A COMPARITIVE STUDY OF SPRING-LOADED SYRINGE WITH GLASS SYRINGE USING THE LOSS-OF-RESISTANCE (LOR) TECHNIQUE WITH SALINE FOR IDENTIFICATION OF EPIDURAL SPACE IN LUMBAR EPIDURALS

A STUDY OF 120 CASES

DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF UNIVERSITY

REGULATIONS FOR THE AWARD OF

M.D. DEGREE EXAMINATION

BRANCH X – ANAESTHESIOLOGY

THE TAMIL NADUDr. M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMIL NADU

APRIL, 2016

CERTIFICATE

This is to certify that this dissertation "**A COMPARITIVE STUDY OF SPRING-LOADED SYRINGE WITH GLASS SYRINGE USING THE LOSS-OF-RESISTANCE (LOR) TECHNIQUE WITH SALINE FOR IDENTIFICATION OF EPIDURAL SPACE IN LUMBAR EPIDURALS"** presented herein by **Dr. K. DINESH KUMAR** is an original work done in the Department of Anaesthesiology, KanyakumariGovt Medical College Hospital, Asaripallam, Nagercoil for the award of Degree of M.D (Branch – X) Anaesthesiology under my direct supervision and guidance, during the academic period of **2013 – 2016**.

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Professor and HOD,

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CERTIFICATE FROM GUIDE

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DECLARATION

I, **Dr. K. DINESH KUMAR** hereby declare that the dissertation titled **"A COMPARITIVE STUDY OF SPRING-LOADED SYRINGE WITH GLASS SYRINGE USING THE LOSS-OF-RESISTANCE (LOR) TECHNIQUE WITH SALINE FOR IDENTIFICATION OF EPIDURAL SPACE IN LUMBAR EPIDURALS"** has been prepared by me.

This dissertation work is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfilment of requirement for the award of M.D. degree, Branch – X (ANAESTHESIOLOGY) Degree Examination to be held in **April 2016**.

Place : Asaripallam

Date :

Dr. K. DINESH KUMAR

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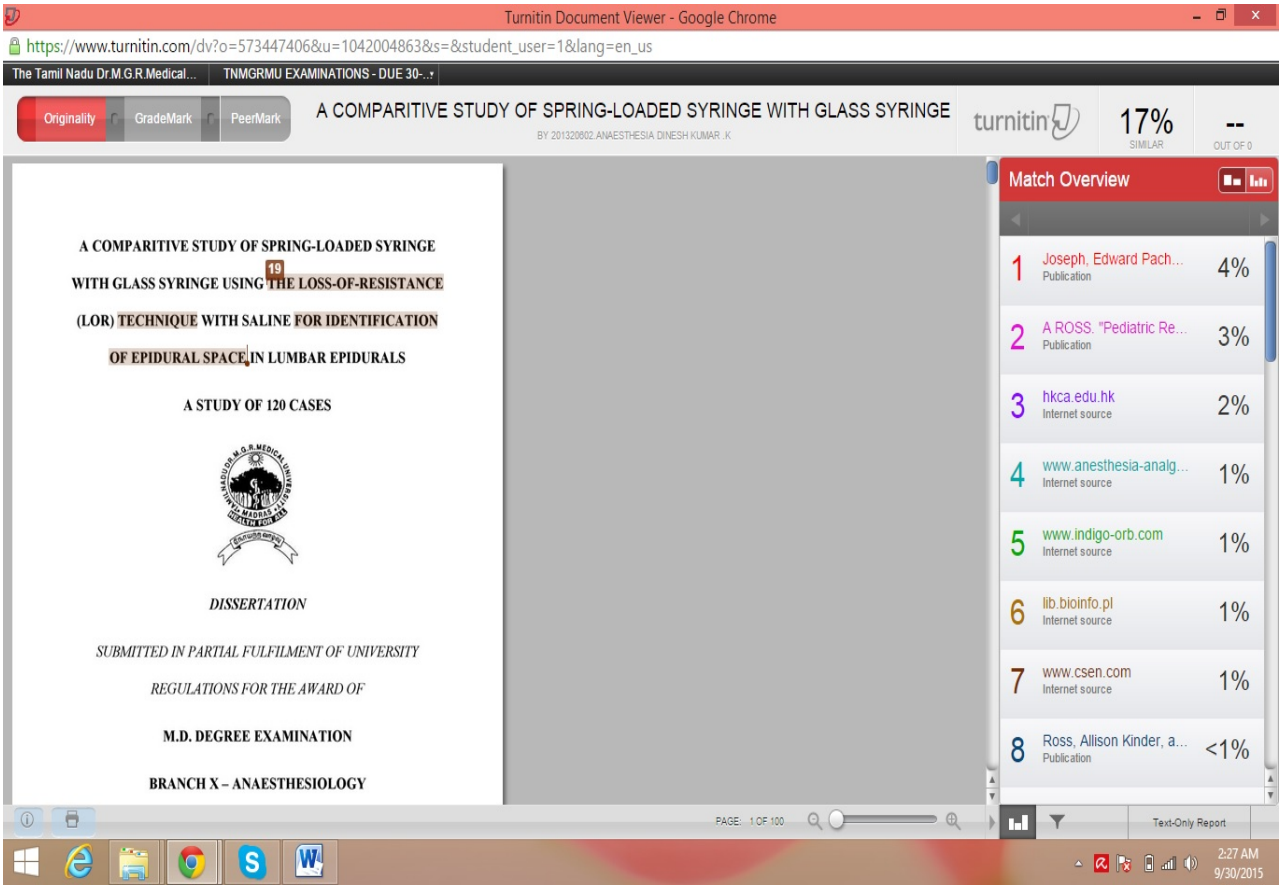

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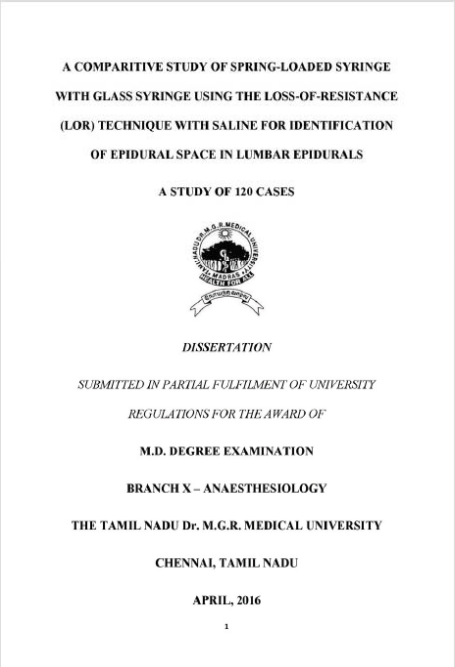

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INTRODUCTION:

Epidural anaesthesia and analgesia is a form of central neuraxial anaesthetic technique involving the injection of drugs, mainly local anaesthetic drugs in the epidural space, producing a reversible motor as well as sensory block. It is the most commonly performed regional anaesthetic technique for performing abdominal & lower limb surgeries. It can be performed either in conjuction with general anaesthesia or as a sole anaesthesia in recent years. It provides excellent operating conditions for surgical procedures below the umbilical level. It has a wide range of clinical applications for surgery & obstetrics, acute post-operative pain management and in chronic pain relief.

HISTORY

It was first introduced by *Leonard J. Corning*. Later it was first used in dogs by *Cathelin and Sicard* in 1901. First human usage was performed by *Kappis and Bleeck&Straiss*. The first lumbar epidural catheterization for surgery was performed by *Curbelo* of Cuba in 1947. The use of epidural morphine analgesia was first reported by *Behar* in 1979[1].

ADVANTAGES OF EPIDURAL ANAESTHESIA

Evidences demonstrate that epidural anaesthesia and analgesia reducesthe mortality and morbidityrelated to cardiovascular and pulmonary complications. This is particularly usefulin patients who are considered at-risk and high-riskand those undergoing complicated thoracic and abdominal operations[2]. More recently, the goals of epidural analgesia have shifted from reduction of morbidity and mortality in high-risk patients to facilitation of fast-track recovery in otherwise healthy patients undergoing various types of elective inpatient surgical procedures.

It can provide anaesthesia for prolonged surgeries with better hemodynamic stability.Plus, there will also be a choice to provide postoperative analgesia.Intubation &extubation responses as well as adverse physiologic responses to surgery in general anaesthesia are avoided. Airway manipulation is avoided and hence it is a desirable technique for asthmatics, patients with difficult airways, and full stomach. There is also proven benefit in orthopaedic hipsurgery in that there will be less thrombogenesis and subsequent thrombo-embolism. Bowel motility is increased as a result of sympathetic blockade with relatively uninhibited parasympathetic tone with less distension.

Consciousness is intact during the procedure which iscomfortable for arthroscopic procedures and caesarean sections.Post-operative nausea,vomiting

andsedationis reduced and pulmonary dysfunctionis less as a result of better pain control and virtually nil airway manipulation.

ANATOMY OF VERTEBRAL COLUMN

The vertebral column comprises of 33 numbers of vertebrae which comprise as follows: 7 in cervical, 12 in thoracic, 5 in lumbar, 5 fused in sacral and 4 in coccygeal. It also has four curves. The convex anterior curves include cervical and lumbar curves while the thoracic and sacral curves are concave posteriorly. This provides a pivotal role on the local anaesthetic spread in the epidural space.

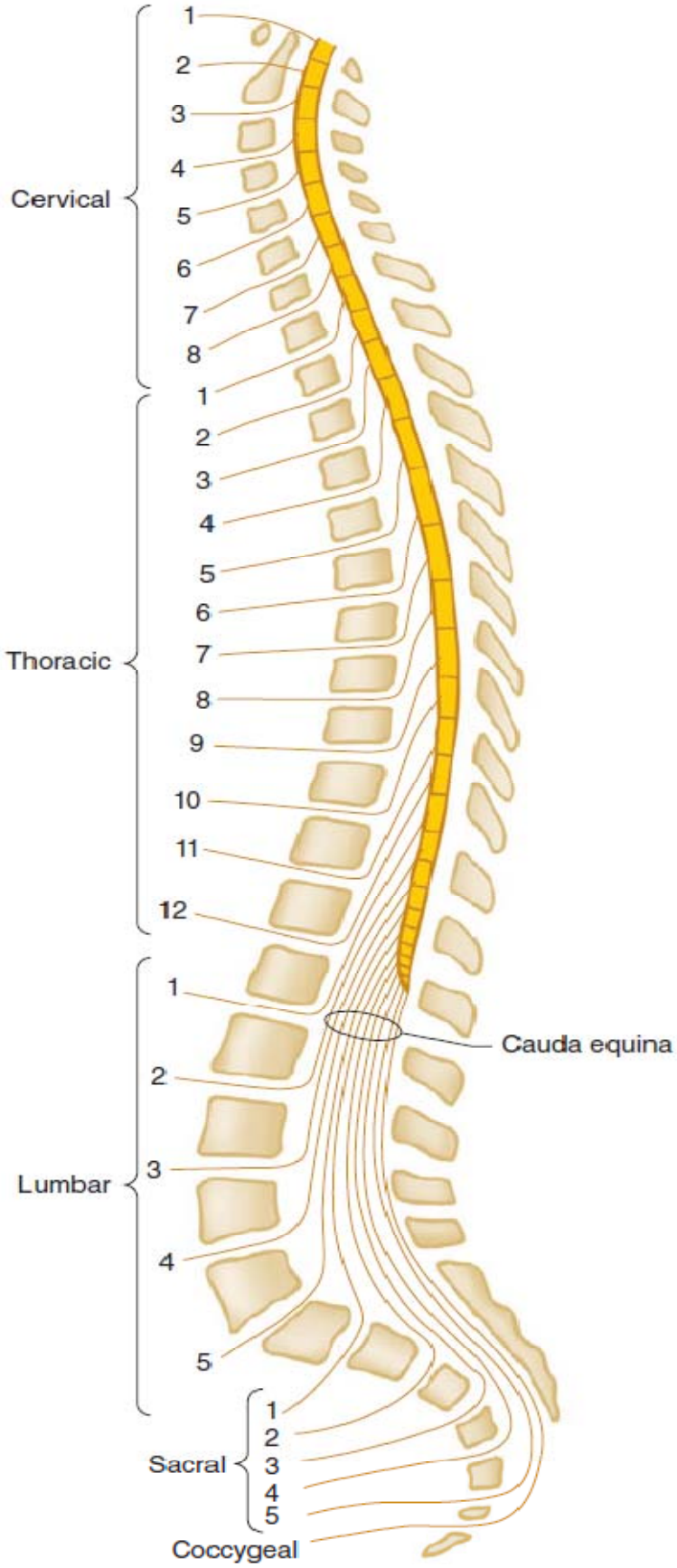

Fig. 1 Curvature of the Vertebral column

The vertebrae are bound together with several ligaments which give it stability and elasticity. The vertebral bodies are strengthened by five ligaments. Each ligament increases in size from the cervical and lumbar vertebrae.

They are

1. **Supra-spinous ligament** – A strong fibrous cord connecting the spinous process apices from C7 to sacrum, and then extends to external occipital protruberance as the ligamentum nuchae.
2. **Inter-spinous ligament** – Thin membranous ligament connecting the spinous processes. Later, itmerges with ligamentum flavum anteriorly and posterioly with the supraspinous ligament.
3. **Ligamentum flavum** – Also called as 'yellow ligament'. It comprise of yellowish fibres which are elastic in nature. It connects thenearby lamina and extends above from the vertebral caudal edge to the laminal cephalad edge below. Although classically portrayed as a single ligament, it is actually divided by the vertebral spines into two ligamenta namely right and the left, arising from each lamina and join to form an acute angle with a ventral opening in the middle[3,4]. In cadavers, it measures about 2–5 mm in thickness.

   From skull to sacrum, the ligamentum is not uniform nor within an intervertebral space. Ligament thickness, width to the dura, and skin to dural width vary with the vertebral canal area. The vertebral canal is

triangular and largest in area at the lumbar levels, and it is circular and smallest in area at the thoracic levels. The ligamental fusion or lack of fusion occurs variably in different levels of vertebra in various patients[10].

4. **Longitudinal ligaments** – Two in number. One is anterior to the vertebral bodies and hence called the anterior longitudinal ligament and second is posterior longitudinal ligaments. Both ligamentsbind the vertebral bodies together.

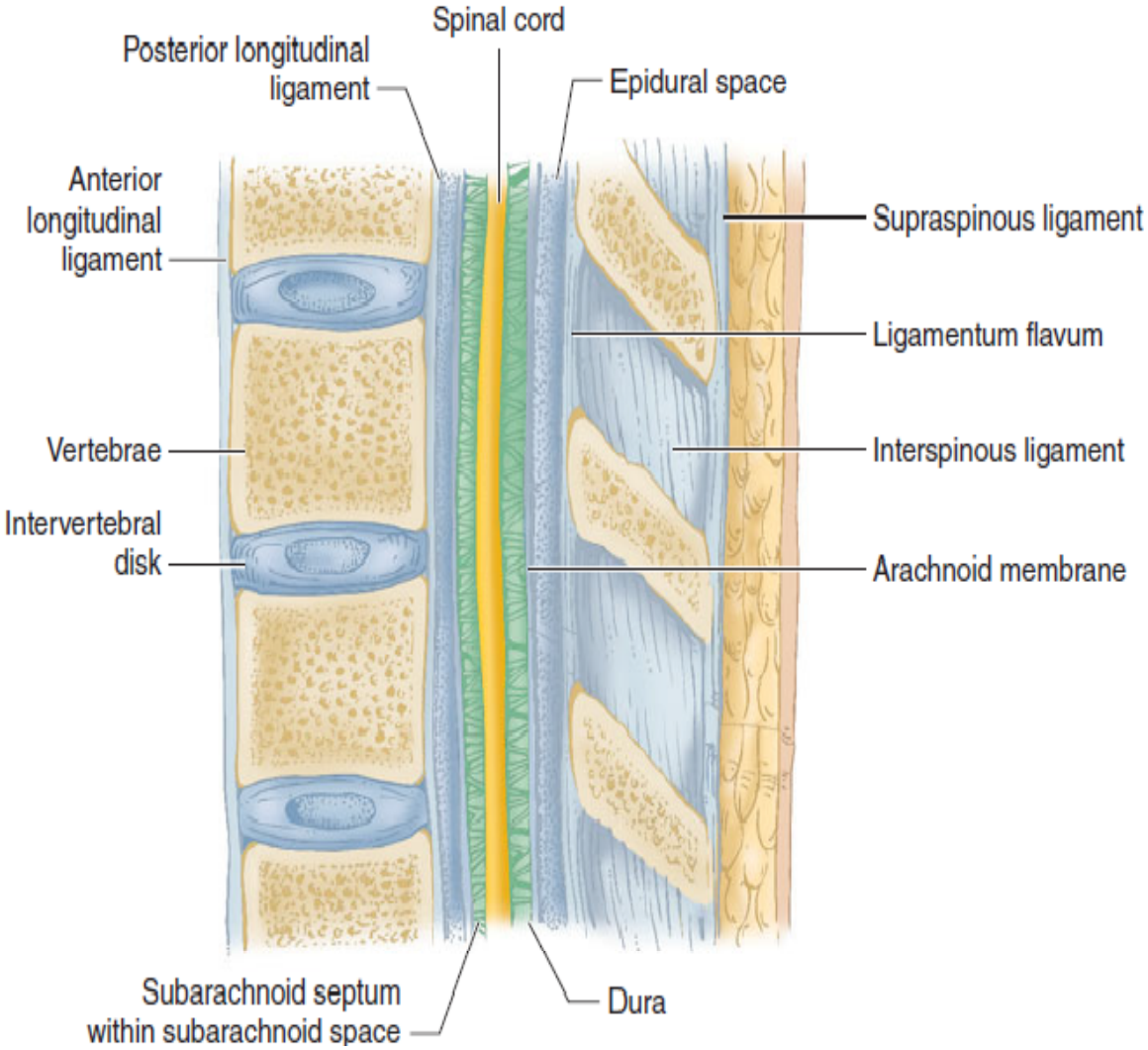

Fig. 2 Sagittal view of Vertebral column

LANDMARKS OF VERTEBRAL INTERSPACES

Various landmarks are used in identifying the vertebral level along with the vertebral interspaces. They include the spinous process of C2 which forms the first prominent spinous process in the back of neck. Next is the

spinousprocess of C7 which is the most prominent spinous process followed by T1. It is also called the vertebra prominens. The inferior angle of both scapulas can be traced to identify the spinous process of T7. An imaginary line drawn in connectionbetween both the iliac crests crosses the body of L5 or the L4–L5 interspace. This is called as the inter-cristal line or the Tuffier's line.

THE SPINAL CORD AND SPINAL NERVES

The spinal cord continues above with medulla oblongata as it commences from the level of foramen magnum and ends below as the conusmedullaris. It is cylindrical in shape, 45 cm in length in adults, flattened in the lumbar region. A thin thread, filumterminale is attached to the coccyx. At birth it extends to the lower border of L3 and rises to end in adult life upto the lower border of L1.

There are totally 31 pairs of symmetrically arranged spinal nerve roots:

8 Cervical

12 Thoracic

5 Lumbar

5 Sacral

1 Coccygeal

Cauda equina is created as a result of elongation of the nerve roots in lumbar and sacral region before they exit from the intervertebral foramen. It resembles that of the Horse's tail.

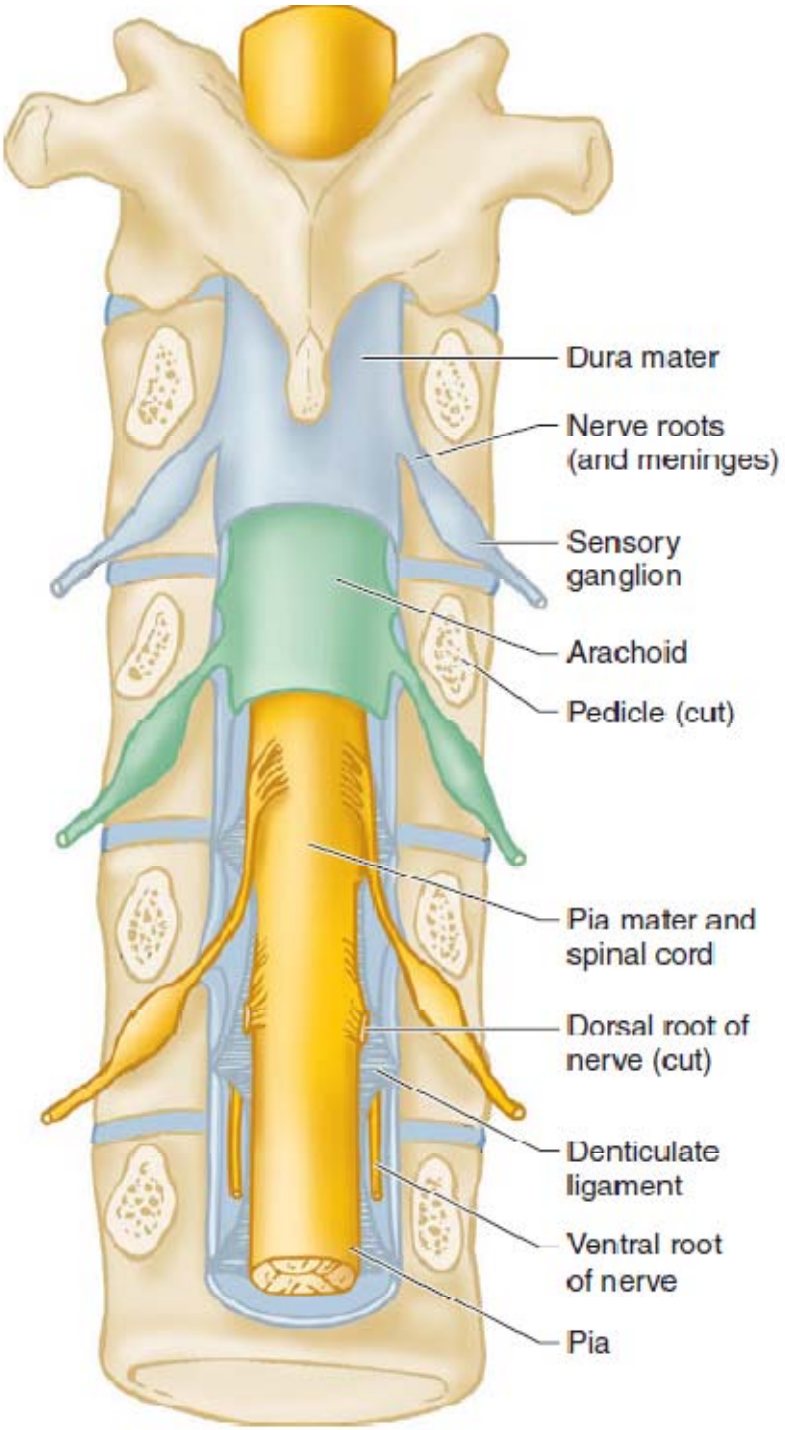

Fig. 3 Spinal cord in Adults

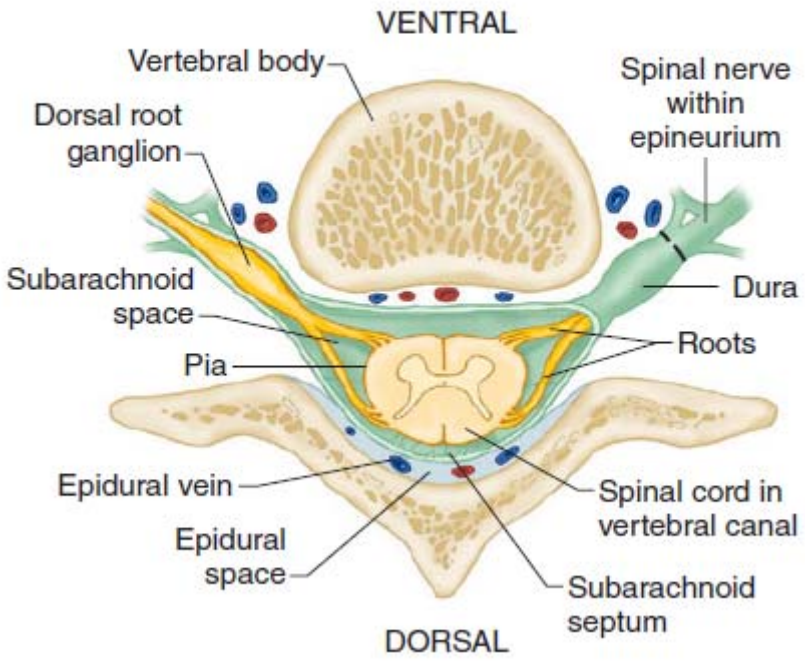

Fig. 4 Nerve root emerging from intervertebral foramen

ANATOMY OF EPIDURAL SPACE

Epidural space is a potential space extendingfrom foramen magnum cranially to lining membranesfusion at the sacro-coccygeal membrane, the sacral hiatus caudally, surrounding the dura mater. This space surrounds the dura mater anteriorly, laterally and posteriorly.

From skin, the following layers are encountered which include:

- Skin
- Subcutaneous fatty tissue
- Supra-spinous ligament
- Inter-spinous ligament
- Ligamentumflavum
- Epidural space

The widest partof the epidural space is at L2, where it is 5 mm in thickness.

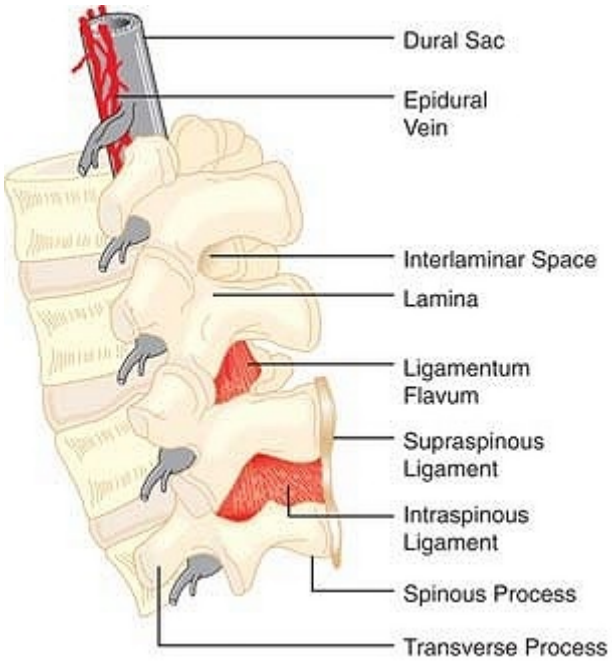

Fig. 5 Anatomy of Vertebral column

BOUNDARIES:

Anteriorly → Vertebral bodies, Inter-vertebral discs and Posterior longitudinal ligaments

Laterally → Vertebral arch pedicles and foramina between vertebrae

Posteriorly → Laminae and Ligamentumflavum

CONTENTS:

Epidural space contains the spinal nerve roots,blood vessels, Bateson venous plexus, lymphatics, fatty tissue andmainly loose areolar tissue.

The epidural fat has important effects on the pharmacology of epidurally and intrathecally administered opioids and local anesthetics.Its high lipid solubility leads to sequestration of opioids in the epidural fat with decreased bioavailability. Also the transfer of opioids to the intrathecal space fromthe epidural space is greatest inmorphine which is poorly lipid-soluble and comparatively least for the drugs like sufentanyl and fentanil which are more lipid-soluble.

Each segment is wedge-shaped and the segmental structure is more pronounced in midline. Some proposed that the epidural space has a saw-tooth pattern. These findings confirm that the epidural space is larger in the caudal part than in cephalic part by three to four times in each segment. In each segment, the lower end of epidural space is about 4 mm widewhile it is 6 mm in the upper end.

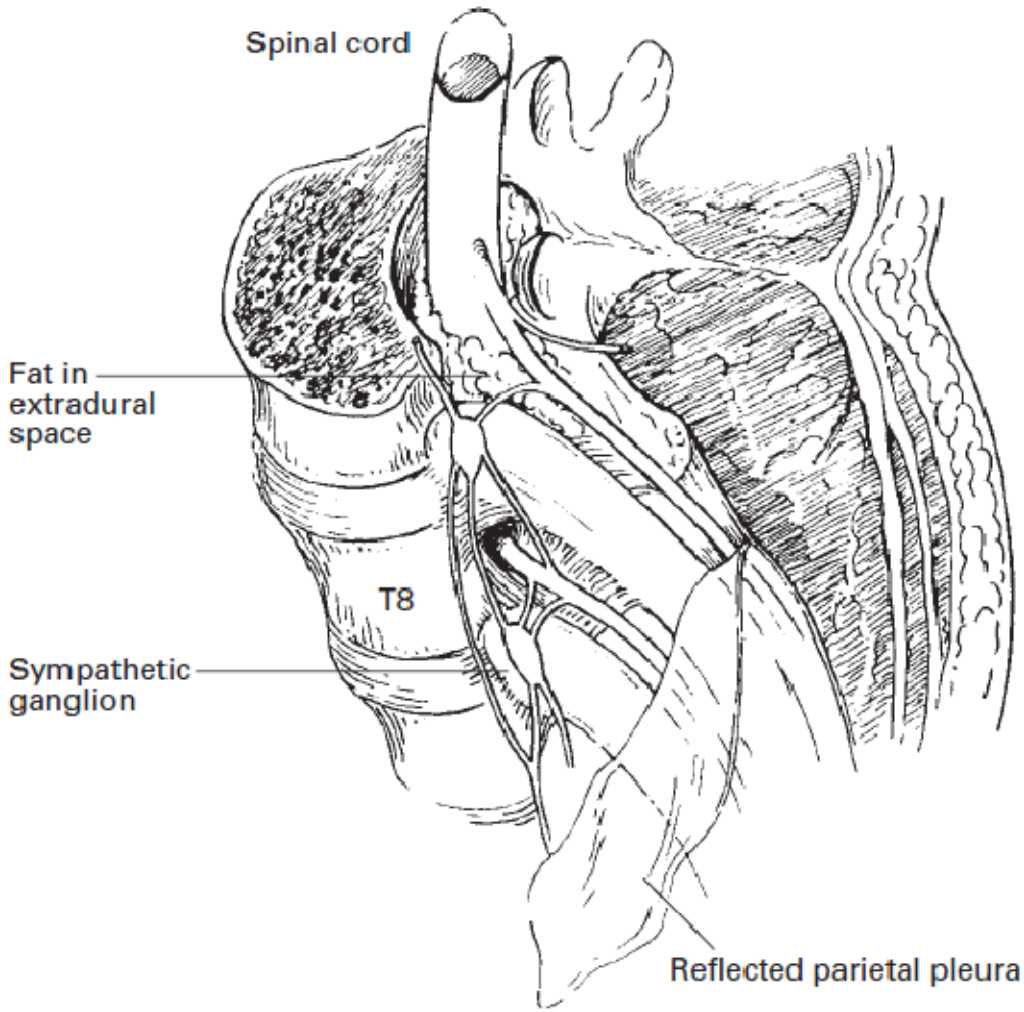

Fig. 6 The Epidural space

There is also a posterior fold of dura and it is called as the plicamedianadorsalis. It is nothing but an artefact createdas a result of increase inintrathecalpressure produced with injection. Also there are fibrousbands that extendto theligamentumflavumfrom the dura in a complicated way. It can divert epidural catheter.

For given level, the capacity of the space capacity is much greater compared to spinal space. In lumbar region, 0.3 mL of volume of the drug is enough for one segment with spinal while around 1.5–2 mLis needed to produce at the same level of anaesthesia by the epidural route. The main reason for this discrepancy is that when each of the spinal nerve passes into the paravertebral space, through its intervertebral foramen, it brings an array of fatty areolar tissue of the epidural space along with it.

The paravertebral spaces communicate via the epidural space not only serially but also contralaterallywith each other. But there is no direct communication existing between the paravertebral spaces adjacent.

The pressure in the epidural space is usually negative. It is because of the fact that there exists a communication of the epidural space with the para-vertebral spaces. In thoracic region, these paravertebral spaces are separated alone from the pleural cavities by the parietal pleura. This transmits the pressure changes that occur in the pleural cavity to the para-vertebral spaces in the thorax and finally to the epidural space. Taking a deep breath results in increase of the

negative epidural pressure whilecoughing out produces pressure increase in the space.

These changes occurring at epidural space are more prominent in the thoracic region. The epidural fat can act as a buffer and hence the pressure changes can get distributed progressively elsewhere and thus the negative pressure is not felt in the sacral or ends of epidural space. The negative pressure is also produced by the dural tenting which is produced as a result of the insertion of curved Tuohy needle pressed against the dura.

Approaching the epidural space is with a needle inserted in between the laminae or can also be approached caudally via the sacral hiatus. The distance between the lumbar vertebral laminae and the posterior aspect of the spinal cord is 5 mm. The distance from the skin to the lumbar epidural space varies in between 2 cm - 7 cm with approximately of 3 – 5cm in the most of the population.

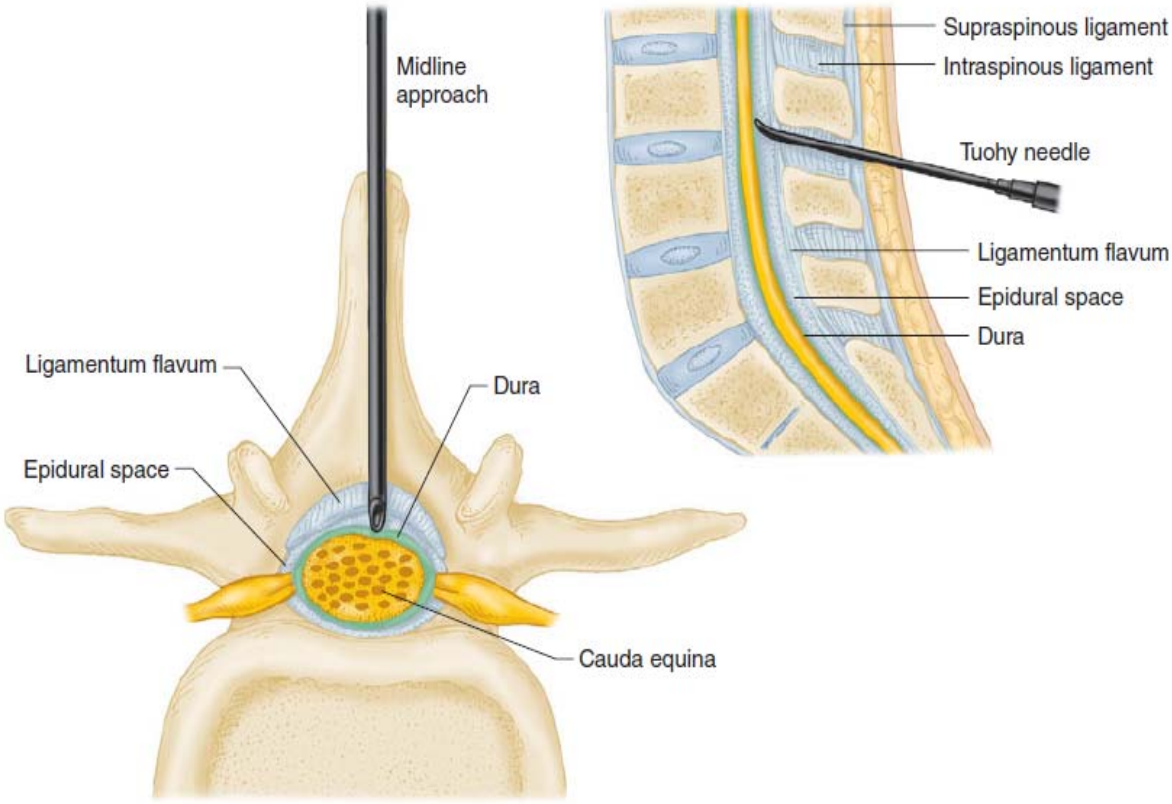

Fig. 7 Lumbar epidural anaesthesia

The epidural space comprises of a venous network. They passin longitudinal direction. It comprises to four main trunks, with two trunks located on either sides of theposterior longitudinal ligament whilethe other two trunks lie posterior andfront of the vertebralarches. There exists a free communication by forming venous rings at the level of each vertebra.

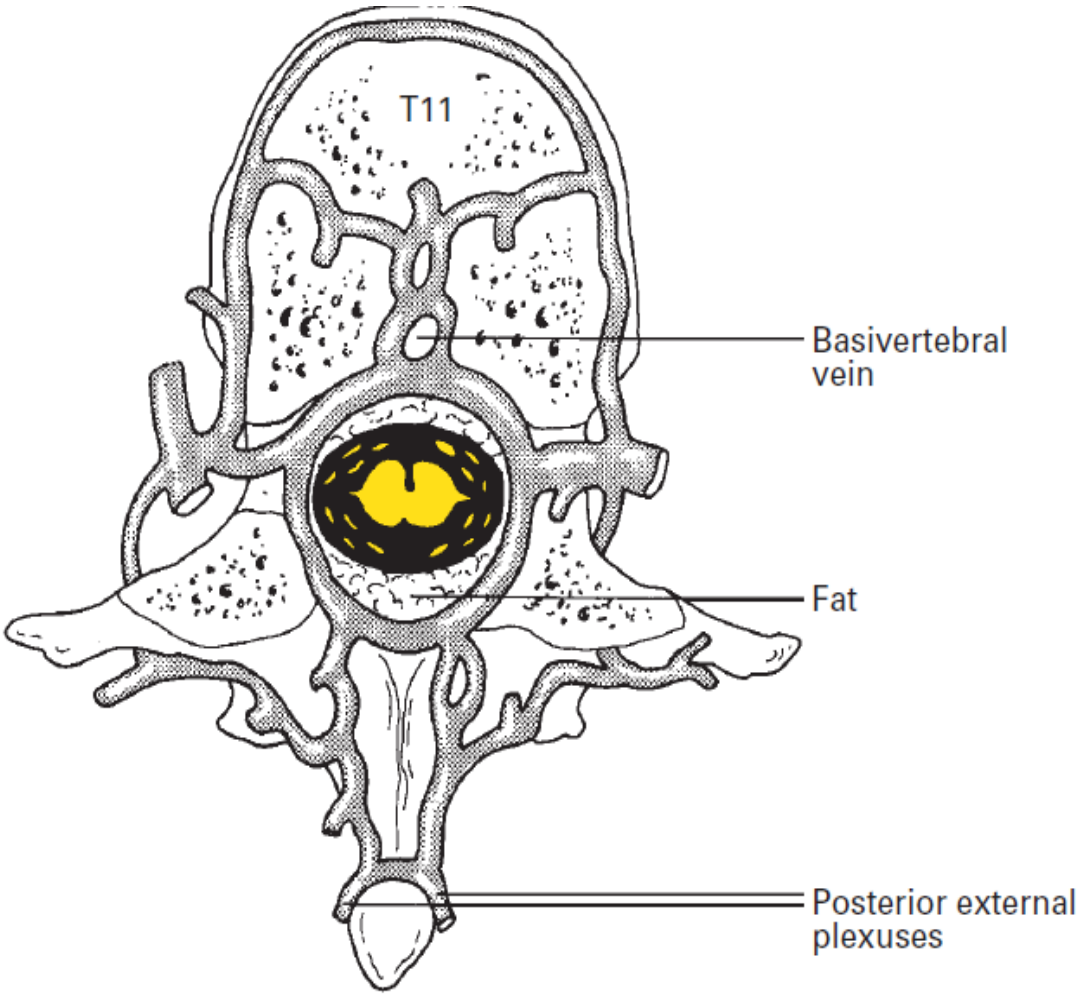

Fig.8 Transverse section showing the epidural venous network and the connections with external vertebral venous plexuses.

The basivertebral veins exit from respective vertebral body on the posterior part. It also receives twigs from the vertebral,ascending cervical, deep cervical, intercostal, lumbar, ilio-lumbar and lateral sacralveins. They all enter into the intervertebral and sacral foramen in a serial manner.

These veins are called valveless vertebral venous plexusof Bateson. It forms a communication from the cerebral veins above to pelvic veins below. Hence it providesa possible pathway for the spread of both bacteria andmalignant cells.

The pressure in the CSF is increased in straining and coughing, it resultsin the shunt of blood into thesethin-walled vertebral veins from the abdominal and thoracic veins. Thus in case of increasedthoracic or abdominal pressure, these veins get distended more readily and make a bloodytap.

The arteries are less significant and they emerge fromthe arteries that lie adjacent to theirrespective venous system. Theyall enter into their intervertebral foramen and located primarily in lateral aspect of epiduralspace. It mainly supplies the ligaments, spinal cord and adjacent vertebrae.

PREGNANCY:

Mechanical changes in the vertebral column also contributeto altered response to anesthetic solutions injected into theepidural or subarachnoid space. The epidural space can beregarded as a rigid tube that contains two fluid-filleddistensible tubes, the dural sac and the epidural veins, inaddition to epidural fat. The amount of epidural fat gets enlarged and theepidural veins get distended during pregnancy and so theCSFvolumein spinal level is reduced.

In lateral decubitus position, lumbar epidural pressure becomes positivein term pregnant women but negative in more than 90% of non-pregnant women.Turning a parturient fromthe lateral decubitus to supine position results in an increasedpositive epiduralpressure which increases even further during parturition.This greater pressure results from augmentation of diversion ofblood in the veins through the vertebral plexus, specificallyfrom either aorto-caval compression in supine position or increased intra-abdominalpressure during parturition. The epidural pressurereturns to the non-pregnant level by 6 to 12 hourspostpartum.

The CSF pressure remains unchanged as in non-pregnant women although the epidural veins compress the dural sac.Uterine contractions andpushing result in increased CSF pressure that is secondaryto acute increases in epidural vein distention.

EPIDURAL IN PEDIATRIC POPULATION

ANATOMY

Epidural space in children has 4 levels. They include the sacral, lumbar, thoracic and cervical levels. A caudal epidural involves injection at the sacral level. A lumbar epidural involves placement of the needle or catheter into the L3-4 interspace. It can be traced in older children where it is found in the line

that is drawn in connection between the highest point of two iliac crests in midline. The landmarks are almost accurate in older children. But in neonates, the intercrestal line crossesat the level of the L5-S1 interspace while in infants up to the age of one year, it crosses at the L4-5 interspace. This discrepancy is due to the growth lag of the spinal cord. Because of the developmental changes occuring withdural sac positions and the spinal cord, the placement of an epidural catheter below the level of the intercrestal line decreases the incidence and risk of obtaining a wet tap in a neonate or young infant.

Epidural pressures vary according to the age of the patient in which epidural is performed. Infants up to the age of one year have narrowed epidural spaces. Hence they are more likely to show some leak around the injected epidural catheter. This is mainly as a result of backflow of the injected drug solution if done in faster rate. However, even at slow injection rates, in infants, the epidural pressures are always higher for the same level when compared to adults.

In pediatric population, the thoracic spine anatomy is almost similar to that of the lumbar spine. But there are some exceptions. They include the spinous processes of the thoracic area, which are longer when compared to the adult population. Another is the interspinous spaces, which aremuch narrower. These differences should be kept in mind during the insertion of the epidural needle, with a sharper angle in a cephalad direction. Also thevertebral ligaments

in the thoracic area are more lax. This makes the needle insertion more difficult to discern when compared with the performance of a lumbar epidural needle insertion of the same patient. And mainly,most of the spinal canal area in the thoracic level is occupied primarily by the spinal cord. Hence, utmost caution should be borne in mind while performing the thoracic epidural, leaving only a little margin for error when the needle reaches the epidural space.

TECHNIQUE

Most commonly, the child will be placed in the lateral position with knees and hips flexed to the chest. Then the line that joins the two iliac crests should be identified. The intercrestal line varies in its level of crossing, depending on the age of the patient. In neonates, it crosses the body of S1 while in infants, it crosses at L5. It crosses the L4-5 level in young children, and finally at L4 in older children and in adolescent population. After sterile preparation and draping, local anaesthetic is infiltrated over the skin area where the epidural is performed. Then the epidural needle is placed in the midline between the spinous processes that are being closer to the intercrestalline and the needle should be directed slightly cephalad but almost at perpendicular angle to that of the skin. Then needle is slowly advanced with one hand holding firmly against the child's back and holding the needle portion that is entering the child's skin. The purpose of this is to prevent any inadvertent and over-shooting of the epidural needle. The layers traversed by the needle are the same as that of

the adult, i.e., skin, subcutaneous tissue, the supra-spinous ligament, inter-spinous ligament, and then the ligamentumflavum before entering the epidural space. In correct identification of the epidural space, the recommended approach is to use a continuous loss of resistance technique using saline to confirm the epidural space. Usage of air is not recommended as it carries a risk of causing air embolus.

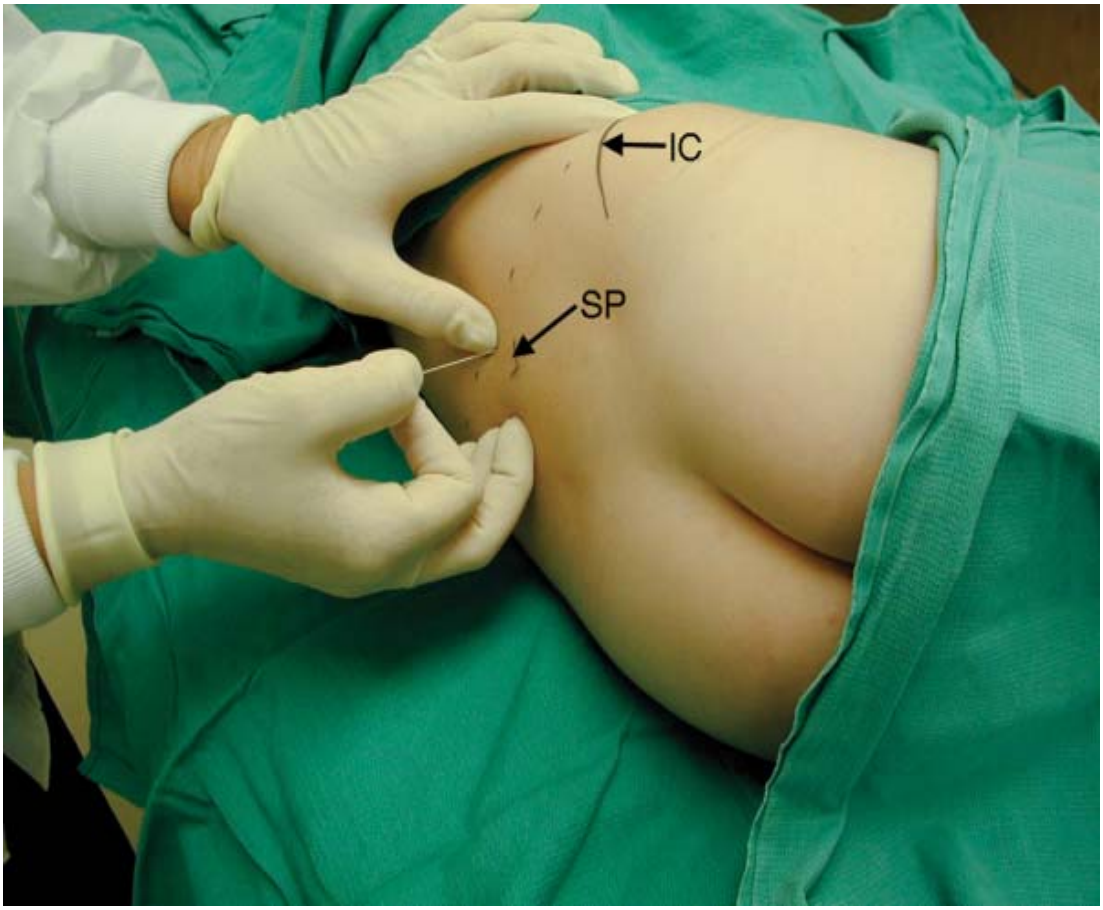

Fig. 9 Epidural in pediatric population

In infants, there is only subtle ability in feelingthe entry into the ligamentumflavum with the loss of resistance as the epidural space is entered when compared to the classical loss of resistance “feel” in adults. After successful identification of the epidural space, the needle should be aspirated for CSF or blood. After negative aspiration, a small amount of the desired local anesthetic with epinephrine should be injected initially as an initial test dose before delivering the planned dose of local anesthetic. In infants, based on the relationship between rate of injection of local anesthetics, volume of the drugand the epidural pressure, a slow rate of injection is used. It is recommended to use 0.5 mL/min.

The child is positioned in the lateral decubitus position. After sterile preparation and draping, the epidural needle inserted at the midpoint of the spinous processes in the desired level. Needle is directed at an angle of 45- to 60-degree and in slightlycephaladdirection until resistance is felt as the needle encounters the various spinous ligaments. A syringe to detect loss of resistance to saline is attached and the needle is continuously advanced slowly with light pressure on the plunger of the syringe. A sudden loss of resistance indicates the needle is in the epidural space. One of the characteristic features of a successful thoracic epidural needle placement is the ease at which a catheter is threaded in this area. It should pass easily and without any resistance.

EQUIPMENT

Appropriate-sized short Touhy needles and small-gauge catheters, with and without metal helixes, loss of resistance syringe and local anaesthetic should bekept on the tray. Main disadvantage in using a small-gauge catheter is that they exhibit increased resistance to continuous infusions of local anesthetics. Postoperatively this can result in frequent alarming of the infusion pump.

DOSING

Epidural catheters are kept in-situ with the main purpose of continuing their use in the post-operative period. The tip of the catheter should be in close proximity to the level of surgery. Because the lumbar/thoracic epidural space is more compact than the caudal space, the initial bolus of local anesthetic required for lumbar and thoracic epidural blocks is smaller than the volumes required for a caudal injection. The dosage is 0.3 – 0.5 mL/kg for thoracic epidural. Approximately 90 minutes after the test dose, the continuous infusion may be administered with care in staying within the dosing guidelines. Local anesthetics used commonly for epidural analgesia include Bupivacaine, Levobupivacaine, and Ropivacaine.

PHYSIOLOGIC EFFECTS OF EPIDURAL ANAESTHESIA

Neuraxial anaesthesia causes efficient blockade of sympathetic, sensory and motor nerves. It also blocks the compensatory reflexes of sympathetic system and provides an unopposed parasympathetic activity. The physiologic effects of epidural anaesthesia are similar to those of spinal anaesthesia, with the exception that local anaesthetic blood levels reach concentrations sufficient enough to produce systemic effects.

CARDIOVASCULAR

Neuraxial blockade effect on blood pressure is comparableto the effects produced with co-administrated use of α1-and β-adrenergic blockers intravenously on cardiac output which leads to decreasedstroke volume and heart rate. It is caused byblockade of the peripheral (T1-L2) and cardiac (T1-T4) sympathetic fibers as well as adrenal medullary secretion.

The decrease in arterial blood pressure is believed to bemore gradual and of less magnitude with epidural thanwith spinal anesthesia of comparable levels. Of prime importance is the rate of fall of arterial blood pressure which depends patient age, intravascular volume status, etc...

Epidural anesthesia is safer in Pulmonary artery Hypertension patients. Epidural anesthesia ispreferred in this scenario as the rate of fall of blood pressure secondary to fall in systemic vascular resistance is gradual and more predictable. However, invasive monitoring is still suggested in monitoring of vitals as the magnitude is almost the same in both epidural and spinal anaesthesia. The patient should be augmented with preload. More importantly, the medications to treat sudden fall in systemic vascular resistance or changes in rate are kept ready.

Stroke Volume:

Sympathectomy usually decreases stroke volume. Venous vasodilatation reduces preload (venous return) and arterial vasodilation reduces afterload (systemic vascular resistance). Approximately 75% of the total blood volume resides in veins and the veno-dilation effect predominates, owing to the les smooth muscle in venules while there is adequate smooth muscle in arteries which provide the intrinsic autonomous tone.

Cardiac output is thought to be either maintained or slightly decreased during the onset of epidural anesthesia. Yet a biphasic response, characterized by an early transient increase followed by an eventual decrease in cardiac output has been observed. This initial increase is caused by a greater magnitude of

decline in the systemic vascular resistance than by venous return, especially in elderly patients with preexisting hypertension and high baseline systemic vascular resistance.

The vasodilatory changes after neuraxial blockade that can affect cardiac output depend on each patient's baseline sympathetic tone (i.e., higher sympathetic tone in the elderly equates to a greater hemodynamic change) and the extent of the sympathectomy (i.e., the height of the block). The extent of the sympathectomy is typically described as extending for two to six dermatomes above the sensory block level with spinal anesthesia and at the same level with epidural anesthesia. If normal cardiac output is maintained, systemic vascular resistance should decrease only 15% to 18% after neuraxial blockade in healthy normo-volemic patients, even with nearly total sympathectomy. In elderly patients with cardiac disease, systemic vascular resistance may decrease almost 25%, whereas cardiac output decreases only 10%.Determination of baseline autonomic nervous system activity (e.g., blood pressure variability signaled by low-frequency band power and near-infrared spectroscopy reduction) has been found to predict the risk of hypotension in the elderly.

Heart Rate

Heart rate may decrease during a high neuraxial block. It occurs primarily secondary to cardio-accelerator fibres blockade from T1-T4.Bradycardia occurs also in extensive peripheral sympathectomy (T5-L2), with venous pooling in the lower extremity and the abdominal and pelvic viscera.

Although hypotension will trigger a compensatory baroreceptor sympathetic response (vasoconstriction and increased heart rate) above the level of blockade, thereduction in venous return and right atrial filling causes a decreased signal output from the chronotropic stretch receptors located in the great veins and right atrium, leading to a marked increase in parasympathetic activity (vagal tone). The two opposing responses are usually in check with a minimal change in heart rate (or a slight reduction)[5].

However, when neuraxial anesthesiais extended to the T1 level, blockade of the cardio accelerator fibers in addition to a marked reduction in venous return may result in severe bradycardia and even asystole because of unopposed parasympathetic activity. However, the likelihood of cardiac arrest, though rare, appears to be more likely in young, healthy and conscious patients.

Coronary Blood Flow

When coronary artery blood flow and myocardial metabolismwere determined in humans during neuraxial anesthesiain coronary blood flow (153 to 74 mL/100 g per minute)paralleled the fall of mean arterial blood pressure(119 to 62 mmHg), and the percent extraction of myocardial oxygen was unchanged (75% to 72%). Extraction of oxygen was unchanged because myocardial work, as expressed by myocardial use of oxygen, paralleled the decrease in mean arterial blood pressure and coronary blood flow (16 to 7.5 mL/100 g per minute) [6].

A high thoracic block in patients with ischemic heart disease can be beneficial, with improvement in global and regional myocardial function and reversal of ischemic changes likely as a result of reduced myocardial oxygen demand and left ventricular afterload[7].

Both infarction size and ischemia induced arrhythmias improved in coronary occlusion experiments in animals, with no apparent vasodilatory effect on the coronary vessels.

CENTRAL NERVOUS SYSTEM

Neuraxial anesthesia-induced hypotension may decrease regional cerebral blood flow (CBF) in elderly patients and those with preexisting hypertension.

Both CBF and velocity decline as a result of changes in the cerebral vasculature, especially in the elderly. Whether cerebral auto-regulation is impaired in the elderly is still debatable.

RESPIRATORY SYSTEM

Alterations in pulmonary variables in healthy and even inelderly patients during neuraxial block are usually of little clinical consequence. A decrease in vital capacity follows a reduction in expiratory reserve volume related to paralysis of the abdominal muscles necessary for forced exhalation rather than a decrease in phrenic or diaphragmatic function. Abdominal and intercostal muscular blockade during neuraxial anesthesia is equally compensated with effective contraction of the diaphragm and other accessory respiratory muscles (e.g., sternomastoid, scalenes), especially for forceful inspiration and expiration.

Nonetheless, neuraxial block techniques must be used carefully in patients of severe respiratory compromise. This is because of the blockade of the abdominal and intercostals muscles which further worsen the respiratory pathology. Incidence of respiratory arrest is rare, if occurs, it is due to reduced blood flow to the brain stem respiratory centers. The apnea thus produced gets disappeared soon after the pharmacologic and fluid therapies in restoration of blood pressure and cardiac output.

PREGNANCY

Uterine enlargement and vena caval compression result in engorgement of the epidural veins. Unintentional intravascular cannulation and injection of local anesthetic are more common in pregnant patients than in non-pregnant patients. In addition, the vertebral foraminal veins, which are contiguous with the epiduralveins, are enlarged and obstruct one of the pathways for anesthetic regress from the epidural space during administration of epidural anesthesia. The enlarged epidural veins also may displace cerebrospinal fluid (CSF) from the thoraco-lumbar region of the subarachnoid space, as does the greater intra-abdominal pressure of pregnancy.

The effect of neuraxial anesthesia on utero-placental blood flow depends on the complex interaction of many factors. Blood flow to uterus is increased with neuraxial blockade. This is by providing sufficient pain relief, decreased sympathetic trigger and reduced maternal hyperventilation. On the other hand, uterine blood flow can be reduced due to hypotension, accidental systemic local anaesthetics injection, addition of epinephrine and local anesthetic absorption (little effect).

Epidural anesthesia during labor may result in increased maternal as well as fetal temperature, possibly because epidural anesthesia impairs the maternal thermo-regulatory response to warming mainly by increasing the thermoregulatory sweating threshold and also it preventing leg sweating.

OBESITY

The impact of neuraxial anesthesia on lung volume variables is significantly reduced compared with general anesthesia but is significantly more in overweight patients than in normal-weight patients. The magnitude of decline in vital capacity is proportional to the BMI value (vital capacity−19% for BMI 30 to 40 kg/m^2 versus −33% for BMI>40 kg/m^2). Importantly, however, for obese patients undergoing laparotomy surgery, thoracic epidural anesthesia lessens the extent of decline in post-operative vital capacity and hastens recovery when compared with parenterally administered opioids.

GASTRO-INTESTINAL

Neuraxial anaesthesia of segments between T6 and L1 deranges splanchnic sympathetic supply to the gut. It causes gut contraction and leads to hyper-peristalsis. Because of the unopposed parasympathetic (vagal) activity and hyper-peristalsis, there is nearly 20 % incidence of nausea and vomiting. Atropine is effective in treating nausea associated with high (T5) neuraxial anesthesia.

Thoracic epidural anesthesia (TEA) has a direct blood pressure dependent effect on intestinal perfusion. TEA improves anastomotic mucosal blood flow in patients undergoing esophagectomy when mean arterial blood pressure is

minimally altered but worsens local perfusion when arterial blood pressure is decreased by about 50%.

In colorectal surgery, TEA decreases anastomotic blood flow but improves gastric and transverse colonic blood flow. Correction of systemic hypotension by vasopressor therapy (e.g., norepinephrine) has been found to reverse impaired colonic perfusion. TEA may also reduce the rate of anastomotic leak after emergency laparotomy, esophageal surgery, and other gastrointestinal interventions[52].

A reduction in hepatic blood flow parallels the reduction in mean systemic arterial pressure in the setting of spinal anesthesia. Although lumbar epidural anesthesia also results in a decline in hepatic perfusion despite colloid preloading in young and elderly patients, hepatic perfusion can increase, though mildly (<10%), with TEA after major abdominal surgery.

RENAL

There occurs a predictable decrease in blood flow to the renal system following neuraxial blockade, but this decrease is not significant. One aspect of genitourinary function of clinical importance is the belief that neuraxial blocks are a frequent cause of urinary retention, which delays discharge of out-patients

and necessitates bladder catheterization in inpatients. However, this belief is questionable.

In any case, excessive volumes of intravenous crystalloid solutions should not be given to patients undergoing neuraxial anesthesia. The requirement for voiding before discharge in low-risk ambulatory surgery patients after epidural anesthetics should be encouraged.

EPIDURAL ANAESTHESIA WITH ANTICOAGULANTS

ANTI-PLATELET MEDICATIONS

No contraindication with NSAIDs. Discontinue ticlopidine for 14 days, clopidogrel for 7 days and GP IIb/IIIa inhibitors for 8-48 hours in advance.

UNFRACTIONATED HEPARIN

Subcutaneous

No contraindication with twice-daily dosing and in total daily dose <10,000 U. Consider delaying the heparin dose until after block if technical difficulty anticipated. The safety of neuraxial blockade in patients receiving doses >10,000 U of UFH daily, or more than twice daily dosing of UFH has not

been established. Needle placement is 8-12hours after the dose; subsequent dose can be given 2 hours after the block or after the withdrawal of the catheter.

Intravenous

Needle placement and catheter removal can be done 4 hours after discontinuing heparin, heparinize 1 hour after neuraxial technique. Delay the bypass surgeryfor 12 hours if traumatic.

LMWH

Twice-daily dosing: LMWHis given 24 hours after surgery, regardless of technique; remove neuraxial catheter2 hours before the first LMWH dose.

Single-daily dosing: Neuraxial block should be delayed for at least10-12 hours after LMWH; next dose is given 4 hours after needle or catheter placement.

Therapeutic dose: Delay block for 24 hours

FACTORS AFFECTING EPIDURAL LOCAL ANESTHETIC DISTRIBUTION AND BLOCK HEIGHT

	More Important	Less Important	Not Important
Drug Factors	Volume	Concentration	Additives
	Dose		
Patient Factors	Elderly age	Weight	
	Pregnancy	Height	
		Pressure in adjacent body cavities	
Procedure Factors	Level of Injection	Patient Position	Speed of Injection
			Needle orifice direction

DRUG FACTORS

Increased volume of local anaesthetic drug results in greater spread and density of block as well as increased distribution in cephalad direction. Dosage of the drug is also important with volume in determining spread and density of block as increasing dose results in increased duration and density while drug concentration is relatively less important in determining block spread. Addition of additives like adrenergic agonists (epinephrine 1:200,000) prolongs duration of local anaesthetics mainly by decreased absorption from epidural space or direct inhibitory effect of epinephrine on sensory and motor neurons.

Drug distribution in the epidural space is more by the following mechanisms:

1. Crossing the dura mater into the subarachnoid space
2. Rostral and caudal (longitudinal)spread within the epidural space
3. Circumferential spread within the epidural space
4. Exit of the epidural space through the intervertebral foramina
5. Binding to epidural fat
6. Vascular absorption into the epidural vessels.

PATIENT FACTORS:

Patient age plays a vital role in epidural anaesthesia as there will be greater spread in elderly because of less compliant epidural space and decreased likelihood of local anaesthetic solution to escape via intervertebral foramina. Height and weight have a weak correlation except at the extremes of ends. Pregnancy has a conflicting data while relationship with atherosclerosisis not confirmed.

Epidural catheters are inserted through a curved-tip Tuohy needle to help the catheter in directing away from the dura mater. The operator encounters resistance when the catheter reaches the curve of the needle, but using gradual and steady pressure, it passes smoothly into the epidural space. Probable reason for failure in threading an epidural catheter is that the tip of the epidural needle was bent during its contact with the vertebral bony contact and that has partially occluded the needle lumen. Epidural catheter should be advanced only 3 to 5 cm into the epidural space. This minimizes the risk of kinking, forming a knot, entering a vein, puncturing dura mater, exiting via an intervertebral foramen, and wrapping around a nerve root. After appropriate positioning of the catheter, the needle is slowly withdrawn with one hand as the catheter is stabilized with the other. The length of the catheter in the epidural space is confirmed because this distance is important

when trying to determine if a catheter used in the postoperative period has been dislodged.

PROCEDURE FACTORS:

Injection site plays a major part in epidural anaesthesia because there is production of segmental block in which the drug spreads both caudally and cranially from the site of injection. Epidural anesthesia is segmental.

Patient position does not seem to have a clinically important effect on the spread of the block from side to side.

METHODS OF ADMINISTERING EPIDURAL ANALGESIA

Various techniques are being applied in delivery of local anaesthetic drugs into the epidural space. They include

1. Intermittent injection of the local anaesthetic drug
2. Epidural analgesia may also be maintained by continuous infusion of a volume of dilute local anesthetic with or without added opioid
3. Recently Patient-controlled epidural anesthesia (PCEA) where the patient controlsthe delivery of incremental doses in addition to set infusion in controllingthe analgesia required for the patient.

COMPLICATIONS OF EPIDURAL ANAESTHESIA

Though epidural anaesthesia is considered as safe technique, it has the following complications.

Major complicationsassociated with epidural anaesthesia are

1. Direct trauma to the nerves.
2. Systemic toxicity associated with inadvertent intravascular injection.
3. Subdural injection of drugs.
4. Total spinal anaesthesia.
5. Epidural abscess and meningitis.

Minor complications include

1. Backache
2. Nausea and vomiting
3. Post-dural puncture headache
4. Pneumocephalus
5. Shivering
6. Urinary retention.

IDENTIFICATION OF EPIDURAL SPACE:

Insertion of Touhy needle to identify the epidural space is a blind procedure which is commonly associated with high rates of failedepidural analgesia. It occurs mainly due to failure in identifying the space accurately. During insertion of the epidural needle, one perceives each of the tissue layers through which the needle is passing, mainly by feeling the resistance. This is called the haptic feedback.

Many techniques have been found for the correct identification of the epidural space. This dates back to 1921 when Pages first described the feel of the "giving way" of the needle as it advanced through the ligaments[10]. In the same year, Sicard & Forestier described loss of resistance to the injection of fluid. In 1933, Dogliotti popularised the loss of resistance technique using either air or saline. Other methods described in the literature over the last 60 years include Gutierrez's "hanging drop" in 1932, Baraka's saline infusion and the change in electrical conductivity when the needle enters the epidural space. Heldt & Moloney in 1928 describes a hissing sound as air rushes in when the epidural space is entered. In 1980, Cork et al. described an ultrasonic method of localisation of the lumbar epidural space.

Of all these methods described so far, Dogliotti's loss of resistance technique remains the most popular and mainstay of currently used methods of identification.

LOSS OF RESISTANCE (LOR) TECHNIQUE

Among all the techniques, the loss of resistance (LOR) techniques forms the main play in identifying the epidural space by compression of either fluid or air when the epidural needle passes through various layers of the lumbar vertebral column.

Saline or air can be compressed in the syringe intermittently or continuously as needle advances towards the layers of epidural space. In a survey conducted in UK on the usage of loss of resistance technique in identifying the epidural space, majority of Anaesthetists used Loss of Resistance to Saline continuous technique followed by Loss of Resistance to Air, Saline or Air intermittent technique.

Epidural space can be identified by using various special gadgets that have been developed over the years. All the designs were based on the principle that there is sudden loss of resistance and/or sub-atmospheric pressure. These include Odom's indicator (1936), Macintosh's balloon (1950) and Brooke's modification of the Odom's indicator (1957). Dawkins in 1963 employed the effect of gravity in which a bubble of air moves towards the needle indicating entry into the epidural space. Chester in 1978 modified the design. In 1949, Brunner & Ikle designed a spring-loaded plunger which applied a constant pressure instead of the pressure applied by the thumb. This design was further modified by Dawkins in 1963. He replaced the spring with an elastic band

which was stretched over the whole syringe. In 1982, it was modified and re-introduced as the Oxford indicator.

Among all these gadgets, spring loaded Episure syringe is the most promising one for trainees and trainers in identification of epidural space.

EPISURE AUTO-DETECT SPRING-LOADED SYRINGE

The Episure™ AutoDetect™ is a new gadget in loss-of resistance syringe. It comprises of a compression spring internally which appliesaconstant pressure on the syringe plunger. By this, it eliminates the requirement to apply pressure on the syringe plunger and allows using both hands during advancement of the epidural needle. Once the epidural space is reached, the plunger gets depressed automatically. Hence it delivers the morereliable objective and visual confirmation of Loss ofResistance, when compared to the subjective “feel” produced with standard Loss of Resistance syringes.

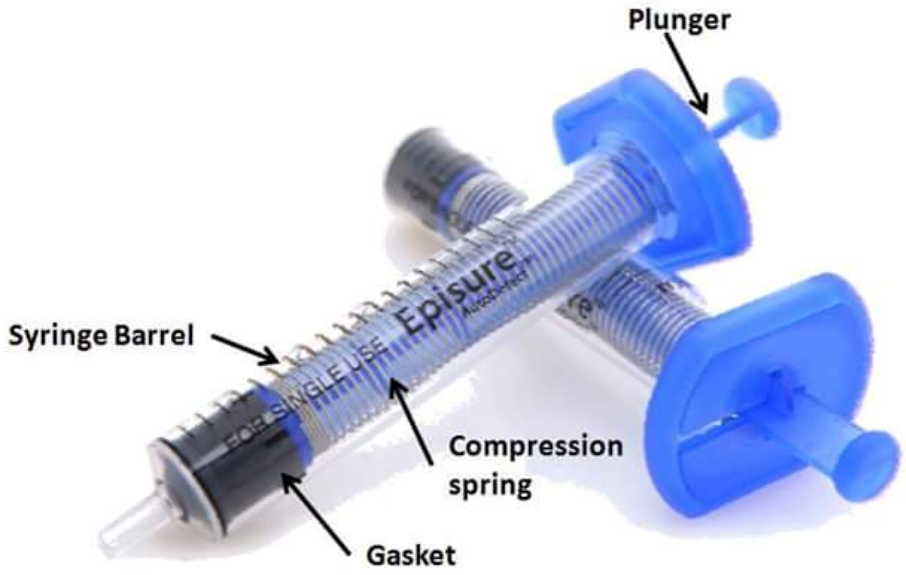

Fig. 10 :TheEpisure™ AutoDetect™ Spring-loaded syringe

AIMS & OBJECTIVES

To compare the performance of **"EPISURE™ AUTODETECT™ SPRING-LOADED SYRINGE (EAS)"** with the **"CONVENTIONAL GLASS SYRINGE (GS)"** Using the loss of resistance technique with saline in identification of the epidural space in lumbar epidurals for abdominal & lower limb surgeries.

REVIEW OF LITERATURE

1. **Ashraf S.Habib et al (2007)**did a comparativestudy between the spring-loaded syringe and the glass syringe for identifying the epidural space in parturientsduring the performance of epidural analgesia. Incidence of failed epidural analgesia was the main outcome. A total of three-hundred and twenty-five female parturients were selected and eight residents did 291 procedures (90%) and two attendings did 34 procedures (10%). Five subjects had failure of epidural analgesia with the glass syringe group and in no incidences of failed analgesia in the spring-loaded syringe group (*P* = 0.025).

2. **Jean M. Carabuena et al (2012)**evaluated the advantages of the spring-loaded syringe on successful epidural labor analgesia, time taken for catheter placement, and learning curve (cumulative summary analysis, i.e., Cusum) of experienced anesthesiologists. 14 attending and fellow anesthesiologists were randomized to perform 50 consecutive epidural technique attempts using a spring-loaded or conventional glass syringe. 10 participants completed an additional 50 attempts with the alternate syringe.1200 epidural placement attempts were performed in total. Use of the spring-loaded syringe was associated with a non-significant difference of estimated success rate in obtaining analgesia success (absolute

difference of 1.0% 95% confidence interval, CI: −8.9% to 10.8%), shorter mean time to epidural catheter placement (ratio of 0.92 95% CI, 0.89–0.96); $P = 0.003$) and similar Cusum curves when compared with a conventional glass syringe. Analgesia success was more common with attending versus fellow anesthesiologists (absolute difference of 34.6% 95% CI, 14.9% to 54.3%; $P < 0.001$), and when the initial preferred technique was loss-of-resistance to continuous saline versus intermittent air (absolute difference of 33.8% 95% CI, 12.6% to 55.0%; $P < 0.001$). Shorter mean times were also observed in the group exposed to the spring-loaded syringe first (ratio of 0.65 95% CI, 0.62–0.67; $P = 0.02$). Spring-loaded syringe is associated with a similar overall rate for establishing successful epidural labor analgesia, a shorter elapsed time to epidural catheter insertion, particularly when the anesthesiologist was randomized to use the novel syringe first, and a similar Cusum curve when compared with a conventional glass syringe.

3. **Edward T. Riley et al (2007)** evaluated the Episure syringe™ using an artificial model of the ligamentumflavum, an anesthetized pig, and women who desired epidural analgesia for labor. The operator, using the spring-loaded syringe, was able to stop the forward movement of the needle, so that compared with a standard LOR syringe less of the needle protruded out the back of the laboratory model. Satisfactory labor

analgesia in the human study and radiograph analyses in the porcine model confirmed epidural placement in all attempts. They concluded that the spring-loaded syringe is a potentially useful LOR syringe that provides a reliable, objective end-point for identification of the epidural space.

4. **V. Soskin et al** conducted a prospective randomized study where they used the FDAapproved Episure™ AutoDetect™ Syringe (ADS) developed by Indigo-Orb, Inc. to evaluate user opinion and satisfaction. Groups consisting of Attendings (Group 1), CRNAs (Group 2) and Anesthesia Residents (Group 3) followed protocol in placing 161 epidurals on laboring patients (ASA I-III). All labor epidurals were inserted in sitting position at L2-3 or L3-4 interspace, using 17G Tuohy needles and 19G closed-tip springwood catheters. LOR was detected using the ADS loaded with 3-5ml of normal saline. Data collected included patient demographics, history of dural puncture/PDPHA, depth of LOR, number of attempts and epidural placement difficulties. Participants completed a pre-study survey and a post-study satisfaction survey.

5. **Edward Johnson et al (2015)** conducted a study on Episure AutoDetectSpring-loaded syringe withthat of glass syringe in

identification of the epidural space for lower thoracic epidural. Here they compared the performance of Episure Auto-detect Syringe and Glass Syringe for epidural space identification in those undergoing lower thoracic epidurals. Totally hundred and twenty American Society of Anesthesiolgists Physical status I–II people of age 18–60 yrs undergoing lower thoracic epidural anaesthesia are selected and randomised into two groups. Group I (EAS) – Received EAS and Group II (GS) – Received Glass Syringe. The following parameters were recorded which include , age, sex, height (cm), weight (kg), time taken to reach epidural space (s), number of attempts, inadvertent dural puncture, intravascular catheter placement and failed epidural analgesia. Demographic parameters as well as depth to the epidural space showed no significant differences between two groups. There were 5 cases of inadvertent dural punctures in the Glass Syringe group and no incidences of inadvertent dural puncture with EAS group ($P = 0.0287$). Also there are 5incidences of failed anaesthesia in Glass Syringe group while no incidence of failed epidural anaesthesia in EAS group ($P = 0.0287$) as a result of false identification of loss of resistance. Epidural space identification was performed in fewer attempts in Group EAS and total time needed in identifying epidural space was found to be faster with EAS ($P = 0.0012$). The usage of Spring-loaded syringe has allowed confirmatory and quicker in identifying the epidural space when compared to glass syringe in lower thoracic epidural

technique. There were very few incidences of inadvertent dural puncture or failed epidural anaesthesia with Spring-loaded syringes.

MATERIALS AND METHODS

STUDY DESIGN:

This prospective, randomised, parallel group double-blinded study conducted in the Department of Anaesthesiology, Kanyakumari Government Medical College and Hospital, Asaripallam.

SAMPLE SIZE:

A study population of one hundred and twenty patients were enrolled and studied using mean time differences in reaching epidural space collected from the pilot study data. Calculation of minimum sample size required was found to be120 cases with 60 cases per group and 95% power (beta error).

RANDOMISATION:

Randomisation of study population was done as simple random sampling using computer-generated random numbers.

PERIOD OF STUDY:

The study has been performed for a period of one year.

COLLABORATING DEPARTMENTS:

The study population has been chosen from patients admitted for surgery in the Department of General Surgery and from the Department of Orthopaedics in Kanyakumari Government Medical College, Asaripallam, Nagercoil.

INCLUSION CRITERIA:

- Age 18 – 60 yrs of both sexes
- Weight 50 – 100 kg
- Height 150 – 200 cm
- BMI – 20 – 35
- ASA grade I – III patients
- Patients requiring abdominal & lower limb surgeries
- Patients requiring post-operative analgesia

EXCLUSION CRITERIA:

- Patient refusal
- ASA grade IV and V patients
- Patients with infection at site of injection

- Patients with known contra-indication to regional anaesthesia – Known or suspected coagulopathy
- Patients with neurological diseases & abnormalities of spinal column
- Patients with H/O allergy or hypersensitivity to local anaesthetics

ALLOCATION:

After ethical committee approval and informed written consent among the study population, they were allocated randomly into two groups.

1. Group EAS (n=60)
2. Group GS (n=60)

PREOPERATIVE PREPARATION:

Patients, age, body weight and baseline vital parameters were recorded. History regarding previous anaesthesia, surgery and significant other co morbid illness, medications and allergy was recorded. Complete physical examination and airway assessment were done.

In the preoperative period, all patients were explained about the procedure and new technique of epidural anaesthesia and we obtained informed consent from all the study group patients.

PROCEDURE

Resuscitation equipments must be immediately available before the performance of Epidural anaesthesia.

Epidural anaesthesia was performed with an 18 Gauge Tuohy needle in the L2 – L3 lumbar epidural space in right-lateral position. In Group EAS, the epidural space identification was done with Episure Auto-detect Syringe, a spring-loaded syringe and Group GS, with Glass Syringe. Saline was used for the identification of Loss of Resistance in both syringes. The epidural catheter placement was done before general anaesthetic induction.

Epidural anaesthesia was activated with 10 ml 0.25%bupivacaine along with Inj. Fentanyl 2 μg/mL. After confirming successful analgesia, General anaesthesia was given. Top-up for epidural anaesthesia was given at the end of the surgery for post-operative analgesia.

Parameters recorded include: Age, Sex, Height, Weight, depth of epidural space, total attempts tried, time to reach epidural space, incidences of inadvertent dural puncture, incidence of intravascular catheter placement and failed epidural anaesthesia.

In accidental dural pucture, the catheter was inserted in different space using the same type of syringe. Occurrence of false Loss of Resistance and failed epidural anaesthesia were also noted.

The failed epidural anaesthesia is the need for resitement of epidural catheter as a result of failure to obtain a sensory block after giving an initial loading dose of the local anaesthetic drug.

Time to reach epidural space is measure by supervising anaesthetist using a stopwatch. It was started soon as the syringe being attached to the epidural needle with its tip in inter-spinous ligament. Needle advancement is stopped when the epidural space was reached as indicated by visualisation of Loss of Resistance in the syringe.

STATISTICAL ANALYSIS

The minimum desired sample size was calculated with a pilot study of about fifteen cases in each group which was performed before. On themean time differences in reaching epiduralspace, the minimum sample size required was predicted as one hundred and twenty cases with sixty in eachgroup and with beta error of 95% power.

All parameters collected were recorded in Master Chart using Microsoft Excel Sheet. Independent sample t test was used to calculate the mean and standard deviations of demographic parameters, Time to reach epidural space, total number of attempts and Depth to reach epidural space.

Pearson chi square test was used to calculate the mean, standard deviation and p value for Ease of Catheter placement in both the groups. Fisher's exact test was used to calculate mean, standard deviation and p value for Incidence of Inadvertent dural puncture, Intra-vascular catheter placement and Incidence of failed Epidural anaesthesia.

$P < 0.05$ was calculated to denote the statistical significance between two groups. Microsoft Excel sheet was used to prepare the charts.

OBSERVATION AND RESULTS

A total of one hundred and forty patients were evaluated for the study. Of which fifteen patients were excluded as they did not meet the inclusion criteria. Five patients refused to give informed consent; hence, we randomized 120 patients in two groups of 60 each.

All the parameters collected are entered in a table and analysed statistically.

Table 1: Age, Sex and Anthropometric profile of cases studied

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	MEAN	SD	MEAN	SD	
Age (years)	47.5	9.93	47.73	11.55	0.906
Height (cm)	162.28	7.2	163.9	7.45	0.23
Weight (kg)	61.85	7.41	63.1	7.64	0.365

In our study, the demographic parameters such as age, height and weight were found to be non-significant in both the groups.

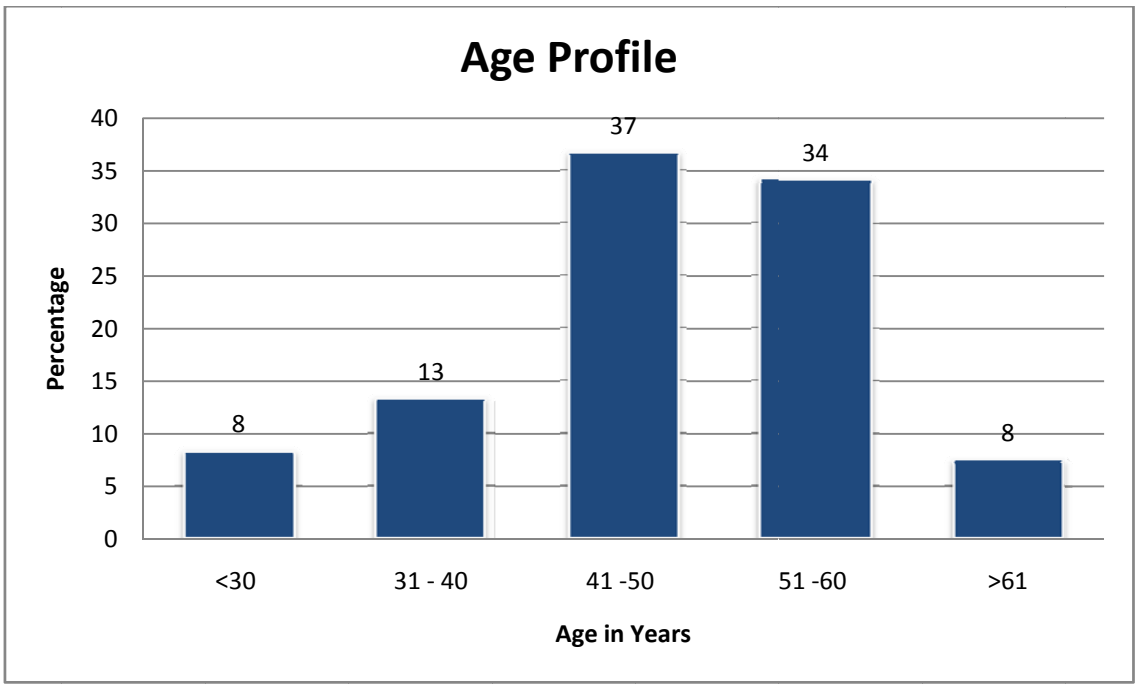

Fig 11: Age profile of patients of both groups

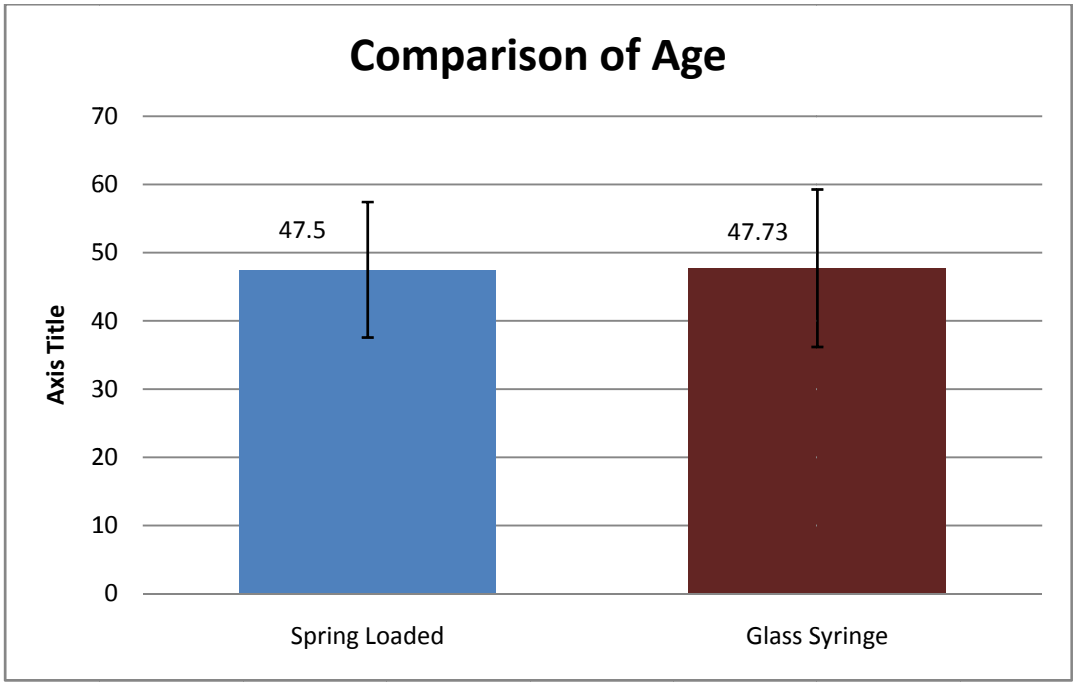

Fig 12: Comparison of Age between two groups

Table 2: Distribution of Gender

PARAMETERS	GROUP EAS (n = 60)	GROUP GS (n = 60)	%
MALE	46	45	76
FEMALE	14	15	24

In our study, the gender distribution was found to be equal in both the groups and it is non-significant. Males form a higher percentage of participation in both the groups when compared to females.

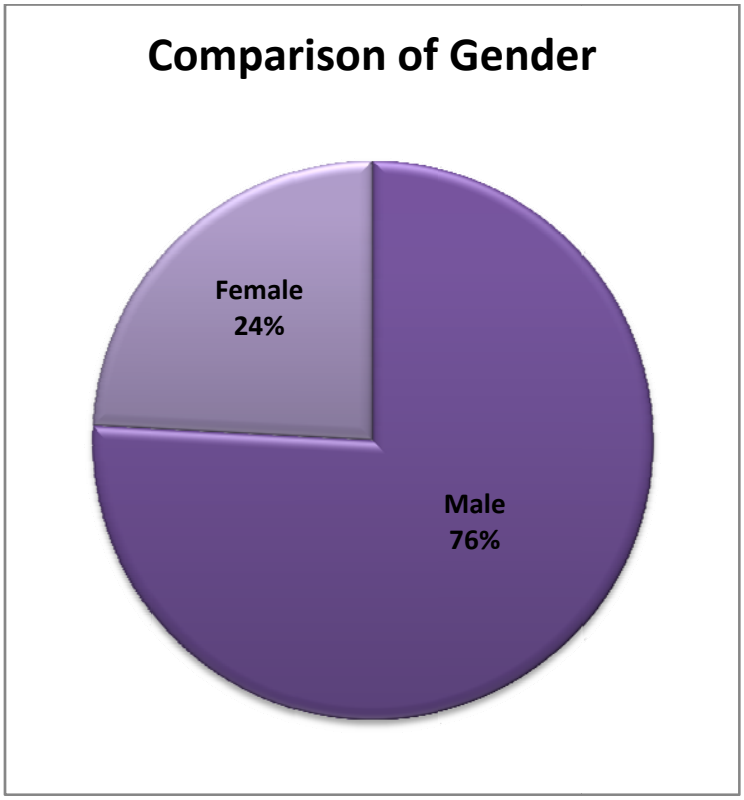

Fig 13: Proportion of Gender in study population

Table 3: Depth to reach Epidural space

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	MEAN	SD	MEAN	SD	
Depth to Epidural space (cm)	**4.88**	**0.42**	**5.15**	**0.29**	**< 0.0001**

In our study, the identification of depth to reach the epidural space was slightly significant with the Spring-loaded study group population have a lesser depth to the epidural space when compared to that of the Glass syringe group.

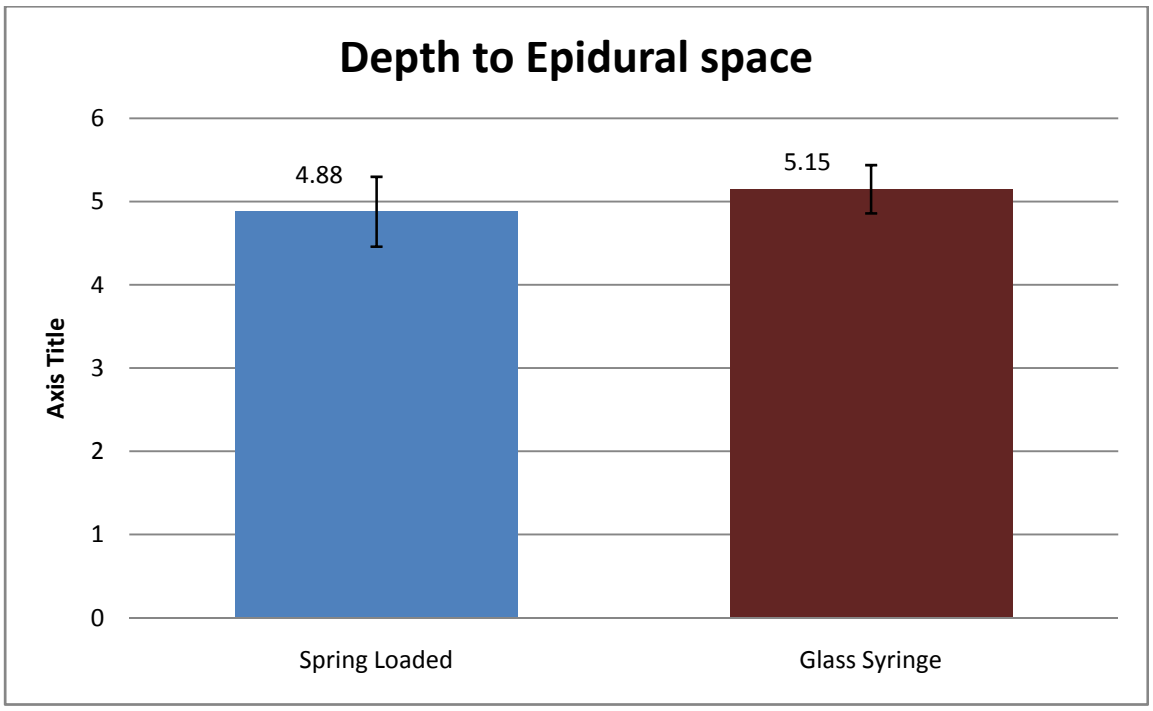

Fig 14: Depth to Epidural space

Table 4: Number of Attempts

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	MEAN	SD	MEAN	SD	
Number of Attempts	1.1	0.3	1.23	0.46	0.065

In our study, the incidence of successful epidural space identification in first attempt was more (54 patients) with Spring-loaded syringe group, when compared to the Glass syringe group (47 patients).

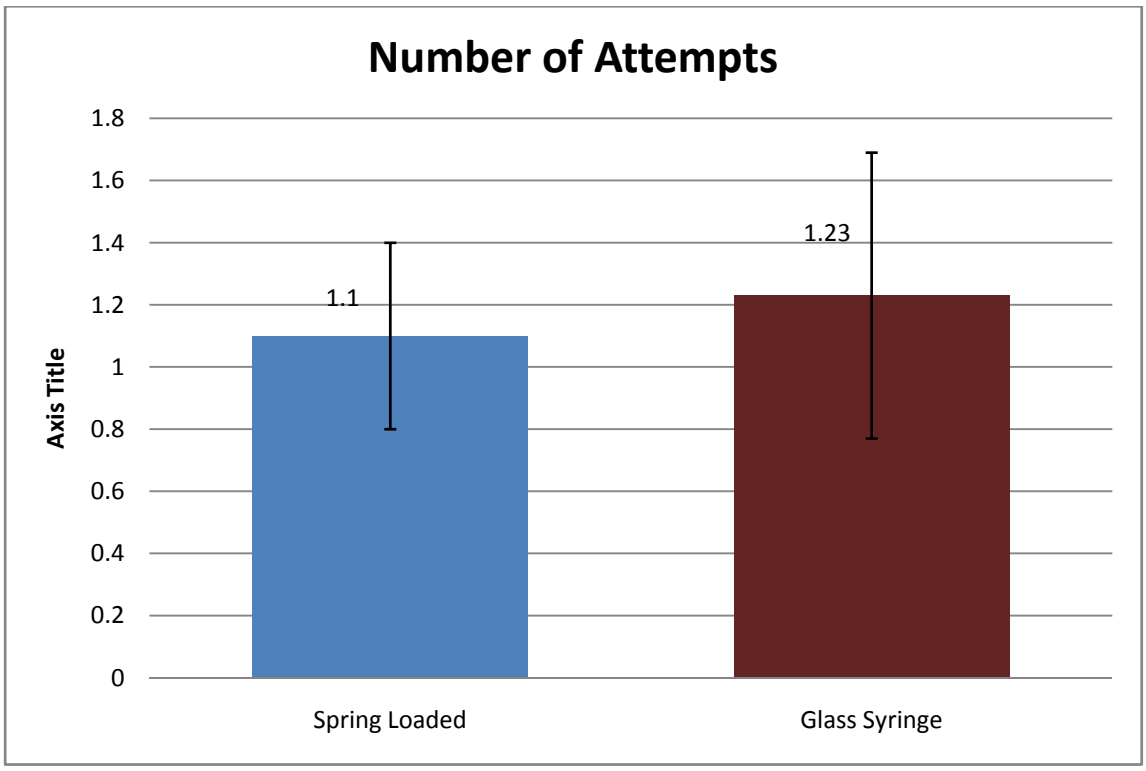

Fig 15: Number of Attempts

Table 5: Time to reach Epidural space

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	MEAN	SD	MEAN	SD	
Time to reach Epidural space (sec)	**37.71**	**9.06**	**39.11**	**14.16**	**0.001 SIGNIFICANT**

In our study, time to reach the epidural space was found to be significantly lesser in Group EAS (37.71 ± 9.06 s) when compared to Group GS (39.11 ± 14.16 s) (P=0.001)

Fig 16: Time to reach Epidural space

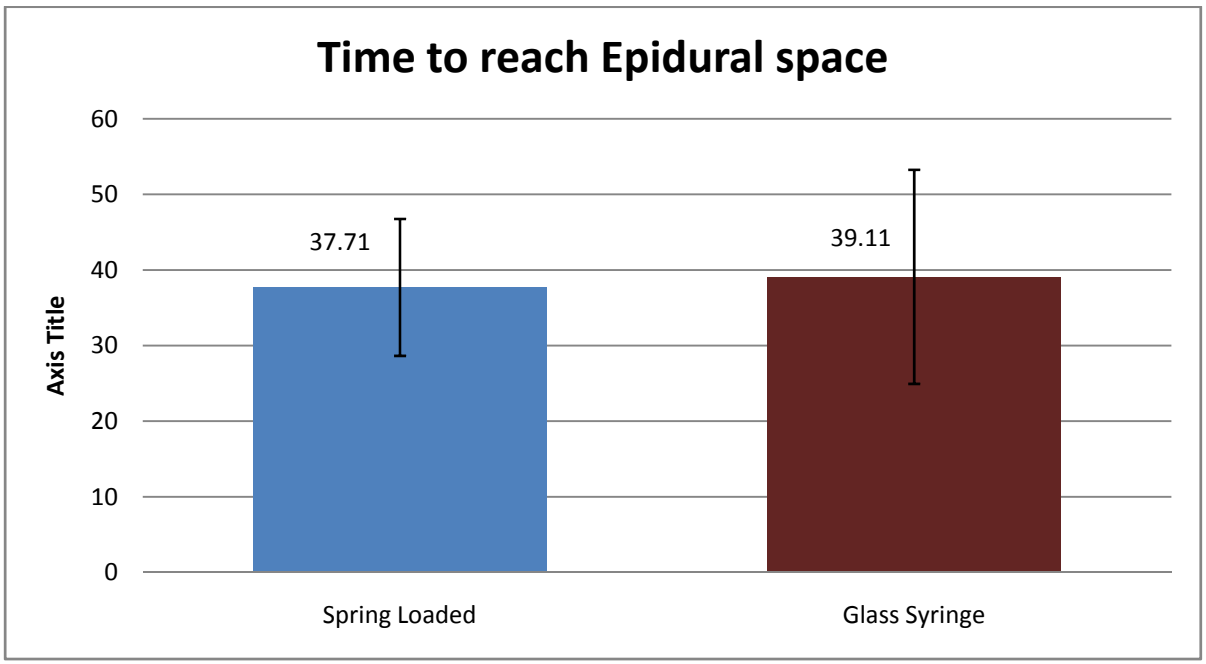

Table 6: Ease of Catheter placement

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	Easy	Difficult	Easy	Difficult	
Ease of Catheter Placement	50 (83%)	10 (17%)	51 (85%)	9 (15%)	0.803

In our study, there is no significant difference between the spring-loaded syringe with Glass syringe in the ease of catheter placement.

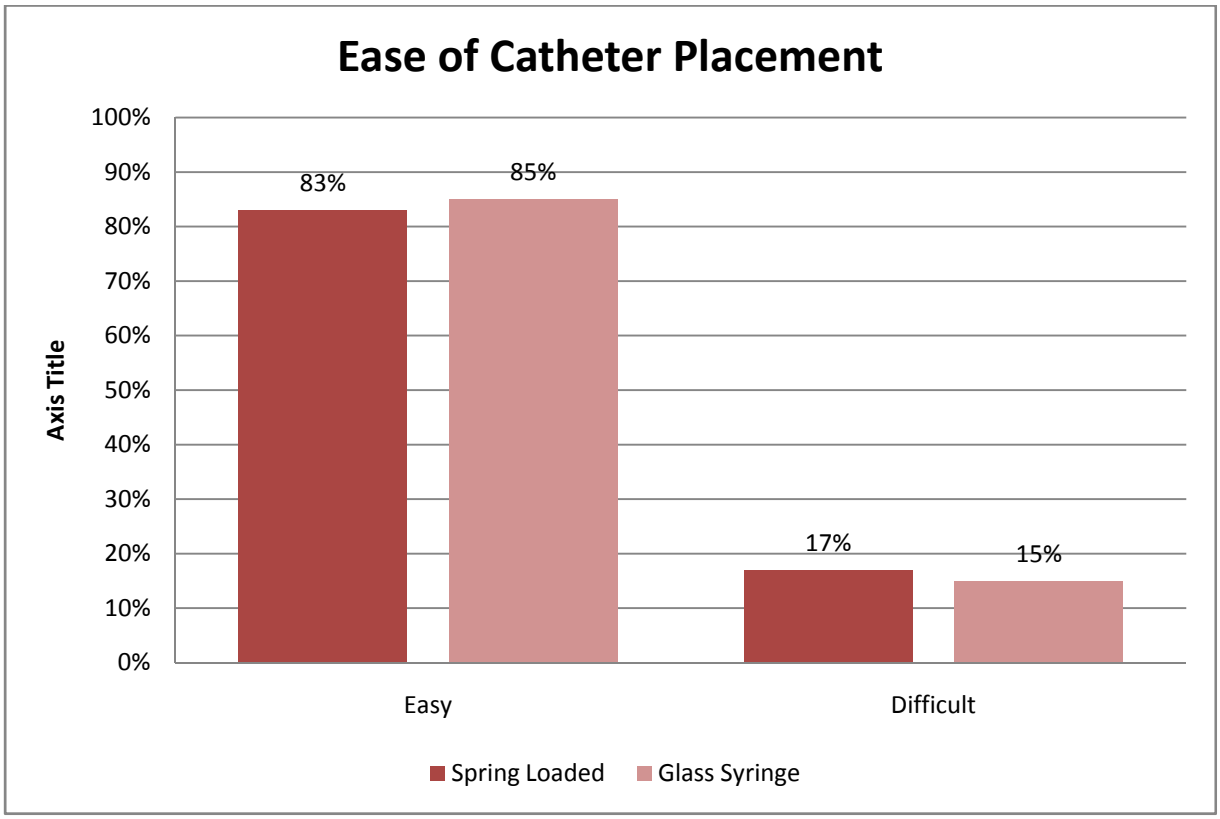

Fig 17: Ease of Catheter placement

Table 7: Inadvertent Dural Puncture

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	YES	NO	YES	NO	
Inadvertent dural puncture	0 (0%)	60 (100%)	6 (10%)	54 (90%)	0.027 SIGNIFICANT

In our study, therewere six cases of inadvertent dural puncture in Group Glass syringe group while no such incidence seen in Spring loaded syringe group.

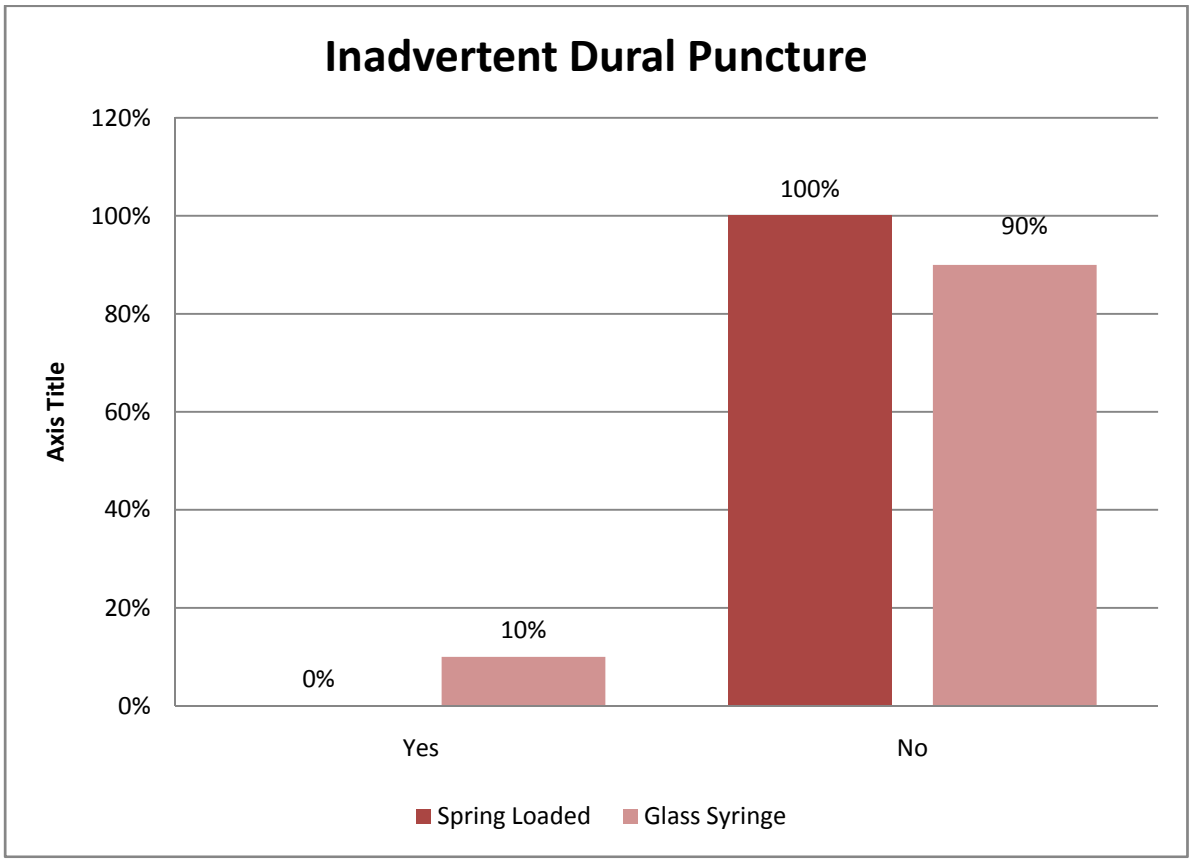

Fig 18: Inadvertent Dural Puncture

Table 8: Intravascular Catheter Placement

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	YES	NO	YES	NO	
Intravascular Catheter Placement	2 (3%)	58 (97%)	6 (10%)	54 (90%)	0.272

In our study, there was slightly lesser incidence (2 patients) (3%) of intravascular catheter placement in spring-loaded syringes when compared to Glass syringes (6 patients) (10%).

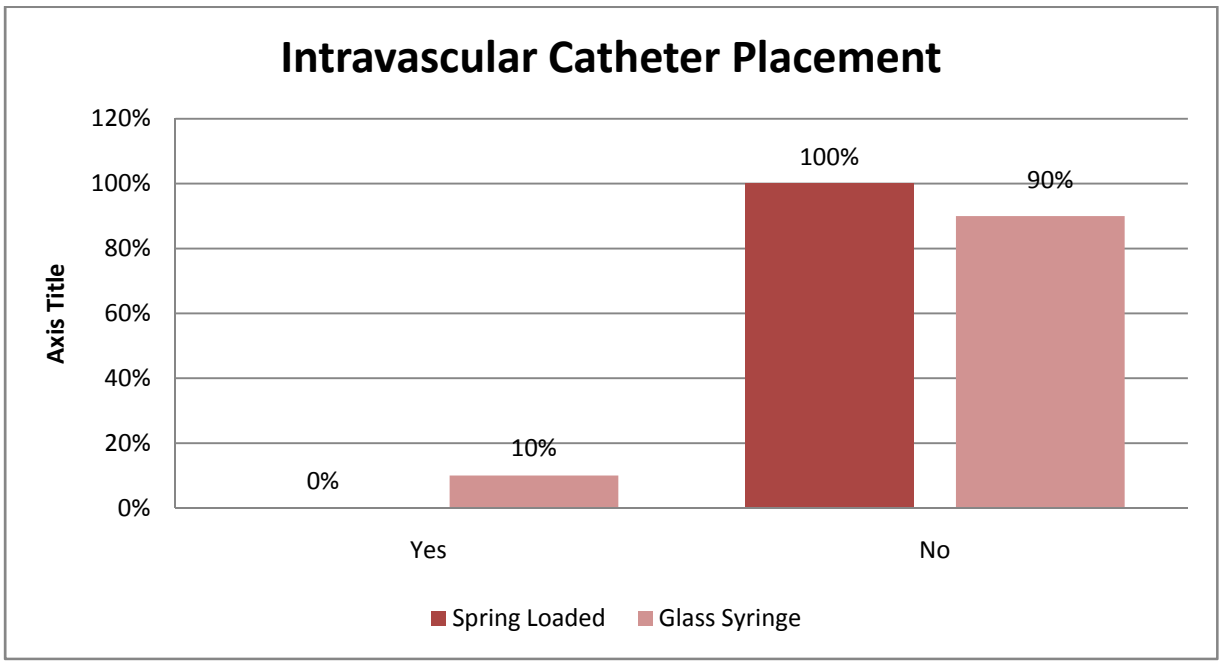

Fig 19: Intravascular Catheter Placement

Table 9: Failed Epidural Analgesia

PARAMETERS	GROUP EAS (n = 60)		GROUP GS (n = 60)		p VALUE
	YES	NO	YES	NO	
Failed Epidural Analgesia	0 (0%)	60 (100%)	6 (10%)	54 (90%)	0.027 SIGNIFICANT

In our study, there was six cases of failed epidural analgesia and all such incidences happened in Glass syringe while there is no incidence in Spring-loaded syringes. This result is statistically Significant.

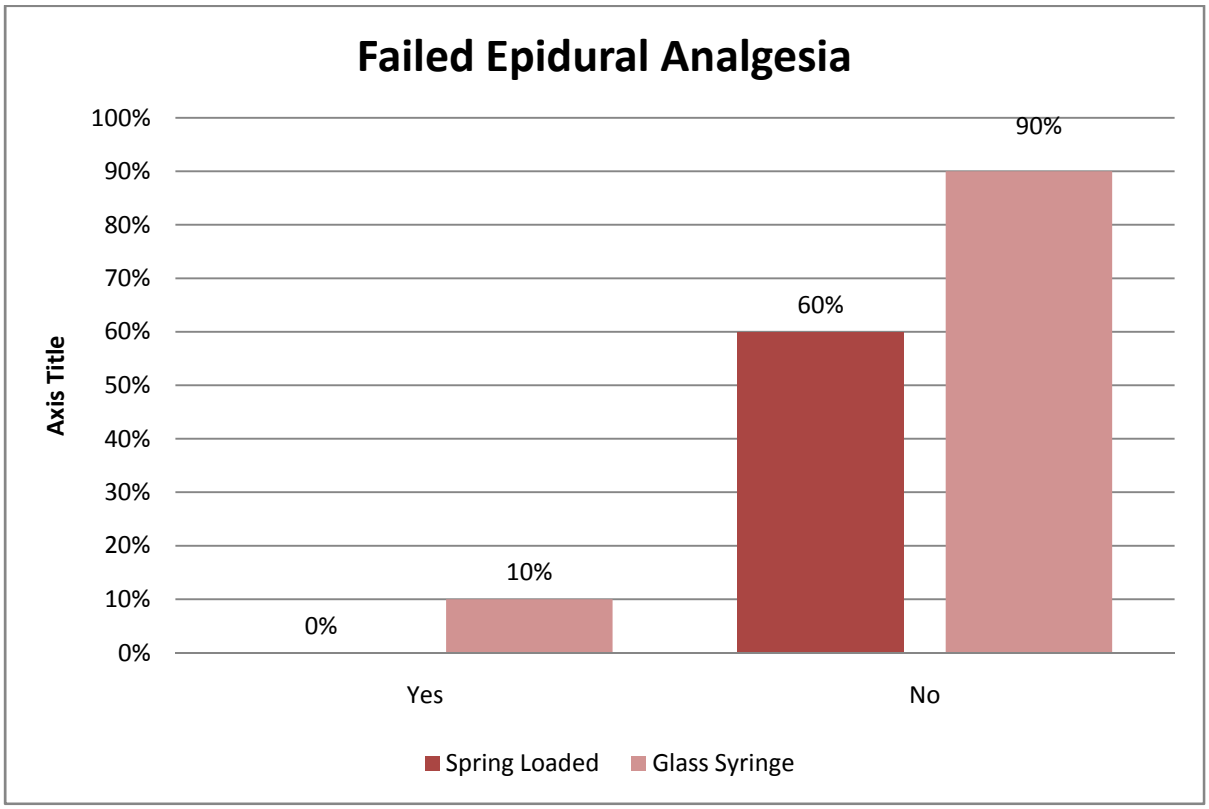

Fig 20: Failed Epidural Analgesia

DISCUSSION:

Epidural analgesia and anaesthesia are used commonly in providing anaesthesia as well as analgesia for both intra-operative as well as post-operative surgeries. Also it is been used as a form of pain relief during parturition and for the treatment of chronic low back ache.To provide adequate surgical blockade with an epidural anesthetic, it is necessary to know theinnervation of the structures stimulated during the procedure[12].

The epidural anesthesia is performed before induction of general anesthesia because in few surgical procedures, controlled ventilation is safe for the patient and surgery as in the case of intrathoracic or upper abdominal operations. They often cause moderate to severe postoperative pain. In those patients, epidural anesthetic is vital in providing adequate pain relief and also in in postoperative mobilization. Intra-operatively, the requirements of general anesthetic drugs are greatly reduced and hence hemodynamic changes are less. Recovery is also quicker[3].

Baraka A reported a ‘saline infusion technique’ where saline infusion set is connected to the needle. As the needle enters the epidural space, saline flows into it as there is negative pressure in the epidural space. The main advantage is that the needle can be gripped by using both the hands and can be directed cephalad or caudad based on the requirement. It has a high success rate, very economical and relatively easy to perform.

Based on this, a new spring-loaded AutoDetect syringe Episure™ came into usage. In Episure Auto detect Syringe, there is a constant pressurebeen applied which offers increased successrate in correct identification of epidural space and hence better quality of anaesthesia[6].

Sometimes it is quite difficult to determine whether there is true loss-of-resistance just by simply watching the performance of the procedure due, in part, to the varying pressure applied to the plunger. This probability is eliminated by the visual observation of loss of resistance with the spring-loaded syringe. It removes the subjectivity and variability and thus offers a more precise end-point compared with the standard Glass Syringe in identifying the Epidural space[3].

There is relatively quicker identification of the epidural space with the spring-loaded syringe (37.71 ± 9.06 s) as compared to Glass Syringe (39.11 ± 14.16 s) (p=0.001). It is mainly due to the difference between using continuous pressure to advance the needle in the spring-loaded syringe groupcompared with intermittent advancement in the GS group. It is similarto that of Habib *et al.*,who noted that the median elapsed time with the spring-loaded syringe versus aconventional GS was 20 s (11–28 s) and 40 s (25–58s) respectively ($P <$ 0.001) with epidural analgesia inparturient[2].

The incidence of dural puncture is greatly reduced when using loss-of resistance to saline while applying constant pressure on the plunger. In our

study, there were six cases of inadvertent dural puncture in Glass Syringe while there is no incidence of dural puncture with that of spring-loaded syringe. This finding is similar to that of Habib *et al*., who noted the incidence of accidental dural puncture in spring-loaded syringe of 0 (0–2.2) versus the conventional Glass Syringe 4(0.7–6.4) (*P=0.05*) with epidural analgesia in parturient[12].It is also similar to that of Riley *et al.*, where the incidence of accidental dural puncture is zero with Spring-loaded syringe[11].

This is mainly due to use of Loss of Resistance to saline by applying constant pressure on the plunger. With this technique, the needle advancement is prevented from advancing further when the epidural space is identified, and the pressurised saline pushes thedura away from the tip of the Tuohy needle, soon after it enters the epidural space. During intermittent needle advancement, there is a risk of accidental "over-shooting" that can occur even withsmall incremental advancement, thus breaching the dura and into the sub-arachnoid space.

Successful identification of epidural space in the first attempt using this spring-loaded syringe is seen in 54 patients while that of the Glass Syringe it is in 47 patients. Second attempt is required in six incidences in spring loaded group while in glass syringe group, it is in 12 patients. There were no incidences of third attempt, while there was one incidence in Glass syringe group. In Habib et al., it is 1 with the range of 1–3 attempts for spring-loaded syringes while it is

1 with the range of 1–6 attempts (P=0.01) for Glass Syringes with epidural analgesia in a parturient[12].

The failed epidural analgesia was reported in six cases, and all happened in Group GS, while there was no incidence of failed epidural analgesia in Group EAS. This finding is similar to that of Habib *et al*., who noted that the incidence of failed analgesia in spring-loaded syringe versus aconventional GS was zero and 5 cases respectively (P =0.03) with epidural analgesia in parturient[12].

The overall success in performing epidural analgesia with spring loaded syringe is mainly due to both hands-free technique, application of constant pressure on the plunger and the visual observation of loss-of-resistance.Previous studies too demonstrated the success of spring loaded syringein lumbar epidural for labour analgesia[13].

PITFALLS

Our study has clearly proven the advantages of using the spring-loaded syringe in successful administration of epidural anaesthesia to the patients when compared to the conventional Glass syringe. However there had been few pitfalls in our study which include the following.

1. The sample size selected was smaller.
2. In the beginning, it was quite difficult to hold the Episure Auto detect Syringe, which was overcame by experience.
3. In our study, few patients in the Spring-loaded syringe group experienced pain while the plunger depresses the saline automatically when the epidural space is reached. This was minimised by having lesser amount of saline injected into the space.
4. In the beginning, there had been few incidences of accidental expulsion of saline before its attachment to the Tuohy needle due to absence of a locking mechanism in the syringe.
5. Depression of saline in the subcutaneous tissue during withdrawl and redirection of the Tuohy needle and thus offering a chance of false LOR.

SUMMARY

In our study, we compared the efficacy of Episure Auto detect spring-loaded syringe with the conventional Glass syringe in identification of Epidural space using loss of resistance to saline in lumbar epidurals. When compared to glass syringe, the spring-loaded syringe

1. Required lesser time in identifying the Epidural space.
2. Higher successful identification of Epidural space in first attempt.
3. Very less incidence of inadvertent dural puncture.
4. Very less incidence of failed epidural analgesia.

Also it is a valuable gadget and as a learning tool for the beginners.

CONCLUSION

The spring-loaded syringe provides the ease of using both the hands in holding the needle and has better control over the needle advancement. It also has improved success rate when compared to the conventional Glass Syringe. In addition, with Spring-loaded Syringe, we had both subjective and objective confirmation of epidural space by automatic depression of the plunger. This objective confirmation of epidural space has prevented the overshooting and there by accidentaldural puncture. It also provided faster identification of epidural space. It has no incidence of failed epidural analgesia when compared to the standard Glass Syringe since there is no occurrence of false loss of resistance.

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கன்னியாகுமரி அரசு மருத்துவக்கல்லூரி

மருத்துவமனை,

ஆசாரிப்பள்ளம், நாகர்கோவில்

மயக்க மருந்து செலுத்தும் முறை ஒப்புதல் படிவம்

நோயாளியின் பெயர்: வயது: இனம்:

அறுவைசிகிச்சை:

எனது அறுவை சிகிச்சைக்காக அளிக்கப்படும் மயக்க முறை, மாற்று முறை மற்றும் அவற்றின் பலன்கள், தீங்குகள் குறித்து நன்கு அறிந்து கொண்டேன்.

மேலும், அறுவை சிகிச்சைக்கு எனது முதுகில் ஊசி போட்டு மயக்க மருந்து செலுத்தி அறுவை சிகிச்சை செய்ய வேண்டும் என்பதை மருத்துவர் விளக்கிக்கூற புரிந்து கொண்டேன்.

அவ்வாறு மயக்க முறையில் எனக்கு EPISURE AUTODETECT SPRING-LOADED ஊசியோ அல்லது CONVENTIONAL GLASS ஊசியோ

உபயோகித்து மருந்து செலுத்தபடும் என்பது பற்றி மருத்துவரால் நன்கு விளக்கிக்கூறப்பட்டுள்ளது.

நெருக்கடி நிலைக்கு ஏற்ப தகுந்த வைத்திய முறை, மருந்து மற்றும் கருவிகளை பயன்படுத்த சம்மதம் அளிக்கிறேன்.

நான் இந்த படிவத்தை படித்து(அ) படித்து காண்பிக்க கேட்டு புரிந்து கொண்டேன் என்றும் முடிவெடுக்க போதிய அவகாசம் எனக்கு அளிக்கப்பட்டது என்றும் ஒப்புக்கொள்கிறேன்.

ஒப்பம் நோயாளியின்ஒப்பம்

மயக்கவியல்கவனிப்புகுழுவிற்காக மாற்றான்ஒப்பம்:

தேதி: நோயாளிக்கு உறவுமுறை:

PROFORMA

Comparison of Spring-Loaded Syringe with Glass Syringe using Loss of Resistance Technique with Saline for Identification of Epidural Space in Lumbar Epidurals

LUMBAR EPIDURALS	SPRING-LOADED SYRINGE (EAS)		GLASS SYRINGE (GS)	

PERFORMED BY : DATE:

PATIENT DETAILS:

NAME :

AGE/SEX : IP NO : WARD:

HEIGHT :

WEIGHT :

DIAGNOSIS :

PLAN OF SURGERY :

ANAESTHESIA :

ASA RISK STATUS : I / II / III

POSITION :

SPACE OF EPIDURAL GIVEN :

TECHNIQUE : LOSS OF RESISTANCE WITH SALINE

DRUG GIVEN :

TABLE:

PARAMETERS	VALUES
Age	
Height (cm)	
Weight (kg)	
Depth to Epidural space (cm)	
Number of attempts	
Time to identify Epidural space (s)	
Ease of Catheter Placement Easy = 1 Difficult = 2	
Inadvertent dural puncture if any	
Intra-vascular catheter placement if any	
Failed Epidural analgesia	

MASTER CHART

1. GROUP EAS

S. No	Age (yr)	Sex	Height (cm)	Weight (kg)	Depth to epidural space (cm)	No of attempts	Time to reach epidural space (s)	Catheter placement 1-easy 2-difficult	Inadvertent dural puncture	Intravascular catheter placement	Failed epidural analgesia
1	56	M	165	48	4	1	28	1	NO	NO	NO
2	60	M	166	50	4	1	24	1	NO	NO	NO
3	50	M	170	50	5	1	28	1	NO	NO	NO
4	45	M	172	70	5.5	1	38	1	NO	NO	NO
5	54	M	170	68	4.5	1	38	1	NO	NO	NO
6	56	F	155	54	4.5	2	45	2	NO	NO	NO
7	63	M	161	54	5	1	32	1	NO	NO	NO
8	55	M	156	55	4.5	2	45	2	NO	NO	NO
9	44	M	158	60	5	1	10	1	NO	NO	NO
10	63	M	160	50	4	1	18	1	NO	NO	NO
11	44	F	152	61	4.5	1	16	1	NO	NO	NO
12	50	M	160	64	4.5	2	46	2	NO	NO	NO
13	45	M	176	84	5.5	1	30	1	NO	NO	NO
14	56	M	170	70	5.5	1	24	1	NO	NO	NO
15	50	M	158	58	4.5	1	34	2	NO	YES	NO
16	49	M	172	70	5	1	28	2	NO	NO	NO
17	43	F	150	50	4.5	2	40	2	NO	YES	NO
18	25	M	174	60	5	1	28	1	NO	NO	NO
19	32	M	178	60	4.5	1	15	1	NO	NO	NO
20	49	M	174	65	5	1	24	1	NO	NO	NO

S. No	Age (yr)	Sex	Height (cm)	Weight (kg)	Depth to epidural space (cm)	No of attempts	Time to reach epidural space (s)	Catheter placement 1-easy 2-difficult	Inadvertent dural puncture	Intravascular catheter placement	Failed epidural analgesia
21	50	M	148	45	4	1	18	1	NO	NO	NO
22	30	M	168	66	5	1	26	1	NO	NO	NO
23	45	M	170	68	5	1	28	1	NO	NO	NO
24	45	F	155	60	4.5	1	36	1	NO	NO	NO
25	50	M	170	68	4.5	1	20	1	NO	NO	NO
26	52	M	166	68	5	1	34	1	NO	NO	NO
27	29	M	165	62	4.5	1	34	1	NO	NO	NO
28	65	M	164	60	5	1	24	1	NO	NO	NO
29	60	M	162	68	5.5	1	28	1	NO	NO	NO
30	54	F	152	56	5	1	38	2	NO	NO	NO
31	35	F	152	54	5	1	40	1	NO	NO	NO
32	65	F	156	56	5	1	32	1	NO	NO	NO
33	33	M	160	60	5.5	1	33	1	NO	NO	NO
34	36	M	165	54	5	1	42	1	NO	NO	NO
35	42	M	166	56	5	1	24	1	NO	NO	NO
36	47	M	170	64	5.5	1	37	1	NO	NO	NO
37	50	F	150	70	5.5	1	55	1	NO	NO	NO
38	35	M	162	66	5	1	32	1	NO	NO	NO
39	52	F	156	73	5	1	36	1	NO	NO	NO
40	52	M	162	60	5	1	33	1	NO	NO	NO

S. No	Age (yr)	Sex	Height (cm)	Weight (kg)	Depth to epidural space (cm)	No of attempts	Time to reach epidural space (s)	Catheter placement 1-easy 2-difficult	Inadvertent dural puncture	Intravascular catheter placement	Failed epidural analgesia
41	54	M	165	70	5.5	1	38	1	NO	NO	NO
42	47	M	163	65	5	1	36	1	NO	NO	NO
43	46	F	167	63	5.5	1	25	1	NO	NO	NO
44	55	M	165	66	5	1	42	1	NO	NO	NO
45	60	F	152	56	4	1	43	1	NO	NO	NO
46	40	M	166	68	5	1	32	1	NO	NO	NO
47	43	M	168	66	4.5	1	35	2	NO	NO	NO
48	47	F	154	58	4.5	1	31	1	NO	NO	NO
49	33	M	160	69	5	1	17	1	NO	NO	NO
50	30	M	163	65	5	1	26	1	NO	NO	NO
51	29	M	166	63	5	1	40	1	NO	NO	NO
52	46	M	167	55	4.5	1	25	1	NO	NO	NO
53	57	M	159	62	5	2	41	2	NO	NO	NO
54	44	M	161	66	5	1	23	1	NO	NO	NO
55	34	M	158	60	5	1	19	1	NO	NO	NO
56	52	F	150	55	5	1	34	1	NO	NO	NO
57	45	M	157	66	5.5	1	32	1	NO	NO	NO
58	57	M	162	75	5.5	2	34	1	NO	NO	NO
59	55	M	165	70	5	1	44	1	NO	NO	NO
60	60	F	153	58	4.5	1	45	2	NO	NO	NO

2. GROUP GS

S. No	Age (yr)	Sex	Height (cm)	Weight (kg)	Depth to epidural space (cm)	No of attempts	Time to reach epidural space (s)	Catheter placement 1-easy 2-difficult	Inadvertent dural puncture	Intravascular catheter placement	Failed epidural analgesia
1	48	M	174	68	5.5	1	39	1	NO	NO	NO
2	67	M	170	64	5	1	36	1	NO	NO	NO
3	54	M	155	55	5	2	60	1	NO	NO	NO
4	67	F	160	68	5.5	2	82	2	YES	YES	NO
5	62	F	156	70	5.5	3	110	1	NO	NO	NO
6	48	F	160	70	5	2	25	1	NO	NO	NO
7	86	M	174	50	4.5	1	34	1	NO	NO	NO
8	50	M	164	64	5	2	48	1	NO	NO	NO
9	44	M	166	60	5	2	42	1	NO	NO	NO
10	46	F	152	40	4.5	2	55	1	NO	NO	NO
11	26	M	174	66	5	1	39	1	NO	NO	NO
12	72	M	166	56	4.5	1	26	1	NO	NO	NO
13	52	M	160	64	5	1	32	2	NO	NO	NO
14	55	M	156	48	5	1	29	2	YES	NO	NO
15	57	M	164	65	5.5	2	32	2	YES	YES	NO
16	55	F	150	56	5	1	54	1	NO	NO	NO
17	46	M	160	60	5	1	44	1	NO	YES	YES
18	33	F	152	60	5	1	56	1	NO	NO	NO
19	45	M	168	74	5.5	1	43	1	NO	NO	NO
20	32	M	163	67	5.5	1	45	1	NO	NO	NO

S. No	Age (yr)	Sex	Height (cm)	Weight (kg)	Depth to epidural space (cm)	No of attempts	Time to reach epidural space (s)	Catheter placement 1-easy 2-difficult	Inadvertent dural puncture	Intravascular catheter placement	Failed epidural analgesia
21	56	M	160	70	5.5	2	56	1	NO	NO	YES
22	55	M	162	60	5	1	43	1	NO	NO	NO
23	52	M	166	59	5	1	34	1	NO	NO	NO
24	35	M	170	66	5	1	35	1	NO	NO	NO
25	50	F	153	58	5	1	37	1	NO	NO	NO
26	53	F	156	50	4.5	2	52	2	YES	NO	YES
27	28	M	169	68	5.5	1	31	1	NO	NO	NO
28	29	M	167	66	5.5	1	25	1	NO	NO	NO
29	32	M	171	70	5.5	1	28	1	NO	NO	NO
30	36	M	164	68	5	1	35	1	NO	NO	NO
31	32	M	160	63	5	1	25	1	NO	NO	NO
32	49	M	162	68	5.5	2	43	1	NO	NO	YES
33	42	M	170	71	5.5	1	26	1	NO	NO	NO
34	48	F	172	76	5.5	1	34	1	NO	NO	NO
35	43	M	164	58	5	1	37	1	NO	NO	NO
36	37	M	178	79	5.5	1	28	1	NO	NO	NO
37	52	M	184	69	5.5	1	33	1	NO	NO	NO
38	42	M	177	70	5	1	46	1	NO	NO	NO
39	50	F	156	54	5	1	35	1	NO	NO	NO
40	51	F	158	56	5	1	37	1	NO	NO	NO

S. No	Age (yr)	Sex	Height (cm)	Weight (kg)	Depth to epidural space (cm)	No of attempts	Time to reach epidural space (s)	Catheter placement 1-easy 2-difficult	Inadvertent dural puncture	Intravascular catheter placement	Failed epidural analgesia
41	52	F	157	57	5	1	41	2	NO	YES	NO
42	42	M	169	69	5.5	1	32	1	NO	NO	NO
43	51	M	166	61	5	1	35	1	NO	NO	NO
44	54	M	165	60	5	1	39	1	NO	NO	NO
45	48	M	172	77	5.5	1	43	1	NO	NO	NO
46	45	M	168	73	5.5	1	36	1	NO	NO	NO
47	56	M	159	54	5	1	28	2	NO	NO	NO
48	54	F	152	52	5	1	34	1	NO	NO	NO
49	42	M	170	68	5.5	1	27	1	NO	NO	NO
50	34	M	168	65	5	1	26	1	NO	NO	NO
51	54	M	164	59	5	2	42	2	YES	YES	YES
52	43	M	165	67	5.5	1	52	2	NO	YES	NO
53	54	F	149	50	5	1	44	1	NO	NO	NO
54	60	M	162	63	5	1	25	1	NO	NO	NO
55	53	M	160	62	5	1	37	1	NO	NO	NO
56	42	M	165	66	5.5	1	22	1	NO	NO	NO
57	56	M	163	64	5	2	28	1	NO	NO	NO
58	26	M	169	66	5	1	33	1	NO	NO	NO
59	28	M	174	70	5.5	1	34	1	NO	NO	NO
60	53	F	154	59	5	1	38	1	NO	NO	NO