Advances in obstetric anesthesia: ambulation during labor with combined spinal-epidural analgesia

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Abstract

Epidural analgesia is widely considered as the most effective method of providing pain relief in labor. However, epidural labor analgesia is not a generic procedure and many technical modifications have been invented over time. Continuous search for a balanced labor analgesia, which provides relief of pain of contractions while preserving motor function, has led to the development of the ambulatory labor analgesia. The combined spinal-epidural analgesia (CSEA) performed with subarachnoid opioids (with or without local anesthetics) causes minimal motor block and is particularly applicable to ambulatory labor analgesia. While there still remains some concern about dural puncture, the CSEA technique offers many advantages to the parturient, and has gained wide spread popularity in obstetric anesthesia worldwide.

The advantages of CSEA

The combined spinal-epidural labor analgesia technique (CSEA) has attained wide spread popularity in obstetric anesthesia. In many centers it has begun to replace or has replaced traditional epidural techniques. While there still remains some concern about dural puncture, the CSEA technique offers many advantages to the parturient. Several authors have reported a very low incidence of post dural puncture headache (PDPH) associated with CSEA, which may reflect the fact that the epidural needle, which must be correctly placed first, serves as the introducer for the spinal needle, which then results in a one-time very small gauge dural puncture by the spinal needle. The low incidence of PDPH may be particularly advantageous in patients with a history of PDPH. It is known that symptoms of PDPH are more likely if there has been a preceding PDPH. Additionally, the appearance of the CSF in the hub of the spinal needle may indirectly confirm (reconfirm) the correct epidural needle placement, which is of increased importance in patients with difficult anatomic landmarks and/or increased skin-epidural space distance.

It has been reported that combining spinal and epidural blocks may appear cumbersome and time consuming. Because newer CSEA trays have eliminated many equipment limitations, and thus reduced preparation time, the CSEA technique should become even more attractive to practitioners. It is believed that in experienced hands the entire procedure should not take longer than approximately 4-5 minutes. An 18-Ga Tuohy-Schliff (or other type) epidural needle, placed in the lumbar epidural interspace, serves as an introducer to a long 27-Ga pencil point spinal needle that punctures the dura and subarachnoid mater of the spinal cord allowing the initial injection of the subarachnoid dose for induction of labor analgesia. The definite end point for successful dural puncture is free flow of CSF at the spinal needle hub. During the injection into the subarachnoid space, the parturient is asked to report feeling of warmth under the buttocks and thighs. If this symptom is not reported within 30 seconds, the CSEA induction dose may not have been injected into the subarachnoid space. After subarachnoid injection of the induction dose the spinal needle is removed, and the epidural catheter is inserted 5 cm into the epidural space and secured to the skin. Proper epidural catheter position is confirmed by negative aspiration of CSF or blood. This may be followed by the injection of about 1-1.5 ml of saline into the epidural catheter to test its patency. The onset of analgesia is rapid and reliable. Rapidity of onset and reliability of technique improve quality of analgesia and maternal satisfaction.

It has been a long-time tradition to verify the proper epidural catheter placement by administering an epidural test dose. However, some proponents of CSEA have advocated that when low-dose mixtures of opioids and/or local anesthetics are used with a multi-orifice epidural catheter (such as in CSEA technique), an epidural test dose is not necessary. Furthermore, administration of a traditional epidural test dose causes unwanted loss of proprioceptive and motor functions, the preservation of which are necessary to permit safe ambulation in labor.

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The optimal length of the spinal needle in CSEA

The distance from the tip of the epidural needle to the posterior wall of the dural sac in the midline varies from 0.30-1.05 cm. Furthermore, the anteroposterior diameter of the dural sac varies considerably during flexion and extension of the spinal column. Additionally, because the dural sac is triangular with its base resting on the vertebral body and the triangle apex pointing posteriorly to the ligamentum flavum, the above measurements are valid only when the epidural is performed in the midline. The length of protrusion of the spinal needle beyond the tip of the epidural needle for a successful CSEA placement has been the subject of significant debate, and at most institutions varies from 10-16 mm. Joshi et al. reported that the length of spinal needle protrusion should be more than 13 mm. On the other hand, Vandermeersch considers a protrusion of at least 17 mm to be optimal. The type of spinal needle may also influence the success rate of the CSEA.

A great variety of special CSEA needle sets are commercially available. Interestingly, in a European survey it was reported that special CSEA needle sets were used only by 31% of anesthesiologists. The remainder used their own combination of epidural needles and extra long spinal needles. The newly introduced Espocan CSEA needle set, allows a different exit point for the passage of the epidural catheter and the spinal needle. A "back eye" at the epidural needle curve near its bevel permits the passage of the spinal needle, while the epidural catheter enters the epidural space through the "regular" needle eye. The point of dural contact by the epidural catheter is thus at some distance from the dural hole, which might reduce the risk of epidural catheter penetration through the hole in the dura made with the spinal needle.

With the needle-through-needle CSEA technique, the tip of the spinal needle may scrape against the inner wall of the Tuohy-Schliff needle, and concern has been raised about the possibility of metal particles being carried into the subarachnoid space. However, Herman et al. could not find any evidence of metal particles produced by the needle-through-needle CSEA technique.

Ambulation during labor with CSEA

CSEA performed with subarachnoid opioids (with or without local anesthetic) causes minimal or no motor block and has been referred to as the "walking epidural". At the University of California, San Diego, CSEA with both local anesthetics and opioids combined, has become the standard practice for ambulatory labor analgesia. The initial subarachnoid dose of bupivacaine 2.5 mg, and fentanyl 5-10 µg is extremely efficacious, abolishing most severe labor pain in 2-3 minutes. Although the initial dose is usually a low-dose mixture of local anesthetic and opioid, fentanyl or sufentanil alone may also be used. Sufentanil and fentanyl have been reported to cause fetal bradycardia (with higher incidence following subarachnoid administration of sufentanil); however, recent studies suggest the median effective dose (ED_{50}) of subarachnoid sufentanil is less than 3 µg and have failed to demonstrate any fetal problems.

Palmer et al, in a retrospective study compared the incidence of fetal heart rate abnormalities after institution of two techniques of labor analgesia (either subarachnoid fentanyl or conventional epidural labor analgesia). Both techniques were associated with a low (6%-12%) incidence of fetal heart rate, and no difference in neonatal outcome was found.

For ambulatory labor analgesia the CSEA technique offers the possibility of combining rapid onset of subarachnoid analgesia with the flexibility of continuous epidural analgesia. This approach with the application of low-dose local anesthetic and/or opioid can provide a very selective sensory block with minimal motor blockade, allowing parturients to ambulate. Traditionally in clinical practice, the degree of motor block is assessed using the Bromage/modified Bromage scale. These scales attempt to quantify the power of various muscle groups of the leg, foot and thigh. To enable ambulation in labor, all muscle group innervated by the L5-S1 nerve roots should have normal or "nearly normal" power.

Many researchers have established that proprioceptive (dorsal column) functions can be selectively preserved with low-dose CSEA. To achieve this goal however, it is necessary to omit the traditional epidural test dose with lidocaine and epinephrine.

In the author's practice at the University of California, San Diego, following placement of CSEA, the patient is monitored for 20 minutes (maternal blood pressure and external fetal heart monitoring). If she desires, and if the obstetrician, the nurse and the anesthesiologist agree, the patient is assessed for motor strength and the ability to ambulate. If the patient is able to get out of bed without assistance, she is then asked to stand and walk several steps across the room. After attempting ambulation, a deep knee bend (could the patient do this before CSEA placement?) and/or "modified" Bromage scale (ability to raise extended leg up from bed lying supine with left uterine displacement (LUD), ability to flex knee, and flex/extend ankle) are routinely utilized. The score from 0 to 3, where 0 = no paralysis, raises extended leg, full flexion of knee and ankle (full motor strength), 1 = inability to raise extended leg, able to move knee, 2 = inability to flex knee, able to flex ankle, and 3 = inability to move lower limb, is performed (Table 1).

TABLE 1: Modified Bromage Score
(Assessment of the degree of motor block in laboring parturients performed at the University of California, San Diego)

Score	*Description*
0	No paralysis, raises extended leg, full flexion of knee and ankle (full motor strength)
1	Inability to raise extended leg, able to move knee
2	Inability to flex knee, able to flex ankle
3	Inability to move lower limb

Patients who have full motor strength may ambulate with assistance of an IV pole on one side and a support person (usually her nurse or her partner) on the other. Most patients usually walk around the room or to the bathroom, where they void, spending approximately 10-15 minutes out of bed on each occasion. If the patient is receiving an oxytocin infusion ambulation in close proximity to her bed or sitting in the armchair is usually recommended. It is very important to provide a suitable, safe environment for ambulating parturients (safe floors, no cables, and the like). To avoid epidural catheter displacement the anesthesiologist needs to ensure good fixation of the epidural catheter to the skin. Suitable (remote, cordless) fetal monitoring is recommended to ensure fetal well-being. Epidural maintenance of labor analgesia is usually achieved with a low-dose mixture of local anesthetics and opioids (0.0625% bupivacaine mixed with fentanyl 1.9 µg/ml, at the rate of 8-12 ml/hour). Combinations of bupivacaine with fentanyl or sufentanil have been the most studied maintenance solu-

tions. However, recently interest has turned to ropivacaine and levobupivacaine, which appear to spare motor function better than bupivacaine.

Concerns specific to CSEA

Four major concerns regarding potential complications specific to CSEA technique have been raised in the literature; 1) the risk of epidural catheter migration through the dural puncture hole; 2) the potential risk of increased drug leakage through the dural puncture hole; 3) the possibility of infectious complications; 4) the risk of contamination of CSF with metal particles from damaged spinal needle tips during the needle-through-needle technique. Epidural catheter migration into the subarachnoid space could be potentially a very serious complication leading to total subarachnoid anesthesia if not recognized. However, the low incidence with which this complication has been reported indicates that this does not constitute a major problem in clinical practice. In an in vitro study of pieces of isolated human dura, Rawal et al. reported that it was virtually impossible to force an 18-Ga epidural catheter through dural holes made by 26 or 27-Ga spinal needles. On the other hand, total spinal block is an acknowledged complication of "top-ups" of previously normally functioning epidural catheters. Continuous epidural infusion of low-concentration local anesthetic is much safer than high-concentration bolus injection. Every reinjection/top-up should be considered a test dose.

Theoretically, a hole in the dura mater may allow the transdural passage of drugs from/to the epidural/subarachnoid spaces. Although leakage of epidural local anesthetic into the subarachnoid space is theoretically possible, the rapid onset of spinal anesthesia suggests involvement of other mechanisms. Furthermore, current knowledge of pressures within the subarachnoid and epidural spaces suggests that the flow of fluid (CSF) is more likely to be away from the subarachnoid space rather than towards it.

Although an increased incidence of meningitis following perforation of the dura mater by the spinal needle is theoretically possible, review of the literature suggests that the frequency of meningitis after CSEA is no greater than in the average population.

Buggy et al. found that 66% of parturients had impaired dorsal column function after receiving 15 ml bupivacaine, 0.1%, with 2-ug/ml, fentanyl during labor, the effect of which precluded safe ambulation. However, critics of this study pointed out that all patients participating in the study also received a 3 ml bupivacaine, 0.5% test dose, which by itself might have affected sensory and motor function. In a subsequent study using an identical epidural bolus dose, but no test dose, Parry et al. reported abnormal dorsal column function only in 7% of parturients, a similar incidence to that in their control group of patients who received subarachnoid fentanyl with bupivacaine as part of a CSEA technique. Cohen et al. in a randomized double-blind study found that omitting a lidocaine-epinephrine test dose and using 0.125% bupivacaine for the initial bolus should permit ambulation in the early post block period for most parturients who elect this option. Many anesthesiologists have abandoned the routine use of a standard lidocaine-epinephrine test dose when using a multiorifice epidural catheter and dilute concentrations of local anesthetics, regarding the entire first dose as a test dose.

The additional argument against traditional epidural test dose is the well-documented safety of continuous infusions of low-dose local anesthetic, or low-dose mixtures of local anesthetic and opioids for labor analgesia. Most likely, intravascular injection will result in no analgesia, with minimal adverse effects on the mother and fetus (signs of CNS toxicity and cardiovascular collapse would not occur). If the administration of local anesthetic/opioids solution is subarachnoid (or subdural),it is highly likely that a gradually increasing degree of motor block, with minimal loss of sympathetic tone will occur, with respiratory depression being very rare. The omission of the traditional epidural test dose with 45 mg of lidocaine and 15ug of epinephrine may seem like a radical departure from traditional thinking. Nevertheless, if selective sensory block with minimal sympathetic block is desired, and motor function is to be preserved, then the omission of a traditional test dose is necessary. Based on the author's experience, such an omission of a traditional test dose is safe. This is further supported by similar findings by Morgan at Queen Charlotte's Hospital in London, England.

Use of the CSEA technique without the test dose for ambulatory labor analgesia leaves the epidural catheter untested. Although some have expressed concern about the unknown functional status of the epidural catheter following subarachnoid drug injection, it has been well established that the epidural failure rate for the CSEA technique does not exceed that of conventional epidural analgesia for labor. However, prior to using the epidural catheter with greater concentrations of local anesthetic such as may be needed with a cesarean delivery a formal test dose should be administered.

The most common complications of CSEA technique for labor analgesia include pruritus, maternal hypotension, and fetal heart rate changes. The etiology of hypotension after subarachnoid opioid administration is unclear. Some authors have speculated that the sudden onset of analgesia may produce hypotension, whereas others attribute a decrease in maternal blood pressure to rapidly decreasing catecholamine levels in maternal blood. The hypotension, however, is generally minimal and is easily treated with CSEA analgesia. Additionally, several authors have recently reported uncommon complications including aphasia, dysphagia, altered level of consciousness, high sensory block, respiratory depression, and respiratory arrest, following induction of CSEA for labor pain.

Conclusion

In summary, the CSEA technique for ambulatory analgesia in labor has a good record of efficacy and safety and can be accomplished with minimal or no side effects. Appropriate maternal and fetal monitoring following administration of CSEA for ambulatory labor analgesia, as true of any kind of labor analgesia, is recommended by the American Society of Anesthesiologists (Practice Guidelines for Obstetrical Anesthesia).

Bibliography

1. *Arkoosh V, Cooper M, Norris M, et al. Intrathecal sufentanil dose-response in nulliparous patients. Anesthesiology 1998; 89: 364-370.*
2. *Bernards CM, Kopacz DJ, Michel MZ. Effect of needle puncture on morphine and lidocaine flux through the spinal meninges of the monkey in vitro: implications for combined spinal-epidural anesthesia. Anesthesiology 1994; 80: 853-858.*
3. *Buggy D, Hughes N, Gardiner J. Posterior Column Sensory Impairment During Ambulatory Extradural Analgesia in Labour. Br J Anaesth 1994; 73: 540-542.*

4. *Burke D, Wildsmith JAW. Meningitis after spinal anaesthesia. Br J Anaesth 1007; 78: 635-636.*
5. *Camann WR, Minntzer BH, Denney RA, et al. Intrathecal sufentanil for labor analgesia: effects of added epinephrine. Anesthesiology 1993; 78: 870-974.*
6. *Cascio M, Pygon B, Bernett C, Ramanathan S. Labour analgesia with intrathecal fentanyl decreases maternal stress. Can J Anaesth 1997; 44: 605-609.*
7. *Clarke VT, Smiley RM, Finster M. Uterine hyperactivity after intrathecal injection of fentanyl for analgesia during labor: A case of fetal bradycardia? Anesthesiology 1994; 81: 1083.*
8. *Cohen SE, Yeh JY, Riley ET, Vogel TM. Walking with labor Epidural Analgesia. Anesthesiology 2000; 92: 387-392.*
9. *Collis RE, Davies DWL, Avelinng W. Randomized comparison of combined spinal-epidural and standard epidural analgesia in labour. Lancet 1995; 2: 1413-1416.*
10. *Currier DS, Levin KR, Campbell. Dysphagia with intrathecal fentanyl. Anesthesiology 1997; 87: 1570-1571.*
11. *D'Angelo R, Eisenach JC. Severe maternal hypotension and fetal bradycardia after a combined spinal epidural anesthetic. Anesthesiology 1997: 87: 166-168.*
12. *Fernando R, Price CM. Posterior column sensory impairment during ambulatory extradural analgesia in labour. Br J Anaesth 1995: 74: 540-542.*
13. *Ferouz F, Norris MC, Leighton BL. Risk of respiratory arrest after intrathecal sufentanil. Anesth Analg 1997; 85: 1088-1090.*
14. *Fragneto RY, Fisher A. Mental status change and aphasia after labor analgesia with intrathecal sufentanil/bupivacaine. Anesth Analg 2000; 90: 1175-1176.*
15. *Friedlander JD, Fox HE, Cain CF, Dominguez CL, Smiley RM. Fetal bradycardia and uterine hyperactivity following subarachnoid administration of fentanyl during labor. Reg Anesth 1997; 22: 378-381.*
16. *Hamilton CL, Cohen SE. High sensory block after intrathecal sufentanil for labor analgesia. Anesthesiology 1995; 83: 1118-1121.*
17. *Herman NL, Calicott R, Van Decar TK, et al. Determination of the dose-repsonse relationship for intrathecal sufentanil in laboring patients. Anesth Analg 1997; 84: 1256-1261.*
18. *Herman N, Molin J, Knape KG. No additional metal particle formation using the needle-through-needle combined epidural/spinal technique. Acta Anaesthesiol Scand 1996; 40: 227-231.*
19. *Holmstrom B, Rawal N, Axelsson K et al. Risk of catheter migration during combined spinal block – percutaneous epiduroscopy study. Anesth Analg 1995; 80: 747-753.*
20. *Joshi G, McCaroll S. Evaluation of combined spinal-epidural anaesthesia using two different techniques. Reg Anesth 1994; 19: 169-174.*
21. *Kuczkowski KM. Respiratory arrest in a parturient following intrathecal administration of fentanyl and bupivacaine as part of a combined spinal-epidural analgesia for labour. Anaesthesia 2002; 57: 939-940.*
22. *Kuczkowski KM, Benumof J.L. Post-dural puncture syndrome in an elderly patient with remote history of previous post-dural puncture syndrome. Acta Anaesthesiol Scand 2002; 46: 1049-1050.*
23. *Kuczkowski KM, Benumof J.L. Repeat cesarean section in a morbidly obese parturient: a new anesthetic option. Acta Anaesthesiol Scand 2002; 46: 753-754.*
24. *Kuczkowski KM, Goldsworthy M. Transient aphonia and aphagia in a parturient after induction of combined spinal-epidural labor analgesia with subarachnoid fentanyl and bupivacaine. Acta Anaesthesiol Belg 2003; 54: 165-166.*
25. *Morgan BM. Is an epidural test dose necessary? Eur J Obstet Gynecol 1995; 59: 559-560.*
26. *Morton CP, Armstrong PJ, McClure JH. Continuous subarachnoid infusion of local anaesthetic. Anaesthesia 1993; 48: 333-336.*
27. *Norris MC. Are combined spinal epidural catheters reliable? Int J Obstet Anesth 2000; 9: 3-6.*
28. *Norris MC, Fogel ST, Dalman H, Borrenphohl S, Hoppe WH, Riley A. Labor epidural analgesia without an intravascular "test dose". Anesthesiology 1998; 88: 1495-1501.*
29. *Palmer CM, Maciulla JE, Cork RC, Nogami WM, Gossler K, Alves D. The incidence of fetal heart rate changes after intrathecal fentanyl labor analgesia. Anesth Analg 1999; 88: 577-581.*
30. *Parry MG, Fernando R, Bawa GPS, Poulton BB. Dorsal column function after epidural and spinal blockade: Implications for the safety of walking following low dose regional analgesia for labour. Anaesthesia 1998; 53: 382-403.*
31. *Patel M. Combined spinal and extradural anesthesia. Anesth Analg 1992; 75: 640-641.*
32. *Pham LH, Camann WR, Smith MP, Datta S, Bader AM. Hemodynamic effects of intrathecal sufentanil compared with epidural bupivacaine in laboring parturients. J Clin Anesth 1996; 8: 497-501.*
33. *Phillip J. Brown W. Total spinal anesthesia late in the course of obstetric bupivacaine epidural block. Anesthesiology 1976; 44: 340-341.*
34. *Plaat F, Alsaud S, Crowhurst JA, et al. Selective sensory blockade with low-dose combined spinal/epidural (CSE) allows safe ambulation in labour: a pilot study. Intl J Obstet Anaesth 2996; 5: 220.*
35. *Practice Guidelines for Obstetrical Anesthesia. The Task Force on Obstetrical Anesthesia, American Society of Anesthesiologists, 520 Northwest Highway, Park Ridge, IL. House of Delegates, October 1998.*
36. *Ravindran A, Albrecht W, Mckay M. Apparent intravascular migration of epidural catheter. Anesth Analg 1979; 58: 252-253.*
37. *Rawal N, Holmstrom B, van Zundert A, Crowhurst JA. The Combined Spinal-Epidural Technique. In Birnbach DJ, Gatt SP, Datta S (eds). Textbook of Obstetric Anesthesia. New York, Churchill Livingstone 2000; pp 157-182.*
38. *Rawal N, Schollin J, Wesstrom G. Epidural versus combined spinal epidural block for Caesarean section. Acta Anaesthesiol Scand 1988; 32: 61-66.*
39. *Riley ET, Ratner EF, Cohen SE. Intrathecal sufentanil for labor analgesia: Do sensory changes predict better analgesia and greater hypotension? Anesth Analg 1997; 84: 346-351.*
40. *Riley ET, Walker D, Hamilton CL, Cohen SE. Intrathecal sufentanil for labor analgesia does not cause a sympathectomy. Anesthesiology 1997; 87: 874-878.*
41. *Robson JA, Brodsky JB. Latent dural puncture after lumbar epidural block. Anesth Analg 1977; 56: 725-726.*
42. *Scavone BM. Altered level of consciousness after combined spinal-epidural labor analgesia with intrathecal fentanyl and bupivacaine. Anesthesiology 2002; 96: 1021-1022.*
43. *Segal S, Csavoy AN, Datta S. The tocolytic effect of catecholamines in the gravid rat uterus. Anesth Analg 1998; 87: 864-869.*
44. *Vandermeersch E. Combined spinal-epidural anaesthesia. Baillieres Clin Anaesth 1993; 7: 691-708.*
45. *Van Zundert A, Vaes L, Soetens M, et al. Every dose given in epidural analgesia for vaginal delivery can be a test dose. Anesthesiology 1987; 67: 436-440.*
46. *Wildsmith JAW. Peripheral nerve and local anaesthetic drugs. Br J Anaesth 1986: 58: 692-700.*