A PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE THE EFFECTS OF ROPIVACAINE WITH BUPIVACAINE IN BRACHIAL PLEXUS BLOCK

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Dedicated to my guide, co-guides, family and well wishers

DECLARATION OF ORIGINALITY

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COMPLIANCE OF ACADEMICS

I do hereby declare that the thesis contain data and original research work by the undersigned candidate, as per my work on **"A PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE THE EFFECTS OF ROPIVACAINE WITH BUPIVACAINE IN BRACHIAL PLEXUS BLOCK".**

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This is to certify that I have personally worked on the research project entitled **"A PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE THE EFFECTS OF ROPIVACAINE WITH BUPIVACAINE IN BRACHIAL PLEXUS BLOCK".** The data mentioned in this report was obtained during the thesis period and the data included in this thesis is genuine and collected by me. None of the findings pertaining to work has been concealed. The results embodied in this project have not been submitted to any other university or institution for the award of my degree.

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CERTIFICATE OF APPROVAL

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TABLE OF CONTENTS

CHAPTER-1

INTRODUCTION

INTRODUCTION

The brachial plexus is a network of nerve fibres that supplies the skin and musculature of the upper limb. It begins in the root of the neck, passes through the axilla, and enters the upper arm. This plexus extends from the spinal cord, through the cervicoaxillary canal in the neck, over the first rib, and into the armpit. It supplies afferentand efferent nerve fibresto the chest, shoulder, arm and hand. It is a somatic nerve plexus formed by intercommunications among the ventral rami (roots) of the lower 4 cervical nerves (C5-C8) and the first thoracic nerve (T1). [1]

Anatomy of Brachial Plexus [2, 3]

The brachial plexus is divided into Roots, Trunks, Divisions, Cords, and Branches. There are five "terminal" branches and numerous other "pre-terminal" or "collateral" branches that leave the plexus at various points along its length. (Figure 1)

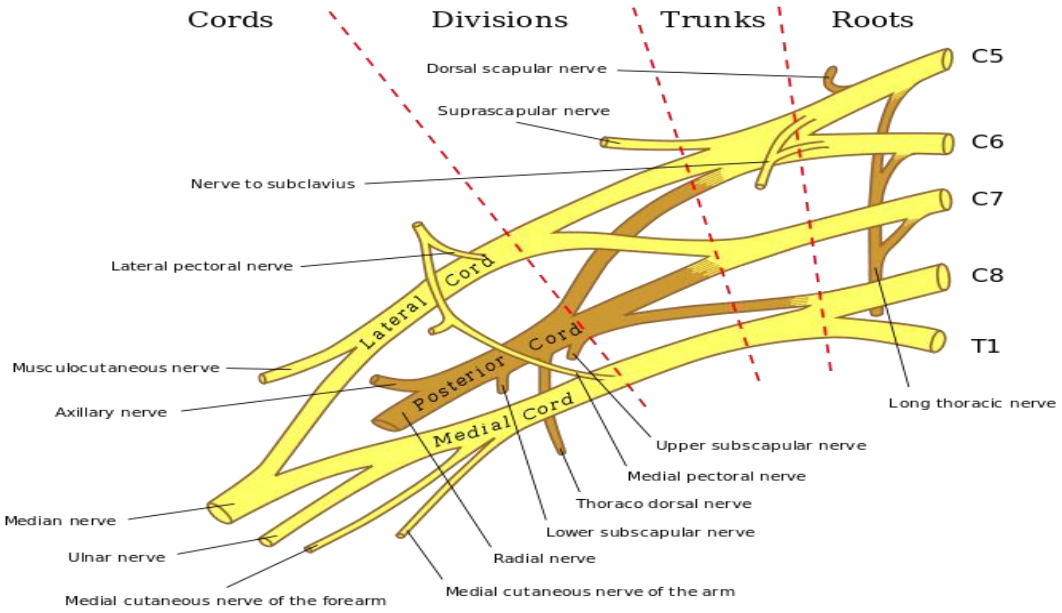

Figure 1 showing the anatomy of the brachial plexus

Roots

The 'roots' refer to the beginning of the brachial plexus. They are formed by the spinal nerves C5, C6, C7, C8 and T1. At each vertebral level, paired spinal nerves arise. They leave the spinal cord via the intervertebral foramina of the vertebral column. Each nerve then divides into anterior and posterior nerve fibres. The roots of the brachial plexus are formed by the anterior divisions of spinal nerves C5-T1 (the posterior divisions go on to innervate the skin and musculature of the trunk). After their formation, these nerves pass between the anterior and medial scalene muscles to enter the base of the neck (Figure2)

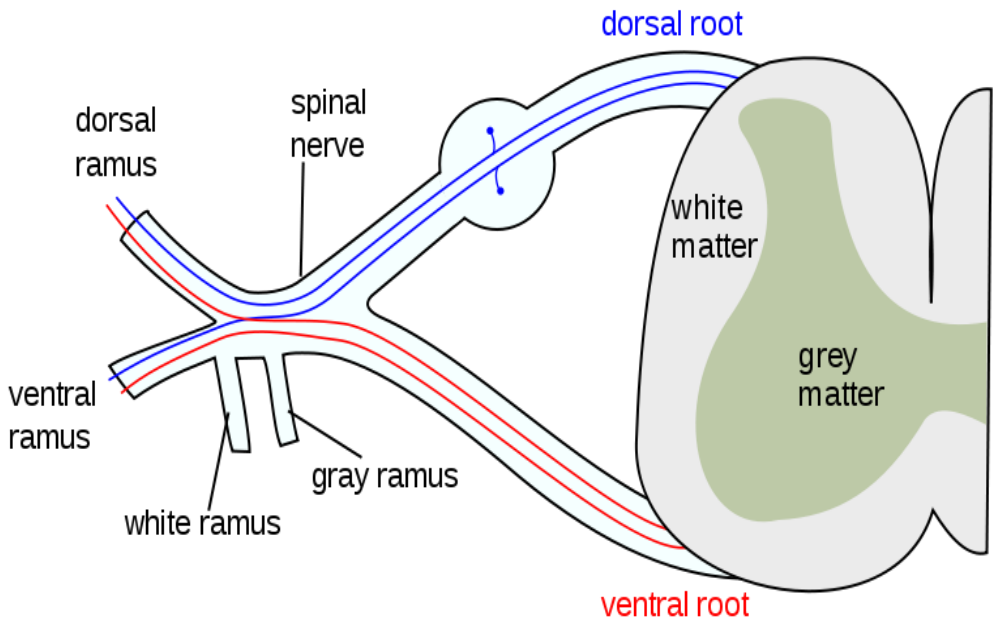

Figure 2 showing the roots of the brachial plexus

Trunks

At the base of the neck, the roots of the brachial plexus converge, forming three trunks. These structures are named by their anatomical position:

- **Superior trunk**: A combination of C5 and C6 roots.
- **Middle trunk:** A continuation of C7.
- **Inferior trunk:** A combination of C8 and T1roots.

The trunks begin to move laterally, crossing the posterior triangle of the neck.

Divisions

Within the posterior triangle of the neck, each trunk divides into two branches. One division travels **anteriorly** (toward the front of the body) and the other **posteriorly** (towards the back of the body). Thus, they are known as the anterior and posterior divisions.

There are three anterior and three posterior nerve fibers. These divisions leave the posterior triangle and pass into the axilla region. They recombine in the next part of the brachial plexus.

Cords

The anterior and posterior divisions after entering the axilla, combine together to form three nerves. These nerves are named by their position relative to the axillary **artery.**

The **lateral cord** is formed by:

- The anterior division of the superior trunk.
- The anterior division of the middle trunk.

The **posterior cord** is formed by:

- The posterior division of the superior trunk
- The posterior division of the middle trunk
- The posterior division of the inferior trunk

The **medial cord** is formed by

- The anterior division of the inferior trunk.

The cords give rise to the major branches of the brachial plexus (Figure 3).

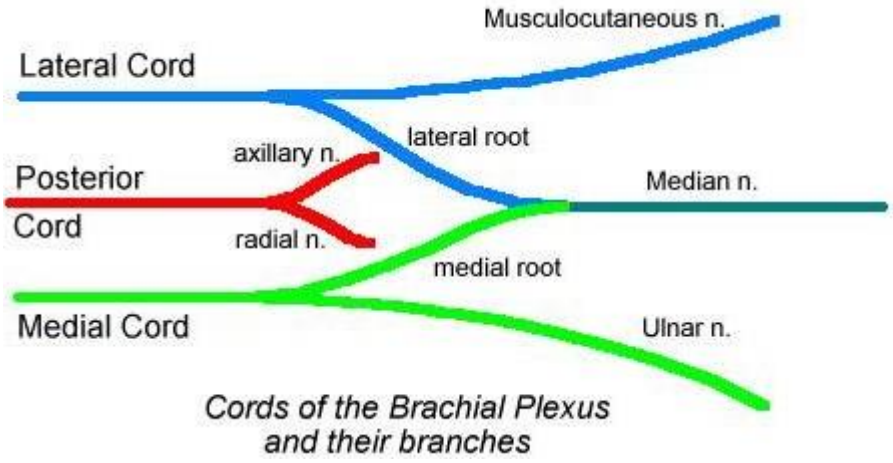

Figure 3 showing the major cords of the brachial plexus

Major Branches

In the axilla and the proximal aspect of the upper limb, the three cords give rise to five major branches. These nerves continue into the upper limb to provide innervation to the muscles and skin present. The five major nerves are as follows:

(i)MusculocutaneousNerve

***Roots*:** C5, C6, C7.

***Motor Functions*:** Innervates the brachialis, biceps brachii and coracobrachialis muscles.

***Sensory Functions*:** Gives off the lateral cutaneous branch of the forearm, which innervates the lateral half of the anterior forearm, and a small lateral portion of the posterior forearm.

(ii) AxillaryNerve

Roots: C5 andC6.

Motor Functions: Innervates the teresminor and deltoid muscles.

Sensory Functions: Gives off the superior lateral cutaneous nerve of arm, which innervates the inferior region of the deltoid ("regimental badgearea").

(iii) <u>Median Nerve</u>

Roots: C6 – T1. (Also contains fibres from C5 in some individuals).

***Motor Functions*:** Innervates most of the flexor muscles in the forearm, the thenar muscles, and the two lateral lumbricals that move the index and middle fingers.

Sensory Functions: Gives off the palmar cutaneous branch, which innervates the lateral part of the palm, and the digital cutaneous branch, which innervates the lateral three and a half fingers on the anterior (palmar) surface of the hand.

(iv)<u>Radial Nerve</u>

Roots: C5-C8 andT1.

Motor Functions: Innervates the triceps brachii, and the extensor muscles in the posterior compartment of the forearm.

Sensory Functions: Innervates the posterior aspect of the arm and forearm, and the posterior, lateral aspect of the hand.

(v) <u>Ulnar Nerve</u>

Roots: C8 andT1.

Motor Functions: Innervates the muscles of the hand (apart from the thenar muscles and two lateral lumbricals), flexor carpi ulnaris and medial half of flexor digitorum profundus.

Sensory Functions: Innervates the anterior and posterior surfaces of the medial one

and half fingers, and associated palm area.

Minor Branches

In addition to the five major branches of the brachial plexus, there are a number of smaller nerves that arise. They do so from all five parts of the brachial plexus.

Table 1 lists the smaller nerves arising from the brachial plexus. A summary of the anatomy of the entire brachial plexus is shown in Figure4.

Roots	**Trunks**	**Lateralcord**	**Medialcord**	**Posteriorcord**
Dorsal scapular nerve	Suprascapular nerve	Lateralpectoral nerve	Medialpectoral nerve	Superior subscapular nerve
Long thoracic nerve	Nerve to subclavius		Medial cutaneous nerve of arm Medial cutaneous nerve of forearm	Thoraco dorsal nerve Inferior subscapular nerve

Table 1 showing the smaller nerves arising from the brachial plexus.

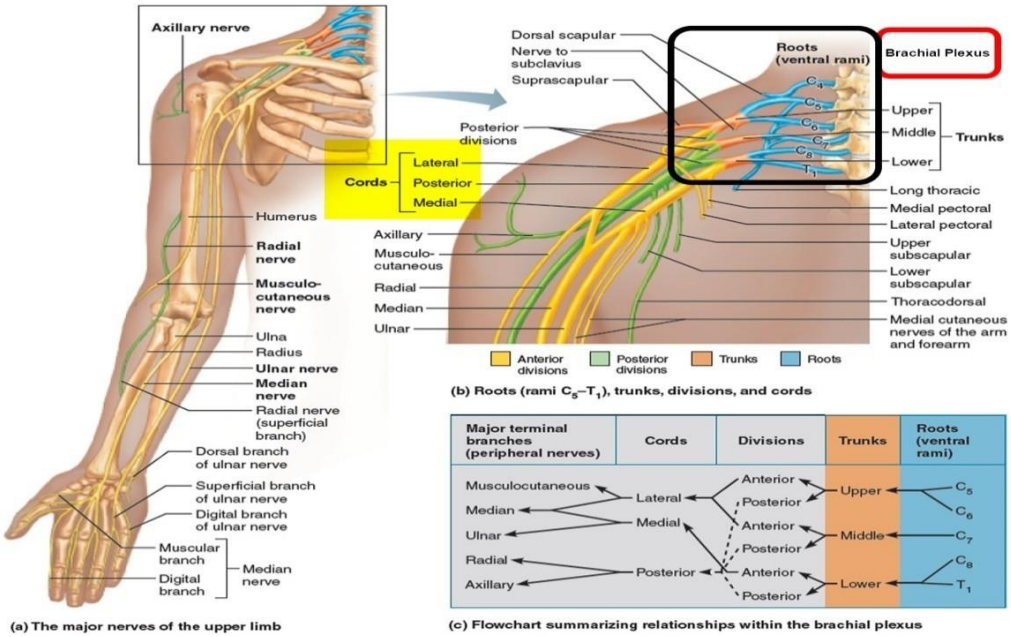

Figure 4 showing the summary of the anatomy of the entire brachial plexus

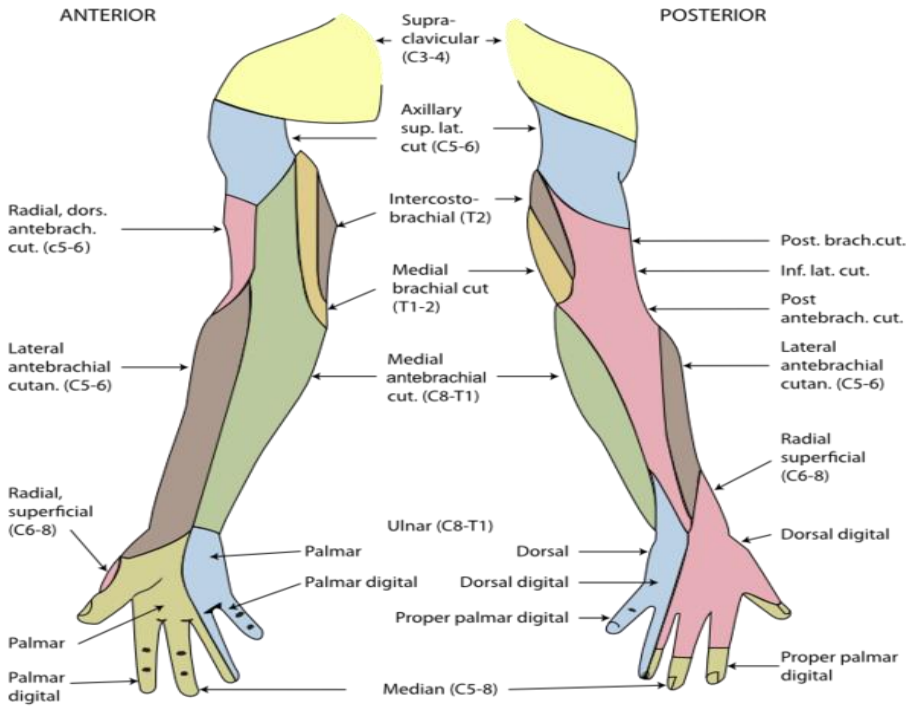

Figure 5 showing dermatome distribution in brachial plexus block.

What is Brachial Plexus Block [4]

Brachial plexus block is a **local anaesthesia technique** that is sometimes employed as an alternative or as an adjunct to general anaesthesia for surgery of the upper extremity. This technique involves the injection of local anaesthetic agents in close proximity to the brachial plexus, temporarily blocking the sensation and ability to move the upper extremity. The subject can remain awake during the ensuing surgical procedure, or she/he can be sedated or even fully anaesthetized if necessary. There are multiple approaches to blocking the brachial plexus which are dependent on the indication, patient habitus and anatomy, co-morbid conditions, and anatomy.

What is Local Anaesthesia

Local anaesthesia involves numbing an area of the body using a type of medication called a local anaesthetic. These medications can be used to treat painful conditions, prevent pain during a procedure or operation, or relieve pain after surgery. [5]

What are Local Anaesthetics

Local anaesthetic are drugs which when applied topically or injected locally, block nerve conduction and cause reversible loss of all sensations in the part supplied by the nerve. The order of blockage of nerve function proceeds in the following manner- pain, temperature, touch, pressure and finally skeletal-muscle power.[6]

Indications of local anesthesia

Local anesthesia is indicated when:

- Surgery is minor and does not require general or regional anesthesia.
- The procedure can be done quickly and the patient does not need to stay overnight.
- The operation does not need the muscles to be relaxed or the patient to be unconscious.

Advantages of Local Anaesthetics

Local anaesthetics are drugs that reversibly block the conduction of impulses in the peripheral nervous system. Local Anaesthetics may be combined for rapid onset of action (lignocaine or xylocaine) and prolonged duration of action (bupivacaine or ropivacaine). Local Anaesthetic toxicity of combination of drugs is additive rather than synergistic.[7]

Types of Brachial Plexus Block [8, 9]

The brachial plexus can be blocked at multiple sites for varying effect.

Familiarity with multiple approaches is essential to deal with variant patient anatomy and indications. The multiple sites of brachial plexus block are:

- Interscalene
- Supraclavicular
- Infraclavicular
- Axillary

Interscalene

Indications: provides analgesia or surgical anaesthesia to the shoulder capsule, proximal humerus, and clavicle.

Contraindications: pulmonary disease, heart disease, cellulitis/abscess over the site of injection, patient refusal, allergy to the local anaesthetic. Morbid obesity may be a relative contraindication as respiratory insufficiency can result from hemi-diaphragmatic paralysis.

Supraclavicular

Indications: analgesia or surgical anesthesia of the upper limb from the mid humerus to the fingertips.

Contraindications: cellulitis/abscess over the site of injection. Patients with poor pulmonary reserve need special attention.

Infraclavicular

Indications: analgesia or surgical anaesthesia of the upper limb from the mid humerus to the fingertips. This block typically spares the intercostobrachial nerve.

Contraindications: cellulitis/abscess over the site of injection.

Axillary

Indications: analgesia or surgical anaesthesia of the upper limb from mid humerus to the fingertips. This block also spares the intercostobrachial nerve, although it is blocked easily.

Contraindications: cellulitis/abscess over the site of injection, inability to visualize a clear needle path through the highly vascularregion.

Among these approaches, the supraclavicular approach is associated with a rapid onset of anaesthesia and a high success rate. The various approaches to a brachial plexus block are shown in Figure 6.

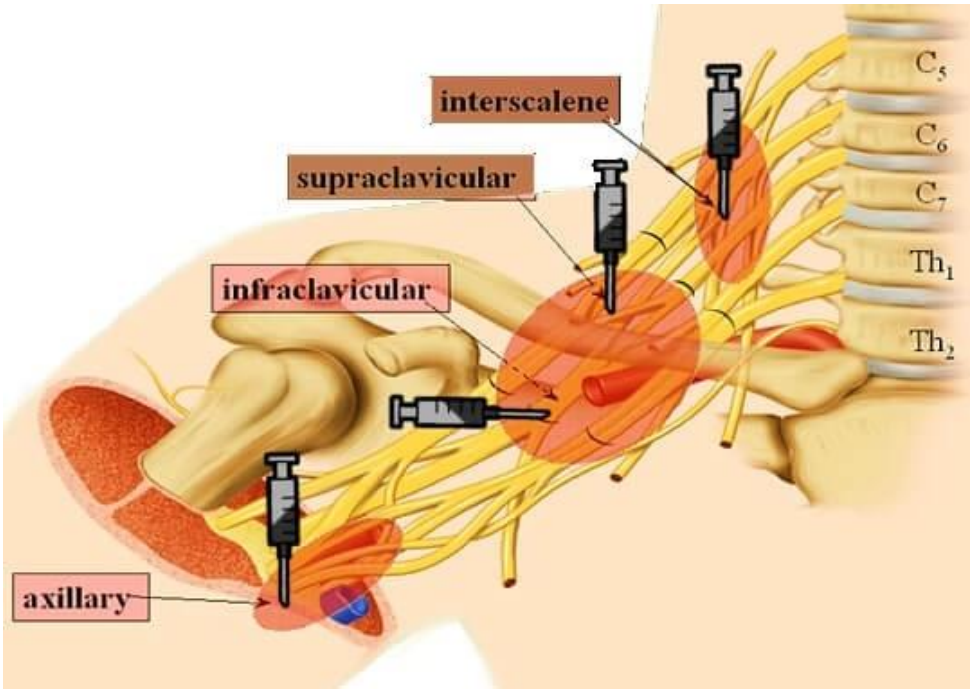

Figure 6 showing the various approaches to a brachial plexus block

Common Local Anaesthetics used in Brachial PlexusBlock

The commonly used local anaesthetics in brachial plexus block are Lignocaine or Xylocaine, Bupivacaine, Ropivacaine. Their mechanisms of action are shown in Figure 7a and 7b [6].

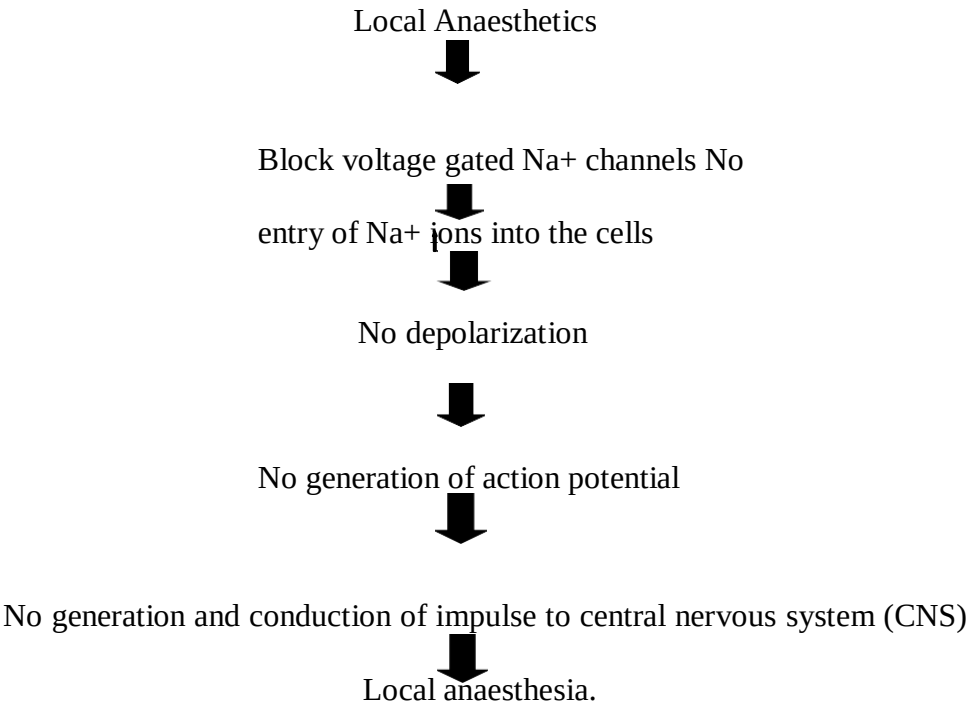

Figure 7a showing the mechanism of action of regional anaesthetics

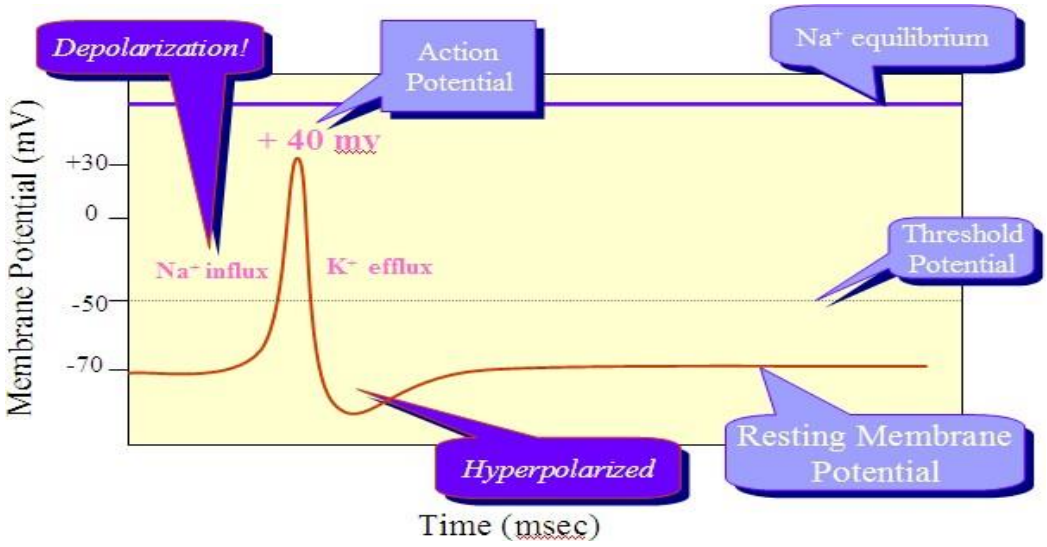

Figure 7b showing the mechanism of action of regional anaesthetics

Lignocaine [9-16]

Lignocaine **is** a synthetic organic compound used in medicine, usually in the form of its hydrochloride salt, as a regional anaesthetic. Lignocaine produces prompter, more intense, and longer lasting anaesthesia than does procaine (Novocaine). It is widely used for infiltration, nerve-block, and spinal anaesthesia in a 0.5 to 2 percent aqueous or saline solution and is also applied to mucous membranes (2 to 4 percent) for mucosal anaesthesia. It's main use in the prevention of ventricular arrhythmias. It is now used with other anaesthetics agents like Ropivacaine and Bupivacaine for prolongation of the duration of action.

Ropivacaine [9-16]

The enantiomerically pure (S-enantiomer) amide regional anaesthetic drug ropivacaine has been shown to block nerve fibres responsible for transmission of pain (Aδ and fibres) more completely than those that control motor function (Aβ fibres) in in-vitro studies. The

drug shares the biphasic vascular effects common to the amide regional anaesthetic drug class. In vitro studies indicate that ropivacaine is less cardio toxic than equimolar concentrations of Bupivacaine. Adverse events associated with epidurally administered ropivacaine include hypotension, nausea, bradycardia, transient paraesthesia, back pain, urinary retention and fever. Ropivacaine is used as a local (in only one area) anesthesia for spinal block, also called an epidural block. The medication is used to provide anesthesia during a surgery or C-section, or to ease labor pains. The drug also induces profound blockade of other animal nerves in vitro. Small volumes of ropivacaine injected intradermally have a vasoconstrictive effect. Similarly,in human tissues *in-vitro*,low concentrations of ropivacaine induce vasoconstriction; however, due to the biphasic vascular effects of amide regional anaesthetic drugs, this effect can be reversed at higher concentrations.

Studies indicate that intravenous infusion of ropivacaine 50mg over a 15-minute period produced a mean maximum plasma concentration (Cmax) of 1.5 mg/L. The mean volume of distribution of unbound drug (6%) was 742L, plasma clearance was 0.5 L/h and the terminal elimination half-life was 1.85 hours. In patients undergoing orthopaedic surgery, epidural injection of ropivacaine 100, 150 or 200 mg produced Cmax values of 0.53, 1.07 and 1.53 mg/L, respectively after 96 (100mg) or 40 (150 or 200mg) minutes (tmax). Mean residence time was inversely proportional to the dose but the area under the plasma concentration versus time curve was not dose- dependent [13]. Similar trends were observed in patients undergoing other types of surgery including hysterectomy, hernia repair or varicose vein stripping. Continuous infusion of ropivacaine over a 21-hour period was associated with a continuous increase in plasma concentration. Compared with data from bolus dose studies, the apparent plasma clearance of the drug was higher and the half-life shorter[13].

Bupivacaine[9-16]

Bupivacaine belongs to the amide family, and its structure is similar to that of lidocaine. Bupivacaine is a potent agent capable of producing prolonged anaesthesia. Its long duration of action plus its tendency to provide more sensory than motor block has made it a popular drug for providing prolonged analgesia during labor or during the postoperative period. Bupivacaine, like lidocaine, can be used for infiltration anaesthesia. Elevated serum levels of bupivacaine can lead to cardiac toxicity. Clinically,this manifests as severe ventricular arrhythmias and myocardial depression.

Both lidocaine and bupivacaine rapidly block cardiac sodium channels during systole; however, bupivacaine dissociates much more slowly than lidocaine during diastole. Hence, a significant fraction of the sodium channels remain blocked with bupivacaine at the end of diastole. The cardiac toxicity caused by bupivacaine may also be partially mediated centrally, because the direct injection of small quantities of bupivacaine into the medulla can produce malignant ventricular arrhythmias. The treatment of bupivacaine induced cardiac toxicity is difficult, particularly in the presence of coexisting acidosis, hypercarbia, and hypoxemia. Other common sideeffects of bupivacaine include anxiety, back pain, blurred vision, apprehension, confusion /disorientation, convulsions (seizures), drowsiness, dizziness, high blood pressure, metallic taste, nausea, headache, constricted pupil, respiratory arrest, vomiting.

Bupivacaine's duration of action (2 to 5 hr) is longer than lidocaine's as is its onset of action (5 to 20 min). It is commonly used in concentrations of 0.125% to 0.75%. Final concentrations are often diluted by 30% to 50% by the addition of a corticosteroid. The

higher concentrations generally have a faster onset of action. Bupivacaine has a slow onset but long duration of action. It binds to plasma proteins and has a plasma half – life of 1.5 – 5.5 hours. Bupivacaine is largely metabolized in the liver.

Bupivacaine 0.25% and 0.5% solutions are used for the production of local anaesthesia by percutaneous infiltration, peripheral nerve block (s) and central neural block (caudal or epidural), that is, for specialist use in areas where prolonged anaesthesia is indicated. Bupivacaine without adrenaline may also be used for intradural spinal anaesthesia. Bupivacaine is particularly useful for pain relief e.g. during labour, as its sensory nerve block is more marked than its motor block. Bupivacaine rarely causes allergic reactions: about <1%. Bupivacaine has been used for all the types of nerve blocks, lumbar and caudal epidurals, paracervical blocks and intravenous regional analgesia.

Comparison between Ropivacaine and Bupivacaine

Trials comparing Ropivacaine and Bupivacaine shows that Ropivacaine is less cardiac toxic than Bupivacaine. Currently both Ropivacaine and Bupivacaine are used as local anaesthetics for brachial plexus block[14].

Overall, direct comparisons show that epidural ropivacaine is less potent than epidural bupivacaine when the two drugs are administered at the same concentration. However, this difference is less marked in terms of sensory blockade than motor blockade[14]. The greater degree of separation between motor and sensory blockade seen with ropivacaine relative to bupivacaine is more apparent at the lower end of the dosage scale[14]. Nevertheless, higher doses of ropivacaine than bupivacaine are generally required to elicit equivalent anaesthetic effects. Limited data indicate that

continuous epidural infusion of ropivacaine post-operatively reduces postsurgical pain in a dose-related manner. Morphine consumption is also reduced[15]. Higher doses of ropivacaine are significantly more effective than placebo. Similarly, ropivacaine controlled postsurgical pain when infiltrated directly into surgical wound sites (i.e. wound infiltration) was as effective as bupivacaine, and more effective than placebo, in this regard [15]. Compared with bupivacaine, ropivacaine has a significantly shorter elimination half-life(≈5*vs*≈10hours)but is cleared at a similar rate (apparent plasma clearance ≈18 L/h) [16]. Bupivacaine is frequently used as the local anaesthetic for brachial plexus anaesthesia because it offers the advantage of providing a long duration of action and a favourable ratio of sensory to motor neural block [10,11]. Ropivacaine on the other hand has a improved safety profile and is less lipophilic compared to Bupivacaine.[15] Numerous comparative studies between ropivacaine and bupivacaine suggested that ropivacaine produces less cardiac as well as central nervous system toxic effects, less motor block and a similar duration of action of sensory analgesia as bupivacaine [17,18]. More recently, a double-blind comparison of 0.5% ropivacaine with 0.5% bupivacaine demonstrated the two drugs to be similar in terms of both onset and duration of sensory and motor block and in terms of the incidence of analgesia, anaesthesia, paresis, and paralysis. [19-21]. Ropivacaine is chemically similar to Bupivacaine, the butyl group being replaced by a propyl group. Ropivacaine shows greater selectivity for the sensory blockade and a lower systemic toxicity as compared to Bupivacaine[7].

When clinically effective doses and concentrations are used, there are no clinically relevant differences in the comparative efficacy of Ropivacaine and

Bupivacaine. [22,23]. With a mean dose of Ropivacaine shows maximum tolerable central nervous system (CNS) effect, maximum tolerated total venous plasma

concentration and higher arterial unbound plasma concentration of Ropivacaine when compared to Bupivacaine. Both Bupivacaine and Ropivacaine can be used for all types of nerve blocks, epidural, spinal anesthesia, infiltration of field block, acute pain management. They can cause minimal side effects which are depending on plasma concentration of drug, such as numbness of tongue and circumoral tissues, restlessness, tinnitus, vertigo, slurred speech, seizures, hypotension,cardiac arrhythmias, cardiac arrest, hepatotoxicity [24]. Table 2 shows the comparison of different regional anaesthetics, their maximum dose and duration of action.

Esters	Max Dose (mg/kg)	Duration (h)
Chloroprocaine	12	0.5 – 1
Procaine	12	0.5 – 1
Cocaine	3	0.5 – 1
Tetracaine	3	1.5 – 6

Amides	Max Dose (mg/kg)	Duration (h)
Lidocaine	4.5/(7 with epi)	0.75 – 1.5
Mepivacaine	4.5/(7 with epi)	1 – 2
Prilocaine	8	0.5 – 1
Bupivacaine	3	1.5 – 8
Ropivacaine	3	1.5 – 8

Table 2 showing the comparison of different local anaesthetics, their maximum dose and duration of action.

Brachial plexus block has a long history existing till date, providing surgical anaesthesia and postoperative analgesia [9]. The brachial blocks usually employed in upper limb surgery such as soft tissue surgery, bone surgery, and in plastic surgery has the advantage of that it is simple, easy to learn and practice without any untoward effects of general anesthesia agents. It can also be employed in patients with a systemic diseases where general anesthesia is hazardous. It is used in prolonged duration of surgery by a continuous infusion technique. It gives prolonged duration of post-operative analgesia [25]. Recently peripheral nerve block anaesthesia has become popular

against general anaesthesia as it is devoid of intubation and muscle relaxants and systemic haemodynamic changes. This type of anaesthesia is particularly advantageous in case of prolonged orthopedic, plastic reconstructive surgeries and in emergency surgeries where the patients are full stomach, not adequately starving and in high risk patients. This technique not only provides anaesthesia but also postoperative analgesia. When compared to general anesthesia, peripheral nerve block anaesthesia is cost effective, has a favourable postoperative recovery profile, preserves CNS functions and prevents complications of intubation, laryngoscopy and muscle relaxants. Recently nerve locators with ultrasound guidance technique help proper nerve localization and optimal needle placement thus minimizing unpleasant paraesthesia and reducing any incidence of neural damage, with higher rate of block success and faster onset times[26,27].

CHAPTER-2

LITERATURE REVIEW

REVIEW OF LITERATURE

Brachial plexus is a common mode of regional anaesthesia for the upper limb surgery. Newer drugs like Ropivacaine and Bupivacaine are being used for Brachial Plexus block along with Lignocaine or Xylocaine. The following articles give an overview about the studies and researches that has been done with these drugs.

Hickey et al. (1991) compared the effectiveness of 0.5% ropivacaine and 0.5% bupivacaine for brachial plexus block. Forty-eight patients received a subclavian perivascular brachial plexus block for upper-extremity surgery. One group (n = 24) received ropivacaine 0.5% (175 mg) and a second group (n = 24) received bupivacaine 0.5% (175 mg), both without epinephrine. Onset times for analgesia and anesthesia in each of the C5 through T1 brachial plexus dermatomes did not differ significantly between groups. Duration of analgesia and anesthesia was long (mean duration of analgesia, 13-14 h; mean duration of anesthesia,9-11h)andalsodidnotdiffersignificantlybetweengroups.Motor block was profound, with shoulder paralysis as well as hand paresis developing in all of the patients in both groups. Two patients in each group required supplemental blocks before surgery. Ropivacaine 0.5% and Bupivacaine 0.5% appeared equally effective in providing brachial plexus anesthesia [28].

Hickey et al. (1992) conducted a comparative study in 44 patients on the effectiveness of 0.25% ropivacaine and 0.25% bupivacaine. The patients were assigned to two equal groups in this randomized, double-blind study; one group received ropivacaine 0.25% (112.5 mg) and the other, bupivacaine 0.25% (112.5 mg), both without

epinephrine and found that the mean onset time for analgesia ranged from 11.2 to 20.2 min, and the mean onset time for anaesthesia ranged from 23.3 to 48.2 min. The onset of motor block differed only with respect to paresis in the hand, with bupivacaine demonstrating a shorter on-set time than ropivacaine. The duration of sensory and motor block also was not significantly different between the two groups. The mean duration of analgesia ranged from 9.2 to 13.0 h, and the mean duration of anaesthesia ranged from 5.0 to 10.2 h. Both groups required supplementation with peripheral nerve blocks or general anaesthesia in a large number of cases, with 9 of the 22 patients in the bupivacaine group and 8 of the 22 patients in the ropivacaine group requiring supplementation to allow surgery to begin. In view of the frequent need for supplementation noted with both 0.25% ropivacaine and 0.25% bupivacaine, the authors did not recommend using the 0.25% concentrations of these local anaesthetics to provide brachial plexus block [29].

Vainionpaa et al. (1995) conducted a study on the clinical and pharmacokinetic properties of ropivacaine and bupivacaine, both 5 mg/mL, used in axillary plexus block. The authors compared 60 patients in a randomized, double-blind, parallel-group study. The axillary plexus was identified with a nerve stimulator and 30, 35, or 40 mL of drug, depending on body weight, was injected into the perivascular sheath. In 20 patients, venous blood samples for the pharmacokinetic measurement were obtained over 24 h. The median onset times for anaesthesia and complete motor block were in the range of 12- 48 min and 5-20 min, respectively. Thirty-eight percent of patients in the ropivacaine group and 29% in the bupivacaine group needed additional nerve block(s) or supplementary analgesia and 7% in the bupivacaine group needed general anaesthesia for surgery. Anaesthesia was achieved in 52%-86% of the evaluated six nerves in the ropivacaine group and in 36%-87% in the bupivacaine group; the lowest figures were

seen in the musculocutaneous nerve. In the pharmacokinetic study the mean peak plasma concentrations(Cmax)were1.28+/-0.21mg/Lintheropivacainegroupand1.28+/-

0.47 mg/L in the bupivacaine group and the median times to peak plasma concentration (tmax)were 0.86 hand 0.96h,respectively.Themedianterminalhalf-lives(t1/2)were 7.1 h and 11.5 h in the ropivacaine group and the bupivacaine group, respectively (P = 0.07). No statistically significant differences were found between ropivacaine and bupivacaine in either the clinical or the pharmacokinetic comparisons [30].

Klein et al. (1998) compared bupivacaine and ropivacaine to determine the optimal long acting local anesthetic and concentration for interscalene brachial plexus block. Seventy-five adult patients scheduled for outpatient shoulder surgery under interscalene block were entered into this double-blind, randomized study. Patients were assigned (n = 25 per group) to receive an interscalene block using 30 mL of 0.5% bupivacaine, 0.5% ropivacaine, or 0.75% ropivacaine. All solutions contained fresh epinephrine in a 1:400,000 concentration. At 1-min intervals after local anesthetic injection, patients were assessed to determine loss of shoulder abduction and loss of pinprick in the C5-6 dermatomes. Before discharge, patients were asked to document the time of first oral narcotic use, when incisional discomfort began, and when full sensation returned to the shoulder. The mean onset time of both motor and sensory blockade was <6 min in all groups. Duration of sensory blockade was similar in all groups as defined by the three recovery measures. The authors concluded that there was no clinically important difference in times to onset and recovery of interscalene block for bupivacaine 0.5%, ropivacaine 0.5%, and ropivacaine 0.75% when injected in equal volumes. This study demonstrated a similar efficacy between equal concentrations of ropivacaine and

bupivacaine. In addition, increasing the concentration of ropivacaine from 0.5% to 0.75% fails to improve the onset or duration of interscalene brachial plexus block[31].

Bertini et al. (1999) investigated clinical features of axillary brachial plexus anaesthesia with two different concentrations of ropivacaine (0.5% and 0.75%) and compared results with those obtained with 0.5 % bupivacaine. Three groups of patients were randomized and prospectively studied. They received, in a double-blind fashion, 32 ml of the regional anesthetic solution into the midaxilla, by a nerve-stimulator technique. Onset time in each of the stimulated nerves was recorded both for the sensory and motor block. Peak time (ready to surgery), rate of supplemental blocks, need for intraoperative opioids, duration of sensory and motor block, postoperative analgesic requirements, and patient satisfaction were also recorded and found that the rate of complete sensory and motor block observed with both ropivacaine groups was higher at 10, 15, and 20 minutes postinjection ($P < 0.001$). The mean peak time was shorter with ropivacaine than with bupivacaine (R50 = 16.37 minutes, R75 = 14.7 minutes, B = 22.3 minutes, $P < 0.05$). The quality of the anesthesia was higher with ropivacaine, as measured by the intraoperative needs for opioids and the overall patient's satisfaction ($P < .05$). No significant differences were noted with all the other studied parameters. Ropivacaine showed advantages over bupivacaine for axillary brachial plexus block. Because no statistical differences were found between the two ropivacaine groups, the authors concluded that 0.75 % does not add benefit and that 0.5 % ropivacaine should be used to perform axillary brachial plexus blocks [32].

Vaghadia et al. (1999) conducted a study and compared the efficacy of ropivacaine 7.5 $mg \cdot ml^{-1}$ with bupivacaine 5.0 $mg \cdot ml^{-1}$ for subclavian perivascular brachial plexus block. After informed consent, 104 adults participated in a randomized, double-blind, multi-centre trial to receive 30 ml of either ropivacaine 7.5 $mg \cdot ml^{-1}$ or bupivacaine 5.0 $mg \cdot ml^{-1}$ for subclavian perivascular brachial plexus block prior to upper limb surgery. Onset and duration of sensory and motor block in the distribution of the axillary, median, musculo-cutaneous, radial and ulnar nerves were assessed. Onset times and duration of sensory and motor block were similar between groups. Mean duration of analgesia for the five nerves was between 11.3 and 14.3 hr with ropivacaine andbetween

10.3 and 17.1 hr with bupivacaine. Quality of muscle relaxation judged as excellent by the investigators was not significantly different (ropivacaine —35/49, bupivacaine — 30/49). The median time to first request for analgesia was comparable between the two groups (11–12 hr). Apart from one patient developing a grand mal seizure shortly after receiving bupivacaine who recovered consciousness within 30 min, there were no serious adverse events in the ropivacaine group. The study concluded that thirty ml ropivacaine

7.5 $mg \cdot ml^{-1}$ (225 mg) produced effective and well tolerated brachial plexus block of long duration by the subclavian perivascular route. In this study, the results were similar to those of 30 ml bupivacaine 5.0 $mg \cdot ml^{-1}$[33].

Casati et al. (1999) conducted a study based on the comparison of interscalene brachial plexus block performed with ropivacaine or bupivacaine, 45 healthy, unpremedicated patients, undergoing elective shoulder surgery, were randomly allocated to receive interscalene brachial plexus anaesthesia with 20 mL of either ropivacaine 0.75%

(n=15), ropivacaine 1% (n=15), or bupivacaine 0.5% (n=15). Readiness for surgery (loss of pinprick sensation from C4 to C7 and inability to elevate the limb from the bed) was achieved later with bupivacaine 0.5% (28±15 min) than with ropivacaine 1% (10±5 min) (P=0.005) and ropivacaine 0.75% (15±8 min) (P=0.0005). No differences in success rate were observed between the three groups; but seven patients receiving bupivacaine 0.5% required intra-operative analgesic supplementation (fentanyl 0.1 mg intravenous) compared with one patient receiving ropivacaine 0.75%, and two patients treated with ropivacaine 1% (P=0.02). The time from the block placement to first request for pain medication was similar in the three groups (10.7±2 h, 11±2.4 h, and 10.9±3.9 h after 0.75% and 1% ropivacaine or 0.5% bupivacaine, respectively). The study reported that interscalene brachial plexus block performed with 20 mL of either 0.75% or 1% ropivacaine allows for a prolonged post-operative pain relief, similar to that provided by bupivacaine 0.5%, with short onset time of surgical anaesthesia[34].

Raeder et al. (2002) stated a study to compare the efficacy and safety of 40 ml ropivacaine 7.5 mg/ml (300 mg) and 40 ml bupivacaine 5 mg/ml (200 mg) for axillary plexus block. One hundred and four adult patients were included in a prospective, double-blind study. Sensory and motor block were tested for the five main terminal nerves of the armat10-min intervals until start of surgery and every second hour thereafter until full resolution of the block. The overall evaluation of the block by the surgeon and the anesthesiologist showed a significantly better quality in the ropivacaine patients, regarding both anaesthesia and motor block. There were no differences in the time to onset and duration of the block. Except for one patient, who had seizures after an accidental IV injection of ropivacaine, there were no major side effects and concluded that ropivacaine 7.5 mg/ml, 40 ml, produces axillary plexus block of similar onset and

duration but better quality than 40 ml of bupivacaine 5.0 mg/ml [35].

Thornton et al. (2003) compared the use of ropivacaine 0.2% with bupivacaine 0.25% for axillary brachial plexus block in children undergoing hand surgery. In a double-blind, randomized study, 35 children undergoing hand surgery received axillary brachial plexus blocks with 0.5 ml.kg of either 0.2% ropivacaine or 0.25% bupivacaine. Pain scores were noted at 0, 3, 6, 12 and 24 h after surgery. The time to first dose of codeine phosphate and the total doses of all analgesics given were recorded and it was found that there was no significant difference between the two groups in pain scores, the time to first dose of codeine phosphate or in analgesic requirements in the first 24 h . The study concluded that Ropivacaine 0.2% is as effective as Bupivacaine 0.25% for axillary brachial plexus blocks in children undergoing hand surgery [36].

Eroglu et al. (2004) compared the same volume and concentration of Bupivacaine and Ropivacaine for interscalene brachial plexus block anaesthesia and postoperative analgesia in shoulder surgery. Forty-four patients scheduled for elective shoulder surgery were prospectively randomized to receive in a double-blind fashion 30 mL of either 0.5% bupivacaine or ropivacaine for interscalene block. The block was prolonged after surgery by using a patient-controlled interscalene analgesia with 0.15% of either bupivacaine or ropivacaine. The mean onset times of surgical blocks were determined after interscalene block and found two patients with bupivacaine and one with ropivacaine failed to achieve surgical blocks. The mean onset times of surgical blocks were 18± 12 minutes with ropivacaine and 21± 13 minutes with bupivacaine. Postoperative pain control was similar effective and patient satisfaction was high in both groups. This study concluded that the

same volume and concentration of ropivacaine and bupivacaine (30 mL of 0.5%) for interscalene brachial plexus block anaesthesia analgesia infusion, 0.15% bupivacaine or ropivacaine provide adequate pain relief, similar side effects and patient satisfaction after shoulder surgery [37].

Brkovic et al. (2008) did a study to assess the local analgesic efficacy of ropivacaine for lower third molar surgery. The aim of this double blind study was to compare local anaesthetic parameters and postoperative analgesic requirements after the use of ropivacaine and bupivacaine for the inferior alveolar nerve block. 20 healthy patients were equally randomized into the ropivacaine (0.75%, 2 ml) or bupivacaine (0.5%, 2 ml) groups. The onset and duration of anaesthesia (the lower lip numbness and pinprick test) and intensity of anaesthesia (visual analogue and verbal rating scales) were determined. The postoperative pain reports and analgesic requirements were also recorded. There were no significant differences concerning parameters of the achieved anaesthesia. 2 patients in the bupivacaine group felt postoperative pain without the need for pain medication. It was concluded that Ropivacaine is suitable for achieving local anaesthesia in lower third molar surgery, especially when prolonged analgesia is desired [38].

Mageswaran et al. (2010) conducted a prospective randomized double-blind study involving sixty patients aged 18-65 years; who had elective or emergency orthopaedic surgeries of the upper limbs. They were randomly divided into two groups: Group I received 30 mls of 0.5% ropivacaine; and Group II received 0.5% levobupivacaine for infraclavicular brachial plexus block based on the coracoid approach. The onset time required for sensory block of all required dermatomes (C5–T1) and the

onset time of motor block were documented. Based on the Visual Analogue Score, pain scores were recorded every 30 minutes during surgery and at the 6th hour. The mean onset time (SD) for sensory block with ropivacaine was 13.5 ± 2.9 minutes compared to levobupivacaineat11.1±2.6minutes(p=0.003).Theonsettimeformotorblockwas

19.0 ± 2.7 minutes in Group I compared to 17.1 ± 2.6 minutes (p=0.013) in Group II. Patients in both groups experienced both mild to moderate pain at the 6th hour. In conclusion, there were statistically significant differences in the onset-time for sensory and motor block. However, there was no statistically significant difference in terms of effectiveness of analgesia at the 6th hour. Although the clinical advantage of levobupivacine is not substantial, its safety profile becomes a major consideration in the choice of local anaesthetic for brachial plexus block where a large volume is required for an effective result[39].

Tripathi et al. (2012) evaluated ropivacaine for its anaesthetic and safety profile in brachial plexus block for upper limb orthopedic surgery and its clinical comparison with bupivacaine. The study was a prospective, randomized, double blind clinical study and was carried out in 60 consenting adults of either sex, aged 20-40 yrs, scheduled for elective upper limb orthopedic surgery. Patients were randomly allocated to one of the two groups of 30 patients each. Group B received 30 ml of 0.5% bupivacaine and Group R received 30ml of 0.75% ropivacaine in Supraclavicular brachial plexus block after confirming the proximity of brachial plexus with nerve locator. Patients were observed

for onset, peak and duration of sensory and motor blockade, post-operative analgesia using visual analogue scale and complications if any. In comparison to equal volume of 0.5% bupivacaine, 0.75% ropivacaine provides earlier onset and peak of sensory blockade

($p<0.05$) with comparable duration of postoperative analgesia ($P>0.05$). Though, it provided earlier onset of motor blockade ($p<0.05$), there was statistically significant delay in achieving peak effect as compared to bupivacaine ($p<0.05$). Haemodynamics remained stable and no complications were encountered in both the groups. The study conclude that 30ml of 0.75% ropivacaine has effective anaesthetic and safety profile in Supraclavicalar brachial plexus block with excellent post operative analgesia. The authors recommended 30ml of 0.75% dose of ropivacaine against equal volume of 0.5% bupivacaine for achieving earlier onset of sensory and motor blockade[40].

Nishiyama (2012) compared the effects of two different concentrations of the combination of ropivacaine or bupivacaine with lidocaine. One hundred adult patients scheduled for repair of fracture of the upper extremity under interscalene block were randomly allocated into one of the groups receiving the combination of 15 mL of ropivacaine 0.375% (Ropivacaine 0.375 group), ropivacaine 0.75 % (Ropivacaine 0.75 group), bupivacaine 0.25 % (Bupivacaine 0.25 group), or bupivacaine 0.5 % (Bupivacaine 0.5 group) with lidocaine 1.0 % 15 ml. The onset and duration of motor and sensory blocks were compared among the 4 groups. Three patients in the Ropivacaine

0.375 group did not show any motor blocks. Ropivacaine groups had significantly slower onset of motor block and longer duration of motor and sensory blocks than Bupivacaine groups. Bupivacaine 0.5 group had significantly longer duration of both blocks than Bupivacaine 0.25 group, while Ropivacaine 0.375 and 0.75 groups had the similar duration of both blocks.This study concluded that interscalene block combined with lidocaine, ropivacaine had slower onset of motor block and longer duration of both blocks than bupivacaine. Only bupivacaine showed the different duration of the blocks between two concentrations [41].

Kooloth et al. (2015) performed a study to compare the clinical characteristics of ropivacaine 0.5% and bupivacaine 0.5% when used for supraclavicular brachial plexus block. This was a comparative study where cases were randomly divided into two groups (Group R-Ropivacaine and Group B-Bupivacaine) and administered the drug. Pulse, blood pressure, sensory and motor blockade were monitored and complications of brachial plexus block and side effects of local anaesthetics used were also noted. The mean onset time of motor blockade was 14.33+4.92 minutes in Group R and 15.30+5.01 minutes in Group B while mean duration of pain relief was 688+86.78 minutes in Group R and 664.37+102.97 minutes in Group B. There was no statistically significant difference in onset of sensory block, duration of sensory block, onset of motor block, duration of motor block, mean duration of pain relief between two groups ($p>0.05$) and concluded that Supraclavicular brachial plexus block using 0.5% ropivacaine were similar in terms of onset of sensory and motor block, duration of sensory and motor block, duration of analgesia, post-operative analgesic supplements, incidence of side effects and complications as compared with 0.5% bupivacaine[42].

Rathod et al. (2015) compared the effect of 35 ml of 0.375% of Ropivacaine and Bupivacaine in supraclavicular brachial plexus block. In this prospective double blind study, sixty patients of ASA- I and II scheduled for upper limb orthopedic surgeries were randomly divided into Group B and Group R which received 35 ml of 0.375% bupivacaine and 0.375% ropivacaine respectively. Sensory and motor block onset and duration and duration of analgesia were evaluated. The sensory and motor onset (mean-minutes) was 21.13 and 25.87 in group Band was 13.3 and 21.37 in group R respectively. The duration of sensory and motor block (mean- minutes) was 480.3 and 472.8 in group

R, and 472.1 and460.2 in group B The duration of post-operative analgesia was 504.2 minutes in Group R and 499.6 minutes in Group B. The study concluded Group R provided statistically significant & rapid onset of sensory and motor blockade than Group B for upper limb surgeries. There were no significant differences in duration of sensory and motor blockade, any complication or side effects. Ropivacaine may therefore be a preferred option because of its higher therapeutic index. [43].

Barsagade et al. (2015) compared the clinical profiles of 0.5% levobupivacaine, 0.5% bupivacaine and 0.75% ropivacaine in equal volumes when used in supraclavicular brachial plexus block in patients undergoing upper limb surgeries. The design was a prospective double blinded randomized study enrolling 90 patients of either sex, ASA I and II, were randomly allocated into three groups in which supraclavicular brachial plexus block was performed with nerve stimulator using 30 ml of levobupivacaine 0.5%, bupivacaine 0.5% and ropivacaine 0.75% respectively. The onset and duration of sensory and motor block, quality of block and possible adverse events were recorded. Onset of sensory block was earlier for levobupivacaine than bupivacaine but it was similar for Ropivacaine. The duration of sensory and motor blockade was longer in group of patients treated with levobupivacaine than in other two groups. The quality of block was comparable in all the three groups of patients. In group of patients who received bupivacaine, two episodes of reduction in heart rate without significant hypotension have been observed and concluded Ropivacaine 0.75% seems better local anaesthetic agent for supraclavicular block as it is having shorter duration of motor blockade with comparable onset, quality and duration of sensory block[44].

Gonuguntla (2016) conducted a study which compared the efficacy of 0.5% bupivacaine and 0.75% ropivacaine - the onset, duration and quality of the brachial plexus block through supraclavicular approach. A total of 60 patients belonging to ASA Grades 1 and 2 between 20 and 60 years age of either sex were included in this study. The onset of sensory and motor block were tested every 1 min interval for a maximum of 35 min after injection of local anesthetics through supraclavicular plexus block. All patients were kept under observation for 24 h. All the observed characteristics were analyzed and founded the actual difference between mean duration of the onset of sensory and motor blockade in Group A and in Group B was 1.6 and 2.7 min, respectively. Duration of analgesia of Groups A and B were 678.75 ± 187 and 648.17 ± 180.91, respectively. The most number of cases attained Grade IV that means complete block of sensory and motor functions among both Groups A and B. Complete blockade was more in Group B when compared to Group A about 66.67% and 58.62%, respectively. This study concluded, there were no much clinical differences in onset, duration and analgesia among 0.5% bupivacaine and 0.75% ropivacaine when injected in equal volumes for brachial plexus block by the supraclavicular approach. Ropivacaine has potentially improved safety profile compared with bupivacaine[45].

Modak et al. (2016) evaluated the clinical efficacy of 0.5% ropivacaine for supraclavicular bronchial plexus block for upper limb surgeries and comparing it with 0.5% bupivacaine in terms of characteristics of supraclavicular blockade and side effects. The design was a prospective double blind randomized study enrolling 60 patients of either sex, ASA I and II, were randomly allocated into two groups in which supraclavicular brachial plexus block was performed with nerve stimulator using 30 ml of ropivacaine 0.5% and bupivacaine 0.5% respectively. The onset and duration of sensory and motor block

and possible adverse events were recorded. The study reported Ropivacaine had earlier onset of sensory and motor blockade compared to bupivacaine. The duration of sensory and motor blockade was longer in group of patients treated with ropivacaine than in bupivacaine group. No statistically significant difference was found in quality of blocks in both groups. There were no adverse effects observed in the study. Thus the study concluded Ropivacaine 0.5% can be safely used as an alternative to bupivacaine 0.5% in supraclavicular bronchial plexus block [46].

Badheka et al. (2016) performed a prospective double blind study designed with the aim of comparing the onset, duration of sensory and motor block and analgesic effect of ropivacaine 0.5%with bupivacaine 0.5% when used in supraclavicular brachial plexus block in patients undergoing upper limb orthopedic surgeries. 60 patients of either sex, aged 20-66 yrs, scheduled for elective upper limb orthopedic surgeries under supraclavicular brachial plexus block, were randomly divided into two groups containing 30 patients in each. Group B received 0.5% 30ml bupivacaine and group R received 0.5% 30ml ropivacaine. Patients were observed for onset, duration of sensory and motor blockade, post-operative analgesia using visual analogue scale and complications if any. The study showed that in comparison to equal volume of 0.5% bupivacaine, 0.5% ropivacaine provides significant earlier onset of sensory block (9.5±2min& 7.46 ±2.54 min respectively) and motor block (12.6±2.2min& 10.66±2.24 min respectively).There was statistically significant longer duration of motor block with bupivacaine (486.16±56.74)as compared to ropivacaine (359±55.66 min). However duration of sensory blockade, duration of analgesia and haemodynamics were comparable in both groups. One patient in bupivacaine group had convulsions which was successfully managed. No complications were encountered in ropivacaine group. The study stated that

Ropivacaine provided faster onset of sensory and motor block with less duration of motor block, equal postoperative analgesia and higher safety profile as compared to bupivacaine [47].

Barsagade et al. (2016) compared the clinical characteristics of ropivacaine 0.5% and bupivacaine 0.5% with fentanyl when used for interscalene brachial plexus block. In this prospective randomized double blind study, 60 patients were randomly divided into two groups, group BF-bupivacaine with fentanyl and group RF-ropivacaine with fentanyl. Effects in terms of onset, duration and quality of sensory and motor blockade, pulse and blood pressure, respiration were monitored and complications of interscalene brachial plexus block were also noted. The mean onset time of sensory and motor blockade was 2.65 and 4.31 minutes in group BF and 4.08 and 6.08 minutes in group RF group respectively. The mean duration of sensory and motor block was 644.44 min and 595.55 min in group BF respectively. Whereas, in group RF the mean duration of sensory and motor block was 573.46 min and 513.46 min respectively. The study concluded that Ropivacaine has greater margin of safety than Bupivacaine. Ropivacaine with an almost comparable blockade profile could be the better choice in view of safety of the patient[48].

Chaverneff (2017) conducted a randomized prospective trial, to determine whether levobupivacaine could provide longer-lasting analgesia than ropivacaine after brachial plexus block. The study was conducted on 62 patients undergoing orthopedic surgery,consisting of open reduction and internal fixation of fractures, who were randomly assigned in a double-blind manner to receive levobupivacaine (group L; n=31; mean age,

67 years; 58% women) or ropivacaine (group R; n=31; mean age, 68 years; 64.5% women) for brachial plexus nerve block. Nerve block was achieved using an interscalene approach for humerus (n=9 in group R, n=10 in group L) and elbow (n=4 in group R, n=3 in group L) fractures, or an axillary approach for wrist fractures (n=18 in both groups). Group L was injected with 20 mL 0.375% levobupivacaine in saline, and group R with 20 mL 0.375% ropivacaine in saline. Peripheral nerve blocks guided by ultrasound and combined with nerve stimulation (using a 6-13-Hz linear probe and a 22-g needle) were performed in patients under general anaesthesia by anaesthesiologists experienced in the technique. Oral lornoxicam (4 mg) was administered after each meal, from postoperative days 1 to 5, and patients could request analgesics at any time after surgery (25 mg *per rectum*diclofenac as first-line, and 15 mg intravenous pentazocine as second-line therapy). No difference was found between groups R and L for the "time interval until the first request for pain medicine"(*P* =.32); the duration of the motor block assessed with a 0 to 6 modified Lovett rating scale (*P* =.44); pain scores, evaluated with a 0 to 5 verbal rating scale, at any point after surgery (*P* =.92); need for rescue analgesics (*P* =.6); or rate of sleep disturbance (*P* =1.0). The study concluded levobupivacaine and ropivacaine display similar analgesic effects after brachial plexus blocks[49].

So, to summarise, Ropivacaine appears to be a better drug than Bupivacaine in brachial plexus block.

CHAPTER-3

AIMS AND OBJECTIVES

AIMS & OBJECTIVES

The aims and objectives of the present study is

- ✓ To study and compare the analgesic and anaesthetic effects of Ropivacaine and Bupivacaine in Brachial Plexus Block
- ✓ To assess a better local anaesthetics for brachial plexus block out of Bupivacaine and Ropivacaine in terms of effectiveness, acceptability and post-operative complications.

CHAPTER-4

STUDY RATIONALE

STUDY RATIONALE

Bupivacaine and Ropivacaine are currently the commonest local anaesthetic drugs used for brachial plexus block. Most studies show that Ropivacaine is a better regional anaesthetic compared to Bupivacaine in terms of safety and efficacy. This data has not been well validated in an Indian setting. Ropivacaine is less cardio toxic but more expensive drug compared to Bupivacaine. Hence a comparison of the anesthestic effects of these two drugs will help us assess whether Ropivacaine has significant benefits over Bupivacaine in an Indian population and should be prescribed despite it being more expensive.

CHAPTER-5

MATERIALS AND METHODS

MATERIALS & METHODS

Study Setting

This study was conducted in the operation theatres of **AMRI Hospitals,** Dhakuria, Kolkata. About 15/16 upper limb surgeries were performed in the operation theatre every month and brachial plexus block is used in about 90 % of upper limb surgeries unless there are any contraindications.

Study design and Study period:

This study was a prospective observational study carried over a period of 9 months from June 2018 to March 2019. Prospective data will be collected during this period.

Study population:

The observational study was conducted on all elective surgical patients receiving local anaesthetics and undergoing upper limb surgeries (Surgery of shoulder, upper arm (orthopedics or muscular surgery), elbow joint, wrist joint, fingers, palm and decompression of Carpal Tunnel Syndrome) etc. Patients will be randomly selected based on the following inclusion and exclusion criteria.

Inclusion criteria

- Age: All patients above 18years.
- Sex: Both Male & Female.
- Physical Status: ASA I, II &III.
- Patients undergoing upper limb surgeries.

Exclusion criteria

Patients will be excluded if:

- Patient refusal of regional anaesthesia.
- Paediatric age group.
- Physical status of ASA IV & V, patient on mechanical ventilation.
- History of Bleeding disorders, Blood dyscrasias.
- Patient with history of recent (less than 3 days) intake of antiplatelet drugs (Ecospirin, Clopidogrel etc).
- Patients having local infection, eczema at the site ofinjection.
- Patients with gross bonydeformities.
- Patients with hepaticfailure.
- Not indicated in a weak or paralysed limb.

Variables that will be collected:

- Pre-operative vitals (pulse, BP, incidence of nausea, retching or emesis).
- Intra-operative vitals(pulse, BP, incidence of nausea, retching or emesis).
- Anti-emetic, analgesic and anaesthetic drugs used during surgery.
- Post-operative vitals (pulse, BP, incidence of nausea, retching or emesis).
- Presence of post-operative nausea, retching or emesis.
- Time of onset of analgesia (Sensoryblock).
- Time of onset of anaesthesia (Motorblock).
- Duration of analgesia.
- Duration of anaesthesia.
- Any complications of either technique of nerve block or use of local anaesthetics(viz. Injury to nerves and vessels, haematoma, pleural injury leading to pneumothorax, allergic reaction to local anaesthetics, cardiac and neurotoxicity of local anaesthetics).

Methodology

Patients were selected according to inclusion criteria. The study was conducted in AMRI Hospitals, Dhakuria from June 2018 to March 2019. Proper written informed consent were taken from patients prior to brachial plexus block. Brachial Plexus block was administered to patients with Inj. Bupivacaine(0.5%)+ Inj. Lignocaine(2%) or Inj.

Ropivacaine(0.5%) + Inj. Lignocaine(2%) - drug doses was calculated according to body weight. Total volume of drug administered - 40ml. Data was collected in data collection sheets and analysed statistically.

Data collection:

All data were collected from the operation theatre database which was updated by the anaesthesia consultants on a daily basis. Data were collected on a paper data sheet and uploaded on an electronic database prepared on an excel format. Data was cross checked for maintaining data quality.

Ethical approval

Ethical approval was taken from the AMRI Institutional Ethics Committee prior to data collection process.

CHAPTER-6

RESULTS

RESULTS

There were a total of 119 patients (n=119) who received brachial plexus block during the study period. 89 (74.8%) received Ropivacaine and 30 (25.2%) received Bupivacaine (Figure 8).

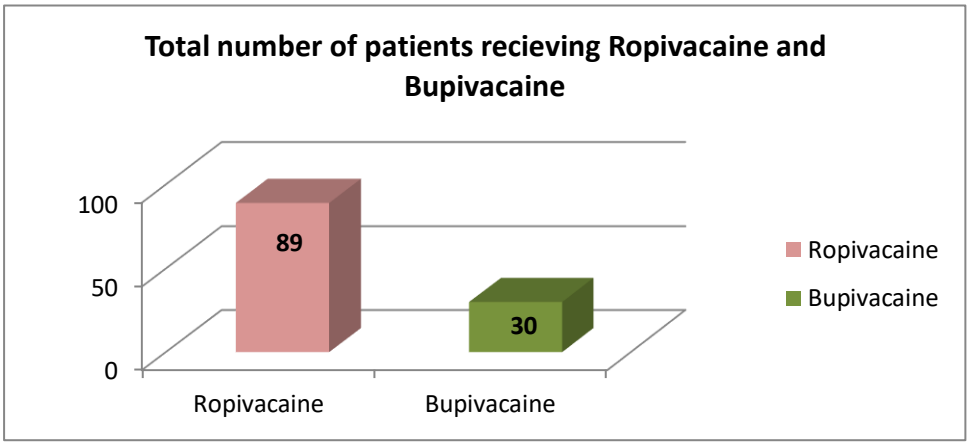

Figure 8: Total number of patients receiving Ropivacaine and Bupivacaine

Baseline characteristics

The mean age of patients in the Ropivacaine group (53±16 years) was significantly higher compared to patients in the Bupivacaine group (47.3±10.1 years) (p =0.006). Majority (56.2%) patients in the Ropivacaine group were females while Bupivacaine group had more male patients (56.7%); however the sex distribution was not statistically significant (p=0.2). (Figure 9).

The baseline characteristics of patients is described in Table 3.

Characteristics	*Ropivacaine, n = 89*	*Bupivacaine, n = 30*
Age in years, mean±SD	53±16	47.3±10.1
Sex, n(%)		
Male	39 (43.8)	17 (56.7)
Female	50 (56.2)	13 (43.3)

Table 3: Baseline characteristics of patients

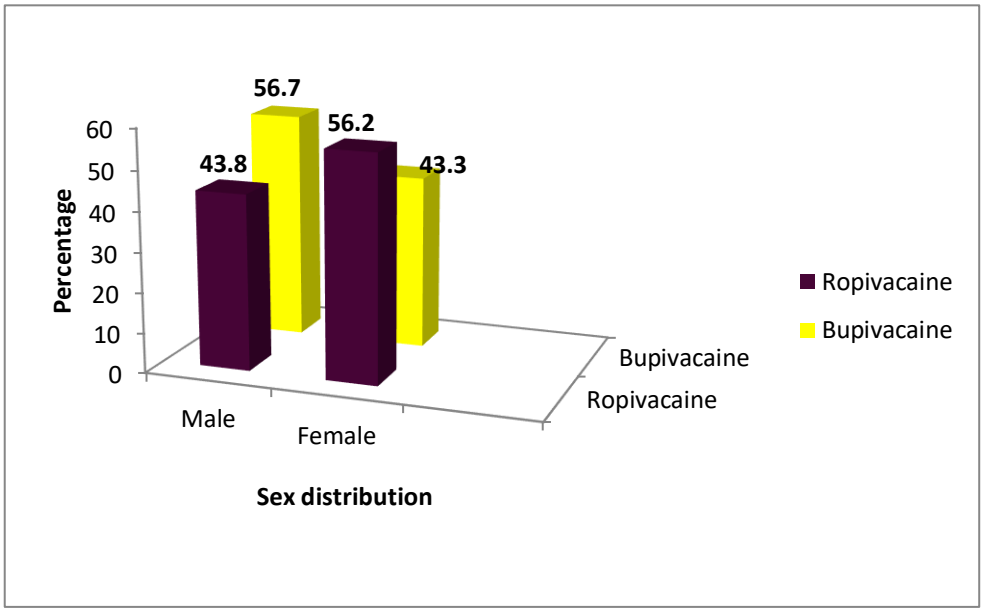

Figure 9: Sex distribution of overall population

Brachial plexus block with respect to fractured bones

We assessed the use of Ropivacaine and Bupivacaine with respect to the fractured bones. Radius was the commonest fracture in the Ropivacaine group (29.2%) followed by shoulder (25.8%) and humerus (15.7%). Radius fracture was also the commonest fracture treated in the Bupivacaine group (36.7%), followed by radius and ulna (16.7%) and shoulder (13.3%). The use of Ropivacaine and Bupivacaine significantly differed in the treatment of

fractures involving combined fractures of radius and ulna (3,4% vs. 16.7%; p= 0.01). The type of fractures that were treated with Ropivacaine and Bupivacaine are described in Table 4, Figure 10.

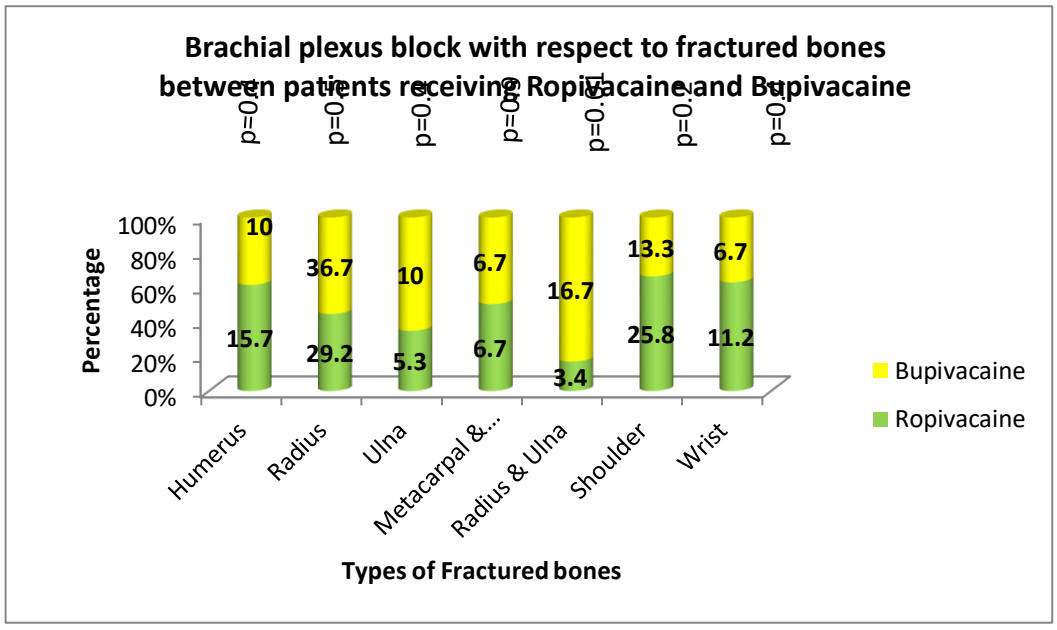

Figure 10: Brachial plexus block with respect to fractured bones

Fracture segment, n(%)	*Ropivacaine*	*Bupivacaine*	*P value*
Humerus	14 (15.7)	3 (10)	0.4
Radius	26 (29.2)	11 (36.7)	0.5
Ulna	5 (5.3)	3 (10)	0.4
Metacarpal and carpal	6 (6.7)	2 (6.7)	0.9
Radius and ulna	3 (3.4)	5 (16.7)	0.01
Shoulder	23 (25.8)	4 (13.3)	0.2
Wrist	10 (11.2)	2 (6.7)	0.4

Table 4: Brachial plexus block with respect to fractured bones

Co-morbidities

Hypertension was the commonest co morbidity in both groups (55.1% and 60%), followed by diabetes (29.2% vs. 30%). Other co morbidities that were assessed included COPD and thyroid disorders. There was no significant difference in the prevalence of comorbidities between the two groups. The distribution of comorbidities between the two groups is shown in Table 5, Figure 11.

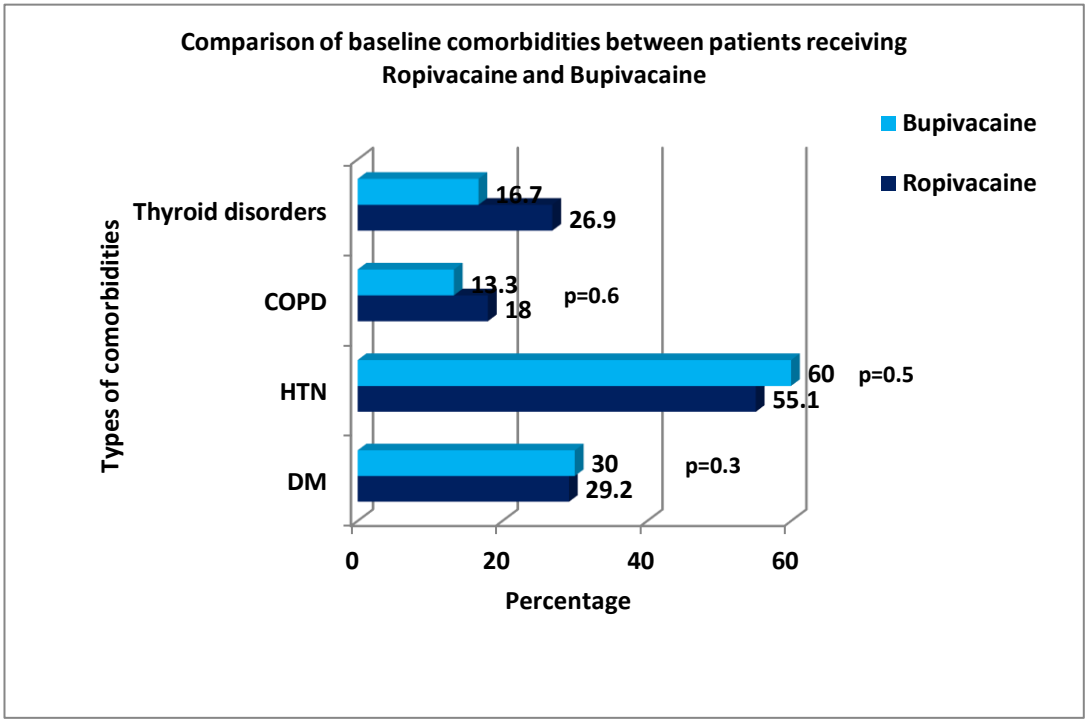

Figure 11: Types of comorbidities

Comorbidities, n(%)	*Ropivacaine*	*Bupivacaine*	*P value*
Diabetes Mellitus	26 (29.2)	9 (30)	0.9
Hypertension	49 (55.1)	18 (60)	0.6
COPD	16 (18)	4 (13.3)	0.5
Thyroid disorders	24 (26.9)	5 (16.7)	0.3

Table 5: Types of comorbidities

Concommitant medications

Concommitant medications that the patients received were also comapred between both groups. The use of anti-diabetisc, anti-hypertensives, bronchodialators and antithyroid medicines were assessed. The usage of these medications was similar in both the groups. Anti hypertensives were the commonest medication that were used by patients in both groups (Table 6, Figure 12).

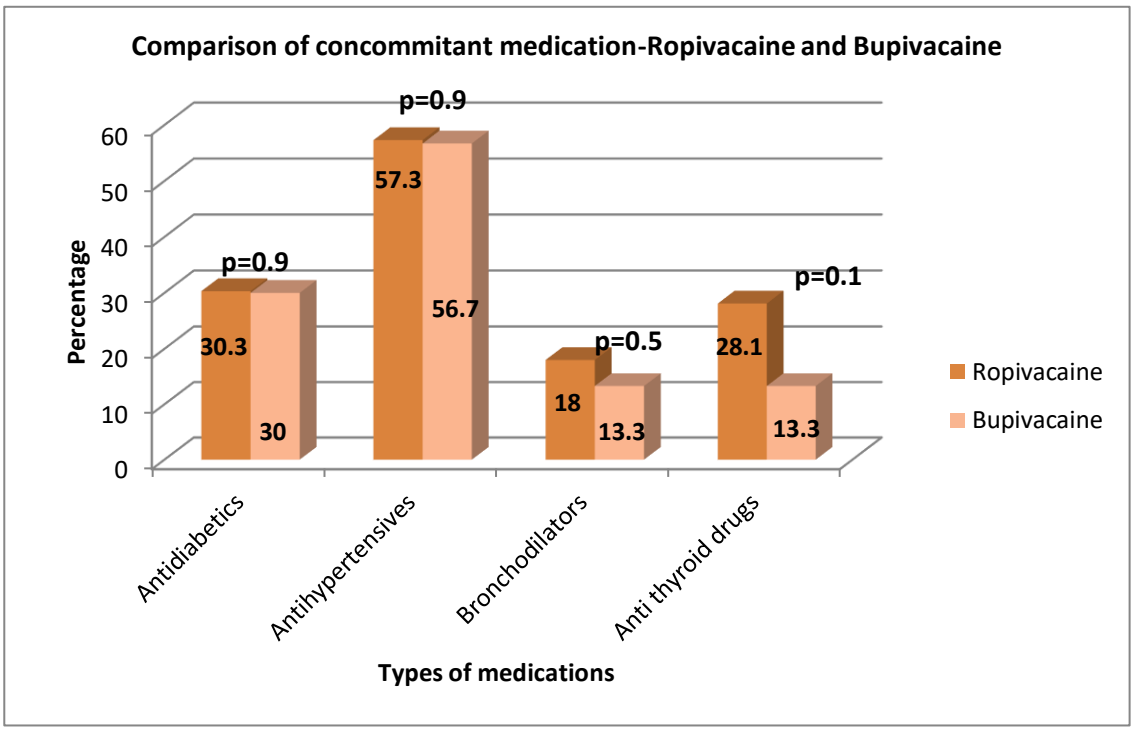

Figure 12: Types of conmmitant medications

Concommitant medications, n(%)	*Ropivacaine*	*Bupivacaine*	*P value*
Antidiabetics	27 (30.3)	9 (30)	0.9
Antihypertensives	51 (57.3)	17 (56.7)	0.9
Bronchodilators	16 (18)	4 (13.3)	0.5
Anti thyroid drugs	25 (28.1)	4 (13.3)	0.1

Table 6: Types of conmmitant medications

Type of brachial plexus

Supraclavicular type was the most common type of of brachial plexus block that was used for both groups of patients (64% vs. 73%). Axillary brachial plexus block was the next common type in both groups (20.2% vs. 16.7%). However, the distribution of the type of brachial plexus block use was similar in both groups (Table 7, Figure 13).

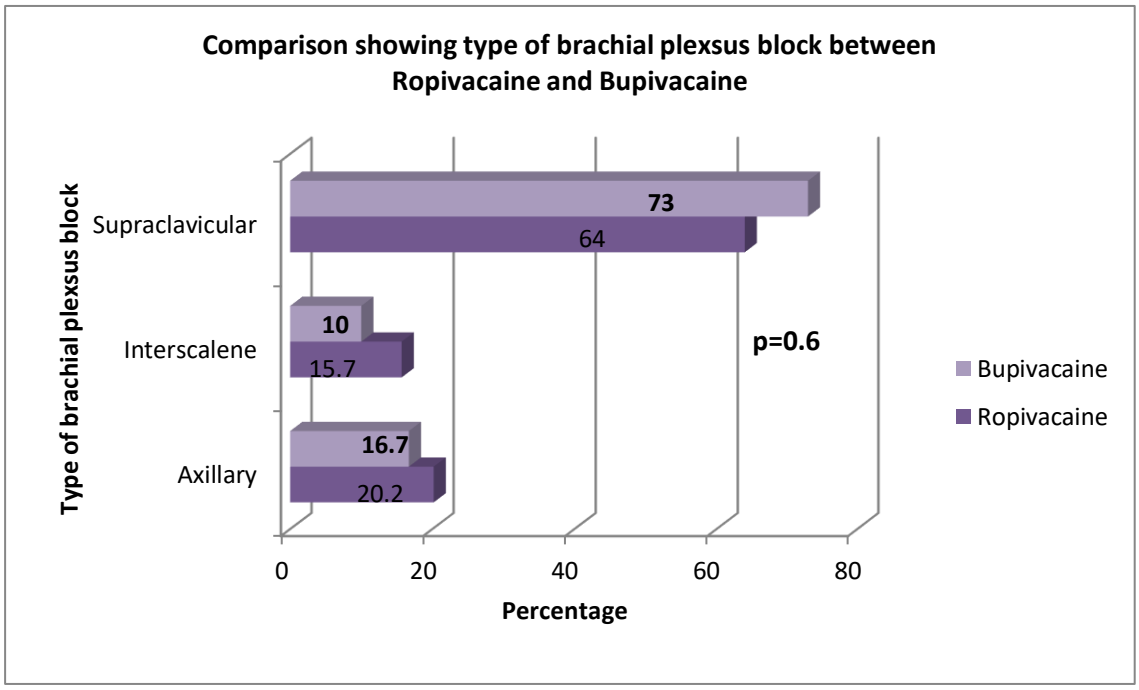

Figure 13: Type of brachial plexsus block

Type of block, n(%)	*Ropivacaine*	*Bupivacaine*	*P value*
Axillary	18 (20.2)	5 (16.7)	0.6
Interscalene	14 (15.7)	3 (10)	
Supraclavicular	57 (64)	22 (73)	

Table 7: Type of brachial plexsus block

Anaesthetic and analgesic properties

We compared the onset to and duration of anaesthetic and analgesic properties of Ropivacaine and Bupivacaine (Table 8). While the time to onset of analgesia (sensory block) was similar in both groups (Ropivacaine: 19.3±7.9 minutes, Bupivacaine: 21.7±6.3 minutes; p= 0.2), the time to onset of anaesthesia (motor block) was significantly lower in the

Ropivacaine group compared to Bupivacaine group (28.1±9.1 mins vs. 30.3±6.1 minustes, p= 0.01). The duration of analgesia was significantly higher with Ropivacaine compared to Bupivacaine (282.6±110.5 minutes vs. 286.8±55.8 minutes; p<0.0001); the duration of anaesthesia was however similar with both drugs (229.3±122.2 minutes vs. 236.2±99 minutes; p =0.2).

Anaesthetic parameters in mins (mean±SD)	**Onset**	**P value**	**Duration**	**P value**
Analgesia				
Ropivacaine	19.3±7.9	0.2	282.6±110.5	<0.0001
Bupivacaine	21.7±6.3		286.8±55.8	
Anaesthesia				
Ropivacaine	28.1±9.1	0.01	229.3±122.2	0.2
Bupivacaine	30.3±6.1		236.2±99	

Table 8:Aanaesthetic parameters

Post operative symptoms

Post operative symptoms (nausea, vomiting and pain) were assessed between patients who received Ropivacaine and those who received Bupivacaine. There was no difference in

the incidence of nausea (21.3% vs.20%; p= 0.7) or vomiting (28.1% vs.20%; p=0.8) between the two groups. The incidence of post operative pain was also similar between the two groups (p= 0.4). However, 1 patient complained of severe pain in the Ropivacaine group. The post operative symptoms in Ropivacaine and Bupivacaine groups are described in Table 9, Figure 14.

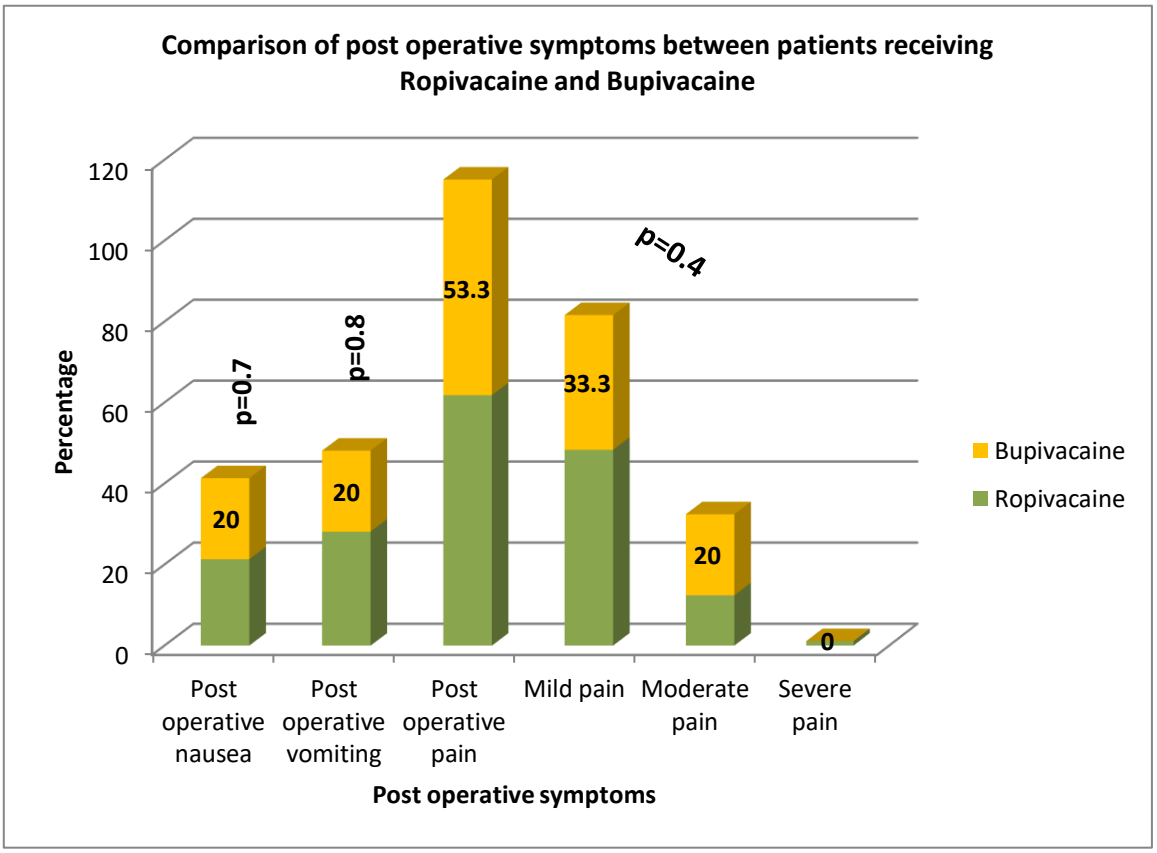

Figure 14: Post operative symptoms

Outcome characteristics	*Ropivacaine*	*Bupivacaine*	*P*
Post operative nausea, n(%)	19 (21.3)	6 (20)	0.7
Post operative vomiting, n(%)	25 (28.1)	6 (20)	0.8
Post operative pain, n(%)	55 (61.8)	16 (53.3)	0.4
Mild	43 (48.3)	10 (33.3)	
Moderate	11 (12.4)	6 (20)	
Severe	1 (1.1)	0	

Table 9: Post operative symptoms

Physiological parameters

Blood pressure

Post-operative physiological parameters in the two groups were also compared. The pre-operative and intra-operative systolic blood pressure differed significantly between Ropivacaine and Bupivacaine group (pre-operative: 146.6 ± 17.9mmHg vs. 148.5 ± 11.8mmHg, p= 0.01; intra-operative: 134.5 ± 12mmHg vs. 134.5 ± 7 mmHg, p= 0.005 respectively). The pre-operative diastolic pressure also significantly differed between the two groups (85.4 ± 8.8mmHg vs. 85.7 ± 6.3, p=0.04) (Table 10, Figure 15)

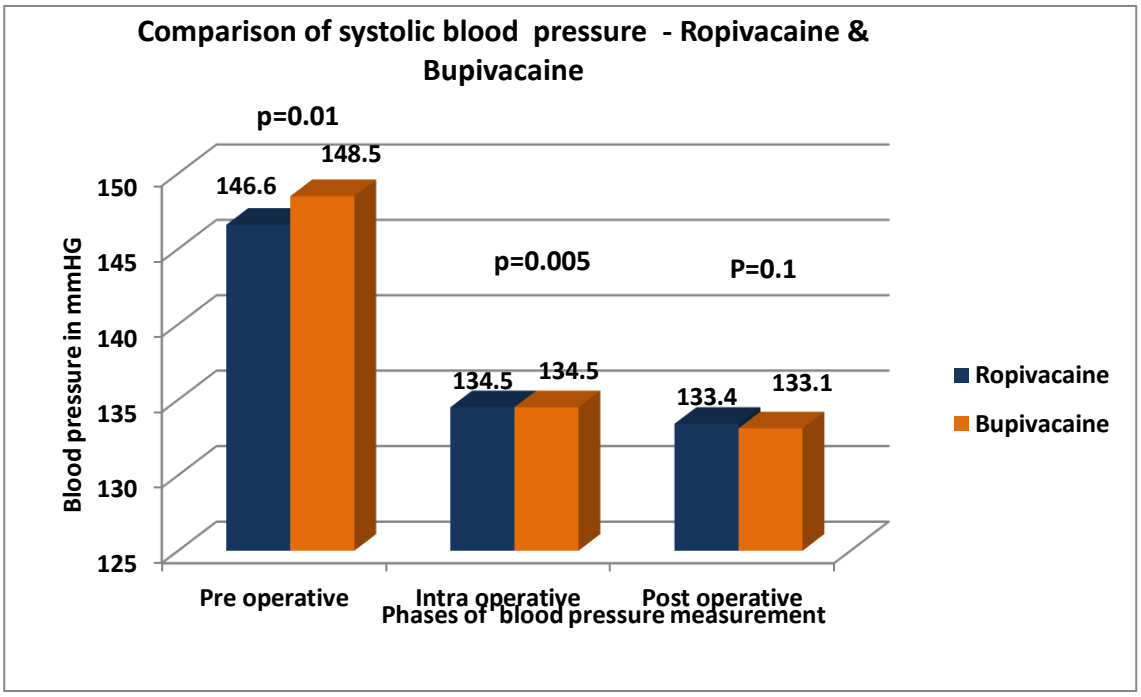

Figure 15A: Systolic blood pressure

Mean systolic blood pressure, mean±SD	*Ropivacaine*	*Bupivacaine*	*P value*
Pre-operative	146.6 ± 17.9	148.5 ± 11.8	0.01
Intra-operative	134.5 ± 12	134.5 ± 7	0.005
Post operative	133.4 ± 10.6	133.1 ± 8.1	0.1

Table 10A: Systolic blood pressure

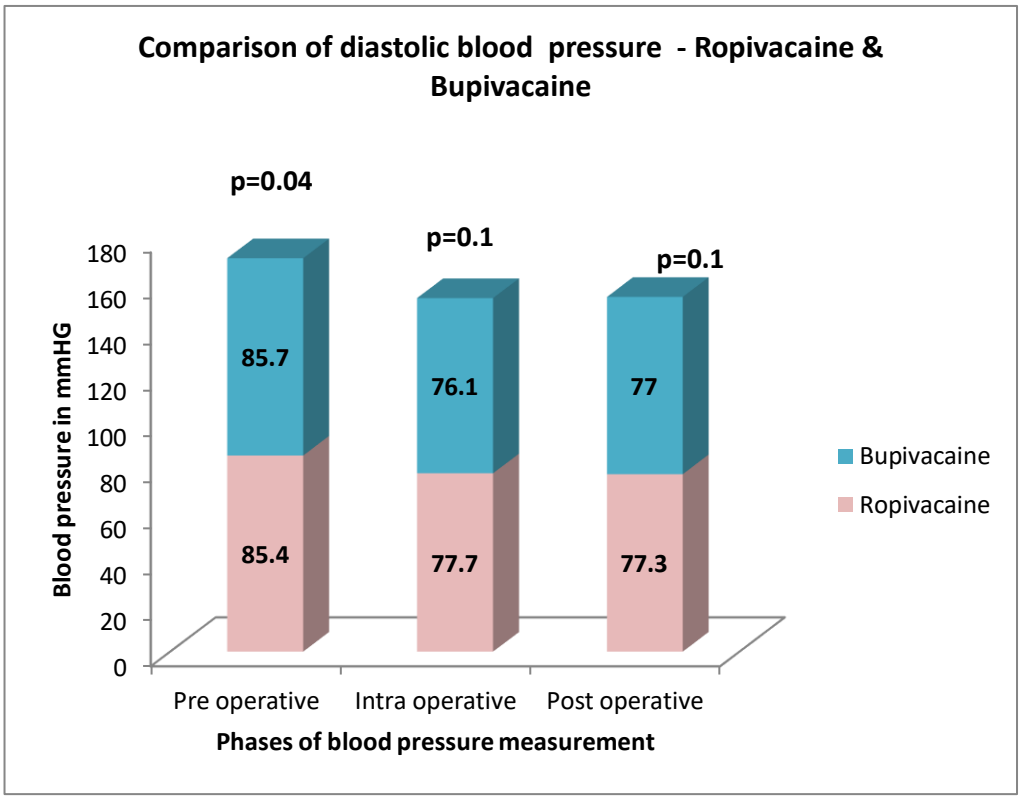

Figure 15B: Diastolic blood pressure

Mean diastolic blood pressure, mean±SD	*Ropivacaine*	*Bupivacaine*	*P value*
Pre-operative	85.4 ± 8.8	85.7 ± 6.3	0.04
Intra-operative	77.7 ± 8.5	76.1 ± 6.6	0.1
Post operative	77.3 ± 6.7	77 ± 8.4	0.1

Table 10B: Diastolic blood pressure

Pulse rate

Pre-operative, intra-operative and post operative pulse rates were similar in both groups (Table 11, Figure 16).

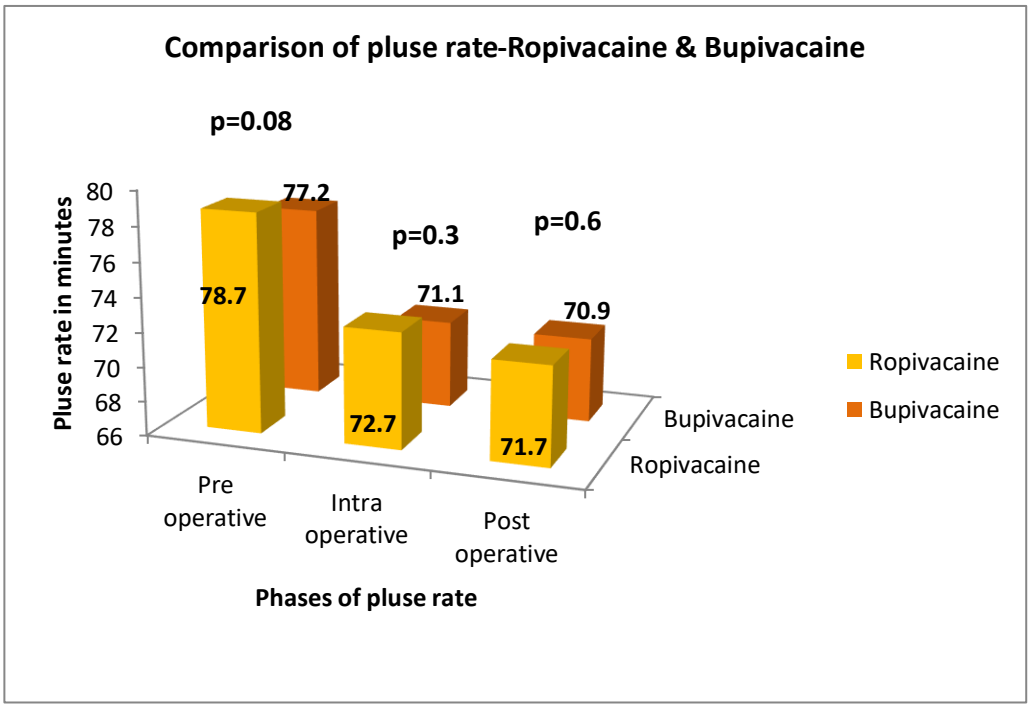

Figure 16: Pluse rate

Mean pulse rate, mean±SD	*Ropivacaine*	*Bupivacaine*	*P value*
Pre-operative	78.7 ± 9.8	77.2 ± 7.4	0.08
Intra-operative	72.7 ± 9	71.1 ± 7.5	0.3
Post operative	71.7 ± 6.5	70.9 ± 5.9	0.6

Table 11: Pluse rate

SpO2

The oxygen saturation differed significantly between groups during pre-operative, intraoperative and post operative phases (Table 12, Figure 17).

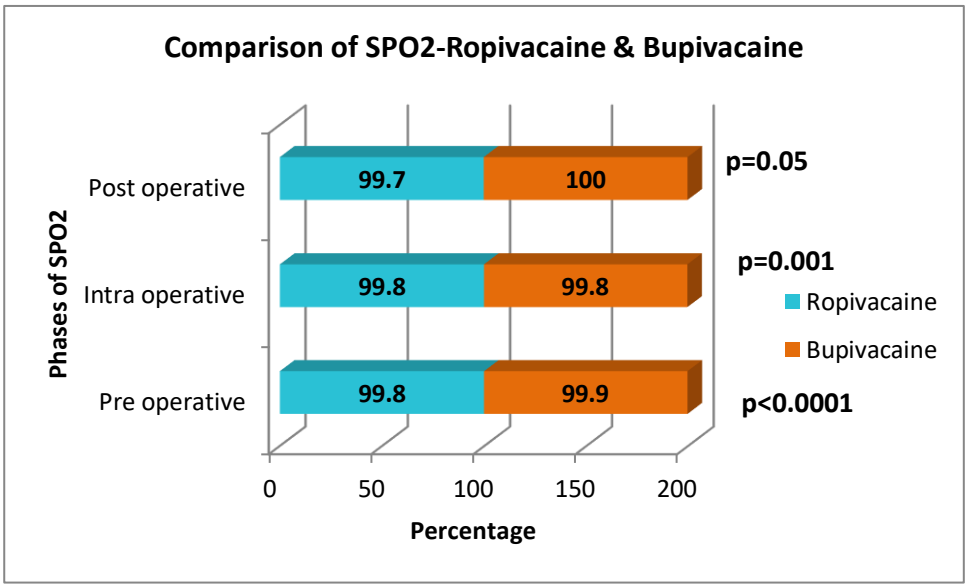

Figure 17: SPO2 measurement

Spo2, mean±SD	*Ropivacaine*	*Bupivacaine*	*P value*
Pre-operative	99.8 ± 0.06	99.9 ± 0.04	0.05
Intra-operative	99.8 ± 0.05	99.8 ± 0.01	0.001
Post operative	99.7 ± 0.06	100 ± 0.2	<0.0001

Table 12: SPO2 measurement

Requirement of additional medications

The requirement of added medications to enhance patient comfort intra-operatively was assessed for both Ropivacaine and Bupivacaine groups. We assessed what proportion of patients required Midazolam, Dexmedetomidine or Fortwin for enhancing patient comfort. Dexmedetomidine was the most common medication used, but the use was similar in both groups (40.5% vs. 43.3%, p= 0.8). The use of Midazolam and Fortwin was also similar in

both groups (5.6% vs. 6.7%, p=0.8 and 6.7% vs. 3.3%, p=0.5 respectively (Table 13, Figure 18)

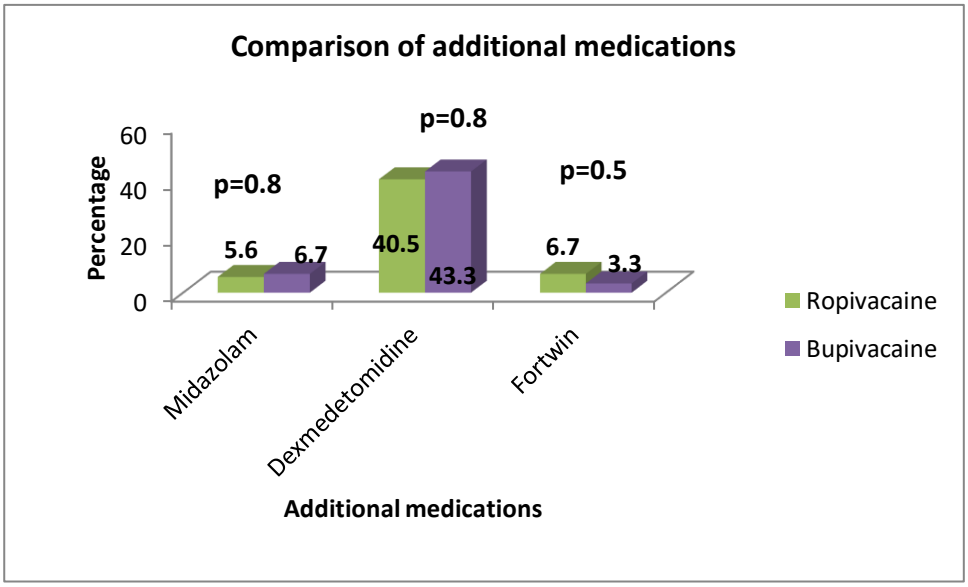

Figure 18: Additional medications

Additional medication requirements,n(%)	Ropivacaine	Bupivacaine	P value
Midazolam	5 (5.6)	2 (6.7)	0.8
Dexmedetomidine	36 (40.5)	13 (43.3)	0.8
Fortwin	6 (6.7)	1 (3.3)	0.5

Table 13: Additional medications

CHAPTER-7

DISCUSSION

DISCUSSION

Brachial plexus block is a regional anesthesia technique that is sometimes employed as an alternative or as an adjunct to general anesthesia for surgery of the upper extremity. This technique involves the injection of local anesthetic agents in close proximity to the brachial plexus, temporarily blocking the sensation and ability to move the upper extremity. Brachial plexus block for upper limb surgeries is an advantageous, as the effect of the drug is limited to the part of the body to be operated upon. Anaesthesia can either be general anaesthesia or involve a small area of the body (regional anaesthesia). Regional anaesthesia avoids the complications of general anaesthesia and also intubation while providing adequate analgesia and muscle relaxation in the operative area. It thus is a good alternative to general anaesthesia. In addition it provides the advantages of early ambulation and decreased incidence of thromboembolic complications. Ropivacaine and Bupivacaine are the most common local anesthetic agent used for giving brachial plexus block.

Hence the present study has compared the analgesic and anesthetic effects of Ropivacaine with Bupivacaine in brachial plexus block.

119 patients of American Society of Anesthesiologists (ASA) status I, II & III and age group above 18 years undergoing upper limb surgeries were randomly selected and investigated for the study purpose.

Paediatric patients below 18 years of age were not included because they form a separate group of patients with variations in vitals. Moreover they are not always clear in expression of feelings which would create confusing situations in determination of post-operative symptoms.

Patients belonging to ASA status IV & V are mostly with severe systemic disease that is a constant threat to life or a moribund person who is not expected to survive without operation. Considering these factors patients of ASA status IV & V were kept out of the study investigation.

The present study was a prospective, observational study. Data was collected from indoor surgical patients of a tertiary care hospital, AMRI Hospitals, Dhakuria, Gariahat Road, Kolkata. The study was conducted from June 2018 to March 2019 involving 119 randomly selected patients. Out of 119 patients selected, 56 patients were male and the remaining 63 patients were female. Due to random selection, number of female patients were more.

Out of three different types of brachial plexus block that is supraclavicular, interscalene and axillary blocks involved in the study, patients receiving supraclavicular block were found to be 79% followed by axillary block 23% and interscalene block 17%.

Additional medications namely Midazolam, Dexmedetomidine and Fortwin were also used to enhance patient's comfort during surgery. Among these three medications, the use of Dexmedetomidine was found to be more (83.8%).

From the study it was observed that the number of patients receiving Ropivacaine were more than that of Bupivacaine. The mean age of patients in the Ropivacaine group (53±16 years) was significantly higher compared to patients in the Bupivacaine group (47.3±10.1 years) ($p = 0.006$). Though the number of female patients were more compared to males but still the sex distribution was not satistically significant.

The study also compared the brachial plexus block with respect to fractured bones. Observations made from the study showed that the use of Ropivacaine and Bupivacaine significantly differed in the treatment of fractures involving combined fractures of radius and

ulna (3,4% vs. 16.7%; p= 0.01).

Though not significant, patients having hypertension as comorbidities had gone under the upper limb surgeries more compared to that of diaebetes mellitus,thyroid disorders and chronic obstructive pulmonary disease. Concommitant medications that the patients received were also compared between both groups. Despite of the use of more antihypertensive agents; the study found no significant difference between the medications.

Though supraclavicular type was the most common type of of brachial plexus block that was used for both groups of patients but the study found no statistical difference in the types of block given to the patients.

The study showed while the time of onset of analgesia was similar in both groups (Ropivacaine: 19.3±7.9 minutes, Bupivacaine: 21.7±6.3 minutes; p= 0.2), the time of onset of anaesthesia was significantly lower in the Ropivacaine group compared to Bupivacaine group (28.1±9.1 mins vs. 30.3±6.1 minutes, p= 0.01). ***Hickey et al. (1991)*** observed that the efficacy of 0.25% Ropivacaine for brachial plexus anesthesia was virtually identical to that of 0.25% Bupivacaine in terms of onset and sensory block as well as the need for supplementation. However, the 0.25% concentration of both agents appears to be unsuitable for brachial plexus block because of a high failure rate. The supplementation rate for the 36% Ropivacaine group and 43% for the Bupivacaine group is n sharp contrast to the supplementation rate of 8% for both local anaesthetics when used in a 0.5% concentrations.

The main advantage of Ropivacaine over Bupivacaine is its lesser cardiac potential for cardiac toxicity. In isolated rabbit Purkinje fibre ventricular muscle preparations, Moller and Covino demonstrated that the effect of Ropivacaine on altering various electro physiologic variables was greater than Lignocaine but less than Bupivacaine. Feldman etol. demonstrated in a dog model that although the convulsive doses of Ropivacaine and

Bupivacaine were similar, Ropivacaine was less arrhythmogenic than Bupivacaine. In a single human study that has examined the acute toxicity of Ropivacaine was reported by Scott et al in a group of 12 volunteers who received intravenous infusing of Ropivacaine and Bupivacaine upto a maximal dose of 150mg. It was noted that Ropivacaine cost less central nervous system symptoms and could be tolerated at a larger total dosage than Bupivacaine. In our study, we noted no overt signs of cardiac or central nervous system toxicity with either Bupivacaine or Ropivacaine.

Hickey et al. (1992) conducted a comparative study in 44 patients on the effectiveness of 0.25% ropivacaine and 0.25% bupivacaine. The patients were assigned to two equal groups in this randomized, double-blind study; one group received ropivacaine 0.25% (112.5 mg) and the other, bupivacaine 0.25% (112.5 mg), both without epinephrine and found that the mean onset time for analgesia ranged from 11.2 to 20.2 min, and the mean onset time for anesthesia ranged from 23.3 to 48.2 min.

And also, the duration of analgesia was significantly higher with Ropivacaine compared to Bupivacaine (282.6±110.5 minutes vs. 286.8±55.8 minutes; $p<0.0001$); the duration of anaesthesia was however similar with both drugs (229.3±122.2 minutes vs. 236.2±99 minutes; $p =0.2$).

Comparing with the above established data of 1992, our study showed higher time for both onset and duration of action

The study also inferred there was no difference in the post operative symptoms like nausea,vomiting and pain.

However, the pre-operative and intra-operative systolic blood pressure differed significantly between Ropivacaine and Bupivacaine group (pre-operative: 146.6 ± 17.9mmHg vs. 148.5 ±

11.8mmHg, p= 0.01; intra-operative: 134.5 ± 12mmHg vs. 134.5 ± 7 mmHg, p= 0.005 respectively). The pre-operative diastolic pressure also significantly differed between the two groups (85.4 ± 8.8mmHg vs. 85.7 ± 6.3, p=0.04).

Observations made from the study showed significant difference in the oxygen saturation levels during the pre-operative, intraoperative and post operative phases .

Despite of any significant association between the additional medications the use of Dexmedetomidine was more compared to Midazolam and Fortwin.

CHAPTER-8

LIMITATIONS

LIMITATIONS

Limitations of the present study are

- The sample size of the total population as well as individual recipient groups were small.
- Uneven patient distribution in each group.
- Paediatric patients were excluded from the study.
- Study did not take into account patients of ASA status IV and above.
- Study was conducted in a well-equipped tertiary care hospital.
- Ropivacaine and Bupivacaine were used randomly in patients and not in groups or sub-groups.

CHAPTER-9

SUMMARY

SUMMARY

Objective: This is a prospective observational study to compare the effects of Ropivacaine with Bupivacaine in brachial plexus block and also to assess a better local anaesthetics for brachial plexus block out of Bupivacaine and Ropivacaine in terms of effectiveness, acceptability and post-operative complications.

Method: Patients were selected according to inclusion criteria. The study was conducted in AMRI Hospitals, Dhakuria from June 2018 to March 2019. Proper written informed consent were taken. Brachial Plexus block by using nerve stimulator technique was administered with Inj. Bupivacaine+ Inj. Lignocaine or Inj. Ropivacaine+ Inj. Lignocaine. Drug doses was calculated according to body weight. Total volume of drug administered - 40ml. Data was collected in data collection sheets and analysed statistically.

Result: Total number of patients were 119; out of which female 63 patients, male 56 patients. Out of 119 patients,89 patients received inj Ropivacaine with inj Lignocaine and 30 patients received inj Bupivacaine with inj Lignocaine. The mean age of patients in the Ropivacaine group was significantly higher compared to patients in the Bupivacaine group ($p = 0.006$). While the time of onset of analgesia(sensory block) was similar in both groups (Ropivacaine: 19.3±7.9 minutes, Bupivacaine: 21.7±6.3 minutes; $p= 0.2$), the time of onset of anaesthesia(motor block) was significantly lower in the Ropivacaine group compared to Bupivacaine group (28.1±9.1 mins vs. 30.3±6.1 minutes, $p= 0.01$). And also, the duration of analgesia(sensory block) was significantly higher with Ropivacaine compared to Bupivacaine (282.6±110.5 minutes vs. 286.8±55.8 minutes; $p<0.0001$); the duration of anaesthesia(motor block) was however similar with both drugs (229.3±122.2 minutes vs. 236.2±99 minutes; $p = 0.2$). No significant differences were seen in the post-operative symptoms but only one patient in the Ropivacaine group experienced severe pain.

CHAPTER-10

CONCLUSION AND RECOMMENDATION

CONCLUSION

- This study was conducted in the operation theatres of AMRI Hospitals, Dhakuria, Kolkata from June 2018 to March 2019.
- This study was a prospective observational study.
- Total number of patients were 119,(ASA I,II&III)out of which 56 were male and 63 were female patients.
- Effects of injection Ropivacaine and injection Bupivacaine were compared.
- Injection Lignocaine hydrochloride was used with both the local anaesthetics.
- Mode of anaesthesia was brachial plexus block.
- Supraclavicular, interscalene and axillary routes of plexus blocks were studied.
- Axillary block was adequate for distal upper limb surgeries.
- Supraclavicular block was adequate for lower arm and forearm surgeries.
- Interscalene block was required for shoulder joint and upper arm surgeries.
- Supplementation drug was used viz ,injection Fortwin, Midazolam and Dexmedetomidine.
- Onset of action of sensory block was similar in both the groups.
- Onset of action of motor block was significantly lower in Ropivacaine group than to Bupivacaine group($p=0.01$)
- Duration of sensory block was significantly higher in Ropivacaine group compared

to Bupivacaine group($p<0.0001$)

- Duration of motor block was however similar in both the groups.
- The majority of surgeries were ORIF both bone upper arm.
- Post operative nausea,vomiting was not significant in any group.
- One patient in Ropivacaine group experienced severe pain though most of the patients in both the groups did not experienced any significant post operative pain.
- Among comorbidities, incidence of hypertension was highest.

RECOMENDATION

Based on the evidences gathered from the study, it can be recommended that Ropivacaine is the better local anaesthetics for brachial plexus block for upper limb surgeries. It is less cardio toxic than Bupivacaine. So this can be used in geriatric populations as majority of elderly patients do have cardiac ailments. It can also be recommended that Ropivacaine cost less central nervous system symptoms and could be tolerated at a larger total dosage than Bupivacaine.

CHAPTER-11

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ANNEXURES

DATA INFORMATION SHEET

Hospital	Date of Surgery	Regn. No.		
Age		Sex		
Disease	Operation	Type of Anaesthesia	Duration of Operation	
Co-Morbidities		Drug History		
Personal History		ASA Status		
Investigations	Hb	Coagulation Profile	Creatinine	
	Tc	Plasma Sugar	CXR	
	DC	Urea	ECG	
Preoperative Vitals		BP	Pulse	SPO_2
Type of Brachial Plexus Block	Supraclavicular	Infraclavicular		
Side	Right	Left		
Drug used	Ropivacine	Bupivacine		
Drug Dosage (ml)				
Onset of Action	Sensory (min)	Motor (min)		
Duration of Action	Sensory (hrs.)	Motor (hrs.)		
Intraoperative	Pulse	B.P.		
Post-operative	Pulse	B.P.		
Nausea/Vomiting				
Requirement of Additional Analgesics				
Conversion to general Anesthesia				
Visual analogue scale for Pain	Mild	Moderate	Severe	

LIST OF ABBREVIATIONS

- ASA- American Society of Anaesthesiologists
- LA- Local Anaesthetics
- RA- Regional Anaesthetics
- BP- Blood Pressure
- DM- Diabetes Mellitus
- HTN- Hypertension
- COPD- Chronic Obstructive Pulmonary Disease
- H/o- History of
- Mins/mins- minutes
- Hrs/hrs- hours
- Mg/mg- milligram
- ORIF- Open reduction and internal fixation
- Inj/inj- Injection
- ml- Millilitre
- n- Number of population