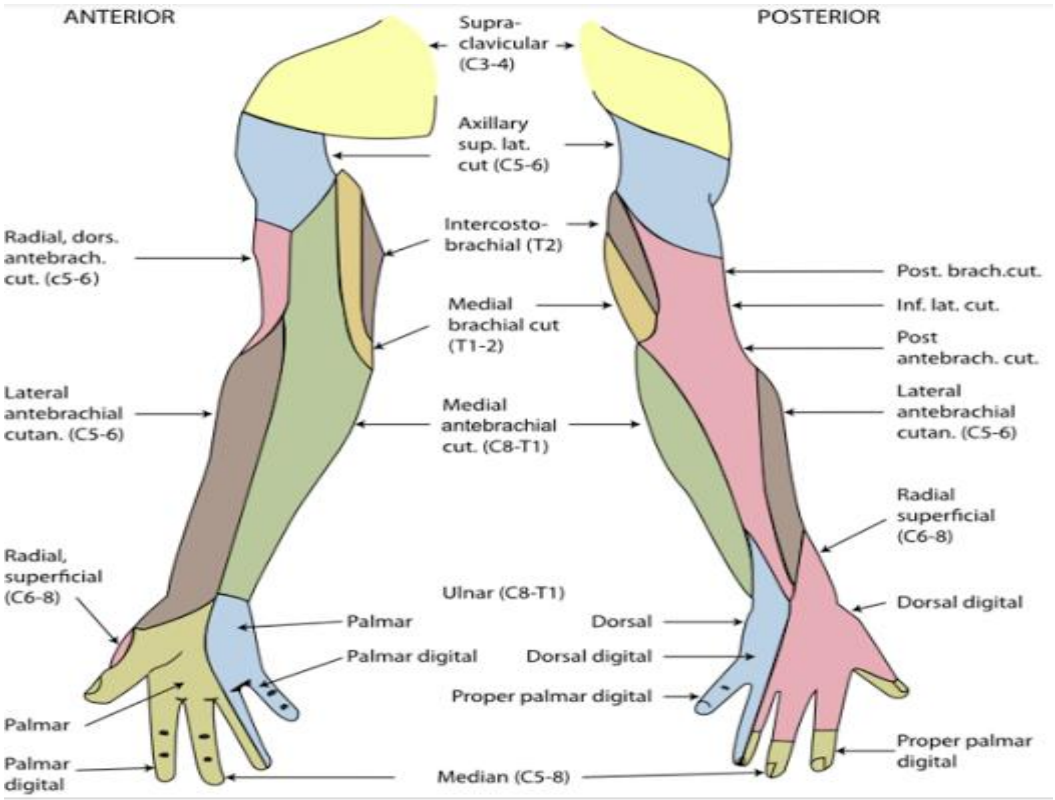


Figure 3.Dermatomal distribution in the upper limbs

Sympathetic innervations in the Brachial Plexus: The sympathetic nerves for the upper limb are derived from spinal segments T2-T6. The vasoconstrictor fibers emerge from the T2 and T3 segments while the pre-ganglionic fibers arise from the lateral horn cells and passing through the white rami communicans they reach the sympathetic chain and end in the middle and inferior cervical and first thoracic ganglia.

The post ganglionic fibers from the cervical ganglion pass through the grey rami communicans to reach the C5-C6. They pass through the roots, trunks, divisions, cords and the branches.

The arteries of skeletal muscles are dilated by sympathetic activity and for the skin they are pilomotor, pseudomotor and vasomotor .

The Brachial Plexus Sheath

The prevertebral fascia and the anterior and middle scalene muscles envelope the brachial plexus and the subclavian vessels in a sheath known as the “Brachial Plexus Sheath”.

It is cylindrical to conical in shape with a volume of approximately 42ml. It is 8-10 cms in length.Proximally it is densely packed and becomes more loosely arranged once it moves distally.

There are fibrous septae present in the sheath which can impair the even distribution of the local anaesthetic drug when giving blocks

APPROACHES TO THE BRACHIAL PLEXUS	INDICATIONS	COMPLICATIONS	ADVANTAGES
Supraclavicular	- Any surgical procedure of the upper extremity (not involving the shoulder) - Surgeries on the elbow, forearm and wrist	- Pneumothorax (2-6%)- May develop over 24 hours; cupula of the lung can be pierced if the needle overshoots the rib. - Accidental subclavian arterial puncture causing hematoma formation, but compression in an attempt to stop the bleeding is not beneficial as the artery lies beneath the clavicle - Stellate ganglion block and vagus nerve block due to the spread of local anaesthetic	- Complete sensory and motor blocade
Interscalene	- Shoulder and proximal humerus surgeries - Elbow surgeries - Neck surgerie - Brachial plexus explorations	- Phrenic nerve injuries leading to ipsilateral diaphragmatic paresis- caution in patients with pulmonary diseases. - Accidental injections in the subarachnoid and epidural space - Horners syndrome - Neuropraxia - Pneumothorax - Hoarseness of voice- recurrent laryngeal nerve palsy	- It can provide anaesthesia to shoulder surgeries
Infraclavicular	Provides complete anaesthesia to upper extremities	- Pneumothorax especially with medially directed needles - Hematoma formation due to vascular puncture - Intravascular injection	- Stable location for catheter based techniques - less infections - avoidance of injury to neurovascular structures of the neck - Blockade of musculocutaneous nerve

Axillary	- Pulmonary diseases when the risk of pneumothorax or phrenic nerve paralysis must be avoided - For children with fractures of the arm - when disease exists in the supraclavicular area like infection, injury or tumors - When bilateral brachial plexus block is desired	- Injury to nerves and vessels - Hematoma formation - Intravascular drug injection	- Simple technique - Low incidence of complications like pneumothorax - Phrenic nerve is spared - Excellent anaesthesisand analgesis distal to elbow - Suitable for continuous catheter technique required for prolonged anaelgesia immobilization and sympathetic blockade

ULTRA SONOGRAPHY AND SUPRACLAVICULAR BLOCK[20]

P. La Grange and his collegues were the first Anaesthesiologists to publish a case series report of Ultrasound application for peripheral nerve blockade in 1978 .

In 1989, P. Ting and V. Sivagnanaratnam used B- Mode ultrasonography to demonstrate the anatomy of the axilla and to observed the spread of local anaesthetics during axillary brachial plexus block .

Ultrasound waves are high frequency waves in the range of more than 20 kHz . These are emitted from the transducer and travel through the tissue and are reflected or absorbed. Based on this the image is created .

A coupling medium (usually a gel) is a must between the transducer and the skin to displace the air .

The frequency to be used depends on the structure to be visualised . Frequencies between 6 and 12 MHz yield better resolution for imaging of the peripheral nerves as they are superficial .

There are 3 modes of ultrasound :-

- A – Mode
- B - Mode
- Doppler Mode

The B – Mode supplies a 2-D image of the area by simultaneous scanning from a linear array of 100-300 piezoelectric elements .This mode provides a cross sectional

image through the area of intrest and hence is the primary mode currently used in regional anaesthesia.

Doppler Mode is based on the work of Austrian physicist Johann Christian Doppler. ColourDoppler produces a colour coded map of Doppler shifts superimposed on a B- Mode ultrasound image.

Blood flow towards the transducer is seen as red while blood flow away from transducer is seen as blue.

This mode helps to identify the vascular structures in the area of interest .Thus it helps to avoid accidental intravascular injection of local anaesthetic .

Two types of scan transducers are used in Regional anaesthesia i.e. Linear and Curved. Linear transducer produces parallel scan lines and rectangular display whereas a Curved transducer produces an arc- shaped image .

SONOANATOMY OF BRACHIAL PLEXUS [20,21,22,23]

The brachial plexus in supraclavicular area is scanned using a high frequency 5-14 MHz linear ultrasound probe held in an oblique plane, (coronal or sagittal) which scans both in longitudinal and horizontal direction.

The subclavian artery is a prominent landmark identified immediately superior to first rib as a pulsatile hypoechoic tennis ball like image on ultrasound. The first rib appears as a bright hyperechoic rim with a drop out bony acoustic shadow. The brachial plexus normally appears superior, supero-lateral or superomedial to subclavian artery as multiple hypoechoic ovals/circles, often described as a honeycomb pattern or "bunch of grapes". The brachial plexus may acquire a triangular, linear or vertical (or oblique) arrangement of trunks/division/cords around subclavian artery in supraclavicular region on ultrasound scan.

The pleura is seen as a hyperechoic line at same level as more "shiny" than the rib. Pleura moves and shines more with breathing. The hyperechoic pleural shadow does not have a drop out acoustic shadow, which differentiates it from the rib shadow. The scalenus anterior and medius muscles appear as hypoechoic structures on ultrasound scan and can be followed commencing from their origin to the point of insertion on first rib. The phrenic nerve lies on anterior surface of scalenus anterior from C4-7 level in neck. The long thoracic and dorsal scapular nerves pass through middle scalene muscle and may appear as "holes" or hypoechoic structures. Often part of brachial plexus passes through scalenus anterior or medius muscles and is seen as small round or oval hyperechoic or hypoechoic structures.

The thyrocervical trunk and transverse cervical arteryoften appear similar to

nerve trunks on ultrasound scan. The pulsations of smaller arteries or branches are easily masked by the strong pulsations of subclavian artery. These vessels may fall in nerve block needle trajectory or course along or through the brachial plexus. This poses a threat of vascular injury, hematoma formation or inadvertent intra-vascular injection. Color Doppler may help in differentiation of brachial plexus from arteries by demonstrating color enhancement. Thus ideally the proposed nerve block needle trajectory should be routinely scanned with Color Flow Doppler. In addition, veins are collapsible and may be identified by applying and releasing pressure with help of ultrasound probe while scanning.

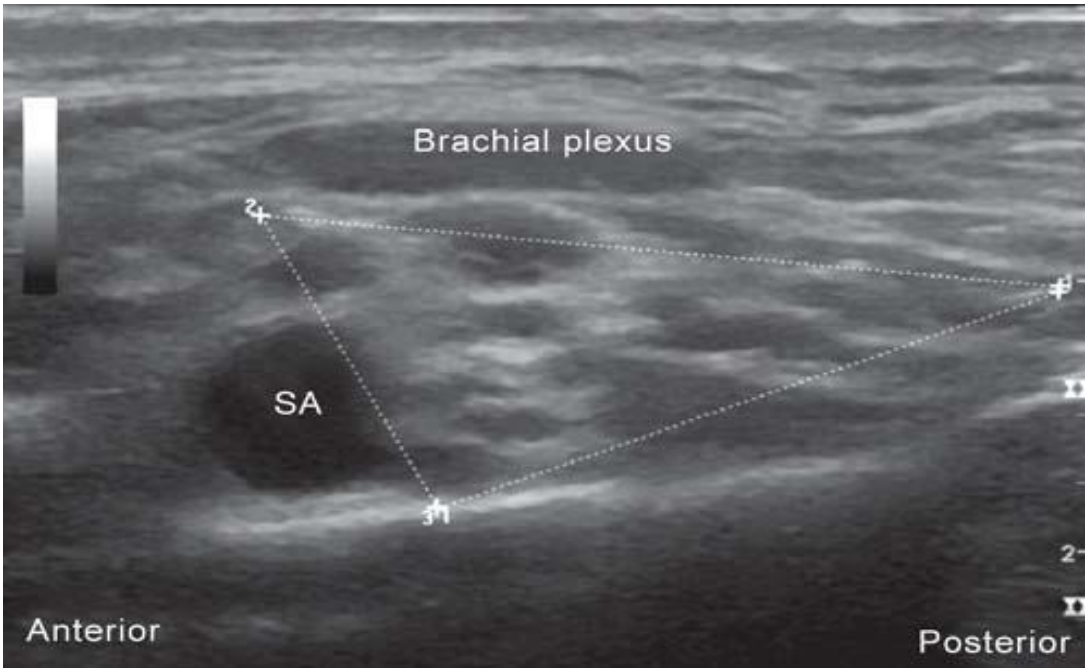


Fig. 4a: Supraclavicular brachial plexus arranged in triangular pattern seen as rounded hypoechoic structures. Subclavian artery (SA) is seen as large rounded hypoechoic structure which is pulsatile in real time.

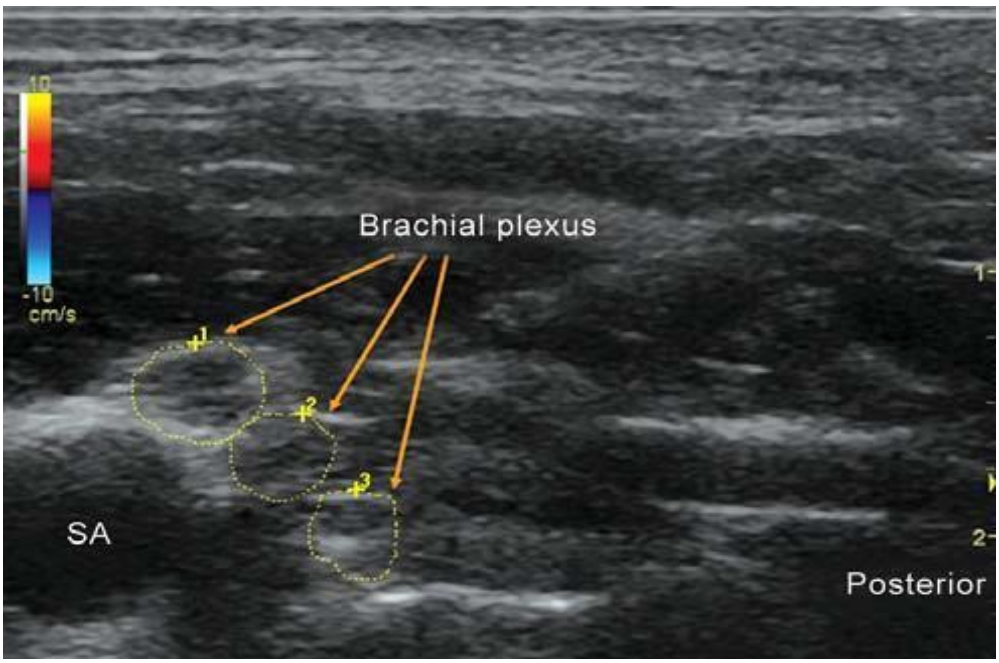


Fig. 4b: Supraclavicular brachial plexus as vertical/obliquely arranged circles.

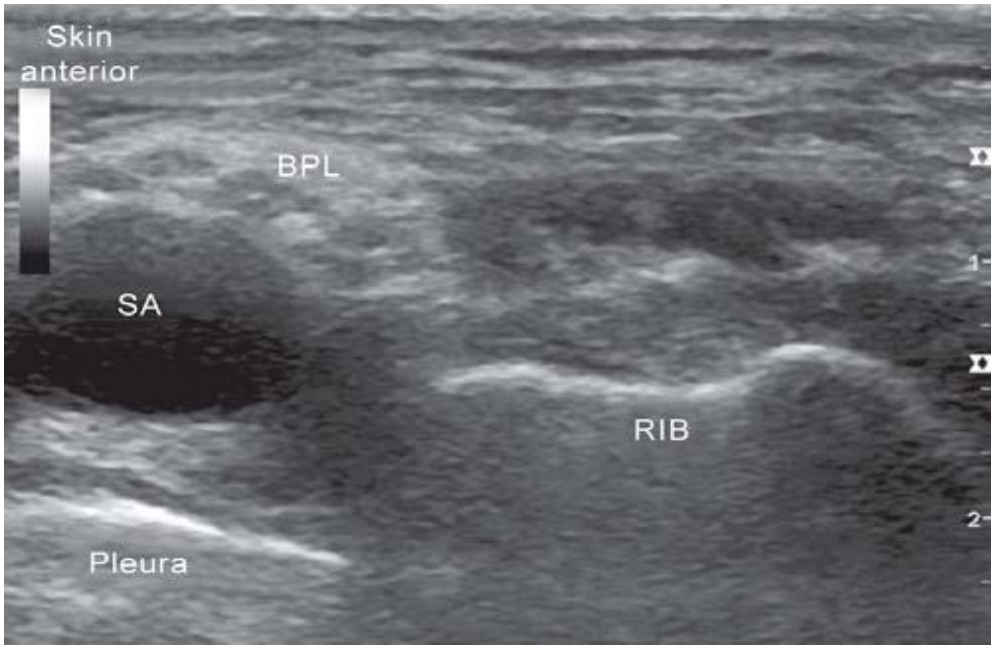


Fig. 4c: Showing pleura and rib. Rib is seen as linear hyperechoic area with acoustic shadowing, pleura as hyperechoic structure without acoustic shadow. SA, subclavian artery; BPL, brachial plexus.

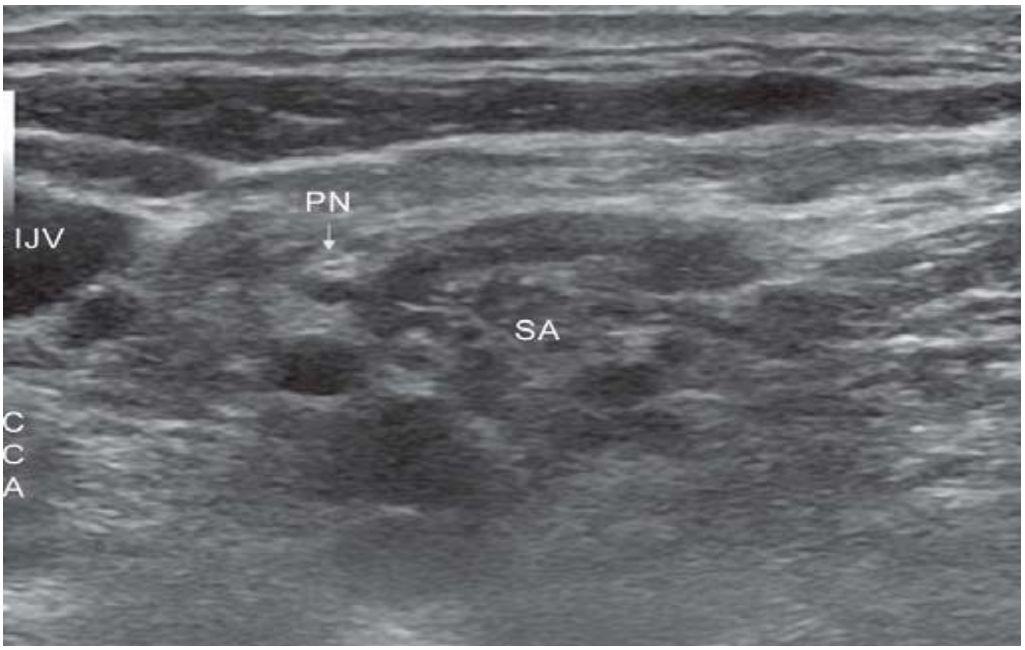


Fig. 4d: Showing phrenic nerve (PN) as hyperechoic structure onanterior surface of scalenus anterior (SA) muscle. IJV, internal jugular vein;

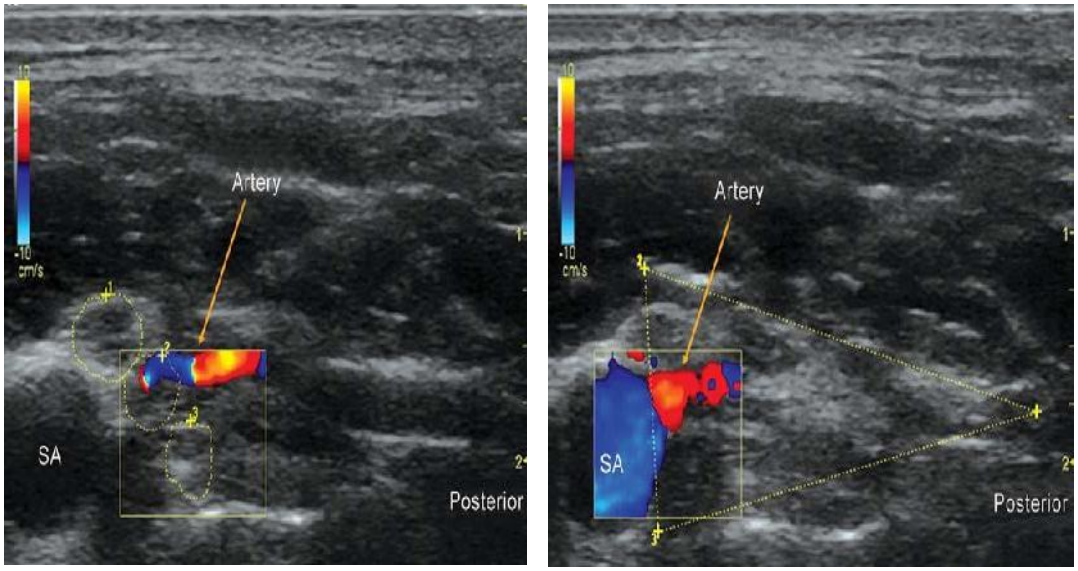


Fig 4e: Showing a branch of subclavian artery coursingthrough brachial plexus on colourdoppler. SA, subclavian artery.

ULTRASOUND GUIDED SUPRACLAVICULAR BLOCK[24,25,]

Anatomy:- The most important landmark for the supraclavicular block is the subclavian artery , which is readily imaged in the cross – section as it lies atop the bright hypoechoic first rib and itself is anechoic , hypodense ,round and pulsatile .[27]

The plexus is identified as a "cluster of grapes" like appearance of 3 or more hypoechoic nodules located superolateral to the artery.

Patient position :- Supine with head turned away from the side of the block .

Transducer :- 25 or 38 mm linear transducer oscillating at 13 MHz is used . It is placed in the Coronal Oblique plane.

The needle is inserted immediately above the clavicle in a lateral to medial direction with a slight cephaladangle . This approach will ensure that the needle approaches the nerve structure before reaching the Subclavianartery.

25 to 40 ml of Local Anaesthetic solution will produce adequate analgesia .

NERVE STIMULATION[26,6]

Basics of Technique and Equipment

Electrical stimulation of nerve structures was introduced to regional anesthesia in the middle of the 20th century. A low-current electrical impulse applied to a peripheral nerve produces stimulation of motor fibers and theoretically identifies proximity to the nerve without actual needle contact or related patient discomfort. When NS techniques are used it is not necessary to make actual contact with the nerve (in contrast to the paresthesia method). This notion theoretically infers that the risk of nerve injury should be less when using NS methods. However, this theory has not been proved. Stimulating catheters have recently been introduced and have increased our ability to accurately advance catheters along nerve structures for greater distances.

Using motor responses to NS as a primary nerve-localization technique has drawbacks. The main limitations with NS are related to the inconsistent results of this technique[13,14] and the variance in electrical properties of different nerve stimulators.[15] Many variables affect the ability to stimulate nerves, including conductive area of the electrode (needle or stimulating catheter tip), electrical impedance of the tissues, electrode-to-nerve distance, current flow, and pulse duration.[16] Ultimately, the technique relies on the physiologic responses of neural structures to the stimulating current, which is subject to considerable interindividual variation.

Today's nerve stimulators have features to improve ease of use and success, such as maintaining a constant current with adjustable frequency, pulse width, and current intensity (in milliamperes [mA]). This consistency enables a stable current output (an important safety feature) in the presence of varied resistances from the

needle, tissues, and connectors. A clear digital display indicating the actual current delivery is important, as is regular calibration and testing. Some nerve stimulators are equipped with low (up to 6 mA) and high (up to 80 mA) current output ranges. The lower range is primarily for localizing peripheral nerves, and the higher range is mainly used for monitoring neuromuscular blockade. Recently, higher ranges have been used for transcutaneous NS techniques (2 to 5 mA) including percutaneous electrode guidance and surface nerve mapping, and the epidural stimulation test (1 to 10 mA).Most nerve stimulators deliver an electrical pulse width of 100 µs or 200 µs for stimulating motor nerves. Similar to current amplitude, the length of time over which the current is delivered (pulse width) is usually considered important because currents of shorter duration can selectively stimulate motor components of mixed nerves while sparing the discomfort caused by sensory components. Some sophisticated devices allow variable pulse widths from 50 µs to 1 ms in an attempt to provide such selective stimulation. The general rule is to use short-duration current of ≤100 µs for peripheral NS, although there is some evidence that duration does not impact patient discomfort[22] and that intensity (number of milliamperes) of the stimulation is perhaps the most important variable.

Practical Guidelines

During initial advancement of the needle, the nerve stimulator should be set to deliver a current of 1 to 2 mA in order to gauge the approximate distance to the nerve. Depolarization of the nerve can also be improved by using the positive (anode; red) pole of the stimulator as the ground (reference or surface electrode) electrode and the negative (cathode; black) lead as the connection to the needle itself (known as cathodal preference). The actual location of the ground is of little importance with the

use of constant-current nerve stimulators. Generally, the needle is in close proximity to the nerve when the threshold for motor response is between 0.3 and 0.5 mA; placing the needle to the point where a motor response only requires 0.1 to 0.2 mA may increase the chance of nerve puncture and should be avoided. Once a low threshold response is obtained, 2 to 3 mL of local anesthetic is injected and the operator watches for disappearance of the motor twitch, which is a signal to inject the remainder of the proposed dose in divided aliquots. This “Raj test” was originally thought to result from the physical displacement of the targeted nerve by the injection solution, but this response has recently also been attributed to a change in the electrical field at the needle-tissue interface. Electrically conducting solutions (e.g., local anesthetic or saline) reduces the current density at the needle tip, thereby increasing the current threshold for motor response, while nonconducting solutions (e.g., dextrose 5% in water [D5W]) increase the current density and maintain or augment the twitch response

After nerve localization using a stimulating needle, introduction of a stimulating catheter with continuous stimulation of the nerve is suitable for provision of continuous analgesia. Similar current thresholds are applicable with the use of stimulating catheters. If an attempt to dilate the per neural space is undertaken, injection of D5W is preferable in order to maintain the motor response to stimulation.

PHARMACOLOGY[27,28]

Local Anaesthetic Drugs : These drugs produce reversible conduction blockade of nerve conduction along the central and peripheral nerve pathways . When the concentration is increased gradually the transmission of autonomic. Somatic sensory and somatic motor impulses are interrupted in the same sequence. This produces autonomic blockade ,sensoryanaesthesia, and muscle paralysis in the area supplied . Gradual removal by absorption into systemic circulation causes the reversal of this blockade .

Molecular Structure: These drugs have two portions. One is lipophillic while the other is hydrophilic and the two are connected by a hydrocarbon chain. The hydrophilic portion is usually a tertiary amine while the lipophillicpostion is an unsaturated aromatic ring.

This lipophillic potion is essential for anaesthetic activity.

LOCAL ANESTHETIC MECHANISMS IN NERVE BLOCKADE

Impulse blockade by local anaesthetics may be summarized by the following chronology:

- Solutions of local anaesthetic are deposited near the nerve. Removal of free drug molecules away from this locus is a function of tissue binding, removal by the circulation, and local hydrolysis of amino-ester anaesthetics. The net result is penetration of the nerve sheath by the remaining free drug molecules.
- Local anaesthetic molecules then permeate the nerve's axon membranes and reside there and in the axoplasm. The speed and extent of these processes

depend on a particular drug's pKa and on the lipophilicity of its base and cation species.

- Binding of local anesthetic to sites on voltage-gated Na^+ channels prevents opening of the channels by inhibiting the conformational changes that underlie channel activation. Local anesthetics bind in the channel's pore and also occlude the path of Na^+ ions.
- During onset or recovery from local anesthesia, impulse blockade is incomplete and partially blocked fibers are further inhibited by repetitive stimulation, which produces an additional use-dependent blinding to Na^+ channels.
- One local anesthetic binding site on the Na^+ channel may be sufficient to account for the drug's resting (tonic) and use-dependent (phasic) actions. Access to this site may potentially involve multiple pathways, but for clinical local anesthetics, the primary route is the hydrophobic approach from within the axon membrane.
- The clinically observed rates of onset and recovery from blockade are governed by the relatively slow diffusion of local anesthetic molecule into and out of the whole nerve, not by their much faster binding and dissociation from ion channels. A clinically effective block that may last for hours can be accomplished with local anesthetic drugs that dissociate from Na^+ channels in a few seconds.

PHARMACOLOGY OF BUPIVACAINE [28,29] :

BUPIVACAINE :

Bupivacaine is a long acting, amide-type local anaesthetic. It was prepared by A.F. Ekenstam in 1957 and introduced by Telivuo in 1963.

Chemically related to lignocaine and its structure is similar to that of Mepivacaine except that the amine-containing group is a butyl piperidine. Its potency is approximately four times that of lignocaine.

Its long duration of action plus its tendency to provide both sensory and motor block has made it a popular drug for providing prolonged analgesia during labor or the postoperative period.

By taking advantage of indwelling catheters and continuous infusions, bupivacaine can be used to provide several days of effective analgesia.

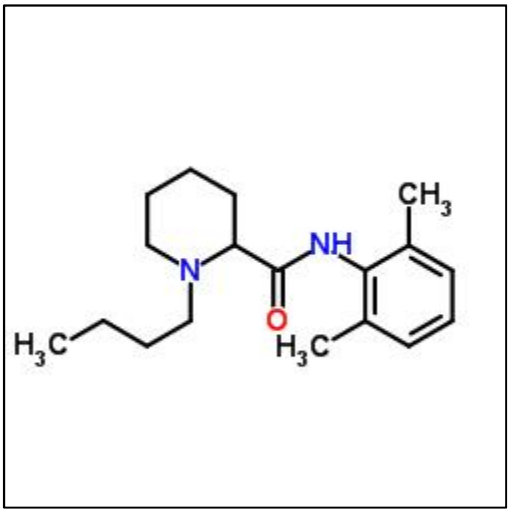


Figure 5 Structure of Bupivacaine

Physiochemical Properties :

1. Chemical name : 1-N-butyl-DL-piperidine 2 carboxylic acid-2,6 dimethyl anillide hydrochloride
2. Molecular weight : 324.9

   Solubility : 28
3. pka : 8.1
4. Half life : 1.5 -5.5 hours in adults and 8.1 in neonates.
5. Specific gravity : 1.026 at 37°C
6. Volume of Distribution = 73 liters

Pharmacology :

The addition of a butyl group to the piperdine Nitrogen of Mepivacaine makes Bupivacaine 35 time more lipid soluble

Potency : It is approximately 3 to 4 times more potent thaMepivacaine or Lignocaine

Onset and Duration :

The onset of action of Bupivacaine is between 5 and 7 minutes and maximum anaesthesia is achieved in between 15 and 25 minutes .

The duration varies according to the type of block ;average duration of epidural block is – 2.5 to 4 hours average duration of spinal block is – 2 to 3 hours

Mechanism of Action :

The mechanism of action of bupivacaine is similar to lignocaine.

Local Anaesthetics bind to specific site in the voltage gated sodium channels and block Na+ current and reduce the excitability of Neuronal ,Cardiac or CNS Tissue.

The large transient increase in permeability to sodium ions necessary for popogation of the impulse is prevented .

Thus the resting membrane potential is maintained and depolarisation in response to stimulation is also prevented.

The mechanism of sodium conductance blockade :-

a) The cationic form of Local anaesthetics acts on the receptors within the Na+ Channel on the cell membrane and block it. The local anaesthetics can reach the Na+ channel either via the lipophillic pathway directly across the lipid membrane or via the axoplasmicopening .

b) The second mechanism is a non specific action i.e. by membrane expansion

Available concentrations of Bupivacaine:- 0.25% and 0.5%

Dosage of Bupivacaine: - Maximum dosage – 3mg /Kg body weightBupivacaine is less likely to produce vasoconstriction unless sufficiently dilute [32] . Adrenaline prolongs its action only marginally, if at all.

Tachyphylaxsis is much less likely than with Lignocaine .

Metabolism and Elimination :-

Bupivacaine gets metabolised by the following mechanisms–

a) Aromatic Hydroxylation
b) N- dealkylation
c) Amide Hydrolysis
d) Glucuronide – conjugation

The chief mechanism is N- dealkylation and the metabolite is N-desbutylBupivacaine .

The mean total of urinary excretion of Bupivacaine and its dealkylation and hydroxylation metabolites account for >40% of the total anesthetic dose.

Systemic Actions :-

Central Nervous System:-

Over dosage concentrations of Bupivacaine produce dizziness and light headedness followd by visual and auditory disturbances such as difficulty to focus and tinnitus .Shivering , muscular tremors and tremors of facial muscles can occur.The plasma concentration of Bupivacaine associated with seizures is 4.5 to 5.5 mcg/ml

Cardiovascular System :-

Usually cardiovascular system is more resistant to the toxic effects of high plasma concentrations of local anaesthetics.

Lignocaine concentration <5mcg/ml is devoid of adverse effects but causes decrease in automaticity. Lignocaine concentrations 5-10 mcg/ml can produce

profound hypotension due to arteriolar vascular smooth muscle relaxation and direct myocardial depression.

Blockade of cardiac sodium channels by local anaesthetics contributes to anti dysrhythmic properties.

With increase in concentration more Na+ channels become blocked and conduction and automaticity become affected adversely.This is evident by prolongation of PR interval and QRS Complexes.

Accidental IV injection of bupivacaine may result in precipitous Hypotension , cardiac dysrhythmias and AV Heart block.

Most common dysrythmias include Widening of QRS Complex,Premature Ventricular contractions and Ventricular tachycardia.

Cardiotoxicity of Bupivacaine is seen when plasma concentrations are 8 – 10 mcg/ml

Pregnancy may increase sensitivity to cardiotoxic effects of Bupivacaine .

Cardiotoxic threshold of Bupivacaine may be decreased in patients being treated with drugs like digitalis,calcium channel blockers and beta blockers.

Epinephrine and phenylephrine can increase cardiotoxicity of Bupivacaine induced inhibition of catecholamine induced production of cyclic AMP .

Bupivacine blocks cardiac Na+ ion channels during systole but due to its high lipid solubility ,it gets dissociated during diastole . This explains its persistent

depressant effect on Vmax and hence greater cardiotoxicity.The R- enantiomer of Bupivacaine is more cardiotoxic.

Tachycardia can enhance frequency dependent blockade of cardiac sodium channels by Bupivacaine .

Treatment :-

Bretyllium 20mg/Kg IV reverses Bupivacaine induced cardiac depression and hence increases the threshold for ventricular tachycardia .

Lipid emulsion infusion is also used for Treatment of cardiotoxicity . Its use is recommended at the earliest sign of toxicity .

Initial bolus of 1.5 ml/Kg 20% lipid emulsion followed by 0.25ml/Kg/min. the infusion should be continued for atleast 10 minutes after circulatory stability is achieved.

Respiratory System :-

Local Anaesthetics in very high plasma levels depress medullary respiratory center which can precipitate decreased oxygenation

Toxicity :-

The toxic plasma concentration is >3mcg/ml but cardiotoxicity of Bupivacaine becomes evident when plasma concentration are 8 – 10 mcg/ml.

Pharmacokinetics :-

Levels of Bupivacaine are detectable in blood 5 minutes after infiltration. Peak blood concentrations depend on the total dosage given and range between 0.14-0.18mcg/ml.

These levels are from 5 mins to 2hrs and slowly reduce to 0.1 to 0.34 mcg/ml in approximately 4 hrs .

Being an amide the liver is the primary site of metabolism of Bupivacaine.

Bupivacaine is secreted in the breast milk and also crosses the placenta but in very less concentrations with feto-maternal concentration ratios ranging from 0.2-0.4

PHARMACOLOGY OF LIGNOCAINE[28,29,30]

Lignocaine, commonly referred to as “Lidocaine”, is an amide local anesthetic agent and a Class 1b antiarrhythmic. Lignocaine is an essential drug on World Health Organisation essential drug list, considered efficacious, safe and cost-effective for any health-care system.

Indication:

The indications of lignocaine include the requirement for local, neuraxial, regional or peripheral anesthesia by infiltration, block or topical application, or the prophylaxis or treatment of life-threatening ventricular arrhythmias. It has also been extensively used for chronic and neuropathic pain management, and more recently as an intravenous infusion for the management of postoperative analgesia and surgical recovery.

Structure:

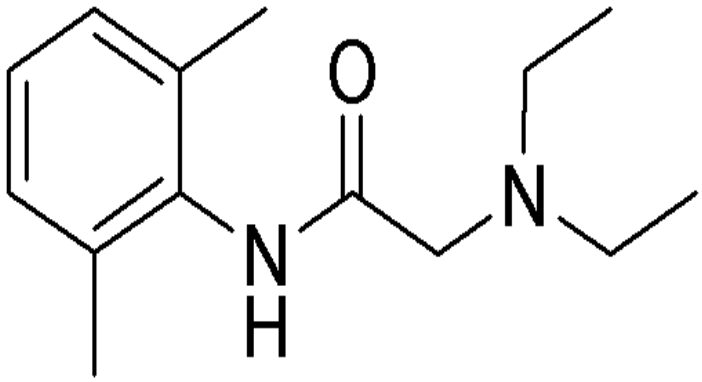


Figure 6: Structure of Lignocaine

Physiochemical properties

Lignocaine is a stable, crystalline, colourless solid whose hydrochloride salt is water soluble. Solutions for injection are available with or without adrenaline. All lignocaine solutions should be protected from light and maintained at a room temperature of approximately 25 degree Celcius

1. Chemical name: 2-diethylaminoaceto-2',6'-xylidide (C14H22N2O
2. Molecular weight: 270.801

   Solubility:
3. Pka: 7.9
4. Half-life: 10-20 mins in adults following IV bolus
5. Specific Gravity: 0.9998- 1.005 gm/dl at 37°C
6. Volume of distribution: 4.5 liters

Onset and duration:

It was observed that lignocaine displayed a rapid onset of action, but of very short duration (between 10-20 min) after the intravenous administration of either 50 or 100 mg boluses doses.

Mechanism of Action

Local anesthetic blockade

Similar to other local anesthetics, the mechanism of action of lignocaine for local or regional anesthesia is by reversible blockade of nerve fibre impulse propagation. Some local anesthetic is removed by tissue binding and circulation when lignocaine is infiltrated near a nerve. The remaining anesthetic enters the nerve cells

by diffusion through membranes. Lignocaine then binds to sodium channels, causing a conformational change that prevents the transient influx of sodium, therefore depolarisation. All potentially excitable membranes are affected, however sensory fibres are blocked preferentially because they are thinner, unmyelinated and more easily penetrated.

Antiarrhythmic effects

An important indication for lignocaine is prophylaxis or treatment of life-threatening ventricular arrhythmias. The mechanism of action of lignocaine for its antiarrhythmic action is by direct effect on mammalian Purkinje fibres. By decreasing the slope of phase 4 and changing the excitability threshold, lignocaine reduces automaticity. This results in a decrease of both the action potential length and the refractory period duration of the Purkinje fibres. The PR interval, QRS and QT durations are not commonly effected by lignocaine.

Antinociceptive effects

The antinociceptive effects of lignocaine are thought to be attributable to the blockade of neuronal sodium channels and potassium currents, and the blockade of presynaptic muscarinic and dopamine receptors. Local anesthetics have also been shown to block sodium and potassium currents centrally at a spinal cord level, specifically targeting the spinal dorsal horn neurons, in addition to their generally accepted peripheral nerve blockade.

Anti-inflammatory effects

Lignocaine has potential utility as a potent anti-inflammatory agent, although to date well-designed studies are lacking to substantiate its use in most clinical settings. The anti-inflammatory actions of lignocaine are thought to be attributable to lignocaine's direct effects on macrophage and polymorphonuclear granulocyte function, in addition to its inhibition of the release of several critical markers of the inflammation cascade.

Available concentrations of Lignocaine – 2%, 4%, 5%, 10%

Maximum Dosage: 2-3 mg/kg

Metabolism and Elimination

Lignocaine is dealkylated in the liver by the cytochrome P450 system forming numerous metabolites. Monoethylglycinexylidide and glycine xylidide are the key active metabolites, both of which have reduced potency but have comparable pharmacologic activity to lignocaine. The only reported metabolite of lignocaine found to be carcinogenic in a rat model is 2, 6-xylidine.

Hepatic blood flow appears to be a limiting factor in lignocaine's metabolism. The rate of metabolism is slower reduced in patients with congestive cardiac failure, chronic liver disease and hepatic insufficiency, and after acute myocardial infarction. Lignocaine and its metabolites are predominantly renally excreted. Less than 10% of lignocaine is excreted without being metabolised.

The majority of lignocaine elimination occurs in the liver, and since the total body plasma clearance of lignocaine is about 800 mL/min and hepatic blood flow is

about 1.38 L/min, up to 60% of an oral dose is metabolised before entry into the systemic circulation.

Systemic Actions:

Central Nervous System:

The following CNS toxicity can be seen with lignocaine.

Early: CNS excitation with seizures

Late: CNS depression, termination of convulsions, reduced level of consciousness, leading to respiratory depression and/or arrest

Mechanism: Local inhibition of inhibitory CNS pathways (CNS stimulation), then inhibition of inhibitory and excitatory pathways (CNS inhibition)

Symptoms and signs: Anxiety ,Dizziness or light headed, Confusion, Euphoria, Tinnitus, Blurring of vision or diplopia, Nausea and vomiting, Twitching and tremors, Seizures with reduced consciousness

Cardiovascular System:

The following CVS toxicity can be seen with lignocaine.

Conduction block of neural impulses

Prevention of passage of sodium through sodium channels

Stabilization of excitable membranes

Prevention of the initiation and transmission of nerve impulses

Attenuation of phase 4 diastolic depolarization

Reduction in automaticity

Reduction in absolute refractory period

Increase in the ratio of effective refractory period: action potential duration

Decrease in action potential duration

Ventricular fibrillation threshold: raised

Higher serum concentrations: Blockage of sodium channels

Depression of rate of depolarization during phase 0 of the cardiac action potential

Re-entrant arrhythmias

Suppression of conduction through the sinus and atrioventricular nodes

Symptoms and signs: Bradycardia, Hypotension, Cardiovascular depression, Cardiac arrest

Respiratory System:

Symptoms and signs: Tachypnea, Respiratory depression, Respiratory arrest

Pharmacokinetics

It was observed that lignocaine displayed a rapid onset of action, but of very short duration (between 10-20 min) after the intravenous administration of either 50 or 100 mg boluses doses.

It is reported that lignocaine had a half-life of approximately 10 to 20 min one hour after the administration of an intravenous bolus. Patients with occlusive coronary artery disease who were administered a continuous intravenous lignocaine infusion, without an initial loading dose, achieved acceptable plateau plasma concentrations within a 30 to 60 min period, suggestive of a 10 to 20 min half-life.

There is an early fall in lignocaine plasma levels after the administration a 50 mg bolus dose. The mean half-life is 7 min.

Absorption

The speed of onset of lignocaine is 1 to 5 min after local infiltration, and 5 to 15 min after peripheral nerve blockade. Lignocaine's absorption is dependent upon the total dose administered, the route by which it is delivered, and blood supply to the site of injection. Major nerve blocks and epidurals result in intermediate peak plasma levels. Irrespective of the administration site, peak serum levels occurred 20 to 30 min following injection. The addition of adrenalin (1:200000) to the local anesthetic solution reduced peak levels and delayed the rate of absorption.

Protein binding

The plasma binding of lignocaine is inversely proportional to the drug concentration. It is 60% to 80% protein-bound at concentrations of between 1 and 4 mcg/mL. Binding fraction also depends on the plasma levels of the acute phase reactant alpha-1-glycoprotein. Lignocaine has been shown to cross the placenta and blood-brain barrier by simple passive diffusion. Lignocaine may exist in ionised or unionised form depending on the pH of the environment. As a weak basic drug, lignocaine tends to be more unionised and able to cross cell membranes in basic media.

Infusion Kinetics

Plasma levels of between 0.5 and 5.0 mcg/mL (2-20 μmol/L) are required for many of reported clinical effects after both intravenous or subcutaneous administration. A infusion of intravenous lignocaine administered at a dose of 2 to 4 mg/min results in plasma levels of between 1 and 3 mcg/mL after 150 min. After 15

min of the same infusion, a 2 mg/kg intravenous bolus of lignocaine leads to peak plasma levels of 1.5 to 1.9 mcg/mL.

The aim of an intravenous lignocaine infusion is to achieve a therapeutic steady-state concentration while minimizing systemic toxicity.

METHODOLOGY

The present study titled **"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES. "** was conducted in the Department of Anaesthesiology, Jawaharlal Nehru Medical College KAHER during the period January 2017 to December 2017. A total of 70 patients belonging to ASA grade I and II between the age group of 18-60 years of either gender, scheduled for elective upper limb surgeries under supraclavicular brachial plexus block were included in the study.

The inclusion and exclusion criteria were as follows

a) Selection Criteria

Inclusion

1. ASA physical status I and I
2. Age between 18 to 60 years.
3. Patients undergoing elective upper limb surgeries.

Exclusion

1. Patients allergic to local anaesthetics.
2. Patients with coagulation abnormalities.
3. Patients with neurological deficits.
4. Patients with infection at the site of block.
5. Patients with severe cardiovascular and respiratory co morbidities.

b) Sample Size (n)

Using the results of the previous studies and taking the time taken for performance of block as the parameter. With type I error rate $\alpha = 0.05$ and type II error rate $\beta = 0.2$ and a power of 80% in the below mentioned formula-

$$n = \frac{2\,(Z\alpha+Z\beta)^2(S_1+S_2)}{(X_1-X_2)^2}$$

$$n = \frac{2(1.96+0.84)^2(16+4)}{(9-6)^2}$$

$n = 34.8 \approx 35$

n = number of patients per group

$Z\alpha = 1.96$

$Z\beta = 0.84$

X_1= 9(time taken for performance of block under ultrasound guidance) X_2 = 6(time taken for performance of block under ultrasound assisted peripheral nerve stimulator guidance)

$S_1 = 4$

$S_2 = 2$

The sample size obtained was 6. By thumb rule, the sample size taken was 70.

c) Randomization

After obtaining the approval of the Institutional Review Board and Ethical committee and written informed consent, 70 ASA I-II patients undergoing elective upper limb surgeries under brachial plexus block were included in the study.

Patients were randomly divided into two groups by using computer generated table.

Group A –Supraclavicular brachial plexus block under ultrasound guidance.

Group B – Supraclavicular brachial plexus block under nerve stimulation assisted ultrasound guidance.

d) Methodology

A routine pre-operative assessment and basic investigations of all the patients was done and after explaining the anesthetic procedure an informed consent was taken. Preoperatively adequate fasting of 8 hours was confirmed. In the operation theatre 18G intravenous cannula was placed. Electrocardiogram, non invasive blood pressure, pulse oximeter was attached and the procedure was explained to the patient. On the operation table patient was placed in supine position with head resting on ring with ipsilateral arm adducted, shoulder depressed, roller pack placed in between scapula and head turned slightly to contra lateral side. Under all aseptic precaution local site was prepared.

In group A patients ultrasound machine was prepared and checked, a sterile high frequency linear array ultrasound (9-18 MHZ) was used. The clavicle being a proper landmark which is easily felt in most of the patients. The probe was positioned

in supraclavicular fossa just superior to the clavicle. The probe was moved medially and laterally and also in rocking fashion in order to locate pulsating subclavian artery. The area lateral and superficial to subclavian artery was explored. Under USG view the brachial plexus is seen as a bundle of hypo echoic round nodules (grapes) just lateral and superficial to the artery. The needle was inserted from lateral side of the probe first perpendicular to the skin to penetrate the skin and then at a shallow angle under the probe. The needle was then advanced under the ultrasound beam by in plane technique till the plexus was seen with characteristic honey comb appearance.

At this point injection of 10 ml of 0.5% bupivacaine and 10 ml of 2% lignocaine with adrenaline was injected following gentle aspiration and spread of drug and bulging of plexus was noted.

In group B patients the nerve stimulator was connected to the stimulating needle and set to deliver current of 2mA at 1 Hz frequency and 0.1 ms of pulse duration. Under ultrasound guidance, the needle was inserted posterior, medially and caudally. The needle was then slowly advanced under the palpating finger to elicit contraction of innervated muscle. Once the elicited motor response of the fingers was obtained at 0.5 mA, the injection of 10 ml of 0.5% Bupivacaine and 10 ml of 2% Lignocaine with adrenaline was carried out after gentle aspiration.

The following parameters were recorded and noted

1. Time for the onset and duration of sensory and motor blockade.

2. Time taken for performance of block

Time taken for performance of block was defined as the time taken from the insertion of needle to the delivery of drug.

Sensory block was assessed by pinprick test using a 3 point scale in all nerve territories:

0= sharp pin felt

1= dull sensation felt (analgesia)

2=no sensation felt (anesthesia)

Complete sensory block is defined by anaesthetic block (score 2) in all nerve territories.

Onset of sensory block is defined as the time interval between the end of total local anaesthetic administration and complete sensory block. (Score 2)

Duration of sensory block is defined as the time interval between the end of local anaesthetic administration and the complete resolution of anaesthesia in all nerve distribution.

Motor block was assessed by thumb abduction(radial nerve) , thumb adduction(ulnar nerve), thumb opposition (median nerve) and flexion at the elbow (musculocutaneous nerve) on a 3 point scale for motor function.

0= normal motor function with full flexion and extension of elbow, wrist and fingers

1= reduced motor strength but able to move fingers

2= complete motor block with inability to move fingers

Onset of motor block is defined as the time interval between administration of local anaesthetic solution to loss of movements. (Score 2) Complete motor block is defined as absence of voluntary movement in hand and forearm. (Score 2) Duration of motor block is defined as the time interval between the end of local anaesthetic administration and the recovery of complete motor function of the hand and forearm.

An inadequate block or failure of effect were noted and supplemented with general anaesthesia. The patients were also monitored for the vitals and any perioperative complications like hypotension, bradycardia, nausea, vomiting, respiratory distress; local hematoma, weakness and hypoesthesia due to nerve injury, pneumothorax, and surgical emphysema and treated accordingly.

OBSERVATIONS AND RESULTS

The objectives of the present study were to compare the onset and duration of sensory and motor block and the time taken for performance of the block, using ultrasound and ultrasound assisted with nerve stimulator in patients undergoing upper limb surgeries under supraclavicular brachial plexus block.

70 patients were randomly enrolled into two groups of 35 each.

Group A	Received Supraclavicular brachial plexus block under ultrasound guidance.
Group B	Received Supraclavicular brachial plexus block under nerve stimulation assisted ultrasound guidance.

The data obtained were analyzed and the observation and results are tabulated as below

Demographic Data

Gender: Table 1: Gender distribution of patients

	Female	**Male**	**Total**
Group A	**16**	**19**	**35**
Group B	**10**	**25**	**35**
Total	**26**	**44**	

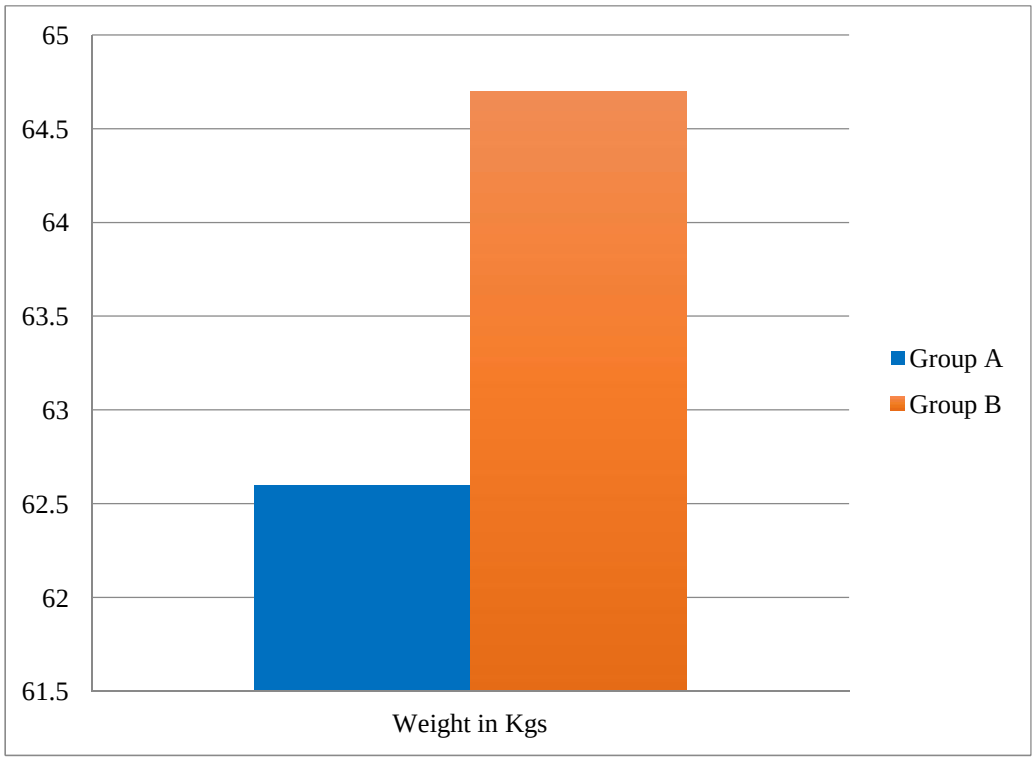
The gender distribution of the patients in the two groups was comparable. There were a total of 26 female and 44 male subjects in this study.

Table 2: Mean age and weight of patients in both the groups

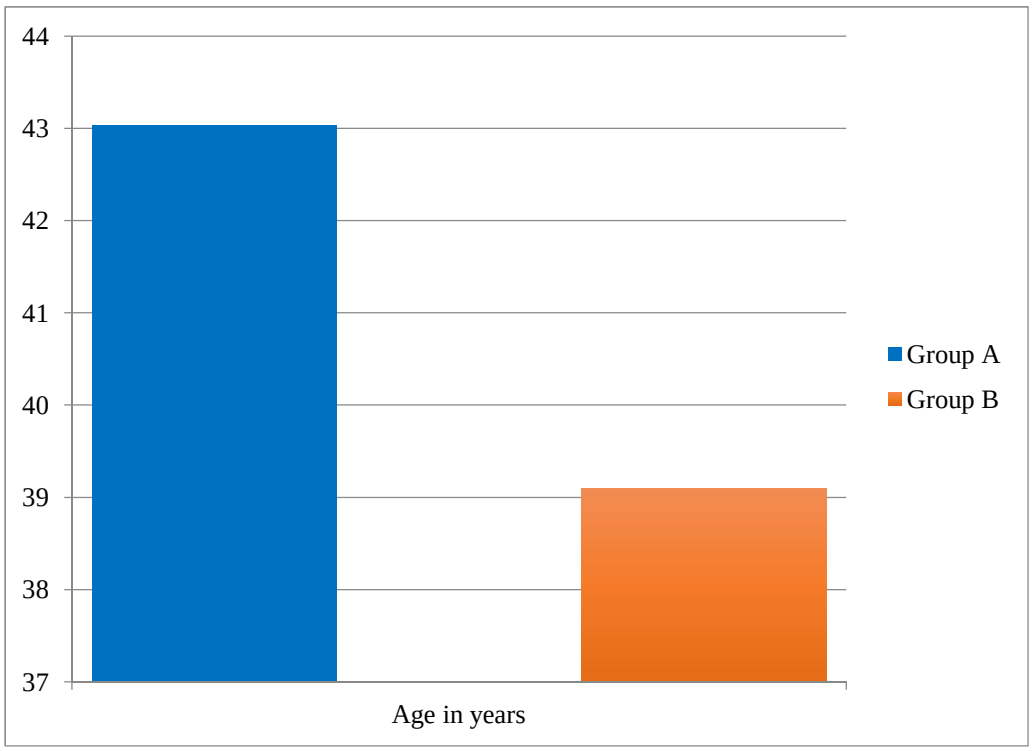
	Group A		Group B			
	Mean	**S.D.**	**Mean**	**S.D.**	**P value**	**Inference**
Age (in years)	43.0371	±14.7080	39.1010	±12.6813	0.2346	NS
Weight (in kgs)	62.6000	±7.6934	64.7429	±7.1921	0.2329	NS

The mean weight of patients in group A was 62.6±7.6 in group A and 64.74±7.19 in group B. The two groups did not differ significantly with respect to their weight. The mean age of the patients in group A (43.03 years) and in group B (39.10 years) were comparable and did not differ significantly.

Graph 1: Weight Distribution



Graph 2: Age distribution



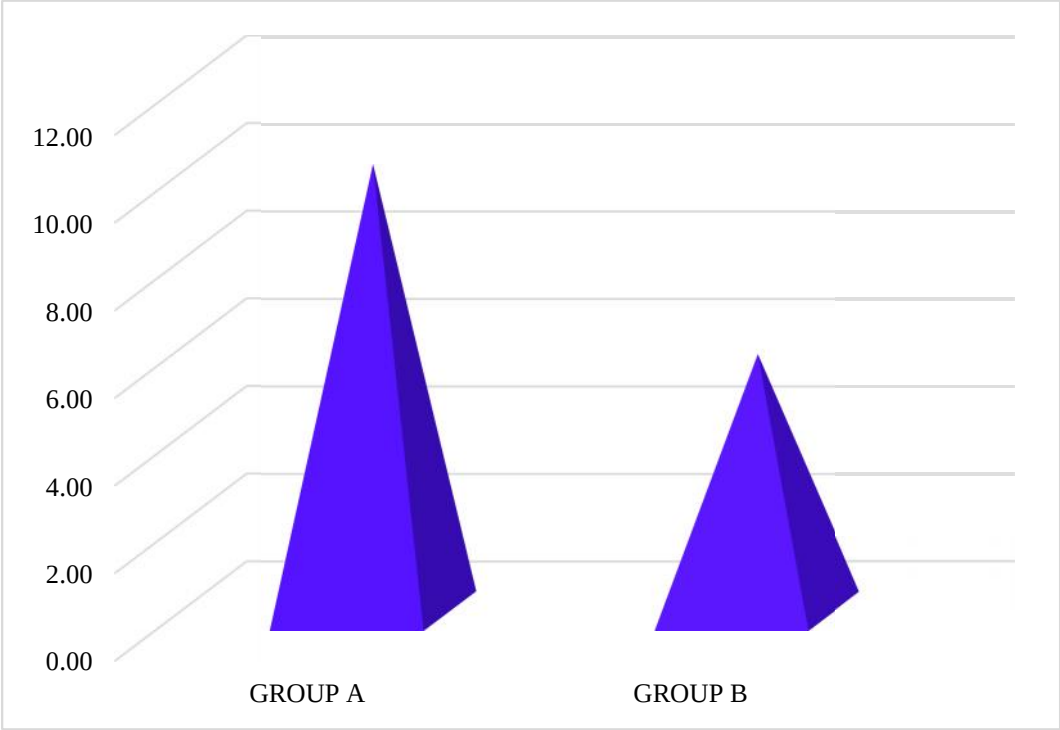
The mean age and weight between the two groups was comparable with no significant difference between the demographic parameters.

Block Characteristics:

Table 3: Mean time taken for the performance of the block in both the groups

	GROUP A		GROUP B			
	MEAN	**S.D.**	**MEAN**	**S.D.**	**P value**	**Inference**
Mean time taken for the performance of block (minutes)	10.2200	±2.1138	5.8771	±1.0762	<0.0001	HS

Graph 3: Mean Time taken for performance of block



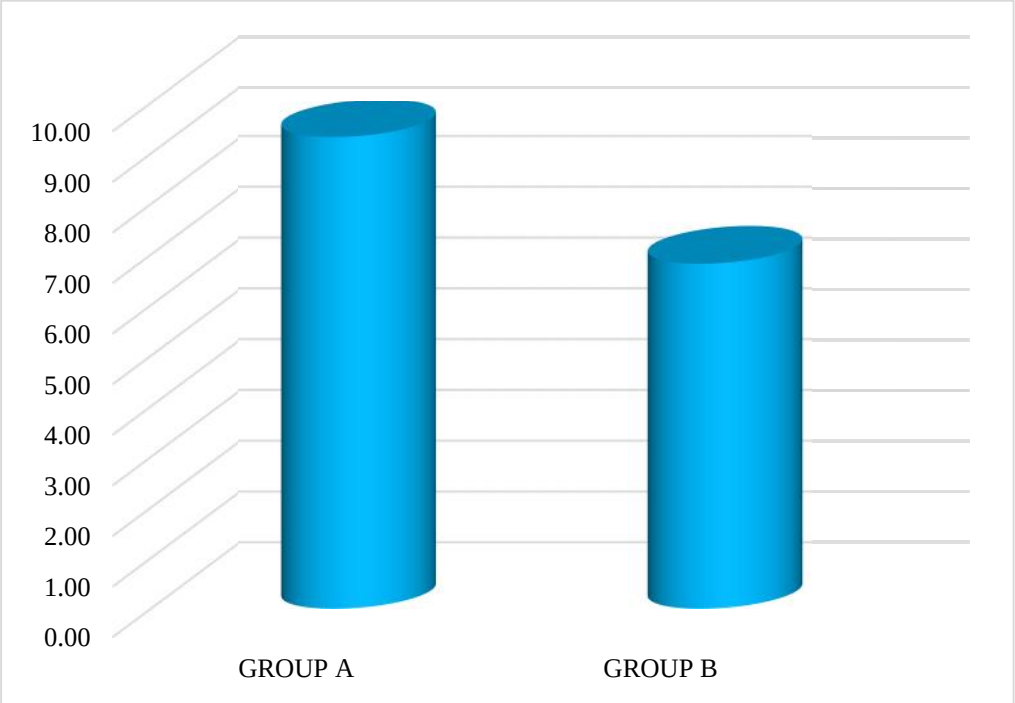
The mean time taken for performance of block was 10.22±2.11 minutes in group A and 5.87 ±1.07 minutes in group B. The statistical analysis by students unpaied t test showed that there is a significant decrease in procedural time with a p value <0.0001, which was statistically significant

Table 4: Mean time for onset of Sensory and Motor Block

		GROUP A		GROUP B			
		MEAN	**S.D.**	**MEAN**	**S.D.**	**p VALUE**	**INFERENCE**
Time of Onset (mins)	**Sensory**	9.2857	±1.8606	6.7914	±1.0427	<0.0001	HS
	Motor	17.6943	±1.4594	14.5629	±2.5348	<0.0001	HS

The mean time for onset of sensory block was 9.28±1.86 in group A and 6.79±1.04 in group B. The mean time for onset of motor block was 17.69±1.45 in group A and 14.56±2.53 in group B. The statistical analysis by students unpaired t test showed there is significant difference in the mean onset times of sensory block between the two groups with p value <0.001 which was statistically significant.

Graph 4: Mean time for Onset of Sensory Block



Graph 5: Mean time forOnset of Motor Block

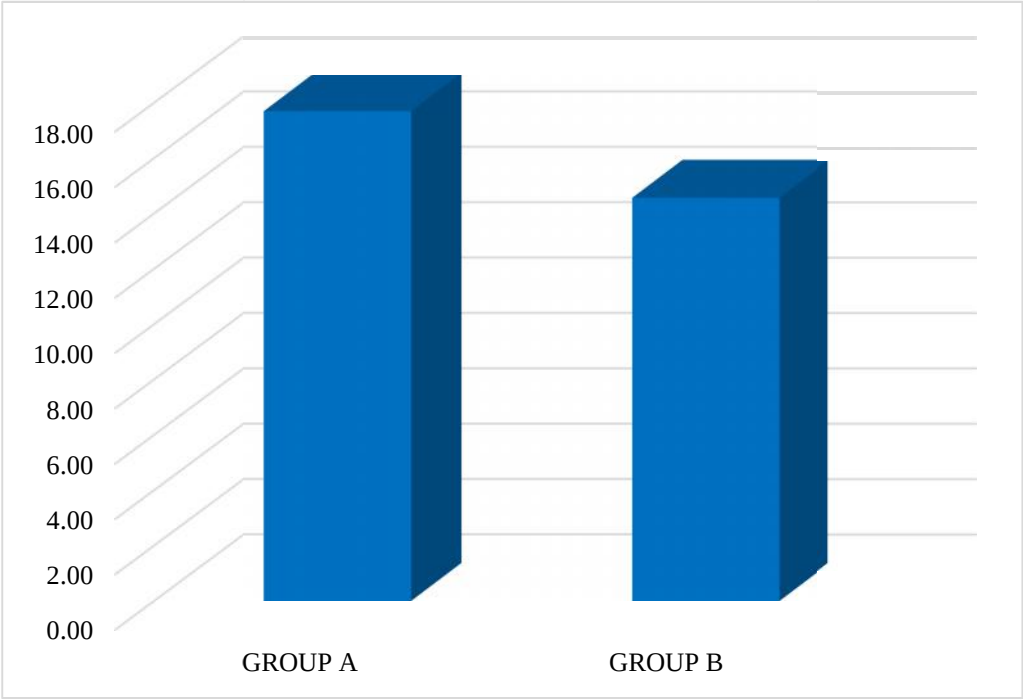
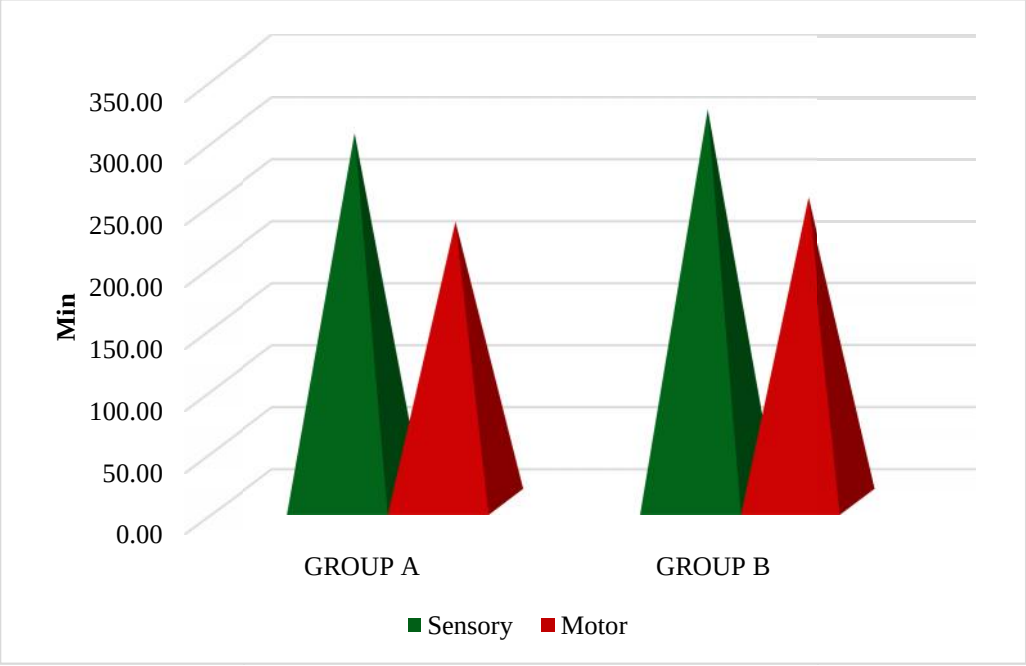


Table 5: Mean duration of Motor and Sensory Block

		GROUP A		GROUP B			
		MEAN	**S.D.**	**MEAN**	**S.D.**	**p VALUE**	**INFERENCE**
Duration of Block (mins)	**Sensory**	**297.29**	**±47.79**	**316.43**	**±37.57**	**0.0668**	**NS**
	Motor	**225.94**	**±42.72**	**245.60**	**±42.82**	**0.0591**	**NS**

The mean time for duration of sensory block was 297.29±47.79 min in group A and was 316±37.57 mins in group B. The mean time for duration of motor block was 225.94±42.72 mins in group A and 245.60±42.82mins in group B. The statistical analysis using students unpaired t test showed that there isnot a significant difference in the duration of sensory and motor block between the two groups.

Graph 6: Mean duration of block



Hemodynamic ChangesIn both the Groups

Table 6: Mean Pulse Rate

	Mean +/- SD		P value	significance
	Group A	**Group B**		
Pre op	**78.23**	**76.14**	**0.2125**	**NS**
0 mins	**77.74**	**78.15**	**0.3248**	**NS**
5 mins	**76.66**	**75.46**	**0.5269**	**NS**
10 mins	**76.09**	**75.77**	**0.8772**	**NS**
15 mins	**75.40**	**74.49**	**0.6249**	**NS**
20 mins	**74.00**	**74.14**	**0.9378**	**NS**
25 mins	**74.26**	**73.86**	**0.8089**	**NS**
30 mins	**73.60**	**72.49**	**0.4835**	**NS**
60 mins	**73.34**	**73.09**	**0.8661**	**NS**
90 mins	**73.20**	**72.77**	**0.7796**	**NS**
120 mins	**72.77**	**72.86**	**0.9536**	**NS**

The above table is of the mean pulse rates at different times before and after the performance of block.

Table 7: Mean Systolic Blood Pressure

	Mean +/- SD		P value	significance
	Group A	**Group B**		
Pre op	**131.46**	**129.26**	**0.0582**	**NS**
0 mins	**130.69**	**128.03**	**0.0526**	**NS**
5 mins	**128.91**	**125.63**	**0.0575**	**NS**
10 mins	**127.20**	**123.83**	**0.0582**	**NS**
15 mins	**126.17**	**123.54**	**0.0577**	**NS**
20 mins	**125.86**	**121.69**	**0.0565**	**NS**
25 mins	**125.26**	**121.03**	**0.0591**	**NS**
30 mins	**124.74**	**121.83**	**0.0618**	**NS**
60 mins	**124.43**	**123.63**	**0.0997**	**NS**
90 mins	**124.11**	**123.83**	**0.1176**	**NS**
120 mins	**124.20**	**123.11**	**0.0540**	**NS**

The above table is of the systolic BP readings at different times before and after the performance of block.

Table 8: Mean Diastolic Pressure

	Mean +/- SD		P value	significance
	Group A	Group B		
Pre op	76.40	75.43	0.5674	NS
0 mins	75.69	74.83	0.5673	NS
5 mins	75.46	73.29	0.1762	NS
10 mins	74.69	72.89	0.2580	NS
15 mins	74.23	72.46	0.2436	NS
20 mins	73.31	70.63	0.0561	NS
25 mins	73.17	70.71	0.0618	NS
30 mins	72.66	70.63	0.1108	NS
60 mins	72.57	70.06	0.0593	NS
90 mins	72.89	71.49	0.2606	NS
120 mins	72.86	71.49	0.2576	NS

The above table is of the diastolic BP readings at different times before and after the performance of block. The above data shows that there was no significant difference in the vital parameters of the two groups.

*NS= Not significant

All the blocks performed were successful in both the groups. There were no adverse effects reported like hematoma formation, vascular punctures, respiratory distress, nerve injury or pneumothorax in both the groups.

DISSCUSION

Brachial Plexus block is one of the commonest anesthetic techniques for surgeries on the upper limb. The supraclavicular block is the preferred approach to the brachial plexus[31]. The approach results in a dense block of the sensory, motor and autonomic innervations of the upper extremity. All three nerve trunks are located in a very compact surface area resulting in rapid onset and dense anaesthesia.

Several studies have compared the use of paraesthesia techniques, ultrasound guidance and nerve stimulator assisted blocks. The blind or paraesthesia techniques involve a lot of patient discomfort, pain (due to multiple injections) and require more time for the performance of the block[32, 33].

The goal of nerve stimulation is to place the needle tip in close proximity to the target nerve in order to inject the local anesthetic in the vicinity of the nerve. The twitch response to PNS is objective and reliable and is independent from the patient's (subjective) response. This reduces the chance of injury to the nerve. However the nerve stimulation can result in inconsistent results as the technique has various variables like conductive area of electrode, electrical impedance of tissues and electrode to nerve distance.

Ultrasound (US) guidance is now a standard nerve localization technique for peripheral nerve block (PNB)[34,35]. Ultrasonography (US) allows simultaneous visualization of the needle, target nerve, local anesthetic injectate along with the surrounding structures.[36,37,38] The precise relationship between the needle tip and the target nerve is unknown at the moment of injection due to limited visibility of the needle tip and the nerve surface.

Importantly, an inappropriately placed needle or inappropriately placed local anaesthetic may lead to nerve injury. This can be attributed to either the US machine (ie, decreased ability to insonate deep neural structures) or the operator. Patients with distorted anatomy and overweight patients also make visualization of neural structures difficult with ultrasound[39].

In the present study 70 patients were randomized into two groups of 35 each

- Group A: Received supraclavicular brachial plexus block under ultrasound guidance
- Group B: Received supraclavicular brachial plexus block under nerve stimulator assisted ultrasound guidance.

The mean age, sex and weight between the two groups was comparable with no significant difference between the demographic parameters.

In our study the onset of sensory block in group A was 9.29±1.86 minutes compared to 6.79±1.04 minutes in group B. The onset of motor block in group A was 17.69±1.46 minutes and in group B was 14.56±2.53 minutes, these findings were statistically significant ($p<0.001$). The results were similar to a study done by **Arnuntasupakul V et al[16]** who observed that combined ultrasonography-neurostimulation resulted in decreased mean onset of sensory block (10.2 ± 5.6 minutes) as compared to ultrasound alone (15.5 ± 9 minutes). Similarly in a study by **Sandhu and Capan** the average time taken to attain surgical anesthesia of the limb was 6.7 minutes with ultrasound guidance. Similar results were seen in a study by **Shreshta BR[4]** et al who observed that the onset of motor block was 16 min with nerve stimulator assisted ultrasound guidance, and 20 min with nerve stimulator

alone. These findings prove that the use of ultrasound assisted by nerve stimulation significantly reduces the time needed for the onset of sensory and motor action. Combined US-neurostimulation may provide better objective end point (i.e., an evoked motor response) for neural proximity[42]. Many a times the ultrasound is unable to reach the deep neural structures, this limitation can be circumvented simultaneous neurostimulation[40,41]. Shortcomings associated with the operator can be explained by mistakes made in perception (i.e., ambiguous criteria for needle/catheter tip–to–nerve proximity) or interpretation.[43]

In our study the time for performance of the block was 10.22±2.11mins in the ultrasound group and 5.88±1.08 minutes in the nerve stimulator assisted ultrasound guidance group. This finding was statistically significant ($p<0.001$). These results were similar to a study performed by **Orenbough et al** who observed the mean time of performance of block using nerve stimulator was 6.5 minutes and that with dual guidance was 1.8 minutes. Thus it was seen that ultrasound aided nerve stimulation helped reduce the time taken for the performance of the supraclavicular block. This may be due to the fact that nerve stimulation is often helpful to confirm that the structure imaged with ultrasound is actually the nerve that is sought. This is because the needle-nerve relationship may not always be visualized on US; an unexpected motor response can occur, alerting the operator that the needle tip is already in close proximity to the nerve[43]. This results in faster identification of the target nerve.

The mean time for duration of sensory block was 297.29±47.79 minutes in group A and was 316.43±37.57 minutes in group B. The mean time for duration of motor block was 225.94±42.72 minutes in group A and 245.60±42.82mins in group B. This was not statistically significant. In a study by **Singh[45] et al** the mean duration

of the block using ultrasound guidance was, 286.22 ± 42.339 compared to 204.37 ± 28.54-min under PNS guidance, which was similar to our study. The duration of block was similar in both the groups as the same dosage of the 0.5% bupivacaine and 2% lignocaine with adrenaline was used in the two groups.

The decreased procedural time in group B lead to better patient comfort in group B compared to group A. This finding was in agreement to a study by **Bomber H et al** who concluded that the combined use of ultrasound/nerve stimulation showed lower odds of unintended paresthesia (P = .007) compared with ultrasound alone. Ultrasound can help prevent accidental blood vessel punctures and of the pleura and the use of the nerve stimulator avoids the need to elicit paraesthesia and hence reduces nerve damage. Hence the technique of nerve stimulator assisted ultrasound guidance helps improve efficacy and safety[46].

There was no significant change in the vital parameters like pulse rate and blood pressure in the two groups. These vital parameters were comparable in both the groups. There were no adverse effects seen in the two groups.

LIMITATION

In this study we have used 30 ml of local anesthetic mixture for the block that is 15 ml of 2% lignocaine with adrenaline and 15 ml of 0.5% bupivacaine. However, with ultrasound guidance a lower volume of the drug could have been used for the performance of block.

FUTURE SCOPE

As Ultrasound technology continues to advance, machine recognition and 3-dimensional imaging tools may prove to be useful for enhancing the accuracy of nerve identification. Liposomal delivery systems enabling the slow release of LA at the injection site are some developments in the provision of prolonged analgesia and may remove the requirement for postoperative perineural catheters. There is need to improve the anaesthetic training and skill in USG regional anesthesia. However, in less-experienced hands a combination of techniques (ultrasonography, neurostimulation, and injection pressure control) may prove to be more successful and safer when performing PNBs[47].

CONCLUSION

In conclusion, the use of nerve stimulation along with ultrasound guidance significantly reduces the time taken for the performance of the block, the onset of sensory and motor block compared to ultrasound guidance alone in patients undergoing supraclavicular brachial plexus block.

SUMMARY

In this prospective randomized control study, 70 ASA grade I and II patients were randomly enrolled to receive supraclavicular block using ultrasound guidance (Group A) and supraclavicular block using nerve stimulator assisted ultrasound guidance (group B).The time taken for performance of block, onset, duration of sensory and motor block were compared between the two groups.

The mean time taken for performance of block was 10.22±2.11 minutes in group A and 5.87 ±1.07 minutes in group B. The mean time for the onset of sensory block was 9.28±1.86 minutes in group A and 6.79±1.04 minutes in group B and time of onset of motor block was 17.69±1.45 minutes in group A and 14.56±2.53 minutes in group B. The difference in between the two groups was statistically significant.

The mean time for duration of sensory block was 297.29±47.79 minutes in group A and was 396±37.57 minutes in group B. The mean time for duration of motor block was 225.94±42.72 minutes in group A and 245.60±42.82 minutes in group B. The difference in between the two groups was statistically not significant.

The haemodynamic changes between the two groups were both statistically and clinically not significant.

In conclusion, the use of nerve stimulation along with ultrasound guidance significantly reduces the time taken for the performance of the block, the onset of sensory and motor block compared to ultrasound guidance alone in patients undergoing supraclavicular brachial plexus block.

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ANNEXURE I – CONSENT FORM

CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr/Mrs/Miss. _____ we are requesting you to enrol in study titled **"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES. "**

Respected Sir/Madam We request you to enroll yourself to participate in our study as you are eligible for participating in the study. During the study you will be asked some questions regarding your present complaint and you are supposed to answer to the best of your knowledge.

Your participation in this research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N.Medical College. If you decide not to participate you are free to withdraw at any time.

Purpose of the study:

The purpose of this study is to compare ultrasound guided and nerve simulator assisted ultrasound guidance for supraclavicular brachial plexus block in patients undergoing upper limb surgeries.

Procedure Involved:

If you agree to enrol yourself in my study, you will be interviewed regarding your present, past and family history. You will then be clinically examined in detail and investigational procedures will be performed. You will be randomly allocated either into Group A wherein block will be given under ultrasound guidance or Group B where nerve stimulator assisted ultrasound guidance will be used for performance of block as per randomization protocol.

Risks and Benefits:

The benefits of the study are that we can avoid general anaesthesia with good quality of analgesia during and after the study. The risks of the procedure are minimal but can include hypotension, bradycardia, nausea, vomiting, respiratory distress; local hematoma, weakness and hypoesthesia due to nerve injury, pneumothorax, and surgical emphysema.

Voluntary Participation/Withdrawal:

Taking part in the study is voluntary. You may choose not to enrol yourself in this study. Your decision will not change present or future health care services offered to you at K.L.E. hospital.

Alternatives:

Even if you decline the participation in the study, you will get the routine line of management.

Privacy and Confidentiality:

The only people to know that you are a research subject are members of the research team. No information about you or information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.

2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with your identity remaining confidential.

Financial Incentives for participation:

No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Compensation:

In the event of injury related to the study, treatment will be made available through KLES' Hospital & MRC, Belagavi. There is no compensation or payment for such medical treatment by law

Questions:

If you have any queries about your rights as a study subject, you may call Dr. Ganga Pilli, Professor, Department of Pathology and Chairman, J.N. Medical College Institutional Ethical Committee for Human Subjects Research, Phone number-9480275601, or extension 4052 at J.N. Medical College, Belagavi.

CONSENT FOR PARTICIPATION IN RESEARCH TRIAL.

"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES. ".

I, Mr/Ms/Mrs _____ voluntarily agree for participation as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read for me in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name : _____

Signature or the Left Thumb Print of parent : _____

Date:

Witness Name : _____ Signature:_____

Date:

Investigators Name: _____ Signature:_____

Date:

Place : _____

ANNEXURE-II

PROFORMA

"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES. "

Name & Address of the patient: _____ _____

_____ _____

Age of the Patient: _____ IP. No. _____

Weight of Patient: _____ Sex.

Anaesthesiologist: _____ Surgeon: _____

PREANAESTHETIC EVALUATION:

Chief Complaints:

Past History:

- History of Diabetes Mellitus/Hypertension/Asthma/Tuberculosis
- Drug Therapy:
- Previous Anaesthetic procedure/Previous surgeries:
- History of renal disease, hepatic disease and neurological diseases.

Family History

General Physical Examination:

Weight: Temperature: Pallor: Height

Cyanosis: Pedal Edema: Clubbing:

Pulse : B.P: RR:

Airway Assessment:

Mouth Opening: Teeth:

Jaw Movements: MP Grading:

SYSTEMIC EXAMINATION:

Cardiovascular System:

Respiratory System:

Per Abdomen:

Central Nervous system:

Spine assessment:

INVESTIGATIONS:

Hb%: Platelet count:

Any Other:

ASA STATUS: Grade 1 / 2

Diagnosis:

Proposed Surgery:

Inclusion Criteria:

- ASA physical status I and II
- Age between 18 to 60 years.
- Patients undergoing elective upper limb surgeries.

Exclusion Criteria:

- Patients allergic to local anaesthetics.
- Patientswith coagulation abnormalities.
- Patients with neurological deficits.
- Patients with infection at the site of block.
- Patients with severe cardiovascular and respiratory comorbidities.

Methodology:

After obtaining the approval of theEthical committee and written informed consent, ASA I-II patients undergoing elective upper limb surgeries under brachial plexus block will be included in the study.

Patients will be randomly divided into two groups by using computer generated table.

- Group A –Supraclavicular brachial plexus block under ultrasound guidance.

- Group B – Supraclavicular brachial plexus block under nerve stimulation assisted ultrasound guidance.

A routine pre-operative assessment of all the patients will be done and after explaining the anesthetic procedure an informed consent will be taken. Preoperatively adequate fasting of 8 hrs has to be confirmed. In operation theatre intravenous cannula will be placed. Electrocardiogram, noninvasive blood pressure, pulse oximeter will be applied and the procedure will be explained to the patient. On operation table patient will be given the position for brachial plexus block via supraclavicular approach, supine position with head resting on ring, ipsilateral arm adducted, shoulder depressed, roller pack placed in between scapula and head turned slightly to contra lateral side. Under all aseptic precaution local site will be prepared.

In group A patients ultrasound machine will be prepared and checked, a high frequency linear array ultrasound (9-18 MHZ) will be used. Clavicle is proper landmark which is easily felt in most of the patients. The probe will be positioned in supraclavicular fossa just superior to the clavicle at mid point. The probe is moved medially and laterally and also in rocking fashion in order to locate pulsating subclavian artery. The area lateral and superficial tosubclavian artery will be explored. The needle inserted from lateral side of the probe first perpendicular to the skin to penetrate the skin and then at a shallow angle under the probe. The needle will now be advanced inside ultrasound beam by in plane technique till the plexus is seen with characteristic honey comb appearance.

Under USG view the brachial plexus can be seen as a bundle of hypo echoic round nodules (grapes) just lateral and superficial to the artery. At this point injection of 10 ml of 0.5% bupivacaine and 10 ml of 2% lignocaine with adrenaline is to be injected following gentle aspiration and spread of drug and bulging of plexus is to be noted.

In group B patients the nerve stimulator is to be connected to the stimulating needle and set to deliver current of 2mA at 1 Hz frequency and 0.1 ms of pulse duration. Under ultrasound guidance, the needle is inserted posterior, medially and caudally. The needle will be then slowly advanced under the palpating finger to elicit contraction of innervated muscle. Once the elicited motor response of the fingers is obtained at 0.5 mA, the injection of 10 ml of 0.5% Bupivacaine and 10 ml of 2% Lignocaine with adrenaline is carried out after gentle aspiration.

The following parameters will be recorded,

1) Time for the onset and duration of sensory and motor blockade.

2) Time taken for performance of block

Time taken for performance of block was defined as the time taken from the insertion of needle to the delivery of drug.

Sensory block will be assessed by pinprick test using a 3 point scale in all nerve territories:

0= sharp pin felt

1= dull sensation felt (analgesia)

2=no sensation felt(anesthesia)

Motor block will be assessed by thumb abduction(radial nerve) , thumb adduction(ulnar nerve), thumb opposition (median nerve) and flexion at the elbow (musculocutaneous nerve) on a 3 point scale for motor function.

0= normal motor function with full flexion and extension of elbow, wrist and fingers

1= reduced motor strength but able to move fingers

2= complete motor block with inability to move fingers

Onset of sensory block is defined as the time interval between the end of total anaesthetic administration and complete sensory block. (score 2)

Complete sensory block is defined by anaesthetic block (score 2) in all nerve territories.

Duration of sensory block is defined as the time interval between the end of local anaesthetic administration and the complete resolution of anaesthesia in all nerve distribution.

Onset of motor block is defined as the time interval between administration of local anaesthetic solution to loss of movements.(score 2)

Complete motor block is defined as absence of voluntary movement in hand and forearm. (score 2)

Duration of motor block is defined as the time interval between the end of local anaesthetic administration and the recovery of complete motor function of the hand and forearm.

An inadequate block or failure of effect were noted and supplemented with general anaesthesia. Any perioperative complications like hypotension, bradycardia, nausea, vomiting, respiratory distress; local hematoma, weakness and hypoesthesia due to nerve injury, pneumothorax, and surgical emphysema were noted and treated.

Observations:

Readings will be recorded in the following manner:

Technique used : _____.

Group: _____.

Preoperative baseline values

HR: SBP: DBP:

Monitors attatched:

Pulse oximetry: NIBP:

ECG:

Vital Parameters:

Time	Heart rate	NIBP

Motor and Sensory Block

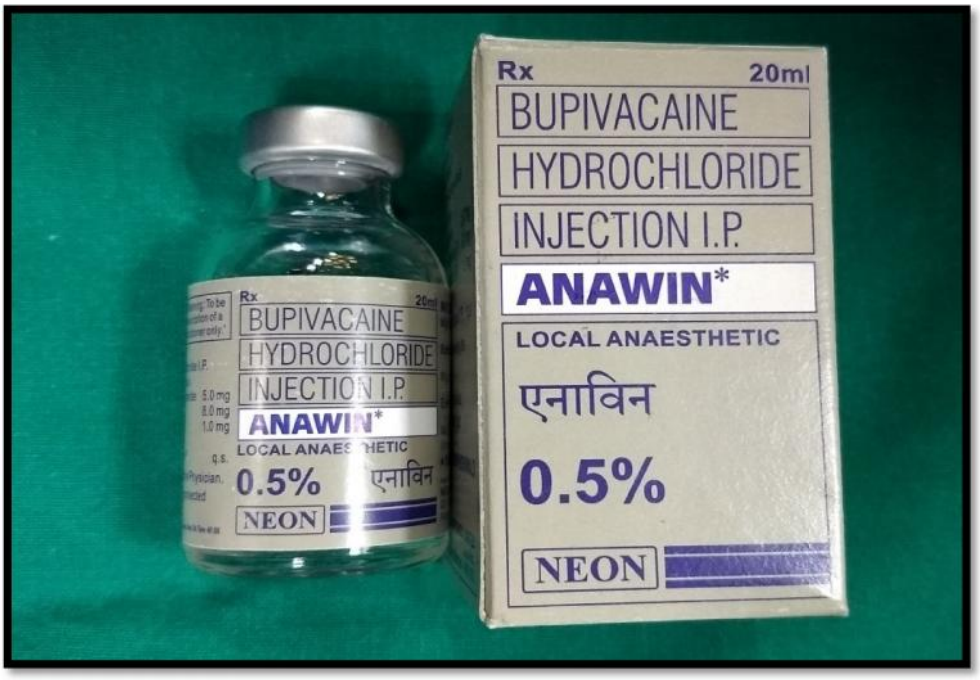
Parameter	Group A	Group B
Time taken to perform block		
Onset of sensory block		
Duration of sensory block		
Onset of motor block		
Duration of motor block		

Side Effects/ complications –

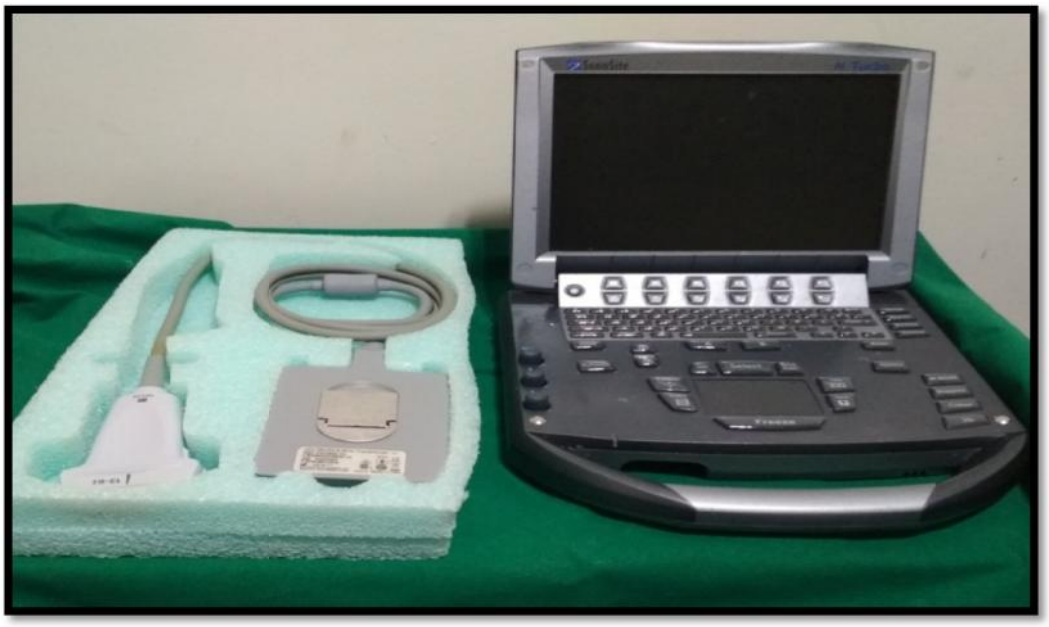
Signature of staff in charge:

ANNEXURE III – PHOTOGRAPHS

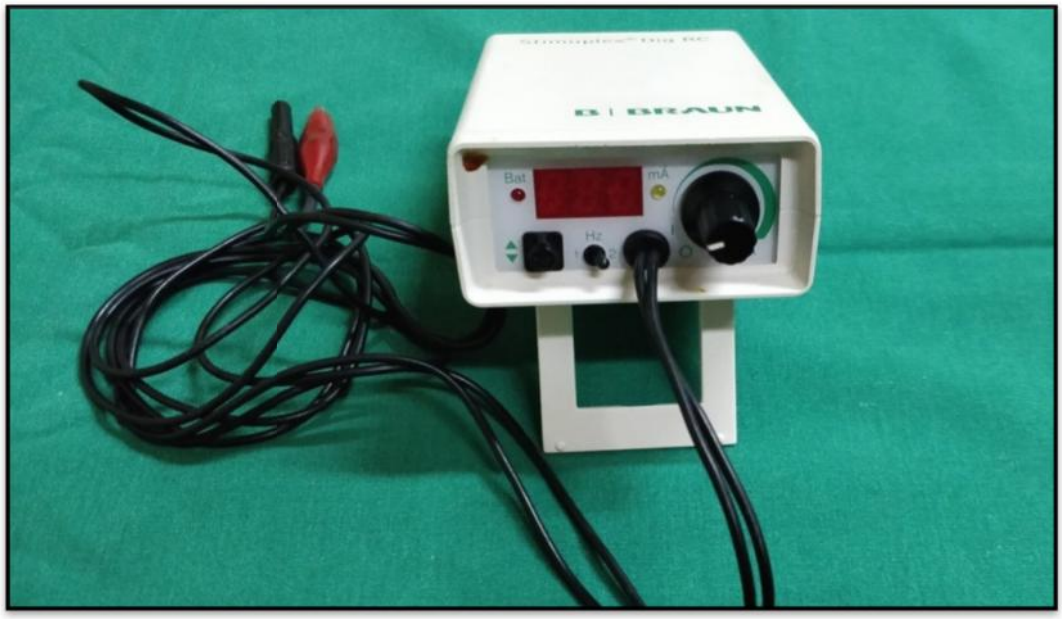
Photograph : 1. Lignocaine with Adrenaline Vial



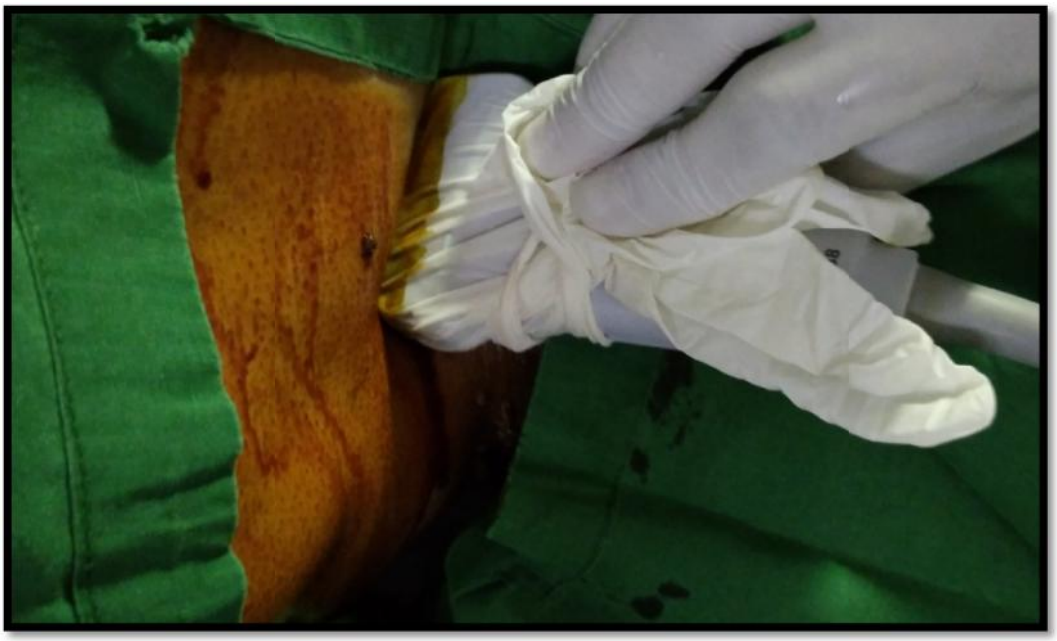
Photograph :2. Bupivacaine Vial



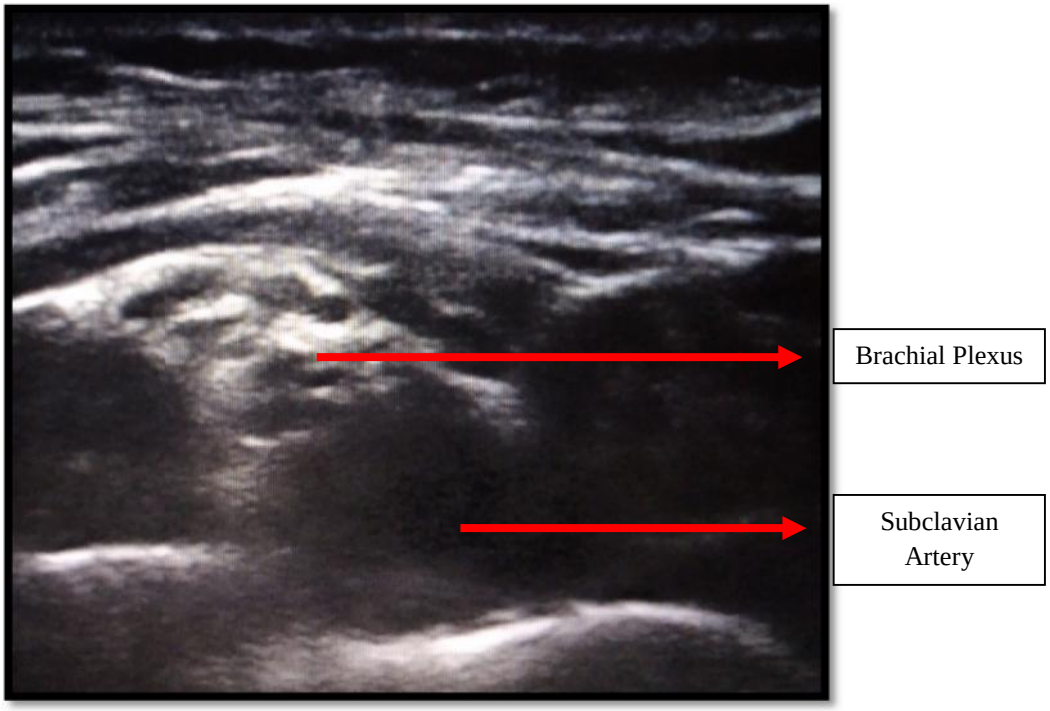
Photograph :3 . SonoSite Ultrasound Machine



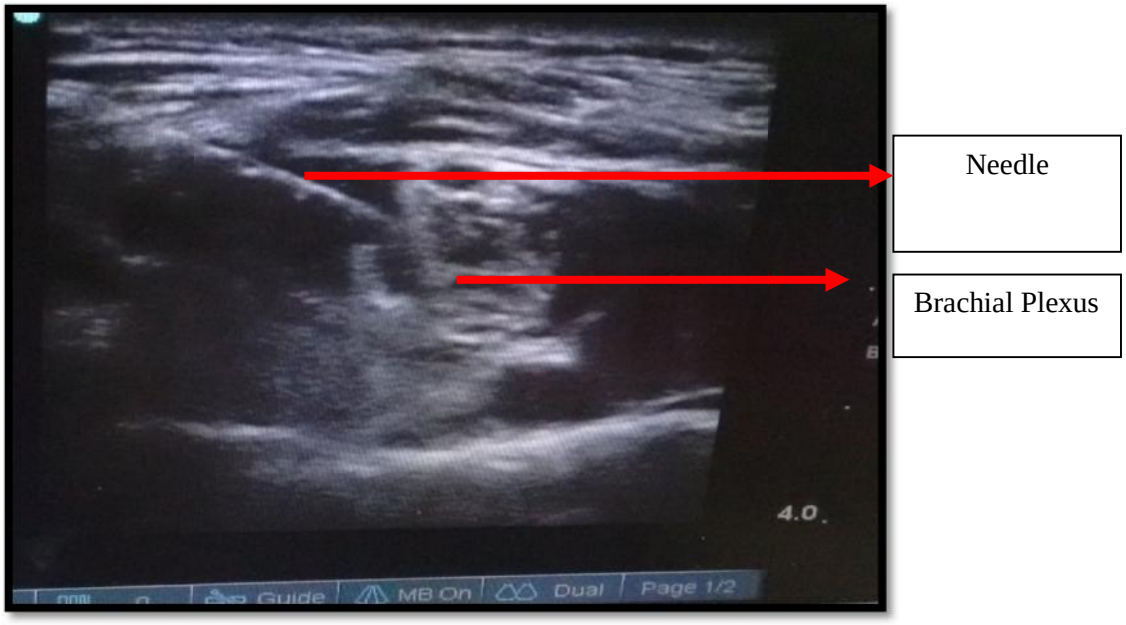
Photograph 4: Peripheral Nerve Stimulator



Photograph: 5 . Position of the Ultrasound Probe



Photograph 6. Brachial Plexus Under Ultrasound



Photograph: 7. Injection of Local anaesthetic under USG Guidance

Photograph 8: Brachial Plexus Block with Nerve Stimulator assisted USG Guidance

ANNEXURES IV - MASTER CHART

Group A USG

S.No.	Age(years)	Sex	IP Number	Time of perfoemance of bloc	Weight(Kgs)	Onset of Block (mins)		Duration of Block (mins)		Pulse Rate (beats per min)											Systolic Blood Pressure (mmHg)											Diastolic Blood Pressure (mmHg)										
						Sensory	Motor	Sensory	motor	pre op	0 min	5 min	10 min	15min	20 min	25 min	30 min	60 min	90 min	120 min	pre op	0 min	5 min	10 min	15min	20 min	25 min	30 min	60 min	90 min	120 min	pre op	0 min	5 min	10 min	15min	20 min	25 min	30 min	60 min	90 min	120 min
1	45	F	840804	10.4	55	9.5	18.5	322	262	85	84	88	78	74	70	70	72	68	67	68	140	141	138	138	138	138	130	130	132	128	130	88	80	84	90	90	82	84	80	78	82	82
2	18	F	847546	11.5	56	10	20	350	260	88	82	84	86	88	80	82	84	86	84	84	130	128	128	126	126	126	120	122	124	120	118	70	72	72	73	74	74	72	74	74	74	74
3	19	M	826480	11	78	8.5	20	265	220	78	78	80	76	78	86	80	82	76	78	77	130	130	125	120	122	122	118	122	120	118	118	70	70	72	70	72	70	72	72	68	70	72
4	43	F	846288	15.2	59	10.4	19	270	220	80	80	82	78	76	70	70	72	70	70	70	130	130	128	128	128	118	119	118	118	116	116	80	80	78	78	74	74	74	72	76	74	72
5	46	M	820009	15.4	58	8.5	15.5	285	225	78	80	76	82	88	78	80	80	80	78	80	130	118	118	116	118	118	116	120	120	122	126	70	70	70	72	72	68	70	70	72	72	74
6	60	M	841105	9.6	52	8	15.5	248	215	90	92	90	100	88	88	90	84	90	90	84	118	120	118	120	110	110	118	118	120	120	118	60	64	60	64	62	60	64	64	70	80	80
7	57	F	841030	6.8	61	8.8	21	272	195	90	88	84	84	82	84	86	78	78	78	74	136	136	130	132	132	130	128	130	130	130	132	76	74	74	72	72	72	68	70	70	72	72
8	60	M	841777	7.5	60	9	16.5	253	193	62	60	62	60	58	56	60	58	63	62	60	136	130	130	128	128	130	128	124	126	126	128	76	76	70	70	76	76	78	76	72	74	74
9	23	M	834397	6.8	60	10	18	270	205	80	80	84	84	78	76	78	78	79	80	80	126	126	120	128	128	118	120	118	118	120	118	80	80	78	80	80	82	76	68	70	68	68
10	58	M	846709	10.2	56	9	18	293	248	78	70	66	66	65	66	64	62	64	66	68	136	130	130	128	126	126	128	126	122	122	126	70	70	76	68	68	64	66	66	62	64	64
11	60	M	849825	11.5	65	8	15.5	242	182	70	70	72	68	65	64	64	64	62	63	64	130	134	134	130	130	130	132	130	132	132	132	78	78	72	73	73	78	78	76	74	74	72
12	19	F	820610	12.5	57	10	16	280	190	90	90	92	90	91	88	86	86	78	78	78	130	130	130	124	124	124	120	120	124	124	124	70	70	72	64	66	66	64	64	66	64	66
13	58	M	841186	13	69	8.5	16.5	262	187	70	70	64	66	62	64	64	62	63	64	64	138	136	132	132	136	133	130	132	125	128	128	80	80	80	80	82	83	82	80	80	80	82
14	58	F	829399	9.5	50	7.8	18	333	253	80	80	82	82	83	82	80	80	82	82	82	117	117	120	110	112	112	113	111	112	112	113	70	70	70	72	73	72	73	74	73	73	74
15	60	F	840842	8.6	58	9	18	423	315	66	66	66	64	64	64	64	62	63	64	65	130	132	130	132	132	126	126	122	123	124	124	78	78	78	74	74	72	72	74	76	76	76
16	60	F	849631	7.8	60	8.2	18	257	197	74	73	72	70	72	73	72	72	73	73	72	126	126	126	124	120	122	122	120	118	118	118	80	80	82	82	80	80	82	80	80	82	82
17	35	M	845901	7.5	62	8	19	302	242	80	80	70	78	78	76	77	77	76	76	72	130	130	128	130	130	136	130	132	132	130	132	70	70	70	70	72	76	74	74	74	72	72
18	35	M	867952	9.8	67	8.4	19	312	211	72	72	70	72	74	70	68	68	70	72	70	132	130	128	128	125	128	128	128	126	126	126	68	68	68	64	64	65	64	64	65	66	66

19	60	F	849637	8.5	60	8	16.8	287	202	73	73	72	70	72	73	74	73	72	72	70	126	126	126	124	120	122	122	118	118	120	120	80	80	80	82	80	80	80	78	76	76	74
20	44	M	840124	7.8	70	10	16	210	149	66	66	64	60	62	62	64	62	60	62	60	120	120	118	118	114	116	116	115	115	114	114	70	70	66	66	66	62	64	64	64	62	60
21	48	M	842176	8.8	68	7.5	15.5	293	233	90	90	88	89	84	80	80	82	82	80	80	130	130	130	130	125	128	128	130	128	122	120	76	76	74	76	72	74	74	70	72	76	76
22	18	M	841129	9.5	60	7.5	18	313	225	76	76	74	80	76	76	78	80	78	78	76	130	130	132	120	122	122	122	124	122	124	122	70	70	70	72	70	70	72	76	74	74	72
23	18	F	834634	8.5	50	8	20	232	172	90	90	88	82	86	80	82	82	80	84	86	130	130	120	122	118	118	118	116	116	118	118	70	70	70	70	74	70	70	70	74	74	74
24	45	F	842957	9.8	68	7.8	18	233	165	70	70	68	64	66	66	66	64	66	62	66	130	130	132	132	130	130	130	128	130	128	122	70	70	68	68	72	72	70	70	72	72	70
25	37	F	798822	10	58	8	18	302	190	82	80	76	76	74	76	74	72	80	76	76	142	140	140	136	136	130	130	130	132	130	130	90	90	88	82	76	76	76	72	72	72	70
26	29	M	799150	11.4	65	8.3	17	382	283	80	80	78	72	72	76	78	76	74	74	76	136	136	132	132	130	130	130	132	128	128	128	72	72	72	74	72	72	72	70	69	70	72
27	22	M	824464	12.5	72	8.5	19	337	247	80	80	78	82	82	78	76	77	74	77	74	138	138	130	130	128	128	128	126	128	126	126	76	76	77	76	72	74	72	73	73	72	72
28	54	F	823038	12	56	8	16.5	254	179	70	70	68	68	66	68	65	65	66	70	65	130	130	128	130	128	122	124	122	122	122	130	70	70	70	66	66	60	60	62	62	64	64
29	60	F	853198	12.2	58	7.8	16.5	283	173	88	88	88	84	84	80	86	80	82	82	80	136	130	130	128	128	130	130	130	128	128	122	76	76	74	74	74	76	72	72	70	70	68
30	50	M	832810	10.5	62	10	18	320	250	80	85	85	80	75	74	75	74	74	72	72	140	150	145	130	130	140	132	132	130	130	132	100	90	90	88	80	76	74	74	74	72	72
31	43.3	M	845678	9.5	78	12	18	300	260	80	82	80	78	78	80	80	78	76	68	74	140	140	134	128	126	128	132	128	128	128	128	90	89	88	80	80	76	78	78	78	78	76
32	42	M	843674	10	78	13	17	320	280	80	78	78	76	78	80	78	78	76	74	72	140	138	140	138	136	136	136	132	132	134	132	90	80	88	88	86	80	80	80	78	78	78
33	40	M	853478	12.5	77	14	16	360	280	74	72	70	68	68	68	70	74	70	70	70	130	128	128	128	128	128	130	128	128	128	128	80	80	80	78	78	78	80	82	76	76	76
34	42	F	845634	10.6	68	12	18	380	300	76	74	72	76	76	68	70	70	68	68	70	130	128	128	126	126	126	126	128	128	128	128	80	80	80	80	78	78	78	78	76	68	76
35	40	F	823498	9	60	15	19	360	300	72	72	72	74	76	70	68	68	68	68	68	128	126	126	126	126	124	124	124	120	120	120	80	80	80	78	78	78	76	76	80	80	78

Group B USG NS																																										
S.No.	Age(years)	Sex	IP Number	Time of performance of block	Weight(Kgs)	Time of Onset(mins)		Duration of Block (mins)		Pulse Rate (per min)											Systolic Blood Pressure (mmHg)											Diastolic Blood Pressure (mmHg)										
						Sensory	Motor	Sensory	Motor	pre op	0 min	5 min	10 min	15 mins	20mins	25 mins	30 mins	60 mins	90 mins	120 mins	pre op	0 min	5min	10 min	15mins	20mins	25mins	30 min	60 mins	90 mins	120 mins	pre op	o mins	5mins	10 mins	15 mins	20 mins	25 mins	30 mins	60 mins	90 mins	120 mins
1	41	M	863005	4.3	68	6.5	15.2	300	200	70	68	70	66	66	66	68	70	66	68	68	130	130	126	126	126	126	124	126	120	126	122	70	70	70	68	66	66	68	68	66	66	68
2	18	M	862181	4.2	57	6.6	14	280	250	70	70	72	74	70	68	68	68	70	70	72	120	120	118	118	118	118	114	114	112	114	116	70	70	68	68	70	66	66	70	72	70	72
3	45	M	860681	5.6	68	5.5	17	290	300	76	76	74	78	74	70	70	68	68	66	68	130	130	120	120	118	120	120	118	116	116	116	76	76	76	70	68	68	70	68	70	70	74
4	25	F	859891	6.5	56	6	18	290	300	84	84	80	83	80	88	80	84	80	82	84	124	120	124	118	120	120	120	124	122	124	110	79	76	72	74	74	74	79	72	70	74	74
5	48	F	829174	5.5	68	6	12.5	300	250	70	70	72	64	64	70	70	72	72	74	68	114	114	110	118	110	110	118	118	110	114	114	70	70	60	62	70	64	68	68	60	62	62
6	31	M	857037	4.5	60	8	15	300	250	80	80	76	78	76	72	74	74	70	72	72	136	136	136	130	130	128	130	130	126	120	120	72	72	72	72	74	72	70	70	68	70	70
7	36	M	858519	3.8	68	5.5	12	350	270	80	80	70	78	74	76	74	76	80	80	80	114	120	118	114	114	118	118	118	114	114	114	70	70	68	68	72	76	70	68	70	76	76
8	18	M	855125	5	60	5	17	400	300	80	80	76	74	80	78	78	74	78	80	78	130	130	124	124	124	120	120	122	124	118	118	80	80	72	72	78	70	72	72	64	72	70
9	36	F	823456	6.5	65	8	12.4	350	280	68	68	70	82	84	76	80	74	82	70	70	110	124	124	122	118	110	110	112	12	130	138	70	70	68	70	62	72	64	60	62	72	82
10	60	M	831662	7.4	63	7.5	12	350	300	80	80	82	82	84	90	82	76	78	74	76	140	140	130	136	136	136	130	130	130	136	130	90	90	88	88	88	84	84	80	82	84	80
11	35	M	819304	8	50	6	12	300	250	80	80	88	88	78	78	70	74	70	72	70	130	130	128	128	120	120	118	120	130	130	130	80	80	76	76	64	64	66	66	70	74	74
12	55	F	855180	6.4	50	5.3	10.8	250	150	80	78	72	74	74	70	82	78	78	70	78	150	150	152	150	152	140	140	140	140	140	138	80	80	80	76	80	70	70	68	70	80	78
13	27	M	831625	5.2	70	7	16	300	250	73	70	74	73	73	74	73	72	73	74	74	130	130	128	118	128	118	120	120	120	118	116	70	70	70	70	70	70	68	68	68	70	70
14	37	F	841154	4.5	56	5.2	11	300	220	78	80	78	78	76	80	84	74	76	74	80	118	114	120	118	118	112	110	112	118	118	120	78	78	76	80	76	74	68	68	64	70	72
15	26	M	834974	5.6	60	7	17	300	230	90	95	90	89	85	84	84	83	80	78	78	120	120	120	115	115	118	118	118	118	116	116	75	75	75	78	78	70	72	80	78	78	76
16	28	M	820771	5.5	62	7.4	15.5	250	200	66	62	58	60	62	62	60	62	65	68	68	110	110	118	112	118	112	114	112	114	120	114	76	76	70	74	70	72	70	68	68	70	76
17	38	M	833945	5	68	5	11.4	300	230	80	88	88	84	85	72	72	68	70	68	70	130	128	130	110	110	114	114	112	114	110	112	80	80	80	76	78	70	68	70	68	70	68
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19	24	M	837669	7	66	7	18	300	250	70	70	72	68	74	72	72	74	76	76	72	130	130	132	132	128	126	126	124	126	126	126	70	72	74	78	78	70	70	70	70	70	68

20	28	M	822766	5.5	69	8.5	15	350	280	88	88	82	82	80	82	80	78	78	78	76	130	130	126	126	126	126	124	126	120	120	120	70	70	68	68	68	66	68	68	64	64	64
21	25	M	858456	5.6	70	7	13	400	320	80	80	78	88	88	90	80	74	76	80	80	130	130	124	130	120	124	130	132	132	130	130	80	80	80	70	68	68	70	68	68	68	68
22	57	M	844514	6.8	68	6.5	15	350	250	70	68	68	70	68	64	68	64	68	68	68	130	130	128	126	118	118	120	122	122	122	118	70	70	72	70	72	70	70	68	72	70	70
23	60	F	833753	5.5	58	8	18	350	250	64	64	66	62	60	62	64	66	68	62	62	130	130	132	128	130	126	126	126	124	124	124	72	72	74	72	72	70	70	72	72	72	72
24	32	M	858630	7	65	5.5	10.5	350	260	80	80	88	90	80	84	80	82	80	84	80	130	128	128	130	124	134	122	122	118	120	124	86	86	80	82	80	74	72	80	80	76	76
25	60	F	841211	7.5	60	8	17	340	280	80	72	80	74	72	73	73	78	80	78	78	130	134	130	132	130	128	130	130	132	128	128	76	76	77	76	70	70	70	72	80	80	76
26	60	M	854060	7.4	60	7	17	340	290	70	69	69	69	68	70	72	68	68	68	72	128	128	128	126	126	126	120	120	118	118	119	72	72	72	70	72	70	70	70	72	72	74
27	48	M	844161	6.4	70	7.2	15.6	350	255	80	80	82	83	80	82	80	74	76	74	74	130	130	128	126	128	126	126	128	122	124	122	76	76	72	72	74	74	72	74	74	76	72
28	48	M	824328	6	78	6.5	18	350	250	74	74	72	70	72	70	72	68	70	68	70	132	132	132	132	120	120	130	130	130	124	126	76	76	76	75	72	72	70	70	72	68	68
29	39	M	831625	6.2	70	8	20	320	280	78	80	80	75	78	75	75	75	74	75	76	138	138	135	132	133	133	130	132	134	132	130	90	90	91	90	92	90	86	86	84	78	72
30	43	M	836118	7.5	77	6.5	15	250	160	70	68	70	70	68	71	70	70	70	70	68	130	120	128	115	115	114	110	114	118	120	120	68	70	70	60	63	60	80	72	58	62	62
31	38.26666667	M	845678	5.5	76	7	10.8	300	150	70	75	76	78	70	68	68	69	70	70	68	130	128	126	130	128	120	118	116	120	120	118	70	80	70	72	70	70	70	72	74	70	70
32	38.26666667	F	845739	6.5	56	6.5	13	300	200	80	78	76	74	72	74	72	68	70	70	68	120	120	116	114	116	114	112	114	116	118	116	80	70	70	72	72	70	72	70	72	72	72
33	50	M	845892	6.5	78	8	14	275	200	80	82	80	78	78	76	78	80	74	76	78	130	128	126	126	126	128	130	126	124	120	120	80	70	72	74	72	70	72	74	70	72	70
34	49	F	846772	5.5	68	9	15	300	200	80	78	78	76	78	66	68	68	70	74	72	120	116	114	116	116	118	114	118	120	120	118	70	72	72	74	70	72	70	72	72	74	76
35	45	F	856438	4.2	68	7.5	13	350	250	78	78	74	80	74	78	76	70	72	76	74	130	128	128	126	120	120	120	124	124	122	122	80	74	76	74	74	72	70	72	70	70	70

KEY TO MASTER CHART

DBP : Diastolic Blood Pressure

SBP : Systolic blood Pressure

HR : Heart Rate

ANNEXURE V – ETHICAL CLEARANCE CERTIFICATE

K.L.E.UNIVERSITY'S
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
(Accredited 'A' Grade by NAAC)

Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu

Phone: (+ 91-(0)831 Office : 2471350
Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref: MDC/DOME/ 59 **Date: 17/10/2016**

To,

[redacted],
J.N.Medical College,
BELAGAVI.

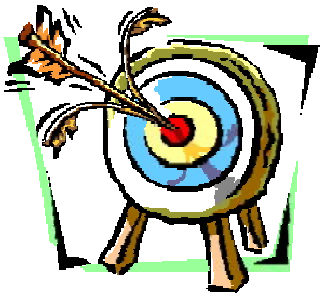
Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"A COMPARISON BETWEEN ULTRASOUND GUIDANCE VERSUS NERVE STIMULATOR ASSISTED ULTRASOUND GUIDANCE ON THE EFFICACY OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES"**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Arathi Darshan)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Ganga Pilli)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

Introduction



Objectives

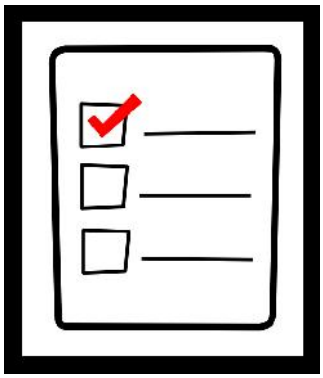
Review of Literature

Methodology

Results

Discussion

Conclusion

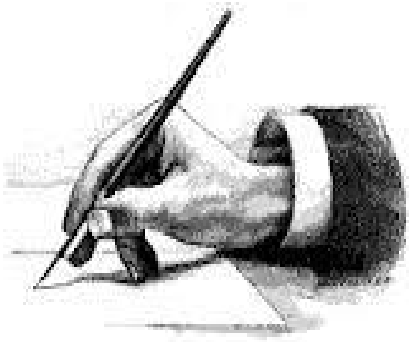


Limitations

Recommendations

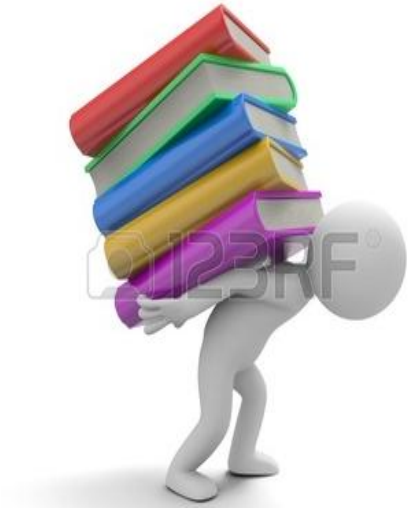
Summary

Bibliography



Annexure-I

Annexure-II



Annexure-III

Annexure-IV

Annexure-V