"HAEMODYNAMIC EFFECTS OF UNILATERAL SPINAL ANAESTHESIA WITH LOW DOSE OF 0.5% HYPERBARIC BUPIVACAINE – A CLINICAL STUDY"

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LIST OF ABBREVIATIONS USED

ASA	-	American Society of Anaesthesiologist
BT	-	Bleeding time
BP	-	Blood pressure
bpm	-	Beats per minute
CBC	-	Complete blood count
CT	-	Clotting time
CO_2	-	Carbon di-oxide
CNS	-	Central nervous system
CVS	-	Cardiovascular system
CSF	-	Cerebrospinal fluid
DBP	-	Diastolic blood pressure
ECG	-	Echocardiograph
FRC	-	Functional residual capacity
G	-	Gauge
HR	-	Heart rate
HCl	-	Hydrochloride
HCO3	-	Bicarbonate
IHD	-	Ischaemic heart disease
INR	-	International normalized ratio
IV	-	Intravenous
Kg	-	Kilograms
MAP	-	Mean arterial pressure
MBP	-	Mean blood pressure
Min	-	Minute

mg	-	Milligrams
meq/L	-	Milli equivalents per litre
mL	-	Millilitre
mm Hg	-	Millimeters of mercury
mg/dL	-	Milligrams per deciliter
$PaCO_2$	-	Partial pressure of carbon dioxide
PDPH	-	Post dural puncture headache
PT	-	Prothrombin time
SAB	-	Subarachnoid block
SSA	-	Selective spinal anaesthesia
SA	-	Spinal anaesthesia
SBP	-	Systolic blood pressure
TPVR	-	Total peripheral vascular resistance
V/Q	-	Ventilation / perfusion
VDSS	-	Volume of distribution and steady state

ABSTRACT

Background and Objectives

Unilateral spinal anaesthesia is a promising alternative to traditional, widely used techniques of central neuraxial blocks, as it restricts markedly the anaesthetized area thereby, decreases the risk of adverse events and complications. The present study was taken up to assess the haemodynamic effects of low dose 0.7 ml (3.5 mg) of 0.5% hyperbaric Bupivacaine and also to assess the level achieved and duration of block.

Methods

The present one year clinical trial was conducted in the Department of Anaesthesiology, during the period of January 2010 to December 2010 at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum attached to Jawaharlal Nehru Medical College, Belgaum on 100 patients undergoing unilateral lower limb surgery under unilateral spinal anaesthesia with bupivacaine. 0.7 ml of (3.5 mg) 0.5% bupivacaine heavy was injected with patient in lateral position with the limb to be operated on the lower side.

Results

In this study out of 100 patients studied 72 (72%) were males and 28 (28%) were females with male to female ratio of 2.57:1. Majority of the patients (45%) were aged between 46 to 60 years. Overall mean age was 47.79±13.91 years and mean weight was 57.90±8.56 Kgs. The SBP, DBP and MBP showed a gradual fall with maximum fall noted at 40 minutes and gradually increased, subsequently reaching the baseline levels at 90 minutes. The maximum increase in HR was seen at 40 minutes after giving spinal and it gradually reduced coming to baseline levels at 90 minutes. Maximum sensory level of L1 was achieved. The block remained unilateral in all the cases. Motor blockade was adequate in the limb to be operated.

Conclusion and interpretation

Subarachnoid block with 0.7 mL (3.5 mg) of 0.5% hyperbaric bupivacaine used in this study does not produce any adverse haemodynamic changes and lasts for short duration that is 90 minutes and can be used in surgeries of shorter duration.

Keywords: Hyperbaric bupivacaine; Motor blockade; Sensory blockade; Spinal anaesthesia;

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INTRODUCTION

Unilateral spinal anaesthesia is a promising alternative to traditional, widely used techniques of central neuraxial blocks, as it restricts markedly the anaesthetized area thereby, decreases the risk of adverse events and complications.

Unilateral spinal anaesthesia has been used successfully in patients undergoing surgery involving one lower limb. It is particularly advantageous in high risk patients such as patients with ischaemic heart disease (IHD), congenital cardiac diseases, pulmonary diseases, diabetes where it produces less haemodyanamic changes.[1] It has many advantages over conventional spinal anaesthesia such as lower incidence of hypotension, faster recovery and increased patient satisfaction.[2]

Spinal anaesthesia is commonly used in anaesthetic practice although the undesirable sequels related to this technique are well known. In the majority of cases, spinal anaesthesia is accompanied by a decrease in arterial pressure; bradycardia, due to blockage of preganglionic sympathetic fibres. The incidence of hypotension depends upon number of factors such as the extent of subarachnoid blockage, age, associated coexisting disorders presence of medication like ß-adrenergic receptor blockers etc.[3,4] Moreover, the sympathetic blockage is often accompanied by uncontrolled hypothermia, especially at low environmental temperature.[5]

To achieve successful unilateral anesthesia, several factors need to be considered, including site and speed of injection of anesthetic solution, volume, baricity, and concentration of the anesthetic solution, type of needle and bevel direction, as well as degree of operating table inclination. Moreover, patient posture is thought to be fundamental in determining the level of spread of anesthesia particularly when a hyperbaric anesthetic solution is used.[6]

The dose commonly used for unilateral spinal anaesthesia is 2 ml (10 mg) of 0.5% hyperbaric Bupivacaine. The smallest dose studied is 1 ml (5 mg) of 0.5% of hyperbaric Bupivacaine. Since majority of patients requiring unilateral spinal anaesthesia have associated morbidities such as diabetes, hypertension, ischaemic heart disease, renal failure etc, anaesthetic technique which will cause no or minimal haemodynamic changes is required. In addition, the block should be adequate and should last for reasonable period of time.[1]

All earlier conducted studies[1,2,7,] have used 1-3 ml of 0.5 hyperbaric bupivacaine to produce unilateral anaesthesia. Increasing dosage of 0.5% hyperbaric bupivacaine is associated with increased incidence of hypotension, bradycardia and increased incidence of bilateral block which are disadvantageous in these patients.

Keeping the above scenario in mind, the present study is taken up to assess the haemodynamic effects of low dose 0.7 ml (3.5 mg) of 0.5% hyperbaric Bupivacaine and also to assess the level achieved and duration of block.

OBJECTIVES

The objectives of the present study were;

a. To assess the haemodynamic effects of unilateral spinal anaesthesia with low dose that is 0.7 ml (3.5 mg) of 0.5% hyperbaric Bupivacaine.

b. Level of block achieved.

c. Duration of block.

REVIEW OF LITERATURE

Spinal anaesthesia, also referred to as subarachnoid block (SAB), or intrathecal analgesia, has a fascinating historical background. Spinal anaesthesia is produced when a local anaesthetic agent is injected into the subarachnoid space and was the first major regional technique attempted.

The first planned spinal anaesthsia for surgery in man was performed in 1898 by August Karl Bier (1861-1949) on 16th August, in Keil, in Germany.[8] Bier and his assistant Hildebrandt tried spinal anaesthesia by injecting cocaine into each others theca both experienced severe headache which lasted for days and they postulated that their headache was due to loss of large volume of cerebrospinal fluid.[9]

The technique of spinal anaesthesia was eventually well accepted all over Europe and many reports were published on its usage.

In the following years, the popularity of spinal anaesthesia had steadily increased with the introduction of newer drugs and techniques. The technique was found to be safe in expert hands and preferred over general anaesthesia for operations involving lower limbs and lower abdomen.

Since 1909 various techniques of localised spinal analgesia aimed at restricting the spread of somatic and sympathetic block have been described.[10] Unilateral spinal anaesthesia was first achieved in 1947 by subarachnoid injection of a hypobaric solution with the patient placed in the lateral position.[8]

Unilateral spinal anaesthesia has been used successfully in patients undergoing surgery involving one lower limb. It is particularly advantageous in high risk patients such as patients with IHD, congenital cardiac lesions, pulmonary diseases, diabetes where it produces less haemodyanamic changes.[1]

Moreover, it has been demonstrated by clinical trials comparing unilateral spinal anaesthesia with conventional bilateral spinal block that cardiac index values are much more stable during the former than during the latter, with a smaller reduction in arterial blood pressure and heart rate,[11] and a much lower incidence of clinically relevant hypotension (5% Vs 20%).[12]

Various authors reported that we can not predict the distribution of spinal block; however, other authors described how to restrict spinal block at the operated side in patients receiving surgical procedures involving one lower limb.[3]

In a study[13] aimed to determine the ideal dosage of hyperbaric bupivacaine and the time required for the lateral decubitus position for a unilateral spinal block on Ninety patients who were scheduled to receive spinal block for surgery in the lower extremity were randomised into 9 groups (n = 10). The spinal block was performed through the L4-L5 intervertebral space with the patient in the lateral decubitus position. Patients in groups Ia, Ib, Ic/IIa, IIb, IIc/ IIIa, IIIb, IIIc received 1.5 ml of 0.5%, 2 ml of 0.5%, and 2.5 ml of 0.5% hyperbaric bupivacaine solutions, respectively. The patients were turned to the supine position for 5 min after the injection in groups Ia, IIa, IIIa, 10 min after the injection in groups Ib, IIb, IIIb, and 15 min after the injection in groups Ic, IIc, IIIc. The rate of block progression to the non-dependent side was higher in the groups receiving 2.5 ml 0.5% hyperbaric bupivacaine solution than in the other groups; at the same time the level of block was higher and the duration of block was longer. The incidence of hypotension was 10-20% in these groups. In the 2 ml 0.5% hyperbaric bupivacaine solution group, a satisfactory block level and duration of anaesthesia for surgery was obtained. The rate of block progression to non-dependent side in the groups receiving 1.5 ml of 0.5% hyperbaric bupivacaine solution was lower than the other groups, but the duration of block was shorter and the level of block was lower than the other groups. The study concluded that, for unilateral spinal anaesthesia in lower extremity operations, 2ml 0.5% hyperbaric bupivacaine solution for operations above the knee and 1.5 ml 0.5% hyperbaric bupivacaine solution for operations below the knee and keeping the patients for 10 min in the lateral decubitus position were found to be appropriate.

A prospective, randomized, clinical study[14] was conducted recently to determine the dose of hyperbaric bupivacaine 0.5% required for unilateral spinal anesthesia during diagnostic knee arthroscopy. This was performed among 80 patients who were assigned to four groups to receive different doses of intrathecal hyperbaric bupivacaine (5 mg, 7.5 mg, 10 mg and 12.5 mg in Groups 1, 2, 3, and 4 respectively). Onset of sensory and motor block, hemodynamic changes, regression of motor block, and incidence of complications were recorded. Unilateral sensory block was reported in 90% and 85% of patients in Group 1 and Group 2, respectively, but not in any patient in Group 3 and Group 4. Unilateral motor block (modified Bromage scale 0) was reported in 95% of patients in Group 1, 90% in Group 2, and only 5% in Group 3, while no patient in Group 4 showed unilateral motor block. The time required for regression of motor block (Bromage scale 0) was prolonged with higher doses. The incidence of nausea, vomiting, and urine retention was similar in the study groups. The study concluded that, unilateral sensory and motor block can be achieved with doses of 5 mg and 7.5 mg hyperbaric bupivacaine 0.5% with a stable hemodynamic state.

Various studies were conducted to study the haemodynamic effects and adequacy of SAB with low dose of bupivacaine.

In a study, 1 ml (5 mg) of 0.5% hyperbaric Bupivacaine was injected to produce unilateral spinal anaesthesia. The study concluded that, there were less haemodynamic changes and the block was predominantly unilateral with faster anaesthetic recovery and increased patient satisfaction.[2]

In another study 1.1 to 1.8 ml of 0.5% hyperbaric Bupivacaine was used to produce unilateral subarachnoid block and concluded that it was very effective and showed minimal haemodyanamic changes.[1]

Effect of 1.5 ml (8 mg) of 0.5% hyperbaric Bupivacaine was assessed in a study and concluded that there was predominantly unilateral block with minimal effects on the cardiovascular homeostasis.[3]

Another study used 8 mg of 0.5% and 1% of hyperbaric bupivacaine in patients and concluded that, 1% hyperbaric bupivacaine was not advantageous over 0.5% in obtaining unilateral spinal anaesthesia.[15]

The effects of 0.5% hyperbaric bupivacaine 1.5, 2 and 3 ml were compared in double blind study in patients undergoing unilateral spinal anaesthesia. The study showed that the significant decrease in BP was observed in 2 and 3 ml groups. The changes in HR were moderate.[16]

A study[17] to compare hyperbaric bupivacaine 4 mg versus 6 mg for outpatient knee arthroscopy concluded that, a unilateral, segmental spinal anesthesia for outpatient knee arthroscopy can reliably be produced with 4 or 6 mg of hyperbaric bupivacaine. The 4 mg dose appears superior to the 6 mg dose because it produces more selective spinal anaesthsia (SSA) and allows criteria for home readiness to be fulfilled significantly faster.

Unilateral spinal anesthesia provides adequate sensory blockade and provides hemodynamic stability. Intrathecal opioids enhance spinal anesthesia without prolonging motor recovery or hemodynamic side effects. A study[18] was conducted to evaluate the effect of intrathecal fentanyl on unilateral spinal blockade with hyperbaric bupivacaine for knee arthroscopy in 36 healthy patients undergoing unilateral knee arthroscopy. Patients randomly received unilateral spinal anesthesia with 0.5% hyperbaric bupivacaine 4 mg (Group I) or 0.5% hyperbaric bupivacaine 4 mg combined with fentanyl 10 microgram (Group II). The regression time of sensory block by two segments on dependent site was prolonged on Group II more than Group I ($p<0.05$). There was no significant difference between two groups in recovery time of sensory and motor block. Unilateral sensory block was observed in 18 patients in Group I (100%) and in 2 patients in Group II (11%). Hemodynamic side effects were minimal in both groups, but pruritus was observed in 6 patients in Group II (33%). Study concluded that, small dose of intrathecal fentanyl with bupivacaine prolonged the duration of sensory block on operated site, but did not increase the duration of motor block. However the incidence of bilateral block was much higher in this group.

Very few studies determining the haemodynamic, effects and adequacy of very low dose of intrathecal 0.5% hyperbaric bupivacaine are available.

Hence this study was done to determine the haemodynamic effects and adequacy of SAB with intrathecal 0.7 ml of 0.5% hyperbaric bupivacaine.

BASIC SCIENCES

ANATOMY

Sound knowledge of anatomy of vertebral column and its contents is essential to all the anaesthesiologists for safe and successful administration of spinal anaesthesia, not only in terms of performance but also in terms of spread of drug in CSF and level of block achieved.

Vertebral column

Main function of the vertebral column is to protect the spinal cord. The vertebral column comprises of 33 vertebrae and includes;[19]

- Cervical - 7
- Thoracic - 12
- Lumbar - 5
- Sacrum - 5 (fused)
- Coccyx - 4 (fused)

Curves of spine

In adult, the vertebral column has four curves which have significant effect on spread of drugs in sub arachnoid space namely;[19]

- Cervical curve - Convexity anterior
- Thoracic curve - Concave anterior
- Lumbar curve - Convexity anteriorly

In adults the curves of the spine are important when patient is supine or horizontal. The highest point of cervical and lumbar curves in supine position are at cervical (C) five and lumbar (L) five; lowest points of thoracic and sacral are at thoracic (T) five and sacral (S) two respectively.[19]

Vertebral ligaments[20]

Vertebral column is bound together by following ligaments which give stability and elasticity.

Supraspinous ligament: This is a strong fibrous cord which connects apices of spinous processes from where it continues as the ligamentum nuchae (Figure 2).

Interspinous ligament: This is a thin membranous ligament which connects spinous processes blending anteriorly with ligamentum flavum and posteriorly with supraspinous ligament (Figure 2).

Ligamentum flavum: This ligament comprises yellow elastic fibres and connects adjacent lamina. Laterally this ligament begins at the root of articular processes and extends posteriorly and medially to the point where laminae join to form spinous process (Figure 2).

Longitudinal ligaments: There are two longitudinal ligaments (anterior and posterior) that bind vertebral bodies together (Figure 2).

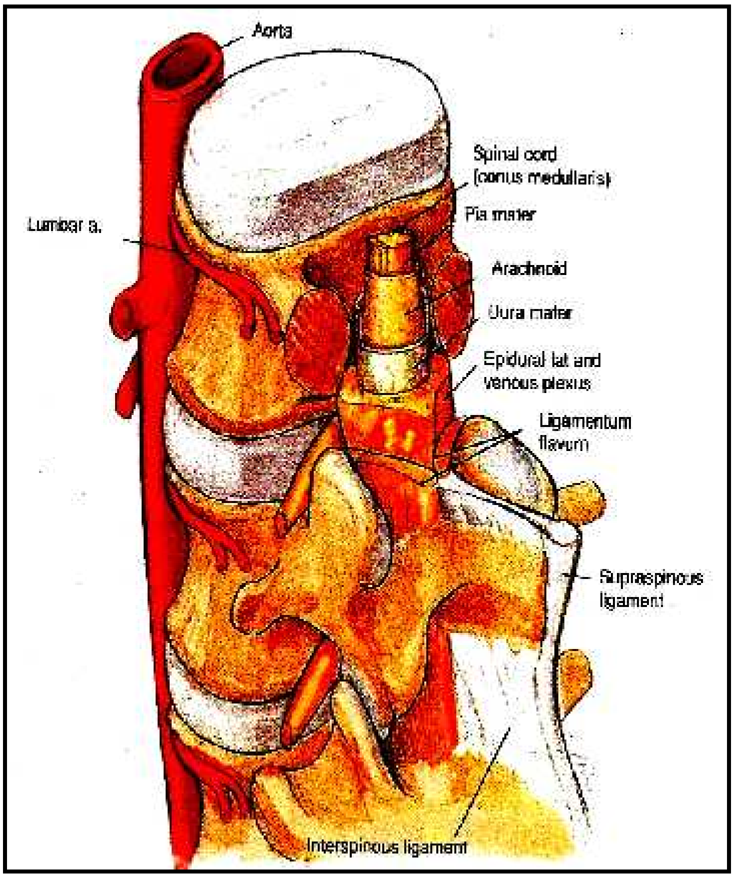


Figure 1. Vertebral Column

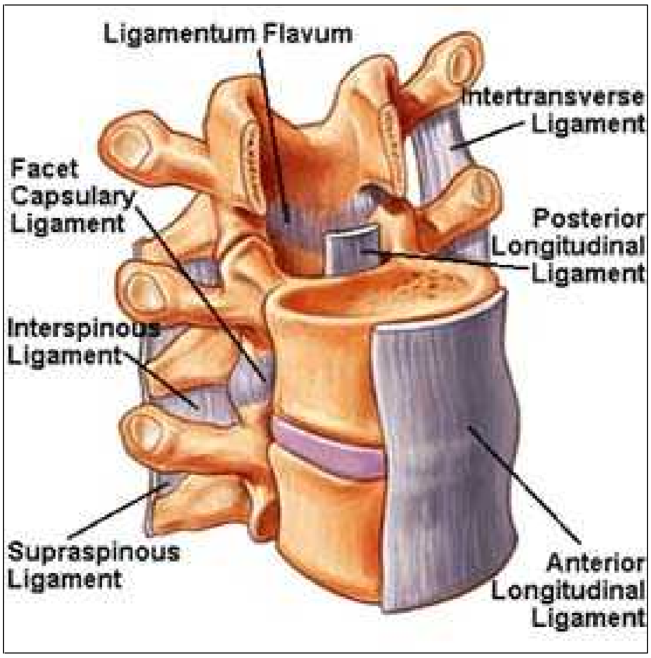


Figure 2. Spinal Ligaments

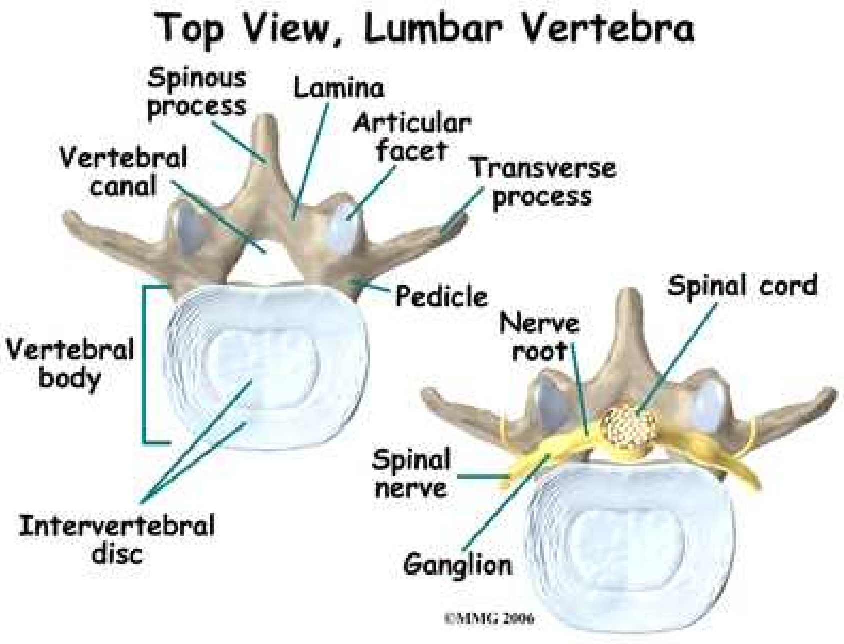


Figure 3. Typical Lumbar Vertebra

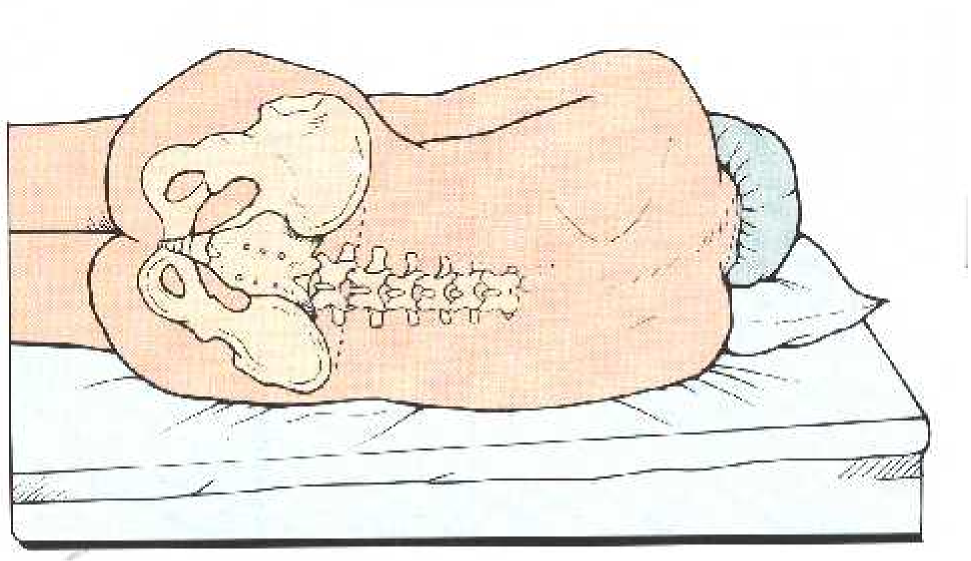


Figure 4. Line of Tuffier

Lumbar vertebrae[21]

A typical lumbar vertebrae consists of (Figure 3);

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

Topographical Line of Tauffier[22]

This is a horizontal line across the back between the crests of the ilia passing over the spine of the 4th lumbar vertebra in the upright position. In a patient lying in the lateral position it may also pass through L4 and L5 interspaces. The superior iliac crest is used to identify the L4 and L5 interspace during spinal anesthesia (Figure 4).

Intervertebral Discs[21]

These are principle connecting link between vertebral bodies. The intervertebral discs account for about 25% of the length of the spine. They have two parts. The outer fibrous part called the annulus fibrosus is made mostly of fibrous tissue, while the softer core of the disc is the nucleus pulposus. Atrophy of the discs along with osteoporosis of the vertebra leads to decreased height and kyphotic deformity of old age (Figure 3).

Contents of vertebral canal

- Spinal cord
- Spinal nerve roots
- Meninges
- Cerebrospinal fluid
- Vessels
- Fat
- Loose areolar tissue

Spinal cord[19]

The average length of the spinal cord in males is 45 centimeter (cm) and females it is 42 cm.

The spinal cord is a continuation of the 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 first segment of coccyx from apex of conus medullaris. This is known as the filum terminale.

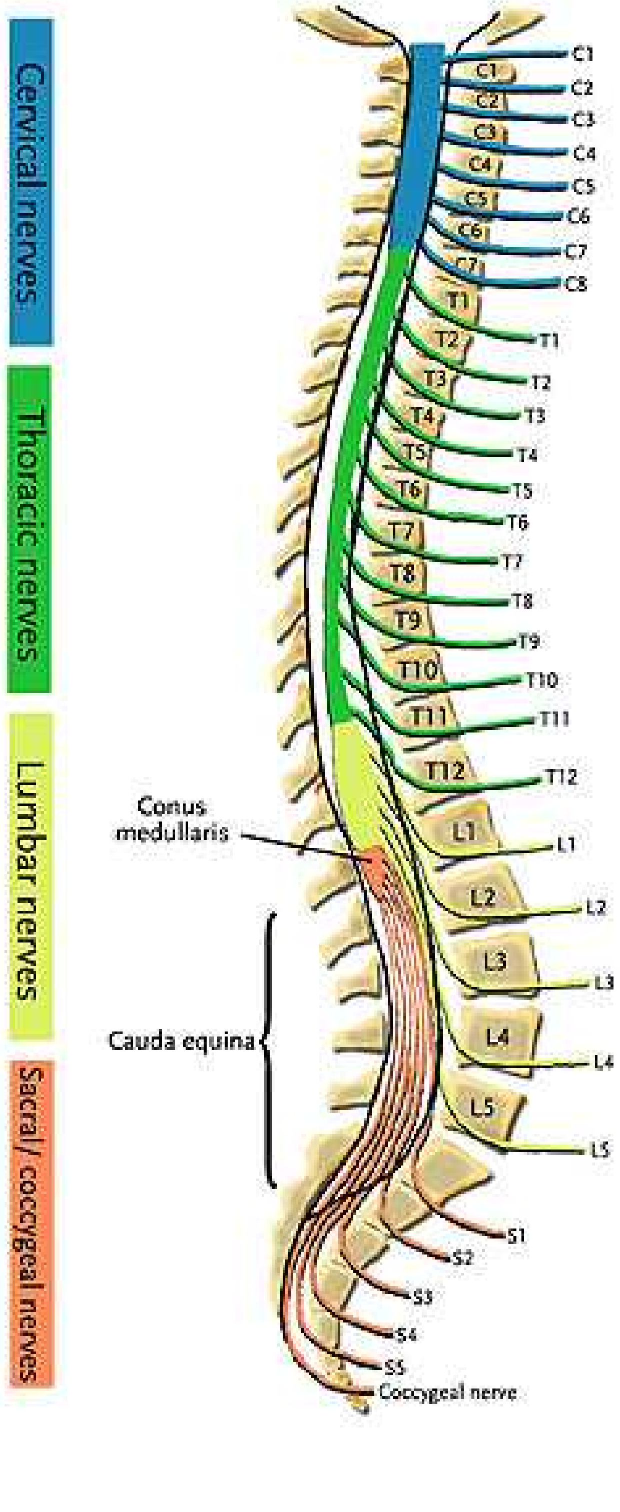


Figure 5. Spinal nerve roots

At birth, spinal cord ends at the level of lower border of lumbar (L) three vertebra. In the adult, the vertebral level of termination of spinal cord may be as follows;

- Lower border of L1 - 50%
- Upper border of L2 - 40%
- Upper border of L3 - 3%

From the spinal cord 31 pairs of spinal nerves arises made of a ventral and a dorsal root. These anterior and posterior roots cross the subarachnoid space, pass through the dura and extradural space independently and unite at the level of intervertebral foramen to form spinal nerve trunks, which soon divide into anterior and posterior primary divisions.

Amount of white matter decline progressively from the cervical down to the lumbar region. The gray matter is greately increased in the both the lumbar and cervical enlargement

Blood Supply of Spinal Cord[19]

The arterial supply is from the anterior and posterior spinal arteries. The anterior spinal artery is a single vessel lying in front of the anterior median fissure. It arises from the meeting of two small arteries, one given off from each vertebral artery at the level of the foramen magnum. It descends along the whole length of the cord receiving small communications from the intercostal and lumbar arteries; to provide the extra blood supply needed in the cervical, thoracic and lumbar enlargements.

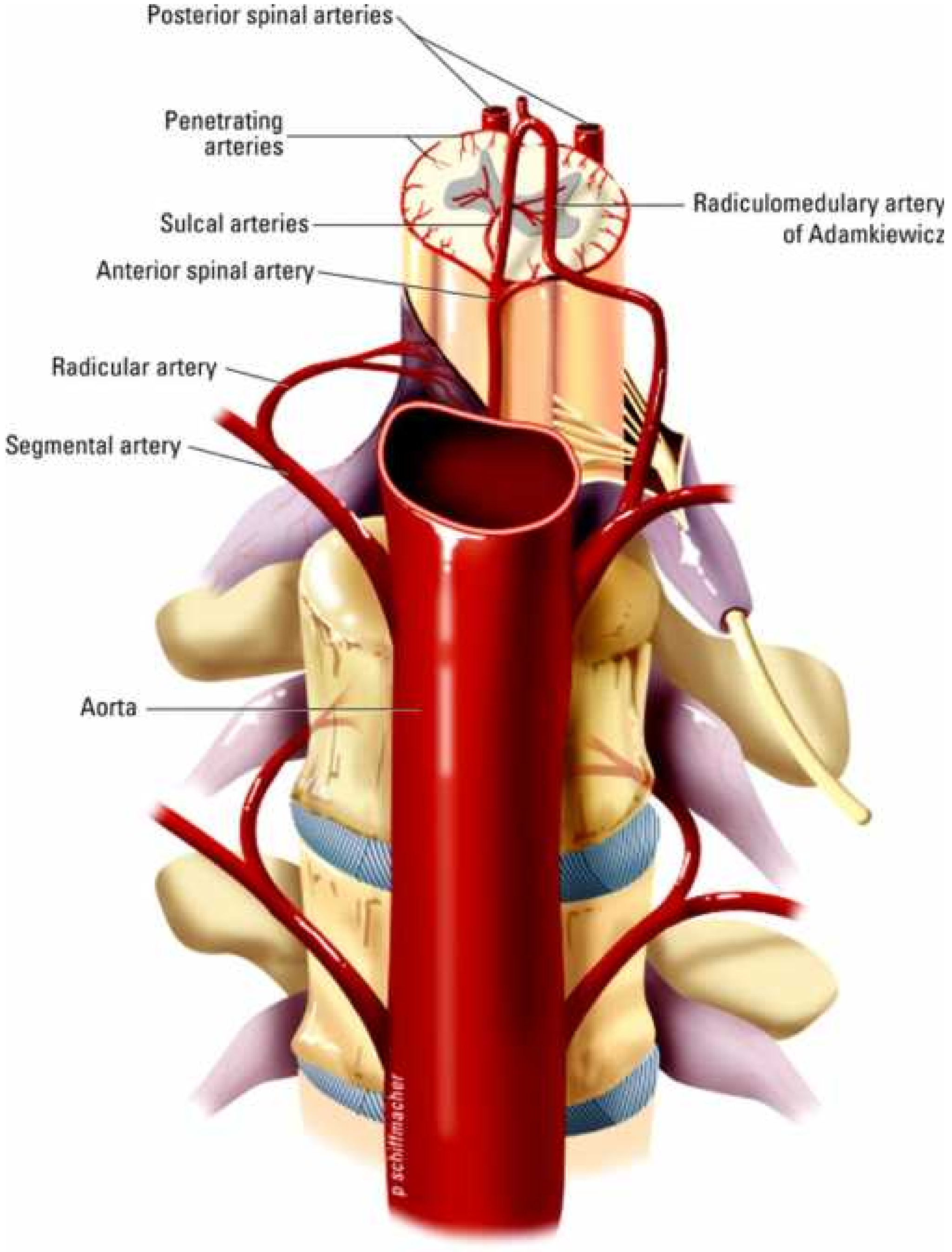


Figure 6. Blood Supply of Spinal Cord

There are two posterior spinal arteries-one on each side. They are derived at the base of the brain directly from the vertebral artery or more often from a primary branch of each vertebral artery. They supply the posterior one-third of the spinal cord. This supply is augmented by spinal branches of vertebral, ascending cervical, posterior intercostals, lumbar and lateral sacral arteries, which pass through the intervertebral foramina.

Venous drainage is through a plexus of anterior and posterior veins in the neck, azygous veins in the thorax, lumbar veins in the abdomen, and lateral sacral veins in the pelvis. There is no anastomosis between the anterior and posterior spinal arteries.

The longest of the feeder arteries is the radicularis magna (artery of Adamkiewicz), which supplies the anterior spinal artery in the area of the lumbar enlargement of the cord. It enters by way of a single intervertebral foramen (78% of the time on the left) between the T8 and L3 foramina.

Meninges[23]

The spinal cord has three covering membranes from inward to outward. They are the pia mater, the arachnoid mater and the dura mater. The dural sac of spinal duramater is the continuation of meningeal layer of the cranial duramater. It is a circular sac or sleeve surrounding the spinal cord. Above, it is firmly attached to the circumference of the foramen magnum.

Duramater[23]

It is the outermost membrane, the fibers of which run longitudinally. Although continuous, it can be described in two parts: the cranial and the spinal. The cranial dura consists of an outer layer (endosteal), which lines the skull, and an inner layer (meningeal), which invests the brain and folds inward to form the falx cerebri and tentorium cerebelli.

Arachnoid Mater[23]

The arachnoid mater is a delicate non-vascular membrane applied closely to the dura mater. The lower extent of dural sac is as follows;

- S2 vertebra 35%
- Below S2 40%
- Above S2 25%

Below this the dura continues as the filum terminale. The subarachnoid space is the space between the arachnoid and pia mater. This space is traversed by cobweb trabeculae and by the cranial and spinal nerves, it is bathed in spinal fluid. The space is annular in the cranial and thoracic vertebrae and is about three mm deep. Below the first lumbar vertebrae it is circular.

Subarachnoid Space[23]

The space between the arachnoid and pia is called the subarachnoid space and is filled with cerebrospinal fluid and contains numerous arachnoid trabeculae which form delicate sponge like mass. This space has three divisions which are free communication to each other: cranial (surrounding the brain), spinal (surrounding the spinal cord) and root (surrounding the dorsal and ventral nerve roots). In the spinal cord these nerve roots are covered only by pia 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 meningeal layers and have a distinct epidural, subdural, subarachnoid and sub pial spaces. The subarachnoid space extends separately along both the dorsal and ventral roots to the level of dorsal root ganglion, where arachnoid and pia continue as perineural epithelium of peripheral nerve.

Pia Mater[23]

The pia mater, the innermost membrane is a vascular sheath which closely invests the brain and spinal cord.

Cerebrospinal Fluid[23]

It is a clear colourless fluid found in the cranial and spinal subarachnoid spaces and in the ventricles. CSF is mainly formed by either secretion or ultrafiltration from the choroidal plexus of lateral ventricles. CSF flows from the lateral ventricles into the third ventricle through the foramina of Monro into the fourth ventricle through the Aqueduct of Sylvius into the cerebromedullary cisterna (cisterna magna) through foramen of Magendie and foramina of Luschka. From the cisterna magna, CSF enters subarachnoid space circulating around brain and spinal cord before being absorbed into the arachnoid granulations over the cerebral hemispheres.

Composition of cerebrospinal fluid

- Specific gravity : 1.003 to 1.009 at 37^0C.
- Volume : 120 ml to 150 ml (25 ml to 35ml in spinal space).
- CSF pressure : 60 to 80 mm Hg in lumbar space.
- pH : 7.27 to 7.37
- PCO_2 : 48 mm Hg
- HCO_3 : 23 mEq/L
- Sodium : 135 to 145 mEq/L
- Calcium : 2 to 3 mEq/L
- Phosphorous : 1.6 mg/dl
- Magnesium : 2 to 2.5 mEq/L
- Chloride : 15 to 20 mEq/L
- Proteins : 23 to 38 mg/dl

It is important to know that certain drugs alter the rate of formation of CSF. Carbonic anhydrase inhibitors like acetazolamide reduce the rate of CSF formation by as much as 50%. Furosemide in large doses may reduce the CSF formation. Inhalational anaesthetics like isoflourane and vasoconstrictors decrease the CSF formation. CSF formation is decreased when the serum osmolality is increases and increased when the serum is made hypotonic. During equilibrium, rate of formation equals the rate of absorption (500 mL/day).

PHYSIOLOGY OF SUB ARACHNOID BLOCK

The well recognized physiological effects of subarachnoid block are often mistakenly termed as complications. It is imperative to make a clear distinction between the physiologic effects of an anaesthetic technique and complications that implies some harm to the patients. The various factors, which control the different effects of a spinal anesthetic technique are;[24]

- Amount and type of drug
- Volume of solution
- Site of injection
- Rate of injection
- Specific gravity of solution – density and baricity
- Barbotage

The various factors which affect the spread of local anaesthetics include;[25,26]

- Patient factors:
- Age
- Height
- Position
- Spinal column configuration
- Cerebrospinal fluid volume
- Technical factors :
- Site of injection

- Spread of injection
- Direction of needle
- Local anesthetic dose
- Local anesthetic baricity
- Local anesthetic volume

The sensory and motor blockade results from direct effects of local anesthetic on the spinal nerve roots. The primary site of action is on both anterior and posterior nerve roots, affecting smaller nerve fibers first and thick large motor fibers last. Generally, the sympathetic paralysis is more diffuse and will extent two to four segments above motor block. The sympathetic fibers are affected first and last to recover, on the other hand motor nerve blockade is usually last to be affected and first to recover.

A difference in density between local anaesthetic solution and CSF enables the nerve roots of the treated side to be affected selectively with the patient turned in a lateral decubitus position. The normal density of the CSF (37°C) is between 1.0001 and 1.0005 g/ml in 95% of cases. Solutions with density < 0.9998 g/ml at 37°C are considered hypobaric; solutions with density >1.00088 at 37°C are considered hyperbaric; solutions with densities between these two values at 37°C are considered isobaric.

Hypobaric solutions (density at 37°C < 0.9998 g/ml) being "lighter" than CSF tend to spread towards the nondependent side. Hyperbaric solutions containing glucose in various percentages have a density at 37°C >1.0008 g/ml and tend to spread towards the dependent side. The few studies of hypobaric solutions available in the literature show a more predictable unilateral distribution of nerve blockade when using hyperbaric solutions. This could be explained by the much greater measured density difference between hyperbaric solutions and CSF in comparison with hypobaric solutions and CSF. Hypobaric solutions are, of course, low concentration and therefore should be used in large volumes. In addition, their density at room temperature is often > 1.008 g/ml, dropping to hypobaric levels once injected and reaching 37°C. During the time it takes for this process to occur the density may be isobaric or even hyperbaric.

Maintaining a lateral decubitus position allows surgical anaesthesia to be restricted to the operative side only. Before performing the dural puncture, the position of the spine must be maintained as horizontal as possible using pillows or tilting the operating table and the dural puncture must be performed in the most appropriate vertebral interspace. In the 5 - 10 minutes after intrathecal injection the progression of sensory and motor block must be carefully evaluated, tilting the operating table in a cranial or caudal direction to extend the block to other dermatomes if it is inadequate.

With regard to hypobaric solutions, the position of the operated side in a nondependent side theoretically allows the lateral decubitus position to be maintained during the entire surgical procedure. When using hyperbaric solutions the patient must lie on the surgical side and this may require sedation or analgesia when turning the patient in certain situations such as femoral fracture.

Directional pencil point needles available are the Whitacre and the Sprotte type. Both have an atraumatic non-cutting tip and a side orifice. The Sprotte type has got a longer and wider side hole: this theoretically may help to produce a laminar flow during injection, but also may limit the success rate of spinal anaesthesia as a part of the local anaesthetic solution can escape into adjacent compartments during injection. During dural puncture, after the free flow of CSF is observed, the orifice must be turned toward the operative side before starting the injection of anaesthetic solution. As regards the size of the spinal needle, a smaller size produces greater injection speed and turbulence and increases the risk of post dural puncture headache (PDPH).

Sequence of spinal anaesthesia (SA)[27]

- Vasomotor block: Dilatation of skin vessels and increase cutaneous blood flow
- Temperature fibers: Cold first and then warmth
- Loss of temperature discrimination
- Pain – pin prick fibers first
- Loss of tactile sensation
- Motor paralysis
- Pressure sensation
- Proprioception and vibratory sensation.

Sympathetic blockade is the major determinant of physiologic response to spinal anesthesia.

Sympathetic blockade

Because the level of sympathetic denervation under SAB determines the magnitude of cardiovascular responses to spinal anesthesia, it might be anticipated that the higher the level of neural blockade, the greater would be the change in the cardio-circulatory parameters. In the presence of partial sympathetic blockade, a reflex increase in sympathetic activity occurs in sympathetically intact areas. The result is vasoconstriction that tends to compensate for the peripheral vasodilatation-taking place in the sympathetically denervated areas. This can be seen in the changes in the arterial pressure waveforms and in the cutaneous blood flow in the upper extremities in the presence of low or midthoracic sensory levels of spinal anaesthesia. Of even greater importance is the fact that the most cephalad preganglionic sympathetic fibers exit the spinal cord at the level of T1. Since sympathetic denervation is complete at the T1 level, cardiovascular changes are no greater with mid cervical sensory levels of anesthesia than they are with T1 levels.

Functional Anatomy of Sympathetic Nervous System[28]

The sympathetic nervous system originates from spinal cord in the thoracolumbar region, from the first thoracic through the second lumbar segment. The preganglionic neurons have cell bodies within the intermediolateral columns of the spinal gray matter. Nerve fibers from these cell bodies extend to three types of ganglia grouped as paired sympathetic chains, various unpaired distal plexus or terminal or collateral ganglia near the target organs. The 22 paired ganglia lie along either side of vertebral column. Nerve trunks connect these ganglia to each other and gray rami communicants connect the ganglia to the spinal nerves. The preganglionic fibers leave the cord in the anterior nerve roots, join the spinal nerve trunks and enter the ganglion at that level via white ramus. Leaving the ganglion, postsynaptic fibers re enter the spinal nerve via gray ramus, then go on to innervate pilomotor and sudomotor effectors and blood vessels of skeletal muscle and skin. Sympathetic innervation of trunk and limbs is thus carried by the spinal nerves.

The sympathetic distribution to head and neck comes from the three ganglia of cervical sympathetic chain. The unpaired pre vertebral ganglia reside in the abdomen and pelvis anterior to the vertebral column and are primarily the celiac, superior mesenteric, aorticorenal, and inferior mesenteric ganglia. Celiac ganglia is innervated by T5 – T12 and innervates the liver, spleen, kidney, pancreas, small bowel, and proximal colon .The superior mesenteric ganglion innervates the distal colon, whereas inferior mesenteric ganglion innervates rectum, bladder, and genitals. Adrenal medulla and other chromaffin tissue are homologous to sympathetic ganglia.

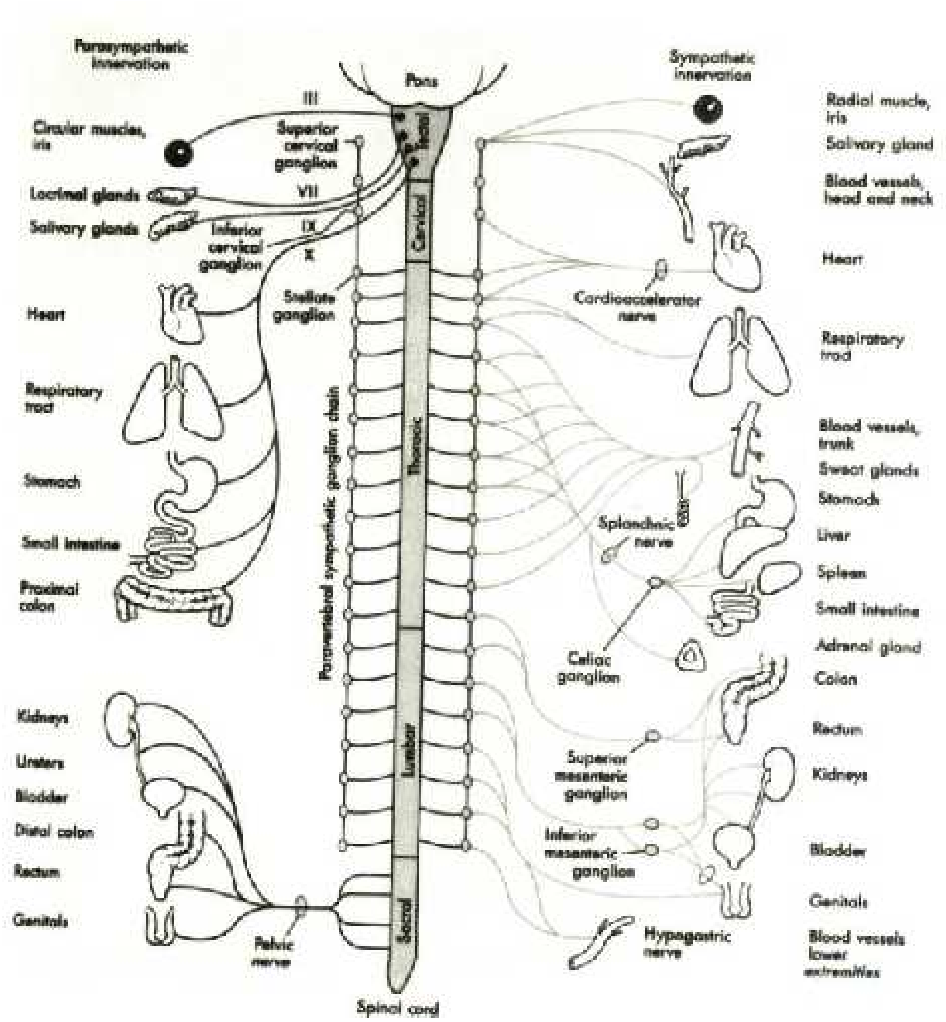


Figure 7. Schematic Representation of Autonomic Nervous System

Sympathetic pre-ganglionic fibers are relatively short because sympathetic ganglia are generally close to the CNS, but they are distant from the effector organs. Therefore, post-ganglionic fibers run a long course before innervating effector organs.

Cardiovascular effects of spinal anesthesia[29]

The most important physiologic response to spinal anesthesia involves the cardiovascular system. They are mediated by the combined effects of autonomic denervation and, with higher levels of neural blockade, added effects of vagal innervation. Because of the importance of sympathetic denervation in the genesis of cardiovascular changes during spinal anesthesia, the effect of spinal anaesthesia on the sympathetic nervous system warrants discussion before consideration of the cardiovascular responses themselves.

Arterial Circulation

Sympathetic denervation produces arterial and, physiologically more important, arteriolar vasodilatation, although vasodilatation is not maximal. Vascular smooth muscle on the arterial side of the circulation retains a significant degree of autonomous tone following acute, pharmacologically induced sympathetic denervation. As a result, total peripheral vascular resistance (TPVR) decreases only modestly, about 15 to 18% in normal subjects even in the presence of total sympathetic denervation, provided cardiac output, the other determinant of blood pressure, is kept normal. Because TPVR decreases only 15 to 18%, mean arterial pressure decreases only 15 to 18% in the presence of a normal cardiac output.

Venous Circulation

Veins and venules, with only few smooth muscles in their walls, retain no significant residual tone following acute pharmacologic denervation and so they can vasodilate maximally. Whether they do so or not is determined by intraluminal hydrostatic pressure. Intraluminal hydrostatic pressure on the venous side of the circulation depends on the gravity. If the denervated veins lie below the right atrium, gravity causes peripheral pooling of blood in these venous capacitance vessels and if above, gravity causes the blood to flow back to the heart. Preload therefore depends on the position of the patient during spinal anesthesia.

Cardiac Output

Preload is an important determinant of cardiac output. During levels of spinal anesthesia high enough to produce total sympathetic denervation, cardiac output remains unchanged in normovolemic patients as long as they are positioned with the legs elevated above the level of the heart.

Heart Rate

Heart rate characteristically decreases during spinal anesthesia in the absence of autonomically active drugs. The bradycardia is due in part to blockade of preganglionic cardiac accelerator fibers arising from T1 to T4 during high levels of spinal anesthesia. The bradycardia is also mediated by significant decrease in the right atrial pressure and pressure in the great vessels as they enter the right atrium. Placing the patient in a slight head down position increases the venous return, which in turn increases the heart rate. The direct relationship between the right atrial pressure and heart rate during high spinal anesthesia is mediated by the intrinsic chronotropic stretch receptors located in the right atrium and adjacent great vessels. The extent, to which heart rate decreased in response to total sympathetic denervation has been found to be on an average, only moderates (10 to 15%). The mechanism responsible for such cardiovascular responses have been described as the Bezold – Jarisch reflex.[30]

Blood pressure

The preceding indicates that slight decreases in the arterial pressure in the range of 15% or so during high spinal anesthesia in normovolemic patients can be ascribed to decreases in after load that is decreases in TPVR. Severe hypotension, however, can be due only to decreases in cardiac output secondary to decreases in preload associated with peripheral pooling of blood in vasodilated capacitance vessels or to hypovolemia, or to both.

Myocardial Oxygenation

Myocardial oxygen demands decrease during hypotension associated with spinal anesthesia for three reasons:

- After load decreases; the resistance against which the left ventricle ejects blood during systole is decreased.
- Preload decreases; as venous return and cardiac output decrease, so too does the work load of both ventricles because the amount of blood to be ejected per unit time is lessened.
- Heart rate decreases.

Cerebral Blood Flow

Cerebrovascular autoregulatory mechanisms maintain cerebral blood flow in humans at constant levels even in the presence of wide fluctuations of mean arterial pressure. Cerebrovascular autoregulation is independent of the sympathetic nervous system.

Respiratory System

The phrenic nerve supplying the diaphragm arises from the anterior root, root of C3 to C5 and should not be encroached on in spinal analgesia, but phrenic paralysis can occur. Apnea may be due to medullary ischaemia or due to toxic effects of the drug in extradural blocks. During spinal analgesia breathing becomes quite and tranquil. This is not only due to motor blockade but also due to differentiation with reduction of sensory input to the respiratory center. Lowered arterial and venous tone also lessens the work of the heart and tends to relieve any existing pulmonary congestion. The ventilation perfusion relationship during extradural block is not greatly altered and the effect on respiratory function is relatively small with no evidence of change in functional residual capacity (FRC) or ventilation / perfusion (V/Q) ratio. The pulmonary gas-exchange is preserved. Intercostal paralysis is compensated for by increased descent of the diaphragm, which is made easier by a lax abdomen.

Gastrointestinal System

Pre-ganglionic sympathetic fibers from T5-Ll are inhibitory to the gut. There is no effect on oesophagus, the innervation of which is vagal. The small gut is contracted as sympathetic inhibitory impulses are removed, the vagus being all-powerful. The sphincters are relaxed and peristalsis is active although not more frequent. Pressure within the bowel lumen is increased. Handling of small bowel by the surgeon may cause it to dilate, as may the injection of atropine before the operation. Nausea and vomiting due to the hypotension may occur and usually comes on in waves lasting a minute or so and passes away spontaneously.

Causes of Nausea and Vomiting

- Hypotension
- Hypoxia
- Increased peristalsis
- Traction on nerve endings, especially vagus
- Presence of bile in stomach due to relaxation of pyloric sphincters
- Narcotic analgesics used in pre medication
- Psychological effects

Spleen

The spleen enlarges 2-3 times in high blocks when its sympathetic efferent fibers are paralyzed. Colonic blood supply and oxygen availability are increased in animal following spinal analgesia, perhaps an important factor in the prevention of anastamotic breakdown following gut resection.

Liver

There are no effects of major significance. If the liver is diseased, a decrease in the mean arterial pressure (MAP) affects the liver blood flow and also the metabolism of amide anesthetics.

Endocrine System

Spinal block delays adrenal responses to injury and trauma, so there is no change in the levels of 17- hydroxy corticosteroids.

Spinal block suppresses the hyperglycaemic response to surgery and stress and so is useful in diabetic patients. The response to insulin is augmented, one should be aware of possibility of hypoglycaemia. Infused glucose is well utilised.

Genitourinary System

Sympathetic supply to kidney is from T11 to L1 via the lower splanchnic nerve. Any effects on renal function are solely due to hypotension, renal blood flow is decreased but does not cease until blood pressure has fallen to about 80 mm Hg. These changes are transient and disappear when blood pressure (BP) rises again. The penis is often engorged and flaccid due to paralysis of nervi erigenti (S2 to S3) and this is also a positive sign of a successful block.

Post spinal retention of urine may be moderately prolonged as S2 to S3 contain small autonomic fibers and their paralysis lasts longer that of larger sensory and motor fibers.

Uterus

The tone of uterus is not greatly altered after spinal analgesia in pregnancy. Block of nerves from T11 downwards results in painless labour. In late pregnancy, smaller doses of local anesthetics are required because of decreased extradural space.

Body Temperature

Vasodialtation favours heat loss, absence of sweating favours hyperpyrexia in hot environment, catacholamine secretion is depressed hence heat loss is prevented by metabolism.

PHARAMACOLOGY OF BUPIVACAINE[31]

Local anaesthetics are drugs that produce reversible blockade of conduction of nerve impulses.

The primary desirable properties of an ideal local anaesthetic agent are:

1. Short latency
2. High potency or anaesthetic activity
3. Superior penetration or diffusion
4. Low toxicity
5. Complete reversibility of action
6. Prolonged duration of action
7. No tachyphylaxis
8. Stability and ability to withstand heat sterilization.

Bupivacaine (Marcain, Marcaine and Sensorcaine)

Bupivacaine, an amino amide local anesthetic was first synthesized in Sweden by A.F Ekenstam and his colleagues in 1957. First report of its use was in 1963 by L.J Teluvio. It is one of the long acting local anesthetic agents available, which is extensively used for intrathecal, extradural and peripheral nerve blocks.

Chemistry

The molecular weight of chloride salt is 325 and that of base form is 288. pH of plain solutions varied between 4.5 to 6 and pKa 8.16. Bupivacaine HCl is chemically designated as 2-piperidinecarboxamide, 1-butyl-N-(2,6-dimethylphenyl)-, monohydrochloride, monohydrate and has the following structure:

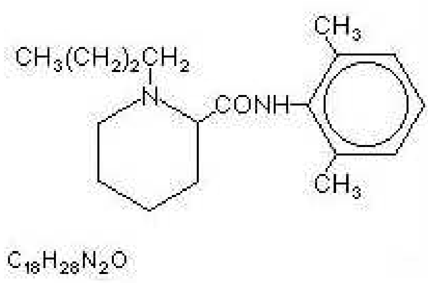


Figure 8. Chemical structure of bupivacaine

Presentation

Bupivacaine is presented as 2.5 mg/ml, 5 mg/ml and 7.5 mg/ml solutions. Bupivacaine is also present as 5 mg/ml with 80 mg/ml dextrose in a 4 ml clear ampoule.

Chemical Structure

Bupivacaine has an IUPAC nomenclature of 1-butyl-n-(2, 6-dimethylphenyl) piperidine-2-carboxamide.

Dosage

Bupivacaine can be used in a dose for block upto a maximum of 2 mg/kg depending on the type and duration of surgery.

Properties

The base is sparingly soluble, but the hydrochloride salt is readily soluble in water. In spinal anesthesia, the onset of action is about three to four minutes and complete anesthesia occurs in five minutes and lasts for 3.5 to 4 hours. Because bupivacaine is an amide, the liver is the primary site of metabolism. The most of the drug is metabolized by N-dealkylation.

Physiochemical Properties

- Molecular formula C18 H28 N2O
- Molecular weight 288.43 g/mol
- Solubility in water 25 mg/ml
- pH of saturated solution 5.2
- pKa 8.1
- Specific gravity 1.021 at 37°c

Mechanism of Action

Mechanism of action is similar to that of any other local anesthetic. The primary action is on the cell membrane axon, on which it produces electrical stabilization. Bupivacaine prevents the generation and the conduction of the nerve impulse. Bupivacaine blocks conduction by decreasing or preventing the large transient increase in permeability of excitable membranes to sodium that normally is produced by a slight depolarization of the membrane. This action of Bupivacaine is due to its direct interaction with the voltage gated sodium channels. As the anesthetic action progressively develops in a nerve, the threshold for electrical excitability gradually decreases, the rate of rise of the action potential declines, impulse conduction slows, and the safety factor for conduction decreases, these factors decrease the probability of propagation of the action potential and nerve conduction fails. The mechanism by which local anaesthetics block sodium conductance is as follows:

Local anesthetics in the cationic form act on the receptors within the sodium channels on cell membrane and block it. The local anesthetics can reach the sodium channel either via the lipophilic pathway directly across the lipid membrane, or via the axoplasmic opening. This mechanism accounts for 90% of the nerve blocking effects of amide local anesthetics.

The second mechanism of action is by membrane expansion. This is a non-specific drug receptor interaction. Bupivacaine is available in the following concentrations:

- 0.25%. 0.5% and 1%
- 0.25% and 0.5% solution in isotonic saline
- 0.5% solution in 8% dextrose
- Dosage is two mg/kg limited to 150 mg in four hours. The intrathecal minimum local analgesic dose of Bupivacaine is 2.37 mg.

Basic Pharmacology

Bupivacaine hydrochloride is 2-piperidine carboxamide, 1 butyl N-2, 6 dimethyl phenyl, monohydrochloride, monohydrate. Bupivacaine molecule is a tertiary amine separated from an aromatic ring system that is a benzene ring by an intermediate chain. The tertiary amine is a base that is a proton acceptor. The chain contains an amide linkage (-NHCO-) therefore; it is classified as an aminoamide compound. This amide linkage contributes to the anaesthetic potency.

The aromatic ring system gives a lipophilic character to its portion of molecule whereas; the tertiary amine end is relatively hydrophilic.

Structure – Activity relationship

Bupivacaine being more lipophilic (because of butyl group) it is very potent and produces longer lasting blocks.

pKa of any drug is defined as the hydrogen ion concentration specific for each drug at which the concentration of local anaesthetic base is equal to the concentration of charged cation. pKa of bupivacaine hydrochloride is 8.1 at 36ºC.

Anesthetic Potency

Hydrophobicity appears to be a primary determinant of intrinsic anesthetic potency and Bupivacaine is highly hydrophobic, hence is very potent.

Onset of Action

The onset of conduction blockade is dependent on the dose or concentration of the local anesthetic

Differential Sensory Motor Blockade

Bupivacaine in low concentration (0.125%) produces acceptable analgesia with only mild muscular weakness.

Pharmacokinetics

The concentration of Bupivacaine in blood is determined by the amount injected, the rate of absorption from the site of injection, the rate of absorption from the site of injection, the rate of tissue distribution and the rate of biotransformation and excretion of Bupivacaine.

Absorption

The site of injection, dose and addition of a vasoconstrictor determine the systemic absorption of Bupivacaine .The maximum blood level of Bupivacaine is related to the total dose of drug administered from any particular site. Absorption is faster in areas of high vascularity.

Distribution

The two-compartment model can describe this. The rapid distribution phase α is believed to be related to uptake by rapid equilibrating tissue i.e., tissues that have high vascular perfusion. The slow distribution phase β is mainly a function of distribution to slowly equilibrating tissue, biotransformation and excretion of the compound.

More highly perfused organs show higher concentrations of the drug. Bupivacaine is rapidly excreted by lung tissue. Though skeletal muscle does not show any particular affinity for bupivacaine it is the largest reservoir of the drug.

Distribution Characteristics

- T1/2 α 2-7 minutes (uptake by rapid equilibrium tissue)
- T1/2 β 28 minutes (distribution by slowly perfused tissues)
- T1/2 γ 3-5 hours (metabolism and elimination)
- VDSS 72 liters (volume of distribution at steady state)

Clinical Pharmacology

1. Anaesthetic potency: Hydrophobicity is a major determinant of intrinsic anaesthetic potency and bupivacaine being highly hydrophobic, is very potent.
2. Onset of action: It depends on the pH of the drug and its concentration.
3. Differential sensory/motor blockade:

Bupivacaine 0.25 to 0.75% produces adequate analgesia with less of motor blockade.

Factors influencing anaesthetic activity

1. ***Dosage of bupivacaine:*** As the dosage of bupivacaine is increased, the probability and duration of satisfactory analgesia will increase and the onset of block will be shortened. Administering either large volume or a more concentrated solution can increase the dosage.

2. ***Addition of vasoconstrictors:*** Addition of adrenaline does not significantly increase the duration of action of bupivacaine.

3. ***Site of action:*** The latency and duration are long when given for brachial block, epidural block and subarachnoid block.

4. ***Compounding of local anaesthetics:*** The basis for this practice is rapid onset of one agent. e.g., lidocaine and longer duration of action of other agent, e.g. bupivacaine.

5. ***Pregnancy:*** The spread and depth of spinal and epidural analgesia are greater in pregnant patients than in non-pregnant women.

6. ***Carbonation and pH adjustment:*** The success of any local anaesthetic depends upon the quantity of drug that can be absorbed on to the axon membrane of the target nerves. This in turn depends upon the ability of the drug to penetrate tissue barrier around the nerve. Alkalinisation of local anaesthetic solution improves the penetration power and more availability of diffusible base of the local anaesthetic. When pH of the solution is equal to pKa of local anaesthetic solution, half of the drug is present as ionized water-soluble cation and rest half as lipid soluble unionized base since this non-ionised soluble form is permeable to nerve cell membrane; it has a major role in penetration.

   Alkalinisation of local anaesthetic solution acts by

   - A direct depressant effect of CO_2 on the axon.
   - Concentrating local anaesthetic inside the nerve trunk (diffusion trapping).

- Converting local anaesthetic to the active cation through its effects on pH at the site of action inside the nerve.

The addition of sodium bicarbonate to bupivacaine increases the pH of the solution without affecting its chemical stability.

Actions

<u>Central Nervous System</u>

Bupivacaine readily crosses the blood brain barrier causing CNS depression following higher doses. The initial symptoms involve feeling of light-headedness and dizziness followed by visual and auditory disturbances. Disorientation and occasional feeling of lightheadedness may occur. Objective signs are usually excitatory in nature, which includes shivering, muscular twitches and tremors, initially involving muscles of the face (perioral numbness) and part of extremities. At still higher doses cardiovascular or respiratory arrest may occur. Acidosis increases the risk of CNS toxicity from Bupivacaine, since an elevation of $PaCO_2$ enhances cerebral blood flow, so that more anesthetic is delivered rapidly to the brain

<u>Autonomic nervous system</u>

Bupivacaine does not inhibit the Nor Adrenaline uptake and hence has no sympathetic potentiating effect. Myelinated preganglionic B fibers have a faster conduction time and are more sensitive to action of Bupivacaine. When used for conduction blockade, all local anesthetics, particularly Bupivacaine produces higher incidence of sensory than motor fibers.

Cardiovascular System

The primary cardiac electrophysiological effect of a local anesthetic is a decrease in the maximum rate of depolarization in Purkinje fibers and ventricular muscle. This action by Bupivacaine is far greater compared to Lignocaine. Also, the rate of recovery of block is slower with Bupivacaine. Therefore there is complete restoration of Vmax between action potential particularly at higher rates. Therefore Bupivacaine is highly arrythmogenic. Bupivacaine reduces the cardiac contractility. This is by blocking the calcium transport. Low concentration of Bupivacaine produces vasoconstriction whereas high doses cause vasodilatation.

Respiratory System

Respiratory depression may be caused if excessive plasma level is reached which in turn results in depression of medullary receptor center. Respiratory depression may be also caused by paralysis of respiratory muscles of diaphragm as may occur in high spinal or total spinal anesthesia.

Biotransformation And Excretion

Bupivacaine undergoes enzymatic degradation primarily in the liver. The excretion occurs primarily via the kidney. Renal perfusion and factors affecting urinary pH affect urinary excretion. Less than 5% of Bupivacaine is excreted via the kidney unchanged through urine. The major portion of injected agent appears in urine in the form of 2, 6 pipecolyoxylidine which is a n-dealkylated metabolite of bupivacaine. Renal clearance of the drug is related inversely to its protein binding capacity and pH of urine.

Adverse effects are encountered in clinical practice mostly due to overdose, inadvertent intravascular injection or slow metabolic degradation.

Adverse Effects

CNS: Nervousness, dizziness, blurring of vision or tremors, drowsiness, convulsions and respiratory arrest.

CVS: Myocardial depression, hypotension, arrhythmia, ventricular type conduction defect, SA node depression and cardiac arrest

Allergic reactions: Urticaria, bronchospasm, hypotension

Other: Constriction of pupil and tinnitus

METHODOLOGY

The present study was conducted in the Department of Anaesthesiology, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum during the period of January 2010 to December 2010.

Source of Data

Patients undergoing unilateral lower limb surgery under unilateral spinal anaesthesia with bupivacaine at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum attached to Jawaharlal Nehru Medical College, Belgaum.

Study design

A one year clinical trial.

Study Period

One year from January 2010 to December 2010

Sample Size and sampling procedure

A total of 100 patients undergoing unilateral lower limb surgery under unilateral spinal anaesthesia with bupivacaine based on inclusion criteria.

Selection Criteria

Inclusion criteria

- ASA Grade I and II.

- Patients undergoing unilateral lower limb surgery.
- Patients with age more than 18 years.

Exclusion criteria

- ASA Grade III and IV.
- Patients with age less than 18 years.
- Patients allergic to bupivacaine.
- Patients in whom SAB is contraindicated.

Procedure

The study was approved and ethical clearance was obtained from Human Ethics Committee, Jawaharlal Nehru Medical College, Belgaum. After finding the suitability according to selection criteria patients were selected for the study and briefed about the nature of the study, the interventions used and written informed consent was obtained (Annexure–I). Further, descriptive data of the patients like name, age, sex, detailed history, were obtained and recorded on predesigned and pretested proforma (Annexure-II).

Pre-anaesthetic evaluation

A thorough pre-anaesthetic evaluation was performed by taking history and clinical examination. In all the patients, height, weight, basal heart rate, respiratory rate and blood pressure were measured and recorded. Investigations like complete blood count, urine for albumin, sugar and microscopy were done. Blood sugar, electrocardiogram and chest x-ray were performed where indicated.

Anaesthesia procedure

In this study 100 patients of ASA Grade I and II, age more than 18 years undergoing unilateral lower limb surgery were included. Preoperatively the patient’s intravenous (IV) line was secured with either 18 G or 20 G branula and IV ringer lactate solution was started half an hour before spinal anaesthesia. The patient was then shifted to the operation theatre and monitors like electrocardiograph (ECG), pulse oximeter and non invasive blood pressure monitor were connected. Preoperatively systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP) and heart rate (HR) were recorded. The patient was then placed in the lateral position with the limb to be operated placed downwards.

Under strict aseptic precautions spinal puncture was performed at L_3 - L_4 interspace with 23 G Quinkes spinal needle and 0.7 ml of 0.5% hyperbaric bupivacaine was injected after free flow of CSF with the bevel of the needle facing towards the foot end of the patient. The drug was injected at a rate of one ml per 15 seconds. Five litres of oxygen was provided to the patient with a oxygen mask throughout the procedure. Patient was maintained in this position for 20 minutes and then placed in the supine position. The haemodynamic parameters like SBP, DBP, MBP and HR were recorded as soon as the drug is injected and at every five minutes interval until the completion of surgery. Sensory block was evaluated by the loss of sensation while motor block was evaluated by Modified Bromage Scale.

Modified Bromage Scale

0 - Free movement of legs and feet

1 - Just able to flex knees with free movement of feet

2 - Unable to flex knees, but with free movement of feet

3 - Unable to move legs or feet.

Sensory and motor block were evaluated in both the limbs every 10 minutes till the surgery was completed.

Hypotension was defined as 20% decrease as compared to the baseline and bradycardia was defined as heart rate less than 60 bpm. The hypotension was treated with intravenous fluids and injection Mephentermine 6 mg bolus and bradycardia was treated with injection Atropine Sulphate 0.6 mg IV.

After the patient was shifted to the recovery the haemodynamic parameters SBP, DBP, MBP, HR and the sensory and motor block were evaluated every 15 minutes until two segment regression of sensory level on the dependent side.

Statistical analysis

The data was tabulated and mean and standard deviation was calculated and compared using paired ‘t’ test and chi-square test.

RESULTS

The present one year clinical trial was conducted in the Department of Anaesthesiology, during the period of January 2010 to December 2010 at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum attached to Jawaharlal Nehru Medical College, Belgaum.

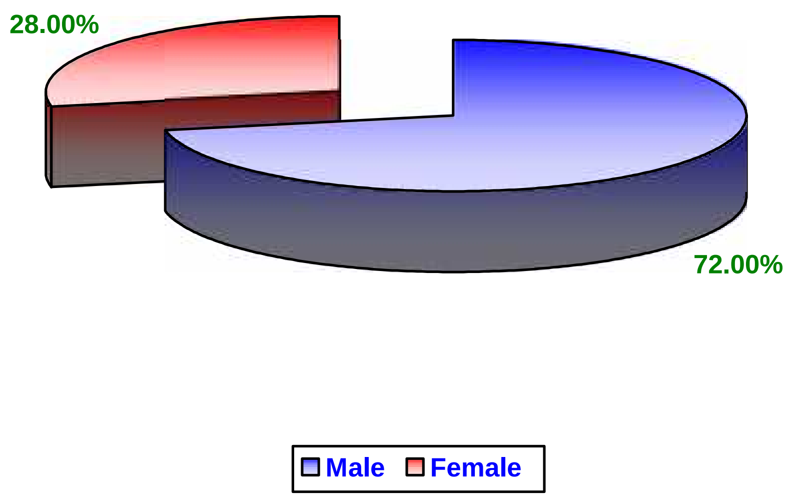
A total of 100 patients undergoing unilateral lower limb surgery under unilateral spinal anaesthesia with bupivacaine were included in the study based on inclusion criteria.

0.7 ml of 0.5% bupivacaine heavy was injected with patient in lateral position with the limb to be operated on the lower side. The patient was made supine at 20 minutes after giving subarachnoid block. The data obtained was tabulated and analysed.

Table 1. Gender distribution

Gender	Study population	
	Number	**Percentage**
Male	72	72%
Female	28	28%
Total	**100**	**100.00**

Graph 1. Gender Distribution

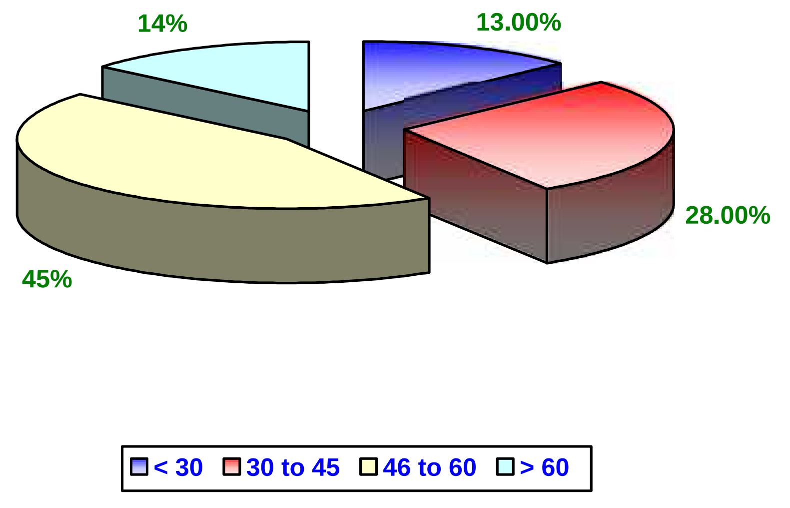


In this study out of 100 patients studied 72 (72%) were males and 28 (28%) were females with male to female ratio of 2.57 : 1.

Table 2. Age distribution

Age (Years)	Study population	
	Number	**Percentage**
< 30	13	13%
30 to 45	28	28%
45 to 60	45	45%
> 60	14	14%
Total	**100**	**100.00**

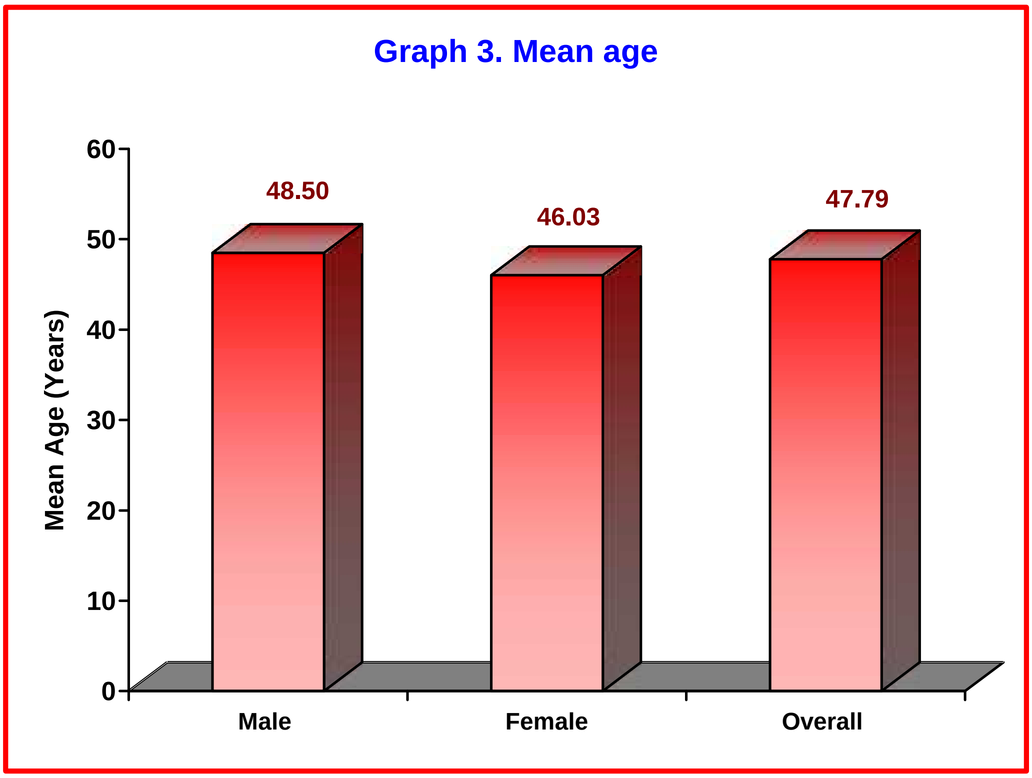
Graph 2. Age Distribution



Majority of the patients (45%) were aged between 46 to 60 years followed by 30 to 45 years (28%). Patients less than 30 years and more than 60 years were 13% and 14% respectively.

Table 2. Genderwise age

Gender	Age (Years)	
	Mean	**S.D.**
Male	48.50	14.46
Female	46.03	12.45
Overall	47.79	13.91



Mean age among males was 48.50 ± 14.46 years and in females it was 46.03 ± 12.45 years. Overall mean age recorded was 47.79 ± 13.91 years.

Table 4. Genderwise height and weight

Gender	Weight (Kgs)		Height (Feet)	
	Mean	**S.D.**	**Mean**	**S.D.**
Male	59.30	8.90	5.60	0.61
Female	54.30	6.49	5.40	0.21
Overall	57.90	8.56	5.50	0.54

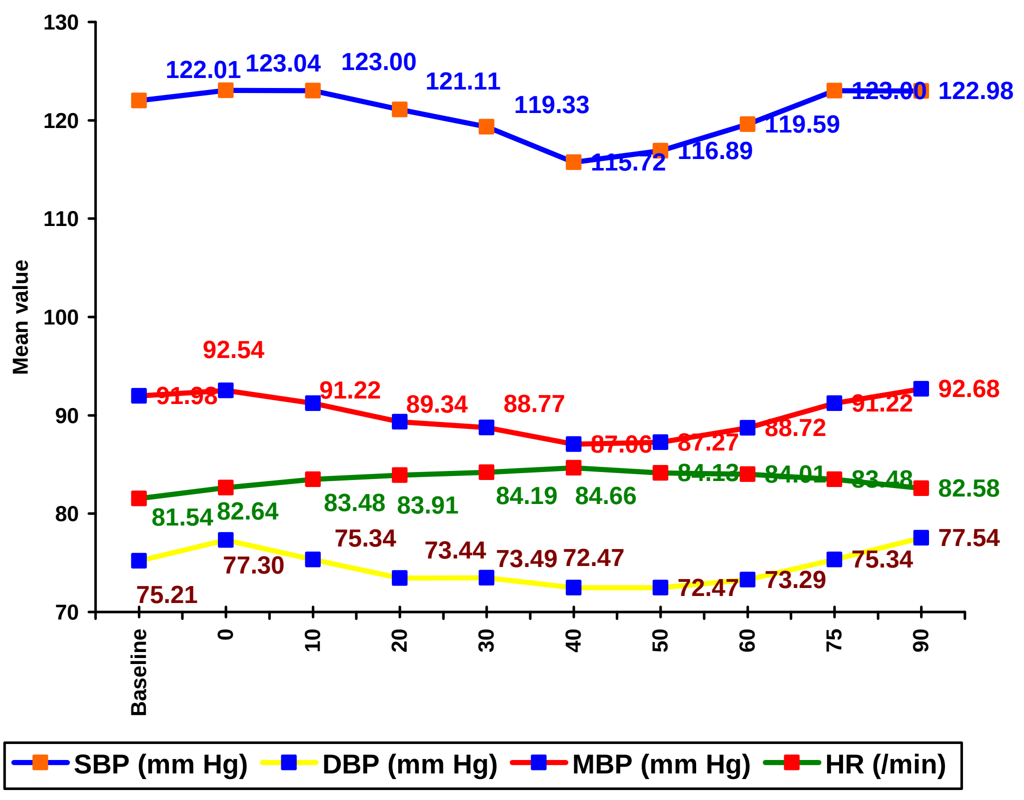
In this study the mean weight among males was 59.30 ± 8.90 Kgs whereas in females it was observed to be 54.30 ± 6.49 Kgs. The overall mean weight among the study population was 57.90 ± 8.56 Kgs.

The mean height among males was observed to be 5.60 ± 0.61 feet whereas in female it was 5.40 ± 0.21 feet. The overall height among the study population was recorded as 5.50 ± 0.54 feet.

Table 5. Haemodynamic parameters

Time interval (Min)	SBP (mm Hg)		DBP (mm Hg)		MBP (mm Hg)		HR (bpm)	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Baseline	122.01	8.07	75.21	4.98	91.98	5.92	81.54	5.86
0	123.04	8.97	77.30	4.94	92.54	5.98	82.64	5.95
10	123.00	8.65	75.34	5.84	91.22	6.30	83.48	7.08
20	121.11	8.20	73.44	5.72	89.34	5.93	83.91	6.46
30	119.33	8.79	73.49	6.64	88.77	6.66	84.19	7.25
40	115.72	10.38	72.47	7.14	87.06	7.75	84.66	6.55
50	116.89	9.85	72.47	6.15	87.27	6.91	84.13	6.45
60	119.59	8.96	73.74	6.74	88.72	6.77	84.01	7.02
75	123.00	8.65	75.34	5.85	91.22	6.36	83.48	7.08
90	122.98	8.94	77.54	4.79	92.68	5.78	82.58	6.02

Graph 4. Haemodynamic paramters



The baseline SBP, DBP, MBP and HR of the patient was recorded on shifting the patient to operation theatre. Time zero was the time at which spinal anaesthesia was given. The haemodynamic parameters were recorded as soon as the drug is injected and at every five minutes interval until the completion of surgery.

The SBP was 123.04 ± 8.97 mm Hg immediately after giving spinal. It showed a gradual fall with maximum fall noted at 40 minutes, the SBP being 115.72 ± 10.38 mm Hg. The SBP gradually increased, subsequently reaching the baseline levels at 90 minutes.

The DBP was 77.30 ± 4.94 mm Hg immediately after giving spinal. It showed a gradual fall with maximum fall noted at 40 minutes, the DBP being 72.47 ± 7.14 mm Hg. The DBP gradually increased, subsequently reaching the baseline levels at 90 minutes.

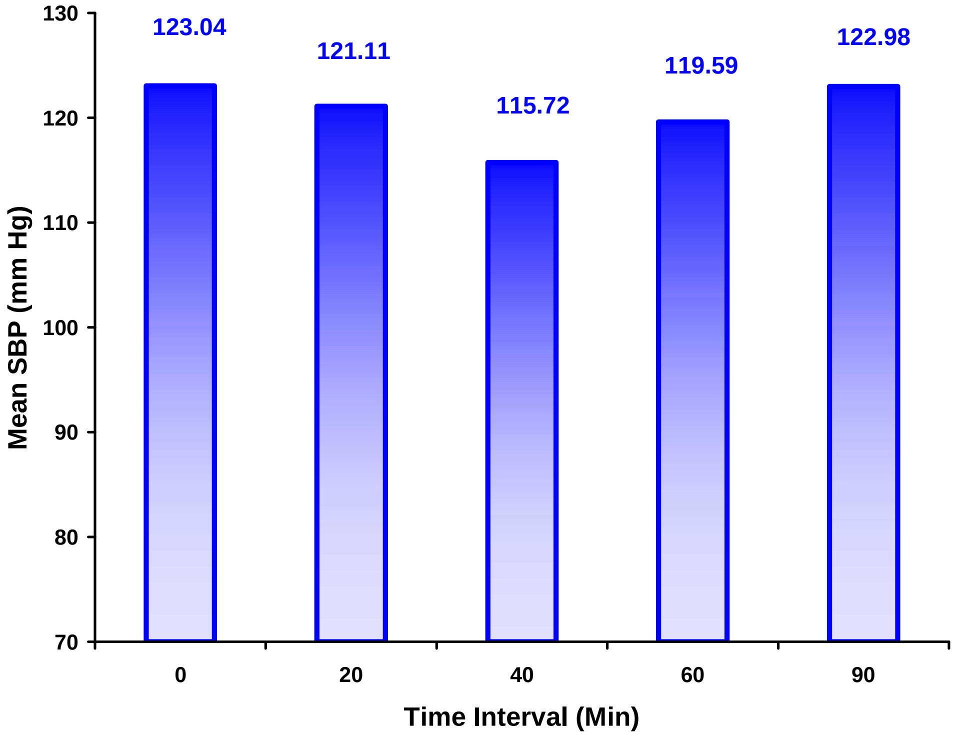
The MBP was 92.54 ± 5.98 mm Hg immediately after giving spinal. It showed a gradual fall with maximum fall noted at 40 minutes, the MBP being 87.06 ± 7.75 mm Hg. The MBP gradually increased, subsequently reaching the baseline levels at 90 minutes.

The maximum increase in HR was seen at 40 minutes after giving spinal (84.66 ± 6.55 bpm) and it gradually reduced coming to baseline levels at 90 minutes.

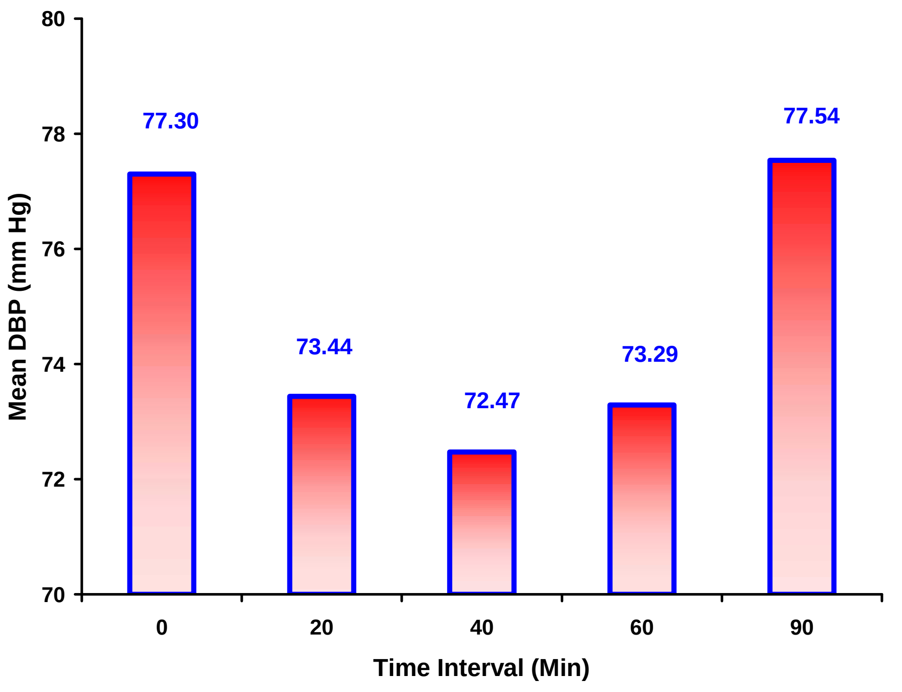
Table 6. Mean change in haemodynamic parameters

	0 Minutes		Time of maximum change (40 Minutes)		'p' value
	Mean	S.D.	Mean	S.D.	
SBP (mm Hg)	123.04	8.97	115.72	10.38	0.960
DBP (mm Hg)	77.30	4.94	72.47	7.14	0.724
MBP (mm Hg)	92.54	5.98	87.06	7.75	0.861
HR (/Min)	82.64	5.95	84.66	6.55	0.936

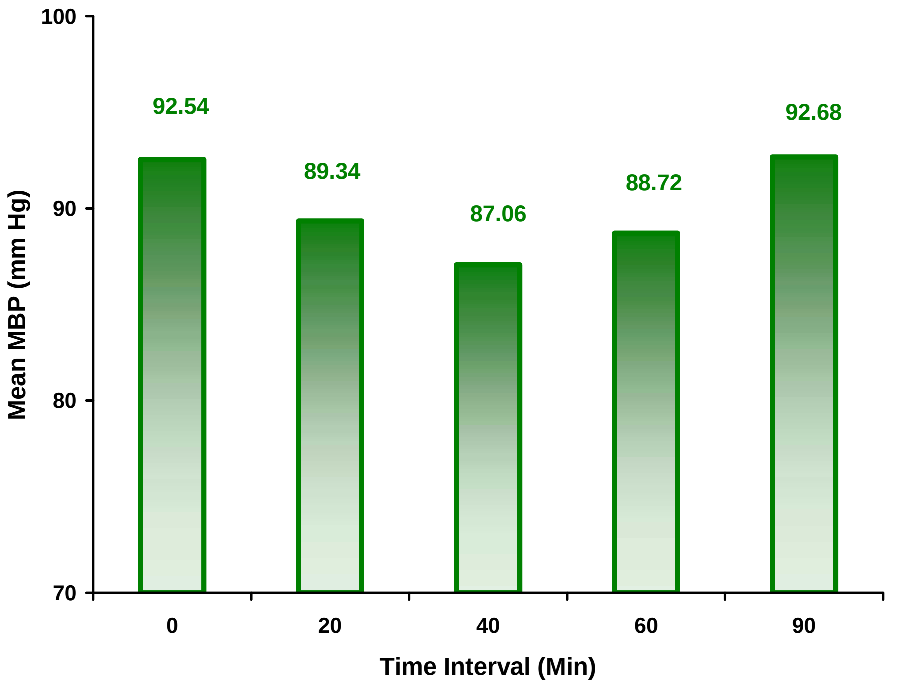
Graph 5. Mean change in SBP

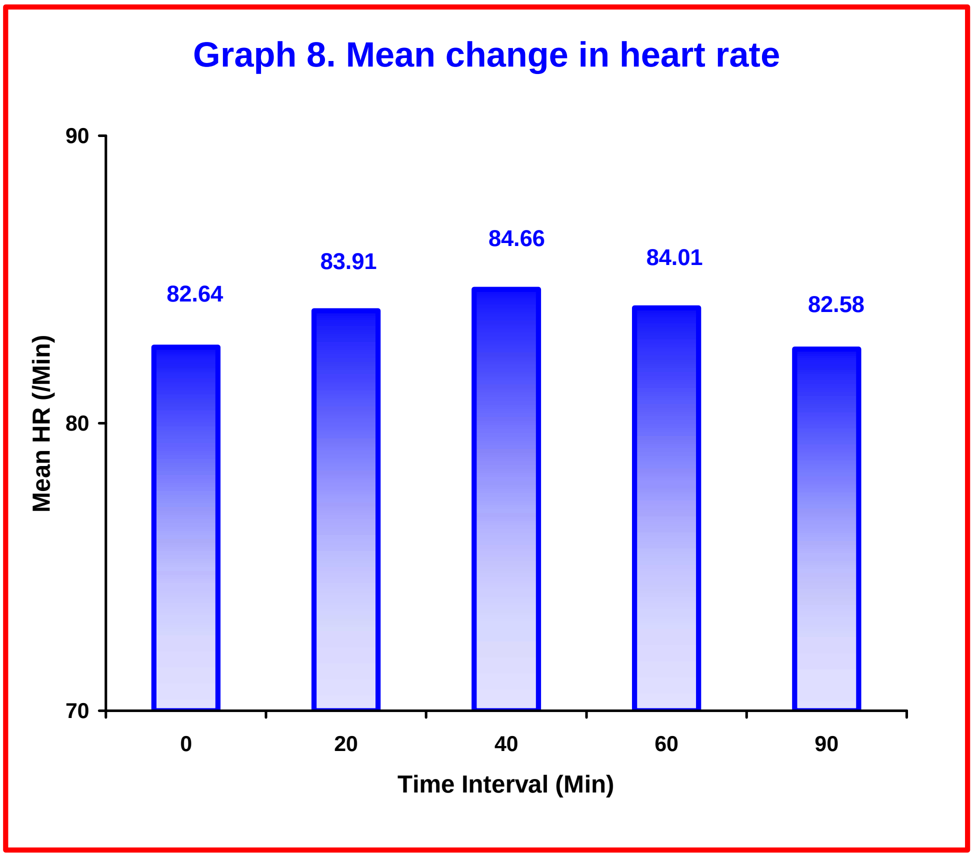


Graph 6. Mean change in DBP



Graph 7. Mean change in MBP



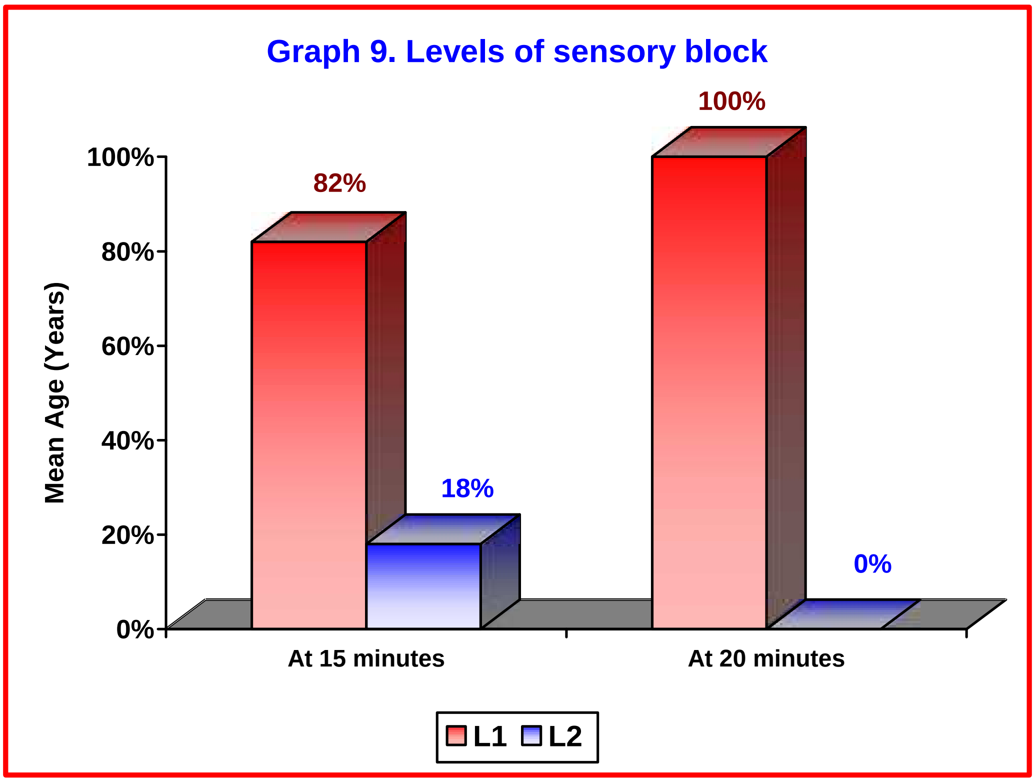


The maximum fall in SBP which was seen at 40 minutes following subaranchnoid block was compared with SBP at time 0 using chi-square test and not found to be statistically significant (p=0.960). The maximum fall in DBP was also seen at 40 minutes following subaranchnoid block and was compared with DBP at time 0 using chi-square test and not found to be statistically significant (p=0.724). The maximum fall in MBP was seen at 40 minutes following subaranchnoid block and was compared with MBP at time 0 using chi-square test and not found to be statistically significant (p=0.861).

The maximum change in HR was seen at 40 minutes following subaranchnoid block and was compared with HR at time 0 using chi-square test and not found to be statistically significant (p=0.936).

Table 7. Levels of sensory block

Block Levels	At 15 minutes		At 20 minutes	
	Number	Percentage	Number	Percentage
L1	82	82%	100	100%
L2	18	18%	00	00%



Most of the patients (85%) had L1 sensory block at 15 min whereas 15% had L2 sensory block. At 20 minutes all the patients (100%) had L1 sensory block. The mean duration of sensory block was 77.9 ± 10.40 minutes with range being 65 to 100 minutes.

Motor blockade was adequate in the limb to be operated which was analysed using modified bromage scale score being zero in all the cases. The mean duration of motor block was 77.1 ± 9.75 minutes with range being 65 to 100 minutes. Block remained unilateral in all the cases.

Modified Bromage Scale

0 - Free movement of legs and feet

1 - Just able to flex knees with free movement of feet

2 - Unable to flex knees, but with free movement of feet

3 - Unable to move legs or feet.

DISCUSSION

Spinal anaesthesia is one of the most commonly used technique in anaesthesia. It is economical, safe, easy to administer and needs less sophisticated anaesthetic equipments and hence preferred over general anaesthesia. It is most popular because of its profound analgesia and muscle relaxation.[32]

Spinal anaesthesia is produced when a local anaesthetic agent is injected into the subarachnoid space and was the first major regional technique attempted.

Spinal anesthesia was initially produced inadvertently by J. Leonard Corning, a neurologist in New York in 1885. He accidentally pierced the duramater while experimenting with cocaine on spinal nerves of a dog. But spinal anesthesia could not become an acceptable means for use of cocaine until a safe predictable means for performing lumbar puncture was described.[33] Quincke did this in 1891. In 1899, August Bier used Quincke`s technique to inject cocaine in order to produce operative anesthesia in six patients, the first real spinal anesthesia.[11] In the same year, Matas in New Orleans and Tuffier in France also reported on the use of cocaine spinal anesthesia. However, the popularity of cocaine SAB was limited owing to the high incidence of central nervous system (CNS) side effects like tremors, hypereflexia, severe headache and muscle spasm and pains.

Procaine was the first synthetic local anesthetic to be used. Einhorn prepared it in 1904. In 1905, Heinrich Brown, German surgeon, reported the use of procaine for SAB. The understanding of causes of spinal anesthesia induced hypotension and its management was described by clinicians like Babcock, Koster, Labat, and Pitker.[34]

Unilateral spinal anaesthesia is a promising alternative to traditional, widely used techniques of central blocks, as it restricts markedly the anaesthetized area thereby, decreases the risk of adverse events and complications.[5]

Anesthesiologists often act on procedures involving just one lower limb, especially in short orthopedic surgeries. Unilateral spinal anesthesia may show advantages for these procedures as compared to conventional spinal anesthesia, which are: lower incidence of hypotension, fast recovery and increased patients' satisfaction.[35-37] Anesthetic injection in the lateral position, low anesthetic doses, direction of pencil point or cutting point needles and slow injection rate have been suggested to induce unilateral spinal anesthesia.[15,35-38] For this purpose, hypobaric,[35,36,39-41] isobaric[37,42] and hyperbaric[14,39,43-45] solutions have been used to induce unilateral spinal anesthesia.

In our study we have used 0.5% hyperbaric bupivacaine as unilateral block can be produced reliably with hyperbaric solutions. With isobaric or hypobaric solutions the incidence of bilateral block has been shown to be higher.

Limiting the spread of the spinal block offers many clinical advantages. First and foremost the haemodynamic impact of spinal anaesthesia is greatly reduced, as the increased venous capacity in affected side is compensated by a reflex vasoconstriction in the non-blocked areas. In case of successful unilateral spinal anaesthesia the difference in levels of sympathetic block between the two sides can be easily detected by measuring a higher temperature in the affected side, caused by a greater vasodilatation due to the sympathetic block. Moreover, it has been demonstrated by clinical trials comparing unilateral spinal anaesthesia with conventional bilateral spinal block that cardiac index values are much more stable during the former than during the latter, with a smaller reduction in arterial blood pressure and heart rate,[46] and a much lower incidence of clinically relevant hypotension (5% Vs 20%).[47] These characteristics justify unilateral spinal anaesthesia in case of elderly patients with poor cardiovascular homeostasis. In addition, other features present advantages for fitter patients, in particular the increased patient autonomy after surgery due to lack of motor block in the non-operated leg. This aids nursing management, maintains spontaneous micturition, provides early ambulation after surgery as well as improved patient well being by avoiding the unpleasant experience of sudden, though reversible, paraplegia.

Hypotension following SAB is mainly due to paralysis of sympathetic vasoconstrictor fibres to blood vessels. This decreased vasoconstrictor tone occurs at the preganglionic levels and affects both arterioles and veins. It leads to decreased total peripheral resistance, venous dilatation, stagnation and decreased venous return to the heart which in turn leads to fall in cardiac output and hypotension.[48]

Other factors which may contribute to hypotension are skeletal muscular paralysis, loss of muscular milking action and interference with thoracic respiratory pump.[48]

Skin temperature evaluated on the foot is a simple method to determine sympathetic function. Temperature increases as result of venous dilatation induced by sympathetic block.[35]

In two recent studies[49,50], skin temperature has shown that bilateral sympathetic block may be prevented in 70% of patients if hyperbaric bupivacaine is slowly injected in low doses. One objective of unilateral spinal anesthesia is to decrease hypotension, which may be present with spinal anesthesia, fact confirmed when conventional spinal anesthesia was compared to asymmetric spinal anesthesia.[50]

Spread of anaesthetic solution depends mainly upon;

- Amount of drug, type of drug.
- Volume of solution.
- Place of injection.
- Rate of injection.
- Patient position.
- Direction of the bevel of the needle.[48]

All the above factors were standardized in our study.

In this study gender distribution showed male preponderance with 72% males and 28% were females. The male to female ratio was 2.57 : 1.

Most of the patients (45%) were aged between 46 to 60 years followed by 30 to 45 years (28%). However patients between less than 30 years and more than 60 years were 13% and 14% respectively. Mean age among males was

48.50±14.46 years and in females it was 46.03±12.45 years. Overall mean age recorded was 47.79 ± 13.91 years. It is considered that duration of spinal anaesthesia increases with age. The time to onset of analgesia and maximal motor blockade have been found to decrease with age. Recovery time from sensory block is prolonged in the older patients. The rate of two segment regression is not affected.[48] In our study however we did not find any significant difference in characteristics of sensory and motor block.

In this study the mean weight among males was 59.30 ± 8.90 Kgs whereas in females it was observed to be 54.30 ± 6.49 Kgs. The overall mean weight among the study population was 57.90 ± 8.56 Kgs. With the standardized technique of spinal anaesthesia, it is usual for higher level anaesthesia to occur in obese patients especially when they are overweight by 40% to 50% or more. None of the patients in our study were obese.[48]

The mean height among males was observed to be 5.60 ± 0.61 feet whereas in female it was 5.40 ± 0.21 feet. The overall height among the study population was recorded as 5.50 ± 0.54 feet. Height has negative effect on the level of blockade for a given weight that is, tall patients with standardized spinal technique had lower levels of analgesia than the patients with short stature. All the patients in our study were comparable in height.[48]

Hyperbaric solutions are readily controlled after SAB by proper positioning of the patient. Generally hyperbaric solution tends to travel to the most dependent part of subarachnoid space.

The optimum time for maintaining the patient in lateral position and thereby producing a unilateral block is controversial. With high doses of hyperbaric bupivacaine (12.5 mg and 15 mg), there is high incidence of bilateral block even when patient remains in lateral position for 30 minutes to one hour.[43,51] Conversely with low doses of hyperbaric bupivacaine, motor block remains unilateral even when patients is made supine after 10 to 15 minutes in lateral position.[15,44,52]

In our study we kept the patient in lateral position for 20 minutes following 3.5 mg of intrathecal hyperbaric bupivacaine. This resulted in successful unilateral block in 100% of the patients. There was no anaesthetic migration leading to bilateral block.

The mean SBP at induction was 122.01 ± 8.07 mm Hg and immediately after giving spinal was 123.04 ± 8.97 mm Hg. Maximum fall was noted at 40 minutes, which was 115.72 ± 10.38 mm Hg.

The mean DBP at induction was 75.21 ± 4.98 mm Hg and immediately after giving spinal was 77.30 ± 4.94 mm Hg. Maximum fall was noted at 40 minutes, which was 72.47 ± 7.14 mm Hg.

The mean MBP at induction was 91.98 ± 5.92 mm Hg and immediately after giving spinal was 92.54 ± 5.98 mm Hg. Maximum fall was noted at 40 minutes, which was 87.06 ± 7.75 mm Hg.

The mean HR at induction was 81.54 ± 5.86 mm Hg and immediately after giving spinal was 82.64 ± 5.95 mm Hg. Maximum rise was noted at 30 minutes, which was 85.49 ± 7.25 mm Hg.

When compared statistically the reduction in SBP, DBP, MBP and increase in HR was not found to be statistically significant.

In a study[5] from Regional Hospital, Mystowice to assess unilateral spinal anaesthesia and to verify the hypothesis about safety-related superiority of this technique over bilateral anaesthesia in patients undergoing unilateral subarachnoid blockage with hyperbaric 0.5% bupivacaine, the decrease in mean MAP at 5th and 16th min of anaesthesia was 13.3 and 17.5 mm Hg, respectively. The comparative assessment of both techniques of administration of 0.5% bupivacaine in the lateral decubitus position did not show differences between the fast and conventional injection: changes in MAP ranged from 1.8 mm Hg to 4.2 mm Hg.[53] Our findings are similar, yet the rate of local anaesthetic injection was the same in all patients. The study concluded that, unilateral spinal anaesthesia is safe especially when the dose of bupivacaine is lower and haemodynamic stability is better.

Another study from Rio de Janeiro reports the regression of two segments with low 0.5% hyperbaric bupivacaine doses varies 67[46] to 99[47] minutes. But authors didn’t evaluated the regression of two segments, but rather total motor block recovery which has varied 1.75 to 3.25 hours. The study recommended that, 5 mg hyperbaric bupivacaine may be a good indication for outpatient procedures.

Our results are comparable with a study from Karachi done to assess whether a unilateral spinal anaesthesia using 0.5% hyperbaric Bupivacaine will restrict the sympathetic block to avoid the undesired cardiovascular effects. The study reported that, unilateral spinal anaesthesia is very effective in restricting the sympathetic block as all high risk patients showed minimal haemodynamic changes following the technique.

A review of clinical studies[54] on this topic trying to outline the feasibility and potential clinical benefits of unilateral spinal anesthesia including the main results of studies recently published on peer reviewed journals concerning the clinical use of unilateral spinal anesthesia reported that, the main factors to be considered when attempting a unilateral spinal block are the use of small doses of local anesthetic solution injected through directional, pencil-point needles, together with a 15-20 min lateral decubitus position and the use of either hypo- or hyperbaric anesthetic solution. Using 6-8 mg of either hyper- or hypobaric bupivacaine provides a unilateral distribution of sympathetic and sensory blocks in 50 to 70% of patients, while unilateral motor block can be observed in up to 80% of cases. Attempting a unilateral spinal block results in a four-fold reduction in the incidence of clinically relevant hypotension with more stable cardiovascular parameters as compared with conventional bilateral spinal block. The small amount of local anesthetic solution injected, as well as the reduced extent of spinal block, also provide a favourable profile of the resolution of spinal block, which can be useful in the ambulatory setting. With simple technical skill we can reliably provide a preferential distribution of spinal block to the operated side. This results in a minimal delay in preparation time, but provides less hemodynamic side effects with higher cardiovascular stability, and increased autonomy after surgery with better patient acceptance.

Another prospective, randomized, parallel group study[3] from Milan to evaluate cardiac performance during unilateral subarachnoid block and to compare it with that produced by standard bilateral spinal anaesthesia reported that, the use of 8 mg of 0.5% hyperbaric bupivacaine slowly injected through a directional needle provided a spinal block relatively restricted to the operative side with minimal effects on cardiovascular homeostasis.

Overall in the present study there was no significant change in SBP, DBP, MBP and HR and the block remained unilateral with adequate sensory and motor blockade.

However with this small dose of drug, block lasted for short duration (90 minutes) and can be used only in surgeries of shorter duration which is a limitation.

In view of short duration of motor blockade the use of this dose of hyperbaric bupivacaine for day care surgeries can be evaluated. Also as this small dose causes minimal haemodynamic changes it can be used judiciously in ASA grade III and IV patients. A study[1] using 1.1 to 1.8 ml of 0.5% hyperbaric bupivacaine reported that, unilateral spinal anaesthesia is very effective and also showed that, there were minimal haemodynamic changes following the technique in ASA grade III and IV patients. Hence effect of this small dose that is, 0.7 mL (3.5 mg) in ASA grade III and IV may be studied.

CONCLUSION

There was no significant fall in SBP, DBP, MBP or variation in HR that is, there is no significant variation in haemodynamic parameters following low dose spinal anaesthesia.

Sensory level of L1, motor block (modified bromage scale score = 3) was achived.

The duration of block was 77.90 ± 10.40 minutes. The block remained unilateral.

SUMMARY

Unilateral spinal anaesthesia is a promising alternative to traditional, widely used techniques of central neuraxial blocks, as it restricts markedly the anaesthetized area thereby, decreases the risk of adverse events and complications. The present study is taken up to assess the haemodynamic effects of low dose 0.7 ml (3.5 mg) of 0.5% hyperbaric Bupivacaine and also to assess the level achieved and duration of block.

The present one year clinical trial was conducted in the Department of Anaesthesiology, during the period of January 2010 to December 2010 at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum attached to Jawaharlal Nehru Medical College, Belgaum. A total of 100 patients undergoing unilateral lower limb surgery under unilateral spinal anaesthesia with bupivacaine were included in the study based on inclusion criteria. 0.7 ml (3.5 mg) of 0.5% bupivacaine heavy was injected with patient in lateral position with the limb to be operated on the lower side. The patient was made supine at 20 minutes after giving subarachnoid block. The data obtained was tabulated and analysed.

In this study out of 100 patients studied 72 (72%) were males and 28 (28%) were females with male to female ratio of 2.57 : 1. Majority of the patients (45%) were aged between 46 to 60 years. Overall mean age was 47.79 ± 13.91 years and mean weight was 57.90 ± 8.56 Kgs.

The SBP, DBP and MBP showed a gradual fall with maximum fall noted at 40 minutes and gradually increased, subsequently reaching the baseline levels at 90 minutes. The maximum increase in HR was seen at 40 minutes after giving spinal and it gradually reduced coming to baseline levels at 90 minutes. Maximum sensory level of L1 was achieved. The block remained unilateral in all the cases. Motor blockade was adequate in the limb to be operated which was analysed using modified bromage scale score being zero in all the cases.

Subarachnoid block with 0.7 mL(3.5 mg) of 0.5% hyperbaric bupivacaine used in this study does not produce any adverse haemodynamic changes and lasts for short duration that is 90 minutes and can be used in surgeries of shorter duration which is a limitation.

In view of short duration of motor blockade the use of this dose of hyperbaric bupivacaine for day care surgeries can be evaluated. Also as this small dose causes minimal haemodynamic changes it can be used judiciously in ASA grade III and IV patients. Hence effect of this small dose that is, 0.7 mL (3.5 mg) in ASA grade III and IV may be studied.

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ANNEXURE I - CONSENT FORM

A study, "**HAEMODYNAMIC EFFECTS OF UNILATERAL SPINAL ANAESTHESIA WITH LOW DOSE 0.5% HYPERBARIC BUPIVACAINE – A CLINICAL STUDY"** is being conducted by Dr. **** *****, Post Graduate in Anaesthesiology at J. N. Medical College Belgaum, Karnataka. Under guidance of Dr. ***** ****** Associate Professor, Dept. of Anaesthesiology, J. N. Medical College, Belgaum, KLE University, Belgaum.

Respected Sir/Madam __________________________ we request you to participate in our study as you are eligible to be included. During the study you will be asked questions regarding your present and past medical history and you are suppose to answer to the best of your knowledge.

Your participation in this study is voluntary. Your decision whether or, not, to participate in the study will not affect your relationship with Jawaharlal Nehru Medical College, Belgaum. If you decide to participate you are free to withdraw at any point of time. The purpose of the study is assess the haemodyanamic effects of unilateral spinal anaesthesia with low dose i.e. 0.7 ml (3.5 mg) of 0.5% hyperbaric bupivacaine.

Procedure involved

If you agree to enroll yourself in this study, you will be interviewed regarding your present, past and family history then you will be clinically examined in detail and investigated accordingly. Further a low dose of 0.7 ml of 0.5% hyperbaric bupivacaine will be injected for unilateral spinal anaesthesia.

Benefits and Risks

The benefits of taking part in this research are that this technique will cause no or minimal haemodynamic changes with adequate block and faster recovery. There are no observable risks associated in this study.

Privacy and Confidentiality

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

1. In emergency to protect your rights and welfare.
2. If required by law.

Authorization to publish results

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

Voluntary participation / Withdrawal

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

Alternatives

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

Financial Incentives for participation

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

Compensation

In the event of injury, related to the study, treatment will be made available at KLES Hospital & MRC, Belgaum. No reimbursement, compensation or free medical care will be given, by law. If you are injured, you may contact Dr. **** ****** at Department of Anaesthesiology, KLES Hospital & MRC or by Ph. No. *******.

Queries/ Contact details

If you have any queries, in future or in case of study related injury or illness, you may contact. Dr. ***** ******, Associate Professor, Department of Anaesthesiology, Jawaharlal Nehru Medical College, Belgaum Mobile No. ***** ***** or Dr. ******* ***** at Department of Anaesthesiology, KLES Hospital and MRC, Ph No. ***** ***** or on phone ***** *****.

If you have any queries about your rights as a study subject, you may call Principal and Chairman, J. N. Medical College Institutional Ethical Committee for Human Subjects Research, Ph. ***** at J. N. Medical College, Belgaum.

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

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

Subject Name : ______________________________

Signature or left impression of the participant: ______________________________

Witness name: ______________________________ Signature: _______________

Date: ___________________

Signature of the participant: __________________ Signature: _______________

Date: ___________________

Date: ____________________

Place: ____________________

ANNEXURE II – PROFOMA

STUDY: "HAEMODYNAMIC EFFECTS OF UNILATERAL SPINAL ANAESTHESIA WITH LOW DOSE 0.5% HYPERBARIC BUPIVACAINE – A CLINICAL STUDY"

Patient Name	:	I.P. No	:
Age	:	Weight	:
Height	:	Gender	:
Date of Operation	:	Occupation	:
Address	:	Anaesthesiologist	:

Preanaesthetic evaluation

Chief Complaints

Past History

a. HTN / DM / Asthma / Epilespy / Drug allergy
b. Drug therapy
c. Previous exposure to anaesthesia

Family history

General Physical Examination

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

Musculoskeletal system examination

Jaw movements	Teeth:
Airway assessment:	Spine:

Systemic examination

R.S.	CNS
CVS	GIT

Investigations

Hb%:	Total count:
Differential count:	Bleeding time:
Clotting time:	PT:
aPTT:	INR:

Urine routine

Any others

Preoperative physical status: ASA Grade I II III IV V

Inclusion criteria

- ASA Grade I, II and III.
- Patients undergoing unilateral lower limb surgeries.
- Patients with age more than 18 years.

Exclusion criteria

- ASA Grade IV and V.
- Patients with age less than 18 years.

Diagnosis

Proposed surgery

A written informed consent will be taken from the patient. In this study 100 patients of ASA Grade I, II and III, age more than 18 years undergoing unilateral lower limb will be included. Preoperatively the patient's intravenous (IV) line will be secured with either 18 G or 20 G branula and IV ringer lactate solution is started. The patient then will be shifted to the operation theatre and monitors like electrocardiograph (ECG), pulse oximeter and non invasive blood pressure monitor will be connected. Preoperatively systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), heart rate (HR) will be recorded. The patient then will be placed in the lateral position with the limb to be operated placed downwards.

Under strict aseptic precautions spinal puncture will be performed at L_3 - L_4 interspace with 23 G Quinkes spinal needle and 0.7 ml of 0.5% hyperbaric bupivacaine will be injected with the bevel of the needle facing towards the foot end of the patient. The drug will be injected at a rate of one ml per 15 seconds. Patient will be maintained in this position for 15 minutes and then placed in the supine position. The haemodynamic parameters like SBP, DBP, MBP and HR will be recorded as soon as the drug is injected and at every five minutes interval until the completion of surgery. Sensory block will be evaluated by the loss of sensation while motor block will be evaluated by Modified Bromage Scale (0 - Free movement of legs and feet, 1 - Just able to flex knees with free movement of feet, 2 - Unable to flex knees, but with free movement of feet and 3-Unable to move legs or feet). Sensory and motor block will be evaluated in both the limbs every 10 minutes till the surgery is completed.

Hypotension will be defined as 30% decrease as compared to the baseline and bradycardia will be defined as 20% decrease in the baseline heart rate. The hypotension will be treated with intravenous fluids and injection Mephentermine 6 mg bolus and bradycardia will be treated with injection Atropine 0.6 mg IV. After the patient is shifted to the recovery the haemodynamic parameters SBP, DBP, MBP, HR and the sensory and motor block will be evaluated every 15 minutes until two segment regression of sensory level on the dependent side.

Observations

Time (Min)	5	10	15	20	25	30	35	40	45	50	55	60
SBP (mm Hg)												
DBP (mm Hg)												
MBP (mm Hg)												
HR (BPM)												

Time (Min)	**Level of sensory block**

Duration of the Block	

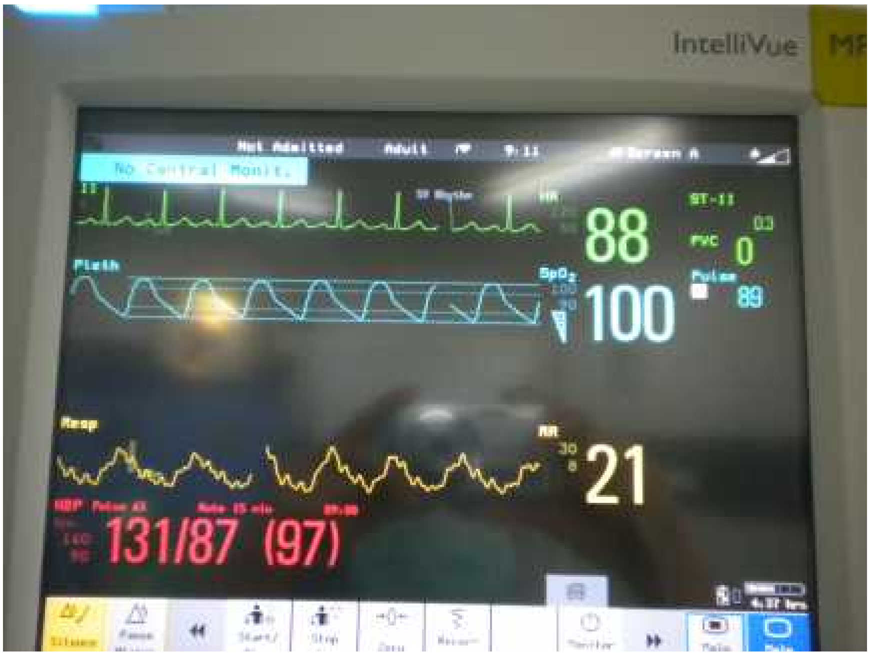
All these above observations will be observed until the completion of surgery.

ANNEXURE III – PHOTOGRAPHS

Photograph 1. Hyperbaric bupivacaine 0.5%

Photograph 2. Spinal tray

Photograph 3. Spinal anaesthesia



Photograph 4. Monitoring haemodynamic parameters

ANNEXURE IV - KEY TO MASTER CHART

ASA	-	American Society of Anaesthesiologists
DBP	-	Diastolic blood pressure
F	-	Female
HR	-	Heart rate
Kg	-	Kilogram
M	-	Male
MBP	-	Mean blood pressure
Min	-	Minute
mm Hg	-	Millimeter of mercury
SBP	-	Systolic blood pressure

MASTER CHART

Serial Number	In Patient Number	Gender	Age (Years)	Weight (Kg)	Height (Feet)	ASA Grade	Observations at regular intervals (Time in minutes)																				Observations at regular intervals (Time in minutes)																Sensory block			Motor block	
							0				10				20				30				40				50				60				75				90								
							SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	15 minutes	20 minutes	Duration (Min)	20 min bromage	Duration (Min)
1	268822	M	56	65	5.8	I	130	80	97	82	130	80	97	80	124	70	88	82	130	80	97	84	120	80	93	80	130	80	97	88	130	80	97	84	132	80	97	82	130	80	97	80	L1	L1	80	3	75
2	373340	M	28	60	5.8	I	120	80	93	82	130	80	97	82	130	80	97	84	120	80	93	84	130	80	97	90	130	80	97	90	120	80	93	84	124	70	88	82	122	80	94	80	L1	L1	75	3	70
3	369037	M	65	70	5.6	I	130	80	97	80	132	80	97	82	128	70	89	82	110	70	83	80	100	60	73	80	110	70	83	80	130	60	83	80	124	70	88	82	120	80	93	80	L2	L1	90	3	85
4	370703	F	60	52	5.6	I	124	80	95	80	120	80	93	80	120	70	87	92	120	80	93	88	124	80	95	82	124	80	95	80	120	80	93	88	110	74	86	82	124	80	95	80	L1	L1	75	3	70
5	363044	M	75	68	5.7	I	130	80	97	82	130	80	97	80	124	70	88	82	120	80	93	84	110	70	83	80	110	70	83	80	110	70	83	80	110	70	83	82	120	80	93	90	L1	L1	90	3	85
6	353930	F	54	50	5.6	I	120	90	100	60	124	80	95	62	124	80	95	62	120	80	93	60	120	80	93	60	120	80	93	60	120	80	93	60	130	82	98	90	134	82	99	82	L2	L1	75	3	65
7	353078	M	62	60	5.8	I	130	80	97	82	124	70	88	80	120	80	93	90	120	80	93	94	130	80	97	90	130	80	97	92	120	80	93	94	132	80	97	92	124	82	96	80	L1	L1	90	3	85
8	353611	F	46	50	5.4	I	110	70	83	80	110	74	86	90	110	70	83	92	124	70	88	84	110	70	83	80	110	70	83	80	124	70	88	84	110	70	83	70	100	80	87	80	L1	L1	75	3	70
9	353347	F	63	60	5.8	I	130	80	97	80	132	80	97	80	124	74	91	84	126	70	89	76	128	72	91	74	130	80	97	70	126	70	89	76	120	80	93	82	120	80	93	96	L2	L1	75	3	70
10	363935	M	55	62	5.7	I	120	70	87	80	124	70	88	82	120	70	87	80	100	60	73	90	120	70	87	72	120	70	87	76	130	80	97	74	110	70	83	82	120	74	89	80	L1	L1	65	3	75
11	352246	M	48	55	5.7	I	130	80	97	80	132	80	97	82	128	70	89	80	110	70	83	80	100	60	73	83	100	60	73	83	110	70	83	80	120	80	93	90	130	80	97	80	L1	L1	75	3	75
12	358738	M	36	55	5.8	I	124	80	95	80	120	80	93	90	120	70	87	82	124	80	95	82	120	80	93	84	120	70	87	90	124	80	95	82	132	82	99	90	130	80	97	80	L1	L1	90	3	85
13	348760	F	27	45	5.6	I	120	80	93	90	124	70	88	80	110	72	85	82	110	70	83	92	108	72	84	90	108	72	84	90	110	70	83	92	130	80	97	92	130	80	97	80	L1	L1	80	3	75
14	363994	M	40	60	5.4	I	110	70	83	70	100	60	73	76	100	70	80	80	124	80	95	82	124	80	95	84	124	80	95	84	124	80	95	82	124	70	88	82	110	70	83	80	L1	L1	75	3	70
15	363045	M	40	62	5.9	I	124	70	88	70	124	80	95	70	120	74	89	74	115	73	87	72	100	70	80	72	100	60	73	76	110	70	83	80	120	80	93	90	110	70	83	83	L1	L1	90	3	85
16	360127	M	56	65	5.8	I	130	80	97	80	130	84	99	82	120	80	93	84	110	73	85	84	110	70	83	94	100	60	73	74	110	70	83	78	140	85	103	80	130	80	97	80	L1	L1	100	3	95
17	364175	M	20	38	5.3	I	110	70	83	90	120	80	93	92	100	70	80	94	100	60	73	96	90	60	70	92	110	70	83	80	110	70	83	84	130	80	97	82	130	80	97	90	L1	L1	75	3	65
18	357954	M	45	62	5.8	I	120	80	93	90	110	70	83	92	110	70	83	92	110	70	83	93	120	80	93	92	130	80	97	94	110	70	83	93	110	70	83	82	110	70	83	82	L1	L1	75	3	70
19	313380	M	31	55	5.8	II	124	70	88	90	120	70	87	92	110	70	83	94	100	60	73	96	90	60	70	90	110	70	83	88	110	70	83	82	130	80	97	92	110	70	83	80	L1	L1	75	3	70
20	353721	M	35	45	0.8	I	111	70	84	80	110	70	83	82	124	72	89	80	124	72	89	82	110	70	83	82	110	70	83	82	124	72	89	82	132	80	97	82	110	70	83	80	L1	L1	65	3	75
21	357090	F	59	65	5.6	I	132	80	97	90	130	80	97	92	124	70	88	80	120	70	87	90	130	80	97	92	130	80	97	80	130	80	97	88	124	70	88	70	124	80	95	80	L1	L1	90	3	85
22	368839	M	50	50	5.6	I	140	85	103	80	132	80	97	82	130	80	97	82	128	86	100	74	133	81	98	76	127	80	96	78	128	82	97	74	134	80	98	98	130	80	97	83	L1	L1	90	3	85
23	356055	M	61	65	5.6	I	130	80	97	80	132	80	97	82	130	80	97	84	130	80	97	82	130	80	97	80	130	80	97	80	130	80	97	82	130	80	97	82	132	80	97	90	L1	L1	90	3	85
24	354585	M	56	60	5.9	I	130	80	97	80	124	70	88	82	122	70	87	80	124	70	88	80	120	70	87	80	120	70	87	80	124	70	88	80	124	70	88	70	130	80	97	82	L1	L1	75	3	70
25	354916	M	95	62	5.6	I	130	80	97	80	124	70	88	82	120	70	87	82	124	70	88	80	124	70	88	82	124	70	88	82	124	70	88	80	124	70	88	80	124	80	95	80	L1	L1	80	3	75
26	355898	M	35	50	5.7	I	110	70	83	80	110	74	86	82	124	80	95	82	110	70	83	82	110	70	83	82	110	70	83	82	110	70	83	82	108	70	83	82	130	80	97	80	L2	L1	75	3	65
27	358738	M	26	50	5.6	I	110	70	83	83	110	70	83	82	120	80	93	90	110	60	77	94	110	70	83	80	100	60	73	76	110	60	77	94	130	82	98	90	132	80	97	80	L1	L1	75	3	70
28	356102	M	50	60	5.7	I	130	80	97	80	130	82	98	90	134	80	98	92	134	80	98	94	130	80	97	96	130	80	97	96	134	80	98	94	120	70	87	82	111	70	84	80	L1	L1	65	3	75
29	353071	M	58	62	5.4	I	130	80	97	90	132	80	97	92	124	70	88	90	124	70	88	90	122	70	87	88	122	70	87	88	124	70	88	90	132	80	97	82	132	80	97	90	L1	L1	90	3	85
30	353016	M	30	50	5.6	I	110	70	83	82	110	70	83	70	100	60	73	72	100	70	80	74	100	60	73	80	124	80	95	82	124	80	95	80	124	70	88	70	140	85	103	80	L1	L1	90	3	85
31	334226	M	55	60	5.7	I	110	70	83	80	120	80	93	82	120	80	93	84	124	80	95	90	130	80	97	90	110	70	83	92	100	60	73	94	120	70	87	92	124	80	95	80	L1	L1	75	3	70
32	355766	M	68	55	5.5	I	110	70	83	80	110	70	83	82	120	70	87	84	120	80	93	84	120	80	93	84	110	70	83	90	110	70	83	90	134	80	98	98	130	80	97	80	L1	L1	80	3	75
33	368818	M	26	50	5.6	I	110	70	83	70	114	64	81	72	124	65	85	65	128	63	85	60	100	68	79	61	100	67	78	68	128	63	85	60	124	70	88	80	132	80	97	80	L2	L1	80	3	75
34	353360	M	35	50	5.8	I	110	70	83	80	124	70	88	82	122	70	87	88	110	70	83	90	110	70	83	90	110	70	83	90	110	70	83	90	130	80	97	90	124	80	95	80	L1	L1	90	3	85

MASTER CHART

Serial Number	In Patient Number	Gender	Age (Years)	Weight (Kg)	Height (Feet)	ASA Grade	Observations at regular intervals (Time in minutes)																				Observations at regular intervals (Time in minutes)																Sensory block			Motor block	
							0				10				20				30				40				50				60				75				90								
							SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	15 minutes	20 minutes	Duration (Min)	20 min bromage	Duration (Min)
35	355786	M	38	45	5.6	I	124	80	95	80	110	70	83	82	110	70	83	80	120	82	95	82	110	70	83	84	110	60	77	84	110	70	83	84	114	64	81	72	132	80	97	90	L1	L1	75	3	70
36	355376	F	60	50	5.2	II	110	70	83	90	120	70	87	92	130	80	97	80	110	70	83	92	100	70	80	92	110	72	85	80	110	70	83	92	110	70	83	70	116	82	93	82	L2	L1	65	3	75
37	357986	M	40	60	5.8	I	110	70	83	90	120	74	89	92	120	74	89	90	124	70	88	94	120	70	87	80	120	80	93	82	120	84	96	84	122	82	95	82	130	82	98	80	L1	L1	90	3	85
38	355878	M	26	40	5.2	I	110	70	83	90	100	60	73	92	90	60	70	90	92	60	71	94	90	60	70	94	110	70	83	90	124	70	88	82	124	70	88	70	130	80	97	80	L1	L1	90	3	85
39	353071	F	55	55	5.3	I	124	70	88	80	122	70	87	82	124	70	88	82	124	70	88	82	120	70	87	82	120	70	87	82	92	60	71	94	134	80	98	96	130	80	97	96	L1	L1	90	3	85
40	354916	M	75	60	5.9	I	130	80	97	90	124	70	88	88	122	70	87	80	120	70	87	80	124	70	88	80	124	70	88	80	120	70	87	80	120	70	87	82	110	74	86	80	L2	L1	75	3	65
41	357206	M	48	60	5.8	I	130	80	97	90	134	80	98	92	124	70	88	80	110	70	83	82	110	70	83	84	130	80	97	84	110	70	83	80	120	70	87	82	110	80	90	90	L1	L1	75	3	70
42	359166	M	45	62	5.6	I	124	80	95	80	122	80	94	82	120	70	87	84	110	70	83	92	110	70	83	90	110	60	77	88	110	70	83	82	132	80	97	82	130	82	98	90	L1	L1	75	3	70
43	355751	M	19	40	5.1	I	110	70	83	80	110	70	83	82	120	70	87	82	120	70	87	82	110	70	83	82	110	70	83	82	120	70	87	82	124	70	88	70	124	80	95	80	L1	L1	75	3	70
44	365600	M	65	70	5.8	I	130	80	97	90	130	80	97	92	124	70	88	92	120	70	87	90	124	70	88	88	110	70	83	80	120	80	93	80	120	80	93	90	124	80	95	80	L2	L1	65	3	75
45	351554	F	16	40	5	I	110	70	83	90	120	80	93	92	110	60	77	94	110	60	77	96	110	70	83	90	100	70	80	90	124	84	97	92	132	82	99	90	110	70	83	70	L1	L1	75	3	65
46	360421	M	40	60	5.7	I	130	80	97	80	124	70	88	82	120	70	87	84	124	80	95	80	120	80	93	82	129	70	90	80	129	70	90	80	130	80	97	92	130	82	98	94	L1	L1	80	3	75
47	356102	M	50	62	5.8	I	130	80	97	80	132	80	97	82	134	80	98	84	130	80	97	90	110	70	83	92	110	70	83	94	110	60	77	94	124	70	88	82	124	80	95	82	L1	L1	75	3	70
48	352208	M	26	38	5	II	110	70	83	82	122	82	95	88	126	72	90	96	116	70	85	90	116	70	85	90	116	70	85	90	116	70	85	90	120	80	93	90	130	80	97	96	L2	L1	80	3	75
49	334125	F	32	44	5.3	I	116	82	93	82	108	70	83	82	102	60	74	90	104	60	75	96	110	70	83	88	112	80	91	92	104	60	75	96	140	85	103	80	110	70	83	90	L1	L1	65	3	75
50	355901	M	52	66	5.9	I	130	82	98	80	130	82	98	90	134	80	98	98	134	80	98	94	130	80	97	96	130	80	97	96	134	80	98	94	130	80	97	82	130	80	97	96	L2	L1	90	3	85
51	364919	F	60	60	5.5	I	130	80	97	80	120	70	87	82	120	70	87	82	114	70	85	80	130	80	97	82	130	80	97	82	114	70	85	80	134	80	98	92	130	80	97	80	L1	L1	90	3	85
52	368023	M	65	72	5.6	I	130	80	97	96	132	80	97	82	120	80	93	90	124	80	95	84	100	60	73	84	124	70	88	82	130	80	97	82	122	80	94	82	130	80	97	96	L2	L1	65	3	75
53	353511	F	46	50	5.4	I	110	74	86	80	124	70	88	70	120	80	93	70	110	70	83	92	110	70	83	94	110	70	83	94	110	70	83	92	110	70	83	82	110	74	86	80	L1	L1	90	3	85
54	363694	F	36	55	5.4	I	124	80	95	80	120	80	93	90	120	80	93	82	108	72	84	90	110	60	77	84	132	80	97	82	108	72	84	90	130	80	97	92	124	80	95	80	L1	L1	65	3	75
55	353360	M	45	60	5.8	I	130	80	97	83	132	82	99	90	124	70	88	87	124	70	88	80	120	80	93	92	124	72	89	84	124	70	88	80	120	80	93	92	130	80	97	83	L1	L1	80	3	75
56	337292	F	59	60	5.6	I	132	80	97	90	130	80	97	92	128	72	91	80	124	80	95	82	120	80	93	82	120	80	93	82	124	80	95	82	124	70	88	82	132	80	97	90	L1	L1	65	3	75
57	370407	F	54	50	5.4	I	130	80	97	82	124	70	88	82	120	70	87	80	120	80	93	90	110	70	83	82	124	70	88	80	120	80	93	90	132	80	97	82	130	80	97	82	L1	L1	90	3	85
58	363932	M	36	55	5.2	I	124	80	95	80	120	80	93	90	120	70	87	82	124	84	97	92	108	72	84	90	108	72	84	90	124	84	97	92	122	82	95	88	124	80	95	80	L1	L1	75	3	70
59	348762	M	55	65	5.7	I	130	80	97	80	140	85	103	80	134	80	98	90	128	78	95	80	122	90	101	92	110	70	83	84	128	78	95	80	108	70	83	82	130	80	97	80	L2	L1	90	3	85
60	353080	M	62	60	5.8	I	132	80	97	80	130	80	97	82	128	80	96	82	127	70	89	82	120	70	87	82	114	70	85	82	127	70	89	82	130	82	98	90	132	80	97	80	L2	L1	65	3	75
61	357983	M	40	60	5.2	I	110	80	90	90	120	70	87	92	120	74	89	94	122	80	94	92	110	70	83	80	110	70	83	80	122	80	94	92	120	80	93	82	110	70	83	80	L1	L1	75	3	70
62	355902	F	52	60	5.5	I	130	82	98	90	134	80	98	98	130	80	97	90	126	72	90	96	122	80	94	90	90	60	70	90	100	60	73	98	110	70	83	82	110	70	83	80	L1	L1	80	3	75
63	355892	M	60	50	5.9	I	124	80	95	80	124	70	88	80	124	80	95	80	130	70	90	82	120	70	87	82	120	70	87	82	130	70	90	82	114	64	81	72	110	70	83	70	L1	L1	75	3	65
64	336812	M	52	50	5.7	I	124	80	95	80	130	80	97	90	124	75	91	82	124	70	88	90	124	88	100	88	110	70	83	92	124	70	88	90	124	70	88	82	110	70	83	80	L1	L1	75	3	70
65	361818	M	26	50	5.6	I	110	70	83	70	114	64	81	72	122	70	87	78	120	82	95	82	100	70	80	92	100	70	80	92	120	82	95	82	110	70	83	82	124	80	95	80	L1	L1	75	3	70
66	357206	F	32	52	5.4	I	130	82	98	94	110	70	83	70	110	70	83	80	120	80	93	85	110	70	83	80	124	70	88	80	120	80	93	85	120	70	87	92	110	70	83	90	L1	L1	90	3	85
67	373932	M	40	56	5.8	I	124	80	95	82	122	82	95	82	120	80	93	92	122	82	95	90	124	70	88	82	124	70	88	82	122	82	95	90	120	74	89	92	110	70	83	90	L1	L1	90	3	85

MASTER CHART

Serial Number	In Patient Number	Gender	Age (Years)	Weight (Kg)	Height (Feet)	ASA Grade	Observations at regular intervals (Time in minutes)																				Observations at regular intervals (Time in minutes)																Sensory block			Motor block	
							0				10				20				30				40				50				60				75				90								
							SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	HR (/Min)	15 minutes	20 minutes	Duration (Min)	20 min bromage	Duration (Min)
68	358772	F	42	58	5.2	I	130	80	97	96	124	70	88	70	120	80	93	82	126	72	90	96	110	70	83	82	110	70	83	100	126	72	90	96	100	60	73	92	110	70	83	90	L1	L1	75	3	70
69	337972	M	40	50	5.4	II	110	70	83	90	134	80	98	96	124	72	89	80	128	78	95	90	110	70	83	82	110	70	83	82	128	78	95	90	122	70	87	82	124	70	88	80	L1	L1	80	3	75
70	353362	F	38	55	5.3	I	130	80	97	96	120	70	87	82	120	70	87	82	114	70	85	80	120	80	93	82	120	80	93	82	114	70	85	80	124	70	88	88	130	80	97	90	L1	L1	80	3	75
71	368024	M	49	60	5.8	I	124	80	95	80	124	70	88	70	128	80	96	82	128	78	95	90	100	60	73	88	100	60	73	88	128	78	95	90	130	80	97	92	132	80	97	90	L1	L1	90	3	85
72	363461	F	52	56	5.4	I	130	80	97	80	134	80	98	98	124	78	93	82	120	80	93	85	110	70	83	80	110	70	83	80	120	80	93	85	132	80	97	82	140	85	103	80	L1	L1	75	3	65
73	354361	M	50	62	5.6	I	132	80	97	80	130	80	97	82	120	80	93	80	124	70	88	82	110	70	83	80	110	70	83	80	124	70	88	82	132	80	97	82	130	80	97	80	L1	L1	75	3	70
74	354512	M	60	66	5.8	I	124	80	95	80	124	70	88	70	124	72	89	80	120	80	93	84	124	88	100	88	124	88	100	88	120	80	93	84	124	70	88	82	130	80	97	80	L1	L1	75	3	70
75	358013	F	62	70	5.9	I	132	80	97	90	124	70	88	80	120	74	89	94	122	70	87	72	122	70	87	80	122	70	87	80	122	70	87	72	124	70	88	82	130	80	97	80	L1	L1	80	3	75
76	346271	M	56	62	5.8	I	116	82	93	82	108	70	83	82	102	60	74	90	104	60	75	96	110	70	83	88	112	80	91	92	104	60	75	96	110	74	86	82	110	70	83	80	L1	L1	80	3	75
77	324216	M	50	66	5.4	I	130	82	98	80	130	82	98	90	134	80	98	98	134	80	98	94	130	80	97	96	130	80	97	96	134	80	98	94	110	70	83	82	110	70	83	83	L2	L1	90	3	85
78	381619	F	48	52	5	I	130	80	97	80	120	70	87	82	120	70	87	82	114	70	85	80	130	80	97	82	130	80	97	82	114	70	85	80	130	82	98	90	130	80	97	80	L1	L1	90	3	85
79	351718	M	36	58	5.8	I	130	80	97	96	132	80	97	82	120	80	93	90	124	80	95	84	100	60	73	84	124	70	88	82	130	80	97	82	132	80	97	92	130	80	97	90	L2	L1	80	3	75
80	373344	F	32	50	5.2	I	110	74	86	80	124	70	88	70	120	80	93	70	110	70	83	92	110	70	83	94	110	70	83	94	110	70	83	92	110	70	83	70	110	70	83	82	L1	L1	90	3	85
81	381738	M	60	72	5.9	I	124	80	95	80	120	80	93	90	120	80	93	82	108	72	84	90	110	60	77	84	132	80	97	82	108	72	84	90	132	80	97	82	130	80	97	80	L1	L1	75	3	70
82	391920	M	58	66	5.1	I	130	80	97	83	132	82	99	90	124	70	88	87	124	70	88	80	120	80	93	92	124	72	89	84	124	70	88	80	120	80	93	90	124	80	95	80	L1	L1	75	3	70
83	368012	M	52	80	5.6	I	132	80	97	90	130	80	97	92	128	72	91	80	124	80	95	82	120	80	93	82	120	80	93	82	124	80	95	82	124	70	88	80	120	80	93	90	L1	L1	75	3	65
84	378134	F	50	60	5.2	I	130	80	97	82	124	70	88	82	120	70	87	80	120	80	93	90	110	70	83	82	124	70	88	80	120	80	93	90	100	60	73	76	110	70	83	70	L1	L1	90	3	85
85	355671	F	48	59	5.4	I	124	80	95	80	120	80	93	90	120	70	87	82	124	84	97	92	108	72	84	90	108	72	84	90	124	84	97	92	124	80	95	70	124	70	88	70	L1	L1	80	3	75
86	367182	M	62	72	5.8	II	130	80	97	80	140	85	103	80	134	80	98	90	128	78	95	80	122	90	101	92	110	70	83	84	128	78	95	80	130	84	99	82	130	80	97	80	L2	L1	90	3	85
87	375562	M	60	70	5.1	I	132	80	97	80	130	80	97	82	128	80	96	82	127	70	89	82	120	70	87	82	114	70	85	82	127	70	89	82	120	80	93	92	110	70	83	90	L2	L1	75	3	70
88	350052	M	52	82	5.6	I	111	70	84	80	110	70	83	82	124	72	89	80	124	72	89	82	110	70	83	82	110	70	83	82	124	72	89	82	110	70	83	92	120	80	93	90	L1	L1	75	3	70
89	354906	M	55	66	5.7	I	132	80	97	90	130	80	97	92	124	70	88	80	120	70	87	90	130	80	97	92	130	80	97	80	130	80	97	88	120	70	87	92	124	70	88	90	L1	L1	90	3	85
90	365002	F	38	60	5.3	I	140	85	103	80	132	80	97	82	130	80	97	82	128	86	100	74	133	81	98	76	127	80	96	78	128	82	97	74	110	70	83	82	111	70	84	80	L1	L1	90	3	85
91	365216	M	40	62	5.7	I	130	80	97	80	132	80	97	82	130	80	97	84	130	80	97	82	130	80	97	80	130	80	97	80	130	80	97	82	130	80	97	80	130	80	97	82	L1	L1	90	3	85
92	365521	M	28	52	5.9	I	130	80	97	80	124	70	88	82	122	70	87	80	124	70	88	80	120	70	87	80	120	70	87	80	124	70	88	80	130	80	97	82	120	80	93	82	L1	L1	75	3	70
93	335921	F	38	50	5.4	I	130	80	97	80	124	70	88	82	120	70	87	82	124	70	88	80	124	70	88	82	124	70	88	82	124	70	88	80	132	80	97	82	130	80	97	80	L1	L1	80	3	75
94	355522	M	52	66	5.9	I	110	70	83	80	110	74	86	82	124	80	95	82	110	70	83	82	110	70	83	82	110	70	83	82	110	70	83	82	120	80	93	80	124	80	95	80	L2	L1	75	3	65
95	353630	F	30	54	5.3	I	110	70	83	83	110	70	83	82	120	80	93	90	110	60	77	94	110	70	83	80	100	60	73	76	110	60	77	94	130	80	97	80	130	80	97	82	L1	L1	75	3	70
96	363061	M	58	70	5.8	I	130	80	97	80	130	82	98	90	134	80	98	92	134	80	98	94	130	80	97	96	130	80	97	96	134	80	98	94	124	80	95	62	120	90	100	60	L1	L1	75	3	70
97	330176	M	60	60	5.9	I	130	80	97	90	132	80	97	92	124	70	88	90	124	70	88	90	122	70	87	88	122	70	87	88	124	70	88	90	124	70	88	80	130	80	97	82	L1	L1	90	3	85
98	353601	M	70	54	5.7	II	110	70	83	82	110	70	83	70	100	60	73	72	100	70	80	74	100	60	73	80	124	80	95	82	124	80	95	80	110	74	86	90	110	70	83	80	L1	L1	90	3	85
99	367012	M	56	60	5.5	I	110	70	83	80	120	80	93	82	120	80	93	84	124	80	95	90	130	80	97	90	110	70	83	92	100	60	73	94	132	80	97	80	130	80	97	80	L1	L1	75	3	70
100	353261	M	44	68	5.8	I	110	70	83	80	110	70	83	82	120	70	87	84	120	80	93	84	120	80	93	84	110	70	83	90	110	70	83	90	124	70	88	82	120	70	87	80	L1	L1	75	3	65