“COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES- A HOSPITAL BASED RANDOMIZED CONTROLLED TRIAL”

By

REG NO: BA0121005

DISSERTATION

SUBMITTED TO THE
KLE ACADEMY OF HIGHER EDUCATION & RESEARCH
(DEEMED-TO-BE-UNIVERSITY), BELAGAVI, KARNATAKA

In Partial Fulfillment of the requirements for the degree of

M.D.

In

ANAESTHESIOLOGY

JAWAHARLAL NEHRU MEDICAL COLLEGE,
BELAGAVI, KARNATAKA

DEC,2024- JAN,2025

ENDORSEMENT

ENDORSEMENT

This is to certify that the dissertation entitled **"COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES- A HOSPITAL BASED RANDOMIZED CONTROLLED TRIAL"** is a bonafide research work done by **REG NO. BA0121005** Department of Anaesthesiology, Jawaharlal Nehru Medical College, Nehru Nagar, Belagavi – 590010.

Dr. RAJESH MANE MD, DNB
Professor and Head,
Department of Anaesthesiology,
J.N.MedicalCollege, Nehru Nagar,
Belagavi– 590010
Date: 29/06/2024
Place: Belagavi

Dr. N. S. MAHANTSHETTI MD (Paed)
Principal,
J. N. Medical College,
Nehru Nagar,
Belagavi – 590010
Date: 29/06/2024
Place: Belagavi

KAHER BELAGAVI J.N. MEDICAL COLLEGE

PRINCIPAL
J.N. Medical College,
BELAGAVI- 590 010

PLAGIARISM CERTIFICATE

JAWAHARLAL NEHRU MEDICAL COLLEGE

(A constituent unit of KLE Academy of Higher Education & Research Deemed-to-be-University)

(Recognized by National Medical Commission, New Delhi)

Accredited 'A+' Grade by NAAC (3rd Cycle) Placed in Category 'A' by MoE (GoI)

Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA

0831 – 2471350 0831 – 2470759 www.jnmc.edu principal@jnmc.edu

Ref No: MDC/PG/ Date: 26-06-2024

"ACCEPTANCE LETTER"

The softcopy of thesis entitled: "COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES- A HOSPITAL BASED RANDOMIZED CONTROLLED TRIAL" has been submitted for anti-plagiarism check through Turnitin software. The scan has been carried out and the scanned output reveals a match percentage of 09% which is within the acceptable limits of 10% as per the guidelines given by UGC.

Guide.

KAHER J.N. MEDICAL COLLEGE BELAGAVI

Dr. (Mrs.) N.S. Mahantashetti.
Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

PRINCIPAL
J.N. Medical College,
BELAGAVI- 590 010

To,
Reg. No. BA0121005
Postgraduate Student,
2021-22 Batch,
Department of Anaesthesiology
J. N. Medical College, Belagavi.

UNDERTAKING

UNDERTAKING

I, REG NO. BA0121005 hereby declare that the information and the data mentioned in my dissertation entitled **"COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES- A HOSPITAL BASED RANDOMIZED CONTROLLED TRIAL"** belongs to me and is original. I am aware of the definition of Plagiarism as detailed below:

- An act or instance of using are closely imitating the language and thoughts of another author without authorization and the representation of that authors work as one's own, as by not crediting the original author.
- A piece of writing or other work reflecting such unauthorised use or imitation.
- The deliberate or reckless representation of another's words, thoughts, or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise.

I hereby declare that the dissertation prepared by me is original-one and does not involve plagiarism anywhere. In case at a later stage, it is found that I have indulged in plagiarism, then, I am solely responsible for the same and the institution is at liberty to take any disciplinary action against me including cancellation of dissertation or any other penalties imposed by the university.

Date: 29th June 2024

Place: Belagavi

REG NO. BA0121005

ETHICAL CLEARANCE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to- be- University)
Accredited 'A+' Grade by NAAC in (3rd Cycle) Placed in Category 'A' by MHRD (GoI)

JNMC INSTITUTIONAL ETHICS COMMITTEE
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)

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

Phone: (+ 91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref No.MDC/JNMCIEC/ 236. **Date: 19/05/2023**

To,
Reg No. BA0121005
PG Student in Anaesthesiology
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES- A HOSPITAL BASED RANDOMIZED CONTROLLED TRIAL",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

(Dr. Smita Sonoli)
Member Secretary
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi.

(Dr. Harsha Hegde)
Chairman,
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi

LIST OF ABBREVIATIONS

ASA	-	American Society of Anaesthesiologists
SA	-	Spinal anaesthesia
SAB	-	Subarachnoid Block
LA	-	Local Anaesthetic
SAS	-	Subarachnoid Space
CSF	-	Cerebrospinal Fluid
CVS	-	Cardiovascular system
CNS	-	Central Nervous System
CS	-	Caesarean Section
ASA	-	American Society of Anaesthesiologists
HR	-	Heart Rate (bpm)
SBP	-	Systolic Blood Pressure (mmHg)
DBP	-	Diastolic Blood Pressure (mmHg)
MAP	-	Mean Arterial Pressure (mmHg)
SpO_2	-	Saturation of peripheral oxygen (%)
Inj	-	Injection
IV	-	Intravenous
L	-	Lumbar vertebra

ml	-	milliliter
mcg	-	micrograms
mg	-	milligram
kgs	-	kilograms
cms	-	centimeters
g/cm	-	grams per centimeter
mEq/L	-	milliequivalents per litre
mg/dl	-	milligrams per decilitre
mcg/ml	-	micrograms per millilitre
g/mol	-	grams per mol
mins	-	minutes
L/min	-	Litres per minute
RCT	-	Randomized controlled trial
CBC	-	Complete Blood Count
BG	-	Blood Grouping
RBS	-	Random Blood Sugar
LFT	-	Liver Function Test
RFT	-	Renal Function Test
CXR-PAV	-	Chest X-ray Postero-anterior view

SD	-	Standard Deviation
vs	-	Versus

ABSTRACT

Title:

Comparison between hyperbaric bupivacaine with fentanyl and hyperbaric levobupivacaine with fentanyl in spinal anaesthesia for infraumbilical surgeries- a hospital based randomized controlled trial.

Context:

Spinal anaesthesia with hyperbaric bupivacaine is commonly used, while hyperbaric levobupivacaine is less studied. We aimed to compare onset and duration of sensory-motor block and hemodynamic effects between these formulations when used with fentanyl.

Aims:

To compare onset and duration of sensory-motor block of fentanyl with hyperbaric formulations of bupivacaine and levobupivacaine in spinal anaesthesia for infraumbilical surgeries and to assess hemodynamic parameters.

Settings and design: one-year randomized controlled trial.

Methods:

100 patients (18-60 years) undergoing elective infraumbilical surgeries under spinal anaesthesia were randomly assigned to 2 groups of 50 each -Group B (3ml of 0.5% Hyperbaric Bupivacaine with 25mcg Fentanyl) and Group L (3ml 0.5% Hyperbaric Levobupivacaine with 25m cg Fentanyl). Onset and duration of sensory-motor block and intraoperative hemodynamic parameters were assessed.

Results:

Similar onset of sensory-motor block was observed in both groups but Group B exhibited significantly longer durations of sensory ($p = 0.001$) and motor block ($p = 0.003$) compared to Group L. Hemodynamic parameters did not differ significantly between groups, however it showed variation over time within both groups ($p < 0.05$).

Conclusion:

When compared to Hyperbaric Levobupivacaine with Fentanyl, Hyperbaric Bupivacaine with Fentanyl demonstrated comparable onset but prolonged motor-sensory block durations with minimal hemodynamic variations underscoring local anaesthetic selection based on type and anticipated duration of surgery.

Keywords:

Spinal anaesthesia, Hyperbaric, Bupivacaine, Levobupivacaine, Fentanyl

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF PHOTOGRAPHS

INTRODUCTION

The most preferred anesthetic technique for patients requiring surgeries below umbilicus is the spinal anesthesia (SA). To achieve sensory-motor, and sympathetic blockade, a local anaesthetic (LA) drug is administered into CSF which is present in subarachnoid space (SAS), either with or without an adjuvant. It's a cost-effective procedure with the added advantage of reduced multiple drug usage, awake and spontaneously breathing patients.

In the present anaesthetic practice, Spinal anaesthesia is commonly done using 0.5% Hyperbaric Bupivacaine but Bupivacaine has its disadvantages of sympathetic and motor blockade that results in fall in blood pressure, fall in heart rate, prolonged immobility, abdominal and intercostal muscle weakness leading to shortness of breath. [1]

Levobupivacaine, racemic Bupivacaine's pure S(-) enantiomer has markedly improved toxicological profile especially of CVS and CNS. [2]

Clinical research on the utilization of isobaric Levobupivacaine in SA, epidural anaesthesia (EA), local procedures and peripheral nerve blocks have been conducted extensively. However, further information is needed about Hyperbaric Levobupivacaine's intrathecal delivery and its effects.

When low dosages of opioids are added to local anaesthetics (LA) in SA, the adverse effects linked to the LA is reduced as it lowers the quantity of LA used, improving the analgesia quality, both during and after surgery.

Opioids like Fentanyl, Buprenorphine, Morphine and Alpha-2 agonists Dexmedetomidine, Clonidine can be paired with LA for Subarachnoid Block (SAB) and these additives are found to prolong period of action and sensory block spread as well.

The current research compares the commencement and time frame of action of sensory block and motor block along with evaluation of consequences of Hyperbaric Levobupivacaine and Hyperbaric Bupivacaine with Fentanyl on hemodynamic variations among people receiving elective infraumbilical surgeries like inguinal hernia repair, hemorrhoidectomy, incision and drainage of abscesses below the umbilicus, lower limb orthopaedic procedures, fasciotomy, debridement, STSG etc.

OBJECTIVES

PRIMARY OBJECTIVE

To compare onset and duration of sensory block and motor block between 15mg Hyperbaric Bupivacaine 0.5% along with 25mcg Fentanyl vs 15 mg Hyperbaric Levobupivacaine 0.5% along with 25mcg Fentanyl for patients receiving SAB for elective infraumbilical surgeries.

SECONDARY OBJECTIVE

To study the haemodynamic changes.

REVIEW OF LITERATURE

The deposition of local anaesthetic into or near the nervous system is known as neuraxial anesthesia. Spinal anaesthesia is a form of neuraxial anaesthesia method and is the most often used anesthetic technique for patients undergoing surgeries of areas below the umbilicus like that of the lower abdominal wall, perineum and lower limbs. [3]

With hyperbaric solutions, a more reliable block with lesser profile of side-effects is anticipated like hypotension, high block, pruritis, vomiting and nausea. Additionally, because of the sympathetic block's cephalad extension, they may result in abrupt cardiac arrest as TJ Scull et al had stated in their study. [4]

While administering LA in SAB, low doses of Opioids like Fentanyl, Sufentanil, Morphine are added to reduce the likelihood of adverse effects due to the local anesthetic and enhances the analgesia quality both during and following the surgery. [5] [6]

Fentanyl, a centrally acting synthetic opioid is widely implemented as an additive and is frequently added to neuraxial procedures to increase the anaesthetic and analgesic properties. It has minimal cephalad spread property along with short acting but rapid onset of action and it is preferred to be utilized in spinal anesthesia as a supplement to local anesthetics. [7]

Other adjuvants like Buprenorphine, Dexmedetomidine [8], Clonidine can be used for SAB in conjunction with LA as they are found to prolong action and distribution of sensory block.

An RCT contrasting SA effects of isobaric levobupivacaine + fentanyl & hyperbaric bupivacaine + fentanyl was carried out by A. Goyal, P. Shankaranarayan, P. Ganapathi. They found that in terms of anaesthesia, plain levobupivacaine + fentanyl is as equally potent as hyperbaric bupivacaine + fentanyl. Additionally, they discovered that levobupivicaine when combined with fentanyl has a shorter motor block duration and enhances hemodynamic stability, suggesting that this combination is the better option for elective CS. [2]

E. Erturk, C. Tutuncu, A. Eroglu, M. Gokben in March 2009 studied the comparison between Ropivacaine 12mg + Fentanyl 20mcg and Bupivacaine 8mg + Fentanyl 20mcg. They deduced that either combinations provided sufficient sensory and motor block without much adverse effects or serious complications. Furthermore, ropivacaine was observed to cause less hemodynamics changes than bupivacaine, suggesting that it could be advantageous for older individuals. [9]

A study was conducted in May 2003 by C.O. Ogun, Kirgiz EN et al comparing 15mg Bupivacaine Plain + 150mcg Morphine vs 15mg Ropivacaine Plain + 150mcg Morphine for SAB. They stated that in addition to comparable sensory block and shorter motor block, Ropivacaine + Morphine enhanced postoperative analgesia. [10]

K. Koltka et al in 2009 undertook a project comparing equipotent doses of 19.5mg plain Ropivacaine + 20mcg Fentanyl vs 13mg plain Bupivacaine + 20mcg Fentanyl. They found that patients receiving plain Ropivacaine + Fentanyl had a lesser degree of sensory block with shorter motor block time frame in contrast to plain Bupivacaine + Fentanyl. [11]

F. Fattorini et al. (2006) assessed 3ml of 0.5% plain Levobupivacaine vs 3 ml of plain 0.5% Bupivacaine for spinal anesthesia in 60 patients. They found that Levobupivacaine is an acceptable replacement for Bupivacaine for spinal anaesthesia. They also stated that despite the fact that individuals receiving levobupivacaine did not experience any significant hemodynamic issues, larger and more comprehensive studies are required to determine whether levobupivacaine is better than bupivacaine in terms of reducing the potential cardiovascular effects of spinal anesthesia. [12]

A. Singh's RCT in 2017 compared intrathecal 3ml plain Levobupivacaine 0.5% vs 3ml Hyperbaric Racemic Bupivacaine 0.5%. They arrived at the conclusion that levobupivacaine, which has shorter time frame of sensory block and motor block than bupivacaine with reduced frequency of intraoperative hypotension, is a useful substitute for bupivacaine in patients undergoing surgical repair of unilateral inguinal hernia. [13]

Sethi D. conducted an RCT in 2015 on 100 parturients with body weight 45 to 85 Kg and height 145 to 155 cm with uncomplicated pregnancies under SAB. They were given one of the three medications at random, i.e., H. Bupivacaine 10mg, Plain Levobupivacaine 10mg or Plain Ropivacaine 15mg. The study concluded that anesthesia produced by Levobupivacaine or Ropivacaine is identical to that produced by hyperbaric bupivacaine and recommended their utilisation in spinal anaesthesia in elective CS for parturients of height 145-155cm. The extended time to motor block onset with Ropivacaine was the sole distinction seen between the spinal block characteristics of all three drugs. [14]

In 2009, Sen H et al carried out an RCT trying to draw comparisons between intrathecal Levobupivacaine Heavy (13.5mg) and Plain Levobupivacaine (13.5mg) in 50 elderly men who were to undergo elective Transurethral Endoscopic Surgery. They observed that Levobupivacaine Heavy led to a noticeably faster onset and offset of motor-sensory inhibition.

They concluded that Levobupivacaine Heavy had superior clinical efficacy than Plain Levobupivacaine for use during Transurethral Endoscopic Surgery under spinal anaesthesia. [15]

In 2007, B. Akan et al conducted an RCT with the purpose of contrasting the adverse effects and effectiveness of Levobupivacaine and Levobupivacaine when given with Fentanyl or Sufentanil on 60 males of 40-80 years, who were to undergo TURP under SAB. They discovered that Levobupivacaine with additives provided shorter mean times for sensory block at the T-ten dermatome than that by Levobupovacaine alone. In terms of hemodynamics, all three groups showed no differences. They found that cutting the dosage of Levobupivacaine to 7.5mg and incorporating it with 25mcg Fentanyl or 2.5mcg Sufentanil provided an adequate anaesthesia by offering a longer period of analgesia, motor blocks with reduced duration along with a quicker sensory block onset in these patients. [16]

In 2017, P. Rahimzadeh et al compared three groups -Bupivacaine + Dexmedetomidine, Bupivacaine + Fentanyl & Bupivacaine + Normal Saline and they concluded that addition of dexmedetomidine to bupivacaine resulted in longer postoperative analgesia with fewer adverse effects along with prolonged duration of motor and sensory blocks. [8]

S. Jagtap, A. Chhabra, S. Dawoodi et al conducted an RCT on 60 individuals who underwent major orthopaedic surgeries of the lower extremity under spinal anaesthesia where they observed that Ropivacaineine+Fentanyl provided satisfactory anaesthesia with hemodynamic stability in these patients when compared to Bupivacaine+Fentanyl but with similar sensory block between the two. However, in contrast to Bupivacaine+Fentanyl group, the Ropivacain+-Fentanyl group experienced a motor block for a shorter length of time. [17]

BASIC SCIENCES

Subarachnoid Block also known as Spinal Anaesthesia is the anaesthesia of choice for surgeries of the lower abdominal wall, the perineum and the lower limbs. It causes sensory, motor and sympathetic blockade. The main advantage of spinal anaesthesia is the avoidance of the usage of multiple drugs and manipulation of the airway as it is done in general anaesthesia. It also causes reduction in the metabolic stress response to surgery, reduction in pulmonary compromise as well as reduction in blood loss.

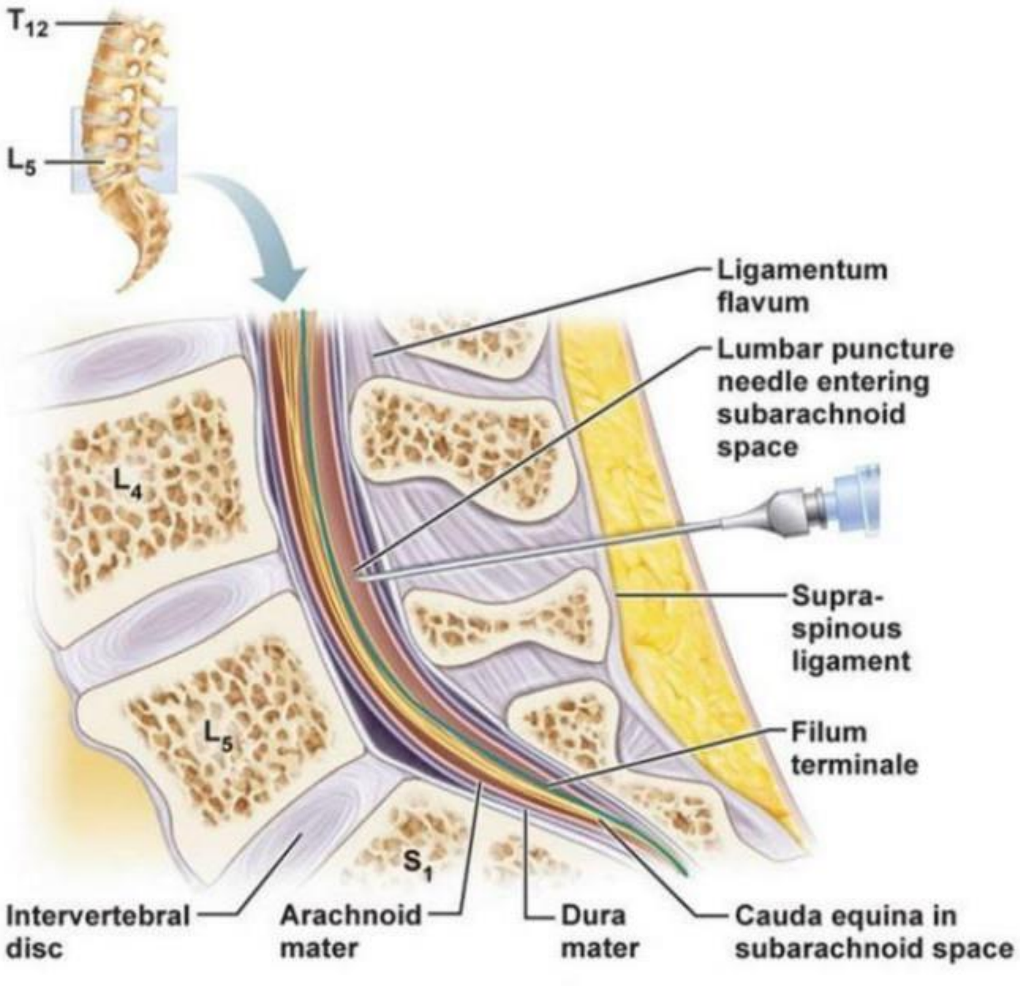


Fig 1: Subarachnoid Block

Spinal anaesthesia is administered only in the lumbar region, specifically the mid to low lumbar levels in order to avoid damaging the spinal cord. This also prevents intrathecally injected drugs from having any activity in the upper thoracic and cervical regions. [3]

CONTRAINDICATIONS OF SPINAL ANAESTHESIA

Absolute contraindications of spinal anaesthesia comprise of refusal by the patient, infection at the injection site, uncorrected hypovolemia, increased intracranial pressure, allergies to local anaesthetics.

Relative contraindications of spinal anaesthesia include coagulopathies, indeterminate neurological disease, fixed cardiac output states, septic shock.

COMPLICATIONS OF SPINAL ANAESTHESIA

Minor: Nausea, vomiting, mild hypotension, shivering, itching, urinary retention and transient hearing impairment.

Moderate: Failed spinal block, Post-dural puncture headache (PDPH).

Major: Direct needle trauma, spinal cord ischaemia, infection (abscess, meningitis), vertebral canal hematoma, cauda equina syndrome, arachnoiditis, peripheral nerve injury, total spinal anaesthesia, cardiovascular collapse, death.

ANATOMY

For a successful spinal anaesthesia, it is important for the anaesthesiologist to have a detailed knowledge of the anatomy of the vertebral column, spinal cord and spinal nerves.

VERTEBRAL COLUMN

The main function of the vertebral column is to protect the spinal cord. There are a total of 33 vertebral bodies that make up the vertebral column which includes the following: [3]

- Cervical - 07
- Thoracic - 12
- Lumbar - 05
- Sacral - 05 (fused)
- Coccyx - 04 (fused)

CURVES OF THE SPINE

The vertebral column has four curves in adults.

- Cervical curve - Convex anterior
- Thoracic curve - Concave anterior
- Lumbar curve - Convex anterior
- Sacral curve - Concave anterior

The curves of the spine are important when the patient is in supine position. The highest point of cervical and lumbar curves in supine position are at cervical-C5 and lumbar-L5, lowest points of thoracic and sacral at T5 and S2 respectively. Spread of local anaesthetic in the subarachnoid space is determined by the vertebral column curves, baricity of the local anaesthetic solution and positioning of the patient

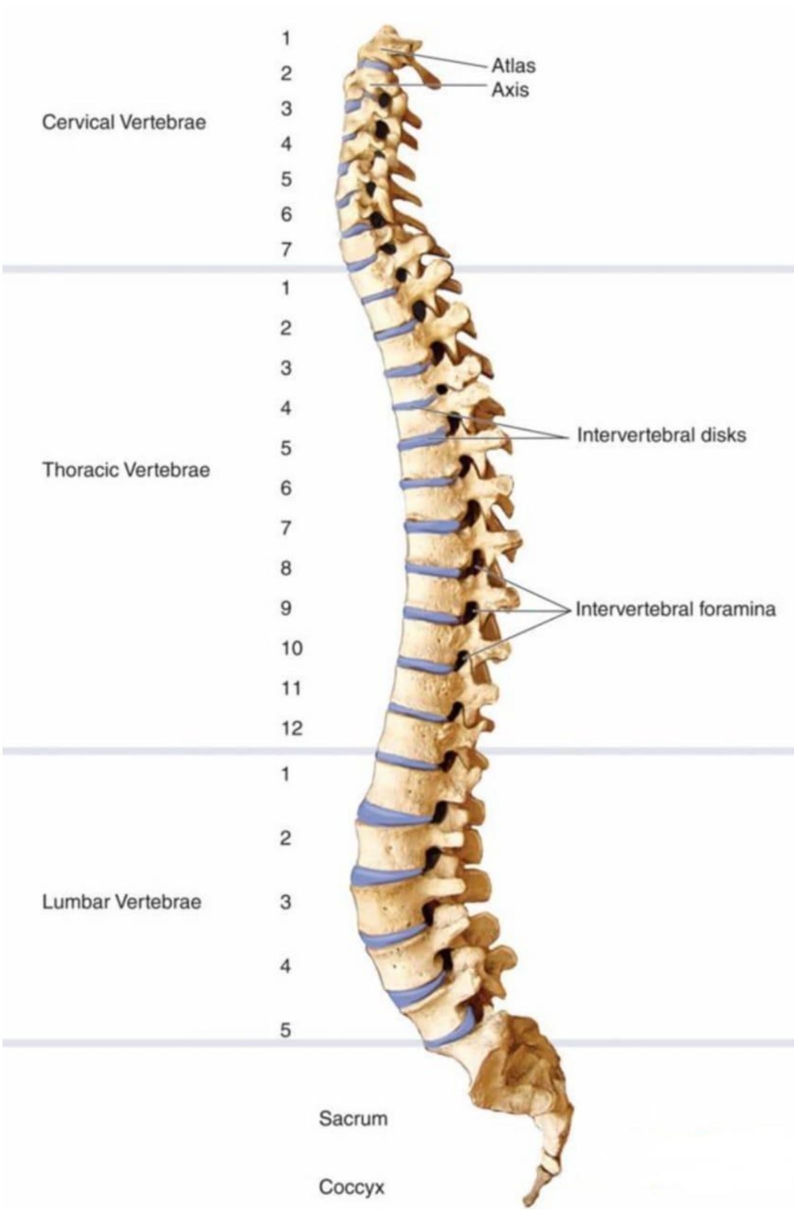


Fig 2: Vertebral Column

VERTEBRAL LIGAMENTS

Vertebral column is bound by the following ligaments that give it stability and elasticity.

Supraspinous Ligament: It is a strong fibrous ligament which connects the apices of the spinous processes from the C7 vertebra to the Sacrum. It is also known as LIGAMENTUM NUCHAE in the area above C7 vertebra.

Interspinous Ligament: It is a thin membranous ligament which connects the spinous processes and it blends anteriorly with ligamentum flavum and posteriorly with supraspinous ligament.

Ligamentum Flavum: It comprises of yellow elastic fibres and connects the adjacent lamina. It begins laterally at the root of the articular processes and extends posteriorly and medially to the point where laminae join to form spinous process.

Longitudinal ligaments: There are two longitudinal ligaments (anterior and posterior) and they bind the vertebral bodies together.

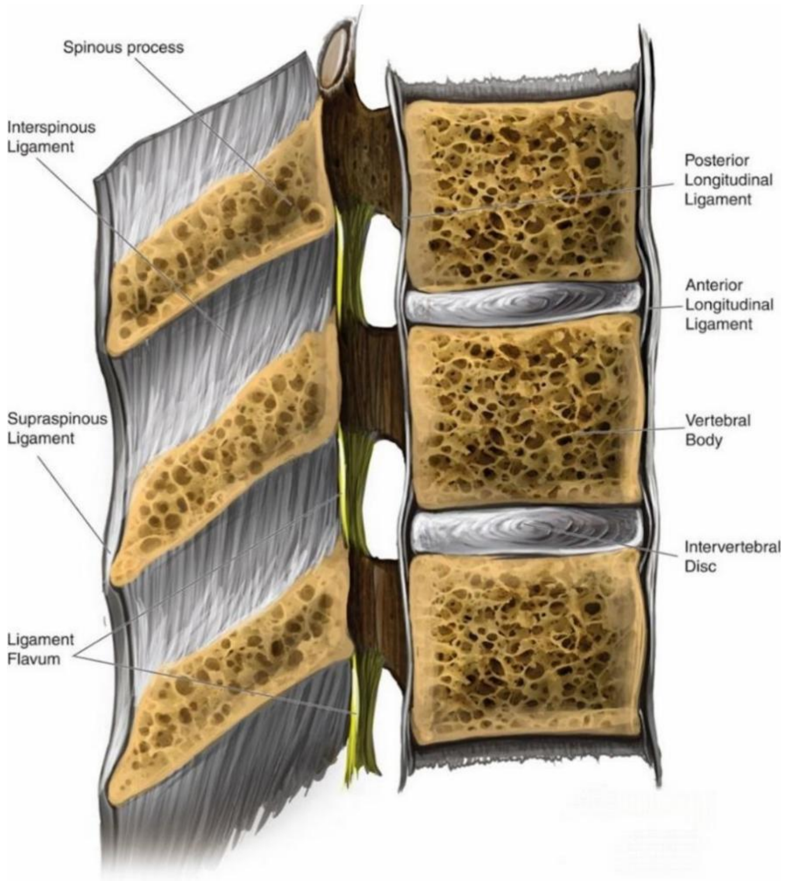


Fig 3: Ligaments of Spine

LUMBAR VERTEBRAE

A typical lumbar vertebra consists of:

- A kidney shaped body
- Two pedicles directed backwards from the upper part of the body
- Two slender transverse processes
- Two laminae meeting posteriorly and enclosing the triangular vertebral foramen
- Spinous processes which are broad, thick and quadrilateral in shape
- Two upper and lower articular processes which prevent rotation but allow limited flexion and extension between the contiguous vertebrae.

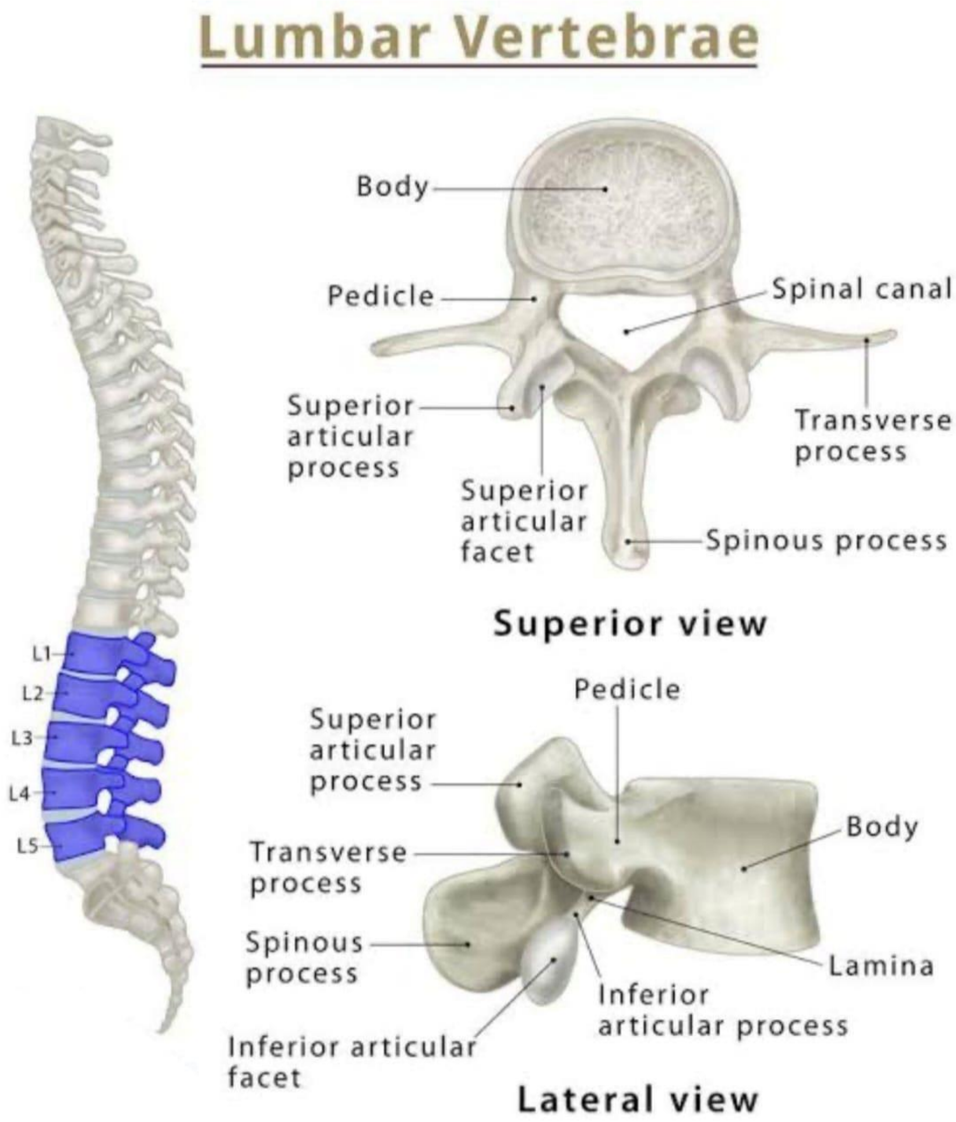


Fig 4: Lumbar Vertebrae

TOPOGRAPHICAL LINE OF TUFFIER

It is an imaginary line that passes between the highest points of the iliac crests which crosses the spine of the fourth lumbar vertebra in the upright position. When the patient is in lateral decubitus position it may pass through the L4-L5 interspace. The lumbar spaces are identified by using the superior iliac crest.

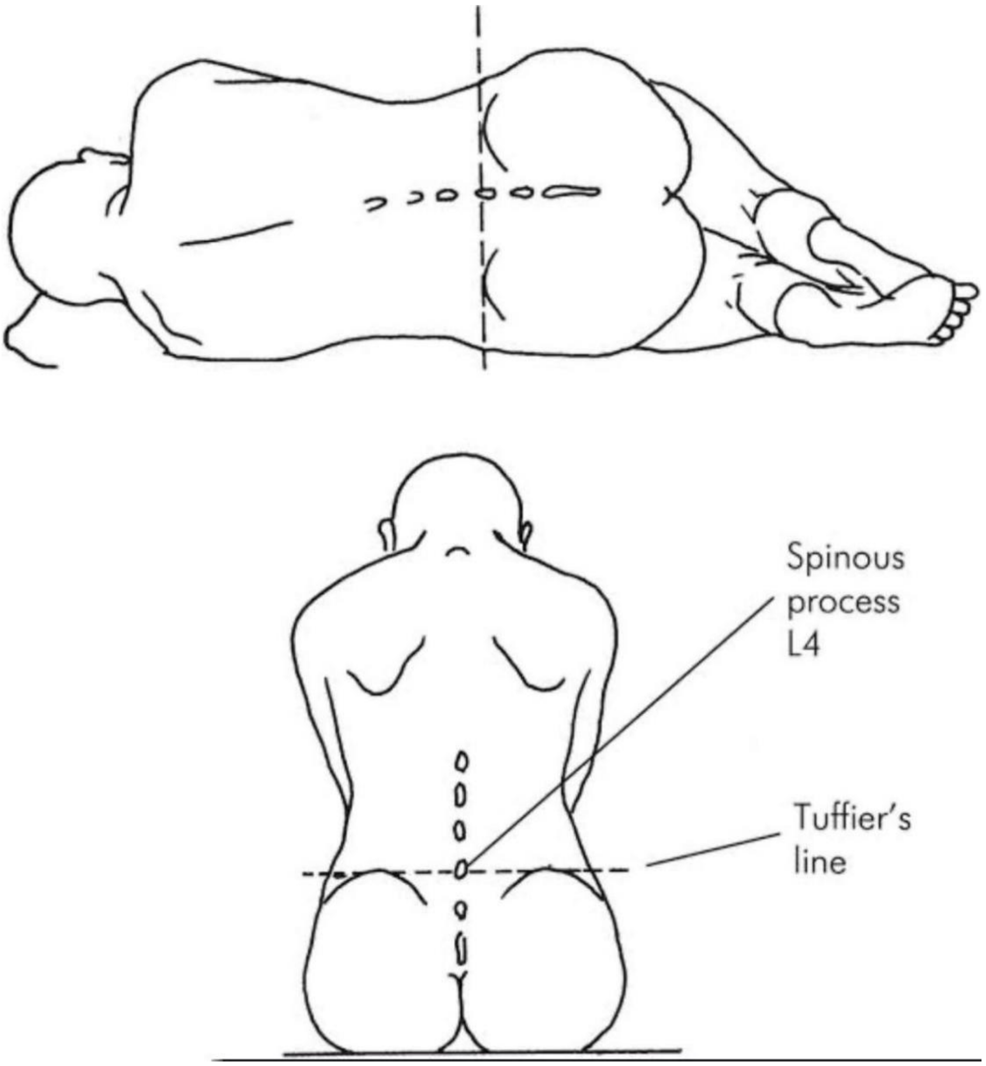


Fig 5: Topographical line of Tuffier

VERTEBRAL CANAL

Vertebral canal is bound posteriorly by the spinous processes and interspinous ligaments, laterally by the pedicles, postero-laterally by the laminae and the ligamentum flavum. Superiorly it extends from foramen magnum and terminates inferiorly in the sacral hiatus.

Its contents are:

- spinal cord
- dorsal root ganglia
- ventral rootlets
- roots of the spinal nerves
- sympathetic trunk

- rami communicantes
- adipose tissue
- CSF
- blood vessels and
- spinal membranes

SPINAL CORD

The spinal cord is the continuation of medulla oblongata below the level of foramen magnum and it tapers off into a conical extremity known as conus medullaris. A delicate fibrous filament descends to the back of the first segment of the coccyx from the apex of conus medullaris which is called *filum terminale* which is a continuation of the pia mater. The average length of the spinal cord in males is 45 cm and 42 cm. The length of the spinal cord differs according to age. In the first trimester, the foetal spinal cord extends up till the end of the spina; column. As the foetus grows the vertebral column lengthens more than the length of the spinal cord. At birth, the spinal cord ends approximately at the L3 space and in adults it ends approximately at the upper border of the L1 vertebra.

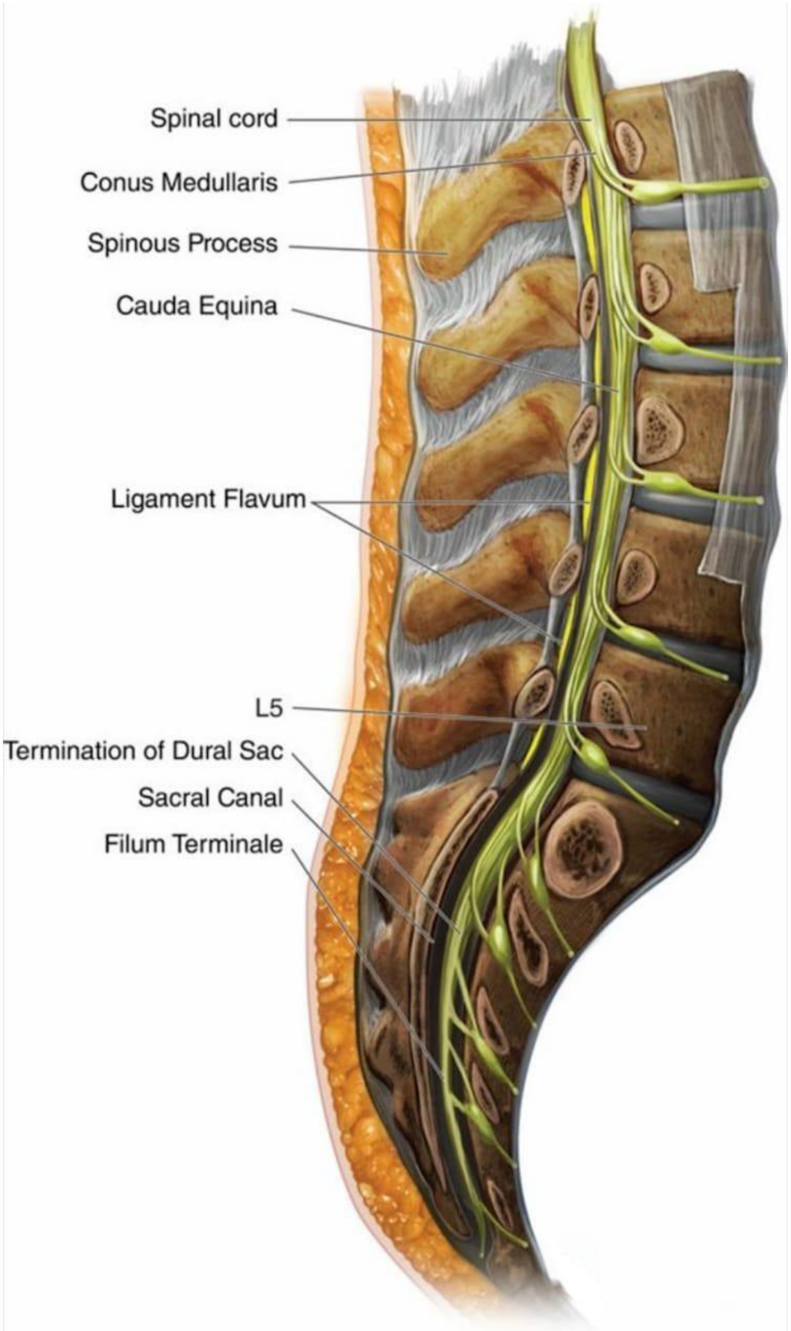


Fig 6: Spinal cord at Lumbo-sacral region.

BLOOD SUPPLY OF THE SPINAL CORD

The spinal cord is supplied by three arteries: One anterior spinal artery and two posterior spinal arteries.

Anterior Spinal Artery is a single vessel lying in the substance of the pia mater overlying the anterior median fissure. It supplies the lateral and anterior columns which comprises the three quarters of the substance of the cord. Thrombosis of this artery leads to Anterior spinal artery syndrome. [18]

There are two pairs of ***Posterior Spinal Arteries*** one pair on each side of the spinal cord arising from the posterior cerebellar arteries at the level of foramen magnum. They supply the posterior column of the spinal cord. [18]

There is no anastomosis between the anterior and posterior spinal arteries.

Anterior and posterior plexus of veins in the neck, azygos veins in the thorax, lumbar veins in the abdomen, lateral sacral veins in the pelvis are responsible for the venous drainage of the spinal cord.

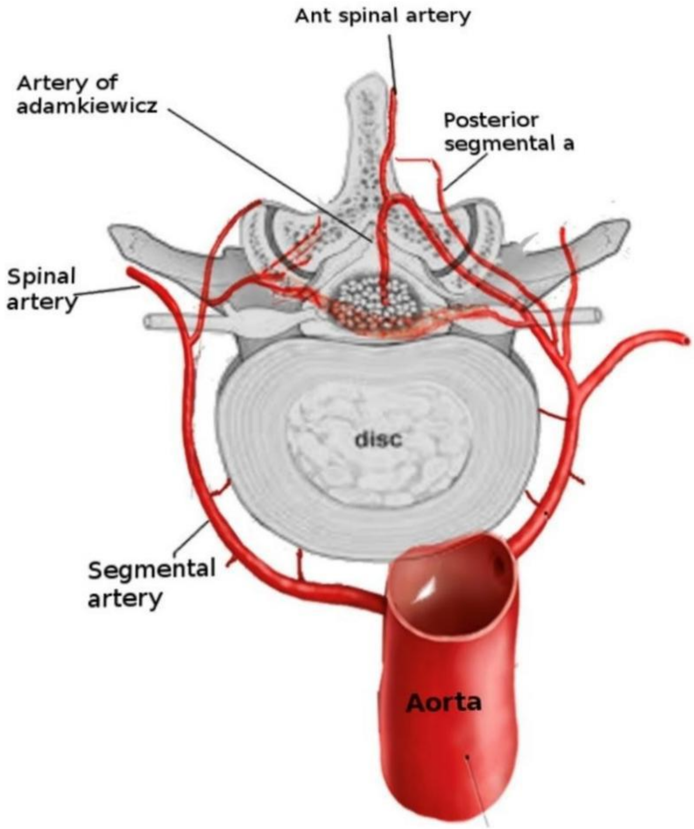


Fig 7: Blood supply of the Spinal cord (transverse view)

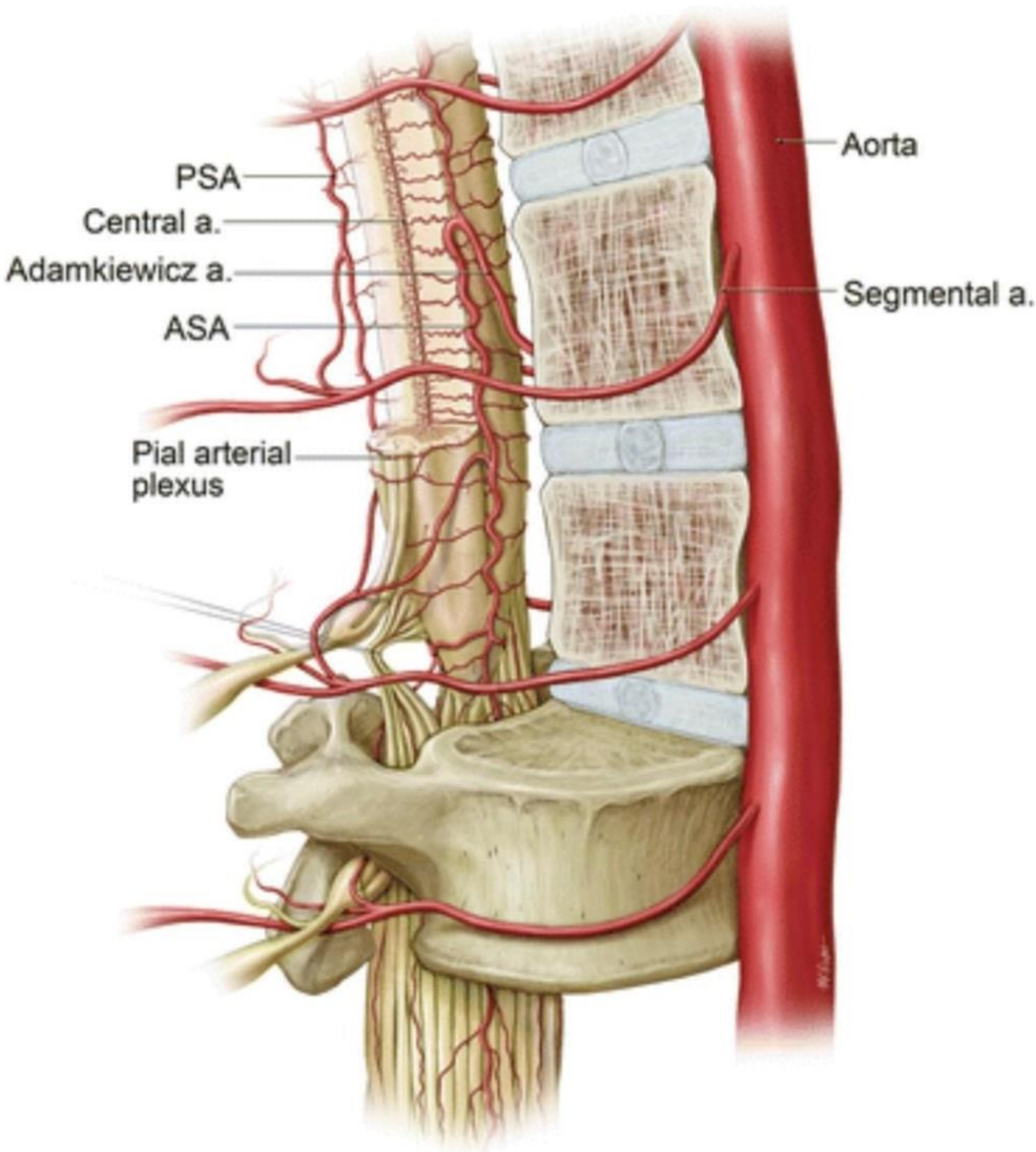


Fig 8: Blood supply of the spinal cord (lateral view)

SPINAL MENINGES

Spinal cord is also protected by three connective tissue coverings called *Meninges*- Dura mater, Pia Mater and Arachnoid mater.

DURA MATER: It is a tough outermost fibro-elastic covering which consists of an outer endosteal layer and an inner meningeal layer. The fibres of the dura mater are aligned longitudinally. The dural sac ends at the lower border of S2 where it is pierced by the filum terminale.

ARACHNOID MATER: It is a delicate, non-vascular, middle layer and is closely attached to the dura mater. There is a potential space between the dura mater and arachnoid mater called the subdural space and it contains serous fluid.

PIA MATER: It is the innermost membrane and is a vascular sheath which closely invests the brain and spinal cord. It continues till the coccyx as filum terminale.

SUBARACHNOID SPACE: It is the space between the arachnoid mater and the pia mater and is filled with cerebrospinal fluid (CSF) along with numerous arachnoid trabeculae which form a delicate sponge like mass. This space has three divisions that are in continuation with each other: Cranial (surrounding the brain), Spinal (surrounding the spinal cord) and Root (surrounding the ventral and dorsal nerve roots). In the spinal cord, these nerves are covered only by pia mater and bathed in CSF. As these spinal nerve roots pass beyond the spinal dura and traverse the epidural space, they carry with them all the three layers of the meninges and have a distinct epidural, subdural, subarachnoid and subpial spaces. The subarachnoid space extends separately along both the dorsal and ventral roots to the level of dorsal root ganglion where the arachnoid and pia continue as perineural epithelium of peripheral nerves.

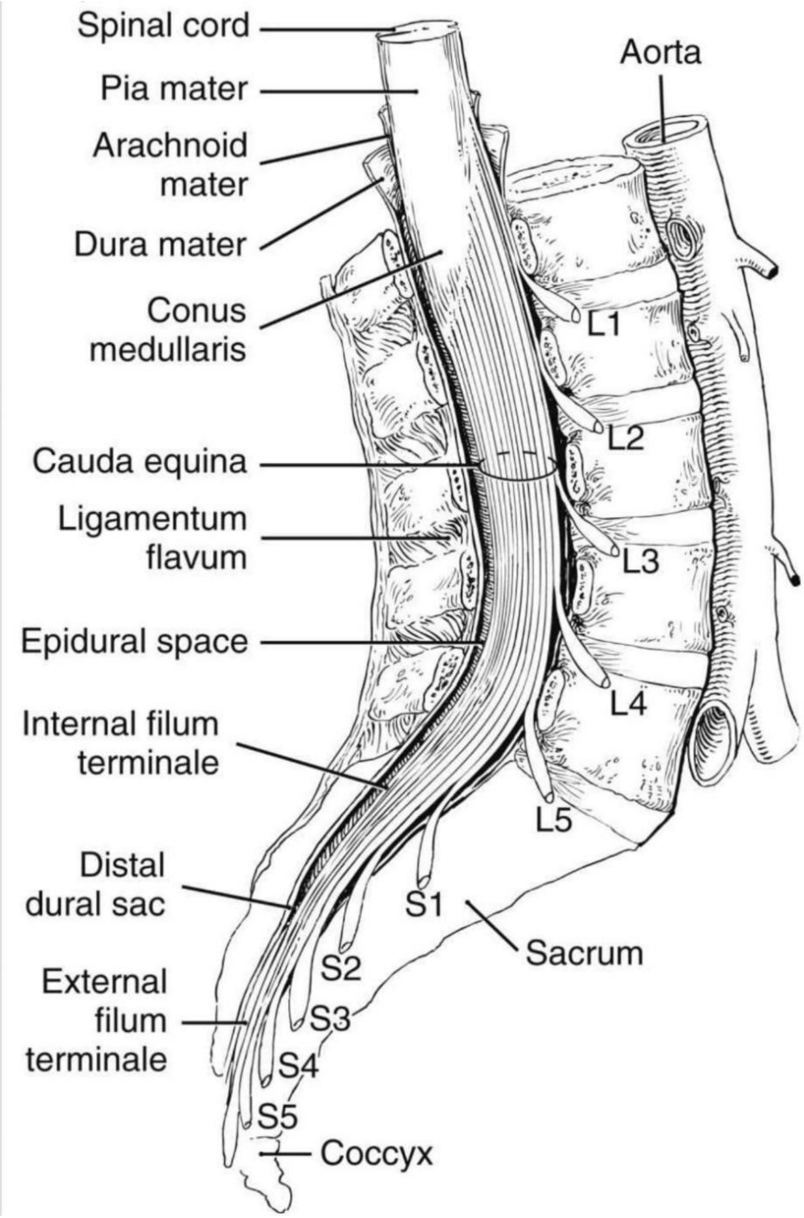


Fig 9: Spinal cord with its meningeal layers at Lumbo-sacral level

CEREBROSPINAL FLUID

It is a clear, colourless fluid found in the cranial and spinal subarachnoid spaces and in the ventricles. It is mainly formed by either secretion or ultrafiltration from the choroidal plexus of the lateral ventricles. It flows from the lateral ventricles into the third ventricle through the Foramen of Monroe and then into the fourth ventricle through the Aqueduct of Sylvius. CSF then flows into the Cisterna Magna (cerebro-medullary cisterna) through the Foramen of Magendie and Foramen of Lushka. From the Cisterna Magna, CSF enters the Subarachnoid Space where it flows over the surface of cerebral cortex and spinal cord before it is absorbed into the arachnoid granulations which are present over the cerebral hemispheres and the finally into the cerebral venous system. [19]

COMPOSITION OF CSF:

- Specific Gravity : 1.003 to 1.00 g/cm at 37°C
- Volume : 120 ml to 150 ml (25 ml to 35 ml in the spinal space)
- CSF pressure : 60-80 mmHg in the Lumbar space
- pH : 7.27 to 7.37
- PCO_2 : 48 mmHg
- HCO_3 : 23 mEq/L
- Sodium : 135-145 mEq/L
- Calcium : 2-3 mEq/L
- Phosphorus : 1.6 mg/dl
- Magnesium : 2-2.5 mEq/L
- Chloride : 15-20 mEq/L
- Proteins : 23-38 mg/dl

PHYSIOLOGY OF SUBARACHNOID BLOCK

The various factors that control the different effects of a spinal anaesthetic technique are as follows:

- The amount and the type of drug
- Volume of the drug solution
- The site of injection
- The rate of injection
- Specific gravity of the solution- baricity and density
- Barbottage.

The factors that affect the spread of local anaesthetics are:

1. Patient factors:

- Age
- Height
- Position
- Cerebrospinal fluid volume
- Spinal column configuration

2. Technical Factors:

- Site of injection
- Direction of the needle
- Dose of the local anaesthetic
- Baricity of the local anaesthetic
- Volume of the local anaesthetic

The nerve roots as well as spinal cord take up the local anaesthetics after injection into the subarachnoid space. More the surface area of exposure of the nerve root, more is the uptake of the drug. There are two mechanisms by which the local anaesthetic gets taken up:

- The first mechanism is by diffusion from the CSF into the pia mater and into the spinal cord. This is a slow process and only the most superficial portion of the spinal cord is affected.

- The second mechanism of local anaesthetic uptake is by extension into the spaces of Virchow-Robin which is the area of pia mater that surround the blood vessels which penetrate the Central Nervous System. These spaces connect with perineural clefts that surround the nerve cell bodies in the spinal cord.

The site of action is on both the anterior and posterior nerve roots, affecting the smaller nerve fibres first and the thick large motor nerve fibres last.

The sympathetic fibres are affected first and are last to recover. The sympathetic blockade is more diffuse and extends two to four segments above the motor block. Sympathetic blockade is the major determinant of physiologic response to spinal anaesthesia.

The motor blockade is usually the last to be affected and first to recover.

SEQUENCE OF SPINAL ANESTHESIA

- Vasomotor Block: Dilatation of skin vessels and increase cutaneous blood flow.
- Temperature Fibres: Cold sensation lost first followed by warm sensation.
- Loss of temperature discrimination
- Pain- Pin prick sensation lost first
- Loss of tactile sensation
- Motor paralysis
- Loss of pressure sensation
- Loss of proprioception and vibratory sensation

SYMPATHETIC BLOCKADE

Sympathetic fibres are usually blocked two to three segments above the sensory blockade and sensory blockade is two segments higher than motor blockade. Since the level of sympathetic denervation determines the magnitude of cardiovascular response to subarachnoid block, it could be anticipated that higher the level of neural blockade, greater would be the changes in the cardiovascular and hemodynamic parameters.

CARDIOVASCULAR EFFECTS OF SPINAL ANAESTHESIA

The autonomic denervation that accompanies spinal anaesthesia affects the cardiovascular system in the following ways:

- Vasodilation of resistance and capacitance vessels

- Blockade of cardiac efferent sympathetic fibres from T1-T4 resulting in loss of chronotropic and inotropic drive and fall in cardiac output.
- Bainbridge reflex causing bradycardia
- Depression of vascular smooth muscles and beta-adrenergic blockade of the myocardium with fall in cardiac output following systemic absorption of local anaesthetic drug.

Block extending above T4 level is associated with fall in Blood Pressure. Bradycardia occurs if any of the anterior roots carrying the sympathetic cardiac accelerator fibres are blocked, which may happen in high spinal block above T4-T5. Bradycardia may also be due to lowering in blood pressure in the right atrium consequent to diminished venous return.

THEORIES OF CAUSATION OF HYPOTENSION

- Reduced venous return leading to diminished cardiac output
- Dilation of post-arteriolar capillaries and small venules
- Paralysis of sympathetic nerve supply to the heart
- Paralysis of the sympathetic nerve supply to the adrenal glands leading to catecholamine depletion.

CEREBRAL BLOOD FLOW

Due to the presence of cerebral autoregulatory mechanism in humans, cerebral blood flow is maintained at constant levels.

RESPIRATORY SYSTEM

Breathing becomes quiet and tranquil during spinal anaesthesia. This is due to differentiation with reduction of sensory input to respiratory centre along with motor blockade. Intercostal muscle paralysis is compensated by increased descent of diaphragm which is enabled by the lax abdomen. However, the pulmonary gas-exchange is preserved.

GASTROINTESTINAL SYSTEM

Pre-ganglionic sympathetic fibres extending from T5 to L1 are inhibitory to the gut with no effect on oesophagus which has vagal nerve innervation. Neuraxial block-induced sympathectomy causes Vagal dominance which leads to small, contracted bowel with active peristalsis. The pressure in the bowel lumen increases. There is relaxation of sphincters.

NAUSEA AND VOMITING

Causes are as follows:

- Hypotension
- Hypoxia
- Traction on nerve endings (especially the Vagus nerve)
- Increased peristalsis
- Relaxation of pyloric sphincter leading to presence of bile in stomach which causes nausea and vomiting
- Psychological effects
- Opioid analgesics that are used as a part of pre-medication.

GENITOURINARY SYSTEM

Renal blood flow is maintained through autoregulation with little effect on kidney function with normal systemic blood pressure. Neuraxial anaesthesia at the lumbar and sacral levels block both sympathetic and parasympathetic control of bladder function.

Urinary retention post spinal anaesthesia may be moderately prolonged due to involvement of autonomic fibres of S2 to S3. Their paralysis lasts longer than that of larger sensory and motor fibres.

Due to the paralysis of *nervi arigentes* (S2 to S3), the penis becomes engorged and flaccid

UTERUS

Uterus muscle tone is not greatly altered after spinal anaesthesia in pregnancy.

NEUROENDOCRINE SYSTEM

Neuroendocrine stress response by activation of somatic and visceral afferent nerve fibres along with localised inflammatory response occur with surgical trauma. Neuraxial blockade can partially suppress or completely block the neuroendocrine stress response.

BODY TEMPERATURE

Hypothermia is a common occurrence. Neuraxial anaesthesia reduces the threshold for shivering by inhibiting the central thermoregulatory control.

Block of peripheral sympathetic and motor nerves prevents vasoconstriction and shivering. Heat loss continues through convection, evaporation and radiation.

Catecholamine secretion is depressed, hence less heat is produced by metabolism.

PHARMACOLOGY

LOCAL ANAESTHETICS

Local anaesthetic drugs are the drugs that case reversible blockade of conduction of nerve impulses. The properties of an ideal local anaesthetic agent are:

- Short latency
- High potency
- High diffusion
- Low toxicity
- Complete reversibility of its actions
- Prolonged duration of action
- No tachyphylaxis
- Stability and ability withstand heat sterilization

CLASSIFICATION

They are divided into two groups depending on the link between the aromatic portion and the intermediate chain- the amino-ester group and the amino-amide group.

The amino-ester group have an ester link and they are Procaine, Chlorprocaine and Amethocaine.

The amino-amide group have an amide link between the aromatic head and the intermediate chain and they are Lignocaine, Bupivacaine, Levobupivacaine, mepivacaine, Prilocaine, Ropivacaine and Etidocaine.

PHARMACOLOGY OF LOCAL ANAESTHETICS

These drugs produce reversible blockade of nerve conduction along the central and peripheral nerve pathways. When their concentration is increased gradually, the transmission of autonomic, somatic sensory and somatic motor impulses are interrupted in the same sequence. This leads to autonomic blockade, sensory anaesthesia and muscle paralysis in the area supplied. These drugs get gradually removed by absorption into the systemic circulation which leads to the reversal of the blockade.

MOLECULAR STRUCTURE

Local anaesthetics have a lipophilic group (usually an aromatic benzene ring) separated from a hydrophilic group (usually a tertiary amine) by an intermediate chain that includes an ester or amide linkage, which forms the basis of its classification as either esters or amides.

BUPIVACAINE ($C_{18}H_{28}N_{20}$)

CHEMICAL STRUCTURE

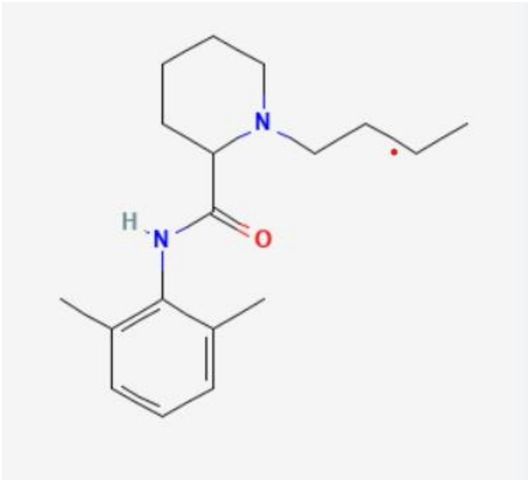


Fig 10: Chemical structure of Bupivacaine

Bupivacaine is a long acting, amide local anaesthetic. It was first prepared by A.F. Ekenstam in 1957 and introduced by Telivuo in 1963. It is chemically related to lignocaine and its structure is similar to that of Mepivacaine except for the amide containing group is a butyl piperidine. Its potency is approximately four times that of Lignocaine.

It is a popular drug for its long duration of action along with its tendency to provide both sensory and motor block and prolonged analgesia during the post-operative period.

Bupivacaine can be used to provide effective analgesia for several days through the use of indwelling catheters and continuous infusions.

PHYSIOCHEMICAL PROPERTIES

- Chemical Name: 1-butyl-N-(2,6-dimethylphenyl)piperidine-2-carboxamide
- Molecular weight: 288.4 g/mol

- pKa: 8.1
- Half-life: 1.5 to 5.5 hours in adults and 8.1 hours in neonates
- Specific gravity: 1.026 at 37°C

PHARMACOLOGY

The addition of a butyl group to the piperidine Nitrogen of Mepivacaine makes Bupivacaine 35 times more lipid soluble.

POTENCY

It is approximately 3-4 times more potent than Mepivacaine or Lignocaine.

ONSET AND DURATION OF ACTION

The onset of action of Bupivacaine is between 5-7 minutes and the maximum anaesthesia is achieved in 15-20 minutes.

The duration of action depends on the type of block- average duration of epidural block is 2.5-4 hours and average duration of spinal block is 2-3 hours.

MECHANISM OF ACTION

The mechanism of action of Bupivacaine is similar to that of Lignocaine.

Local anaesthetics bind to a specific site in the voltage gated sodium channels and block it thereby preventing sodium ion influx through the individual channels and preventing impulse propagation. Local anaesthetic binding to sodium channels does not alter the resting membrane potential. As a consequence of more channels binding a local anaesthetic, the threshold for excitation and impulse conduction in the nerves increase and the rate of rise and magnitude of the action potential decrease and impulse conduction velocity slows. When a large amount of local anaesthetic concentrations, action potentials can no longer be generated and impulse propagation is abolished.

The mechanism of sodium conductance blockade:

- The cationic form of local anaesthetic drug acts on the receptors within the Na^+ channels on the cell membrane and block it. The local anaesthetic can reach the Na^+ channel either via the lipophilic pathway directly across the lipid membrane or via the axoplasmic opening.

- The second mechanism is a non-specific action, i.e. by membrane expansion.

AVAILABLE CONCENTRATIONS OF BUPIVACAINE

0.25% and 0.5%

DOSAGE OF BUPIVACAINE

Maximum dosage: 3 mg/Kg body weight.

Adrenaline prolongs its action only marginally, if at all.

Tachyphylaxis is much less likely than with Lignocaine.

METABOLISM AND ELIMINATION

Bupivacaine gets metabolised by the following mechanisms:

- Aromatic hydroxylation
- N-dealkylation
- Amide hydrolysis
- Glucuronide- conjugation

The chief mechanism is N-dealkylation and the metabolite is N-desbutyl Bupivacaine. The mean total of urinary excretion of Bupivacaine and its dealkylation and hydroxylation metabolites account for >40% of the total anaesthetic dose.

ACTIONS:

ON CENTRAL NERVOUS SYSTEM

Over-dosage concentrations of Bupivacaine produce dizziness and light-headedness followed by visual and auditory disturbances such as difficulty to focus and tinnitus.

Shivering and muscular tremors and tremors of facial muscles can occur.

The plasma concentration of Bupivacaine that is associated with seizures is 4.5 to 5.5 mcg/ml.

ON CARDIOVASCULAR SYSTEM

Usually, the cardiovascular system is more resilient to the toxic effects of high plasma concentrations of local anaesthetics. Lignocaine concentrations <5mcg/ml is devoid of adverse effects but causes decrease in automaticity. Lignocaine concentrations of 5-10 mcg/ml can produce profound hypotension due to arteriolar vascular smooth muscle relaxation direct myocardial depression.

Blockade of cardiac Na^+ channels by local anaesthetics contributes to anti-dysrhythmic properties. With increase in concentration, more Na^+ channels get blocked and conduction and automaticity become affected adversely. This is evident by prolongation of PR interval and QRS complexes.

Accidental injection of Bupivacaine may result in precipitous hypotension, cardiac dysrhythmias and AV heart block. Most common dysrhythmias include widening of QRS complexes, premature ventricular contractions and Ventricular tachycardia.

Cardiotoxicity with Bupivacaine is seen when its plasma concentration is 8-10 mcg/ml. Pregnancy may increase sensitivity to the cardiotoxic effects of Bupivacaine. Cardiotoxic threshold of Bupivacaine may be decreased in patients being treated with drugs like Digitalis, Calcium Channel Blockers and Beta Blockers. Epinephrine and Phenylephrine can increase cardiotoxicity of Bupivacaine-induced inhibition of catecholamine-induced production of cyclic AMP.

Bupivacaine blocks cardiac Na+ channels during systole but due to its high lipid solubility it gets dissociated during diastole. This explains its persistent depressant effect on Vmax and hence greater cardiotoxicity. The R-enantiomer of Bupivacaine is more cardiotoxic. Tachycardia can enhance frequency dependent blockade of cardiac Na+ channels by Bupivacaine.

Treatment of Bupivacaine toxicity:

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

Lipid Emulsion is also used for the treatment of cardiotoxicity with its usage recommended at the earliest sign of toxicity. Initial bolus of 1.5 ml/Kg of 20% Lipid Emulsion followed by 0.25 ml/Kg/min infusion should be continued for at least 10 minutes after the circulatory stability is established.

RESPIRATORY SYSTEM

Local anaesthetics in very high plasma levels depress medullary respiratory centre which can precipitate decreased oxygenation.

TOXICITY OF BUPIVACAINE

The toxic plasma concentration of Bupivacaine is >3 mcg/ml. The cardiotoxic effects of Bupivacaine become evident when the plasma concentration becomes 8-10 mcg/ml.

PHARMACOKINETICS

Bupivacaine levels are detectable in the blood 5 minutes after infiltration. Peak blood concentrations depend on the total dosage given and ranges between 0.14 to 0.18 mcg/ml. These levels are from 5 minutes to 2 hours of infiltration and reduces to 0.1 to 0.34 mcg/ml in approximately 4 hours. Liver is the primary site of metabolism of Bupivacaine. Bupivacaine crosses placenta in very little concentrations with feto-maternal circulation ratios ranging from 0.2 to 0.4. It is also secreted in the breast milk.

HYPERBARIC BUPIVACAINE

Isobaric Bupivacaine (Plain) has density equal to that of CSF. Hyperbaric Bupivacaine is prepared by the addition of Glucose (80 mg/ml) to the Isobaric Bupivacaine, with a density heavier than CSF. The difference in densities between the two is believed to effect their diffusion patterns and thus determine the spread, effectiveness and side-effect of the drugs.

Baricity is defined as the ratio of density (mass/volume) of the local anaesthetic's solution to that of the CSF at 37°C. It influences the distribution of local anaesthetic solution in the CSF, the spread and height of the block since gravity causes hyperbaric solutions to settle downward in the CSF and hypobaric solutions tend to rise. In contrast, gravity has no effect on the distribution of a truly isobaric solution.

LEVOBUPIVACAINE ($C_{18}H_{28}N_{20}$)

INTRODUCTION

Levobupivacaine is the S(–)-enantiomer of the local anaesthetic bupivacaine. Racemic bupivacaine has traditionally been the longest acting local anaesthetic commercially available and widely used. Levobupivacaine's clinical profile closely resembles that of bupivacaine. However, current preclinical safety and toxicity data show an advantage for levobupivacaine over bupivacaine.

CHEMICAL STRUCTURE

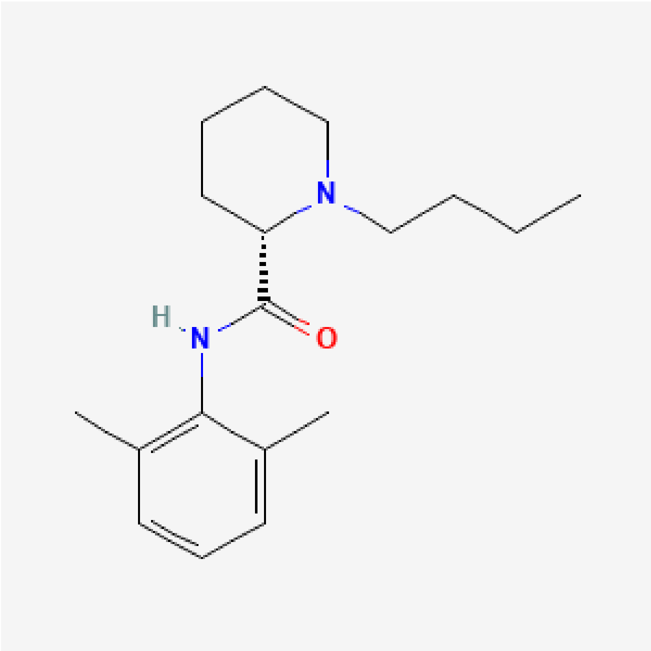


Fig 11: Chemical structure of Levobupivacaine

PHYSIOCHEMICAL PROPERTIES

- Chemical Name: (2S)-1-butyl-N-(2,6_dimethylphenyl)piperidine-2-carboxamide
- Molecular weight: 288.4 g/mol
- pKa: 8.1.

MECHANISM OF ACTION AND CO-RELATION WITH ITS STRUCTURE

Levobupivacaine block the generation and the conduction of nerve impulses, presumably by increasing the threshold for electrical excitation in the nerve, by slowing the propagation of the nerve impulse, and by reducing the rate of rise of the action potential. In general, the progression of anesthesia is related to the diameter, myelination and conduction velocity of affected nerve fibers. Specifically, the drug binds to the intracellular portion of sodium channels and blocks sodium influx into nerve cells, which prevents depolarization.

PHARMACOKINETICS

ABSORPTION

The plasma concentration of levobupivacaine following therapeutic administration depends on dose and also on route of administration, because absorption from the site of administration is affected by the vascularity of the tissue. Peak levels in blood were reached approximately 30 minutes after epidural administration, and doses up to 150 mg resulted in mean C_{max} levels of up to 1.2 mcg/mL.

DISTRIBUTION

After intravenous administration of 40 mg in healthy volunteers, levobupivacaine has a steady state of distribution of 66.91 ±18.23 L. It is 97% protein bound. It's classified as *Category B drug* in pregnancy.

METABOLISM AND EXCRETION

Levobupivacaine is extensively metabolized with no unchanged Levobupivacaine detected in urine or feces. In vitro studies using Levobupivacaine showed that CYP3A4 isoform and CYP1A2 isoform mediate the metabolism of Levobupivacaine to Desbutyl Levobupivacaine and 3-hydroxy Levobupivacaine, respectively.

In vivo, the 3-hydroxy Levobupivacaine appears to undergo further transformation to glucuronide and sulfate conjugates. Metabolic inversion of levobupivacaine to R(+)-Bupivacaine was not evident both in vitro and in vivo.

Following intravenous administration, recovery of the radio-labelled dose of Levobupivacaine was essentially quantitative with a mean total of about 95% being recovered in urine and feces in 48 hours. Of this 95%, about 71% was in urine while 24% was in feces. The mean half-life is 3.3 hours.

PHARMACODYNAMICS

CENTRAL NERVOUS SYSTEM & CARDIOVASCULAR SYSTEM:

The risk of CNS toxicity was less with Levobupivacaine than with Bupivacaine in human volunteers. Central or peripheral nervous system disorders were experienced by 36% of Levobupivacaine recipients in the study where volunteers received intravenous doses of Levobupivacaine (mean 67.7mg).

Similarly, intravenous Levobupivacaine produces tinnitus and CNS depression on EEG. The magnitude of the effect and the area affected was less with Levobupivacaine. For instance, Levobupivacaine is associated with a lesser decrease in high alpha power and does not cause the increase in theta power in the parietal, temporal and central regions that occurred with Bupivacaine.

Levobupivacaine also showed less depressant effect on the atrioventricular conduction and QRS complex duration, and provoked less impairment of the contractile function of the isolated animal heart. Levobupivacaine is also less potent in blocking cloned human heart sodium and potassium channels.

POTENCY

The nerve blocking potency of Levobupivacaine is similar to that of Bupivacaine and the R(+)enantiomer of Bupivacaine (Dexbupivacaine) in vitro. In vivo, the comparative effects of Levobupivacaine and Dexbupivacaine or Bupivacaine were affected by the route of administration and concentration.

ADVERSE EFFECTS

- Cardiovascular system toxicity: bradycardia, hypotension, sudden cardiovascular collapse
- Gastrointestinal system toxicity: nausea (12%), vomiting (14%), constipation (7%),
- Central nervous system toxicity: Headache (7%) disorientation, drowsiness, slurred speech, which may culminate with tonic-clonic seizures
- Hematological: Anemia (12%), increased serum albumin level, leukocytosis and purpura

ADVANTAGES OVER OTHER LOCAL ANAESTHETICS

Levobupivacaine has a lower systemic toxicity than Bupivacaine and also has a better cardio-stable profile. It has been developed to offer a safer alternative to Bupivacaine while retaining the desirable blocking properties of racemic Bupivacaine.

OPIOID RECEPTORS

Opioid receptors were classified into three groups, according to the radio-ligand binding assays in 1973 and were termed Mu **(μ)** for the morphine group, Kappa **(κ)** for the ketocyclazocine group, and Epsilon **(σ)** for the SKF10047 (N-allylnormetazocine) group. Delta

(δ) receptor- the group of high affinity receptors for enkephalins was discovered in vas deferens of mouse. Another Zeta **(ε)** receptor was thought to be the binding site for β-endorphin which was also found to be present in the vas deferens of the mouse.

MECHANISM OF ACTION OF OPIOIDS

Opioids exert its action at both spinal and supra-spinal levels. The majority of the receptors are present at the substantia gelatinosa in the dorsal horn of the spinal cord. The supra-spinal actions are mediated through the descending inhibitory pathways. In substantia gelatinosa, the receptors are present mainly on the presynaptic terminals of the primary afferent sensory neurons. Some of the receptors are also present on the post synaptic dendrites of the inter neurons. These neurons regulate the spinothalamic transmissions. The presynaptic neurons hinder the release of various neurotransmitters including substance P, glutamate etc, whereas the post synaptic receptors inhibit the evoked excitatory post synaptic potential also known as EPSP. The µ and Δ receptors act on the potassium channels and facilitates the opening of the receptors, which further leads to the hyperpolarisation.

It also leads to the reduced neuronal firing. It reduces the action potential plateau and thereby reducing the calcium influx and the neurotransmitter release. Contrary to the above-mentioned receptors, κ receptors, shut the calcium channels.

FENTANYL

Fentanyl was synthesized by Janssen Pharmaceutica in the year 1960 with the emphasis on potency and safety. Fentanyl citrate is a synthetic phenyl piperidine opioid analgesic and a chemical congener of the reversed ester of Pethidine (Meperidine).

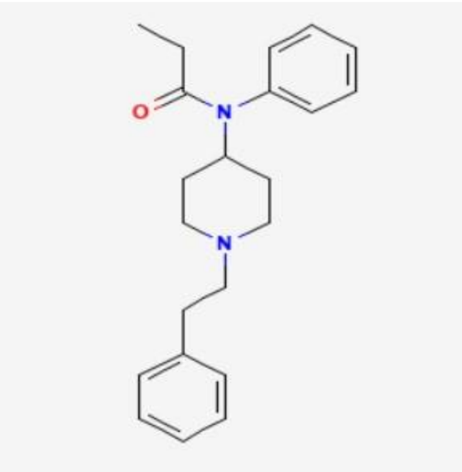


Fig 12: Chemical structure of Fentanyl

PHYSIOCHEMICAL PROPERTIES

It is a white crystalline powder and is highly lipid soluble and sparingly soluble in water. The commercially available injections have a pH of 7 to 7.5, pKa value of 8.4. Less than 10% is in unionized form at physiologic pH of 7.4. its plasma protein binding is 84%. It is 50 to 100 times more potent than Morphine. The preparation should be protected from light and should be stored at 15°C to 30°C. It is also available as intrabuccal, transdermal and aerosolized preparations.

MECHANISM OF ACTION

Fentanyl is primarily a Mu (μ) receptor agonist and these Mu (μ) receptors are present in the brain (periaqueductal gray matter of brain stem, amygdala, corpus striatum and hypothalamus), spinal cord (substantia gelatinosa) and peripheral nerves. These receptors are involved with pain perception, integration of pain impulses and responses to pain.

Opioids act as agonists at stereospecific opioid receptors at pre-synaptic and post-synaptic sites. The most likely mechanism of these peripheral actions appears to be activation of opioid receptors on primary afferent neurons. Fentanyl mimics the actions of endogenous ligands by binding to receptors resulting in activation of pain modulating system.

Opioid receptor activation leads to decrease in neurotransmission. This decrease occurs largely by pre-synaptic inhibition of neurotransmitter (Acetylcholine, Dopamine, Norepinephrine, Substance P) release.

Biochemical events on activation are increased Potassium conductance leading to Hyperpolarization and Calcium channel inactivation or both. Fentanyl also binds to Kappa receptors **(κ)** to a lesser extent in the spinal cord and mediates miosis and sedation.

Fentanyl is metabolized in the liver via the CYP450 enzyme system, specifically CYP3A4. It has a half-life of 3-7 hours and 75% is excreted in the urine and 9% in feces.

PHARMACOKINETICS

After intravenous administration, Fentanyl has rapid onset of action with a short duration of action. The effect site equilibrium time between blood and brain is 6.4 minutes.

DISTRIBUTION

Fentanyl has high lipid solubility so it gets widely distributed throughout the body to inactive sites. Initially it distributes to vascular organs such as the heart, lungs and brain. It then gets distributed to skeletal muscles and fat. Lungs also serve as inactive storage site with estimated 75% of initial dose undergoing first pass pulmonary uptake. Volume of distribution of Fentanyl after administration is 4±0.4 L/Kg.

METABOLISM

Fentanyl is extensively metabolized in the liver by N-demethylation producing Norfentanyl and hydrolysed to 4-N amilinopiperidine and proprionic acid. Lungs exert significant first pass effect and transiently take up 75% of injected dose of Fentanyl, 80% of Fentanyl is bound to plasma proteins, approximately 50% to α-acid glycoprotein.

ELIMINIATION

Fentanyl is excreted mainly in the urine as metabolite as less than 8% is excreted as unchanged drug. The mean clearance after IV administration is between the range of 34-53 Litres/hour or approximately 13 ml/min/Kg body weight. Mean terminal half-lives are between 2.5 to 8 hours. Context sensitive half-life (after continuous infusion of 4 hours) is 260 minutes and this reflects saturation of inactive tissues during infusion.

ADVERSE REACTIONS

CARDIOVASCULAR SYSTEM: Hypotension, orthostatic hypotension, syncope, drug-induced bradycardia.

RESPIRATOTY SYSTEM: Dose-dependent depression of ventilation which is characterized by reduced response of ventilator centres to carbon dioxide.

CENTRAL NERVOUS SYSTEM: In the absence of hypoventilation, Fentanyl decreases cerebral blood flow and in turn decreases intracranial pressure. Myoclonus during administration may resemble generalized tonic-clonic seizures. It can produce thoracic and abdominal skeletal muscle rigidity. Miosis may occur as most of Mu and Kappa agonists cause constriction of pupil by an excitatory action on the parasympathetic nerves innervating the pupils.

It causes pruritis when administered for central neuraxial blockade, which is likely due to cephalad migration of opioids in the cerebrospinal fluid and subsequent interaction with opioid receptors in the trigeminal nucleus. Pruritis is likely to be localized to face, neck and upper thorax.

HEPATOBILIARY SYSTEM: Fentanyl causes dose-dependent increase in biliary duct pressure and sphincter of Oddi tone.

GASTROINTESTINAL SYSTEM: Fentanyl delays gastric emptying and can also produce nausea and vomiting by directly stimulating the ***CTZ*** (Chemoreceptor trigger zone).

IMMUNE SYSTEM: The overall effect appears to be suppressive, leading to increased susceptibility to infections.

ALLERGIC REACTIONS: True allergic and anaphylactoid reactions are rare. Most commonly, local reactions may occur due to preservatives or histamine release.

TOLERANCE AND PHYSICAL DEPENDENCE: Tolerance can occur without physical dependence but the reverse does not seem to occur. Cross tolerance develops between all opioids.

METHODOLOGY

TITLE: "Comparison between Hyperbaric Bupivacaine with Fentanyl and Hyperbaric Levobupivacaine with Fentanyl in Spinal Anaesthesia for Infraumbilical Surgeries- A Hospital Based Randomized Controlled Trial"

Source Of Data: We recruited individuals of either gender, between eighteen to sixty years belonging to ASA grade I – II, posted for elective infraumbilical surgeries under SA at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Nehru Nagar, Belagavi, Karnataka from May 2023 to April 2024.

Study Design: One year hospital-based RCT.

Study Period: May 2023 To April 2024.

Sample Size:

The total sample size = 100 patients. *Group B* = 50. *Group L* = 50

Sampling Procedure: Randomization was achieved by a Computer-Generated Randomization Chart.

Selection Criteria

- Inclusion:

1. ASA grades I-II.
2. Patients posted for infraumbilical surgeries under SA.
3. Age- eighteen to sixty years.

- Exclusion:

1. Allergy to any of the medications being researched (local anaesthetics and opioids).
2. Patients not giving consent.
3. Conditions where SA is contraindicated.

Sample Size Calculation:

Sample size formula:

The minimum sample size formula based on mean and standard deviation is

$$n = \frac{(z_\alpha + z_\beta)^2 (s_1^{\ 2} + s_2^{\ 2})}{(\bar{X}_1 - \bar{X}_2)^2}$$

where $z\alpha$ is linked with the level of significance and $z\beta$ is linked with the power of the test. For 5% level of the significance $z\alpha$ =1.96 and $z\beta$ =0.84 for 80% power of the test.

"Ref: Ayesha Goyal, P. Shankaranarayan, P. Ganapathi. Original article. Title- A randomized clinical study comparing spinal anesthesia with isobaric levobupivacaine with fentanyl and hyperbaric bupivacaine with fentanyl in elective cesarean sections (Anesthesia: Essays and Researches; 9(1); Jan-Apr 2015)"

The parameter considered in the calculation is time to start of motor block(min).

X1 is the mean of the first group (3.9) and X2 is the mean of the second group (3.5). s1 is the standard deviation of the first group (0.71) and s2 is the standard deviation of the second group (0.59).

With these values the sample size obtained is 42. To get confirmative results, the sample size was increased to 50. There were to be two groups with 50 cases in each group.

Procedure:

We included 100 patients who were undergoing elective infraumbilical surgeries under SA, following permission from Ethics Committee.

Patients who satisfied the inclusion and exclusion requirements and provided informed consent were assigned either of the 2 groups randomly, utilising randomization table generated by computer:

GROUP B- who received intrathecal 0.5% Hyperbaric Bupivacaine 15mg + Fentanyl 25mcg

GROUP L- who received intrathecal 0.5% Hyperbaric Levobupivacaine 15mg + Fentanyl 25mcg

For each patient, an extensive pre-anesthetic evaluation was performed along with a thorough physical examination. Medical and personal history was also taken.

Standard tests included a CBC, BG and typing, RBS, serum electrolytes, coagulation profile, LFT, RFT, CXR-PAV, and electrocardiogram. Overnight fasting was prescribed for the patients.

In the Pre-operative room, 18G IV cannula secured on the forearm of the patients and were given with RL (500ml) through IV route 30 mins before anaesthesia was induced.

We moved the patients to the operation table and connected non-invasive monitors like NIBP, ECG and Pulse oximeter and HR, SBP, DBP, MAP was measured and were then positioned to sit. Under strict asepsis, space between the L2-L3 vertebrae was identified by staff anaesthetists who were blinded to the study medication selection and local anaesthetic 2% lignocaine 2ml injected into the skin. Lumbar puncture was performed using 23G Quincke's spinal needle at L2-L3 subarachnoid space and confirmed after establishing free-flow of clear CSF. The patients were administered the study drugs and were immediately put in supine position and assessments were conducted both during and after the procedure. The following variables were assessed:

A) **Sensory Block**- evaluated by pricking with a pin in the mid-axillary line once every minute until the block happens at the T10 Level. For the next two hours, it was evaluated at 10-minute intervals, and after that, it was evaluated at 15-minute intervals until full regression.

The interval of time between the drug's injection to the point at which sensory blockade occurs at T10 dermatome was considered "onset of sensory block." The highest dermatome of sensory block was noted.

Sensory block duration- time required for block to subside to two dermatomes from the highest dermatome attained.

The surgery was cleared to start as soon as T10 dermatomal block was attained. If this did not happen within thirty minutes of intrathecal injection, the case was converted to GA. These were termed as “FAILURE” and were removed from the analysis at the end.

B) **Motor Blockade**- evaluated utilizing MODIFIED BROMAGE SCALE as soon as sensory block assessment is completed.

Bromage 0- No motor block

Bromage 1- Inability to raise extended leg; able to move knees and feet

Bromage 2- Inability to raise extended leg and move knee; able to move feet

Bromage 3- Complete block of motor limb

Onset of Motor block- time taken to attain “Modified Bromage Score- 3.”

The entire motor block duration- return time to “Modified Bromage score- 0.”

Vitals: SpO2, BP, and HR were recorded during the surgery at every 2 mins for 10 mins followed by every 5 mins till 30^{th} minute and then for every 10^{th} minute till the conclusion of procedure.

Hypotension- defined as a 20% drop from baseline SBP levels or SBP <90mmHg and was managed with IV boluses of *Inj Mephentermine 6mg* and an IV RL bolus (250 ml) over 10 minutes.

Fall in heart rate below 60 bpm was referred to as Bradycardia and IV *Inj Atropine 0.6mg* was administered to the patients whenever this occurred.

Face mask was used to deliver Supplemental Oxygen at 5 L/min.

Data Processing and Statistical Analysis:

Our study's primary goal was to compare the two groups.

- Mean and standard deviations for continuous quantitative variables were computed. Intergroup continuous variables were compared with suitable statistical analysis methods: Unpaired student's t-test.
- Using student's paired t-test, we compared two quantitative variables within the same group. We used percentages, ratios, and rates to express the category data
- We assessed the relationship between the outcome and the clinical and demographic factors was done using Fisher's exact test or Chi-square test.
- Furthermore, suitable techniques were employed depending on the situation, such as correlation, regression, ANOVA etc.
- Discrete variables were demonstrated through the median. To compare discrete variables, nonparametric tests were employed.
- Appropriate graphs were put together to illustrate the contrast.
- Every test was regarded as significant if p-value was below 5% (0.05).

RESULTS

SPSS V21 and Microsoft Excel were used to analyse the data.

Frequency tables are used to present categorical variables.
Continuous variables are shown as Mean +/- SD form.

Chi square test is utilised to examine the association of categorical variables with groups.

The Shapiro Wilk test and QQ plot are applied to determine whether a variable is normal.

Parametric tests were applied if the data has normal distribution.

To compare the means of variable across groups independent sample t-test is used. P-value equal to or less than 0.05 indicates statistical significance.

The following illustrates the results of the study:

Age

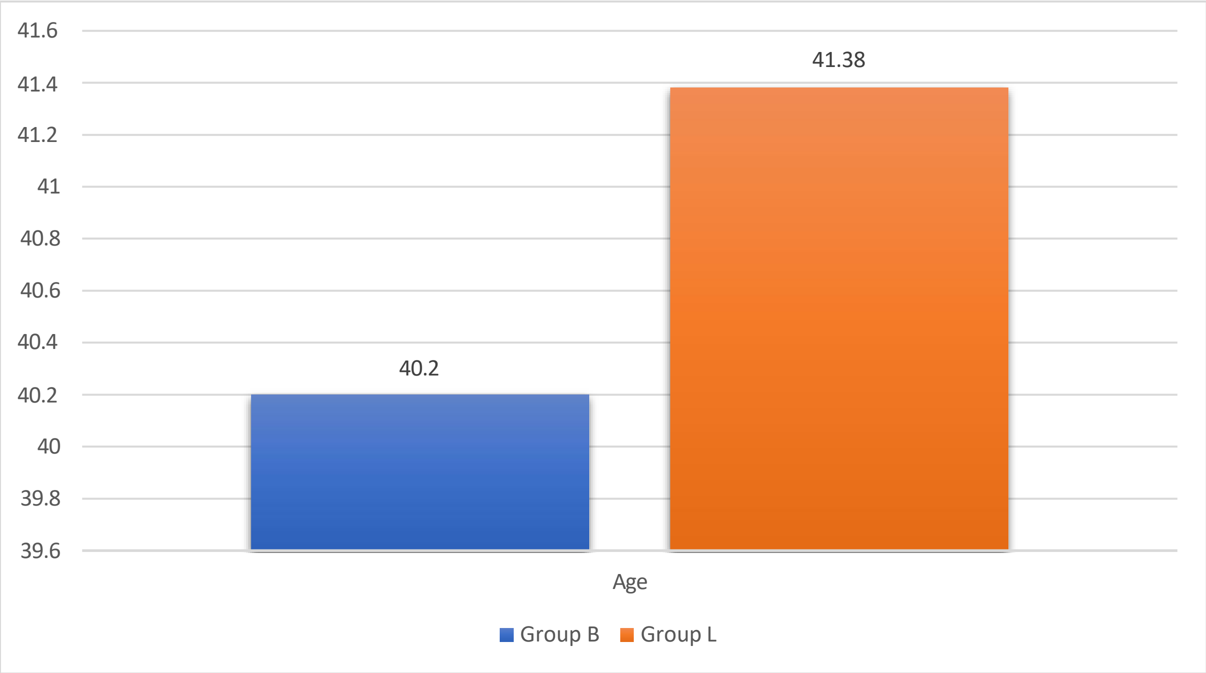
The Table below is a summary of age distribution between 2 groups- Group B and L who received different drug sets. The table showing the means and standard deviations for age:

Table 1- Age

Variable	B		L		p-value
	Mean	SD	Mean	SD	
Age	40.20	12.091	41.38	10.422	**0.602**

The study participants' mean age in B was 40.2+12.09 years, while it was 41.38+10.42 years in L. This distinction **wasn't statistically noteworthy** (Unpaired t-test with p-value >0.05).

Graph 1- Age distribution of the patients



Sex

The table below shows the distribution of Group B and L across genders- Male and Female.

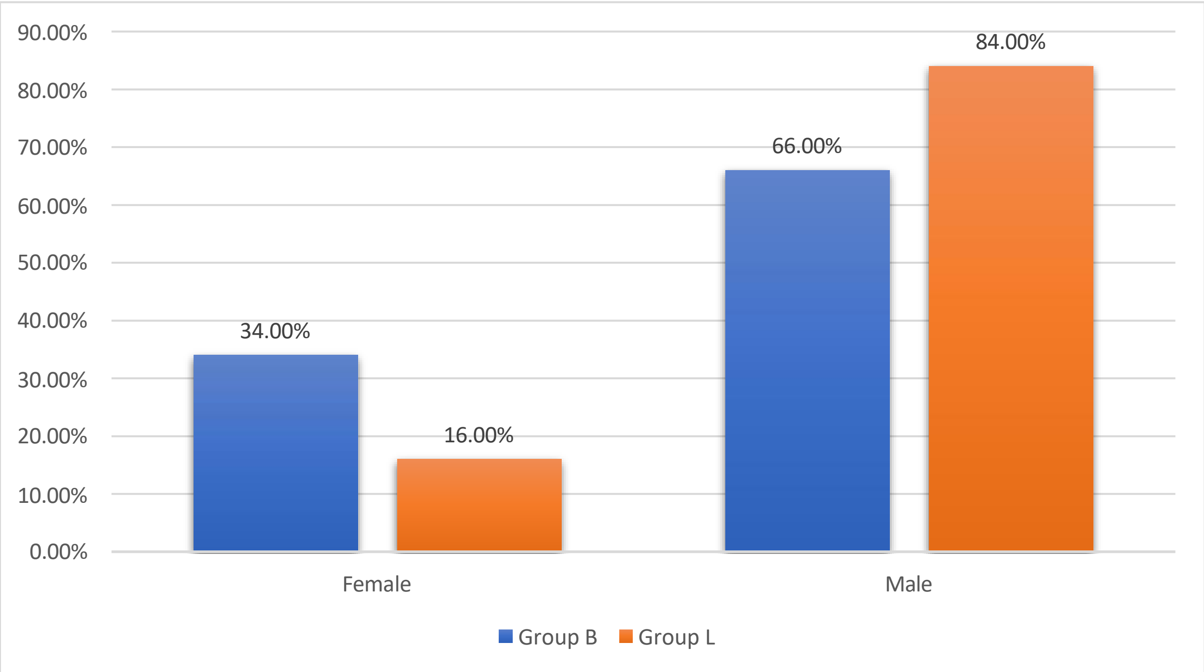
Table 2- Sex

			Group		Total
			B	**L**	
Sex	**Female**	**Count**	17	8	**25**
		%	34.0%	16.0%	**25.0%**
	Male	**Count**	33	42	**75**
		%	66.0%	84.0%	**75.0%**
Total		**Count**	50	50	**100**
		%	100.0%	100.0%	**100.0%**

Chi square- 4.320, p-value- 0.038 (S)

In the study, among the B, females comprised of 34% and males comprised of 66%. Among L, females comprised of 16% and males comprised of 84%. This contrast was **statistically noteworthy** (Chi square test with p-value <0.05).

Graph 2- Sex distribution of the patients



ASA Grade

The table below shows the distribution of Group B & L across ASA grade I and II

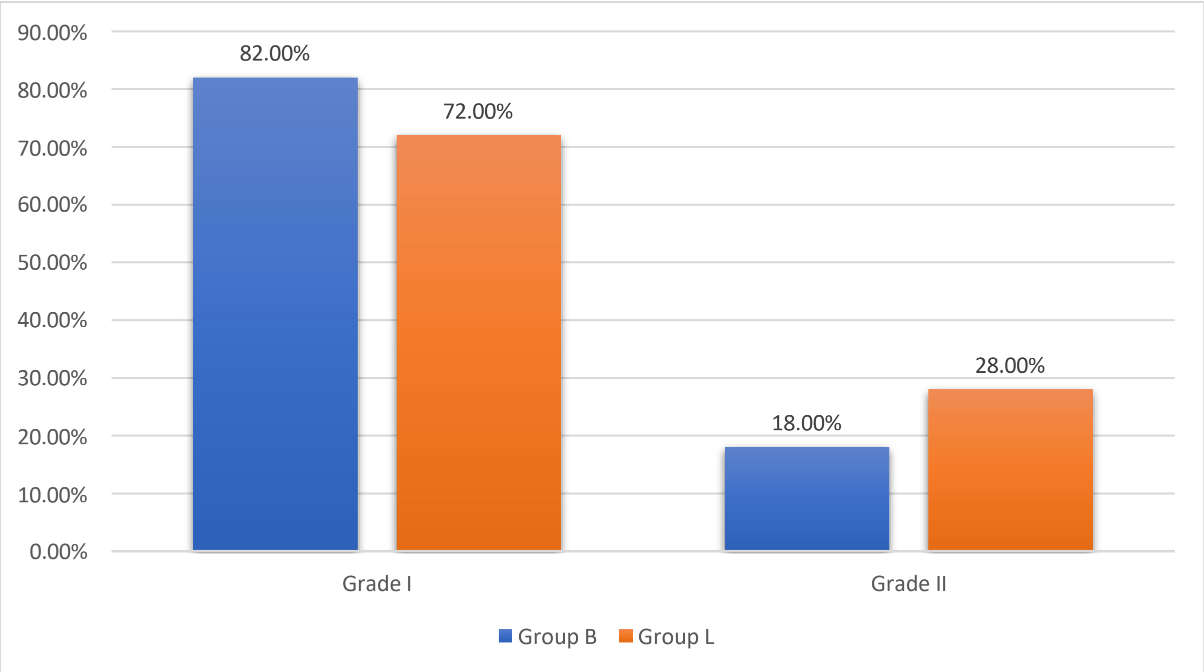
Table 3-ASA Grade

			Group		Total
			B	L	
ASA Grade	I	Count	41	36	**77**
		%	82.0%	72.0%	**77.0%**
	II	Count	9	14	**23**
		%	18.0%	28.0%	**23.0%**
Total		Count	50	50	**100**
		%	100.0%	100.0%	**100.0%**

Chi square- 1.412, p-value- 0.235 (NS)

In the study, B had 82%-ASA- I and 18%- ASA- II and L had ASA grade I-72% ASA- II-28%. Using the Chi square test, we found that this contrast **wasn't statistically noteworthy** (p value >0.05).

Graph 3- ASA Grade distribution of the patients



Highest dermatome of Sensory Block

Table given below shows distribution of Group B & L across different levels of highest sensory block.

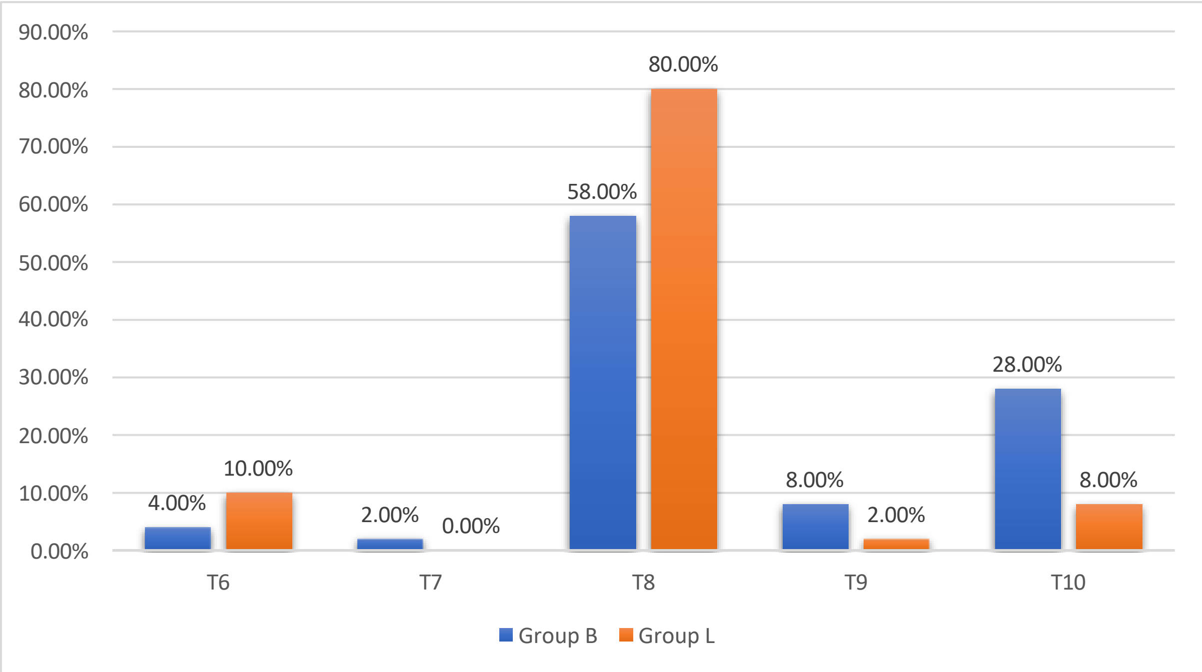
Table 4- Highest dermatome of Sensory Block

			Group		Total
			B	**L**	
Highest dermatome of sensory block	**T6**	Count	2	5	**7**
		%	4.0%	10.0%	**7.0%**
	T7	Count	1	0	**1**
		%	2.0%	0.0%	**1.0%**
	T8	Count	29	40	**69**
		%	58.0%	80.0%	**69.0%**
	T9	Count	4	1	**5**
		%	8.0%	2.0%	**5.0%**
	T10	Count	14	4	**18**
		%	28.0%	8.0%	**18.0%**
Total		Count	50	50	**100**
		%	100.0%	100.0%	**100.0%**

Chi square- 11.395, p-value- 0.022 (S)

In the study, among Group B, 28% had sensory block at T10 level and 58% had block at T8 level. In Group L, only 8% had sensory block at T10 level and 80% had block at T8 level. On performing chi square test, this difference was found to be **statistically significant** (P value <0.05).

Graph 4- Highest dermatome of Sensory Block



Onset & duration of Sensory block & Motor block

The table below compares onset & time period of sensory & motor block for B and L.

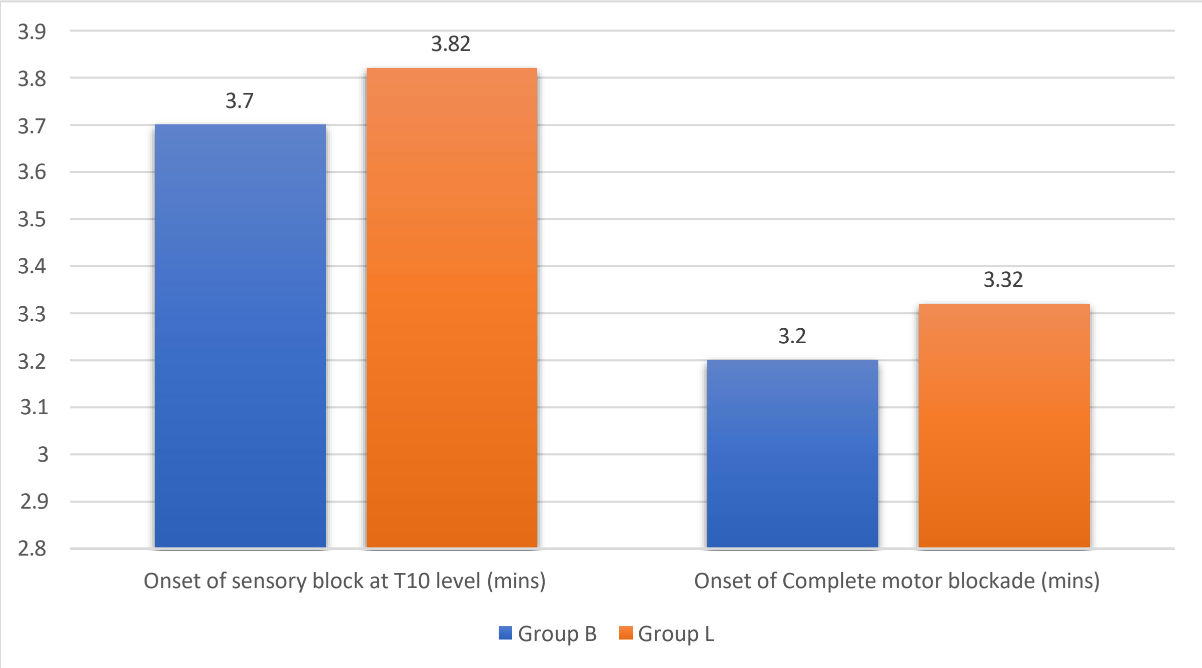
Table 5- Onset and duration of Sensory block & Motor Block

Variable	B		L		p-value
	Mean	SD	Mean	SD	
T10 level sensory block onset (mins)	3.70	1.898	3.82	2.210	**0.771**
Complete motor blockade onset(mins)	3.20	1.884	3.32	1.921	**0.753**
Sensory block duration (mins)	152.68	23.649	132.46	32.329	**0.001**
Total time period of motor blockade (mins)	178.42	32.661	160.38	25.315	**0.003**

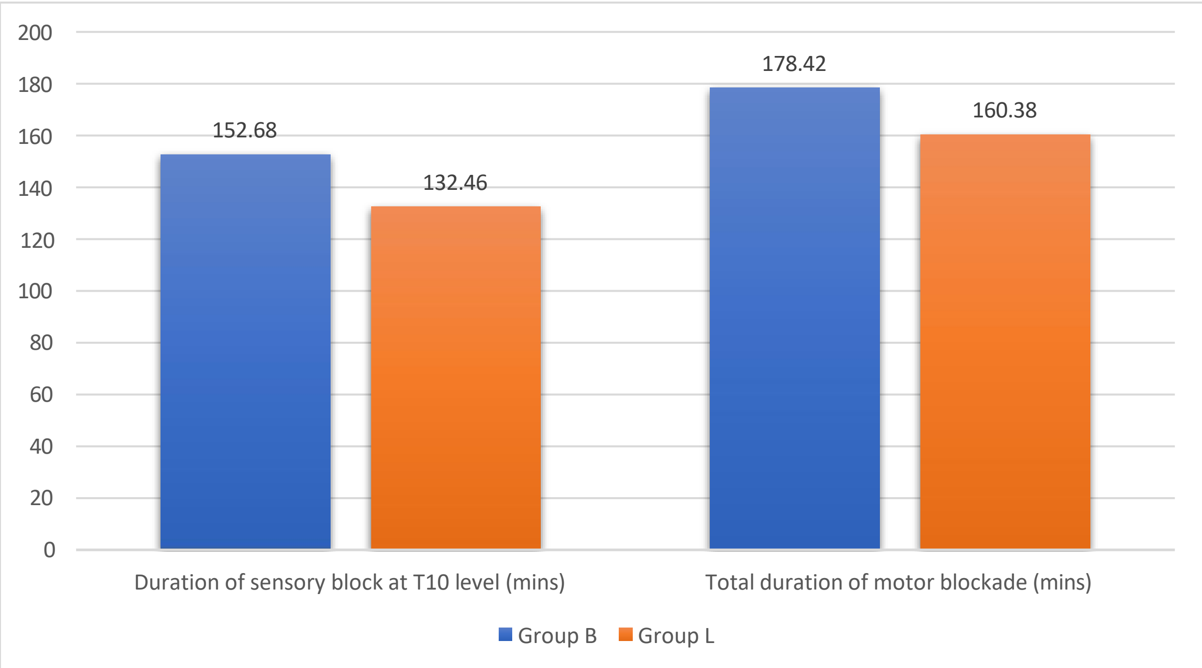
- Group B had a **mean sensory block onset at T10 level** of 3.7$\pm$1.89 mins whereas 3.82$\pm$2.21 mins was in Group L. Using unpaired t-test, it was determined that this **difference wasn't revealed to be statistically important** (p-value >0.05).
- Among Group B, **mean time for total motor blockade onset** was 3.2+1.88 minutes while 3.32$\pm$1.92 mins was in Group L and this **wasn't** determined as **statistically significant** using Unpaired t-test (p-value >0.05).

- **Mean duration of sensory block** in Group B was 152.68±23.64 mins while it was 132.46±32.32 mins in Group L. An unpaired t-test revealed that this **distinction was statistically significant** (p- value <0.05).
- **Mean duration of total motor block** for Group B was 178.42±32.66 mins and Group L was 160.38±25.31 mins. Using an unpaired t test, it was discovered that this **difference was statistically significant** (p-value <0.05).

Graph 5a- Onset of Sensory block & Motor Block



Graph 5b- Duration of Sensory block & Motor Block



Heart rate (BPM)

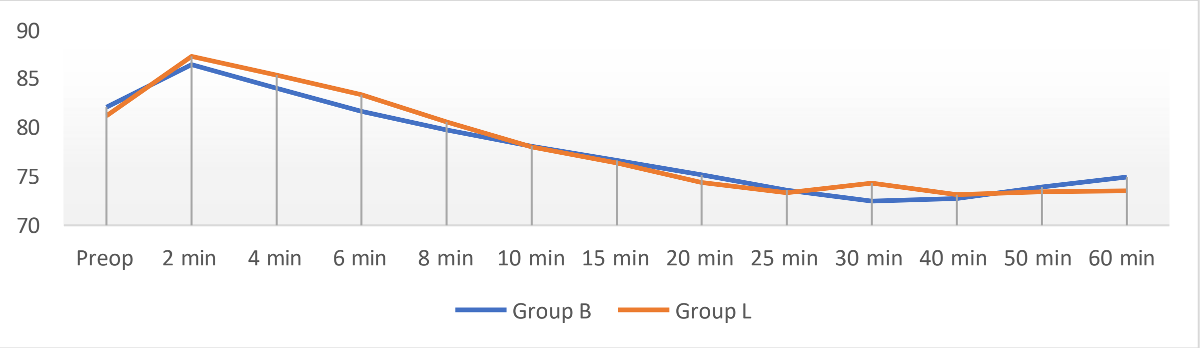
The table below shows the heart rates (beats per minute) various time points after administration of the drug sets.

Table 6- Heart rate

Time	B		L		p-value
	Mean	SD	Mean	SD	
Preop	82.06	11.386	81.18	8.898	**0.668**
2 min	86.40	13.964	87.24	12.909	**0.755**
4 min	84.00	13.383	85.32	11.997	**0.605**
6 min	81.62	12.893	83.32	11.719	**0.492**
8 min	79.74	12.726	80.56	11.203	**0.733**
10 min	78.08	11.709	78.02	11.035	**0.979**
15 min	76.62	11.815	76.36	11.733	**0.912**
20 min	75.16	11.304	74.38	10.162	**0.717**
25 min	73.60	10.509	73.32	9.614	**0.890**
30 min	72.48	10.873	74.32	9.966	**0.380**
40 min	72.74	9.878	73.14	9.829	**0.840**
50 min	73.92	9.544	73.44	8.997	**0.796**
60 min	74.94	9.724	73.52	9.146	**0.454**

Unpaired t test revealed that, for all readings from before surgery till 60 minutes, difference heart rates' mean between Groups B & L **was not significant statistically** (p-value >0.05). On performing repeated measures ANOVA the **drop in mean heart rate from preop till 60 min was significant statistically** (p-value <0.05) in both B an L Groups.

Graph 6- Heart Rate



SBP

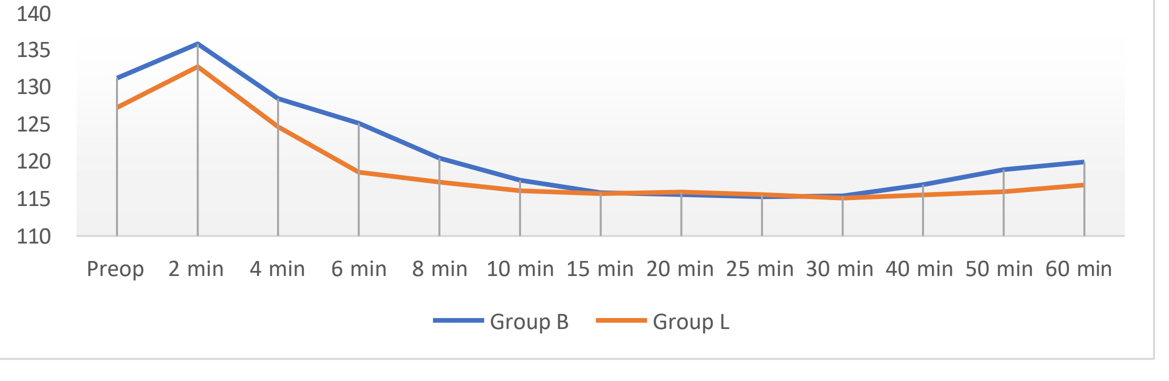
The table below shows the SBP- Systolic Blood Pressures at various time points after administration of the drug sets.

Table 7- SBP

Time	B		L		p-value
	Mean	SD	Mean	SD	
Preop	131.18	12.404	127.20	12.573	**0.114**
2 min	135.76	17.691	132.70	15.512	**0.360**
4 min	128.42	14.826	124.64	17.980	**0.254**
6 min	125.12	16.839	118.56	19.720	**0.077**
8 min	120.46	17.128	117.24	18.821	**0.373**
10 min	117.48	16.666	116.06	17.586	**0.679**
15 min	115.82	20.458	115.66	16.406	**0.966**
20 min	115.56	20.594	115.88	15.954	**0.931**
25 min	115.26	21.357	115.54	17.665	**0.943**
30 min	115.36	15.473	115.08	14.227	**0.925**
40 min	116.88	14.094	115.50	12.245	**0.602**
50 min	118.90	13.703	115.94	9.937	**0.219**
60 min	119.94	13.042	116.82	9.411	**0.173**

The study's unpaired t-test showed **no statistically significant difference** in mean SBP between B and L (p-value >0.05) at all readings from pre-op till 60 minutes. On performing repeated measures ANOVA the **drop in mean systolic blood pressure from preop till 60 minutes** was **significant statistically** (p-value <0.05) in both B & L.

Graph 7- SBP



DBP

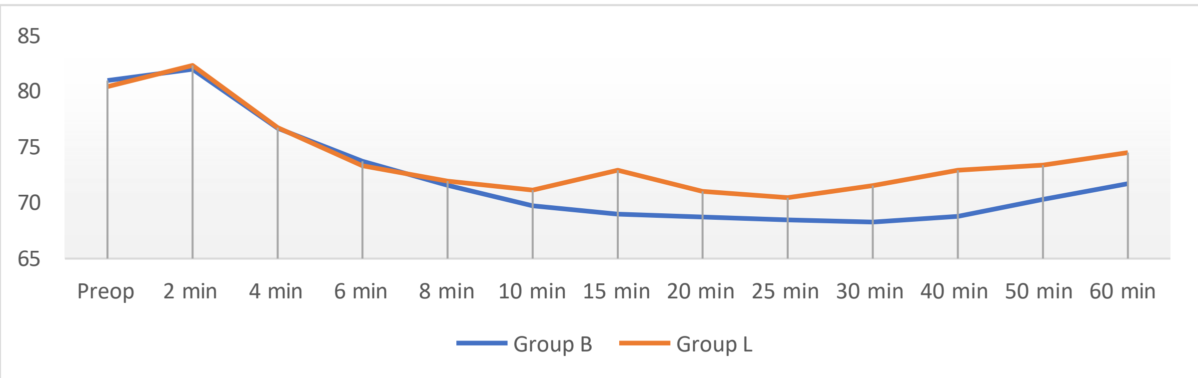
The DBP is displayed in the table below at different intervals following the delivery of the drug sets.

Table 8- DBP

Time	B		L		p-value
	Mean	SD	Mean	SD	
Preop	80.90	7.344	80.36	7.556	**0.718**
2 min	81.90	9.076	82.24	10.985	**0.866**
4 min	76.62	9.903	76.70	13.100	**0.973**
6 min	73.68	10.512	73.30	12.903	**0.872**
8 min	71.54	10.436	71.92	12.578	**0.870**
10 min	69.70	10.974	71.10	11.826	**0.541**
15 min	68.96	14.740	72.88	11.617	**0.143**
20 min	68.70	14.319	71.00	11.425	**0.377**
25 min	68.44	13.767	70.44	11.312	**0.429**
30 min	68.26	12.534	71.52	10.246	**0.158**
40 min	68.76	11.397	72.88	8.573	**0.054**
50 min	70.28	11.016	73.34	8.176	**0.118**
60 min	71.68	10.332	74.46	8.003	**0.136**

In the study, on performing unpaired t test the difference of **mean DBP** between Groups B and L **wasn't significant statistically** (p-value >0.05) at all readings from pre-op till 60 minutes. On performing repeated measures ANOVA the **fall in mean DBP from preop till 60 minutes** was **significant statistically** (p-value <0.05) in both the Groups B and L.

Graph 8- DBP



MAP

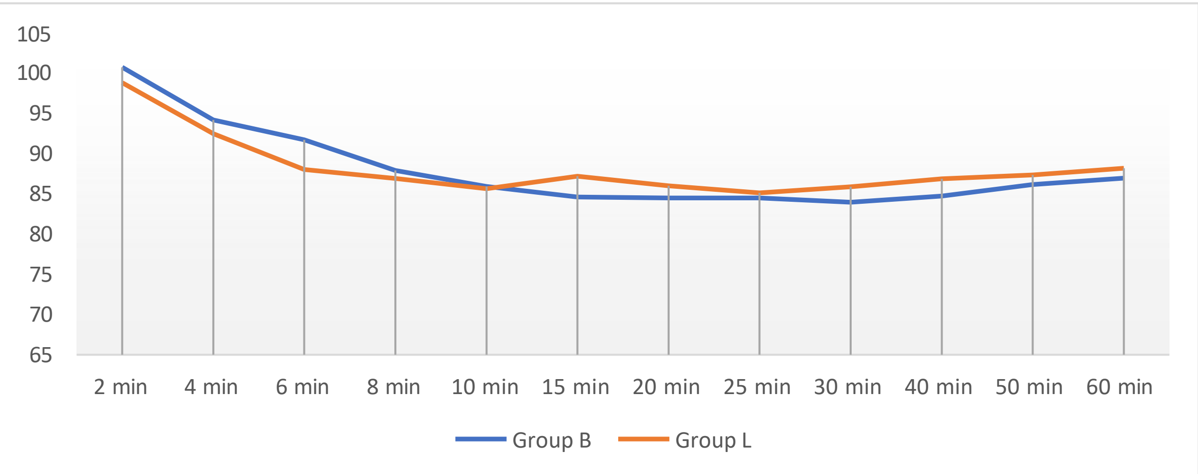
The MAP is displayed in the table below at different intervals following the delivery of the medication sets.

Table 9- MAP

Time	B		L		p-value
	Mean	SD	Mean	SD	
2 min	100.70	12.156	98.78	11.316	**0.416**
4 min	94.14	12.155	92.46	13.802	**0.520**
6 min	91.68	13.042	88.00	15.215	**0.197**
8 min	87.88	13.043	86.90	14.282	**0.721**
10 min	85.90	13.145	85.60	13.340	**0.910**
15 min	84.58	16.654	87.18	12.177	**0.375**
20 min	84.46	16.321	85.98	12.386	**0.601**
25 min	84.48	16.140	85.10	12.724	**0.832**
30 min	83.94	13.350	85.86	11.198	**0.438**
40 min	84.72	12.204	86.84	8.643	**0.319**
50 min	86.14	10.971	87.32	8.039	**0.541**
60 min	86.92	10.501	88.14	7.602	**0.507**

We conducted unpaired t-test to check differences of **MAP** between the 2 groups and **didn't find it to be significant statistically** (p-value >0.05) at all readings from 2 minutes till 60 minutes. On performing repeated measures ANOVA, **drop in mean arterial pressure from 2 minutes till 60 minutes** was **statistically important** (p-value <0.05) in both groups.

Graph 9- MAP



SpO2

100 percent oxygen saturation was maintained throughout the procedure and the difference **wasn’t statistically significant.**

DISCUSSION

Neuraxial anaesthesia has been the popular type of anaesthesia for surgical procedures below the umbilicus like CS, lower abdomen and perineal surgeries along with surgeries of lower-limb including those of orthopaedic surgeries. It includes Subarachnoid Block also commonly known as Spinal Anaesthesia (SA), Epidural Anaesthesia(EA) and Caudal Anaesthesia. [3] [13]

In comparison to General anaesthesia, Spinal anaesthesia has the advantage of better analgesia and reduced stress response along with a rapid onset, awake and spontaneously breathing patients, thereby making it a preferred anaesthetic technique. [8] [17]

In 1998, H. Bardsley et al [20] concluded that Levobupivacaine in comparison to racemic Bupivacaine caused less negative inotropic side-effects in terms of cardiotoxic effects of Bupivacaine which may occur either by a direct action on the heart or through a reflex action involving the nervous system.

Age comparisons across our patients did not show any noteworthy difference statistically (p-value = 0.602) suggesting that distribution of ages of patients in the Group B and L is similar.

With regard to the sex in our study, 34% of the Group B participants were women and 66% were men. In Group L, there were 16% females and 84% males. By using chi square test, it was determined that this distinction was significant statistically.

In order to predict operative risk, ASA physical status (ASAPS) classification system allows categorization of patients' physiological status. The ASAPS originated in 1941 and latest update was made on October 15th 2014. In our study we included only ASA grade I which signifies a normal healthy person (non-obese, fit, with BMI less than 30, non-smoker with good tolerance for exercise) and ASA grade II signifying a person with mild systemic disease (person with a well-controlled disease without any functional limitations) [21]

We found that most of the patients in both groups (77%) were categorised as ASA I and also noted that a slightly higher percentage of patients in the Group L (28%) were classified as ASA II compared to Group B (18%) with Group L having a slightly higher proportion of patients with mild underlying medical conditions. However, statistical significance was not discovered for this difference (p-value >0.05).

According to our research, Group B exhibited a mean sensory block onset at the T10 dermatome of 3.7+1.89 minutes and 3.82$\pm$2.21 mins in the Group L, deeming the contrast statistically insignificant (p-value >0.05).

In their investigation, Sahin AS et al. [22] didn't find any discernible distinction between intrathecal Bupivacaine and intrathecal Levobupivacaine considering the period at which motor and sensory began. Nonetheless, they discovered that the Levobupivacaine group recovered from motor and sensory blockade more quickly.

F. Erdil et al [23] in their study that was conducted in 2009 concluded that time needed to block motor & time for sensory block to attain T10 dermatome was quicker with Bupivacaine than with Levobupivacaine. They proposed that Levobupivacaine with Fentanyl may be the ideal agents for use in the geriatric patients for urological interventions under SAB, owing to the reduced adverse effects and improved hemodynamic stability of Levobupivacaine.

In our study, we found that 3.82 mins was the average time needed for sensory block to occur at T10 dermatome among Group L and among Group B, it was 3.70 mins. However, we didn't find any significant statistical difference between them (p-value 0.771). Group L also has a slightly longer mean onset time of complete motor block with 3.32 minutes compared to Group B with 3.20 minutes (p-value 0.753) thereby indicating that the difference was statistically insignificant with regard to motor block & sensory block onset.

When assessing sensory-motor block duration, we discovered that Group B had a longer mean duration of sensory block with 152.68 mins compared to Group L with 132.46 mins, and p-value 0.001, indicating that the difference was statistically important.

We also found that Group B also has a longer mean total period of motor block (178.42 mins) compared to Group L (160.38 mins) and p-value 0.003 indicating that the difference was statistically significant.

Opioids like Fentanyl, Sufentanil, Morphine when added in low doses to LA during Subarachnoid block can decrease the frequency of adverse effects associated with local anaesthetics and enhance analgesia quality during and after the surgery. In 1995, Harbhej Singh, Yang J et al [24] demonstrated that inclusion of Fentanyl 25mcg with Bupivacaine when given intrathecally extended the time of sensory block and lowered the early analgesic requirement post-operatively, thereby concluding that Fentanyl acted synergistically with Bupivacaine to potentiate the sensory block.

In our study, Group B has an extended period of both motor and sensory block. P-values for these parameters (0.001 and 0.003) indicate the difference that is significant statistically between the two anesthetics.

The studies that were conducted by Fattorini F., Ricci Z. et al [12] and Sathitkarnmanee, Thingrong C. et al [25] didn't find any notable variations between Levobupivacaine or racemic Bupivacaine regarding anaesthetic or hemodynamic characteristics when administered intrathecally.

With regards to HR, SBP, DBP, MAP & SpO2, we didn't identify any statistically significant variations in hemodynamic measures between the two groups.

LIMITATIONS

1. The associated adverse effects like shivering, nausea, vomiting and pruritis were not assessed.
2. The time following the regression of sensory block till the need for post-operative analgesic was not evaluated.

SUMMARY AND CONCLUSION

Spinal anaesthesia is the preferred anaesthesia technique for surgeries below the umbilicus like inguinal hernia repair, hemorrhoidectomy and lower limb procedures. It is done by administration of local anaesthetics into the subarachnoid space in the lower lumbar region which leads to reversible sensory, motor and sympathetic block. Our study contrasts Hyperbaric Bupivacaine and Hyperbaric Levobupivacaine as there are limited studies on spinal anaesthesia utilisation of Hyperbaric Levobupivacaine. Fentanyl, an opioid is added to each group to enhance analgesia and reduce local anaesthetic side-effects by decreasing the amount of local anaesthetic administered.

We recruited 100 patients who were randomly assigned to receive either 0.5% Hyperbaric Bupivacaine (Group B) or 0.5% Hyperbaric Levobupivacaine (Group L), both with 25mcg of Fentanyl. The onset and duration of sensory-motor block was assessed along with hemodynamic paramters.

In this study, we found that the onset of sensory and motor block was comparable between the two groups. However, the duration of sensory block was longer in Group B (152.68±23.64 minutes) than in Group L (132.46±32.32 minutes). The duration of motor block was also longer in Group B (178.42±32.66 minutes) than in Group L (160.38±25.31 minutes).

Intra-operative hemodynamic parameters were comparable between the two groups.

Overall, based on our study, it was observed that 0.5% Hyperbaric Bupivacaine with Fentanyl provided longer duration of both sensory and motor block with negligible variations in hemodynamic parameters when compared to 0.5% Hyperbaric Levobupivacaine with Fentanyl in patients undergoing spinal anaesthesia for infraumbilical surgeries. Therefore, we conclude that the appropriate drug can be selected based on the nature and duration of the surgical procedure.

BIBLIOGRAPHY

1. Huang YY, Chang KY. Sensory block level prediction of spinal anaesthesia with 0.5% hyperbaric bupivacaine: a retrospective study. Scientific Reports [Internet]. 2021 Apr 27;11(1):9105. Available from: https://www.nature.com/articles/s41598-021-88726-2#citeas
2. Goyal A, P Shankaranarayan, P Ganapathi. A randomized clinical study comparing spinal anesthesia with isobaric levobupivacaine with fentanyl and hyperbaric bupivacaine with fentanyl in elective cesarean sections. Anesthesia: Essays and Researches. 2015 Jan 1;9(1):57–7.
3. Olawin AM, M Das J. Spinal Anesthesia [Internet]. PubMed. Treasure Island (FL): StatPearls Publishing; 2021. Available from: https://pubmed.ncbi.nlm.nih.gov/30725984/
4. Scull TJ, Carli F. Cardiac arrest after Caesarean section under subarachnoid block. British Journal of Anaesthesia. 1996 Aug;77(2):274–6.
5. Maves Timothy J, Gebhart G F. Antinociceptive Synergy Between Intrathecal Morphine and Lidocaine during Visceral and Somatic Nociception in the Rat. Anesthesiology. 1992 Jan 1;76(1):91–9.
6. Tejwani GA, Rattan AK, McDonald JS. Role of Spinal Opioid Receptors in the Antinociceptive Interactions Between Intrathecal Morphine and Bupivacaine. Anesthesia & Analgesia. 1992 May;74(5):726???734.
7. Liu SS, McDonald SB. Current Issues in Spinal Anesthesia. Anesthesiology. 2001 May;94(5):888–906.
8. Rahimzadeh P, Faiz SHR, Imani F, Derakhshan P, Amniati S. Comparative addition of dexmedetomidine and fentanyl to intrathecal bupivacaine in orthopedic procedure in lower limbs. BMC Anesthesiology. 2018 Jun 6;18(1).
9. Erturk E, Tutuncu C, Eroglu A, Gokben M. Clinical Comparison of 12 mg Ropivacaine and 8 mg Bupivacaine, Both with 20 µg Fentanyl, in Spinal Anaesthesia for Major Orthopaedic Surgery in Geriatric Patients. Medical Principles and Practice. 2010;19(2):142–7.
10. Cemile Öztin Öğün, Esma Nur Kirgiz, Duman A, Selmin Ökesli, Cemalettin Akyürek. Comparison of intrathecal isobaric bupivacaine–morphine and ropivacaine–morphine

for Caesarean delivery † †Presented at the 2nd World Congress of the World Institute of Pain, I˙stanbul, Turkey, June 2001. 2003 May 1;90(5):659–64.

11. Koltka K, Uludag E, Senturk M, Yavru A, Karadeniz M, Sengul T, et al. Comparison of Equipotent Doses of Ropivacaine-fentanyl and Bupivacaine-fentanyl in Spinal Anaesthesia for Lower Abdominal Surgery. Anaesthesia and Intensive Care. 2009 Nov 1;37(6):923–8.
12. Fattorini F, Ricci Z, Rocco A, Romano R, Pascarella MA, Pinto G. Levobupivacaine versus racemic bupivacaine for spinal anaesthesia in orthopaedic major surgery. Minerva Anestesiologica [Internet]. 2006 [cited 2024 Jun 26];72(7-8):637–44. Available from: https://pubmed.ncbi.nlm.nih.gov/16865082/
13. Singh A, Gupta A, Datta PK, Pandey M. Intrathecal levobupivacaine versus bupivacaine for inguinal hernia surgery: a randomized controlled trial. Korean Journal of Anesthesiology [Internet]. 2018 Jun 1;71(3):220–5. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5995016/
14. Sethi D. Randomised Control Trial Comparing Plain Levobupivacaine and Ropivacaine with Hyperbaric Bupivacaine in Caesarean Deliveries. 2019 Dec 11;47(6):471–9.
15. Sen H, Purtuloglu T, Sizlan A, Yanarates O, Ates F, Gundu I, et al. Comparison of intrathecal hyperbaric and isobaric levobupivacaine in urological surgery. Minerva Anestesiologica [Internet]. 2010 Jan 1 [cited 2024 Jun 26];76(1):24–8. Available from: https://pubmed.ncbi.nlm.nih.gov/20125070/
16. Akan B, Yagan O, Bilal B, Erdem D, Gogus N. Comparison of levobupivacaine alone and in combination with fentanyl and sufentanil in patients undergoing transurethral resection of the prostate. Journal of Research in Medical Sciences : The Official Journal of Isfahan University of Medical Sciences [Internet]. 2013 May 1 [cited 2024 Jun 26];18(5):378–82. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3810569/
17. Jagtap S, Chhabra A, Dawoodi S, Jain A. Comparison of intrathecal ropivacaine-fentanyl and bupivacaine-fentanyl for major lower limb orthopaedic surgery: A randomised double-blind study. Indian Journal of Anaesthesia. 2014;58(4):442.
18. Sassack B, Carrier JD. Anatomy, Back, Lumbar Spine [Internet]. PubMed. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557616/

19. Telano LN;Baker S. Physiology, Cerebral Spinal Fluid [Internet]. 2023. Available from: https://pubmed.ncbi.nlm.nih.gov/30085549/
20. Bardsley H, Gristwood R, Baker H, Watson N, Nimmo W. A comparison of the cardiovascular effects of levobupivacaine and rac-bupivacaine following intravenous administration to healthy volunteers. British Journal of Clinical Pharmacology. 1998 Sep;46(3):245–9.
21. Daniel John Doyle, Garmon EH. American Society of Anesthesiologists Classification (ASA Class) [Internet]. Nih.gov. StatPearls Publishing; 2019. Available from: https://www.ncbi.nlm.nih.gov/books/NBK441940/
22. Şahin AS, Türker G, Bekar A, Bilgin H, Korfalı G. A comparison of spinal anesthesia characteristics following intrathecal bupivacaine or levobupivacaine in lumbar disc surgery. European Spine Journal. 2013 Nov 9;23(3):695–700.
23. Erdil F, Bulut S, Demirbilek S, Gedik E, Gulhas N, Ersoy MO. The effects of intrathecal levobupivacaine and bupivacaine in the elderly. Anaesthesia. 2009 Sep;64(9):942–6.
24. Singh H, Yang J, Thornton K, Giesecke AH. Intrathecal fentanyl prolongs sensory bupivacaine spinal block. Canadian Journal of Anaesthesia. 1995 Nov;42(11):987–91.
25. Sathitkarnmanee T, Thongrong C, Tribuddharat S, Bn MT, Bn KP, Bn RK. A comparison of spinal isobaric levobupivacaine and racemic bupivacaine for lower abdominal and lower extremity surgery. Journal of the Medical Association of Thailand = Chotmaihet Thangphaet [Internet]. 2011 Jun 1 [cited 2024 Jun 26];94(6):716–20. Available from: https://pubmed.ncbi.nlm.nih.gov/21696081/

INFORMED CONSENT FORM

“COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES-A HOSPITAL-BASED RANDOMIZED CONTROLLED TRIAL”

We request you, Mr./Mrs./Miss___________________to kindly participate in our study as you are eligible for it. During the study, you will be asked some questions regarding your medical history and we would like to request you to answer to the best of your knowledge. We would like to state that your participation in this research is completely voluntary. Your reason whether to participate or not will not affect your relationship with J.N.Medical College. If you agree to participate, we would like to also let you know that you are free to withdraw at any point in time.

Purpose of the study:

The purpose of this research is to compare 0.5% Hyperbaric Levobupivacaine 15mg with Fentanyl 25mcg and 0.5% Hyperbaric Bupivacaine 15mg with Fentanyl 25mcg for spinal anaesthesia in patients undergoing elective infraumbilical surgeries to study the onset and duration of sensory and motor blockade and also to evaluate the haemodynamic changes

Explanation of the procedure:

If you agree to enroll in my study, I will ask you your present, past and family history. Then you will be clinically examined in detail. You will be allotted into one of the two groups randomly using computer generated software:

- Group B- 15mg 0.5% Hyperbaric Bupivacaine(3ml) + 25mcg Fentanyl(0.5ml)
- Group L- 15mg 0.5% Hyperbaric Levobupivacaine(3ml) + 25mcg Fentanyl (0.5ml)

  You will be injected using a spinal needle on your back with the drugs based on the group you have been allotted, to achieve spinal anaesthesia for the infraumbilical surgery.

Following which you will be made to lie supine and the level of sensory and motor blockade will be assessed. The surgery will be allowed to commence once you lose sensation at the level of your umbilicus. Your blood pressure, heart rate, SpO2 and ECG will be monitored throughout the procedure. If the block is not achieved within 30 minutes of giving spinal anaesthesia, the procedure will be converted to general anaesthesia.

Withdrawal from participation in the study: Participation in this study is voluntary. You are free to decide whether to participate in this study or to 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.

Questions:
If you have any question or complaints with regard to your right as study participant you may contact **Dr Harsha Hegde**, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

Legal rights: By signing this consent form, you are not waiving any of your legal rights.

CONSENT STATEMENT

I am making a voluntary decision to participate in the study**- "COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR INFRAUMBILICAL SURGERIES- A HOSPITAL-BASED RANDOMIZED CONTROLLED TRIAL**". My signature below indicates that I have agreed 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:

PROFORMA

"COMPARISON BETWEEN HYPERBARIC BUPIVACAINE WITH FENTANYL AND HYPERBARIC LEVOBUPIVACAINE WITH FENTANYL IN SPINAL ANAESTHESIA FOR LOWER LIMB ORTHOPAEDIC SURGERIES-A HOSPITAL-BASED RANDOMISED CONTROLLED TRIAL"

Group allotted:

Age: Weight:

Sex: Date of Examination:

Address: Occupation:

Pre examination evaluation

Past History

- HTN DM IHD Arrhythmia Valvular heart diseases

- H/o previous surgery/ surgeries where airway difficulty was encountered: Yes/No

General physical examination

Weight (Kg): Temperature (degree F): Pallor:

Icterus: Koilonychia: Cyanosis:

Pedal oedema: Clubbing: Lymphadenopathy:

PR: BP: RR:

Musculoskeletal system:

Teeth: Jaw movements:

Airway assessment: Spine:

Investigations

Hb%: Platelet Count:

TLC: INR:

FBS:

Systemic examination:

CNS: RS:

CVS: GIT:

Preoperative physical status: American Society of Anaesthesiologists Grade: I /II

Diagnosis:

Proposed surgery:

Monitors attached:

Pulse oximetry: NIBP:

ECG:

Group: B/L

Sensory Block assessment:

a) Onset at T10 level(min):

b) Duration at T10 level(min):

c) Highest level of sensory block:

Motor Block:

a) Onset of Grade 4 motor blockade(min):

b) Total duration of Motor blockade(min):

Vital Parameters:

TIME	HR	SBP	DBP	MAP	SpO2
2 min					
4 min					
6 min					
8 min					
10 min					
15 min					
20 min					
25 min					
30 min					
40 min					
50 min					
60 min					
70 min					
80 min					
90 min					
100 min					
110 min					
120 min					
130 min					

140 min					
150 min					
160 min					
170 min					
180 min					
190 min					
200 min					

Post-operative baseline values:

HR: BP: SpO2:

Post-operative Analgesia:

Time to request for first post-operative rescue analgesia(min):

SIGNATURE OF THE ANAESTHESIOLOGIST: ____________________

SIGNATURE OF THE WITNESS: ________________________________

SIGNATURE OF THE PRINCIPAL INVESTIGATOR: ________________

PHOTOGRAPHS

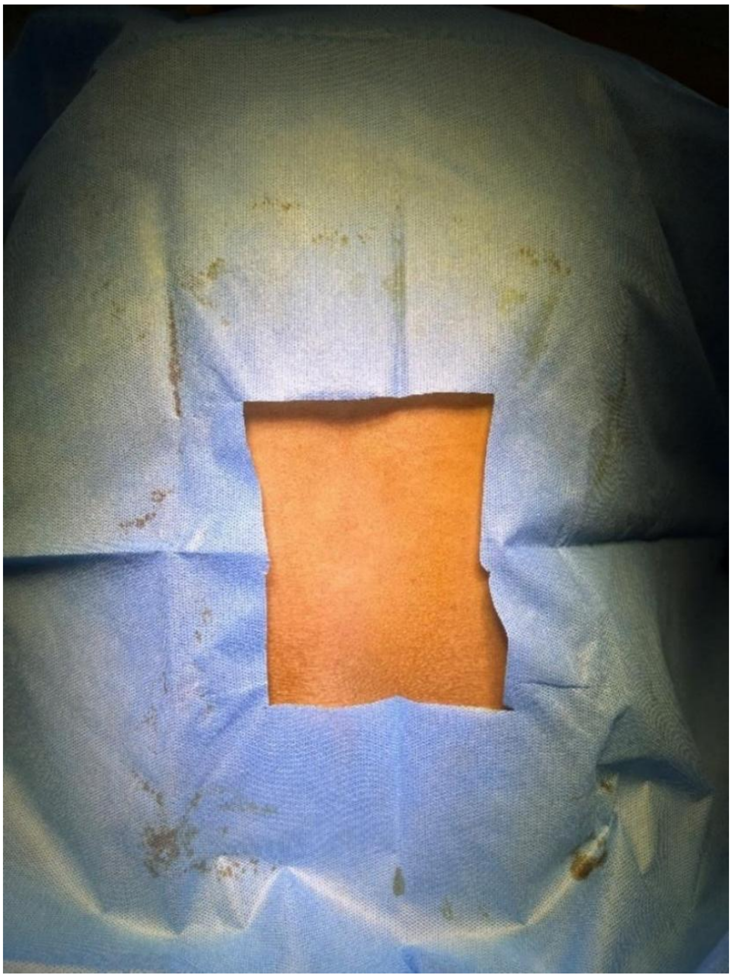
Photograph 1: 0.5% Hyperbaric Bupivacaine

Photograph 2: 0.5% Hyperbaric Levobupivacaine

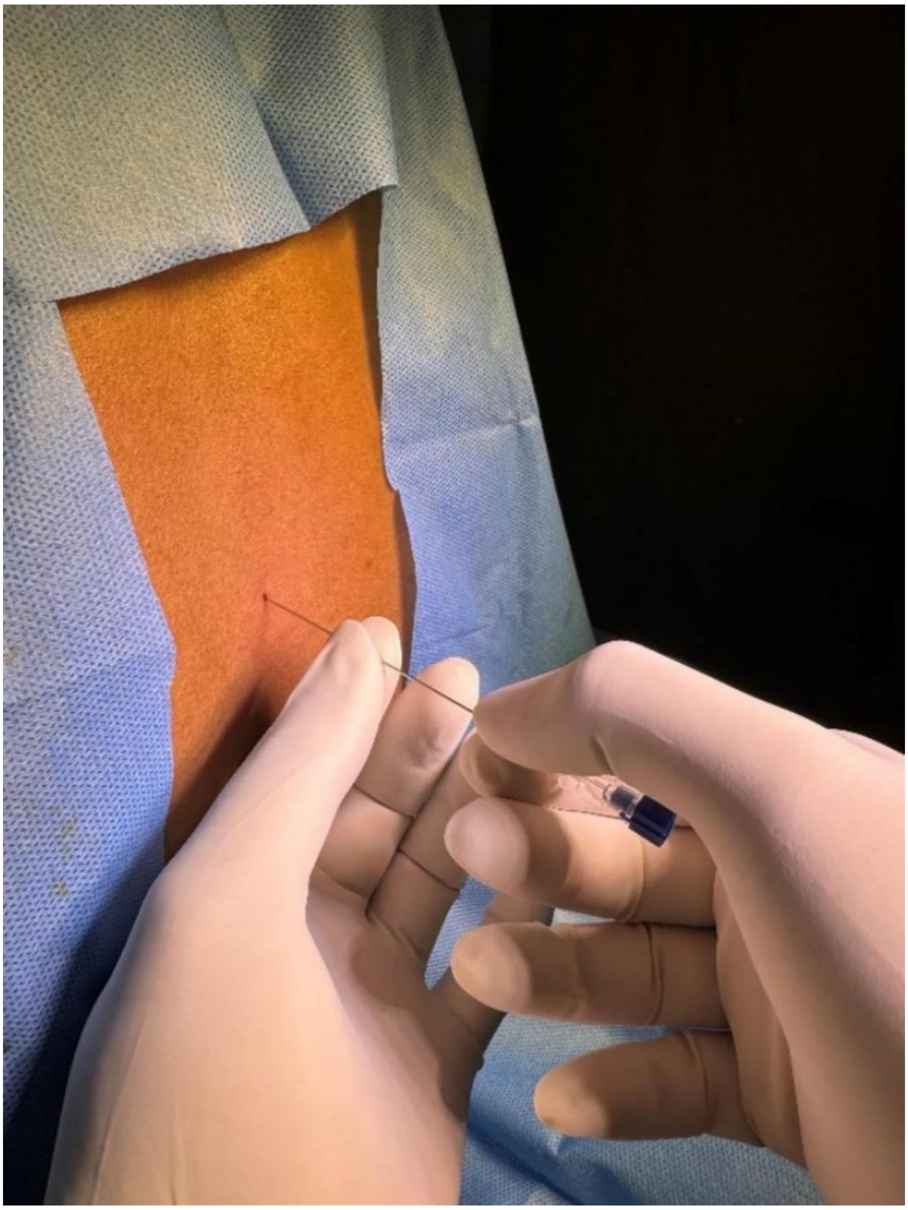
Photograph 3: Fentanyl

Photograph 4: 23G Quincke's Spinal Needle

Photograph 5: Spinal tray



Photograph 6: Painted and draped spine



Photograph 7: Spinal anaesthesia procedure

Photograph 8: Monitoring during surgery

Annexure - Master Chart

Sl no.	Name	Sex	Age	ASA	Diagnosis	Surgery	Group B/L	Sensory Blockade			Motor Blockade	
								Onset at T10 level(mins)	Duration at T10 level (mins)	Highest level of sensory block	Onset of Complete motor blockade(mins)	Total duration of motor blockade
1	Lingaraj	21	M	I	Right inguiinal hernia	Hernia repair	B	2	165.00	T8	2	195
2	Sunanda	50	F	II	Hemorrhoids	Hemorrhoidectomy	B	2	163.00	T10	4	177
3	Shridhar	29	M	I	Gluteal abscess	I & D	B	2	142.00	T9	2	203
4	Ayappa	60	M	I	Urethral Stricture	Cystoscopy and VIU	L	2	132.00	T8	1	145
5	Santosh	32	M	I	Vesical calculus	Cystolithotripsy	L	4	80.00	T10	4	184
6	Chidanand	33	M	II	Op/C/O Ulcer over right Foot	STSG	L	2	155.00	T8	2	163
7	Sugandha	57	F	I	Post-menstrual Bleeding	D&C	L	5	120.00	T8	3	145
8	Piraji	32	M	I	Left ACL tear	Arthroscopic Repair	L	4	150.00	T8	6	160

9	Amol	31	M	I	Vesical calculus	Cystolithotripsy	B	5	120.00	T8	2	151
10	Mahantagouda	53	M	I	Left IT Fracture Femur	ORIF + DHS	B	5	192.00	T8	7	195
11	Chandana	56	F	I	Right Patellar Fracture	Right Patella TBW	B	6	135.00	T10	3	163
12	Rajeshwari	60	F	II	Right Proximal Tibia Fracture	CRIF + Suprapatellar Nailing	B	5	135.00	T8	3	145
13	Bajrang	28	M	I	B/L Hip Avascular Necrosis	Left Hip Core Decompression	B	3	160.00	T10	2	160
14	Ravindra	42	M	I	Right ACL & Medial Meniscus Tear	Arthroscopic Repair	L	7	55.00	T8	3	189
15	Mahantesh	32	M	I	Left ACL + Medial Meniscus Tear	Arthroscopic Repair	L	4	55.00	T8	2	164
16	Rudra	24	M	I	Right ACL Tear	Arthroscopic Repair	L	6	180.00	T9	3	190
17	Arjun	42	M	I	Left ACL Tear	Arthroscopic Repair	L	9	136.00	T10	3	136
18	Mahesh	27	M	I	Op/C/O B/L Tibia Fracture	Dynamisation of B/L Nail	L	4	157.00	T8	2	157
19	Rohan	38	M	II	Op/C/O Right Tibia Distal End Fracture	Implant Removal	L	7	200.00	T8	4	242
20	Madhav	37	M	I	Right LL Osteomyelitis with Implant in situ	Implant Removal	B	1	200.00	T6	2	220
21	Rakesh	28	M	I	Raw Area over Right Leg	Debridement and Grafting	L	1	160.00	T8	2	165
22	Shivanand	18	M	I	Defect in Perianal region	Local Flap Reconstruction	B	6	155.00	T8	2	150
23	Tipanna	40	M	I	Crush Injury Right Foot	Below Knee Amputation	L	9	165.00	T8	7	150
24	Prakash	37	M	I	Op/C/O Right Foot Crush Injury	Debridement and Grafting	L	1	110.00	T8	2	165
25	Imtiyaz	39	M	I	Raw Area over Dorsum of Left Foot	Debridement and Grafting	L	2	123.00	T8	4	124

26	Manjunath	36	M	I	Op/C/O Right Foot Crush Injury	Debridement and Grafting	B	3	125.00	T8	3	188
27	Pramod	34	M	I	Raw Area over Right Leg	Debridement and Grafting	B	5	120.00	T7	3	130
28	Shivaputra	40	M	I	Op/C/O Right Foot Crush Injury	Debridement	L	10	135.00	T8	7	148
29	Raghunandan	29	M	I	Op/C/O Right Tibia Fracture	Implant Removal	B	10	135.00	T8	10	210
30	Rashi	38	F	I	Op/C/O Right Distal Tibia Fracture	Implant Removal	B	10	80.00	T10	2	140
31	Meena	40	F	II	Right Knee Meniscal Tear	Arthroscopic Repair	B	1	110.00	T8	1	270
32	Sangamesh	53	M	I	Left IT Fracture Femur	ORIF + DHS	B	5	175.00	T10	7	185
33	Abhishek	26	M	I	Left Knee Meniscal tear	Arthroscopic Repair	B	6	160.00	T10	6	170
34	Mohan	48	M	I	Right Knee Meniscal Tear	Arthroscopic Repair	B	3	165.00	T8	5	217
35	Gangappa	60	M	II	Left Inguinal hernia	Hernia repair	L	3	120.00	T8	5	140
36	Shankar	38	M	II	Op/C/O Crush injury Right foot	Debridement and Grafting	L	2	120.00	T8	4	130
37	Prasanna	52	M	II	Op/C/O Right Tibia Fracture with nail in situ	Dynamisation of Nail	L	2	74.00	T8	1	139
38	Shreya	26	F	I	Hemorrhoids	Hemorrhoidectomy	B	3	157.00	T8	2	172
39	Maruti	55	M	I	Right Inguinal Hernia	Hernia repair	B	4	158.00	T8	2	185
40	Md Rafiq	45	M	I	Left Inguinal hernia	Hernia repair	L	2	105.00	T6	4	120
41	Ningappa	44	M	II	Abscess over medial aspect of left thigh	Incision and Drainage	B	3	150.00	T8	3	160
42	Santoshi	60	F	I	Both bone Fracture Left Lower Limb	ORIF	B	4	180.00	T8	3	258
43	Vinayak	32	M	I	Left ACL tear	Arthroscopic Repair	L	4	150.00	T8	6	145
44	Sanjay	24	M	I	Right Complete ACL tear	Arthroscopic ACL Reconstruction	B	7	192.00	T6	5	207

45	Ningappa	44	M	II	Abscess over medial aspect of left thigh	I & D	B	3	140.00	T8	3	160
46	Gundu	59	M	II	Bladder Clots	Cystoscopy and Clot Evacuation	B	3	175.00	T8	3	160
47	Irappa	44	M	I	Raw area over Right Foot	STSG	B	3	130.00	T8	2	115
48	Shantagouda	60	M	I	Stricture Urethra	Cystoscopy and endodilation	B	3	140.00	T8	3	120
49	Parappa	60	M	I	Right Inguinal Hernia	Hernia repair	L	8	130.00	T8	6	155
50	Abdul	42	M	I	Hemorrhoids	Hemorrhoidectomy	L	5	125.00	T6	2	130
51	Kalpana	54	F	II	Ischiorectal Abscess	Debridement	L	5	170.00	T6	4	180
52	Raveena	25	F	I	Fissure in ano	Fissurectomy	L	5	136.00	T6	4	140
53	Basavaraj	40	M	I	Bladder Stone	Cystolithotripsy	L	4	180.00	T8	3	190
54	Basappa	60	M	II	Prostatomegaly	TURP	L	2	135.00	T10	7	150
55	Rajashree	60	F	I	Both bone Fracture Left Lower Limb	IMIL Nailing	B	4	180.00	T9	3	258
56	Rajesh	36	M	I	Right Complete ACL tear	Arthroscopic ACL Reconstruction	L	7	192.00	T6	5	207
57	Chinappa	30	M	I	Right Foot 5th toe fracture	K wire Fixation	L	4	112.00	T8	4	112
58	Ramappa	50	M	I	Right foot healing ulcer	STSG	L	2	160.00	T8	3	165
59	Md Shahid	28	M	I	B/L Hip Avascular Necrosis	Core decompression of Left Hip	B	3	160.00	T10	2	160
60	Manohar	58	M	II	Vesical mass	TURBT	B	3	165.00	T8	3	180
61	Maruti	55	M	I	Hemorrhoids	Hemorrhoidectomy	B	3	150.00	T8	3	190
62	Rudrappa	29	M	I	Hemorrhoids	Hemorrhoidectomy	B	2	172.00	T10	2	192
63	Veerappa	55	M	II	Phimosis	Circumcision	L	5	75.00	T8	2	125
64	Champavva	58	F	II	Op/C/O Right Proximal Tibia fracture	Implant Removal	B	2	160.00	T10	2	175
65	Savitri	40	F	I	Osteoarthritis Right Knee	Meniscectomy	B	5	163.00	T8	10	175

66	Rohini	36	F	I	Gluteal abscess	I & D	B	3	163.00	T8	3	163
67	Rahul	41	M	I	Left LL Necrotising fasciitis	Fasciotomy	B	5	136.00	T8	2	170
68	Channappa	44	M	I	Right LL Necrotising fasciitis	Fasciotomy	B	2	135.00	T8	3	185
69	Iqbal	40	M	I	Acute appendicitis	Appendicectomy	L	3	135.00	T8	1	190
70	Shridhar	29	M	I	Hematuria	Bladder clot evacuation	B	2	142.00	T10	2	203
71	Sunanda	50	F	II	Left LL ganglion cyst	Excision	B	2	163.00	T10	4	177
72	Veeresh	46	M	I	Left Inguinal hernia	Hernia repair	L	4	125.00	T8	1	158
73	Lingaraj	22	M	I	Bladder Valve Syndrome	Cystoscopy and PUV fulguration	B	2	165.00	T8	2	195
74	Ayappa	59	M	I	Urethral Stricture	Cystoscopy and VIU	L	2	132.00	T8	1	145
75	Tanvi	40	F	I	Op/C/OFracture Right Tibia	Implant Removal	B	4	115.00	T10	2	135
76	Channabasavva	32	M	I	Raw area over right foot	STSG	B	2	178.00	T8	2	192
77	Santosh	32	M	I	Vesical calculus	Cystolithotripsy	L	4	80.00	T10	4	184
78	Tanushree	36	F	I	Abscess over Right Thigh	I & D	B	3	172.00	T8	2	185
79	Radhika	42	F	II	Hemorrhoids	Hemorrhoidectomy	L	4	85.00	T8	3	125
80	Prashanta	32	M	I	Raw area over right foot	STSG	B	2	170.00	T10	2	190
81	Prakash	37	M	I	Op/C/O right foot crush injury	STSG	L	1	110.00	T8	2	165
82	Vinayaka	34	M	I	Left inguinal hernia	Hernia repair	B	4	165.00	T8	3	185
83	Saba	22	F	I	Multiple ganglion cysts	Excision	L	1	150.00	T8	1	175
84	Mohini	28	F	I	Fistula in ano	Fistulectony	B	5	136.00	T8	4	158
85	Prasad	42	M	I	Hydrocoele	Hydrocoele Repair	B	4	150.00	T9	3	155
86	Rajesh	39	M	I	Left LL Necrotising fasciitis	Fasciotomy	L	3	140.00	T8	1	176
87	Pragati	32	F	I	Perianal abscess	I & D	B	4	120.00	T9	4	130
88	Roshan	45	M	I	Right Inguinal Hernia	Hernia repair	B	4	180.00	T8	3	210
89	Kamalika	36	F	I	Hemorrhoids	Hemorrhoidectomy	B	2	135.00	T10	2	152

90	Prasant	54	M	II	Op/C/O Right great toe amputation	Debridement and Grafting	L	2	165.00	T8	1	190
91	Shreya	38	F	II	Pilonidal Sinus	Excision and repair	L	4	130.00	T8	5	165
92	Aniket	40	M	I	Left LL Necrotising fasciitis	Fasciotomy	L	3	136.00	T8	4	185
93	Yash	45	M	I	Perianal abscess	I & D	L	2	150.00	T8	2	165
94	Kishore	41	M	II	Raw area over left foot	STSG	L	2	143.00	T8	2	150
95	Mahesh	54	M	II	Op/C/O Right LL ulcer	STSG	L	5	130.00	T8	8	170
96	Shalini	32	F	I	Sebaceous cyst	Excision	L	2	125.00	T8	1	135
97	Tulika	40	F	I	Fistula in ano	Fistulectony	B	2	135.00	T8	3	156
98	Rajendra	28	M	I	Op/C/O Left leg Traumatic amputation	Debridement and grafting	L	3	135.00	T8	2	156
99	Mahantesh	48	M	I	Ulcer Left Lower limb	Debridement and Grafting	L	5	165.00	T8	7	200
100	Mallannagouda	50	M	II	Right great toe papilloma	Excision	L	2	155.00	T8	2	174

Sl no.	Name	Preoperative Vitals				Vitals at 2 mins					Vitals at 4 mins				
		HR (BPM)	SBP	DBP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2
1	Lingaraj	100	130	70	99	105	131	70	100	100	79	122	65	86	100
2	Sunanda	70	132	86	98	84	189	103	137	100	82	163	92	120	100

3	Shridhar	90	124	77	96	88	131	75	97	100	77	123	71	89	100
4	Ayappa	82	140	80	97	84	140	60	97	100	83	130	62	89	100
5	Santosh	76	120	74	97	78	112	80	93	100	75	114	77	91	100
6	Chidanand	100	122	70	97	120	128	74	90	100	116	121	73	88	100
7	Sugandha	96	120	80	98	94	124	80	97	100	100	117	73	89	100
8	Piraji	74	130	82	99	72	130	80	96	100	72	116	70	85	100
9	Amol	78	130	90	98	70	136	88	105	100	80	126	76	69	100
10	Mahantagouda	88	120	84	99	84	120	82	95	100	84	116	70	85	100
11	Chandana	88	140	80	98	88	140	80	100	100	88	128	72	90	100
12	Rajeshwari	72	140	80	97	122	145	88	107	100	128	130	74	92	100
13	Bajrang	88	140	86	99	90	140	86	104	100	84	132	64	100	100
14	Ravindra	80	126	80	96	80	135	89	104	100	74	137	97	110	100
15	Mahantesh	68	120	80	99	114	175	125	141	100	114	175	125	141	100
16	Rudra	84	120	80	97	96	126	89	101	100	86	121	89	99	100
17	Arjun	80	120	70	99	72	126	77	88	100	80	129	79	91	100
18	Mahesh	80	125	70	99	73	123	61	78	100	80	113	58	73	100
19	Rohan	98	140	92	98	98	140	92	108	100	98	132	84	100	100
20	Madhav	65	129	80	99	86	128	80	96	100	86	116	74	88	100
21	Rakesh	88	116	68	98	92	116	70	85	100	90	106	62	77	100
22	Shivanand	80	120	70	99	94	120	68	85	100	90	113	64	80	100
23	Tipanna	88	118	78	98	98	129	79	91	100	90	120	74	88	100
24	Prakash	80	106	70	97	80	106	70	82	100	84	100	64	76	100
25	Imtiyaz	78	130	84	99	78	130	80	97	100	74	120	74	89	100
26	Manjunath	84	140	90	99	86	124	77	92	100	86	118	74	88	100
27	Pramod	100	150	90	96	100	140	90	106	100	98	132	84	100	100
28	Shivaputra	88	118	76	99	88	118	76	90	100	88	110	70	83	100
29	Raghunandan	64	130	80	98	58	156	86	109	100	58	148	80	102	100
30	Rashi	70	160	90	98	72	160	90	113	100	75	145	111	120	100

31	Meena	68	130	70	97	88	123	69	87	100	93	124	66	79	100
32	Sangamesh	86	140	90	99	86	140	90	107	100	84	136	88	104	100
33	Abhishek	84	116	64	97	88	99	61	70	100	86	123	73	87	100
34	Mohan	82	130	70	97	82	130	70	90	100	82	128	68	88	100
35	Gangappa	80	180	100	98	73	186	100	129	100	69	180	98	125	100
36	Shankar	88	140	90	98	107	146	95	115	100	110	142	93	113	100
37	Prasanna	66	130	90	99	57	142	80	98	100	61	94	51	64	100
38	Shreya	110	120	80	96	107	128	82	98	100	107	122	82	98	100
39	Maruti	78	132	86	97	69	136	88	107	100	74	114	69	87	100
40	Md Rafiq	90	110	70	99	88	134	84	101	100	90	134	84	101	100
41	Ningappa	80	130	80	98	90	130	80	97	100	90	122	78	93	100
42	Santoshi	90	130	80	99	84	130	80	98	100	83	128	70	89	100
43	Vinayak	74	130	80	99	72	130	80	97	100	74	133	80	97	100
44	Sanjay	72	134	84	98	96	138	80	99	100	96	116	70	85	100
45	Ningappa	80	128	82	97	72	141	85	102	100	70	134	80	98	100
46	Gundu	86	140	80	96	110	143	80	106	100	91	142	79	106	100
47	Irappa	84	130	80	96	80	135	82	102	100	72	145	88	111	100
48	Shantagouda	84	130	76	99	88	108	60	79	100	85	104	56	74	100
49	Parappa	72	140	72	98	89	127	69	85	100	86	120	62	81	100
50	Abdul	56	124	80	97	86	136	80	98	100	78	126	75	92	100
51	Kalpana	84	140	90	100	86	154	98	98	100	84	145	96	96	100
52	Raveena	80	120	78	99	78	112	76	86	100	72	111	72	85	100
53	Basavaraj	74	140	82	97	88	144	83	104	100	84	128	76	96	100
54	Basappa	84	144	92	96	89	168	80	116	100	78	160	74	107	100
55	Rajashree	90	130	80	96	90	130	80	96	100	94	124	76	92	100
56	Rajesh	72	128	80	98	96	138	80	99	100	96	116	70	85	100
57	Chinappa	68	130	80	99	71	127	83	97	100	66	77	48	58	100
58	Ramappa	94	142	90	97	99	132	94	106	100	99	119	73	87	100

59	Md Shahid	88	140	86	96	90	140	86	104	100	83	132	84	100	100
60	Manohar	62	124	80	99	51	137	88	107	100	50	113	68	84	100
61	Maruti	78	132	86	98	74	120	74	89	100	74	113	64	80	100
62	Rudrappa	64	128	88	98	68	130	80	97	100	64	124	76	91	100
63	Veerappa	97	127	90	99	91	127	90	102	100	83	119	78	91	100
64	Champavva	108	190	103	97	104	190	103	134	100	106	180	94	129	100
65	Savitri	68	140	88	99	78	140	88	105	100	80	138	90	106	100
66	Rohini	84	134	84	98	90	140	86	104	100	91	132	84	100	100
67	Rahul	94	118	74	99	98	120	78	92	100	99	118	70	86	100
68	Channappa	64	140	90	97	53	161	94	116	100	51	158	91	113	100
69	Iqbal	90	118	74	98	98	124	82	96	100	96	118	80	93	100
70	Shridhar	90	124	77	99	88	131	75	97	100	77	123	71	89	100
71	Sunanda	70	132	86	99	84	189	103	137	100	82	163	92	120	100
72	Veeresh	88	130	80	99	98	134	88	103	100	90	130	82	97	100
73	Lingaraj	100	130	70	99	105	131	70	94	100	79	122	65	86	100
74	Ayappa	80	134	78	98	84	140	69	97	100	83	130	62	89	100
75	Tanvi	76	124	82	99	74	130	84	99	100	76	132	82	99	100
76	Channabasavva	84	116	72	99	90	130	80	97	100	90	122	78	93	100
77	Santosh	76	120	78	99	78	112	80	93	100	75	114	77	91	100
78	Tanushree	100	116	72	98	104	116	74	88	100	100	108	68	81	100
79	Radhika	74	130	84	99	88	138	90	106	100	84	132	84	100	100
80	Prashanta	70	130	84	99	72	132	84	100	100	71	116	74	88	100
81	Prakash	80	106	70	99	80	106	70	82	100	84	100	64	76	100
82	Vinayaka	78	130	78	98	92	130	84	99	100	94	122	80	94	100
83	Saba	90	134	90	99	125	124	61	82	100	112	103	55	71	100
84	Mohini	84	116	68	100	94	120	78	92	100	88	122	74	90	100
85	Prasad	82	124	82	99	90	138	84	102	100	84	124	74	91	100
86	Rajesh	84	118	80	99	100	140	90	107	100	94	130	82	98	100

87	Pragati	82	116	76	100	94	130	90	103	100	92	124	84	97	100
88	Roshan	88	132	84	97	92	140	82	101	100	88	141	78	99	100
89	Kamalika	78	118	80	99	78	122	80	94	100	79	120	76	91	100
90	Prasant	68	124	80	99	68	124	86	99	100	66	122	84	97	100
91	Shreya	80	118	68	99	92	132	74	93	100	90	130	74	93	100
92	Aniket	90	128	82	99	94	138	84	102	100	94	136	78	97	100
93	Yash	76	120	80	99	78	118	80	93	100	78	108	80	89	100
94	Kishore	84	124	86	97	86	128	88	101	100	84	122	82	95	100
95	Mahesh	78	132	88	99	84	142	88	106	100	86	136	84	101	100
96	Shalini	84	112	72	97	82	140	80	100	100	80	138	76	97	100
97	Tulika	78	124	86	99	80	134	88	103	100	84	130	84	99	100
98	Rajendra	72	110	70	100	88	116	78	91	100	84	114	74	87	100
99	Mahantesh	88	132	84	99	94	136	88	104	100	90	130	80	97	100
100	Mallannagouda	80	150	90	97	78	148	94	112	100	78	144	92	109	100

Sl no.	Name	Vitals at 6 mins					Vitals at 8 mins					Vitals at 10 mins				
		HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2
1	Lingaraj	71	120	60	82	100	62	120	55	80	100	63	116	55	79	100
2	Sunanda	74	146	86	111	100	66	144	90	112	100	66	142	88	110	100
3	Shridhar	79	117	68	88	100	79	119	71	88	100	78	122	72	92	100
4	Ayappa	83	110	58	78	100	79	103	~~59~~	75	100	77	104	55	74	100
5	Santosh	82	118	80	93	100	64	112	76	90	100	62	111	70	86	100
6	Chidanand	108	74	54	48	100	100	110	77	89	100	86	117	76	86	100
7	Sugandha	82	98	59	73	100	77	93	57	70	100	76	96	57	70	100
8	Piraji	70	110	74	86	100	74	112	70	84	100	74	116	80	92	100
9	Amol	77	132	79	99	100	83	125	72	93	100	75	127	71	92	100
10	Mahantagouda	86	112	70	85	100	84	112	74	86	100	80	112	74	86	100
11	Chandana	84	116	70	85	100	84	118	68	84	100	82	118	68	84	100
12	Rajeshwari	126	121	69	86	100	126	121	69	86	100	113	98	71	80	100
13	Bajrang	82	128	70	89	100	74	120	66	85	100	76	110	60	76	100
14	Ravindra	75	145	94	111	100	73	135	92	106	100	73	135	92	105	100
15	Mahantesh	117	172	116	134	100	110	171	116	134	100	104	177	116	136	100
16	Rudra	88	126	80	95	100	88	119	79	92	100	89	125	72	79	100
17	Arjun	73	120	74	88	100	77	119	73	88	100	79	121	71	87	100
18	Mahesh	76	117	54	71	100	75	109	55	70	100	72	107	47	63	100
19	Rohan	90	126	80	95	100	94	128	76	93	100	88	128	74	92	100

20	Madhav	82	110	72	85	100	84	108	70	80	100	78	110	74	82	100
21	Rakesh	86	104	60	75	100	84	98	56	70	100	86	100	60	73	100
22	Shivanand	90	117	54	71	100	86	109	55	70	100	86	109	55	70	100
23	Tipanna	88	119	73	88	100	88	119	73	88	100	86	121	71	87	100
24	Prakash	80	100	66	77	100	78	98	62	74	100	76	98	64	75	100
25	Imtiyaz	74	116	72	89	100	72	108	64	79	100	70	104	58	73	100
26	Manjunath	82	116	72	86	100	82	116	72	86	100	80	115	64	81	100
27	Pramod	102	118	74	89	100	96	108	64	79	100	90	110	62	78	100
28	Shivaputra	86	102	60	74	100	82	100	60	73	100	80	102	64	77	100
29	Raghunandan	57	140	80	100	100	57	138	78	98	100	58	130	80	96	100
30	Rashi	75	158	98	114	100	81	160	98	113	100	93	150	92	111	100
31	Meena	79	116	58	70	100	79	105	59	68	100	75	119	61	74	100
32	Sangamesh	84	116	78	91	100	86	108	78	88	100	86	108	78	88	100
33	Abhishek	80	132	61	84	100	82	124	75	89	100	82	124	75	89	100
34	Mohan	84	122	64	83	100	80	120	68	85	100	78	117	54	71	100
35	Gangappa	72	176	98	124	100	70	174	96	122	100	73	166	90	115	100
36	Shankar	108	135	86	105	100	105	127	79	98	100	101	113	64	82	100
37	Prasanna	50	94	55	67	100	54	99	56	70	100	48	103	66	78	100
38	Shreya	103	126	82	99	100	106	96	57	63	100	100	106	60	77	100
39	Maruti	62	113	68	86	100	62	109	60	80	100	60	106	57	75	100
40	Md Rafiq	94	133	84	100	100	95	133	80	97	100	96	138	86	103	100
41	Ningappa	84	118	76	90	100	82	110	74	86	100	77	104	70	81	100
42	Santoshi	84	120	68	85	100	80	110	64	79	100	82	112	66	81	100
43	Vinayak	70	128	70	89	100	80	120	68	85	100	82	129	79	91	100
44	Sanjay	92	112	70	84	100	90	112	74	84	100	88	110	74	86	100
45	Ningappa	72	134	83	98	100	70	133	81	96	100	72	130	78	96	100
46	Gundu	87	173	84	120	100	84	163	77	111	100	85	154	76	109	100
47	Irappa	70	139	84	106	100	76	137	80	103	100	73	133	78	100	100

48	Shantagouda	87	101	57	75	100	84	100	58	75	100	84	97	56	73	100
49	Parappa	85	110	55	71	100	82	107	56	73	100	80	110	57	72	100
50	Abdul	67	111	75	87	100	65	110	64	79	100	58	100	63	75	100
51	Kalpana	84	140	84	90	100	85	135	82	84	100	86	110	80	82	100
52	Raveena	67	115	64	80	100	65	119	71	79	100	64	108	65	77	100
53	Basavaraj	84	114	69	86	100	67	114	66	85	100	64	114	70	88	100
54	Basappa	77	153	74	107	100	86	169	81	116	100	80	159	75	108	100
55	Rajashree	84	118	80	83	100	82	118	82	83	100	82	116	80	90	100
56	Rajesh	92	112	70	84	100	90	112	74	86	100	88	110	74	86	100
57	Chinappa	73	76	48	58	100	61	74	40	52	100	55	82	53	62	100
58	Ramappa	98	101	65	77	100	93	92	58	69	100	88	89	58	67	100
59	Md Shahid	82	128	70	89	100	73	120	68	85	100	76	110	64	79	100
60	Manohar	66	148	94	115	100	67	135	88	107	100	67	133	87	105	100
61	Maruti	72	116	72	87	100	70	104	60	75	100	70	107	54	66	100
62	Rudrappa	62	120	74	89	100	66	117	72	87	100	60	116	72	87	100
63	Veerappa	84	101	74	83	100	92	105	74	83	100	95	116	80	92	100
64	Champavva	107	179	101	135	100	99	171	89	123	100	93	165	85	119	100
65	Savitri	80	135	58	101	100	80	130	85	102	100	82	137	90	99	100
66	Rohini	82	128	82	97	100	84	125	74	91	100	86	112	71	85	100
67	Rahul	100	102	60	74	100	101	101	61	74	100	94	92	54	67	100
68	Channappa	49	159	91	114	100	49	161	92	115	100	46	162	93	116	100
69	Iqbal	98	114	76	87	100	86	108	70	83	100	84	104	68	80	100
70	Shridhar	79	117	68	88	100	79	119	71	88	100	78	122	72	92	100
71	Sunanda	74	146	86	111	100	66	144	90	112	100	66	142	88	110	100
72	Veeresh	84	126	80	95	100	82	124	76	92	100	80	120	74	89	100
73	Lingaraj	71	120	60	82	100	62	120	55	80	100	63	116	55	79	100
74	Ayappa	83	110	58	78	100	79	103	59	75	100	77	104	5	74	100
75	Tanvi	74	118	72	87	100	72	108	68	81	100	70	100	54	69	100

76	Channabasavva	84	118	76	90	100	82	110	74	86	100	72	104	70	81	100
77	Santosh	82	118	80	93	100	64	112	76	90	100	62	111	70	86	100
78	Tanushree	98	100	60	73	100	90	98	58	71	100	94	102	60	74	100
79	Radhika	88	122	80	94	100	82	116	72	91	100	78	108	64	79	100
80	Prashanta	70	104	72	83	100	72	102	60	74	100	64	96	62	73	100
81	Prakash	80	100	66	77	100	78	98	62	74	100	78	98	64	75	100
82	Vinayaka	90	116	80	92	100	84	114	74	87	100	82	110	73	85	100
83	Saba	102	84	50	61	100	84	109	56	73	100	79	107	56	73	100
84	Mohini	82	118	70	86	100	80	106	64	78	100	79	105	62	76	100
85	Prasad	84	116	72	87	100	82	112	72	85	100	81	108	70	83	100
86	Rajesh	90	128	80	96	100	88	124	78	94	100	82	118	80	93	100
87	Pragati	84	121	78	92	100	84	117	71	86	100	83	104	64	77	100
88	Roshan	88	138	76	97	100	78	130	74	93	100	80	122	72	89	100
89	Kamalika	84	118	77	91	100	80	116	68	84	100	76	104	64	77	100
90	Prasant	66	120	78	92	100	64	116	74	88	100	63	118	72	87	100
91	Shreya	92	124	72	89	100	90	126	74	91	100	82	120	70	87	100
92	Aniket	90	138	76	97	100	90	128	78	95	100	88	130	80	97	100
93	Yash	74	106	76	86	100	72	102	72	82	100	74	106	74	85	100
94	Kishore	84	120	80	93	100	82	118	82	94	100	78	116	80	92	100
95	Mahesh	88	130	84	99	100	84	132	78	96	100	82	122	74	90	100
96	Shalini	80	132	78	96	100	78	130	74	93	100	74	130	70	90	100
97	Tulika	81	128	82	97	100	82	124	83	97	100	76	118	75	89	100
98	Rajendra	82	110	72	85	100	80	108	70	83	100	76	110	72	85	100
99	Mahantesh	84	124	82	96	100	84	124	82	96	100	82	120	76	91	100
100	Mallannagouda	75	138	90	106	100	74	136	90	105	100	70	134	90	105	100

Sl no.	Name	Vitals at 15 mins					Vitals at 20 mins					Vitals at 25 mins				
		HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2
1	Lingaraj	58	116	55	79	100	59	122	61	86	100	61	119	60	83	100
2	Sunanda	62	143	86	109	100	61	142	90	111	100	61	149	89	112	100
3	Shridhar	81	123	74	92	100	79	119	74	90	100	80	118	76	90	100
4	Ayappa	74	101	59	76	100	69	100	55	72	100	67	95	51	66	100
5	Santosh	58	111	72	86	100	58	111	72	88	100	56	111	75	89	100
6	Chidanand	83	112	75	86	100	72	110	70	82	100	75	107	71	82	100
7	Sugandha	75	100	57	72	100	72	99	59	74	100	71	100	60	73	100
8	Piraji	78	116	78	90	100	74	108	70	82	100	68	102	72	82	100
9	Amol	72	120	72	90	100	74	113	63	82	100	74	114	66	85	100
10	Mahantagouda	82	112	80	90	100	78	110	70	82	100	78	104	74	86	100
11	Chandana	78	116	70	85	100	78	116	70	85	100	72	114	70	84	100
12	Rajeshwari	118	97	61	73	100	108	99	60	73	100	99	88	61	73	100
13	Bajrang	74	112	58	74	100	74	108	56	74	100	72	108	55	75	100
14	Ravindra	74	134	91	105	100	81	127	87	100	100	80	117	68	81	100
15	Mahantesh	89	163	114	130	100	74	163	103	123	100	78	165	110	128	100
16	Rudra	78	131	74	93	100	69	116	69	84	100	64	112	70	84	100
17	Arjun	72	123	73	87	100	73	122	75	89	100	69	124	75	89	100
18	Mahesh	64	107	54	66	100	67	102	49	64	100	61	103	49	64	100
19	Rohan	84	120	74	87	100	78	118	72	87	100	78	118	72	87	100

20	Madhav	76	112	78	86	100	78	110	74	86	100	78	114	78	90	100
21	Rakesh	86	102	64	77	100	78	106	62	77	100	78	104	58	73	100
22	Shivanand	84	107	54	66	100	84	107	54	66	100	84	102	49	64	100
23	Tipanna	122	75	89	100	84	100	124	75	89	100	82	124	75	89	100
24	Prakash	72	100	64	76	100	68	100	64	76	100	70	108	66	80	100
25	Imtiyaz	70	104	60	75	100	72	106	64	78	100	68	108	66	80	100
26	Manjunath	87	114	66	82	100	70	114	63	81	100	59	111	57	71	100
27	Pramod	84	102	64	77	100	84	106	64	78	100	82	108	64	80	100
28	Shivaputra	78	104	64	77	100	82	102	68	79	100	84	102	68	79	100
29	Raghunandan	56	132	80	97	100	55	136	88	104	100	57	134	80	98	100
30	Rashi	74	133	90	100	100	79	136	74	89	100	80	127	71	85	100
31	Meena	64	113	55	67	100	95	124	66	79	100	82	116	58	70	100
32	Sangamesh	84	108	70	82	100	82	106	78	87	100	80	110	76	87	100
33	Abhishek	85	124	79	91	100	84	119	72	86	100	88	119	73	84	100
34	Mohan	78	107	54	66	100	74	107	54	66	100	72	109	56	73	100
35	Gangappa	72	158	92	111	100	68	164	96	116	100	63	177	90	113	100
36	Shankar	95	116	64	85	100	91	106	60	77	100	84	110	59	77	100
37	Prasanna	63	129	84	97	100	68	127	88	99	100	76	125	83	95	100
38	Shreya	92	108	68	81	100	94	100	54	69	100	98	100	60	73	100
39	Maruti	59	101	55	72	100	65	102	58	78	100	65	102	58	78	100
40	Md Rafiq	96	138	88	105	100	106	153	92	112	100	105	153	91	112	100
41	Ningappa	80	102	68	79	100	81	100	70	80	100	72	96	64	75	100
42	Santoshi	82	108	60	76	100	84	108	58	74	100	83	108	58	74	100
43	Vinayak	80	119	73	88	100	80	121	71	87	100	76	122	75	89	100
44	Sanjay	88	112	80	90	100	86	114	82	92	100	88	116	80	92	100
45	Ningappa	73	129	83	97	100	78	129	83	97	100	68	126	80	95	100
46	Gundu	83	137	77	100	100	65	155	79	109	100	80	161	74	110	100
47	Irappa	71	137	78	101	100	68	138	77	101	100	68	138	77	101	100

48	Shantagouda	80	91	50	67	100	79	89	51	68	100	79	86	51	66	100
49	Parappa	79	106	59	72	100	76	102	57	71	100	74	106	58	73	100
50	Abdul	55	98	56	70	100	55	102	57	72	100	55	105	64	77	100
51	Kalpana	88	108	78	82	100	86	110	63	80	100	84	112	69	76	100
52	Raveena	65	106	67	76	100	67	106	67	78	100	62	101	65	78	100
53	Basavaraj	63	116	80	95	100	62	122	76	95	100	58	124	76	98	100
54	Basappa	77	160	73	105	100	77	153	74	107	100	75	151	72	102	100
55	Rajashree	76	108	70	82	100	74	102	72	82	100	74	104	76	85	100
56	Rajesh	88	112	80	90	100	86	114	82	90	100	86	114	82	92	100
57	Chinappa	52	109	59	74	100	54	110	57	72	100	63	91	56	67	100
58	Ramappa	77	100	73	82	100	71	93	58	68	100	69	80	50	60	100
59	Md Shahid	74	112	66	81	100	74	108	60	76	100	74	108	58	74	100
60	Manohar	66	130	84	103	100	64	134	84	104	100	66	130	84	104	100
61	Maruti	76	109	59	73	100	66	102	49	64	100	66	106	64	78	100
62	Rudrappa	58	108	66	80	100	54	104	64	77	100	54	118	70	86	100
63	Veerappa	96	118	86	95	100	84	118	86	95	100	84	118	86	96	100
64	Champavva	96	162	87	116	100	90	150	82	104	100	84	154	80	104	100
65	Savitri	72	139	88	100	100	69	130	86	97	100	66	127	79	89	100
66	Rohini	81	108	67	81	100	84	104	65	78	100	78	105	60	75	100
67	Rahul	95	90	50	63	100	90	98	68	78	100	84	108	69	82	100
68	Channappa	72	210	132	158	100	72	211	133	159	100	74	211	134	160	100
69	Iqbal	76	108	64	79	100	68	110	68	82	100	64	124	70	88	100
70	Shridhar	81	123	74	92	100	79	119	74	90	100	80	118	78	91	100
71	Sunanda	62	143	86	109	100	61	142	90	111	100	61	149	89	114	100
72	Veeresh	78	118	70	86	100	78	116	74	88	100	80	124	72	89	100
73	Lingaraj	58	116	55	79	100	59	122	61	86	100	61	119	60	83	100
74	Ayappa	74	101	59	76	100	69	100	55	72	100	67	95	51	66	100
75	Tanvi	64	94	50	69	100	62	98	54	69	100	68	102	64	77	100

76	Channabasavva	70	102	68	79	100	74	100	70	80	100	68	96	64	75	100
77	Santosh	58	111	72	88	100	56	111	75	89	100	60	111	75	89	100
78	Tanushree	92	98	56	70	100	91	100	58	72	100	90	102	58	73	100
79	Radhika	76	104	68	80	100	80	106	64	80	100	81	112	68	83	100
80	Prashanta	62	92	50	64	100	60	98	58	70	100	58	100	64	76	100
81	Prakash	76	100	68	78	100	72	100	64	76	100	68	100	64	76	100
82	Vinayaka	78	104	64	77	100	74	101	66	78	100	68	100	62	75	100
83	Saba	74	99	53	68	100	75	97	53	68	100	89	95	55	68	100
84	Mohini	74	101	59	73	100	64	100	58	72	100	61	92	54	67	100
85	Prasad	83	102	64	77	100	74	98	60	73	100	70	98	62	74	100
86	Rajesh	82	119	82	94	100	84	116	80	92	100	82	117	80	92	100
87	Pragati	88	100	50	67	100	82	102	52	69	100	81	104	58	73	100
88	Roshan	80	122	72	89	100	81	118	68	85	100	76	116	64	81	100
89	Kamalika	68	102	66	78	100	64	108	60	76	100	58	99	56	74	100
90	Prasant	67	108	74	85	100	65	112	70	85	100	66	110	70	83	100
91	Shreya	80	118	70	86	100	81	112	70	84	100	74	108	68	81	100
92	Aniket	84	131	82	98	100	86	133	84	100	100	80	130	78	95	100
93	Yash	72	110	72	85	100	70	112	74	87	100	70	112	74	87	100
94	Kishore	76	118	76	90	100	74	112	74	87	100	77	114	74	87	100
95	Mahesh	80	128	78	95	100	80	126	81	96	100	78	118	82	94	100
96	Shalini	72	132	70	92	100	70	130	72	91	100	70	134	68	90	100
97	Tulika	74	116	77	90	100	73	118	72	85	100	80	122	71	88	100
98	Rajendra	68	116	68	84	100	68	114	64	84	100	67	118	68	85	100
99	Mahantesh	80	116	77	90	100	84	118	74	89	100	82	114	72	86	100
100	Mallannagouda	68	134	90	105	100	68	136	84	101	100	68	130	80	97	100

Sl no.	Name	Vitals at 30 mins					Vitals at 40 mins					Vitals at 50 mins				
		HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2	HR (BPM)	SBP	DBP	MAP	SpO2
1	Lingaraj	60	116	55	79	100	62	117	60	79	100	64	114	62	79	100
2	Sunanda	61	148	93	114	100	60	148	85	111	100	64	146	87	107	100
3	Shridhar	82	117	74	88	100	84	120	76	91	100	82	120	74	89	100
4	Ayappa	66	100	59	76	100	68	100	57	74	100	70	104	64	77	100
5	Santosh	60	111	75	89	100	50	111	75	89	100	62	110	74	88	100
6	Chidanand	70	114	65	80	100	74	104	67	80	100	67	112	79	90	100
7	Sugandha	73	104	60	75	100	72	103	62	76	100	74	110	66	81	100
8	Piraji	62	110	74	86	100	58	112	78	89	100	62	118	80	83	100
9	Amol	66	116	64	84	100	66	117	66	86	100	68	117	65	85	100
10	Mahantagouda	80	116	80	92	100	82	112	78	89	100	84	118	80	93	100
11	Chandana	74	118	72	87	100	78	118	70	86	100	74	120	72	86	100
12	Rajeshwari	98	123	73	89	100	88	126	70	88	100	87	135	70	91	100
13	Bajrang	70	110	55	75	100	68	116	64	83	100	66	117	60	80	100
14	Ravindra	79	108	68	81	100	72	120	78	92	100	83	104	70	81	100
15	Mahantesh	72	159	102	121	100	58	141	95	110	100	64	154	101	118	100
16	Rudra	64	114	69	84	100	60	115	72	86	100	60	119	77	91	100
17	Arjun	69	124	75	89	100	68	124	79	91	100	64	119	72	86	100
18	Mahesh	59	99	47	62	100	52	109	59	73	100	61	112	50	67	100
19	Rohan	80	116	70	85	100	82	108	74	85	100	80	108	74	85	100

20	Madhav	74	114	76	87	100	74	112	78	86	100	78	118	74	87	100
21	Rakesh	80	100	64	76	100	82	100	62	75	100	84	102	62	75	100
22	Shivanand	82	109	59	73	100	82	102	49	64	100	80	112	50	67	100
23	Tipanna	84	124	75	89	100	86	127	80	94	100	82	124	80	94	100
24	Prakash	74	106	70	82	100	68	102	70	82	100	68	104	74	84	100
25	Imtiyaz	66	104	64	77	100	66	118	70	86	100	68	120	72	88	100
26	Manjunath	57	104	58	72	100	64	108	62	77	100	60	103	59	73	100
27	Pramod	80	108	64	80	100	80	110	68	82	100	86	112	70	85	100
28	Shivaputra	82	104	70	81	100	80	106	72	83	100	80	108	76	87	100
29	Raghunandan	54	120	86	97	100	53	128	76	93	100	50	118	74	88	100
30	Rashi	84	124	74	86	100	82	130	74	87	100	81	129	84	93	100
31	Meena	77	114	56	69	100	63	121	60	74	100	91	135	84	94	100
32	Sangamesh	80	112	70	84	100	78	112	70	84	100	78	114	74	87	100
33	Abhishek	84	127	80	94	100	80	124	84	96	100	74	124	84	94	100
34	Mohan	70	102	56	71	100	66	110	54	72	100	68	112	54	73	100
35	Gangappa	66	161	98	117	100	62	164	85	106	100	55	128	80	96	100
36	Shankar	83	105	57	74	100	84	116	64	81	100	85	115	68	84	100
37	Prasanna	83	122	80	94	100	79	119	80	91	100	83	122	77	90	100
38	Shreya	94	102	60	74	100	91	98	56	70	100	94	108	62	77	100
39	Maruti	63	102	56	74	100	65	104	56	74	100	65	111	58	79	100
40	Md Rafiq	107	146	89	108	100	77	133	86	102	100	76	119	75	90	100
41	Ningappa	69	103	62	76	100	77	108	64	78	100	79	116	60	79	100
42	Santoshi	85	110	56	74	100	80	117	55	75	100	78	116	55	75	100
43	Vinayak	72	119	72	86	100	72	124	84	96	100	70	123	79	92	100
44	Sanjay	84	116	80	92	100	84	114	76	90	100	84	112	74	90	100
45	Ningappa	70	125	76	91	100	70	127	86	99	100	73	129	80	96	100
46	Gundu	77	157	73	105	100	74	146	71	101	100	71	140	67	96	100
47	Irappa	70	135	75	99	100	68	135	75	98	100	72	124	70	92	100

48	Shantagouda	77	87	51	64	100	78	92	53	67	100	80	94	52	69	100
49	Parappa	76	106	58	73	100	71	108	61	75	100	69	111	61	76	100
50	Abdul	54	107	67	78	100	58	112	69	83	100	58	110	70	83	100
51	Kalpana	86	105	70	74	100	86	112	70	78	100	85	118	75	89	100
52	Raveena	64	101	72	79	100	64	104	70	81	100	67	107	71	83	100
53	Basavaraj	61	120	80	96	100	67	122	84	98	100	66	122	85	97	100
54	Basappa	75	140	71	100	100	70	129	65	91	100	63	126	60	91	100
55	Rajashree	78	112	78	89	100	72	118	80	93	100	80	114	76	87	100
56	Rajesh	88	116	80	92	100	84	116	78	90	100	84	114	76	88	100
57	Chinappa	59	107	58	73	100	64	110	60	77	100	65	108	61	77	100
58	Ramappa	70	94	64	74	100	65	98	68	78	100	68	100	68	79	100
59	Md Shahid	72	110	56	74	100	70	116	55	75	100	78	117	55	75	100
60	Manohar	62	124	76	95	100	66	122	76	91	100	64	120	74	89	100
61	Maruti	64	112	50	67	100	61	104	64	77	100	67	118	70	86	100
62	Rudrappa	50	113	75	88	100	62	120	72	88	100	60	128	78	95	100
63	Veerappa	84	118	86	96	100	85	118	86	96	100	85	120	84	96	100
64	Champavva	82	140	78	99	100	80	142	80	100	100	80	154	82	106	100
65	Savitri	68	127	71	85	100	63	116	72	82	100	65	127	79	89	100
66	Rohini	74	110	57	75	100	76	113	58	76	100	78	114	64	81	100
67	Rahul	84	110	74	86	100	88	114	76	89	100	82	110	77	88	100
68	Channappa	75	164	114	131	100	80	163	112	129	100	75	164	110	128	100
69	Iqbal	66	120	74	89	100	72	122	72	89	100	70	121	76	91	100
70	Shridhar	81	124	82	96	100	84	122	80	94	100	83	121	85	97	100
71	Sunanda	61	148	93	114	100	60	148	85	111	100	62	147	83	104	100
72	Veeresh	86	120	70	87	100	84	122	74	90	100	82	126	78	94	100
73	Lingaraj	62	118	62	81	100	63	116	61	79	100	61	118	63	81	100
74	Ayappa	66	100	59	76	100	68	100	57	74	100	70	114	64	81	100
75	Tanvi	72	104	60	75	100	74	104	64	77	100	74	110	68	82	100

76	Channabasavva	64	103	62	76	100	76	108	64	78	100	76	108	64	78	100
77	Santosh	62	110	74	88	100	64	114	77	91	100	65	114	75	88	100
78	Tanushree	93	108	62	77	100	94	110	60	77	100	92	116	63	81	100
79	Radhika	84	114	74	87	100	82	110	68	82	100	86	122	74	90	100
80	Prashanta	54	102	63	76	100	52	110	68	82	100	68	122	74	92	100
81	Prakash	70	108	66	80	100	74	106	70	82	100	68	102	74	83	100
82	Vinayaka	68	102	60	74	100	70	106	64	78	100	64	104	66	79	100
83	Saba	84	100	57	71	100	85	100	58	72	100	83	101	62	75	100
84	Mohini	62	94	60	71	100	74	102	64	77	100	74	105	68	80	100
85	Prasad	68	100	64	76	100	64	102	68	79	100	72	104	68	80	100
86	Rajesh	84	119	79	92	100	86	120	80	93	100	84	121	82	95	100
87	Pragati	80	102	60	74	100	81	106	61	76	100	84	104	63	77	100
88	Roshan	74	108	68	81	100	72	110	66	80	100	64	102	68	79	100
89	Kamalika	54	98	54	67	100	58	100	52	68	100	62	104	61	69	100
90	Prasant	68	100	68	79	100	66	102	70	81	100	67	110	67	81	100
91	Shreya	78	107	67	80	100	72	104	66	79	100	68	102	67	79	100
92	Aniket	82	128	80	96	100	88	130	80	97	100	87	131	80	97	100
93	Yash	78	116	72	87	100	77	118	74	89	100	78	119	72	88	100
94	Kishore	78	110	72	85	100	80	108	74	85	100	82	110	74	86	100
95	Mahesh	80	120	80	93	100	81	122	80	94	100	81	120	80	93	100
96	Shalini	72	132	72	92	100	71	133	74	94	100	74	135	71	92	100
97	Tulika	81	124	68	87	100	88	121	74	89	100	84	120	78	92	100
98	Rajendra	76	120	74	89	100	76	120	80	93	100	78	122	81	95	100
99	Mahantesh	84	112	71	85	100	85	114	72	86	100	83	115	71	86	100
100	Mallannagouda	69	130	90	103	100	74	124	84	94	100	74	121	80	94	100

Sl no.	Name	Vitals at 60 mins				
		HR (BPM)	SBP	DBP	MAP	SpO2
1	Lingaraj	64	118	60	79	100
2	Sunanda	62	144	85	105	100
3	Shridhar	80	121	76	91	100
4	Ayappa	74	105	65	78	100
5	Santosh	64	114	77	91	100
6	Chidanand	74	108	70	82	100
7	Sugandha	76	110	67	83	100
8	Piraji	66	112	74	86	100
9	Amol	70	118	76	93	100
10	Mahantagouda	82	112	80	90	100
11	Chandana	80	120	72	86	100
12	Rajeshwari	84	136	71	92	100
13	Bajrang	64	121	76	92	100
14	Ravindra	86	122	78	92	100
15	Mahantesh	64	154	103	118	100
16	Rudra	61	115	80	91	100
17	Arjun	67	119	73	84	100
18	Mahesh	57	110	53	69	100
19	Rohan	78	118	80	92	100

20	Madhav	78	118	76	90	100
21	Rakesh	80	102	64	77	100
22	Shivanand	80	110	53	69	100
23	Tipanna	80	123	79	92	100
24	Prakash	70	108	74	85	100
25	Imtiyaz	70	120	72	88	100
26	Manjunath	66	116	66	83	100
27	Pramod	90	112	72	85	100
28	Shivaputra	84	106	74	85	100
29	Raghunandan	64	116	75	89	100
30	Rashi	87	140	93	103	100
31	Meena	102	132	65	81	100
32	Sangamesh	76	112	72	85	100
33	Abhishek	70	127	80	94	100
34	Mohan	70	112	50	67	100
35	Gangappa	68	109	83	91	100
36	Shankar	86	118	70	86	100
37	Prasanna	80	112	79	90	100
38	Shreya	92	110	60	77	100
39	Maruti	66	103	58	76	100
40	Md Rafiq	67	117	77	90	100
41	Ningappa	79	118	60	79	100
42	Santoshi	74	120	64	83	100
43	Vinayak	68	124	84	89	100
44	Sanjay	84	110	74	90	100
45	Ningappa	78	130	82	98	100
46	Gundu	70	141	71	94	100
47	Irappa	70	121	74	90	100

48	Shantagouda	77	98	62	74	100
49	Parappa	70	115	63	78	100
50	Abdul	56	116	69	85	100
51	Kalpana	86	121	78	92	100
52	Raveena	65	110	70	83	100
53	Basavaraj	68	126	86	99	100
54	Basappa	53	136	66	95	100
55	Rajashree	84	114	76	82	100
56	Rajesh	84	112	74	86	100
57	Chinappa	63	110	62	78	100
58	Ramappa	72	104	74	84	100
59	Md Shahid	72	121	64	83	100
60	Manohar	64	118	72	87	100
61	Maruti	70	110	70	86	100
62	Rudrappa	61	126	77	93	100
63	Veerappa	86	122	84	97	100
64	Champavva	83	150	80	103	100
65	Savitri	60	124	83	82	100
66	Rohini	77	115	68	84	100
67	Rahul	80	111	77	88	100
68	Channappa	75	163	109	127	100
69	Iqbal	71	118	78	91	100
70	Shridhar	81	126	84	98	100
71	Sunanda	64	150	85	107	100
72	Veeresh	80	128	76	93	100
73	Lingaraj	62	117	62	80	100
74	Ayappa	69	118	65	83	100
75	Tanvi	75	112	67	82	100

76	Channabasavva	78	116	60	79	100
77	Santosh	63	117	77	90	100
78	Tanushree	96	117	65	82	100
79	Radhika	85	120	76	88	100
80	Prashanta	64	118	76	90	100
81	Prakash	68	104	74	84	100
82	Vinayaka	70	118	68	85	100
83	Saba	84	104	63	77	100
84	Mohini	78	111	71	84	100
85	Prasad	80	108	76	83	100
86	Rajesh	85	123	84	97	100
87	Pragati	86	107	63	77	100
88	Roshan	60	108	64	79	100
89	Kamalika	68	101	64	70	100
90	Prasant	70	111	69	83	100
91	Shreya	60	108	68	81	100
92	Aniket	85	130	82	98	100
93	Yash	78	120	74	89	100
94	Kishore	81	112	72	85	100
95	Mahesh	83	121	80	94	100
96	Shalini	73	134	73	93	100
97	Tulika	84	120	78	92	100
98	Rajendra	77	120	82	95	100
99	Mahantesh	84	113	70	84	100
100	Mallannagouda	73	122	80	94	100