COMBINED SPINAL – EPIDURAL ANAESTHESIA TECHNIQUE IN OBSTETRICS

Andre Van Zundert
Catharina Hospital
Eindhoven – The Netherlands

Introduction

The combined spinal-epidural anesthesia technique (CSE) has been developed since about fifteen years and has known a widespread use in our clinical practice since then.

Epidural and spinal anesthesia are major regional anesthetic techniques, which have potential advantages over general anesthesia, especially for surgery involving the lower half of the body. These blocks have a long history of effective use for a variety of surgical procedures, and also for postoperative, acute and chronic pain relief.

Spinal anesthesia is practiced very widely due to its simplicity of administration, fast onset of action, producing a reliable and solid block without toxicity as only small doses of local anesthetics are used. The presence of cerebrospinal fluid as endpoint allows for a more certain outcome than epidural anesthesia. Epidural anesthesia on the other hand is chosen as it results in a less dense block and it causes less hypotension than spinal anesthesia. If correctly performed epidural anesthesia does not result in postdural puncture headache (PDPH). Nevertheless there are a number of drawbacks which are most prominent in the obstetric and the high-risk patient. In case a single injection technique is used, a spinal block may produce unwanted effects as hypotension and bradycardia, PDPH and in case of failure of the block or an inadequate block, the anesthesiologist cannot extend the block once the surgeon has begun with the operation. To institute an epidural block, more time and skills are required from the anesthesiologist to perform such a block, and again, there is the inability to extend the block once it is fixed, and the catheter is in situ. In both techniques, the anesthesiologist tends to use more than is necessary to do the job. In order to satisfy the surgeon and the patient (they do not want to experience any pain during the operation), the anesthesiologist wants to be sure about the result of his block. As it is impossible to predict exactly the length of an operation or the exact extend of a central block, a relative 'overdose' of a local anesthetic solution is given, thereby exposing the patient to unnecessary large amounts of local anesthetics. The use of a spinal or epidural catheter avoids the problem of an 'overdose' and allows top-ups in order to extend the block. As such, a more "balanced" and "tailored" anesthesia technique can be used. The catheter can also be used for pain relief in the postoperative period. The advantage of the continuous use of an epidural catheter technique is that it can extend the duration of anesthesia beyond the duration of the operation itself. Possible applications are: postoperative pain management, post-trauma pain management, obstetric anesthesia (both vaginal and cesarean deliveries) and in acute and chronic pain services. Disadvantages of a
continuous spinal anesthesia technique include difficulty in siting the catheter in the subarachnoid space, increased risk of PDPH, and the potential complications of infection, nerve trauma and hemorrhages. Concerns about the use of microcatheter and the cauda equina syndrome caused the FDA in the USA to withdraw subarachnoid placed catheters smaller than 27-gauge. By using the CSE technique, both the disadvantages of spinal and epidural anesthesia can be overcome, while preserving their advantages.

Controversial, Fears, Risks and Pitfalls of the CSE Technique still exists:

- Should the epidural catheter be inserted before or after the spinal block?
- Can the risk of catheter penetration through the dura hole be avoided?
- How do relatively small doses of epidural local anesthetic rapidly elevate the level of spinal block?
- Is there a risk of high spinal block, meningitis?
- What is the optimal length of spinal needle beyond the tip of the Tuohy needle?
- What is the risk of PDPH when using the CSE technique?
- What is the failure rate?
- Should a "test-dose" be used?
- What are the indications for the CSE technique?

History

The simultaneous performance of a spinal and an epidural block may be achieved by a variety of methods:

1. The Single Needle - Single Interspace - Technique (Epi - Subdural Technique)

In 1937 Soresi, a surgeon from New York, performed an epidural block with a fine gauge needle, which was then pushed on through the dura mater into the subarachnoid space to add a spinal block. He even claimed to provide one to two days postoperative analgesia using procaine. Sprotte in 1987 revived the technique using atraumatic-tipped needle. After performing the epidural block, the needle was left in situ until the adequacy of the block was assessed. If it was considered not effective enough, the needle was inserted further into the subarachnoid space and spinal anesthesia was added.

2. The Double Needle – Separate Interspaces - Technique

Curelaru, a Rumanian anesthesiologist, published in 1979 his double needle technique. An epidural catheter was inserted at one lumbar interspace, followed by a spinal block by needle insertion at
another space (two segments technique). Curelaru wanted to find safe and effective method of analgesia in a country where equipment and drugs for anesthesia are in short supply or only of substandard quality.

In 1981 Brownridge from Australia, described a similar technique for cesarean deliveries. In about 90% of his patients, the spinal block alone was sufficient, but due to the fact that there was an epidural catheter in situ, the block could be extended if necessary and it also could provide postoperative analgesia.

3. The Needle through Needle – Single Interspace - Technique

Coates and Mumtaz modified the technique in 1982 for orthopedic surgery and Carrie in 1984 for cesarean section. Rawal described in 1986 a single-segment sequential CSE technique for cesarean delivery. In this two-stage technique the epidural catheter was not just a reserve catheter, it was used to gradually raise the level of an intentional low spinal block. Today this is the most popular of all the combined techniques.

4. The Needle beside Needle - Single Interspace - Technique

In this technique special devices are used: an epidural needle with a hollow spinal needle guide, which is either braised or welded to its side, or incorporated into a rather bulky epidural needle shaft.

Technical Aspects of the "needle through needle" CSE technique

The most popular CSE technique nowadays uses a single space "needle-through-needle" technique in which the epidural needle serves as an introducer for a long fine spinal needle (e.g. 27 or 29 gauge needle). The only barrier the spinal needle may face is the dura mater. As such less failures should occur. The penetration through the dura mater often can be felt as a click. Modifications of the tip of the Tuohy needle have resulted in the fact that the long spinal needle comes out of the Tuohy needle in an almost straight line, although the availability of the back-eye in the Tuohy needle resolves this problem completely. As such the epidural catheter cannot penetrate the dura hole made by the spinal needle. The dura puncture is a distance away from the point where the epidural catheter touches the dura mater, diminishing the risk of catheter migration. The introduction of a spinal needle with a plastic sleeve (which keeps the spinal needle in the center of the Tuohy needle) has eliminated the risk of metal particles being shavelled off the internal bore of the epidural needle. The tip of the spinal needle does not contact the internal wall of the epidural needle due to the plastic sleeve that keeps the spinal needle centrally in the epidural needle and guides it through the hole in the curve of the epidural needle tip.

Epidural migration into the subarachnoid space is potentially very serious because failure to recognize catheter placement and injection of the usual epidural dose would result in total spinal anesthesia. Rawal did experimental studies on isolated human dura and showed that it was impossible to force an 18-gauge Portex epidural catheter through dural holes made by 26- or 27-
gauge spinal needles, even not when 5 holes were made in the same area. However, spinal needles of 22-gauge or larger diameter can make holes large enough to permit passage of an epidural catheter. However, the risk of catheter migration can be expected to be greater if there is a hole in the dura. Therefore confirmation of the catheter position by aspiration and frequent assessment of the block following injection of fractionated doses of local anesthetic, is absolutely necessary. It is clear that the CSE technique is not the technique of first choice for the novice and that the anesthesiologist should master first spinal and epidural techniques before attempting the CSE technique. There is a learning curve as for any new technique.

Once the dura mater is pierced by the spinal needle, the local anesthetic solution is injected in the subarachnoid space. Almost immediately after the first drops of the local anesthetic have reached the subarachnoid space, the patient informs us about the warmth sensation in the lower extremities. After the spinal needle is withdrawn, an epidural (macro) catheter is subsequently inserted in the epidural space. We modified this technique by inserting the epidural catheter first when the Tuohy needle is in the epidural space. Then the spinal needle is passed alongside the catheter into the subarachnoid space. Piercing the epidural catheter by the spinal needle was not seen, even not after trying it out in-vitro two hundred times.

The epidural space is identified in the usual fashion, using the loss-of-resistance to air technique. Strict control of using an aseptic technique will avoid infections. Meningitis will not be seen more frequently with this technique than when a spinal or epidural technique is used. The loss-of-resistance-to-air is used to identify the epidural space as any clear fluid coming out of the spinal needle will be CSF. The most critical stage in the CSE technique is the moment when the spinal needle is held in place only by the dura mater. At that stage there is a risk of needle displacement during syringe connection or during injection of local anesthetic. Needle displacement out of the subarachnoid space is the most likely cause of failure of block.

After plastering the epidural catheter to the back of the patient, the patient can be positioned, adequately monitored (including the use of preloading and if necessary vasopressors), disinfected, draped and the surgeon can begin with the operation without any delay. Smaller doses of a local anesthetic solution can be given into the subarachnoid space. If, for whatever reason, the local anesthetic does not produce the desired block, the epidural catheter can be used and a top-up given. Fractionated doses of local anesthetics should then be used in order to reduce the severity and frequency of hypotension. The less extensive block of sympathetic vasmotor activity due to the low level of the spinal block, combined with the slow onset of the epidural block allows more time for compensatory mechanisms to be effective, avoiding hypotension.

In many instances where the CSE technique is applied, the epidural catheter has any function at all during the operation itself. However, in up to ten percent of patients, the spinal block alone may not be adequate (inadequacy of block or unanticipated prolonged surgery). Also when we deliberately goal to produce a low spinal block as in the case of a sequential block (thereby avoiding the 'overdose' principle). This may be particularly advantageous in the high-risk patient. By positioning the patient prior to induction of spinal anesthesia and by allowing titration with
incremental epidural doses of local anesthetics to the precise level of anesthesia desired, the CSE technique may enhance the safety of regional anesthesia in these patients. Rawal demonstrated in 1988 that the total dose of bupivacaine was three times higher in parturients receiving only epidural anesthesia compared with the CSE group, although the resulting anesthesia was better in the CSE group. The corresponding maternal and fetal blood bupivacaine levels were also three times higher in the epidural group as well as the incidence of maternal hypotension. The sequential CSE technique will take somewhat longer, but it reduces the frequency and severity of hypotension seen after central blocks.

Several authors have reported a lower incidence of PDPH following the use of the CSE technique. Several possible explanations have been given: the Tuohy needle serves as an introducer needle and allows a meticulous puncture of the dura by very fine diameter spinal needles and multiple attempts at identifying the subarachnoid space are thus avoided. The risk of CSF leakage through the dura is decreased due to the use of very fine and less traumatic spinal needles. The increased pressure in the epidural space (the presence of the epidural catheter and/or the injection of local anesthetics) and the use of opioids have a prophylactic effect against PDPH, although more studies are warranted.

In order to allow protrusion of its tip beyond that of an epidural needle, a long-shafted spinal needle is required instead of the use of a normal spinal needle. The protrusion distance of the spinal needle from the end of the Tuohy needle should be about 12 mm, otherwise tenting of the dura matter may be the result without puncturing it. If the spinal needle protrusion beyond the tip of the Tuohy needle is > 17 mm, perforating the dura twice is possible, and thereby an increased incidence of PDPH. Also pencil point needles may pierce the dura mater only partial so that part of the local anesthetic solution will be injected in the subarachnoid space and partly in the epidural space, resulting in a less adequate block. It is essential that the long spinal needle and the epidural needle fit very accurately. This improves the strength while we inject the local anesthetic in the subarachnoid space. It is emphasized that the spinal needle is held in place only by the dura mater and therefore there is a risk of needle displacement when it is connected to the syringe or during injection of the local anesthetic solution. This is the most critical stage in the CSE technique. This problem can be overcome when the hub of the spinal needle locks into the hub of the Tuohy needle and when the protrusion length can be varied by using an adjustable long spinal needle. The latter will overcome the problem of the variable depth of the human epidural space (including tenting of the dura mater), which may vary between 10 and 17 mm. CSF appearing in the transparent hub of the needle is a clear indication that the tip lies in the subarachnoid space. It is advisable, at the end of the injection of the local anesthetic, to aspirate a few drops in order to ensure that the entire volume has reached the subarachnoid space.

Indications of the CSE Technique in Obstetrics

- Parturients in severe pain or with second stage problems
- Operative deliveries including cesarean deliveries
Previous patchy epidural blocks

Obesity and difficult back

High risk parturients in which control of blood pressure is of utmost importance

Walking - mobile epidurals

Any parturient without contraindications for regional blocks

The objectives of pain relief during labor are to produce a barely perceptible sensory block which extends from T10 till S5. Retention of sensation without pain, and maintenance of motor power will increase maternal satisfaction, and reduces both long-term back-ache and the instrumental delivery rate. Anesthetic techniques should avoid producing unpleasant maternal feelings such as: numbness, weakness of the legs, restriction of movement due to the motor block, helplessness and loss of self-control. The only way to reduce the loss of motor power is to use less mg/hr of the local anesthetic (usually bupivacaine). Therefore use less than 10 mg/hr bupivacaine throughout labor, use the CSE technique, inject an initial and small dose into the subarachnoid space, combine the local anesthetic with an opioid, and use intermittent epidural top-ups. As a result when using less local anesthetic, the dose used in a CSE technique will be 50-77% less compared with an epidural technique; the initial analgesia obtained after the subarachnoid injection, will last 30-90 minutes depending on the local anesthetic solution used. Synergic effects will be obtained if local anesthetics are combined with opioids, and/or clonidine - neostigmine. If a tailored anesthesia technique is offered, using epidural top-ups, a 35% dose sparing effect can be obtained compared with a continuous injection technique. As a result of the low dose local anesthetic used, these epidurals in the CSE technique may allow the parturient to stand - up even be mobile for a short while. The mother's preference for retaining the ability to move legs is crucial. It also reduces the need to catheterize the bladder. As there are less patients with dense blocks, there is also a reduction in nursing problems. Reduction in power of expulsion muscles will lead to more spontaneous vaginal deliveries and possibly less cesarean deliveries. The low dose CSE technique produces a fast onset of effective and more complete analgesia. There are less side effects of the spinal block and toxic reactions will not be seen. The epidural catheter is used if labor continues beyond subarachnoid block, in order to improve an inadequate subarachnoid block or to gradually raise the level of an intentional low spinal block.

Mobile - Walking Epidurals

Pregnant women are hypercoaguoble susceptible to pulmonary embolism. Therefore one should change positions frequently, avoiding long time recumbency. The benefits are that the woman is allowed to get up or walk up, sit in a chair, while retaining her mobility. Effects on labor of the upright vs recumbent position are: greater satisfaction, less pain, shorter labors, better fetal heart rate patterns, and less difficulty with bearing-down. Disadvantages of the mobile epidurals are: fears of medicolegal consequences of e.g. a fall, which may be induced by hypotension, dizziness, loss of motor power and loss of proprioception. Besides the above, fetal monitoring should be
performed using telemetry. Laboring women with a CSE technique in place should be accompanied by an adult when walking about. She should remain within the confines of the labor suite and when she wishes she can stand by the bed, rock her pelvis, walk to a nearby toilet and adopt a position of her choice. This will give her a greater overall satisfaction and better feelings of self-control. Intact motor function of the abdominal and pelvic muscles will help in the spontaneous delivery of the baby. Therefore less instrumental deliveries, including cesarean deliveries should be the result.

**Minimal Requirements**

A cooperative informed parturient, continuous midwife attendance and a trained anesthesiologist are essential partners when using the CSE technique. The same standards of care as for epidurals in obstetrics are necessary. Monitoring is essential with frequent assessments of the block are essential: control of pain relief, sympathetic, sensory and motor blockade.

**Advantages**

The CSE technique offers the speed of onset, efficacy and minimal toxicity of a spinal block, combined with the potential of improving an inadequate block or prolonging the duration of anesthesia with epidural supplements, and extending the analgesia well into the postoperative period.

In vaginal and cesarean deliveries, the CSE technique can be used as a sequential technique, aiming deliberately for a low spinal block. Low-dose combinations of local anesthetic and opioid provide a very selective block and no motor block, which allows the parturient to ambulate during labor. Meaningful voluntary motor activity, including walking, is only possible with intact dorsal column functions. The epidural catheter is used if labor continues beyond the duration of the subarachnoid block or to improve an inadequate subarachnoid block. Also in cesarean deliveries, the epidural catheter is used to gradually raise the level of an intentional low spinal block. As such a tailored anesthesia technique can be offered to our obstetric patients, with a fast onset of pain relief - faster than with the use of epidurals alone - whereby the frequency and severity of maternal hypotension is reduced.

**What Kind of Anaesthetic Solutions can be used in Obstetrics?**

A variety of drugs can be used in vaginal deliveries: e.g. for the subarachnoid block: bupivacaine 1.0 - 2.5 mg to which fentanyl or sufentanil 10 mcg is added will produce pain relief for about 1 to 1.5 hours. Via the epidural catheter an hourly solution of 6-8 ml bupivacaine 0.06-0.1% plus fentanyl or sufentanil 1 mcg/ml is used to provide long-lasting pain relief. Its effect can be increased by using clonidine 150 mcg in the epidural space or 75 mcg in the subarachnoid space. Lately 10 mcg of neostigmine is also added to improve the block.

In early labor it is sometimes only necessary to inject an opioid (e.g. sufentanil 10 mcg) to abort the pain and once the pain recurs, a continuous infusion is started as above described. In late labor (cervical dilatation > 8 cm) the subarachnoid injection consists of 2.5 mg of bupivacaine plus
sufentanil 10 mcg. Minimal ambulation should then be allowed, but the parturient may want to walk to the bathroom with assistance.

Relatively small doses of epidural local anesthetic can rapidly elevate the level of spinal anesthesia due to:

- leakage of epidural local anaesthetic through the dural hole
- continuing spread of the initial subarachnoid block (unrelated to the epidural injection)
- compression of the subarachnoid space, by the presence of the epidural catheter and the volume of local anesthetic, resulting in a compression of the subarachnoid space and more extensive spread of local anesthetic. The increased volume within the epidural space causes a decrease in CSF volume and a cephalad shift of local anesthetic within the CSF. Extension of subarachnoid anesthesia is only possible until the block is "fixed". After that, the influence of an epidural injection or subarachnoid anesthesia is unclear. Safest however, is to inject small volumes, e.g. 2 ml of the local anesthetic in the epidural space, and wait for the results. This proves often to result quickly in an adequate block, especially when the subarachnoid injection of the local anesthetic originally produced an adequate block.

Provision of safe and effective anesthesia for a cesarean delivery in the awake obstetric patient is one of the most challenging problems an anesthesiologist can be faced with. An extensive block is required (T4-Sacrals) for adequate anesthesia, which requires large doses in epidural anesthesia. The upper level of sensory block is difficult to control. The subsequent fear of inadequate analgesia has prompted many anesthesiologists to use a relatively large dose of local anesthetic ('overdose'). This may be associated with a relatively high incidence of hypotension and a potential risk of toxicity, which may harm both the mother and the fetus.

For cesarean sections, bupivacaine 8-10 mg to which 5 mcg sufentanil is added can be used. Small amounts of local anesthetic solutions can be injected via the epidural catheter if the extend of the upper sensory blockade is not sufficient enough to perform the cesarean delivery.

The Epidural Test – Dose

A "test-dose" is not advocated when using the CSE technique. Each solution injected in obstetric patients should be a test dose at all times, as the dose should never exceed the one of a test dose. If a dose is injected intravenously, no toxicity should appear; if given epidurally, a slow onset of analgesia will be the result, but not the dense, non-selective block; if injected in the subarachnoid space: rapid analgesia will appear with minimal or no motor block. When using the low dose-low mixture of local anesthetics and opioids, all doses given are tests, provided the anesthesiologist knows the effects of the injected drugs in the different locations. This makes obstetric anesthesia much safer than it was in the past.
Conclusion

The CSE technique offers us the best of both techniques, especially in obstetrics. The combination of the reliability of a spinal block and the flexibility of an epidural block leads to a reduction in drug dosage, the ability to eliminate motor block and the achievement of highly selective sensory block and optimal analgesia, while the patient may be allowed to be ambulate in case of vaginal deliveries. The epidural catheter can be used intraoperatively to increase a deliberately aimed low spinal block, to correct insufficient surgical anesthesia and for postoperative pain management. Also, beyond obstetrics, there are many indications for its use during operations for the lower half of the body. It is an ideal technique if used for continuous analgesia.

Epidural and spinal anesthesia have both advantages and disadvantages. Neither technique should be used to the exclusion of the other. The choice should always be based on the individual patient who has to undergo a particular operation. The CSE technique combines the rapidity, effectiveness and reliability of a spinal block with the ability to refine anesthesia with epidural supplements, but also to extend analgesia into the postoperative period.