“TO DETERMINE THE MINIMUM EFFECTIVE VOLUME OF LOCAL ANAESTHETIC IN 50% PATIENTS (MEAV50) USING DIXON’S UP-AND-DOWN METHOD FOR ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: ONE YEAR HOSPITAL BASED CLINICAL STUDY”

By

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Dissertation

Submitted to the

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BELAGAVI, KARNATAKA

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Sub: Institutional Ethical Clearance for the study.

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ABBREVIATIONS

ASA	-	American society of Anesthesiologists
BMI	-	Body mass index
CI	-	Confidence interval
cm	-	Centimeter
MEAV	-	Minimum effective anaesthetic volume
ICA	-	Internal carotid artery
kg	-	Kilogram
MHz	-	Mega hertz
min	-	Minute
ml	-	Milliliter
ED	-	Effective dose
SA	-	Subclavian artery
SD	-	Standard deviation
LA	-	Local Anaesthetic
US	-	Ultrasound
USG	-	Ultrasonography
yrs	-	Years

ABSTRACT

TITLE: "To determine the minimum effective volume of local anaesthetic in 50% patients (MEAV50) using Dixon's up-and-down method for ultrasound guided supraclavicular brachial plexus block: One year hospital based clinical study"

Background: The study determines the minimum volume of local anesthetic for an effective ultrasound guided brachial plexus block for upper limb surgeries. Dixons up-and-down method was used to administer the predetermined volume of local anaesthetic with 2ml increment or reduction determined by the result of previous patient.

Objectives: The aim is to determine the minimum effective volume of local anesthetic by applying Dixon's up-and-down method needed to produce an effective supraclavicular brachial plexus block under ultrasound guidance in 50% patients (MEAV50) undergoing upper limb surgeries

Methods: Study involved forty patients of ASA I and II status undergoing upper limb surgery. First patient received the 30 ml of (1:1) mixture of local anesthetic including 0.5% bupivacaine and 2% lignocaine with adrenaline. The Dixon's up-and-down method design was applied to successive patients. From the data collected, minimum volume of local anaesthetic for effective block in 50% patient was calculated.

Results: In our study, the minimum effective local anesthetic volume in 50% of patients was 16.22 mL for a successful block (95% confidence interval, 14.95 and 15.47 mL).

Conclusion: To conclude from the present study, the minimum effective volume in 50% patients (MEAV50) for successful ultrasound guided supraclavicular brachial plexus block was 16.22. The calculated volume for 95% patients was 46.64ml.

Key words: supraclavicular brachial plexus block, ultrasound, Dixon's up-and-down method, local anaesthetic.

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INTRODUCTION

The success of the any peripheral nerve block majorly depends on the correct identification of anatomical structures and the administration of an optimal dose of a local anaesthetic around all the nerves supplying the desired surgical field it, to obtain a complete blockade. However, the risk of systemic toxicity increases with the use of large volumes of local anaesthetic, which is one of the main issues with regional anaesthesia. Systemic toxicity occurs less frequently than 0.2% but, can be fatal and difficult to treat. This dictates the reduction in the amount of local anaesthetic used for peripheral nerve block and perhaps reducing the direct neuronal and systemic damage of local anaesthetic toxicity.[4]

There is evidence from studies that ultrasound -guided blocks lead to ease in administration of block, precision in drug placement and faster onset which in turn provides safer and effective block with fewer consequences in comparison with non-ultrasound-based techniques, which depend on anatomical landmarks to place needle. The volume needed to produce an adequate block may be minimized with ultrasound guidance by direct visualization of local anaesthetic spreads around the nerves.[4]

Since ultrasound-guided supraclavicular brachial plexus block can anaesthetize all four distal upper extremity nerve regions (the median, radial, ulnar, and musculocutaneous) at the level of the clavicle, it is frequently employed for procedures on the upper extremities. Here the brachial plexus is relatively compact, and a small volume of local anesthetic produces rapid onset of a reliable blockade. [5]

However, the exact dose of local anesthetic required to block all the nerves involved in the brachial plexus is difficult to predict. The dosage of local anesthetics required widely depends on the age, weight, and associated comorbid conditions of the patients. There are very few studies in the literature on the dose of local anesthetic required for a successful brachial plexus block

Thus, the present study aims to determine the minimum dose of local anaesthetic for a successful ultrasound guided supraclavicular brachial plexus block in 50% of patients, undergoing upper limb surgeries using Dixon's up and down method to choose the dose of the local anesthetic drug.[9]

AIM AND OBJECTIVES OF THE STUDY

PRIMARY OJECTIVE:

1)The objective of this study is to determine the minimum effective volume of local anesthetic required to produce an effective supraclavicular brachial plexus block under ultrasound guidance in 50% patients (MEAV50) undergoing upper limb surgeries.

2) To study the side effects, if any, of the drugs.

REVIEW OF LITERATURE

In 1911, Kulenkampff introduced supraclavicular block as a regional anesthetic technique. It proved to be the alternative to general anesthesia in upper limb surgeries and was widely used for postoperative pain control. Attributing to its landmark approach led to complications like pneumothorax. This was the reason for its fall out. D'Souza RS et al in 2022 discussed the development in the practice of the supraclavicular block. Rightfully known as the "spinal of the arm," the supraclavicular block is gainful since the brachial plexus nerves are closely packed at this position which aids in achieving rapid onset of action. However, this also dictates considering restricted volumes of local anaesthetics to minimum since larger volumes can lead to compression ischemia.[5]

In 1978, La Grange described the use of the Doppler probe to identify arteries Kapral and colleagues advocated ultrasound guidance for needle placement in the supraclavicular brachial plexus block[5.] In 2010 J. Griffin et al reviewed various studies on use of ultrasound and its advantages over conventional techniques in regional anesthesia. They opined that the introduction of ultrasound has made regional anaesthesia more safe, efficient and cost effective. The real time introduction of needle, visualization of anatomical structures and accurate deposition of local anesthetic has made ultrasound the gold standard of regional anesthesia. The added advantages in post operative pain procedures and significant reduction in morbidity involved with blind techniques has led to its increased popularity in clinical practice. [6]

In a study performed by Duggan et al in 2009 included 20 patients who were posted for upper limb surgery, the minimum volume needed for supraclavicular block under ultrasound guidance was 23 mL in 50% of patients, and 42 ml in 95% of patients. They used the Dixon's method for administration of drug volume. Their volume interval was 5ml and minimum volume injected was 10ml which resulted in unsuccessful block. They concluded that no difference was found in the volume requirement of local anaesthetic for an effective supraclavicular block between ultrasound guided and non-ultrasound guided techniques.[1]

In 2014 Di Filippo, Falcini and Adembri in Italy reported a series of studies involving ultrasound guided blocks aiming to reduce local anaesthetic dose. They observed that while the results were widely divergent and inconclusive regarding effective local anaesthetic dose, it was possible to reduce the dose of anaesthetic when blocks were performed under ultrasound guidance.[6]

In a study conducted by Jadranka et al in 2015 concluded that the calculated minimum effective anaesthetic volume in 95% of patients was 16.49 mL (with 95% CI, 12.23-20.75 mL) in elderly age group and 44.52 mL (95% CI, 19.05-69.99 mL) in middle aged group (with95% CI, 0.7-55.3 mL, P=0.044). A ratio of potency of Local Anaesthetic between both the age groups was 2.69 (with 95% CI 2.13 to 3.44). In 95% of elderly individuals, the minimal volume required for an efficient ultrasound-guided supraclavicular block was decreased significantly.. Almost three times stronger local anaesthetic potency with a ratio of 2.69 was found in the elderly.[2]

in 2015 Jeong et al compared the drug volume required for lower limb blocks with nerve stimulator and under ultrasound guidance and observed a 42% decrease in the Minimum effective anaesthetic volume when femoral nerve blocks were performed under ultrasound guidance. They found the ED50 and ED95 for an ultrasound guided popliteal sciatic nerve block to be 6 and 16 ml, respectively, for 0.5% ropivacaine.[8]

Bang et al in 2016 reported a decreased in required volume of local anaesthetic of upto 71% when performing popliteal-sciatic nerve block under ultrasound guidance through subparaneural approach. The reduction in drug requirement was 14.7% with their approach compared to ultrasound guided perineural approach[3]

Johnston et al in 2017 compared the volume of local anaesthetic with the quadriceps strength. The volume of 0.5% ropivacaine required for 30% reduction in function of adductors was determined using the up and down method[9]. This study included 26 patients undergoing orthoscopic knee surgeries. They demonstrate that the volume required to produce a 30% reduction in quadriceps strength following adductor canal block in 50% of patients is 46.5 mL, and the calculated effective volume for 95% of subjects is 50.32 mL. In addition, they also assessed the pain score, sensory and motor blockade starting 20 minutes from block administration to 4 hours postoperatively.

Thitipan Sotthisopha et al in 2017 estimated MEAV90 in a study involving fifty-seven patients for USG guided costoclavicular block as 34ml. (95%CI of 33.4–34.4 mL). They positioned the needle in the costoclavicular space in the middle of the 3 cords of the brachial plexus and deposited the whole volume of drug. They used up and down method for drug assignment. They concluded with the need for further dose finding studies including various lignocaine concentrations and other local anaesthetics.[10]

Kavakli et al in 2018 studied USG guided retro clavicular brachial plexus block by infraclavicular approach to find the minimum effective volume required of bupivacaine0.5%. They observed the MEAV in 50% patients for successful block to be 9.6ml. the calculated MEAV in 95% patients with successful block was found to be 23.3ml. [11]

A single-center prospective controlled study was performed in 2021 by Necati Erdogmus et al where they performed USG guided axillary brachial plexus block using 0.5% bupivacaine (without additives). The study included a total of 55 patients belonging to ASA I-II who underwent hand surgery, starting with 21ml of drug for the first block every subsequent block was performed with the drug volume reduced by 0.5 ml for each of ulnar, median, radial nerve. Study parameters included Block administration time, block onset times, anesthesia times, and time to first analgesic requirement. They found the lowest required volume for each nerve to be 2.5ml.[12]

Deepak Hanumanthaiah et al reviewed the various methods of performing supraclavicular brachial plexus block with special emphasis on ultrasound guidance. They discussed about the growing interest in ultrasound guided supraclavicular blocks, focusing the advantages of ultrasound mainly easy imaging and its role in minimizing the complications associated with blind techniques.[13]

An experimental design in which the stimulus level for the next subject is based on the response of the previous subject is called a staircase design. Each observation is an all-or-none response to a test level of the stimulus. The most used sequential procedure was to use equal step sizes for the stimulus and to increase the stimulus one level if the previous subject did not respond and to reduce the stimulus one level if it did respond. This is called an up-and -down staircase design.[14]

BASIC SCIENCES

ANATOMY[19]

The brachial plexus is a somatic nerve plexus formed by the anterior rami of C5 to C8 and most of the anterior ramus of T1. The plexus originates in the neck, passes laterally and inferiorly over first rib, and enters the axilla. The parts of the brachial plexus, from medial to lateral, are roots, trunks, divisions, and cords. All major nerves that innervate the upper limb originate from the brachial plexus, mostly from the cords. Proximal parts of the brachial plexus are posterior to the subclavian artery in the neck, while more distal regions of the plexus surround the axillary artery

The **roots** of the brachial plexus are the anterior rami of C5 to C8 and most of T1. Close to their origin, the roots receive gray rami communicantes from the sympathetic trunk. These carry postganglionic sympathetic fibers onto the roots for distribution to the periphery. The roots and trunks enter the posterior triangle of the neck by passing between the anterior scalene and middle scalene muscles and lie superior and posterior to the subclavian artery.

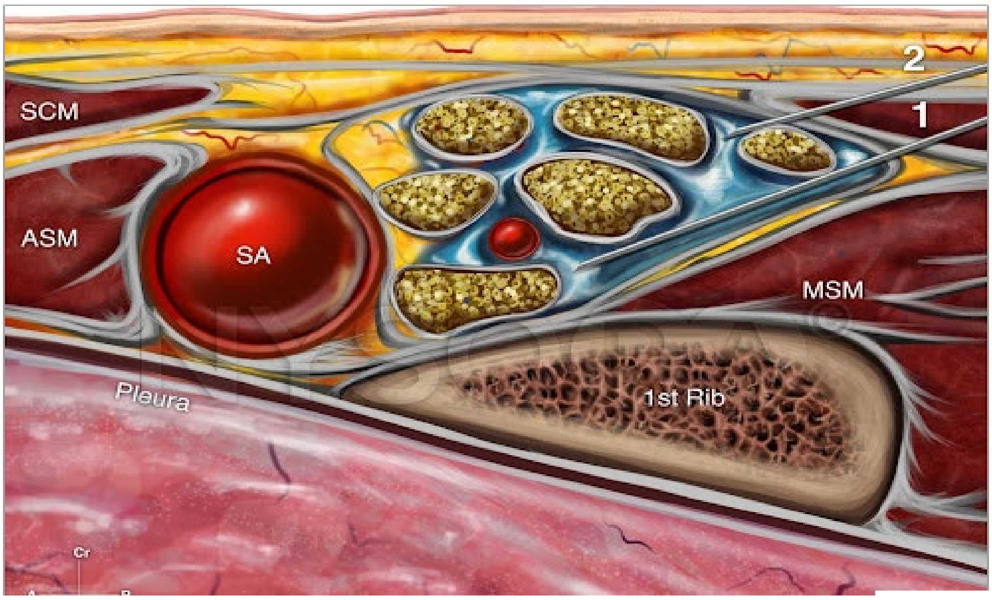


Figure 1 : relation of brachial plexus

BASIC SCIENCES

The three trunks of the brachial plexus originate from the roots, pass laterally over the first rib, and enter the axilla:

■ The superior trunk is formed by the union of C5 and C6 roots.

■ The middle trunk is a continuation of the C7 root.

■ The inferior trunk is formed by the union of the C8 and T1 roots.

The inferior trunk lies on the first rib posterior to the subclavian artery; the middle and superior trunks are superior in position.

Each of the three trunks of the brachial plexus divides into an anterior and a posterior division :

■ The three anterior divisions form parts of the brachial plexus that ultimately give rise to peripheral nerves associated with the anterior compartments of the arm and forearm.

■ The three posterior divisions combine to form parts of the brachial plexus that give rise to nerves associated with the posterior compartments.

The three cords of the brachial plexus originate from the divisions and are related to the second part of the axillary artery:

■ The lateral cord results from the union of the anterior divisions of the upper and middle trunks and therefore has contributions from C5 to C7—it is positioned lateral to the second part of the axillary artery.

■ The medial cord is medial to the second part of the axillary artery and is the continuation of the anterior division of the inferior trunk—it contains contributions from C8 and T1.

■ The posterior cord occurs posterior to the second part of the axillary artery and originates as the union of all three posterior divisions—it contains contributions from all roots of the brachial plexus (C5 to T1).

Branches of the roots:

In addition to small segmental branches from C5 to C8 to muscles of the neck and a contribution of C5 to the phrenic nerve, the roots of the brachial plexus give rise to the

- Dorsal scapular nerve
- Long thoracic nerve

Branches of the trunks:

The only branches from the trunks of the brachial plexus are two nerves that originate from the superior trunk (upper trunk):

- The suprascapular nerve
- The nerve to the subclavius muscle

Branches of the lateral cord:

Three nerves originate entirely or partly from the lateral cord.

■ The lateral pectoral nerve is the most proximal of the branches from the lateral cord.

■ The musculocutaneous nerve is a large terminal branch of the lateral cord.

■ The lateral root of the median nerve is the largest terminal branch of the lateral cord

Branches of the medial cord:

The medial cord has five branches.

■ The medial pectoral nerve is the most proximal branch.

■ The medial cutaneous nerve of the arm (medial brachial cutaneous nerve)

■ The medial cutaneous nerve of the forearm (medial antebrachial cutaneous nerve)

■ The medial root of the median nerve passes

■ The ulnar nerve is a large terminal branch of the medial cord.

Branches of the posterior cord:

Five nerves originate from the posterior cord of the brachial plexus:

■ The superior subscapular nerve

■ The thoracodorsal nerve

■ The inferior subscapular nerve

■ The axillary nerve

■ The radial nerve

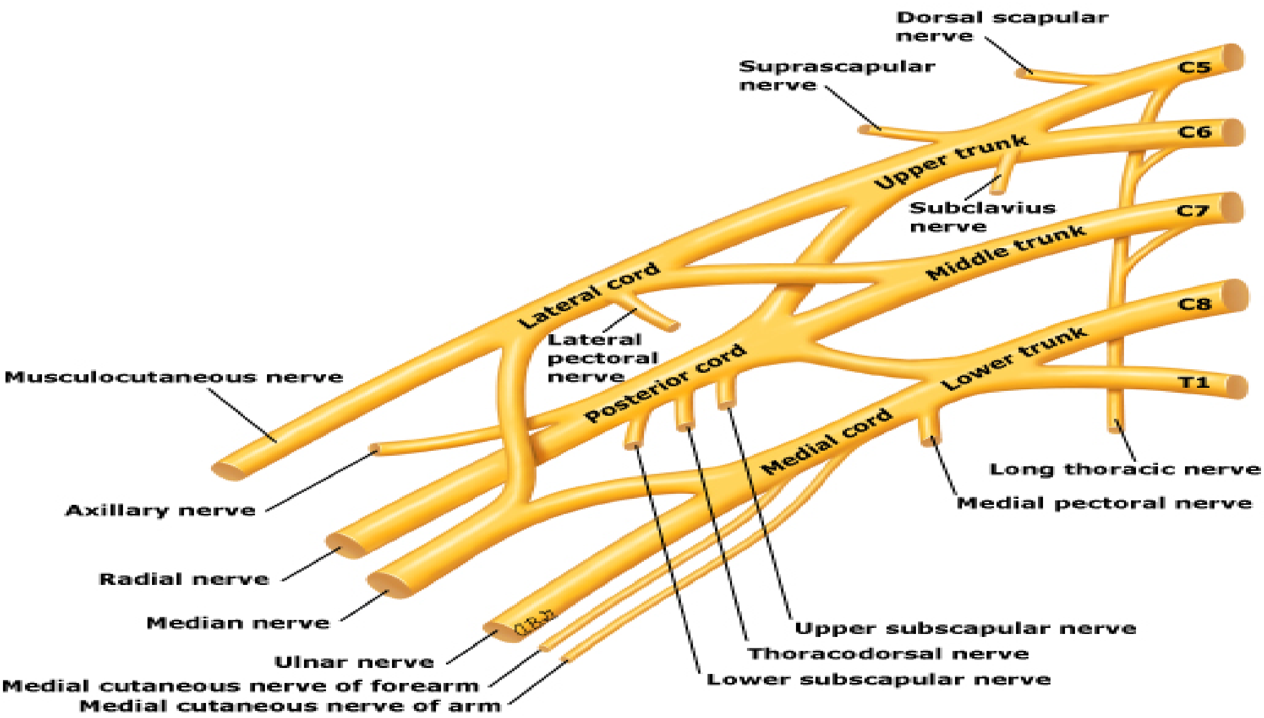


Figure 2 : brachial plexus

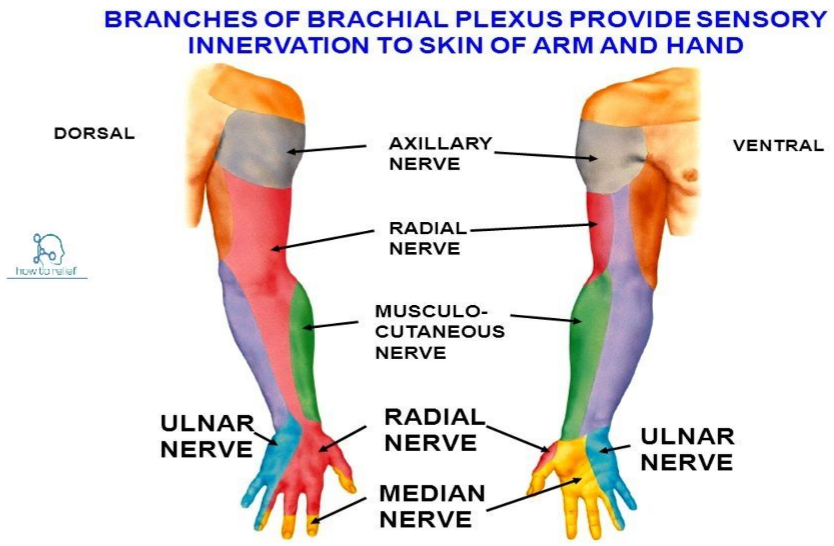


Figure 3

Dermatomes of the upper limb are often tested for sensation. Areas where the overlap of dermatomes is minimal include the:

■ Upper lateral region of the arm for spinal cord level C5

■ Palmar pad of the thumb for spinal cord level C6

■ Pad of the index finger for spinal cord level C7

■ Pad of the little finger for spinal cord level C8

■ Skin on the medial aspect of the elbow for spinal cord level T1.

Selected joint movements are used to test myotomes

■ Abduction of the arm at the glenohumeral joint is controlled predominantly by C5.

■ Flexion of the forearm at the elbow joint is controlled primarily by C6.

■ Extension of the forearm at the elbow joint is controlled mainly by C7.

■ Flexion of the fingers is controlled mainly by C8.

- Abduction and adduction of the index, middle, and ring fingers is controlled predominantly by T1.

ULTRASONOGRAPHY [21]

Ultrasound, is sound waves in a frequency range of around 2 to 15 megahertz has a wide range of diagnostic and treatment purposes in the field of medicine. Ultrasonography works on the principle of the Piezoelectric effect. This effect converts mechanical/kinetic energy into electrical energy by the deformation of crystals. The piezoelectric effect can also be reversed i.e., by electrical energy the crystals can be oscillated to form ultrasound waves (mechanical energy).

The ultrasound transducer has the function of producing the ultrasound by the above-said mechanism. This ultrasound produced travels through tissues and gets reflected. The returned echo waves after reaching the transducer get changed to electrical energy which is later processed and produce an image. The transducers work in a range of frequencies. Transducers with higher frequencies (5 – 7.5 MHz) are used in imaging superficial structures whereas the ones with lower frequencies (2.5 – 3.5 MHz) produce images of deeper structures.

It is on the surface that lies between tissues of varying density, that the ultrasound gets reflected. If the difference in densities is higher, the sound waves that get reflected are also high and the opposite also holds. Therefore, with a very high difference in densities (bones, air, calculi) the sound will be completely reflected. This produces acoustic shadowing. If the tissues are homogenous in their densities, then echo-free images are seen (blood, urine, ascites).

Transducer:

This is the handheld part of the ultrasound machine. It has the function of inter-converting the energies (electrical and mechanical) based on the piezoelectric effect. They contain lead zirconate titanate crystals commonly. They produce ultrasound waves in either linear(sequential) arrays or phased arrays.

It comprises 5 major components:

- Crystals: possessing piezoelectric property. Can be arranged in either a linear or curvilinear manner.
- Electrodes: positive and ground. For electrical connection
- Damping block: to dampen stray sound waves.
- Matching layer: one or multiple. For proper transmission of sound waves to the tissues.
- Housing.

Linear Transducer :

The piezoelectric crystals – Linearly arranged.

Produce rectangular ultrasound beam.

Used for superficial imaging.

Footprint – wide with a frequency of 2.5 – 12MHz at the center in the 2D imaging probe and frequency of 7.5 – 12 MHz at the center in the 3D imaging probe.

Applications:

- ❖ Vascular examination, venous puncture (catheterization)
- ❖ Breast imaging

- ❖ Thyroid imaging
- ❖ Tendons and joints
- ❖ During laparoscopic procedures
- ❖ Measuring body fat thickness
- ❖ Ultrasonic velocity change imaging

Figure 4: Linear USG probe

Curvilinear Transducer:

- The Piezoelectric crystals – curvilinear arrangement.
- They produce a convex ultrasound beam.
- Used to image deeper tissues.
- As the depth of imaging increases, image resolution decreases.
- A footprint is wide with central frequency being, 2.5 – 7.5MHz for 2D imaging and 3.5 – 6.5MHz for 3D imaging.
- Applications:
- ❖ Abdominal examinations,
- ❖ Transvaginal and transrectal examinations,
- ❖ Diagnosis of organs.

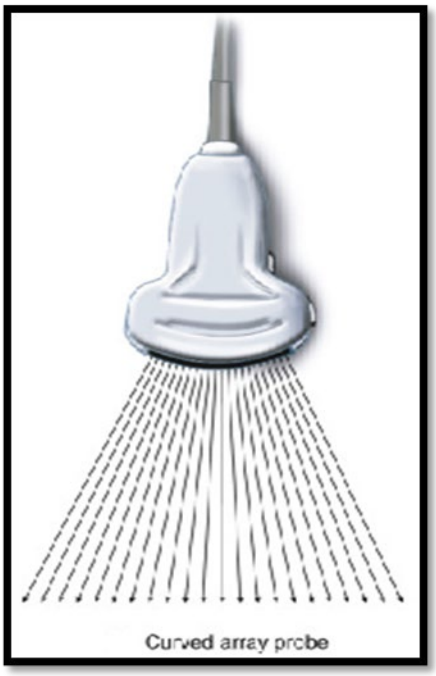


FIGURE 5: Curvilinear USG probe

SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK [22]

At this location, the proximity of the brachial plexus to the chest cavity and pleura had been of concern until ultrasound (US) guidance renewed interest in the supraclavicular approach to the brachial plexus block. The ability to image the plexus, rib, pleura, and subclavian artery with the US has increased safety due to improved monitoring of anatomy and needle placement. Because the trunks and divisions of the brachial plexus are relatively close as they pass over the first rib, the extension and quality of anesthesia are favorable. For these reasons, the supraclavicular block has become a commonly used technique for surgery of the upper limb distal to the shoulder.

SONOANANTOMY:

The subclavian artery crosses over the first rib between the insertions of the anterior and middle scalene muscles, posterior to the midpoint of the clavicle. The subclavian artery is readily apparent as an anechoic round structure, whereas the parietal pleura and the first rib can be seen as a linear hyperechoic structure immediately lateral and deep to the subclavian artery The rib casts an acoustic shadow so that the image field deep to the rib appears anechoic. The brachial plexus can be seen as a bundle of hypoechoic round nodules just posterior and superficial to the artery). It is often possible to see the fascial sheath of the muscles surrounding the brachial plexus. Adjusting the transducer orientation, the upper, middle, and lower trunks of the brachial plexus can be individually identified, as they join together at the costoclavicular space.

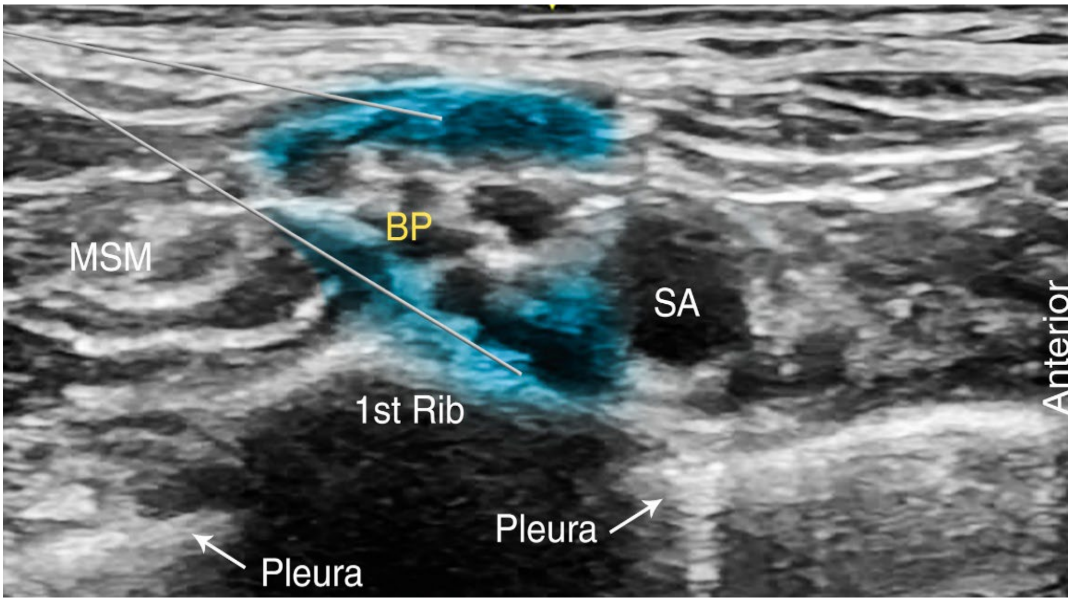


figure 5 : sonoanatomy of brachial plexus

To visualize the lower trunk, the transducer is oriented in the sagittal plane, until the first rib is seen deep to the plexus and the artery. Anterior or posterior to the first rib is the hyperechoic pleura, with lung tissue deep to it. This structure can be confirmed by observing a "sliding" motion of the visceral pleura in synchrony with the patient's respiration. The brachial plexus is typically visualized at a 1- to 2-cm depth at this location. The presence of two separate clusters of elements of the brachial plexus may be more or less obvious, sometimes with separation by a blood vessel. The dorsal scapular artery commonly passes through or within the vicinity of the brachial plexus. It is important to recognize that the more superficial and lateral branches come from C5–C7 (shoulder, lateral aspect of arm, and forearm) and can be tracked up to the interscalene area, whereas the deeper and more medial contingent are branches of C8 and T1 (hand and medial aspect of forearm). Adequate spread of local anesthetic in both areas is necessary for a successful block of the arm and hand

The equipment needed for a supraclavicular brachial plexus block includes the following:

- Ultrasound machine with linear transducer (8–18 MHz),
- sterile sleeve, and gel
- Standard nerve block tray
- 20–25 mL local anesthetic
- 5-cm, 22-gauge, short-bevel, insulated stimulating needle
- Sterile gloves

LANDMARKS AND PATIENT POSITIONING

Any position that allows for comfortable placement of the ultrasound transducer and needle advancement is appropriate. This block can be performed with the patient in the supine, Semi-sitting, or slight lateral position, with the patient's head, turned away from the side to be blocked. When possible, asking the patient to reach for the ipsilateral knee will depress the clavicle slightly and allow better access to the structures of the anterolateral neck. Knowledge of the underlying anatomy and the position of the brachial plexus in relation to the subclavian artery, first rib, and pleura is important for the success and safety of the technique. Scanning is usually started just above the clavicle, approximately at its midpoint.

With the patient in the proper position, the skin is disinfected and the transducer is positioned in the transverse plane immediately proximal to the clavicle, slightly posterior to its midpoint. The transducer is tilted caudally, as if to image the chest contents, to obtain a cross-sectional view of the subclavian artery.

The brachial plexus is seen as a collection of hypoechoic oval structures posterior and superficial to the artery. Color Doppler should be routinely used prior to needle insertion to rule out the passage of large vessels (ie, dorsal scapular artery, transverse cervical artery, suprascapular artery) in the anticipated trajectory of the needle.4 Using a 25- to 27-gauge needle, 1–2 mL of local anesthetic is injected into the skin 1 cm lateral to the transducer to decrease discomfort during needle insertion. To avoid inadvertent puncture of an injection into the brachial plexus, the needle should not be initially inserted deeper than 1 cm. The distribution of local anesthetic via small-volume injections is observed as the needle advances through tissue layers (hydro localization); small-volume injections are used to avoid inadvertent needle insertion into the brachial plexus. The block needle is then inserted in a plane toward the brachial plexus, in a lateral-to-medial direction. After careful aspiration, 1–2 mL of local anesthetic is injected to confirm the proper needle placement. When the injection displaces the brachial plexus away from the needle, an additional advancement of the needle 1–2 mm closer to the plexus may be required to accomplish adequate local anesthetic spread 'When the injection of local anesthetic does not appear to result in a spread around the brachial plexus, needle repositioning may be necessary. Typically, 20–25 mL of local anesthetic is required for adequate block.

LOCAL ANAESTHETICS:

Local anaesthetic drugs are water-soluble salts of lipid-soluble alkaloids. The structure of local anaesthetics consists of three components: a lipophilic aromatic group, an intermediary link and a hydrophilic amine group. The intermediary link categorises local anaesthetics into esters or amides

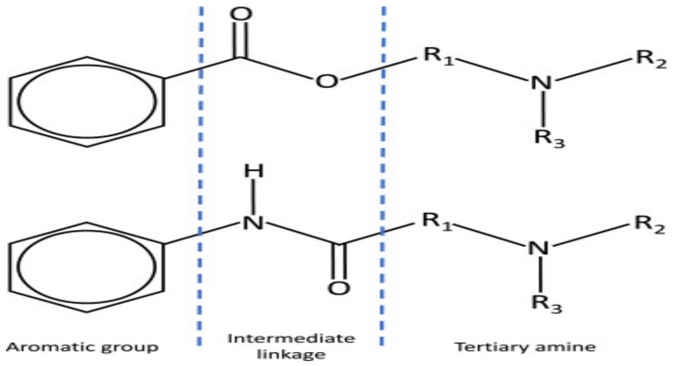


figure 7 : Molecular structure of local anesthetic

Mechanism Of Action Of Local Anesthetic

Local anesthetic agents suppress action potentials in excitable tissues by blocking voltage-gated Na channels. In doing so, they inhibit action potentials in nociceptive fibers and so block the transmission of pain impulses.

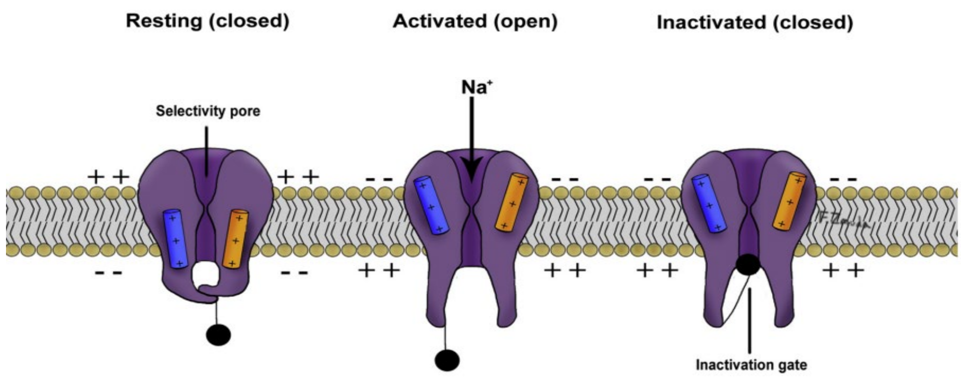


Figure 8 : Mechanism of action of local anaesthetics

Lipophilic, unionized local anaesthetic molecules cross the phospholipid neuronal membrane. The molecules dissociate to reach a new equilibrium of ionised and un-ionized moieties, dependent on the intracellular pH and the pKa of the local anesthetic. The ionized form binds to open voltage-gated Na. channels in a reversible and concentration-dependent manner. The binding site for local anaesthetics is located in domain IV, loop S6 and is only accessible when the channel is open. The binding of local anesthetics to open Na channels increases with the frequency of nerve depolarization.

Bound local anaesthetic drug stabilizes the inactivated receptor state, preventing further neuronal transmission. Local anaesthetic nerve block is concentration-dependent. With increased concentrations of local anaesthetic, the peak of the action potential is reduced, the firing threshold increases, impulse conduction is attenuated, and the refractory period is lengthened. Increased concentrations inhibit all nerve conduction

BUPIVACAINE[18]

First discovered in 1957,bupivacaine is a potent local anesthetic belonging to the amide group of local anesthetics. It is available in three different concentrations: 0.25%, 0.5%, and 0.75%.

Administration is by:

- Local infiltration (post-surgical analgesia)
- Peripheral nerve blocks
- Spinal anesthesia (injected into the CSF to produce anesthesia for orthopedic surgery, abdominal surgery, or cesarean delivery)
- Epidural anesthesia/analgesia for labor pain
- Caudal block (anesthesia and analgesia below the umbilicus, usually for pediatric surgery)

Bupivacaine exists in two enantiomers, which are mirror images of each other. Although structurally identical, enantiomers can exhibit clinical differences including potency and adverse effects. The discovery of a selective blockade of cardiac Na^+ channels by the dextro-enantiomer of bupivacaine led to the creation and widespread use of two levo-enantiomers: levobupivacaine and ropivacaine.

These exhibit lower potency at myocardial Na^+ and K^+ channels and have less effect on myocardial electrical conduction and contractility compared to bupivacaine.

Pka: The dissociation of amphipathic local anaesthetics is determined by their p*K*a and the pH of the tissue into which they are injected. The p*K*a is the pH at which the ionized and un-ionized forms are present in equal amounts.

Molecular weight:

The smaller the molecular weight, the more rapidly molecules diffuse through membranes.

Lipid solubility

Lipid solubility and potency are closely related. The lipid solubility of local anaesthetics is expressed as the partition coefficient, which is defined as the ratio of concentrations when local anaesthetic is dissolved in a mixture of lipid and aqueous solvents. Greater lipid solubility enables more rapid diffusion through lipid membranes to reach their site of action, influencing the speed of onset

	Structural classification	**MW**	**p*K*a**	**Protein binding (%)**	**Onset**	**Elimination half-life (min)**	**Maximum dose without vasoconstrictor (mg kg^{-1})**	**Maximum dose with vasoconstrictor (mg kg^{-1})**
Lidocaine	Amide	234	7.8	70	Fast	100	3	7*
Bupivacaine	Amide	288	8.1	95	Moderate	210	2	2

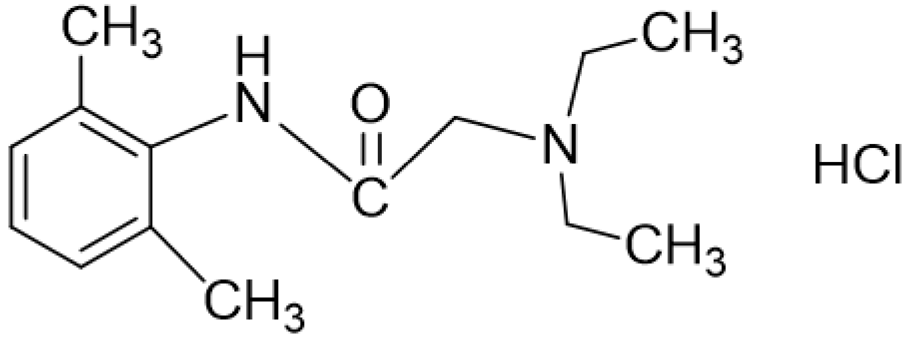
Effectiveness of bupivacaine is evaluated by toxicity to potency ratio , latency of onset degree of sympathetic, sensory and motor block duration of analgesia and regression time.

Both lidocaine and bupivacaine block cardiac Na^+ channels. However, bupivacaine binds with higher affinity and dissociates more slowly. This causes it to accumulate during diastole, prolong conduction and induce re-entry-induced arrhythmias.

Bupivacaine is mainly metabolized in the liver by N-dealkylation and glucuronide conjugation of the hydroxylated parent compound. Elimination is mainly via urinary excretion; however, some excretion of metabolites via the lungs and bile undoubtedly occurs. Very little unchanged drug is recovered in the urine. Bupivacaine is highly bound to nonalbumin plasma proteins. Protein binding contributes to a decreased fetal to maternal drug concentration ratio, which increases the safety of this agent in obstetrics.

LIGNOCAINE :

Lignocaine, 2-diethylaminoaceto-2',6'-xylidide (C14H22N2O), is a amide local anesthetic and a Class 1b antiarrhythmic agent according to the Vaughn Williams classification. A Class 1b antiarrhythmic agent binds to open sodium channels during phase 0 of the action potential, therefore blocking many of the channels when the action potential peaks. Lignocaine is a stable, crystalline, colorless solid whose hydrochloride salt is water soluble. Solutions for injection are available with or without adrenaline.[24]



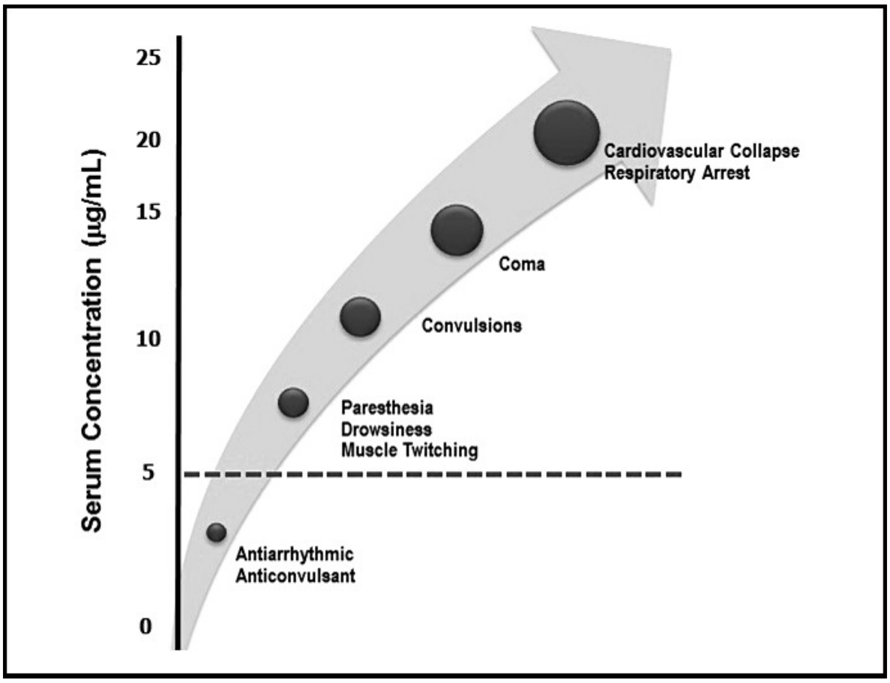
Chemical structure of Lidocaine hydrochloride[25]

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 fibers. 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 fibers. The PR interval, QRS and QT durations are not commonly affected by lignocaine. There is no evidence of any important interactions between lignocaine and the autonomic nervous system, thus lignocaine has minimal effect on autonomic tone.

Antioxidants and preservatives in lidocaine, such as metabisulfite and parabens, may trigger allergic or adverse reactions in some people. The most common allergic reaction is caused by the ester's metabolic product, *para*-aminobenzoic acid, as cross-reactivity between esters is common

TOXICITY[17,18]

Local anesthetic systemic toxicity (LAST) is a life-threatening adverse event associated with the increasingly prevalent utilization of local anesthetic (LA) techniques throughout various health care settings, with an incidence currently estimated to be 0.03%, or 0.27 episodes per 1,000 peripheral nerve blocks.



MATERIALS AND METHODS

The present study titled **"TO DETERMINE THE MINIMUM EFFECTIVE VOLUME OF LOCAL ANAESTHETIC IN 50% PATIENTS (MEAV50) USING DIXON'S UP-AND-DOWN METHOD FOR ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: ONE YEAR HOSPITAL BASED CLINICAL STUDY."**

Source of Data: patients of age group 20-60 years, of both gender, belonging to American Society of Anaesthesiologists (ASA) I and II posted for elective upper limb surgery at KLE Dr. Prabhakar Kore hospital and medical research centre, Nehru Nagar, Belagavi -10

Study Design: One year hospital based clinical study.

Study Period: January 2021 to December 2021

Sample Size: Based on prevalence rate of failed block, the formula for minimun sample size is

$$n = \frac{z_{\alpha}^{2} P(1-P)}{d^{2}}$$

Where P is the percentage of prevalence and d is the percentage likely difference in the prevalence

z_{α} is linked with the level of significance. For 5% level of the significance z_{α} = 1.96 .

With P = 95% and d = 10% of P = 9.5%, the calculated sample size was 20

The sample size was increased to 40 in order to strengthen the study's confirmatory power.[1]

The Inclusion Criteria were as follows:

- Patients with ASA PS I and II.
- Patients with Age 20 - 40 yrs.
- Patients undergoing elective upper limb surgeries under ultrasound guided Supraclavicular block.
- Patients who Provide Consent

The Exclusion Criteria were as follows:

- Patients undergoing emergency surgery.
- Patients who are unable to give consent.
- Patients with BMI of 35 KG/M2 and more.
- Patients with Infection
- Patients with Pre existing neurologic disease.
- Patients with Local anaesthetic allergy.
- Patients with Respiratory disease
- Patients with Coagulopathies
- Patients who do not fulfill inclusion criteria

Study protocol:

After the approval of Institution Review Board, ethical committee clearance and a written informed consent was obtained from the patients, forty patients who met criteria for exclusion and inclusion, posted for elective upper limb surgery receiving a supraclavicular brachial plexus block under ultrasound guidance were included in the study.

A through pre-anesthetic evaluation and routine investigations were done on the day before surgery. On the day of surgery, intravenous access was secured using 18G or 20 G iv cannula and iv fluids was started. Monitoring devices according to ASA standards were attached to the patient before induction of anaesthesia. These included non-invasive blood pressure, ECG and oxygen saturation. Under aseptic precautions, a preliminary scan was performed using Sonosite Ultrasound machine. A 13-6Hz linear probe was used to locate the brachial plexus. A 23-gauge needle was used to perform the block. Equal volume of injection 0.5% bupivacaine and 2% lidocaine with 1:200,000 adrenaline(ratio1:1) was administrated. An experienced anesthesiologist performed all the blocks.

- **Ultrasound Guided Supraclavicular Brachial plexus block technique**: The patient was placed supine on their back, their head turned to non operating side and the arm adducted against side of body during the supraclavicular block. The linear transducer was placed in the coronal or oblique plane just above the clavicle at the midpoint. The brachial plexus divisions and trunks clustered vertically over the first rib on the lateral side of subclavian artery was visualized. Once needle was position and negative aspiration confirmed, equal volume of the local anaesthetic was injected under sonographic view in small aliquots. The needle repositioning done under sonographic view to make sure sufficient spread of the drug around plexus. Spread of drug within the plexus and distribution into the divisions and trunks was visualized.

The first patient in the study was administered with a volume of 30 mL (ratio 1:1). The drug volume was administered using up and down method to subsequent patients. based on the response in last patient, after 30 mins of local anaesthetic injection.

Depending on whether the block in the preceding patient was successful or unsuccessful, the subsequent patients received an increase or decrease in 2 mL using Dixon’s up or down method. It was decided not to exceed maximal volume of 40 ml in order to prevent local anaesthetic toxicity. If the previous patient did not respond with the maximal volume (40 mL), the next subject also received 40 ml. The minimum effective volume required for the successful block in 50% of patients (MEAV50) was estimated from the data collected and then implement Probit regression analysis to estimate the ED95.

BOCK EVALUATION: Block evaluation was done every 5 mins for 30 mins after local anaesthetic injection. Sensory block was assessed for the musculocutaneous, median, radial, and ulnar nerves. Sensory block was evaluated on the lateral forearm, volar aspect of the thumb, lateral dorsum of the hand, and fifth finger volar aspect, in that order.[8]

A cold test with 3-point scale was used to grade the sensory block:

0- no block

1-analgesia (patient can feel touch, not cold)

2-anesthesia (patient cannot feel touch)

Motor blockade was assessed with a 3-point scale:

0 - no block

1 - paresis

2 - paralysis.

Motor block evaluation was done by flexion of elbow (musculocutaneous), abduction of thumb (radial), opposition of thumb (median), and adduction of thumb (ulnar). With the maximal score of 16 points. [8]

Vital parameters were recorded for all the patients.

The data obtained was tabulated as follows:

Subject	Surgical Procedure	Volume (ml)	Block Success (yes/no)	Rescue analgesia

STATISTICAL ANALYSIS:

For the continuous quantitative variables mean and standard deviation was calculated. The pre and post treatment measures were compared using student's paired 't' test.

Median was used to represent discrete variables.

Categorical data were represented using rates, ratios, and percentages.

In order to determine whether there is a correlation between the outcome, clinical, and demographic factors, the Chi-square test, test of proportion, or Fisher's exact test were utilized. Non-parametric tests were used for discrete variables.

Tools like ANOVA, correlation, regression etc., were used wherever suitable.

The value of p less than 5% (0.05) was deemed significant for all tests.

RESULTS

The study titled "To determine the minimum effective volume of local anaesthetic in 50% patients (MEAV50) using Dixon's up-and-down method for ultrasound guided supraclavicular brachial plexus block: One year hospital based clinical study" presented following results

The results were tabulated in Microsoft excel . Relevant graphs and tables were generated using word and Microsoft excel

TABLE 1: GENDER DISTRIBUTION

GENDER	NUMBER
FEMALE	07
MALE	33
TOTAL	40

GRAPH 1:

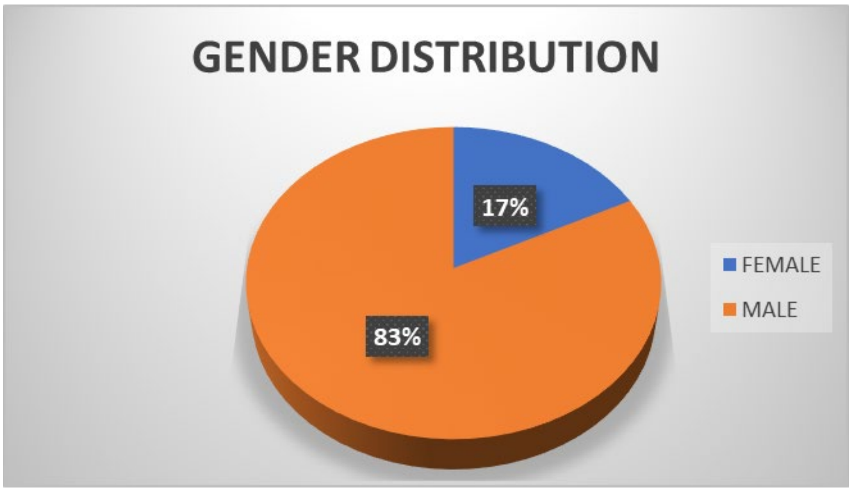


TABLE 2: AGE DISTRIBUTION

AGE	NUMBER
20 - 29	14
30 - 39	9
40 - 49	4
50 - 59	10
60 - 69	3
TOTAL	40

GRAPH 2:

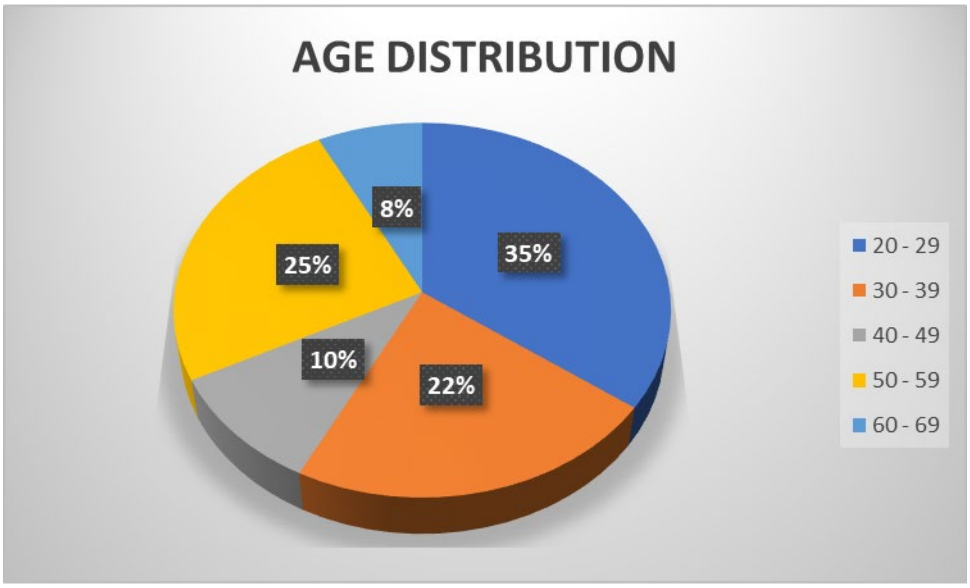


TABLE 3: AGE DISTRIBUTION

	NO SUCCESS		SUCCESS	
AGE	**NUMBER**	**%**	**NUMBER**	**%**
20 - 29	5	55.56	9	29.03
30 - 39	1	11.11	8	25.81
40 - 49	2	22.22	2	6.45
50 - 59	1	11.11	9	29.03
60 - 69	0	0.00	3	9.68
TOTAL	9	100.00	31	100.00

GRAPH 3:

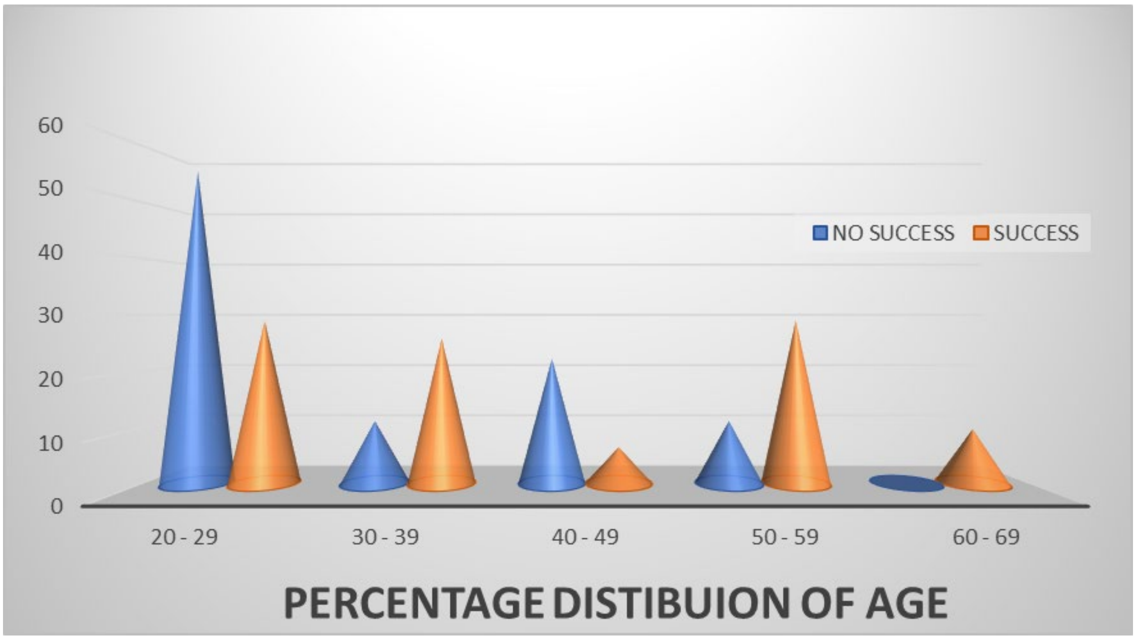


TABLE 4: DEMOGRAPHIC DISTRIBUTION

WEIGHT	NUMBER
50-59	7
60-69	14
70-79	13
80-89	4
90-100	2
TOTAL	4O

GRAPH 4:

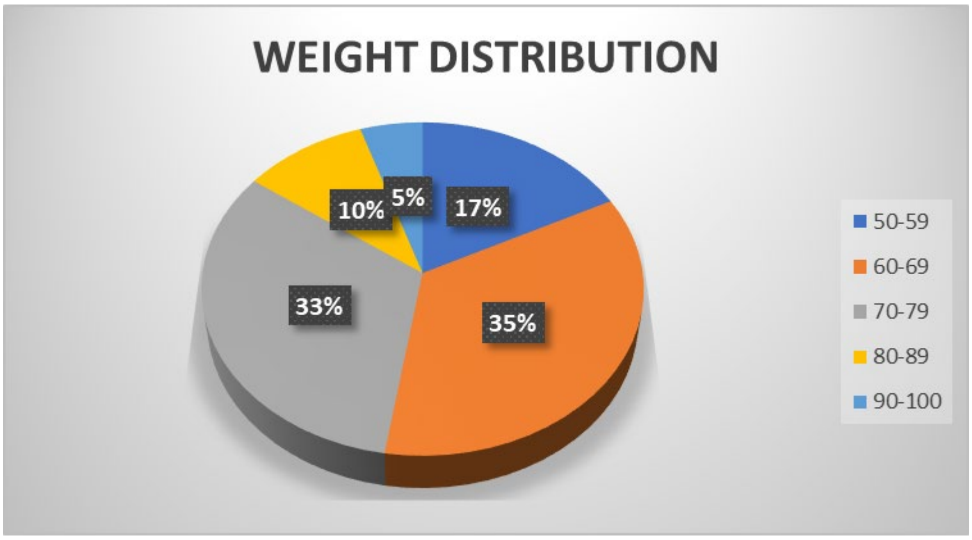


TABLE 5:

	MEAN	S.D.	MIN	MAX
VOLUME	**18.6**	5.7	6	30

Average volume used for performance of block was 18.6 ml with minimum volume of 6ml and 30ml maximum volume.

GRAPH 5:

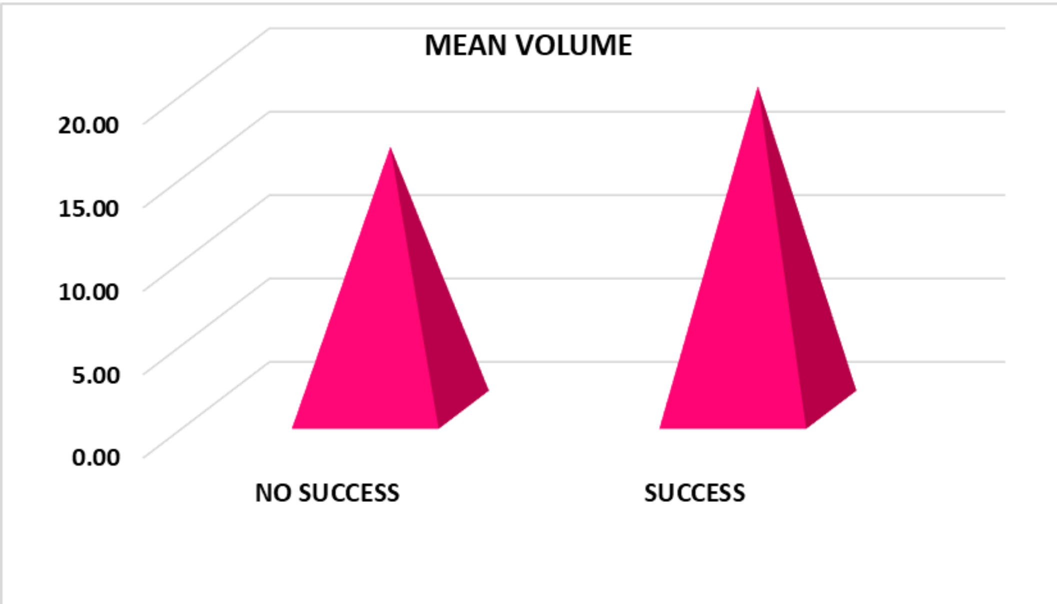


TABLE 6: MINIMUM EFFECTIVE VOLUME IN 50% PATIENTS

	MEAN	S.D.	MIN	MAX	MEAN	S.D.	MIN	MAX
VOLUME	15.78	5.24	6	24	**19.42**	5.59	8	30

Mean volume is 19.42ml with a standard deviation of 8ml and 30ml for a successful block. The 95% confidence interval for successful mean volume for success are 17.45ml and 21.39ml.

The minimum effective volume required is calculated using Dixon and Massey formula given by **"The mean volume + half of the volume interval"**

In the present study the minimum volume in 50% was 16.22 (95% confidence interval are 14.95-15.47 ml)

Using **Probit regression analysis,** the minimum effective volume for 95% of the population is 46.64 ml (95% CI 35.69-84.31 ml)

TABLE 7: STUDY PARAMETERS

SUBJECT NUMBER	VOLUME(ML)	SUCCESS(YES/NO)
1	30	yes
2	28	yes
3	26	yes
4	24	yes
5	22	yes
6	20	yes
7	18	no
8	20	yes
9	18	no
10	16	yes
11	14	yes
12	12	yes
13	10	yes
14	8	yes
15	6	no
16	12	no
17	14	Yes
18	16	Yes
19	12	no
20	16	no
21	20	yes
22	24	no
23	12	yes
24	12	yes
25	20	yes
26	20	no
27	22	yes
28	20	yes
29	18	yes
30	20	yes
31	18	yes
32	20	yes
33	28	yes
34	20	yes
35	18	yes
36	16	no
37	18	yes
38	28	yes
39	26	yes
40	22	yes

DISCUSSION

Supraclavicular approach is commonly used for brachial plexus block in upper limb surgeries. Supraclavicular approach to brachial plexus is superficial and has greater success rate in arm, forearm and hand surgeries. The Efficiency increases with the use of ultrasound guidance[13].

Various studies have proven that ultrasound guided blocks lead to quicker onset times and improve the quality of the block with lesser complications in comparison with other techniques of nerve localization which are non-ultrasound based, where needle placement is guided by anatomical landmarks[1].

Most complications observed are due to systemic toxicity which is related to higher volumes of local anesthetics used for the block leading to severe central nervous and cardiovascular systems. Modern regional anaesthetic practices mainly focus on reduction in dose and volume of local anesthetic which can result in prevention of such complications.

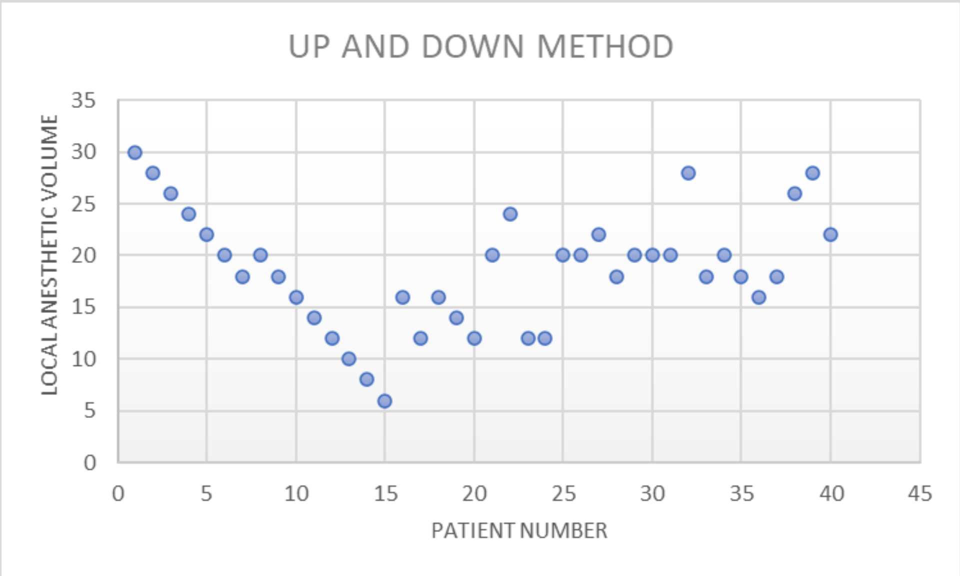
Our present study aims at determining the minimum effective of local anaesthetic volume required for a successful supraclavicular brachial plexus block for upper limb surgeries involving arm, forearm and hand.

In our study forty participants were included out of which 33 were male and 7 were females. The male to female ratio was 1: 0.21. The age group of the subjects included was 20 to 60 years , majority of subjects belong to 20 to 29 years age group.

In a study conducted by Duggan et al[1] , the minimum effective volume of local anaesthetic for 50% patients in ultrasound guided supraclavicular block was 23ml and in 95% patients it was 42ml. They stated that, the use of ultrasound for supraclavicular block did not help in reduction of the local anaesthetic volume requirement. In our study, the minimum effective local anesthetic volume for a successful block in 50% of patients was 16.22 mL (95% confidence interval, 14.95 and 15.47 mL). Out of forty patients, nine patients had unsuccessful block. These patients received supplemental local anesthetic or additional analgesics in the form of local infiltration or intravenous fentanyl. No patient required a general anesthesia. The least volume administered was 6 ml, which resulted in unsuccessful block and Least volume for a successful block was 8ml. The maximum volume administered for a successful block was 30 ml and that for an unsuccessful block was 24 ml. Among the successful blocks, mean volume required was 19.42 ml with a standard deviation of 5.59 ml while that for unsuccessful blocks the value was found to be 15.78 ml with standard deviation of 5.24 ml. Analyzing the data on the basis of Dixon-Massey formula and Probit Regression analysis, the minimum effective local anesthetic volume for a successful block in 50% of patients was found to be 16.22 mL (95% confidence interval, 14.95 and 15.47 mL) and effective volume in 95% of patients (ED_{95}) was calculated to be 46.64 ml (95% CI 35.69-84.31 ml).

For drug administration, we followed the corner pocket technique which involved deposition of drug in three to four small volumes , starting with corner pocket and moving on to other areas, reaching the desired volume as determined by the Dixon's up and down method as described previously. This technique yielded a higher number of successful blocks. Which is in contrast to study done by Deepak et al who reported ulnar sparing in a higher percentage of subjects.

A block failure mostly presented as ulnar sparing. This is associated with the inadequate infiltration of the corner pocket. Corner pocket is the area inferomedial to plexus, posterolateral to the subclavian artery and superior to the first rib.[15,16] It is believed that adequate deposition of local anaesthetic in this area gives a effective ulnar blockade, however, Deepak Hanumanthaiah et al in their study found an unsatisfactorily higher rate of



ulnar sparing with this approach.[13]

In our study the lowest volume of 8ml had a successful block. However in the our studies it was observed that the lower volumes resulted in shorter sensory and motor block duration . The volume of 8ml provided 2 hours of sensory and 2 hour 30 minutes of motor block. In a study done by Necati A. Erdogmus et al, to find the minimum volume for axillary brachial plexus block and its effect on sensory and motor blockade, they mention that regression time of block and the time required for administration of first analgesic was shortened with minimum volumes of local anesthetics.

From our study we conclude that lower volumes of local anaesthetic lead to reduced incidence of local anesthetic toxicity at the cost of duration of sensory and motor blockade.

Hence it is prudent to consider the type of surgery, duration of surgery and requirement of postoperative analgesia before determining the volume of the drug.

CONCLUSION

To conclude from the present study, the minimum effective volume in 50% patients (MEAV50) for ultrasound guided supraclavicular brachial plexus block was 16.22ml. The calculated volume for 95% patients was 46.64ml.

SUMMARY

The study titled "TO DETERMINE THE MINIMUM EFFECTIVE VOLUME OF LOCAL ANAESTHETIC IN 50% PATIENTS (MEAV50) USING DIXON'S UP-AND-DOWN METHOD FOR ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: ONE YEAR HOSPITAL BASED CLINICAL STUDY**".** was conducted.

In our study, 40 individuals who met our inclusion and exclusion criteria, undergoing upper limb surgeries belonging to ASA I and II were enrolled. The initial volume used was 30 ml while subsequent patients received 2 ml more or less based on the response of previous patient. Patients were injected with predetermined volume using Dixon's up and down method and success of block was noted. From the data obtained we concluded that in 50% of patients, the minimal effective anaesthetic volume for an ultrasound-guided supraclavicular brachial plexus block was 16.22 mL and for a successful block in 95% patients was 46.64ml.

While administrating lower volumes help in avoiding the local anesthetic toxicity, we must always consider the duration of action of block and various patient related factors like body mass index. Further multicentric studies with larger sample size and varied BMI might help in better understanding and implementation of study findings.

BIBLIOGRAPHY

1. Kavakli AS, Kavrut Ozturk N, Arslan U. Volume mínimo efetivo de bupivacaína a 0,5% para abordagem retroclavicular guiada por ultrassom no bloqueio do plexo braquial por via infraclavicular [Minimum effective volume of bupivacaine 0.5% for ultrasound-guided retroclavicular approach to infraclavicular brachial plexus block]. Rev Bras Anestesiol. 2019 May-Jun;69(3):253-258. Portuguese.

2. Johnston DF, Sondekoppam RV, Giffin R, Litchfield R, Ganapathy S. Determination of ED50 and ED95 of 0.5% Ropivacaine in Adductor Canal Block to Produce Quadriceps Weakness: A Dose-Finding Study. Reg Anesth Pain Med. 2017 Nov/Dec;42(6):731-736

3. Sotthisopha T, Elgueta MF, Samerchua A, Leurcharusmee P, Tiyaprasertkul W, Gordon A, Finlayson RJ, Tran DQ. Minimum Effective Volume of Lidocaine for Ultrasound-Guided Costoclavicular Block. Reg Anesth Pain Med. 2017 Sep/Oct;42(5):571-574.

4. Duggan E, El Beheiry H, Perlas A, Lupu M, Nuica A, Chan VW, BRULL R 2009 Minimum effective volume of local anesthetic for ultrasound-guided supraclavicular brachial plexus block. Reg Anesth Pain Med 34: 215–8

5. Pavicic Saric J, Vidjak V, Tomulic K, Zenko J 2013 Effects of age on minimum effective volume of local anesthetic for ultrasound-guided supraclavicular brachial plexus block. Acta Anaesthesiol Scand 57: 761–6

6. Di Filippo A, Falsini S, Adembri C. Minimum anesthetic volume in regional anesthesia by using ultrasound-guidance. Braz J Anesthesiol. 2016 Sep-Oct;66(5):499-504

7. Jeong JS, Shim JC, Jeong MA, Lee BC, Sung IH. Minimum effective anaesthetic volume of 0.5% ropivacaine for ultrasound-guided popliteal sciatic nerve block in patients undergoing foot and ankle surgery: determination of ED50 and ED95. Anaesth Intensive Care. 2015 Jan;43(1):92-7.

8. Tran DQ, Dugani S, Dyachenko A, Correa JA, Finlayson RJ. Minimum effective volume of lidocaine for ultrasound-guided infraclavicular block. Reg Anesth Pain

Med. 2011;36:190–194.

9. Bang SU, Kim DJ, Bae JH, Chung K, Kim Y. Minimum effective local anesthetic volume for surgical anesthesia by subparaneural, ultrasound-guided popliteal sciatic nerve block: A prospective dose-finding study. Medicine (Baltimore). 2016 Aug;95(34):e4652.
10. Erdogmus NA, Baskan S, Zengin M, Demirelli G. What Is the Minimum Effective Volume of Local Anaesthetic Applied in Brachial Plexus Blockage With an Axillary Approach Under Ultrasonography Guidance? Cureus. 2021 Aug 3;13(8):e16865. doi: 10.7759/cureus.16865. PMID: 34513440; PMCID: PMC8413900.
11. Hanumanthaiah D, Vaidiyanathan S, Garstka M, Szucs S, Iohom G. Ultrasound guided supraclavicular block. Med Ultrason. 2013 Sep;15(3):224-9. doi: 10.11152/mu.2013.2066.153.dh1mg2. PMID: 23979618.
12. Dixon WJ. Staircase bioassay: the up-and-down method. Neuroscience & Biobehavioral Reviews. 1991 Mar 1;15(1):47-50.
13. Soares LG, Brull R, Lai J, Chan VW. Eight ball, corner pocket the optimal needle position for ultrasound-guided supraclavicular block. Reg Anesth Pain Med. 2007;32:94Y95.
14. Fredrickson MJ, Patel A, Young S, Chinchanwala S. Speed of onset of corner pocket supraclavicular' and infraclavicular ultrasound guided brachial plexus block: a randomised observer-blinded comparison. Anaesthesia 2009; 64: 738-744
15. D'Souza RS, Johnson RL. Supraclavicular Block. [Updated 2022 May 1].In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan.
16. Babst CR, Gilling BN. Bupivacaine: a review. Anesth Prog. 1978 May-Jun;25(3):87-91. PMID: 373511; PMCID: PMC2516024.
17. El-Boghdadly K, Pawa A, Chin KJ. Local anesthetic systemic toxicity: current perspectives. Local Reg Anesth. 2018 Aug 8;11:35-44. doi: 10.2147/LRA.S154512. PMID: 30122981; PMCID: PMC6087022.
18. Mahajan A, Derian A. Local Anesthetic Toxicity. [Updated 2022 Oct 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-.

19. Griffin J, Nicholls B. Ultrasound in regional anaesthesia. Anaesthesia. 2010 Apr;65 Suppl 1:1-12. doi: 10.1111/j.1365-2044.2009.06200.x. PMID: 20377542.
20. Orebaugh SL, Williams BA. Brachial plexus anatomy: normal and variant. ScientificWorldJournal. 2009 Apr 28;9:300-12. doi: 10.1100/tsw.2009.39. PMID: 19412559; PMCID: PMC5823154.
21. Gray's anatomy for students 4th edition
22. Bushberg JT, Boone JM. *The Essential Physics of Medical Imaging*. Wolters Kluwer Health; 2011. https://books.google.co.uk/books?id=tqM8IG3f8bsC
23. Hadzic's textbook of regional anaesthesia and acute pain management 2ND edition
24. Weinberg L, Peake B, Tan C, Nikfarjam M. Pharmacokinetics and pharmacodynamics of lignocaine: A review. World J Anesthesiol 2015; 4(2): 17-29
25. Bahar E, Yoon H. Lidocaine: A Local Anesthetic, Its Adverse Effects and Management. Medicina (Kaunas). 2021 Jul 30;57(8):782. doi: 10.3390/medicina57080782. PMID: 34440986; PMCID: PMC8399637.

ANNEXURE I -INFORMED CONSENT FORM

"TO DETERMINE THE EFFECTIVE MINIMUM VOLUME OF LOCAL ANESTHETIC IN 50% PATIENTS (MEAV50) USING DIXON'S UP AND DOWN METHOD FOR ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: ONE YEAR HOSPITAL BASED CLINICAL STUDY"

Objective: To investigate correlation of body mass index (BMI) and changes in body positioning with the distance from the pleura to the brachial plexus.

Introduction: The aim of this study is to determine the minimum effective anesthetic volume required to produce an effective supraclavicular block for surgical anesthesia using an ultrasound guided technique in 50% patients (MEAV50)

Explanation of procedure: If you agree to enroll in my study, I will ask you present, past and family history. Then you will be clinically examined in detail. you will then be injected with a predetermined volume of a local anaesthetic agent under ultrasound guidance and observed for the results.

Withdrawal from participation in the study: Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You will/will not have nor get any benefits by participating in this study. The data gathered will help the population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

ANNEXURE

CONSENT STATEMENT

I am making a voluntary decision to participate in the study

"TO DETERMINE THE EFFECTIVE MINIMUM VOLUME OF LOCAL ANESTHETIC IN 50% PATIENTS (MEAV50) USING DIXON'S UP AND DOWN METHOD FOR ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: ONE YEAR HOSPITAL BASED CLINICAL STUDY"

My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator

ANNEXURE

ANNEXURE - II - PROFORMA

"TO DETERMINE THE MINIMUM EFFECTIVE VOLUME OF LOCAL ANAESTHETIC IN 50% PATIENTS (MEAV50) USING UP AND DOWN METHOD FOR ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK: ONE YEAR HOSPITAL BASED CLINICAL STUDY"

Volume allotted :

Name	:	Age	:
Gender	:	Weight	:
Height	:	Date of Examination	:
Address	:	Occupation	:

Pre examination evaluation

Past History

HTN ☐ DM ☐ IHD ☐ Arrhythmia ☐ Valvular heart diseases ☐

H/o previous surgery/(s) Yes ☐ No ☐

<u>General physical examination</u>

Weight (Kg)	:	Temperature (^{0}F)	:	Pallor	:
Cyanosis	:	Pedal edema	:	Clubbing	:
PR	:	BP	:	RR	:

Systemic examination:

RS	:	CNS	:
CVS	:	GIT	:

ANNEXURE

Preoperative Physical Status ASA Grade I ☐ II ☐ III ☐ IV ☐ V ☐

Subject	Surgical Procedure	Volume (ml)	Block Success (yes/no)	Rescue analgesia

ANNEXURE

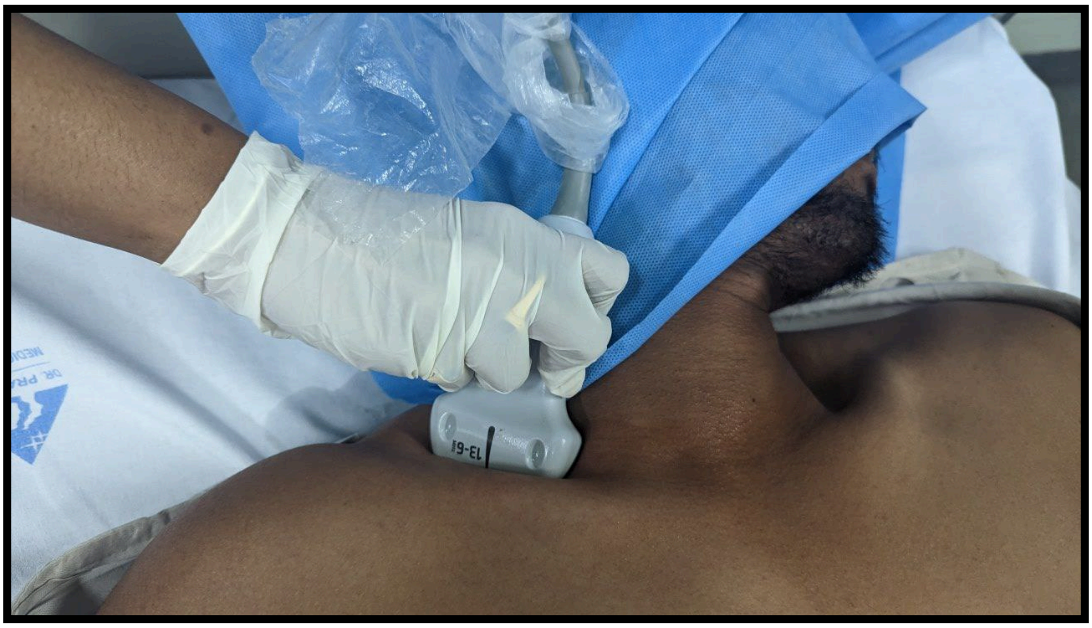
ANNEXURE - III - PHOTOGRAPHS

PHOTOGRAPH 1: USG machine with probe

PHOTOGRAPH 2: Linear ultrasound probe

ANNEXURE

PHOTOGRAPH 3: Brachial plexus



PHOTOGRAPH 4: Probe position

PHOTOGRAPH 5: Patient and USG machine Position

ANNEXURE IV: MASTER CHART

S.NO.	AGE (yrs)	SEX	WEIGHT(KG)	HEIGHT(CM)	BMI(Kg/m2)	ASA PS	VOLUME (ml)	SUCCESS
1	28	male	58	165	20.8	1	30	yes
2	56	male	69	167	24.7	2	28	yes
3	25	male	70	166	25.4	1	26	yes
4	21	male	68	165	25	1	24	yes
5	47	male	80	167	28.7	2	22	yes
6	36	male	68	167	24.4	1	20	yes
7	27	male	60	165	22	1	18	no
8	41	male	72	164	26.8	2	20	yes
9	28	male	62	162	23.6	1	18	no
10	50	male	85	164	31.6	2	16	yes
11	58	female	60	164	22.3	1	14	yes
12	20	male	58	167	20.8	1	12	yes
13	52	female	65	168	23	1	10	yes
14	32	male	70	158	28	1	8	yes
15	42	male	88	169	30.8	1	6	no
16	34	female	65	164	24.2	1	16	yes
17	52	male	78	168	27.6	2	12	no
18	32	male	60	165	22	1	16	no
19	21	male	58	162	22.1	1	14	yes
20	21	male	70	164	26	1	12	no
21	24	male	60	165	22	1	20	yes
22	24	male	70	159	27.7	1	24	no
23	54	female	70	160	27.3	1	12	yes
24	56	male	58	163	21.8	1	12	yes
25	20	female	52	164	19.3	1	20	yes
26	20	male	55	166	20	1	20	no
27	36	male	78	167	28	2	22	yes
28	36	male	80	168	28.3	1	18	yes
29	23	male	68	166	24.7	1	20	yes
30	40	male	70	167	25.1	1	20	yes
31	62	female	78	168	27.6	1	20	yes
32	55	male	92	165	33.8	2	28	yes
33	27	male	76	164	28.3	1	18	yes
34	33	male	74	168	26.2	1	20	yes
35	60	female	66	166	24	2	18	yes
36	59	male	70	164	26	1	16	no
37	52	male	58	164	21.6	1	18	yes
38	60	male	62	166	22.5	2	26	yes
39	39	male	94	167	33.7	1	28	yes
40	37	male	66	163	24.8	1	22	yes

ANNEXURE V: KEY TO MASTER CHART

KG	**-**	**Kilogram**
CM	**-**	**Centimeter**
Kg/m^2	**-**	**Kilogram per square meter**
Yrs	**-**	**Years**
Ml	**-**	**Milliliter**