A COMPARATIVE STUDY OF LOW DOSE INTRATHECAL BUPIVACAINE WITH EPIDURAL VOLUME EXPANSION AND CONVENTIONAL DOSE SPINAL ANAESTHESIA IN CAESAREAN SECTIONS.

Dissertation submitted to

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the award of the degree of

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IN

ANAESTHESIOLOGY

BRANCH X

DEPARTMENT OF ANAESTHESIOLOGY

THANJAVUR MEDICAL COLLEGE

THANJAVUR – 613004.

APRIL 2013

CERTIFICATE

This is to certify that this dissertation entitled **"A COMPARATIVE STUDY OF LOW DOSE INTRATHECAL BUPIVACAINE WITH EPIDURAL VOLUME EXPANSION AND CONVENTIONAL DOSE SPINAL ANAESTHESIA IN CAESAREAN SECTIONS"** is a bonafide record of the work done by Dr. BHAVYA K under my supervision and guidance in the Department of Anaesthesiology at Thanjavur medical college, Thanjavur during the period of her post graduate study from June 2010 to March 2013 for the partial fulfilment of M.D. (Branch X - Anaesthesiology) degree.

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DECLARATION

I, solemnly declare that the dissertation entitled **"A COMPARATIVE STUDY OF LOW DOSE INTRATHECAL BUPIVACAINE WITH EPIDURAL VOLUME EXPANSION AND CONVENTIONAL DOSE SPINAL ANAESTHESIA IN CAESAREAN SECTIONS"** is a bonafide work done by me at Thanjavur Medical College Hospital, Thanjavur, during 2010 – 2013.

This dissertation is submitted to **"The Tamilnadu Dr. M.G.R.**

Medical University, Chennai", Tamilnadu as a partial fulfillment for the requirement of **M.D** Degree examinations – Branch -X (Anaesthesiology) to be held in April 2013.

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"A COMPARITIVE STUDY OF LOW DOSE INTRATHECAL BUPIVACAINE WITH EPIDURAL VOLUME EXPANSION AND CONVENTIONAL DOSE SPINAL ANAESTHESIA IN CAESAREAN SECTIONS"** is a bonafide research work done by Dr. BHAVYA. K , Resident in Anaesthesiology, Thanjavur Medical College, Thanjavur, under my guidance in partial fulfilment of the requirement for the degree of M.D. ANAESTHESIOLOGY [2010-2013].

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CONTENTS

LIST OF ABBREVATIONS

ASA - American Society of Anaesthesiologist

Cm - Centi meter.

CNS - Central Nervous System.

COPD - Chronic Obstructive Pulmonary Disease.

CSF - Cerebro Spinal Fluid.

CSE - Combined Spinal Epidural.

CSEA - Combined Spinal Epidural Anaesthesia.

CPR - Cardio Pulmonary Resuscitation.

CVS - Cardio Vascular System.

CNS - Central Nervous System.

DST - Double Segment Technique.

EVE - Epidural Volume Expansion.

NTN - Needle Through Needle.

MAP - Mean Arterial Pressure.

mcg - Microgram.

mm - Milimeter.

mm /Hg - milimeter of mercury.

Kg - KiloGram.

SAB - Sub Arachnoid Block.

VAS - Visual Analogue Scale.

LIST OF FIGURES

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The Ethical Committee, Thanjavur Medical College has decided to inform that your Dissertation Topic is accepted and you are permitted to proceed with the above study.

Thanjavur

Date :

Secretary

Ethical Committee

"A COMPARATIVE STUDY OF LOW DOSE INTRATHECAL BUPIVACAINE WITH EPIDURAL VOLUME EXPANSION AND CONVENTIONAL DOSE SPINAL ANAESTHESIA IN CAESAREAN SECTIONS"

ABSTRACT:

BACKGROUND: Subarachnoid block (SAB) is a commonly used technique of regional anaesthesia in caesarean sections. Among the adverse effects associated with SAB, Hypotension and bradycardia which are encountered commonly can have fatal effect both on mother and fetus. So a search for an alternative technique is on for a long time. Epidural Volume Expansion(EVE) via a combined spinal epidural (CSE) technique is the enhancement of a small dose intrathecal block by epidural saline boluses.

AIM: To compare the Epidural Volume Expansion of low dose intrathecal Bupivacaine and conventional dose spinal anaesthesia in caesarean sections with respect to its sensory and motor block profile and hemodynamic stability in caesarean sections.

METHODOLGY: In this double blinded, randomised control, prospective study, sixty parturients undergoing caesarean sections under CSE anaesthesia were assigned randomly into two groups(n= 30) group S and group E. Group S received 9mg of 0.5% hyperbaric Bupivacaine with 10 mcg of Fentanyl. Group

E received 5 mg of 0.5% of hyperbaric Bupivacaine with 10 mcg of Fentanyl followed by EVE with 6 ml of saline within 3 minutes of subarachnoid injection. Patients pulse rate, Mean Arterial Pressure (MAP) was monitored every 2.5 minutes. Highest sensory and motor levels achieved, time required for achieving highest sensory and motor levels and block regression, any perioperative adverse effects were recorded.

RESULTS: The maximum sensory level achieved was similar in both the groups. The motor levels were significantly lower in group E. Block regression was significantly earlier in group E. MAP was maintained at higher levels in group E. The time for request of rescue analgesia was earlier in group E.

COCLUSION: In comparision to conventional dose spinal anaesthesia, EVE provides adequate intraoperative analgesia, faster blockade recovery and better hemodynamic stability in caesarean sections.

INTRODUCTION

“The delivery of the infant into the arms of a conscious and pain free mother is One of the most exciting and rewarding moments in medicine” says Moir.

An increasing number of parturients wish to be awake during caesarean section [1] and opt for regional rather than general anaesthesia. Subarachnoid block [SAB] is a time honoured simple regional technique which requires a small dose of intrathecal drug to provide surgical anaesthesia with rapid, intense and reliable neuraxial block. Since from 1901, when Kreis[2] described the first subarachnoid block for vaginal delivery, SAB for labor and delivery has progressed greatly. Though SAB is a commonly preferred conventional technique for caesarean sections, the incidence of spectrum of complications persists even today. Hypotension and bradycardia that are more common are of chief concern as they have an effect both on mother and the fetus.

Conventional dose[3] of drugs in SAB for caesarean sections often produce rapid onset of a dense block that causes significant hemodynamic instability and residual motor blockade, which usually lasts beyond the duration of surgery demanding prolonged post operative anaesthesia care.

This could also lead to maternal anxiety. Even it does not provide post operative analgesia for longer time.

A search for alternative anaesthetic techniques to overcome these problems is on for a long time. Epidural Volume Expansion(EVE) is a modification of conventional sequential Combined Spinal Epidural(CSE) technique, in which SAB is induced with intrathecal local anaesthetic with or without opioids to produce a block which can be extended with epidural top ups of local anaesthetics or saline. Most of the studies[5,6,7,8] available in the literature have evaluated this technique using a conventional dose of intrathecal drug and have demonstrated a higher level of blockade and better post operative pain relief in comparison to SAB alone.

There are only few studies[9,10] which have used low dose intrathecal drug for this technique and demonstrated a better hemodynamic stability with faster motor recovery. These findings open a newer avenue to ensure patient safety with minimal hemodynamic fluctuations and better post operative pain relief in obstetric anaesthesia.

Hence this study was taken up to compare the low dose intrathecal Bupivacaine with EVE technique and conventional dose single shot spinal anaesthesia in caesarean sections.

AIM OF THE STUDY

The Aim of this study is to compare low dose intrathecal Bupivacaine with Epidural Volume Expansion and conventional dose spinal anaesthesia in caesarean sections with respect to:

a. Sensory block profile

b. Motor block profile and

c. Hemodynamic stability.

ANATOMY

The spinal cord and its nerve roots are secured within the spinal canal or the vertebral column, a bony structure that extends from foramen magnum to sacral hiatus.

The vertebral column is comprised of individual pre sacral vertebrae and fused sacral and coccygeal vertebrae:

Pre Sacral vertebrae	- Cervical vertebrae - 7
	- Thoracic vertebrae - 12
	- Lumbar vertebrae - 5
Sacral vertebrae	- 5
Coccygeal vertebrae	- 4

The vertebral canal exhibits four curvatures:

Cervical and Lumbar concavity (lordosis)

Thoracic and Sacral convexity (kyphosis)

The thoracic convexity and lumbar lordosis are of importance in spread of local anaesthetic drug in spinal canal.

Anteriorly the vertebral bodies and intervertebral discs are connected and supported by the anterior and posterior longitudinal ligaments and

posteriorly, the posterior longitudinal ligaments, ligamentum flavum, interspinous ligamentum, supraspinous ligaments provide further stability.

The thickness of ligamentum flavum and its distance from skin varies in different regions. It is of clinical importance while performing neuraxial blockades.

Site	Skin to ligament (cm)	Thickness of Ligament (mm)
Cervical	_	1.5-3.0
Thoracic	_	3.0-5.0
Lumbar	3-8	5-6
Caudal	Variable	2-6

Spinal Cord:

The spinal cord is the direct continuation of the medulla oblongata. It begins at the upper border of the Atlas and terminates in the Conus medullaris. Within the vertebral column it is surrounded by its coverings (meninges), venous plexus and fatty tissue. In term newborn, it extends down to the lower border of L3. Later in adolescence the spinal cord attains its adult position, ending at the level of the intervertebral disk between L1 and L2 due to the differential growth rates between the bony vertebral canal and the spinal cord.

Surrounding the spinal cord in the spinal column are three membranes (from within to the periphery):

1. Piamater
2. Arachnoid mater and
3. Duramater.

The piamater is highly vascular that closely invests the spinal cord. The arachnoid mater is a neovascular membrane closely attached to the outermost duramater. Between the two membranes is the **subarachnoid space** which contains cerebrospinal fluid, spinal nerve roots, blood vessels that supply the spinal cord and the denticulate ligaments. The subarachnoid space continues distally upto S2.

The duramatar, outermost membrane in the spinal canal is a longitudinally organized fibroelastic membrane. This layer is the direct extension of the cranial duramater and extends down from the foramen magnum to S2, where the filum terminale (an extension of the piamater beginning at the conus medullaris) blends with the periosteum of the subdural space which contains only small amounts of serous fluids to allow the dura and arachnoid move over each other.

Surrounding the duramater is the **epidural space** which extends from the foramen magnum to the sacral hiatus. It is bounded cranially by foramen magnum, caudally by the sacrococcygeal ligament, anteriorly by the

posterior longitudinal ligament, laterally by vertebral pedicles of the vertebrae and posteriorly by ligamentum flavum and vertebral lamina. It communicates with paravertebral space through intervetebral foramina.

The depth of epidural space varies at different levels: maximal about 6 mm at L2, 4-5 mm in the midthoracic region and roughly 3 mm where the lumbar and cervical enlargements of the spinal canal encroach on it.

SPINAL ANAESTHESIA

Spinal anaesthesia (subarachnoid block or intrathecal block) is the most frequently used method of regional anaesthesia. It is a form of central neuraxial block which involves the use of small amounts of local anaesthetics with or without adjuvant solutions injected into the subarachnoid space to produce a reversible loss of sensation and motor function.

History of spinal anaesthesia dates back to 1891 when Essex Wynter in 1891[14] described dural puncture. **Augustus Karl Gustav Bier**, a German surgeon, used cocaine intrathecally for lower extremity surgery in 1898[15].

ADVANTAGES OF SPINAL ANAESTHESIA:

1. Easy to perform.
2. Provides excellent operating conditions.
3. Economical than general anaesthesia.
4. Maintenance of patent airway.
5. Lesser pulmonary complications compared to general anaesthesia.
6. Decreased incidence of deep vein thrombosis and pulmonary emboli.

DISADVANTAGES OF SPINAL ANAESTHESIA:

1. Risk of failure.
2. Alteration in the patient's hemodynamics.
3. Shorter duration of post operative pain relief.

PHYSIOLOGY OF SUBARACHNOID BLOCK:

CEREBROSPINAL FLUID:

The cerebrospinal fluid is an ultra filtrate of blood plasma. It is secreted by the choroidal plexus at a rate of 0.3-0.4ml/minute. It is clear, colourless, fluid present in the spinal and cranial subarachnoid spaces and in the ventricles of the brain. In adults average volume ranges from 120-150ml. This fluid is distributed in ventricles (35 ml), cerebral subarachnoid space (25 ml) and spinal subarachnoid space (75ml).

Physical characteristics of CSF:

P_H	7.4
Specific gravity (Body temperature) (At 4^0 C)	1.007 1.0003
Density	1.0003g/ml
Baricity	1.000
Pressure in supine position	8-12mm Hg
Cells	3-5/cu.mm
Proteins	20 mg/dl
Glucose	45-80 mg/dl

Mechanism of Action of intrathecal local anaesthetics:

Local anaesthetics administered in the subarachnoid space block sensory, motor and autonomic impulses as nerve roots pass through the CSF. The site of action includes the spinal nerve roots and dorsal root ganglion. Local anaesthetics block the sodium channels and propagation of action potential along the nerve root.

Uptake & Elimination of Spinal Anaesthetics:

Factors that affect the uptake of local anaesthetics in the subarachnoid space:

1. Concentration of local anaesthetic.
2. Surface area of nerve tissue exposed.
3. Lipid content of the neuronal tissue.
4. Blood flow to the tissue.

Concentration of local anaesthetic is highest at the site of injection. Spinal nerve roots lack an epineurium and are easily blocked. As the local anaesthetic diffuses away from the initial site of injection, its concentration decreases secondary to absorption into neural tissue and dilution by the CSF. Spinal cord tissue absorbs local anesthetics through the pia mater and

the spaces of Virchow-Robin, which are extensions of the subarachnoid space. However, the site of action is not the spinal cord, but the spinal nerves and dorsal root ganglia.

Elimination occurs through vascular absorption in the subarachnoid and epidural space. The rate of absorption is proportional to the vascular surface area that the local anaesthetic comes into contact with. Lipid solubility of the local anaesthetic solution increases the uptake into the tissue, further diluting the concentration. Local anaesthetics also diffuse into the epidural space along a concentration gradient. Once in the epidural space, diffusion into the epidural vasculature occurs.

Zones of differential blockade:

In SAB, sympathetic blockade level is usually two to three segments higher than sensory level. Sympathetic block is intense when more concentrated solutions are used. The motor block attained is two segments lower than the sensory block.

Order of nerve blockade:

- Autonomic preganglionic beta fibres.
- Temperature fibres.
- Fibers conveying pinprick.
- Fibers conveying pain greater than pin prick.

- Touch fibers.
- Deep pressure fibers.
- Somatic motor fibers.
- Fibers conveying vibratory sense and proprioceptic impulses.

During recovery, return of sensations in the reverse order was assumed, but recent concepts suggest that sympathetic activity returns before senation.

INDICATIONS:

1. Lower abdominal surgery.
2. Lower limb surgery.
3. Perineal and rectal surgery.
4. Urological surgery.
5. Obstetric and gynaecological surgery.

CONTRA INDICATIONS:

Absolute:
1. Patient refusal
2. Infection at the site of injection
3. Coagulopathy
4. Hypovolemia.
5. Indeterminate neurologic disease.
6. Raised intracranial pressure.

Relative: 1. Infection distinct from the site of injection.

2. Unknown duration of surgery.

FACTORS AFFECTING THE SPREAD OF LOCAL ANAESTHETIC:

Properties of local anaesthetic solution:

1. Baricity of the drug
2. Volume of the drug
3. Specific Gravity of the drug
4. Dose of the drug

Patient characteristics:

1. Position during and after injection.
2. Height (extremely tall or short)
3. Anatomy of the spinal column.
4. Decreased volume of CSF eg: pregnancy, obesity.

Factors related to technique:

1. Site of injection.
2. Needle bevel direction.

COMPLICATIONS OF SUB ARACHNOID BLOCK:

Immediate: 1**.** Hypotension

2. Bradycardia

3. Local anaesthetic toxicity due to intravascular injection.

4. High spinal block.

5. Total spinal block.

Delayed: 1. Post Dural Puncture Headache

2. Meningitis

3. Arachnoiditis

4. Anterior spinal artery syndrome.

5. Cauda equina syndrome.

6. Permanent neurologic injury.

COMBINED SPINAL EPIDURAL ANAESTHESIA

According to **Steven and Edward** the combination of two different anaesthesia administration routes on the same patient improves effectiveness and reduces side effect. The age-old single shot spinal anaesthesia provides fast and reliable segmental anaesthesia with very minimal risk for toxicity, while epidural anaesthesia provides perioperative anaesthesia followed by excellent analgesia in the postoperative period also.

These two excellent techniques were combined for the first time in 1937 by Dr A. **Soresi,** an Italian surgeon who injected drugs in the subarachnoid and epidural space at the same time [16]. The procedure was described by Dr Soresi, as "Episubdural Anaesthesia" and involved use of the same fine needle for both the epidural and the spinal injection. **Dr. I Curelaru [17]** performed the first combined spinal anaesthesia and catheter-based epidural anaesthesia in 1979 and published a study on it . He used Double Segment Technique (DST) for the study. This technique attracted a huge response only after **Dr. Brownridge**[18] used this technique for elective caesarean sections successfully.

Later in 1982 **Coates [19]** and **Mumtaz et al**[20]described a technical innovation, introducing the "needle through needle" technique in lower limb

surgery. This novel technique was used for caesarean sections in 1984 by **Carrie and O'Sullivan[21].**

CLINICAL USES OF CSE:

CSE anaesthesia though was described originally for urologic surgery, indications for its use have expanded in last decade. CSE is now widely used in obstetrics (for labor analgesia and for caesarean sections), orthopaedic surgery, abdominal, .gynaecologic and vascular surgery.

They are indicated in:

SURGERY TYPE	PROCEDURES
Obstetrics	Labour analgesia, Caesarean section
Abdominal surgery	Colorectal, renal transplant
Vascular surgery	Infrarenal abdominal aortic aneurysm repair
Gynaecology	Hysterectomy
Orthopaedics	Hip and knee surgery
Urology	Prostatectomy, cystectomy

TECHNIQUES OF CSEA:

1. Needle through Needle Technique (NTN Technique):

Though Soresi described first "spinal-needle-through-epidural needle" technique by introducing the same needle into both the spaces, present day needle through needle techniques use separate spinal and epidural needles.

After the epidural space is identified using an epidural needle, the epidural needle serves as introducer to the spinal needle, which is advanced through the epidural needle, beyond its tip, to punctures the dura. Drugs are first injected into the spinal space, and then the epidural catheter is inserted. Needle through Needle technique is the widely used CSE technique. Different types of this technique are also described.

1. A conventional Touhy needle can be used to identify the epidural space and a spinal needle which is longer than the usual needles, can be inserted through it to puncture the duramater.

2. Specially designed epidural needles with a "Backeye" at the needle tip are also available and commonly used. This design allows smooth advancement of the spinal needle, without friction between the epidural catheter and the spinal needle, reduces the risk of epidural catheter migration through the holes created by the spinal needle .Eg: Huber Needle.

3. Double lumen needles in which a Touhy needle is equipped with a parallel tube that acts as a guide for a thinner spinal needle are available recently. They are of two types -bent parallel tube and a straight parallel tube. Eg: Eldor needle

2. Separate Needle Technique (SNT):

CSE may be performed using separate needles also. In this technique, the two components of CSE -spinal and epidural injection are performed by using separate needles, in the same or at different inter-vertebral spaces (cook 2000[22]).

Comparison of Needle through needle and Separate Needle Technique:

The SNT technique has some theoretical advantages over the NTN technique.

1. It enables placement of the epidural catheter prior to initiation of the spinal block. Thus theoretically reducing the risk for neurologic injury, since paresthesia and other symptoms are not masked.

2. If hyperbaric solutions are used for subarachnoid injection in NTN technique, delayed catheter placement (technical problems) can result in fixation of the drug in the lower spaces.

3. Few studies have reported better success and lower failure rates with the SNT. However, these studies also report greater patient acceptance and less discomfort with the NTN technique.

4. The complication associated with NTN technique of metallic particles entering subarachnoid space is avoided with SNT technique

Pharmacological consideration:

CSE anaesthesia is an effective way to reduce drug doses required for anaesthesia or analgesia as the subarachnoid injection achieves rapid onset with minimal doses of local anaesthetics and opioids, which is further extended by epidural medication or saline.

CSE anaesthesia usually produces a more extensive block than expected, and the epidural dose needed to extend the block is often lower compared to doses needed with epidural anaesthesia alone .This observation was explained by two possible explanations .

1. There is alleviation of sub atmospheric pressure by the Tuohy needle before injection of the local anaesthetics and can reduce the volume of the subarachnoid space in the dural sac and extend the level of anaesthesia[23]

2. Diffusion of local anaesthetic molecules from the epidural to the subarachnoid space through the hole in the duramatar due to dural sac compression after injection of local anaesthetic in the epidural space following dural puncture.[4]

Requirement of Bupivacaine for CSE for caesarean section is 7.5-15 mg combined with opioids. Recommended opioid doses are Fentanyl 10-25 mcg and morphine 100-200mcg. Epidural top-ups of Bupivacaine or

Levobupivacaine 0.25 to 0.5% 10-40 mg with Fentanyl 25mcg or Sufentanil 2.5-5mcg is recommended. With this doses adequate anaesthesia with slower onset of maternal hypotension and lesser incidence of adverse effects are documented.

Advantages of CSE in Comparison With Conventional Epidural Or Subarachnoid Anaesthesia:

1. When CSE block was compared with either epidural or subarachnoid block, it was found to be superior to epidural anaesthesia .Motor blockade was denser in CSE anaesthesia.
2. Surgical anaesthesia is rapidly established, 15–20 min earlier compared with epidural anaesthesia.
3. The epidural catheter provides the possibility of supplementing insufficient subarachnoid anaesthesia.
4. CSE enables low-dose spinal anaesthesia for caesarean delivery. The presence of an epidural catheter as a “safety net” allows the anesthesiologist to use the lowest effective dose of local anaesthetic

Epidural volume extension (EVE) is a modified sequential CSE where enhancement of a small-dose intrathecal block by epidural saline injection has been demonstrated via a CSE technique.

CSE in special population:

1. Patients with significant cardiac or pulmonary disease:

CSE anaesthesia alone, without general anesthesia, can be a good anaesthetic option in patients with severe chronic obstructive pulmonary disease (COPD). The safety of low-dose sequential CSE analgesia in women with unrepaired cyanotic heart disease who required analgesia for labor has recently been reported [24]

2. CSE anaesthesia in the elderly:

Several studies have investigated the use of CSE anaesthesia in geriatric patients. Few concluded that compared to spinal or epidural anaesthesia alone, CSE anaesthesia was preferred, providing rapid onset, reliable spinal block and high quality intraoperative and postoperative analgesia.

It was noted that in elderly patients (mean age 75.8 years) CSE anaesthesia provides sufficient anaesthesia with fewer complications than spinal anaesthesia.

3. CSE anaesthesia in Obstetrics:

CSE was introduced in obstetrics as an attempt to reduce the adverse effects of traditional epidural techniques like prolonged labor, increased

need for oxytocin augmentation, and increased incidence of instrumental delivery. CSE is currently very popular in obstetric anaesthesia and analgesia [25]. It is believed to improve maternal mobility during labor and compared to traditional epidural analgesia, provide more rapid onset of analgesia and better maternal satisfaction. In addition, CSE also allows prolongation of epidural analgesia or conversion to CSE.

In addition, CSE can be a good option in pregnant women with many serious medical conditions: Reports of successful use of CSE anaesthesia or analgesia in patients with myasthenia gravis, idiopathic hypertrophic sub-aortic stenosis, mitral stenosis, dilated cardiomyopathy, Guillain-Barre syndrome, Laron syndrome, tetralogy of Fallot, Liddle's syndrome, Wegener's granulomatosis with subglottic stenosis have been reported.

4. CSE anaesthesia in paediatrics:

A study showed that CSE anesthesia could be considered as an effective anesthetic and analgesic technique for elective major upper abdominal surgery in awake or sedated neonates and infants [26].

COMPLICATIONS AND CONCERNS OF CSE TECHNIQUE:

1. Spinal component failure.
2. Spinal migration of catheter or sub arachnoid administration of epidural drugs

3. Neurological trauma

    - Needle trauma
    - Metal toxicity
    - Infection

4. Hypotension

5. Post Dural Puncture Headache.

EPIDURAL VOLUME EXPANSION

Epidural Volume Expansion or extension(EVE) is a modification of the conventional Combined Spinal Anaesthesia where subarachnoid block is induced with a small-dose intrathecal local anaesthetic with or without opioid to produce a limited block, which can be extended or expanded with epidural top-ups of local anaesthetic or saline.

It is well recognised that any alterations in the contents of the spinal canal influences the spread of local anaesthetics. Since the compliance within the spinal canal is dependent on the balance between CSF volume and blood volume the injection of local anaesthetic or normal saline into the epidural space will produce initial shift of these components.

During conventional CSE anaesthesia, injecting local anaesthetic into the epidural space after spinal anaesthesia reportedly speeds the onset and raise of the subarachnoid block. Blumgart et al [4] through their study demonstrated that the mechanism of this extension is larlely a “Volume effect” than the “local anaesthetic effect” as such. Later normal saline was used to produce this same volume effect .Tetsuo Takiguchi et al [7] evaluated the effect of epidural saline on the block profile during CSE anaesthesia clinically and also myelographically. They demonstrated radio graphically that the level of the contrast in the subarachnoid space increased with sequential injection of normal saline into the epidural space. Maximal

extension was seen during the first injection. The diameter of the subarachnoid space was found to diminish with saline injection. The diameter decreased to 40% after the first epidural injection of saline and to 25% after the second injection. This *'volume effect'* produced by the epidurally administered normal saline compresses the subarachnoid space resulting in '*squeezing'* of cerebrospinal fluid and more extensive spread of spinal local anaesthetic.

This volume effect appears to be time-dependent. Beyond 30 minutes or after two-segment regression, epidural top-up of saline would have no effect on block extension and may even accelerate regression of the spinal anaesthetic.

Epidural Volume Expansion has ceiling effect. A ceiling effect was demonstrated after 15 ml of saline injection[10].

Advantages of epidural volume expansion:

1. Early onset of the block
2. Higher level of sensory blockade [8,9]
3. Reducing in local anaesthetic dose [9]
4. Faster motor recovery[9]

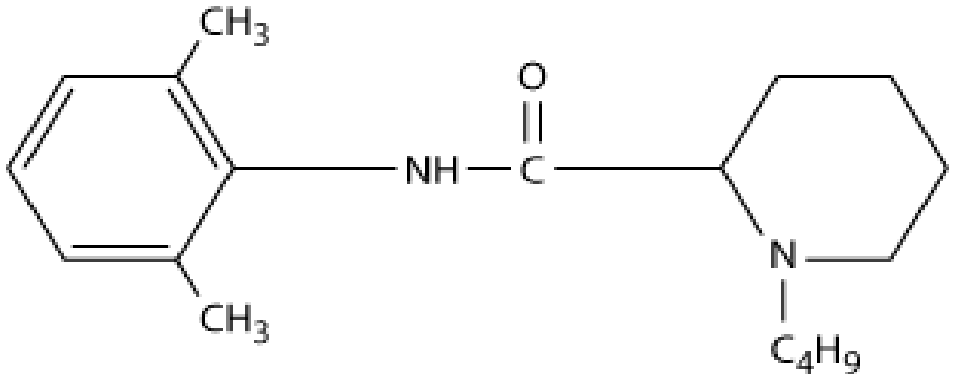
They have similar disadvantages as for Combined Spinal Anaesthesia.

PHARMACOLOGY OF BUPIVACAINE

BUPIVACAINE:

Bupivacaine is an amino amide local anaesthetic characterised as pipecoloxylidides. **Eoaf Ekentem** and his colleagues of Sweden synthesized it in 1957, later in 1963, **L . J. Telivuo used** it clinically for the first time.

Bupivacaine is (RS)-1-butyl-N-(2, 6-dimethylphenyl) Piperidine-2-Carboxamide monochloride monohydrate. Addition of butyl group to the piperidine nitrogen of Mepivacaine results in Bupivacaine. It is a chiral drug because of the presence of asymmetric carbon atom and is available as a racemic mixture. It has the following structural formula:



BUPIVACAINE

It is a very stable compound with a molecular mass of 288.43g/mol.

Preparations available:

Ampoule-0.5% Bupivacaine Hydrochloride, 4cc with dextrose.

-0.5% Bupivacaine Hydrochloride 20cc isobaric.

Vials-0.25% and 0.5% Bupivacaine hydrochloride 20 cc.

USES:

1. Infiltration Anaesthesia
2. Peripheral nerve blocks
3. Sub Arachnoid Anaesthesia
4. Epidural Anaesthesia
5. Caudal Anaesthesia

Pharmacological Properties:

P_{Ka}	:	8.1
Protien binding	:	95%
Lipid Solubility	:	28 %
Volume of distribution	:	73 liters
Onset time	:	5-7 min
Clearance of Drug from plasma:		0.147 lit/min
Elimination Half life	:	3.5 hours (adults)
		8.1 hours (neonates)

PHARMACODYNAMICS:

Bupivacaine binds to the ion selective sodium channels in nerve membrane and blocks sodium influx into nerve cells, which prevents depolarisation. Since pain transmitting fibers are unmyelinated or lighty myelinated, it can diffuse easily into them then the heavily myelinated nerve fibers like touch, proprioception etc. It also blocks Potassium channels which contribute to membrane potential depolarisation.

The order of loss of nerve function is as follows:

Pain> Temperature> Touch > Proprioception>Skeletal muscle tone.

It causes a decrease in cardiac output, by decreasing the sympathetic tone, heart rate and also venous return.

It also increases gastro intestinal tract motility.

PHARMACOKINETICS:

Bupivacaine is a weak base with only 15% of drug existing in non ionised form at physiological P_H.

Absorption:

The systemic absorption of bupivacaine is dependent on various factors like, the total dose and concentration of the drug, the route of administration, the vascularity of the administration site, and the presence or

absence of epinephrine in the anaesthetic solution. Because of its high lipid solubility it easily enters nerve and vascular tissue penetration.80-85 % of absorbed bupivacaine enters plasma.

It also crosses the placenta by passive diffusion. But due to its high protein binding capacity of 95%, it has a low fetal/maternal ratio (0.2 to 0.4).

After caudal, epidural, or peripheral nerve block its peak levels in the blood reached in 30 to 45 minutes.

Distribution:

Bupivacaine has 2 phases of distribution:

Rapid distribution Phase (Alpha): Initial distribution of drug to highly vascular regions. Half time is around 2.7 minutes.

Slow disappearance Phase (Beta): Drugs redistributes and slowly equilibrates into less vascular tissues. Half time is around 28 minutes

Metabolism

Bupivacaine undergoes aromatic hydroxylation, N–dealkylation, amide hydrolysis and conjugation. The major metabolite of bupivacaine is 2,6-pipecoloxylidine, which is mainly catalyzed via cytochrome P450 3A4. $Alpha_1$ acid Glycoprotien is its important binding site. After epidural or

intrathecal injection only N- dealkylated metabolite N-desbuylbupivacaine was measured in blood or urine.

Elimination:

The total urinary excretion of Bupivacaine and its metabolites is >40% of the total anaesthetic dose. Poor water solubility of unchanged drug limits its renal excretion. Only 6% of bupivacaine is excreted unchanged in urine.

Bupivacaine in pregnancy:

Bupivacaine Hydrochloride is contraindicated for obstetrical paracervical block. Local anaesthetics rapidly cross the placenta.When used for epidural, caudal, or pudendal block, can cause varying degrees of maternal, fetal, and neonatal toxicity. Adverse reactions in the mother, fetus, and neonate involve alterations of the peripheral vascular tone, central nervous system and cardiac function. Maternal hypotension has resulted from regional anaesthesia. Local anaesthetics produce vasodilatation by blocking sympathetic nerves.

ADVERSE EFFECTS:

The principal side effects are due to excess plasma concentration of unbound drug, more likely due to inadvertent intravenous injection .Systemic exposure to excessive quantities of Bupivacaine mainly

result in central nervous system (CNS) and cardiovascular effects. Plasma concentration greater than 1.5 microgram/ml is associated with toxic effects. Safe therapeutic dose is less than 3 mg/kg body weight.

1. Central Nervous System toxicity:

CNS effects usually occur at lower blood plasma. Plasma concentration of 4.5-5.5 mcg/ml is associated with seizures. CNS effects may include initial CNS excitation characterised by nervousness, numbness around mouth, tinnitus, tremor, blurring of vision, seizures followed by depression causing drowsiness, loss of consciousness and respiratory depression.

2. Cardio vascular System toxicity:

Cardiovascular effects are mainly hypotension, bradycardia, dysrrhythmias, and/or cardiac arrest .The rate of recovery of bupivacaine induced atrio ventricular blocks is slower than that due to other local anaesthetics.

Management of Local Anaesthetic toxicity Emergencies:

The first consideration is prevention, best accomplished by careful monitoring of vital signs and the patient's state of consciousness after each local anaesthetic injection.

1. Establishment and maintenance of a patent airway and effective assisted or controlled ventilation with 100% oxygen.

2. If necessary, use drugs to control the convulsions. A 50 mg to 100 mg bolus intravenous injection of Succinylcholine will paralyze the patient. 5 to10 mg of diazepam or 50 to 100 mg of thiopental can also be used.

3. The adequacy of the circulation should be evaluated. Intravenous fluids, a vasopressor dictated by the clinical situation (such as ephedrine or epinephrine to enhance myocardial contractile force) should be used. The supine position in pregnant women at term causes aortocaval compression by the gravid uterus. During treatment of systemic toxicity, maternal hypotension or fetal bradycardia following regional block, the parturient should be maintained in the left lateral position if possible, or manual displacement of the uterus off the great vessels be accomplished.

4. Start early CPR if cardiac arrest is noticed.

5. Intravenous Lipid emulsion: 20% lipid emulsion 1.5ml/kg rapidly followed by 0.25ml/kg/min for the next 10 minutes.

PHARMACOLOGY OF FENTANYL

Fentanyl is a potent, synthetic narcotic analgesic with a rapid onset and short duration of action. It is a strong agonist at the μ-opioid receptors. It is phenylpipeidine opioid of the 4-anilopiperidine series which is structurally related to Pethidine. Fentanyl was first synthesized by **Paul Janssen** in 1960.

Commercially it is formulated as a citrate, available as an aqueous solution. Each ml contains a base of 50 mcg of Fentanyl.

Pharmacological properties:

Molecular weight	528.29
pKa	8.4
% of unionised drug at Ph 7.4	8.5%
Octanol/water partition coefficient	816
Protien binding	80-85%
Potency	80 times than Morphine

PHARMACODYNAMICS:

Analgesia:

Fentanyl acts on the mu receptors in the brain and spinal cord to produce an analgesic effect which is 80 times higher than that of Morphine. Intravenously administered Fentanyl provides effective analgesia at plasma concentrations of 0.6-3 ng/ml.

Cardiovascular System:

Fentanyl like other opioids (except Pethidine) causes bradycardia, which responds to intravenous Atropine. Peripheral vasodilatation is less compared to Morphine due to absence of histamine release.

Respiratory System:

Fentanyl causes dose dependent respiratory depression by its depressant effect on the medullary respiratory centre. Plasma concentration of 0.2ng/ml is usually associated with respiratory depression. It is reversed by intravenous Nalaxone administration.

Central Nervous System:

It causes less sedation than equivalent dose of Morphine. Reduction in cerebral blood flow and cerebral metabolic requirement of O2 was found

to be decreased after intravenous doses of 10mcg/kg. Muscle rigidity might be reflection of catatonic state, pharmacological properties of opioids, due to enhancement of Dopamine biosynthesis in the caudate nucleus.

Gastrointestinal Tract:

Gastric mobility decreases on Fentanyl administration. Nausea vomiting is due to increased intrabiliary pressure. Vomiting is also mediated by stimulation of the chemoreceptor trigger zone in the area postrema.

Genito urinary system:

Like other opioids Fentanyl causes relaxation of the detrusor muscle and thus increases the urethral sphincter tone leading to urinary retention. This effect is more common seen during central neuraxial administration.

PHARMACOKINETICS:

Fentanyl is highly lipophilic, producing a rapid onset of action and relatively short duration of action. After intravenous administration, it is rapidly distributed to highly perfused organs like brain. Peak action is seen within 5 minutes. Later it gets redistributed into inactive tissues.

Pharmacokinetic profile:

Volume of distribution	335 liters
Clearance	1530 ml/min
Effect site equilibration time	6.8min
Hepatic extraction ratio	0.8
context sensitive half time	260 minutes
Elimination half time	3.1-6.6 hours

Metabolism:

Fentanyl is biotransformed in the liver to inactive metabolites, primarily Norfentanyl and other hydroxylation products. Only 4-7% is excreted unchanged in urine. The clearance of Fentanyl is limited by hepatic blood flow.

INTRATHECAL FENTANYL:

Intrathecal route of administration of Fentanyl is an established route for intra and post operative analgesia.

Fentanyl has the same baricity as CSF at room temperature. Addition to hyperbaric Lignocaine or Bupivacaine makes the solution hyperbaric. On intrathecal injection, Fentanyl mixes with CSF and attaches itself to opioid receptors in the spinal cord. Protein binding of drug in CSF is negligible and the concentration of opioid in CSF is only free drug

concentration. Once in the CSF, Fentanyl spreads rostrally. Because of the high affinity of Fentanyl with binding sites in the lipid rich spinal cord, only 10% of the administered dose reaches cervical region.

Diffusion into spinal cord and absorption into the blood removes it from the CSF since CSF dynamics does not provide any means of drug removal.

Advantages of Fentanyl as an adjuvant in neuraxial blocks:

Intrathecal Fentanyl is used as an adjuvant to local anaesthetics for perioperative anaesthesia and analgesia. Fentanyl administered intrathecally provides more intense blockade, at a lower dose requirement as compared to epidural or intravenous routes.

SIDE EFFECTS OF INTRATHECAL OPIOIDS:

1. Pruritis.
2. Nausea and vomiting.
3. Urinary retention.
4. Depression of ventilation.
5. Sedation.
6. CNS excitation.
7. Neonatal morbidity.
8. Gastrointestinal dysfunction.

9. Water retention.

10. Thermoregulatory dysfunction.

Side effects are relatively minor with fentanyl. A 30% incidence of urinary retention, respiratory depression, varying degree of prurtis and occasional episodes of nausea have been documented.

Other modes of administration are intramuscular, intravenous, transdermal, transmucosal, intranasal and transpulmonary routes.

ASSESSMENT OF PAIN

Reliable quantification of pain severity is important to assess the analgesic effect of a drug or any therapeutic interventions. Since pain is a subjective experience that is influenced by many factors like psychological, cultural variables, it is difficult to assess the intensity of pain. There are many scales available for assessing pain. Commonly used are:

1. Visual Analogue Scale (VAS).

2. Numerical rating scale.

3 .Faces rating scale.

4. McGill Pain Questionnaire (MPQ).

The VAS is an efficient, simple and minimally intrusive method which gives subjective measure of pain[27] . It consists of a 10cm line with two end-points indicating 'no pain' and 'worst pain imaginable'.

NO PAIN 100mm WORST PAIN

VISUAL ANALOGUE SCALE

Patients are asked to rate their pain by marking on the line corresponding to their current level of pain. The distance along the line from the ‘no pain’ marker is then measured with a ruler giving a pain score out of 10.

ADVANTAGES OF VAS:

1. Simple and easy to use.
2. Valid in a wide range of settings.
3. Versatile.
4. Straightforward to interpret

ASSESSMENT OF MOTOR BLOCK

Assessment of motor blockade is an integral part of any anaesthetic procedure. During neuraxial blockades assessing the motor blockade of lower limbs provide information about the intensity of the block. The commonest method used for assessing the motor blockade is Bromage score.

Bromage score[28]:

Grade	Criteria	Degree of block
I	Free movement of legs and feet	Nil (0%)
II	Just able to flex knees with free movement of feet	Partial (33%)
III	Unable to flex knees, but with free movement of feet	Almost complete (66%)
IV	Unable to move legs or feet	Complete (100%)

Many modifications of Bromage scoring have been described.

GRADE	DEFINITION
0	No motor block
1	Inability to raise extended leg; able to move knees and feet
2	Inability to raise extended leg and move knee; able to move feet
3	Complete block of motor limb

Another modification of Bromage score by Breen et al, which is also used commonly.

Modified Bromage score as used by Breen et al[29]

Score	Criteria
1	Complete block (unable to move feet or knees)
2	Almost complete block (able to move feet only)
3	Partial block (just able to move knees)
4	Detectable weakness of hip flexion while supine (full flexion of knees)
5	No detectable weakness of hip flexion while supine
6	Able to perform partial knee bend

REVIEW OF LITERATURE

1**. C.H. Blumgart et al[4] (1992)** examined the effect of epidural injection of 0.5% bupivacaine or normal saline on the progression of subarachnoid block in 28 pregnant patients undergoing caesarean section. Sub arachnoid block was established in all patients. Nine patients received 10 ml of epidural saline, another nine recieved 10 ml of 0.5% Bupivacaine and control group did not receive EVE following intrathecal injection. Sensory levels were recorded every 5 minutes. The blockade level was found to be higher and faster in patients who received EVE than the control group. Incidence of adverse effects was similar in all 3 groups.

They stated that the mechanism of extension of subarachnoid block by Epidural injection of local anaesthetic was largely a volume effect, and SAB may be extended as effectively with extradural injection of normal saline as with Bupivacaine. And they questioned if subarachnoid block be extended when saline was injected after 20 minutes of intrathecal injection**.**

2.**Mardirosoff et al[5] (1998),** conducted a study to evaluate the time dependency of the volume effect and the local anaesthetic effect on the spinal block extension. They performed there study in two

parts. 30 patients were randomized in each study. CSE anaesthesia was performed in sitting position in all groups. The patients in the first study received 15 mg of hyperbaric 0.5% Bupivacaine into the intrathecal space and were placed supine 2 minutes after spinal injection. They received 10 ml epidural saline either 5 minutes (group A) after or 20 minutes(group B) after intrathecal injection .These two groups were compared to a control group (group C), which did not receive any top ups. The patients in the second study received 12.5 mg of hyperbaric bupivacaine into intrathecal space and were placed supine after 5 minutes. After 7 minutes of intrathecal injection they received either10 mL saline (group D) or 10 ml Bupivacaine (group E) or nothing (group F). After analysis, in the first portion of their study in group A, the maximum sensory block levels were significantly higher ($P < .05$) as compared to groups B and C. In the second portion of the study, sensory block levels were comparable at all times in all the three groups.

In Conclusion they stated that during CSE technique with the use of hyperbaric bupivacaine, the volume effect was time dependent and seen when epidural top up was done soon after spinal injection. This effect was abolished if patients are left seated for more than 5 minutes following intrathecal injection.

3. Walter J. Trautman et al[6] (1997) conducted a study to test the efficacy of normal saline as an epidural top up to prolong the SAB during CSE anaesthesia after two segment regression. Eight volunteers received three separate CSEAs with 50 mg of intrathecal Lignocaine. After two segment regression, each of the volunteer received either 10 ml saline, 10 ml 1.5% Lignocaine, or 0.5 ml saline (control sham). Sensory block was assessed by pinprick and tolerance to Transcutaneous Electrical Stimulation (TES). Motor strength was assessed with isometric force dynamometry.

They observed that epidural lignocaine prolonged the sensory block by an average of 28 minutes compared with saline and control sham injection. Epidural saline decreased the duration of tolerance to TES at knee or ankle.

They concluded that 10 ml of epidural saline, if administered after two segment regression, is an ineffective top up and may decrease duration of initial SAB during CSE anaesthesia.

4. Tetsuo Takiguchi et al[7] (1997) studied the effect of epidural saline on analgesic level during CSE anaesthesia clinically and myelographically. Twenty patients who were undergoing elective surgery under CSE anaesthesia in whom adequate sensory levels were not

achieved even after 10 minutes of spinal anaesthesia at the L4-5 interspace were allotted into 2 groups.10 ml of saline was given epidurally in study group and the control group received nothing in epidural space. They found significantly higher sensory levels in saline group than the control group.

Also to evaluate the effect of epidural saline myelographically, 2 healthy volunteers were given 7 ml of contrast medium iohexol(specific gravity 1.268-1.296) into L4-5 intrathecal space. After radiographic confirmation, 5 ml of saline was injected incrementally into epidural space to a total volume of 20ml. The level of contrast agent was assessed fluoroscopically. There was a rise in the level following every 5 ml injection. The diameter of the subarachnoid space also diminished 40% after first injection and 25% after second injection.

They concluded that a lumbar epidural saline is useful for increasing the anaesthetic level 10 minutes after spinal anaesthesia, which is probably the result of a volume effect.

5. **John Chirayanth and Radhika Dhanpal[8] (2002)** evaluated the effect of epidural top up in CSE in 60 patients who underwent below umbilicus surgery. Three groups of 20 patients each were selected. SAB was established in all the groups with 2.5 ml of 0.5% hyperbaric Bupivacaine. Group 1 recieved 10 ml of 0.5% Bupivacaine as epidural top up. Group 2 recieved 10ml of normal saline as epidural top up. Group 3 did

not receive any epidural top us and acted as control. The blocks were performed in either sitting or lateral position using double segment CSE technique. Maximum level of sensory block, motor block, time for block regression were studied in all 3 groups. Their study demonstrated that the maximal sensory blockade levels were higher in patients who received bupivacaine as epidural top up than in patients who received saline ,which inturn was higher than the group which did not receive any epidural top ups. This study also showed that lateral position results in a greater spread of the intrathecal drug than the sitting position. An additional observation was that the level worn off faster in the group who received normal saline as epidural top up.

This study concluded that deposition of local anaesthetic in the epidural space increased the sensory level of spread of SAB and performing this block in lateral position accentuated this spread. And also epidural top ups with normal saline leads to faster recovery of the block.

6. **Lew E et al [9], (2004)** conducted a double blinded, prospective study in 60 parturients, scheduled to undergo elective caesarean section under Combined Spinal Epidural anaesthesia. They compared the sensory and motor block profile and also the hemodynamic stability of Epidural Volume Expansion (n=30) with single shot spinal anaesthesia (n=30). Patients in EVE group received 5 mg of 0.5% hyperbaric Bupivacaine

intrathecally followed by 6 ml of 0.9% saline in the epidural space, and patients in spinal anaesthesia group received only 9 mg of 0.5% hyperbaric Bupivacaine intrathecally. 10 mcg of Fentanyl was added as an adjuvant to spinal bupivacaine in both the groups. Hemodynamic parameters, sensory block level, Modified Bromage score were recorded. Time required for sensory regression to T10 dermatome, first request of post operative analgesia, and complete motor recovery was noted. It took 73 ± 33 minutes for complete motor recovery in EVE group and 136 ± 32 minutes in spinal anaesthesia group, which was statistically significant. They did not observe any significant difference in hemodynamic parameters.

It was concluded that Combined Spinal Epidural Anaesthesia with EVE provides adequate anaesthesia required for caesarean sections with only **55**% of bupivacaine dose and also allows faster motor recovery of the lower limbs. They suggested that CSE with EVE could be a novel alternative to conventional dose single shot spinal anaesthesia for caesarean sections

7.**Dognci et al[10],(2010)** conducted a study in 75 patients undergoing below umbilicus surgery with an aim to evaluate the block characteristics following epidural saline after sub arachnoid blockade and to find whether EVE has a ceiling effect. Patients were assigned into 5 groups. All patients received 10 mg of spinal isobaric bupivacane. One of the groups did not

receive any epidural top up and acted as control group. Other 4 groups received 5, 10, 15 or 20 ml saline as epidural top ups after 5 minutes of intrathecal injection. Motor and sensory block was assessed every minute. All the EVE groups showed higher block level than control group, but no significant difference was found between the 4 EVE groups. Duration of analgesia was higher in 15 ml saline group.

They concluded that the duration of analgesia was longer with 15ml or more of epidural saline and ceiling effect of maximum analgesic level was obtained with as low as 5 ml of additional saline.

8. Mahmut Deniz et al[11], (2010), investigated the influence of epidural saline as a top up blockade characteristics in CSE anaesthesia in 50 patients undergoing Trans Urethral Resection of Prostrate[TURP]. Subarachnoid block was performed with 10 mg of heavy Bupivacaine in all patients. 25 of them received EVE with 5 ml epidural saline. The sensory, motor blockade profile, hemodynamic variables were recorded at 5 minutes interval. The sensory levels were higher in patients with EVE. The time for sensory regression to S1 and complete motor recovery were same in both the groups. Hemodynamic stability was not significantly different.

They concluded that saline injection as epidural top up provides an increased sensory blockade without changing the hemodynamic data or sensory and motor block profile.

9. Asha Tyagi et al[12], 2011 compared the effect of change in position during block performance, on the epidural volume expansion in 56 patients undergoing caesarean section. They were allotted into 4 groups. All Groups received 9mg of hyperbaric Bupivacaine and 10 mcg of Fentanyl intrathecally. Group S received intratecal injection in sitting position, group L in lateral position. Group LE received intrathecal injection in lateral position followed by 5ml of saline epidurally, whereas group SE received intrathecal injection and 5ml of epidural saline in sitting position. The maximum sensory block attained was found to be highest in patients who received EVE in lateral position. No significant difference was noted in time to achieve maximum sensory level, maximum Bromage score, and time for complete motor block regression, incidence of hypotension or perioperative complications.

This study showed that if EVE technique is used with an intension of increasing the level of spinal block, the CSE should be performed in lateral position rather than in sitting position.

10. **C.Loubert et al[13], (2011)** investigated the effect of EVE on spinal blockade in patients undergoing caesarean section with CSE technique. 90

patients were randomly assigned into 3 groups. Group B7.5 received 7.5 mg hyperbaric Bupivacane intrathecally, group B7.5 EVE received 7.5 mg intrathecal bupivacaine followed by EVE with 5 ml saline and group B10 recieved 10mg of intrathecal hyperbaric Bupivacaine alone. All patients received 25 mcg of Fentanyl as adjuvant. They assessed the height of the sensory block every 5 minutes. The mean sensory levels were found to increase significantly from 5 minutes to 15 minutes of intra thecal injection in all the groups.This study did not demonstrate any significant difference in median sensory block heights between the groups. They observed lesser motor blockade in group B7.5 EVE than in B10 group. Hemodynamic parameters were similar in both the groups.

In conclusion their study did not show any benefit of using EVE with 5 ml of saline as part of CSE technique in patients undergoing caesarean section.

METHODOLOGY

This single centred, prospective, randomized, double blinded study was conducted at Thanjavur Medical College, Thanjavur. After obtaining the institutional Ethical committee approval, 60 patients who got admitted in the obstetrics ward of Raja Mirasrudhar Hospital scheduled for elective caesarean section under regional anaesthesia were included in the study. A written informed consent was obtained from all the patients.

Inclusion criteria:

a. ASA Physical Status I and II.

b. Age between 19-35 years.

c. Body weight between 50-95 kgs.

d. Height 150-170 centimetres.

e. Singleton uncomplicated Pregnancies.

f. Gestational age more than 37 weeks.

Exclusion criteria:

a. Patients with contraindication to regional anaesthesia like bleeding diathesis, spine deformity, local site infection

b. Hypertensive disorders

c. Peripartum hemorrhagic conditions

All the patients were randomly allocated to one of the two groups namely Group S and Group E using sealed envelope method.

Group S: 30 patients received 9 mg of 0.5% hyperbaric Bupivacaine(1.8ml) and 10 microgram of Fentanyl(0.2ml) [1.8ml+0.2ml=2ml] as single shot spinal anaesthesia.

Group E: 30 patients received 5mg of 0.5% hyperbaric bupivacaine (1ml) and 10 microgram of Fentanyl (0.2 ml) into intrathecal space [1.0 ml+0.2ml=1.2ml] followed by 6 ml of saline epidurally.

MATERIALS:

a. Sterile tray, swabs and towels, sponge holding forceps.

b. Sterile disposable 5 ml and 10 ml syringes.

c. Local anaesthetic drug for skin infiltration: 2% lignocaine 2-3ml.

d. 25G Quincke's spinal needle(Spinocan, Braun, Germany).

e. 17G Tuohy needle(Vygon, Ecouen, France)

f. 19G Epidural catheter(Vygon, Ecouen, France)

g. Equipments and drugs for resuscitation

h. Equipments and drugs for conversion to general anaesthesia in case of block failure.

METHODS:

Pre Anaesthetic Assessment:

Preoperative evaluation that included detailed history, physical examination and airway assessment was done and documented. Base line investigations like blood grouping/typing, haemoglobin, bleeding/clotting time, blood sugar, renal function test, urine routine, ECG was done.

Visual Analogue Score consisting of 100mm line with 0 = no pain and 10 =worst pain was explained to all the patients.

Pre operative preparation:

All patients were kept fasting for 6 hr. On arrival of patient in the pre operative room, patients were given reassurance about the procedure and surgery. Baseline vital parameters were recorded. A new intravenous access was established using 18G. Injection Ranitidine 50 mg and injection Metaclopramide 10 mg was given intravenously 30 minutes before surgery.

In the operating room, monitors like pulse oximeter, non-invasive blood pressure and lead II electrocardiography were connected and required interval for recording been set.10ml/kg of Ringer Lactate was infused as preloading 10 minutes prior to regional anaesthesia.

Regional Anaesthesia was performed in right lateral position in all the patients.

In all the 60 patients, with aseptic precautions local infiltration with 2% lignocaine was done both in third and fourth lumbar spaces. Epidural space was identified by loss of resistance to air at L3-L4 space using a 17 G Touhy needle. A multiorificed 19G epidural catheter was placed 4 cms rostrally in the space.

Single Shot Spinal Anaesthesia Group (Group S):

After placing the epidural catheter, 25G Quincke's needle was introduced into fourth lumbar intervertebral space. On confirming free flow of CSF, total volume of 2ml of drug (9 mg of 0.5% hyperbaric bupivacaine with 10 mcg of Fentanyl) was interjected over 10 seconds. Patients were positioned supine with wedged pillow under right hip.

The point at which the spinal needle was removed from the patient marked the completion of spinal anaesthesia.

Epidural Volume Expansion Group (Group E):

After placing the epidural catheter a 25 G Quincke' needle was introduced into L4-L5 intervertebral space and after confirming free flow of CSF 1.2 ml of the drug (5 mg of 0.5% hyperbaric Bupivacaine and 10 microgram of Fentanyl) was injected intrathecally over 10 seconds. patients were positioned supine with a wedge pillow under right hip.

6 ml of sterile normal saline was injected through epidural catheter within 3 minutes of completion of intrathecal injection.

The completion of saline injection marked the completion of EVE.

Intra operative monitoring:

Patients pulse rates, MAP, SpO2 were recorded every 2.5 minutes for the next 30 minutes and every 10 minutes for the following next 30 minutes and then every 30 minutes in recovery room till complete motor recovery.

Block evaluation:

The point of completion of each regional technique was recorded as **Time '0'** [T_0]

Block evaluation was done every 2.5 minutes till 3 consecutive readings remained the same.

Sensory block evaluation:

Patient was explained about the pinpricks by a blunted needle and reassured. The sensory blockade was assessed by loss of pain for pin prick to 25 G blunted needle checked bilaterally in the midclavicular line.

Motor block evaluation:

The motor blockade was assessed using Modified **Bromage score.**

Score 0 – Able to move hip, knee and ankle.

Score 1 – Unable to move hip, able to move knee and ankle.

Score 2- Unable to move hip and knee, able to move ankle.

Score3 – Unable to move hip, knee and ankle.

The following block characteristics were recorded beginning from Time '0'

1. $\mathbf{S_{MAX}}$: Maximum sensory block achieved.
2. $\mathbf{T_{SMAX}}$: Time when S_{MAX} was first achieved.
3. $\mathbf{T_{reg\text{-}10}}$: Time when block regressed to T10 dermatome level
4. $\mathbf{T_{PAIN}}$: Time for first complain of pain.
5. $\mathbf{M_{MAX}}$: Maximum motor block achieved.
6. $\mathbf{T_{M.MAX}}$: Time when M_{MAX} was achieved.
7. $\mathbf{T_{M0}}$: Time for complete motor recovery [modified Bromage score0]

Surgery was allowed to proceed when sensory block level of T4 was at achieved.

Visual Analogue Score was assessed at the point of surgical incision.VAS would be reassessed in patients intra operatively if they complain of pain, and if found to be higher than 3, epidural top ups of 2% lignocaine 3 ml would be given and repeated if VAS is still high. If VAS remains persistently more than 3 then general anaesthesia would be given to the patient.

Oxytocin 10U was given as infusion in both the groups after the delivery.

Hypotension (defined as systolic blood pressure of < 100mm Hg or a reduction in MAP of more than 20% from base line)was planned to treat by intravenous boluses 6 mg of Ephedrine.

Bradycardia(defined as heart rate of less than 60 beats /minute) was planned to be treated with intravenous Atropine 0.6 mg.

Nausea or Vomiting was planned to be treated with rescue antiemetic drugs using intra venous ondansetron 4–8 mg or intra venous metaclopramide 10 mg.

Shivering was planned to be treated with IV tramadol 1mg/kg after delivery of the baby.

APGAR score would be assessed at 1 min and 5 min.

Degree of Maternal satisfaction would be graded as follows on 4 point scale.

4- Excellent

3-Good

2-Satisfactory

1-Poor

In the post operative period, monitoring was continued in all patients.

Post operative analgesia was provided by epidural top ups of 0.125% Bupivacaine.

OBSERVATIONS AND RESULTS

This study comprised of two groups consisting of 30 patients each. The patients in group S received 9 mg of 0.5% hyperbaric Bupivacaine with Fentanyl as single shot spinal anaesthesia. The patients in group E received 5 mg of 0.5% Bupivacaine with Fentanyl intrathecally followed by Epidural Volume Expansion with 6 ml of normal saline.

All the 60 patients completed the study. The collected data was recorded in a master chart. Data analysis was done with the Epidemiological Information package using a computer. Chi square test was used to test the significance of qualitative variables.

After inter group analysis data was presented as range, mean and standard deviation. The probability value ‘p’ of less than 0.05 was considered statistically significant.

Demographic data like age, height and weight were comparable between the two groups.

AGE:

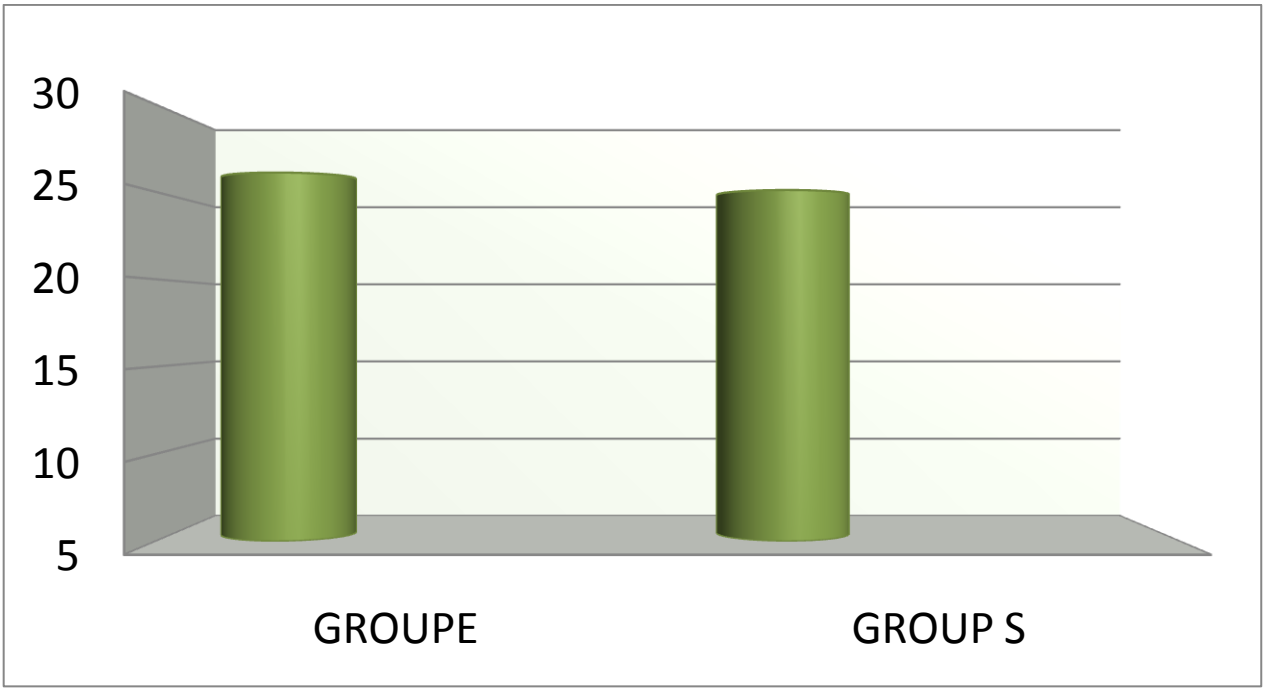
Age distribution in group S was from 20 to 32 years. In group E, was between 19 and 32 years. 'p' value was statistically insignificant.

The results are as shown in Table1/ Figure 1:

Table – 1 Age distribution in years

	MEAN ± SD	'p'
GROUP S	26.13 ± 3.35	0.223 Not significant
GROUP E	25.10 ± 3.14	

Figure 9 - AGE DISTRIBUTION IN YEARS



HEIGHT:

The mean height in group S was 156.13 cms. In group E mean height was 154.67 cms.'p'value was insignificant.

Table - 2 Height distribution (in centimetres)

	MEAN ± SD	'p'
GROUP S	156.13 ± 3.44	0.173 Not significant
GROUP E	154.67 ± 4.69	

WEIGHT:

Group S had a mean weight of 66.37 Kgs. Group E had 67.70 Kgs. 'p' was 0.572 which was insignificant.

Table – 3 Weight distribution (in kilograms)

	MEAN ± SD	'p'
GROUP S	66.37 ± 8.66	0.57 Not significant
GROUP E	67.70 ± 9.47	

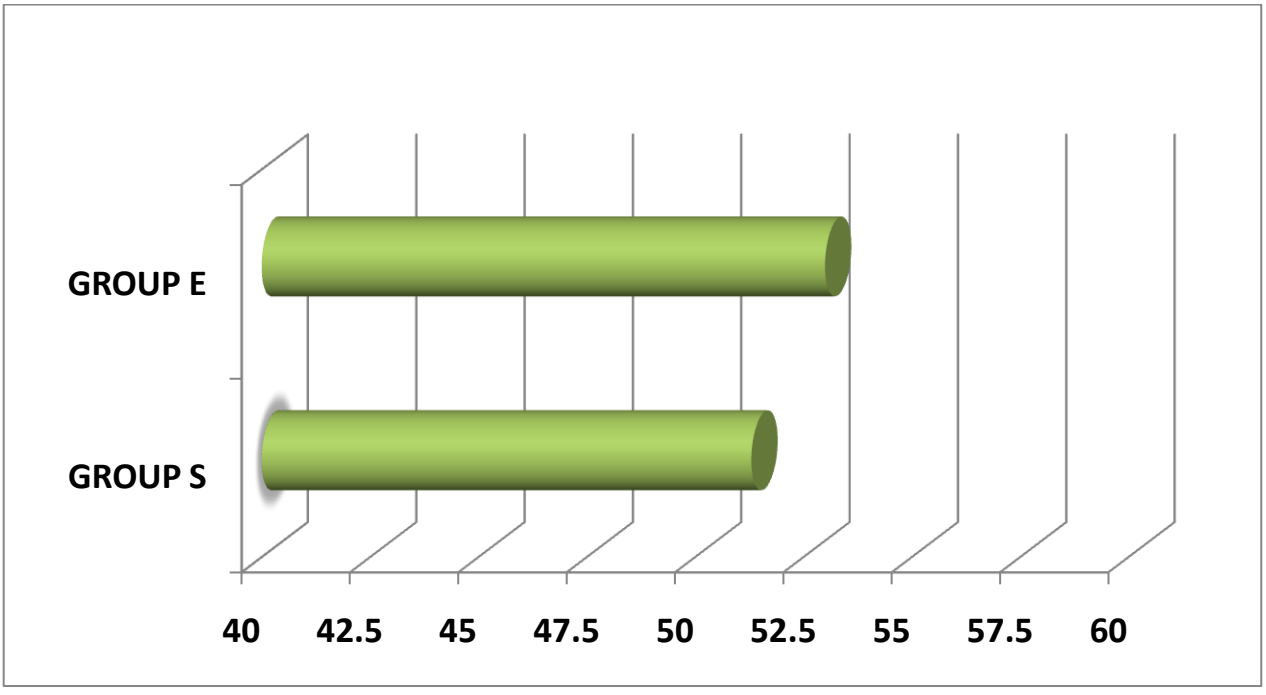
DURATION OF SURGERY:

The mean duration of surgery in group S was 51.33minutes whereas in group E was 53.0 minutes. 'p' value was statistically insignificant.

Table -4 Duration of surgery (in minutes)

	MEAN ± SD	'p'
GROUP S	51.33 ± 6.81	0.414 Not significant
GROUP E	53.00 ± 8.77	

Figure 10 -DURATION OF SURGERY IN MINUTES



MAXIMUM SENSORY BLOCK(S_{MAX}):

The maximum sensory blocade level achieved in group S was T3.8 ± 1.28 minutes and in group E was T3.43 ± 1.22 minutes. 'p'value was not significant.

Table – 5 Maximum sensory levels achieved

	MEAN ± SD	'p'
GROUP S	T3.8 ± 1.28	0.185 Not significant
GROUP E	T3.43 ± 1.22	

TIME FOR MAXIMUM SENSORY BLOCKADE ($T_{S\ MAX}$):

The time required for maximum sensory level blockade in group S was 5.67 minutes. In group E it was 6.08 minutes. 'p' value was statistically insignificant.

Table – 6 Time required for maximum sensory blockade (in minutes)

	MEAN ± SD	'p'
GROUP S	5.67 ± 1.72	0.350 Not significant
GROUP E	6.08 ± 1.60	

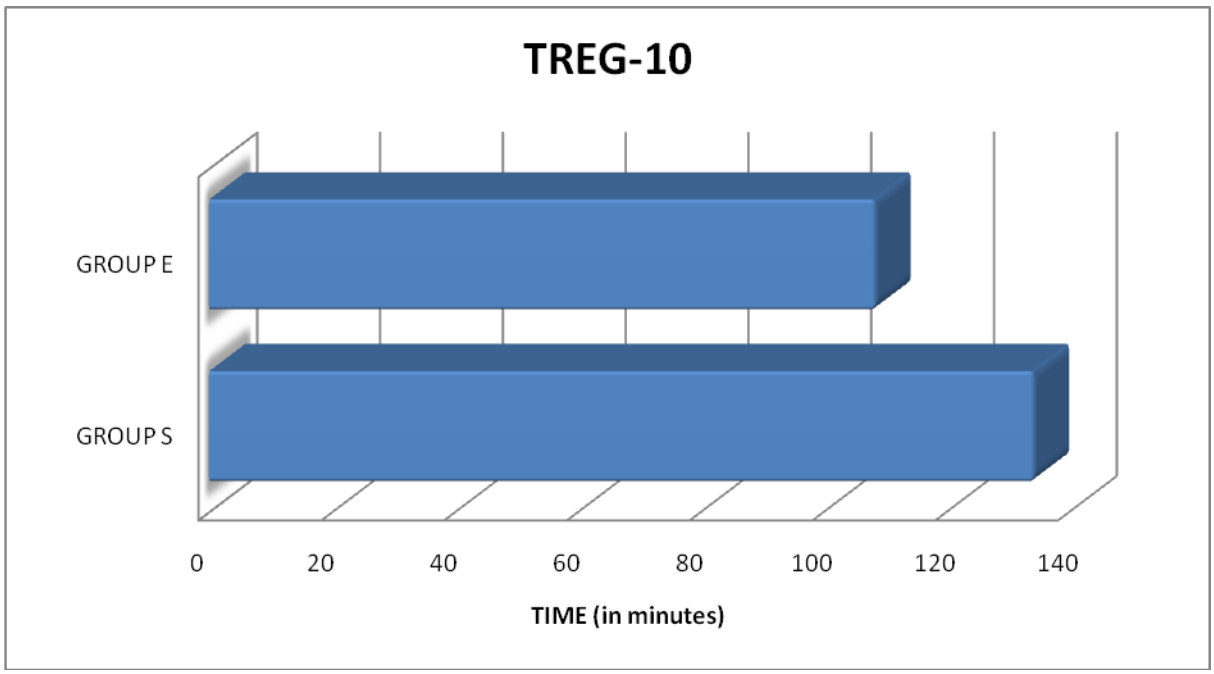
TIME FOR SENSORY LEVEL REGRESSION TO T10 (T_{REG-10}):

The time required for the sensory level regression to 10 th dermatome in group S was 134.3minutes, whereas in group E 108.50 minutes. 'p' value was 0.000 which was statistically significant.

Table – 7 Time for sensory level regression to T_{10}(in minutes)

	MEAN ± SD	'p'
GROUP S	134.33 ± 23.6	0.000 Significant
GROUP E	108.50 ± 17.13	

Figure – 11



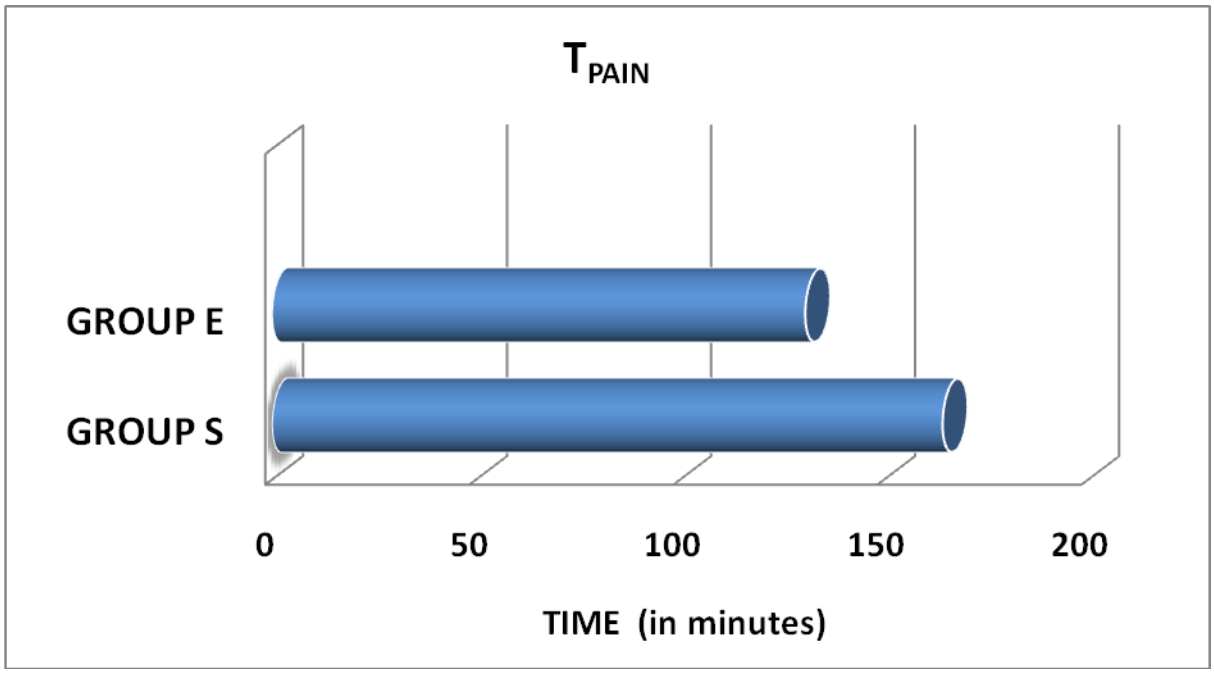
TIME FOR FIRST RESCUE ANALGESIA (T_{PAIN}):

The time at first request of analgesia in group S was 164.33 minutes and in group E 130.67 minutes. 'p' value of 0.000 which is statistically significant was obtained.

Table - 5 Time for first request of rescue analgesia

	MEAN ± SD	'p'
GROUP S	164.33 ± 24.02	0.000 Significant
GROUP E	130.67 ± 15.01	

Figure – 12:



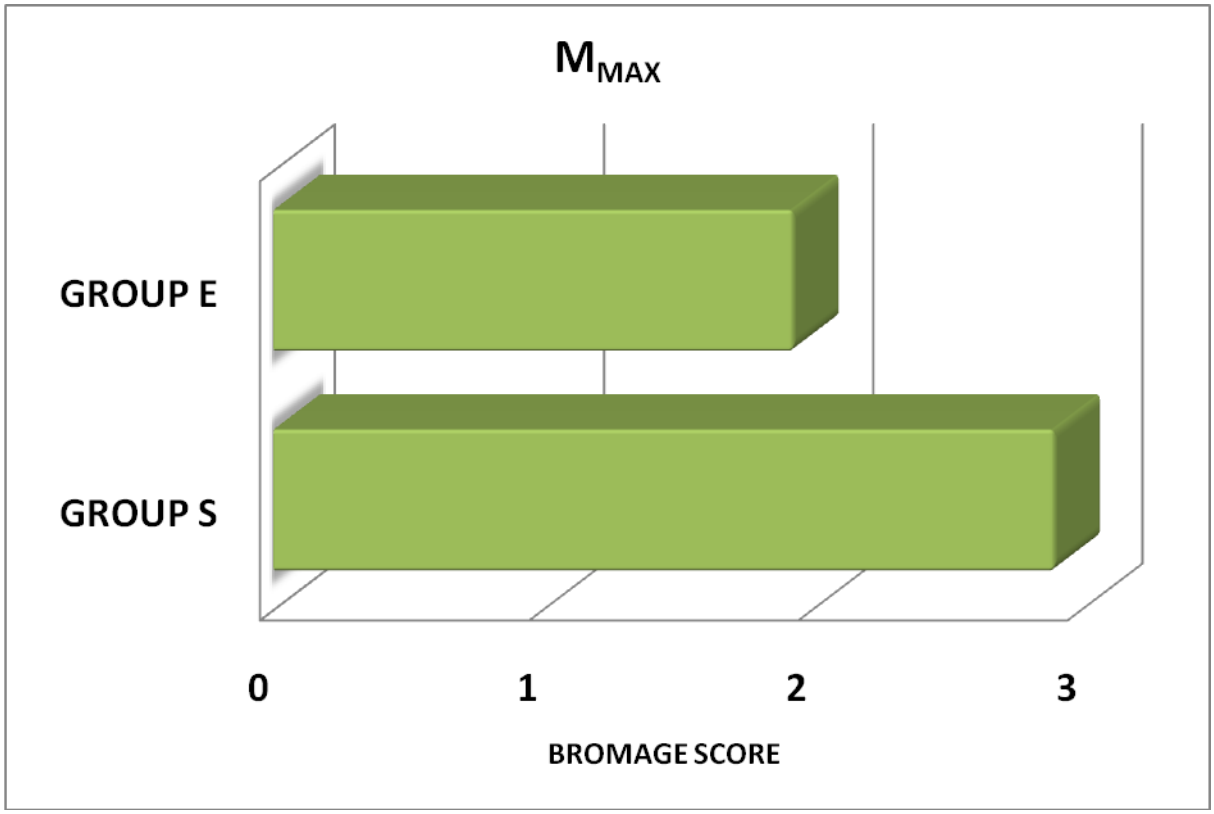
MAXIMUM MOTOR BLOCK - BROMAGE SCORE (M_{MAX}):

The maximum Bromage score attained in group was2.9 and in group E was 1.93. 'p' value was 0.00 which is statistically significant.

Table – 9 Maximum Bromage score

	MEAN ± SD	'p'
GROUP S	2.9 ± 0.30	0.000 Significant
GROUP E	1.93 ± 0.450	

Figure – 13:



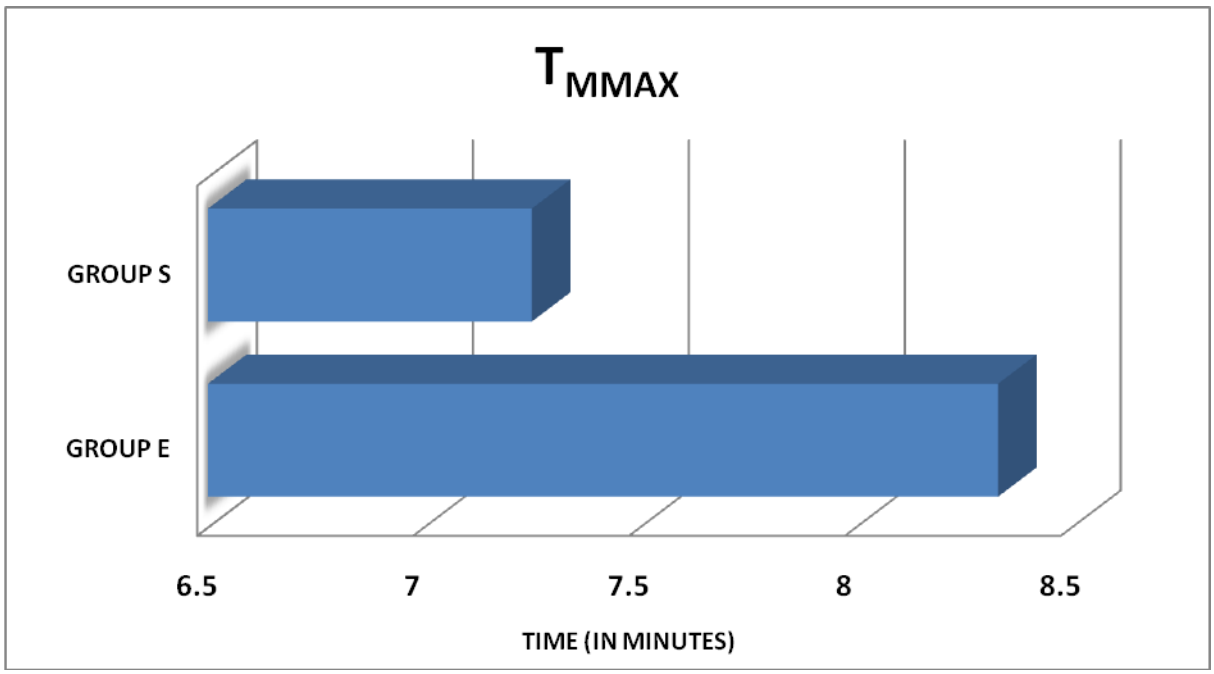
TIME FOR MAXIMUM MOTOR BLOCKADE($T_{M.MAX}$):

The maximum motor blockade was attained after 7.25 minutes in group S whereas it was after 8.33 minutes in group E.'p' value was 0.014 which was statistically significant was seen.

Table – 10 Time for maximum motor blockade(in minutes)

	MEAN± SD	'P'
GROUP S	7.25±1.78	0.014 Significant
GROUP E	8.33±1.51	

Figure -14:



TIME FOR COMPLETE MOTOR REGRESSION (T_{M0}):

The time required for complete motor regression in group S was 183.0 ± 23.21minutes, in group E was 79.50 ± 17.38. 'p ' value was 0.000 which is statistically significant.

Table – 11 Time for complete motor regression(T_{M0})

	MEAN ± SD	'p'
GROUP S	183 ± 23.21	0.000 Significant
GROUP E	79.50 ± 17.38	

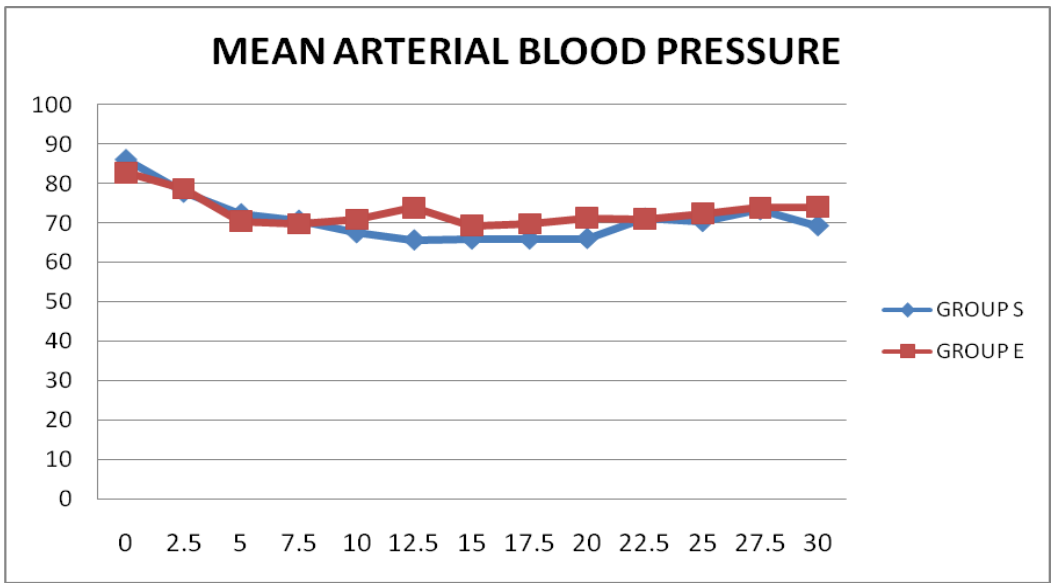
MEAN ARTERIAL BLOOD PRESSURE:

Table - 12 Mean Arterial Blood Pressure(in mm Hg)

INTERVALS IN MINUTES	GROUP S MEAN ± SD	GROUP E MEAN ± SD	'p'
0	86.10 ± 8.25	82.9 ± 9.23	0.16
2.5	77.8±6.73	78.86±15.72	0.34
5	72.3±8.09	70.43±10.16	0.433
7.5	70.7±8.24	69.7±10.85	0.689
10	67.5±8.09	70.93±8.31	0.521
12.5	65.66±9.17	73.9±10.8	0.004

15	65.9±9.12	69.26±6.23	0.001
17.5	65.6±9.17	69.8±7.08	0.05
20	66.06±9.04	71.3±6.13	0.01
22.5	71.23±10.64	71.06±5.14	0.65
25	70.36±7.91	72.4±5.05	0.45
27.5	73.33±8.71	73.86±5.469	0.73
30	69.3±9.28	74.1±5.568	0.08
40	74.6±9.34	75.5±5.923	0.67
50	74.1±7.54	74.9±5.625	0.78
60	71.26±6.54	75.2±6.44	0.69
75	73.86±8.30	75.7±6.54	0.71
90	75.46±8.06	77.7±7.11	0.66
105	74.33±8.05	75.9±5.97	0.67
120	79.33±7.59	77.3±5.77	0.49

Figure – 15



VISUAL ANALOGUE SCORE (VAS):

The VAS was 0.17 in group S and 0.00 in group E. The p value was statistically insignificant.

Table - 13 Visual Analogue Score

	MEAN ± SD	'p'
GROUP S	0.17 ± 0.913	0.321 Not significant
GROUP E	0.00 ± 0.0	

APGAR SCORE:

APGAR score at 1 minute was 9.07 and 8.77 in group S and group E respectively. At 5 th minute was 9.73 in both the groups.'p'value was insignificant at both intervals.

Table – 14 APGAR scores

	MEAN ± SD		'p'
	1 minute	5 minute	
GROUP S	9.07 ± 0.74	9.73 ± 0.45	0.107 (> 0.05)
GROUP E	8.77 ± 0.679	9.73 ± 0.45	1.0 (>0.05)

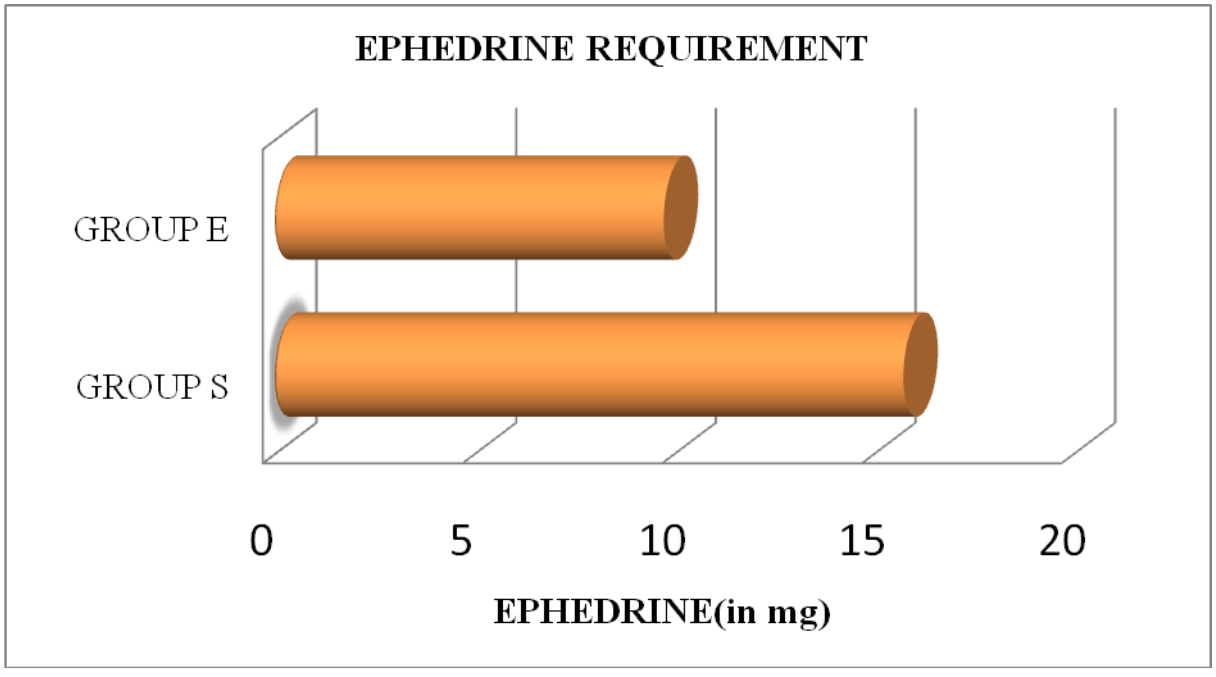
TOTAL EPHEDRINE REQUIRED:

The total dose of Ephedrine required in group S was 15.8 ± 6.59mg 9.80 ± 6.2 mg in group E. 'p' value was 0.000 which was statistically significant.

Table – 15 Total Ephedrine requirements (in milligrams)

	MEAN ± SD	'p'
GROUP S	15.8 ± 6.59	0.001 Significant
GROUP E	9.8 ± 6.2	

Figure – 16



ADVERSE EFFECT:

27 of 30(90%) in group S and 25of 30(83.3%) in group E developed hypotension. Shivering was seen in one patient in both the groups. One patient in group E developed pruritis. 'p'value was insignificant in all the groups.

Table – 16 Adverse effects

ADVERSE EFFECTS	GROUP		Statistical inference
	GROUP S	GROUP E	
Hypotension	27 (90%)	25(83.3%)	$X^2 = 2.744$ 'p' 0.433 not significant
Pruritis	0	1(3.3%)	
Shivering	1(3.3%)	1(3.3%)	

MATERNAL SATISFACTION SCORES:

Mean maternal satisfication score in group S was 2.73 and 3.0 in group E.'p' value was insignificant.

Table -17 Maternal satisfaction scores

	MEAN ± SD	'p'
GROUP S	2.73 ± 0.67	0.321 Not significant
GROUP E	3.0 ± 0.82	

DISCUSSION

Caesarean sections accounts for more than 30% of all births and is a common procedure performed worldwide. Providing anaesthesia to the parturient is a dynamic and multistep process which demands extra responsibility of maintaining both maternal and fetal physiology.

Overall, neuraxial techniques are prefered method for caesarean deliveries. Specific benefits and risks of each technique dictate the eventual choice. In this study it has been attempted to compare two different neuraxial techniques, conventional dose spinal anaesthesia and Combined Spinal Epidural Anaesthesia with EVE in respect to their sensory, motor block profile and hemodynamic stability in 60 patients undergoing caesarean sections.

Collected data was analysed using appropriate tests. A ‘p’value of <0.05 was taken as statistically significant.

Demographic data including age, weight and height were analysed using students t-test and difference was not statistically significant [Table 1, 2, 3 Figure1]. These results were similar to previous studies [9][12].

The duration of surgery in group S was 51.33 ± 6.81 minutes and 53.0 ± 8.77 in group E. The difference was statistically insignificant.

Marc Van de Velde et al [36] and **Asha Tyagi et al** [12] preloaded their patients with 10ml/kg of Ringer Lactate just prior to surgery, which has been followed in this study.

All the patients were premedicated with 50mg of Ranitidine and 10mg of Metaclopramide intravenously 30 minutes before surgery as anti aspiration measures in accordance with Stuart et al [30] recommendations.

Dyer RA, Joubert IA [3] described less than 8mg of Bupivacane as '*low dose'* and more than 8mg as '*Conventional* dose' for intrathecal injections in pregnant patients. In our institution it is a routine practice to use 9mg of 0.5% hyperbaric Bupivacaine with Fentanyl for single shot spinal anaesthesia during caesarean sections. **Lew et al** [9] used 9 mg of intrathecal Bupivacaine with 10 mcg of Fentanyl intrathecally in their control group. In this study also control group received 9mg of Bupivacaine with 10 mcg of Fentanyl intrathecally. Since this study was conducted to evaluate the effect of EVE on low dose intrathecal Bupivacaine, 5mg of 0.5% hyperbaric Bupivacaine with 10 mcg of Fentanyl was used followed by 6 ml of saline epidurally in study group. **C.Loubert**[13] **et al** used 5 ml of saline epidurally.

In most of the studies conducted on non parturients (eg: TURP [11], lower limb surgeries [8]) EVE was done with 10ml of saline. But in parturients, EVE saline was restricted to 5-6ml. Due to the physiological

changes occurring during pregnancy, there is decrease in the volume of the epidural space. So lesser volume of saline was used for EVE in this group.

All the patients were positioned in lateral position during the procedure. **Asha Tyagi et al [12]** and **John Chiraynth, Radhika Dhanapal[8** in their study stated that EVE if done in lateral position, accentuates the spread of SAB in comparision to sitting position.

CSEA could be performed either as Single Space Technique (SST) or Double Space Technique (DST). **C. Loubert et al[13]** and **N. Beale et al[31]** in their study have done CSEA by needle through needle technique of SST where intrathecal injection was followed by insertion of epidural catheter, whereas in DST epidural catheter is placed in the epidural space first and then the drug is injected intrathecally in another vertebral space. During this study CSEA with DST was followed in both the groups. Using CSEA by NTN technique makes the procedure very simple when compared to DST. But injecting the drug intrathecally before the insertion of epidural catheter might cause deposition of hyperbaric drug in the lower levels, decreasing the cephalad spread of the drug.

SENSORY AND MOTOR BLOCK PROFILE:

Maximum sensory blockade level: [S_{MAX}]

Ben david B et al[32] in their study administered 5 mg of 0.5% hyperbaric bupivacaine intrathecally without EVE and was found to have inadequate anaesthesia in 50% of the patients. **Guasch E et al** [33] found that all the 6 patients in their study who received only 5mg of 0.5% Bupivacaine as spinal anaesthesia required rescue analgesia. The recommended level of anaesthesia for caesarean delivery of T_4[34] was not achieved with low dose intrathecal Bupivacaine alone according to the above studies.

In this study the difference in maximum sensory block attained between the groups was statistically insignificant. The mean sensory levels were T3.8 in group S and T3.43 in group E, which has shown that 'Adequate sensory level of blockade' was achieved even with low dose intrathecal Bupivacaine which was augmented by EVE.

Results in this study correlated with the study conducted by **Lew E et al**[9]**.** A sensory level of C7-T4 was obtained in both EVE and SAB group in their study. This could be explained as a result of '*volume effect'* of epidural saline resulting in the '*squeezing*'of CSF and more extensive spread of subarachnoid local anaesthetic.

John Chiraynth, Radhika Dhanapal[8] study also has shown that epidural normal saline extended the block. In their study sensory level in group which received local anaesthetic for EVE, was higher than the group which received normal saline for EVE, which in turn was higher than the group which did not receive EVE.

C. Loubert et al [13] in their study did not show any benefit of EVE in raising the level of the block. As per the author, that might be from the fact that both the spinal injection of hyperbaric Bupivacaine and EVE were performed in sitting position where baricity is a determinant factor of local anaesthetic spread within subarachnoid space. Gravity might have counteracted the cephalad spread of the hyperbaric Bupivacaine.

Time required for maximal sensory blockade: [$T_{S\ MAX}$]

This study did not demonstrate a statistically significant difference in the time required for attaining maximal sensory level. It correlates with the **Doganci et al** [10] and **Lew et al** [9] studies.

Maximum motor block attained: [M_{MAX}]

The motor block was assessed by using modified Bromage score. In group S maximum motor blockade was 2.90 ± 0.30 and in group E 1.93 ± 0.45 which were statistically significant. It was similar to that of **Lew E et al** [9] and **C Loubert et al** [13] studies.

C. Loubert et al[13] put forward a hypothesis to explain their findings. The injection of epidural saline may accelerate the spread of a fraction of the spinal Bupivacaine towards the sacral segments by means of a volume effect. Upon assuming the wedged supine position, it is possible that some amount of Bupivacaine be trapped in the sacral region of the dural sac. As sacral roots do not contribute to motor function of lower limbs, EVE group patients might have a lower Bromage score.

Time for sensory regression to T10 dermatome: [T_{REG-10}]

The time for sensory regression in group S verses group E was 134 ± 23.59 versus 108 ± 17.12 minutes which was statistically significant demonstrating an early sensory regression of block in EVE group. This result was similar to those of **John Chiraynth and Radhika Dhanapal** [8] study.

The early sensory regression might be explained by the fact that the concentration of drug getting diluted in CSF is lesser in group E than in group S. Concentration of the drug falls below the 'concentration minimum' earlier in group E than the group S where higher concentration of drug is used, leading to faster sensory recovery.

Time for complete motor recovery: [T_{M0}]

The patients in group E showed a faster motor recovery as compared to group S (79.50 ± 17.39 minutes V_S 183± 23.216 minutes) which was statistically significant. This correlate with result of **Lew et al** [9] study where patients in group E recovered completely from motor blockade within 73 ± 33 minutes as compared to group S who took 136± 32 minutes.

Walter J Trautman et al [6] during their study on eight volunteers assessed the motor strength by isometric force dynamometer at knee and ankle after EVE using either saline or Bupivacaine and demonstrated a faster motor recovery with epidural saline.

The early motor regression might also be because of the fact that the lower concentration of the drug in CSF, in group E leads to early fall in the concentration of drug below the 'concentration minimum' for motor blockade.

Early motor recovery relieves maternal anxiety as she can move her legs freely without any pain.

Time for request of rescue analgesia: [T_{PAIN}]

The patients in group S complained of pain after 164.33 ± 24.02 minutes and in group E rescue analgesia after 130.67 ± 15.01 minutes. A significant 'p'value of 0.000 was observed. The early regression of the

sensory block in EVE group also explains the early request for rescue analgesia.

The early regression of blockade could be considered as an advantage and also a disadvantage. Advantage because the recovery of the blockade can be ensured by the anaesthesiologist early and patient can be discharged earlier from PACU. It is a disadvantage, because patient complains of pain earlier and early commencement of post operative pain management is necessary.

VISUAL ANALOGUE SCORE (VAS):

VAS assessed at the time of incision, were comparable in both the groups as an insignificant ‘p’ value of 0.321 was observed.

During this study, one patient complained of pain after 25 minutes of commencement of the surgery in group E. VAS score of 5 was recorded. Patient was reassured and 3 ml of 2% lignocaine was administered through epidural catheter. After 5 minutes, surgery was continued. Later VAS scores were 0 in this patient throughout the surgery.

This study has demonstrated that adequate analgesia required for the surgery was provided by low doses of intrathecal drug when it was augmented with EVE.

APGAR SCORE:

APGAR scores were used to assess the neonatal well being at 1 and 5 minutes after the delivery.

In this study APGAR Scores did not show any significant difference between the two groups, showing both the techniques did not have any adverse effect on fetal well being.

These results are in correlation with the studies conducted by **Asha Tyagi et al[ ] and Lew E et al[ ].**

HEMODYNAMIC STABILITY:

When comparing the intraoperative pulse rate and Mean Arterial Pressure (MAP) between the groups, both the groups showed a fall in MAP below the basal values. But patients in group S had a lower MAP than that of group E. The difference was statistically significant between 12.5 and 20 minutes of intraoperative period. Since the onset of action of intrathecal Bupivacane is about 5-8 minutes after intrathecal injection, a higher fall in blood pressure was noted in group S in those intervals.

In group E, the concentration of drug used intrathecally was low, leading to lesser sympathetic blockade than the conventional dose of drug. Thus intraoperative hemodynamics were better than the group S. The

Ephedrine requirement in group E was also lesser than the group S [9.8 ± 6.2 mg versus 15.8 ± 6.6 mg]. This correlates with the Lew et al[ ] study[12 ± 11 mg versus 16 ± 15 mg].

Pulse Rate between the groups were not statistically significant.

MATERNAL SATISFACTION SCORES:

The difference in maternal satisfaction scores were statistically insignificant among the groups, indicating adequate analgesia was achieved in both the groups.

In both the groups adequate rescue analgesia was provided post operatively by intermittent boluses of 0.125% of epidural Bupivacaine, which gave immediate pain relief. In intramuscular mode of analgesia there would be a delay in onset of action, during which patient might experience pain. Because adequate analgesia was maintained in intraoperative and also in post operative period better maternal satisfaction scores were observed in both the groups.

ADVERSE EFFCTS:

83.3% in group E and 90% in group S developed hypotension. Though the incidence of hypotension was similar in both the groups MAP was maintained higher in group E than the group S.

One patient in group E developed pruritis. One patient in each group developed shivering.

LIMITATIONS OF THE STUDY:

1. Higher incidence of hypotension was seen even in group E. Hypotension is one of the common and dangerous complication for both mother and fetus.when the cause for this higher incidence was analysed retrospectively, probably instead of 10 ml/kg of preloading 20 ml/ kg or atleast 15 ml/ kg of preloading would have decreased the incidence of hypotension atleast in group E.

2. APGAR score was used in this study, which has shown fetal wellbeing in both the groups. Umbilical cord blood analysis is a better tool.

3. Early regression of sensory levels in group E due to low intrathecal dose of drug, lead to earlier request for first rescue analgesia. So rescue analgesia should be commenced earlier, if this technique is preferred.

SUMMARY

Sixty patients of ASA I and II undergoing elective caesarean sections were randomly assigned into two groups namely group S and group E. Combined Spinal Epidural technique was performed using double space technique in lateral position in all the patients. Group S received 9 mg of 0.5% hyperbaric Bupivacaine with 10 mcg of Fentanyl intrathecally and group E received 5mg of 0.5% hyperbaric Bupivacaine with 10 mcg of Fentanly intrathecally followed by EVE with 6ml of normal saline.

Intraoperatively pulse rate, MAP, SP02 was monitored. Maximum sensory and motor block achieved, time required to achieve maximum blockade level, time required for regression of the block, time of first request of pain, incidence of adverse effects, dose of Ephedrine required, Visual Analogue Score, Maternal satisfaction scores were compared between the two groups. Post operative analgesia was maintained with epidural topups of 0.125% Bupivacaine.

Statistical analysis was done using chi square test and a ‘p’value of < 0.05 was taken as significant. This study showed that:

1. Similar sensory blockade levels were achieved between both the groups.
2. Time required for attaining maximum sensory block was similar in both groups.

3. Lower Bromage scores are seen with EVE of low dose intrathecal drug.
4. Faster sensory and motor regression was seen in with EVE of low dose intrathecal drug.
5. Intraoperative hemodynamics was better with EVE of low dose intrathecal drug.
6. Incidence of adverse effects was similar in both the groups.

CONCLUSION

Comparing to conventional dose spinal anaesthesia, Epidural Volume Expansion of low dose intrathecal Bupivacaine in caesarean sections provides

1. Adequate intraoperative anaesthesia.

2. Faster motor and sensory recovery.

3. Better hemodynamic stability.

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PROFORMA

A COMPARATIVE STUDY OF LOW DOSE INTRATHECAL

BUPIVACAINE WITH EPIDURAL VOLUME EXPANSION AND CONVENTIONAL DOSE SPINAL ANAESTHESIA IN CAESAREAN SECTIONS

STUDY GROUP:

NAME :

AGE : HEIGHT:

IP NO : WEIGHT:

UNIT :

PRE OPERATIVE:

PR : Hb: BT: CT:

BP : Blood Grouping: B.Glucose:

CVS: B .Urea : S. Creatinine :

RS: Urine analysis: Glucose /Albumin

P/A: ECG

Airway:

ASA Physical Status:

INRA OPERATIVE:

Maximal Sensory level [S_{MAX}] :

Time for Maximum Sensory level [T_{MAX}] :

Maximal Bromage Score [M_{MAX}] :

Time for Maximal Bromage Score [$T_{M.MAX}$] :

VAS Score :

APGAR SCORE -1 min :

- 5 min :

	PR	MAP	SP02	Drugs	Sensory Level	Bromage score
T_0						
$T_{2.5}$						
T_5						
$T_{7.5}$						
T_{10}						
$T_{12.5}$						
T_{15}						
$T_{17,5}$						
T_{20}						
$T_{22.5}$						
T_{25}						
$T_{27.5}$						
T_{30}						
T_{35}						
T_{40}						
T_{45}						
T_{50}						
T_{55}						
T_{60}						

Duration of Surgery : min Total Ephedrine: mg

Intra Venous Fluids : ml

POST OPERATIVE PERIOD:

Period for block regression to level to T10 [T_{Reg-10}] :

Period for complete regression of motor block [T_{M0}] :

Time of request for 1 st post operative Analgesia[T_{PAIN}] :

PERI OPERATIVE COMPICATIONS:

	Intra Operative	Post Operative	Treatment
Hypotension (SBP < 100 mmHg/ MAP< 20% base line)			
Bradycardia (PR < 50 /min)			
Nausea/ Vomiting			
Pruritis			
Shivering			

MASTER CHART

GROUP E

SI NO	GROUP	NAME	AGE	Ht	Wt	PR	MAP	SPO2	Duration of surgery	S_{MAX}	T_{MAX}	T_{REG-10}	T_{PAIN}	(M_{MAX})	$T_{M.MAX}$	T_{M0}	VAS SCORE	APGAR SCORE 1 min	APGAR SCORE 5min	TOTAL EPHEDRINE (mg)	ADVERSE EFFECTS
1	E	KAVIARASI	24	150	61	86	93	99	55	T2	7.5	100	140	2	7.5	95	0	9	10	12	HYPOTENSION
2	E	RADHA	23	154	50	98	94	99	45	T4	5	125	150	2	5	105	0	8	10	0	SHIVERING
3	E	PUNEETHA	32	156	50	90	90	98	55	T5	5	100	135	1	7.5	100	5	10	10	6	HYPOTENSION
4	E	KALAIVANI	23	152	52	111	88	99	60	T4	5	90	120	2	10	50	0	8	9	12	HYPOTENSION
5	E	SEETHALADEVI	21	158	64	104	79	99	40	T4	5	80	100	2	7.5	55	0	8	10	18	HYPOTENSION
6	E	LAKSHMI	23	153	75	99	83	99	50	T4	7.5	90	100	2	10	60	0	9	10	6	HYPO/SHVRNG
7	E	SAMIYAMMAL	26	152	78	78	82	99	55	T2	5	100	135	2	7.5	100	0	9	9	18	HYPOTENSION
8	E	MALA	25	160	54	98	79	98	60	T4	7.5	120	150	1	7.5	60	0	9	10	12	HYPOTENSION
9	E	MAHALAKSHMI	28	153	70	102	70	99	65	T2	5	120	150	2	10	70	0	8	10	18	HYPOTENSION
10	E	ELAYARASI	25	157	80	106	68	98	70	T4	10	85	110	2	10	90	0	9	10		NIL
11	E	MAHESHWARI	29	158	70	98	88	99	60	T4	7.5	120	130	2	7.5	75	0	9	9	6	HYPOTENSION
12	E	SATHYA	32	150	68	108	64	99	60	T2	7.5	100	130	2	10	100	0	10	10	18	HYPOTENSION
13	E	KALAIVANI	23	154	68	90	97	99	55	T2	5	140	150	2	7.5	115	0	9	9	12	HYPOTENSION
14	E	BHARATHI	30	156	58	98	96	98	45	T4	5	120	130	2	10	50	0	9	10	12	HYPOTENSION
15	E	SANGEETHA	26	160	56	86	84	98	40	T4	5	100	130	1	7.5	70	0	9	10	18	HYPOTENSION

16	E	VEERAMAL	24	154	54	90	82	98	45	T2	5	100	120	2	7.5	60	0	8	9	18	HYPOTENSION
17	E	RENUKA	28	150	60	100	68	99	50	T4	7.5	90	110	2	10	75	0	9	10	12	HYPOTENSION
18	E	DEVI	32	158	68	96	82	99	55	T2	2.5	125	135	2	5	75	0	8	10	12	HYPOTENSION
19	E	SARADA	23	160	78	104	68	99	50	T4	7.5	140	150	2	7.5	60	0	9	10	6	HYPOTENSION
20	E	GOMATHI	27	154	70	98	94	99	50	T6	5	120	135	1	7.5	80	0	10	10	6	NIL
21	E	SENTHAMARAI	31	154	75	90	94	99	60	T2	5	120	135	2	7.5	75	0	7	9	18	HYPOTENSION
22	E	PRIYA	19	150	70	100	80	99	65	T4	7.5	115	130	2	10	65	0	9	10	6	HYPOTENSION
23	E	MUTHULAKSHMI	27	156	74	96	88	99	40	T4	7.5	105	130	2	10	90	0	9	10	12	NIL
24	E	VENNILA	23	154	74	98	78	99	45	T4	5	80	100	3	7.5	100	0	8	9	6	HYPOTENSION
25	E	DURGA	25	150	70	94	80	98	50	T2	5	130	145	2	7.5	80	0	9	10	12	HYPOTENSION
26	E	VEERAYE	25	156	78	98	86	98	60	T6	10	125	140	2	10	80	0	9	10	6	NIL
27	E	MAHARANI	29	162	78	84	84	99	65	T4	7.5	100	140	2	10	90	0	9	10	6	HYPOTENSION
28	E	RAMYA	25	154	74	88	86	98	40	T4	5	100	130	2	7.5	95	0	8	9	6	HYPOTENSION
29	E	FATHIMA	28	165	76	94	70	99	40	T2	5	90	120	3	10	80	0	9	10	12	HYPOTENSION
30	E	SUMATI	28	140	78	96	92	98	60	T2	5	125	140	2	7.5	85	0	9	10	12	HYPOTENSION

GROUP S

Sl No	GROUP	NAME	Age	HT	WT	PR	MAP	SPO2	Duration of surgery	S_{MAX}	T_{MAX}	T_{REG-10}	T_{PAIN}	BROMAGE SCORE M_{MAX}	$T_{M.MAX}$	T_{M0}	VAS SCORE	APGAR SCORE 1 min	APGAR SCORE 5 min	TOTAL EPHEDRINE	ADVERSE EFFECTS
1	S	KAVITHA	24	157	84	88	98	99	50	T4	5	150	180	3	7.5	230	0	9	10	18	HYPOTENSION
2	S	ANITHA	32	152	64	90	85	98	60	T4	5	130	200	3	5	210	0	10	10	18	HYPOTENSION
3	S	SHANTHI	29	158	64	96	88	99	55	T2	10	140	200	3	10	200	0	10	10	24	PRUTS/HYPTN
4	S	RAGINI	23	156	70	108	87	99	40	T6	7.5	160	180	3	10	180	0	9	10		NIL
5	S	LATHA	25	158	50	78	77	99	45	T4	5	110	180	3	5	200	0	8	10	18	HYPOTENSION
6	S	SATHYA	20	161	60	102	92	99	40	T2	5	130	180	3	7.5	210	0	8	9	18	HYPOTENSION
7	S	PUNEETHA	22	150	56	108	88	99	50	T6	5	140	190	3	7.5	200	0	10	10	24	HYPOTENSION
8	S	ANUSIYA	24	150	50	90	80	99	50	T4	7.5	150	190	3	7.5	190	0	10	10	12	HYPOTENSION
9	S	USHA	32	156	65	100	89	98	60	T4	2.5	150	160	2	5	180	0	9	10	6	HYPOTENSION
10	S	SUMATY	21	157	55	90	89	98	50	T2	7.5	160	180	3	10	180	0	10	10	12	HYPOTENSION
11	S	KANIMOZHI	29	154	55	88	96	99	55	T4	5	100	180	3	7.5	200	0	10	10	12	HYPOTENSION
12	S	RAJALAKSMI	25	160	68	96	93	99	60	T2	2.5	140	160	3	5	180	0	8	10	18	HYPOTENSION
13	S	BHANUMATI	23	154	70	90	84	99	40	T4	5	90	150	3	5	180	0	9	9	18	HYPOTENSION
14	S	KALAIARASI	26	150	63	86	100	98	45	T6	5	90	100	3	5	160	0	8	9	24	HYPOTENSION
15	S	SUBHULAKSMI	28	154	55	92	73	99	60	T4	7.5	165	180	3	7.5	200	0	9	10	18	HYPOTENSION

16	S	SAMSUNISHA	23	160	78	108	84	99	50	T2	7.5	150	160	3	10	180	0	9	10	18	HYPOTENSION
17	S	VANATHI	26	158	70	104	78	99	55	T4	5	160	185	3	7.5	200	0	9	10	12	HYPOTENSION
18	S	PREETHA	28	154	68	86	90	99	50	T4	5	165	165	3	7.5	180	0	10	10	12	HYPOTENSION
19	S	JEEVA	25	160	78	86	76	99	60	T6	7.5	150	160	2	10	180	0	10	10	6	HYPOTENSION
20	S	TAMILARASI	22	156	58	78	86	99	60	T4	5	145	180	2	7.5	210	0	9	9	18	HYPTN/SHVRG
21	S	ANANDAVALLI	23	156	70	90	78	99	60	T4	7.5	110	130	3	10	150	0	8	10	18	HYPOTENSION
22	S	CHANDRA	30	160	68	106	80	99	50	T2	5	150	160	3	5	180	0	9	9	24	HYPOTENSION
23	S	RUKMANI	24	155	70	90	98	98	45	T4	7.5	90	120	3	7.5	120	0	9	10	12	HYPOTENSION
24	S	REVATHY	28	158	70	80	90	99	40	T4	5	120	135	3	5	140	0	9	9	12	HYPOTENSION
25	S	RAMYA	24	154	68	96	84	99	50	T4	5	130	150	3	7.5	180	0	8	9	24	HYPOTENSION
26	S	MALA	23	162	78	88	70	98	50	T4	2.5	120	130	3	5	150	0	8	10	18	HYPOTENSION
27	S	DEVI	22	156	68	86	76	98	60	T6	5	160	180	3	7.5	200	0	9	10		NIL
28	S	ESWARI	26	150	68	88	84	99	55	T2	5	150	165	3	7.5	180	0	9	9	24	HYPOTENSION
29	S	LAKSHMI	24	158	80	90	104	99	50	T4	7.5	110	150	3	7.5	180	0	10	10	18	HYPOTENSION
30	S	SUGUNA	22	160	70	92	86	99	45	T4	5	115	150	3	7.5	160	0	9	10	18	HYPOTENSION

	GROUP E											MEAN ARTERIAL BLOOD							
MIN	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	40	50	60	75	90	105	120
1	70	68	70	68	68	70	74	64	68	78	80	82	82	80	84	78	82	82	82
2	74	64	68	68	60	70	68	64	64	70	70	70	74	70	72	76	70	80	80
3	68	68	58	60	62	64	78	78	80	70	84	80	84	82	80	74	76	80	84
4	70	76	78	88	76	76	68	68	70	76	70	86	76	70	72	70	74	72	70
5	75	86	77	77	78	68	78	76	68	70	68	68	70	70	68	68	70	72	70
6	70	74	68	70	68	64	68	70	70	68	70	64	70	70	68	64	68	72	84
7	75	86	77	68	70	72	70	76	70	72	72	68	68	74	78	80	88	80	80
8	70	68	70	66	64	68	70	70	72	68	76	72	70	68	70	74	76	76	80
9	72	74	73	70	76	80	82	86	80	82	82	84	78	70	72	74	72	72	74
10	70	54	56	55	57	56	54	68	68	69	72	72	70	72	72	74	78	80	80
11	78	57	59	65	63	66	57	68	60	67	73	75	78	80	82	82	80	78	76
12	90	80	81	82	70	73	74	70	72	70	70	74	88	90	90	94	90	92	90
13	86	85	81	75	73	79	73	61	64	68	71	71	74	78	78	74	80	72	70
14	70	74	68	86	73	57	61	60	73	66	66	71	76	74	72	70	88	84	84
15	86	82	70	68	78	80	80	78	78	76	74	72	70	74	70	72	74	70	72
16	70	54	50	60	63	62	60	64	64	68	86	70	72	80	82	70	74	68	74
17	70	68	86	73	57	61	60	73	66	66	71	76	81	74	68	70	72	72	74
18	78	68	64	62	68	68	60	79	80	80	78	80	90	86	84	79	80	80	83
19	70	68	68	56	70	70	68	64	68	68	70	72	70	70	74	80	82	80	82
20	68	64	68	70	64	62	70	74	70	68	68	70	72	70	72	70	71	70	71
21	72	62	62	64	70	72	74	74	78	80	78	78	70	80	88	90	96	84	82
22	68	74	64	68	70	72	72	74	76	80	76	80	76	70	70	80	84	82	86
23	92	97	108	80	78	68	64	79	70	78	81	82	78	78	80	78	78	70	78
24	90	78	76	78	68	60	76	70	70	78	70	76	78	78	78	76	70	70	70
25	84	68	68	70	64	70	74	78	76	70	64	68	68	70	70	84	80	70	72
26	70	62	65	64	62	70	78	72	74	72	78	70	74	72	70	72	74	70	74
27	86	64	68	68	70	70	72	74	70	78	70	68	80	76	74	74	70	70	70
28	68	64	70	70	68	70	68	70	70	68	76	74	78	70	74	72	86	80	78
29	68	68	56	56	68	70	76	64	68	70	72	70	68	70	64	70	68	70	70
30	68	58	65	63	66	60	67	73	75	78	80	80	82	82	80	84	80	80	80

	GROUP S										MEAN ARTERIAL BLOOD PRESSURE								
	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	40	50	60	75	90	105	120
1	70	66	66	83	96	90	83	83	86	83	93	96	93	83	93	98	96	98	98
2	74	63	66	63	65	65	65	61	69	68	72	76	68	80	82	82	78	82	80
3	80	76	78	78	85	80	85	85	85	78	78	76	78	82	84	86	88	80	86
4	84	80	76	62	62	68	68	72	76	80	80	88	84	78	82	80	78	76	78
5	72	78	79	73	74	79	75	77	88	86	82	91	94	90	78	78	72	78	86
6	84	83	81	76	71	75	68	71	78	74	76	78	71	76	80	86	84	86	86
7	83	71	71	66	66	65	65	58	62	72	72	81	82	76	82	88	80	86	78
8	70	78	78	76	68	68	78	70	74	76	76	78	78	76	74	78	84	88	86
9	90	64	68	65	80	57	56	55	104	80	90	100	94	94	80	100	102	98	100
10	80	70	74	62	67	53	53	59	60	64	60	68	74	80	80	70	74	74	78
11	88	82	85	84	70	70	68	66	58	56	68	75	78	70	80	89	80	80	84
12	86	70	77	84	90	84	78	75	81	80	86	86	78	80	74	86	88	86	76
13	80	80	72	68	66	56	54	60	70	74	74	68	60	68	64	66	78	70	72
14	83	86	85	86	85	66	66	66	66	68	68	70	74	74	78	80	68	70	70
15	68	71	68	56	66	66	62	68	66	60	76	70	61	68	70	68	70	76	76
16	80	90	80	70	83	70	81	86	83	70	78	78	83	84	86	80	86	84	84
17	68	60	66	60	62	63	56	57	65	70	81	70	74	72	73	74	86	86	84
18	70	66	68	68	70	72	74	78	80	80	70	74	72	74	76	79	78	82	84
19	74	60	54	60	70	68	58	54	70	70	76	70	68	70	74	76	74	70	70
20	83	71	71	66	66	65	58	62	72	72	80	78	76	76	74	76	74	78	76
21	80	70	74	62	67	53	53	59	60	58	54	60	54	56	64	70	76	68	70
22	86	70	78	70	72	68	66	60	64	64	68	70	80	80	78	80	80	70	70
23	85	84	60	56	56	60	64	62	68	70	74	74	76	76	70	70	72	72	80
24	70	78	60	58	56	58	60	60	64	62	60	60	64	84	80	72	70	74	76
25	80	72	70	60	60	64	56	58	58	60	64	68	68	70	82	72	70	70	74
26	70	68	68	68	70	56	60	62	64	64	70	72	72	70	72	72	70	74	70
27	76	70	68	56	58	54	56	58	60	62	62	70	72	70	70	72	74	70	72
28	70	68	56	58	60	64	66	60	64	64	70	72	70	84	84	82	74	72	76
29	80	64	68	66	68	64	70	72	72	76	70	74	72	70	70	72	70	72	80
30	70	60	56	66	58	56	68	68	70	70	72	68	70	72	84	84	80	80	80

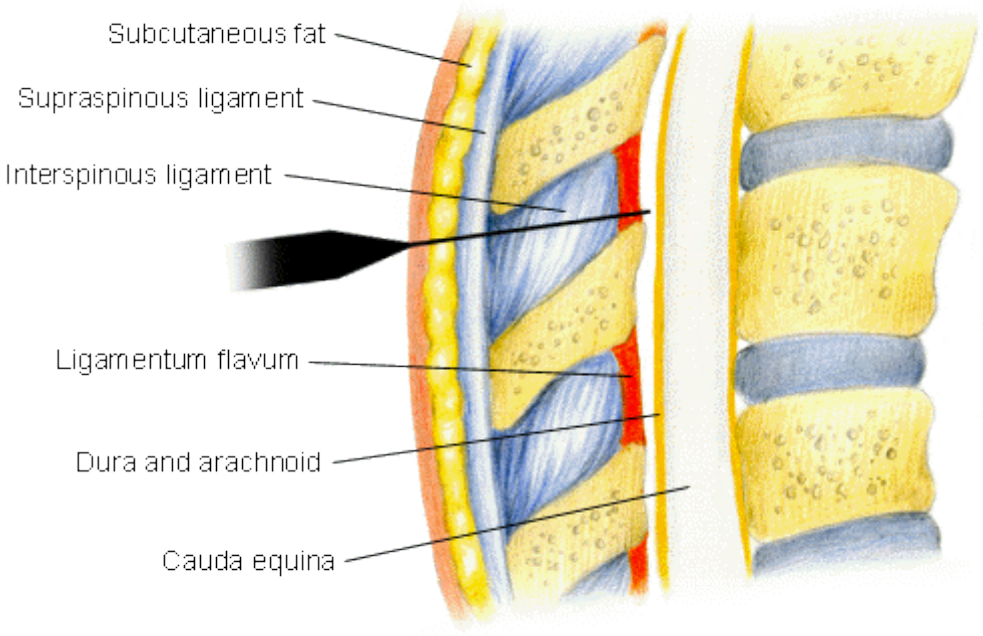


FIGURE 4: ANATOMY OF SUB ARACHNOID BLOCK

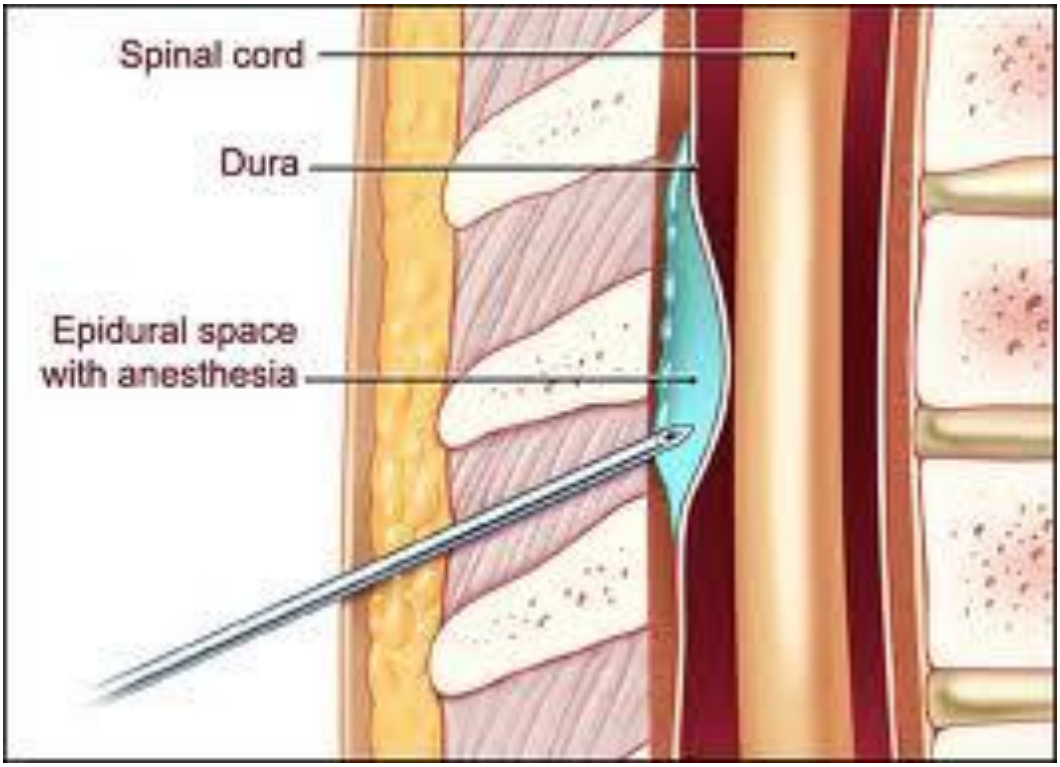


FIGURE 6: **EPIDURAL VOLUME EXPANSION**

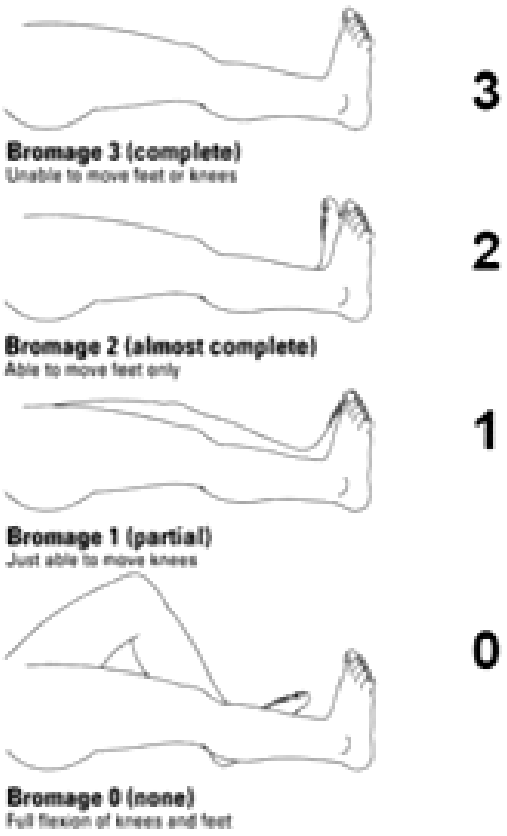


FIGURE 8 **BROMAGE SCORE**

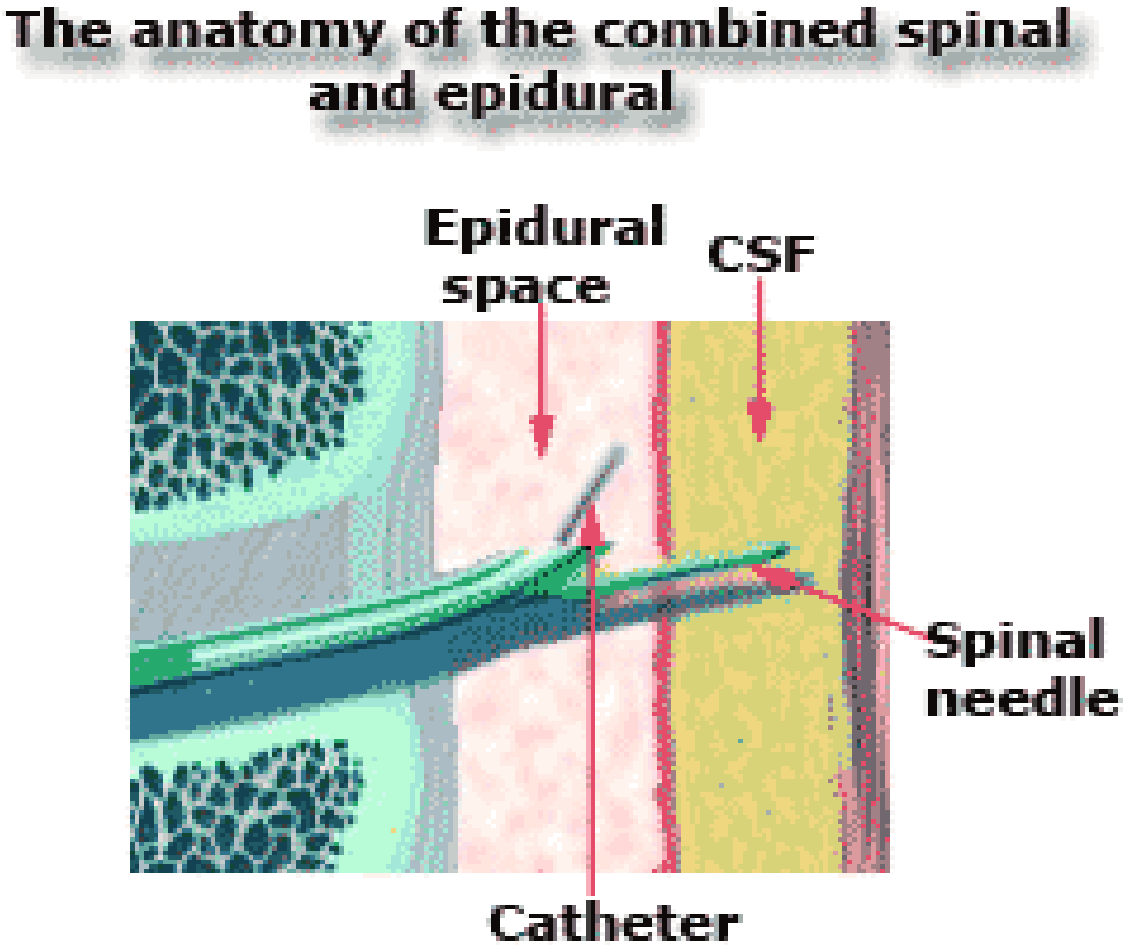

The anatomy of the combined spinal and epidural
Epidural space
CSF
Spinal needle
Catheter

FIGURE 5

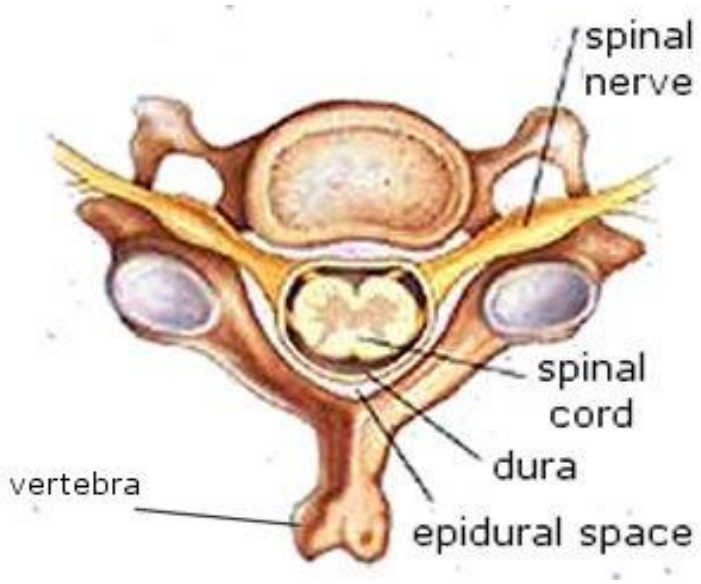


FIGURE 2: **CROSS SECTION OF SPINAL CORD**

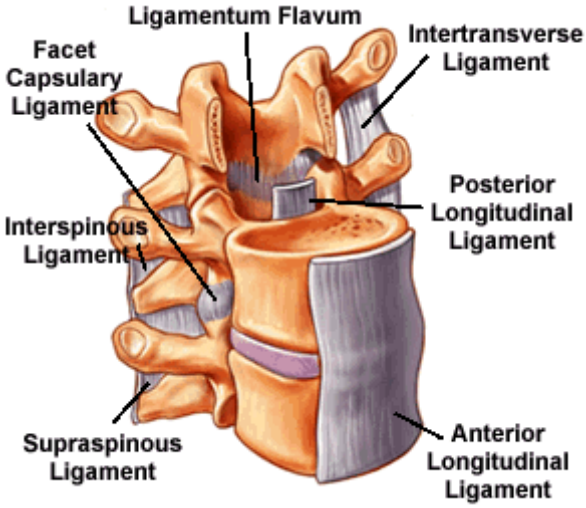


FIGURE 3: **SUPPORTS OF VERTEBRAL COLUMN**

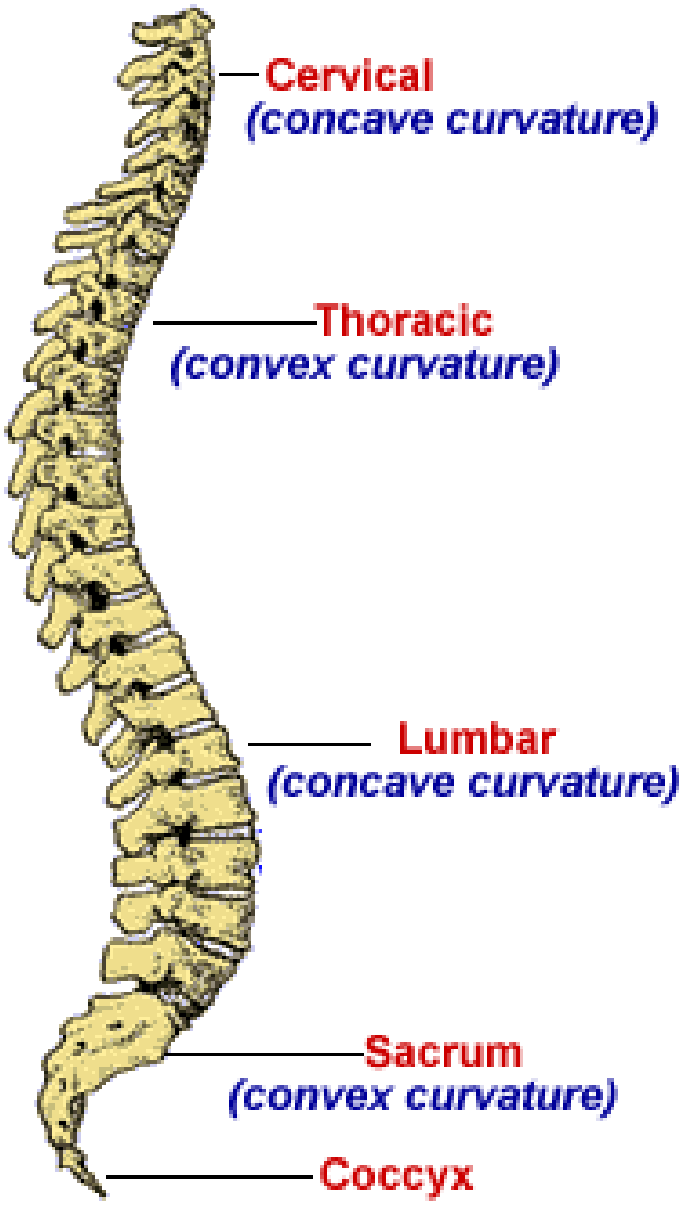
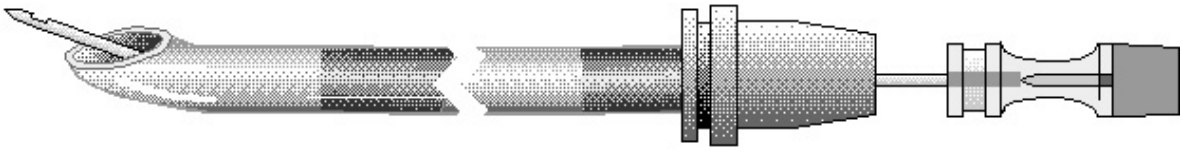
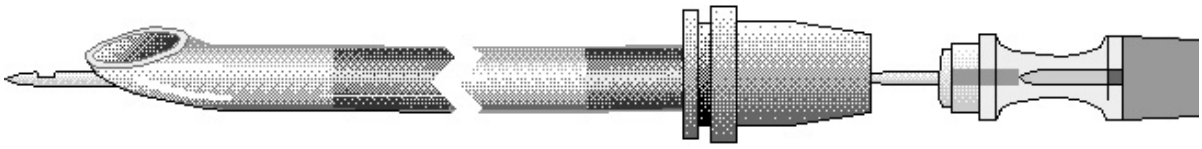


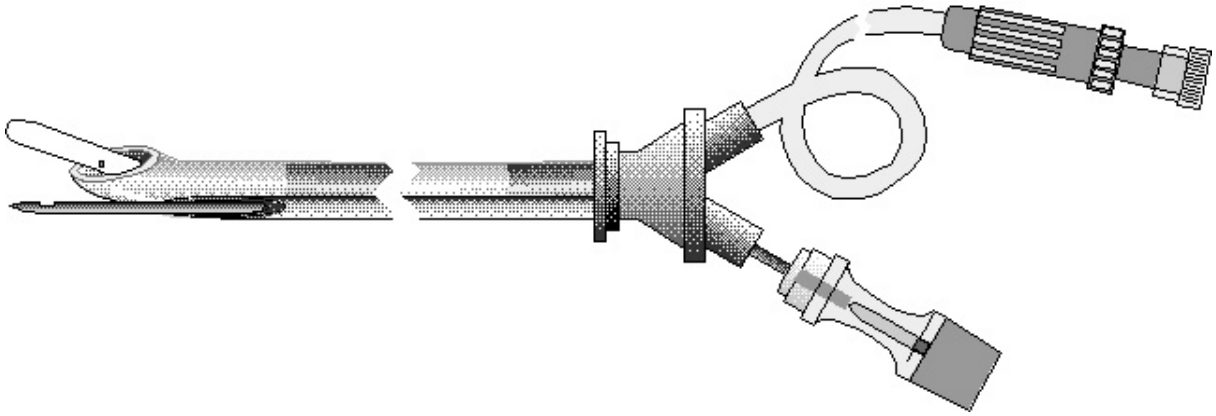
FIGURE 1: ANATOMY OF VERTEBRAL COLUMN



NEEDLE THROUGH NEEDLE



HUBER NEEDLE WITH A BACK EYE



ELDOR NEEDLES (Eldor, Coombs and Torrier modification)

FIGURE 7

often produce rapid onset of a dense block that causes significant hemodynamic instability and residual motor blockade, which usually lasts beyond the duration of surgery demanding prolonged post operative anaesthesia care. This could also lead to maternal anxiety. Even it does not provide post operative analgesia for longer time.

A search for alternative anaesthetic techniques to overcome these problems is on for a long time. Epidural Volume Expansion(EVE) is a modification of conventional sequential Combined Spinal Epidural(CSE) technique, in which SAB is induced with intrathecal local anaesthetic with or without opioids to produce a block which can be extended with epidural top ups of local anaesthetics or saline. Most of the studies[5,6,7,8] available in the literature have evaluated this technique using a conventional dose of intrathecal drug and have demonstrated a higher level of blockade and better post operative