Combined Spinal Epidural Anesthesia

William F. Urmey, M.D.
Assistant Professor of Clinical Anesthesiology
Hospital for Special Surgery, Weill Medical College of Cornell University,
New York, NY, USA

Introduction

Regional anesthetic techniques are rapidly evolving to meet the needs of an ever increasing day surgery patient population. Rapidity and control of onset and offset of anesthesia with minimal side effects are now required of regional anesthetic techniques if these are to compete with general anesthesia. Spinal and combined spinal epidural (CSE) anesthesia for the day surgery patient are discussed below.

Outpatient Spinal Anesthesia

Outpatient spinal anesthesia with small gauge pencil point needles offers distinct advantages for procedures of predictable duration. Spinal anesthesia is characterized by rapid onset and predictable offset, high reliability, a definitive endpoint (presence of CSF), and a low rate of complications and side effects. Spinal anesthesia utilizes a much smaller dose of local anesthetic than epidural. Use of plain local (isobaric) anesthetics virtually eliminates clinically meaningful intravascular injection as well as high spinal or massive epidural anesthetics. Distribution of intrathecal plain local anesthetic in the subarachnoid space is ideal for lower extremity orthopedic procedures.

Choice of Local Anesthetic for Outpatient Spinal Anesthesia

Lidocaine has the longest track record of safe use for outpatient spinal anesthesia. Lidocaine has rapid onset of action, intermediate duration , and low toxicity in clinically recommended doses. In a dose-response study, Urmey, et al.[1] found that 40 to 60 mg lidocaine resulted in duration of motor block of 1 1/2 to 2 hours, making it an excellent choice for knee arthroscopy.

In recent years, intrathecal lidocaine has been the focus of some controversy. For the most part, hyperbaric (especially 5% concentration) preparations have been associated with possible neurotoxicity. Concerns regarding intrathecal lidocaine neurotoxicity surfaced following its use during microcatheter continuous spinal anesthesia in the late 1980's. Many reports linked lidocaine and microcatheter use to cauda equina syndrome.[2-4] This resulted in the withdrawal of microcatheters by the United States FDA in 1992. Factors associated with cauda equina syndrome[3,4] included 1) hyperbaric solutions of lidocaine 2) microcatheter use 3) re-dosing through the microcatheter 4) poor onset, deficient blocks, and 5) high total lidocaine dosage (up to 300 mg!).

Most recently, reports of transient radicular irritation (TRI) following intrathecal or epidural lidocaine use were published[5,6] In response to these reports, editorials were published whose authors questioned the continued use of intrathecal lidocaine.[7,8] However, more recently, intrathecal mepivacaine in hyperbaric[9] and isobaric[10] preparations was found to be associated with similar (up to 30%) incidences of TRI. Pollock, et al.[11] and Hampl, et al.[12] have found similar incidences of TRI with 2% lidocaine as with 5% lidocaine. Nevertheless, the author advocates the use of the lower effective concentrations of lidocaine. Studies have shown that 1.5% lidocaine or 2% lidocaine resulted in no difference or faster recovery postoperatively.[13-15]

Recent data from Hampl, et al.[16] showed that 2% prilocaine was associated with a 4% incidence of TRI compared to 29% with 2% lidocaine.

Whereas, it is important to look for improved alternative drugs and solutions, we must keep in mind the unique large clinical experience and unparalleled safety record of lidocaine. All local anesthetics have rare associated neurotoxicity. For example, bupivacaine was recently associated with cauda equina syndrome in an isolated case report.[17]

Alternative Intrathecal Agents for Day Surgery

Bupivacaine has been associated with much smaller rates of TRI than lidocaine in several studies.[11,12,16,18] With this chemical structure in mind, there has been renewed interest in mepivacaine as an alternative to intrathecal lidocaine.[9,10,18-20] Mepivacaine is an amide local anesthetic of intermediate duration with a chemical structure similar to that of bupivacaine.

Mepivacaine has been safely used for spinal anesthesia for close to 40 years, since the first report on its intrathecal use in 1961.[21] The first publication of mepivacaine's use in a large scale study, reported good outcomes with no neurological complications following 20,000 mepivacaine spinal anesthetics.[22]

In 1966, Lipton et al.[23] compared hyperbaric mepivacaine 4% to tetracaine 1% in a double-blind study of vaginal deliveries. They concluded that "the evidence...points to the superiority of mepivacaine as a more rapidly acting as well as a more profound spinal anesthetic agent."

Henschel, et al.[24] reported on a dose-response study of intrathecal plain mepivacaine in 159 patients with and without added epinephrine. They found that "anesthetic duration increased with dosage and varied from 1 to over 3 hours, averaging over 3 hours with the addition of epinephrine".

Based on this study, this author began using plain mepivacaine 1.5% or 2% five years ago and reported on its use for intermediate-duration orthopedic procedures in 1997.[19] Use of isobaric mepivacaine was further supported by a 1994 publication that demonstrated its favorable intrathecal distribution in a spine model.[25]

Spinal mepivacaine has been more popular in Europe, where it has been marketed for years as a 4% hyperbaric preparation.

Association of Mepivacaine with TRI

Intrathecal mepivacaine has been associated with TRI by case report[26] and prospective studies.[9,18,27] In a study of 4% hyperbaric mepivacaine, Hiller and Rosenberg found a 30% incidence of TRI compared to 3% for bupivacaine. The mepivacaine-associated TRI lasted up to 60 hours after anesthesia.

Salmela and Aromaa found a similar incidence of TRI, 36.7%, with 4% mepivacaine in a study comparing it to lidocaine and bupivacaine. Mepivacaine was found to have the highest incidence of TRI (36.7%) compared to 23.3% for lidocaine and 0% for bupivacaine. This was reported at the September, 1997 ESRA Annual Meeting.

At this same meeting, Salazar, et al. reported on the incidence of TRI associated with isobaric 2% mepivacaine compared to 2% isobaric lidocaine in 80 patients. These investigators also found the highest incidence of TRI, 7.5%, with mepivacaine compared to 2.5% with lidocaine. They concluded that the "*election of 2% isobaric mepivacaine as an alternative to 2% isobaric lidocaine for short term surgery should be questioned. In our study, the incidence of TRI was greater in patients receiving 2% isobaric mepivacaine*". They also found that duration of sensory and motor blockade was significantly longer with mepivacaine.

Following this, Liguori, et al.[20] reported on a comparison of 60 mg 2% lidocaine to 45 mg 1.5% mepivacaine in 60 patients. In this study, the incidence of TRI was 22% with lidocaine, but TRI was not reported with mepivacaine.

Although mepivacaine has a place in spinal anesthesia for intermediate duration procedures, it is apparently not the answer to eliminating TRI. It has been associated with higher incidences of TRI than lidocaine in 2 prospective studies and a lower incidence in one study. With similar dosage and technique, mepivacaine's duration can be expected to be approximately 30-50% longer than that of lidocaine, but significantly shorter than equipotent doses of bupivacaine. The discrepancy in incidences of TRI in various investigations may have to do with the qualitative nature of the phenomenon of TRI or possibly the milligram dosage used. For example a recent report of 1,045 patients who received 3% hyperbaric lidocaine 30-45 mg showed a TRI incidence of only 0.4%.[27]

CSE Anesthesia

The epidural space is most likely a potential space between the ligamentum flavum and the dura mater. Periduroscopic observations by Holmström, et al.[28] indicated that upon entering the epidural space, the epidural needle tip is in contact with the dura. To puncture the elastic dura requires variable further protrusion of the spinal needle beyond the epidural needle tip when performing needle-through-needle CSE. With cutting needles, the experiences of several investigators indicated that 6-10 mm protrusion length was adequate in most patients.[29-32] However, use of a non-cutting spinal needle for CSE, for example a Whitacre needle, may require up to 15 mm protrusion length.[1,33]

It is important, as with spinal anesthesia, that CSE is performed caudad to the termination of the spinal cord (L1).

CSE anesthesia requires familiarity with the techniques for both spinal and epidural insertion. With adequate experience and technical proficiency, success rates should approach 100%. Nevertheless, confusion exists in the medical literature with regard to the "failure rate" of CSE anesthesia. Inadequate data exist presently. The true rate depends upon the definition of failure that is used.

In a recent editorial entitled "Problems with combined spinal epidural anesthesia", Wildsmith[34] quoted failure rates up to 24.5%. This "failure rate", however, was taken out of context from the study by Urmey, et al.[1] These investigators were unable to access the dura in the first 49 study patients 24.5% of the time due to unmatched needle sets with inadequate protrusion length. Do to the nature of the study protocol, CSE needle-through-needle access was limited to a single attempt, only at the L3-4 interspace. All patients had successful CSE in this study when a separate spinal needle was passed in the same interspace, following placement of the epidural catheter. If a simple needle advancement was termed a "failure", many other regional anesthetic techniques would be characterized by similar high failure rates.

With adequate protrusion length and a midline technique, a 12.5% incidence of encountering bone upon passing the spinal needle was observed in the same study.[1] Depending upon the angle of insertion of the spinal needle and any deviation from midline, the added distance of spinal needle advancement necessary to puncture the dura may result in bony contact with the vertebrae above or below the interspace. This incidence is theoretically increased when using the paramedian technique. For this reason, this author prefers the midline technique for needle-through-needle CSE anesthesia.

Preferably, needle protrusion length should be approximately 12-13 mm. This allows successful dural puncture in the vast majority of patients but does not make the technique technically difficult with regard to syringe connection, aspiration, and injection. Use of spinal needles with longer protrusion lengths have been associated with a significantly increased incidence of paresthesias in one study.[35] These paresthesias were not associated with any significant complications, however.

If unable to puncture dura with the needle-through-needle technique, a separate spinal needle placement can be easily performed in most cases. This can be done in the same interspace or in a separate interspace as was originally described by Brownridge in 1981.[36]

Use of an adequate gauge spinal needle that allows spontaneous free flow of CSF without aspiration is crucial to CSE success. Use of a spinal needle as small as 27 gauge is ideal for CSE placement.

Deliberate Hypotension for Total Hip Arthroplasty

Deliberate hypotension has been associated with diminished blood loss during total hip arthroplasty.[37] In addition, a drier femoral canal and acetabular surface results in a theoretical advantage of better cement fixation for cemented prosthesis. A balanced technique using similar principles to those described for cesarean section by Fan et al.[38] with CSE can be used to achieve anesthesia and deliberate hypotension for patients undergoing total hip arthroplasty. An initial dose of isobaric local anesthesia is supplemented by titrating epidural anesthesia through the epidural catheter to achieve the optimal level and deliberately reduce mean arterial blood pressure.

Postoperative Analgesia via Epidural Catheter with CSE

Epidural analgesia, intrathecal analgesia or both may be used with the CSE technique. Epidural analgesia has been shown to yield better postoperative pain control in the total knee arthroplasty patient[39-42] than parentenal techniques. These patients are well recognized as being among the most difficult pain control challenges.

The epidural catheter may be used for analgesia as it is after uncomplicated epidural anesthesia. Following negative aspiration, preservative free opioids such as fentanyl 50-100 µg may be injected via the epidural catheter or local anesthetic / opioid infusions may be used. Bupivacaine or ropivacaine 0.0625% or 0.125% combined with fentanyl 3-5 µg/mL may be infused for analgesia with an on-demand PCA (patient controlled analgesia) pump.

Intrathecal Epinephrine

Chambers et al. concluded that added epinephrine resulted in "little or no clinically useful prolongation of blocks" after a study of lidocaine spinal anesthesia with and without

epinephrine.[43] Newer data has led the author to conclude that addition of epinephrine to spinal anesthetics is contraindicated in the outpatient.[44] Results of a study by Urmey, et al. showed significant prolongation of sensory and motor block characterized by a wide range of duration when 0.2 mg epinephrine was added to 60 mg plain lidocaine. Epinephrine resulted in prolonged times to spontaneous urination and discharge. Similar findings have been reported by Chiu, et al.[45] for hyperbaric lidocaine.

Direction of Pencil Point Needle Aperture

Anatomical orientation of the aperture of pencil point needles influence the intrathecal distribution of local anesthetic.[46,47] Caudad direction of the aperture of a 27-gauge Whitacre needle was associated with an approximate 30 minute increase in sensory/motor anesthesia, ability spontaneous void, and discharge compared to cephalad orientation in one study. Maldistribution of local anesthetic has been reported with caudad direction of the aperture leading to transient neurological deficit following injection of hyperbaric lidocaine.[48]

Conclusions

We are only beginning to properly perform the clinical outcome studies necessary to validate our clinical impressions that regional anesthesia results in improved outcome for many types of surgery. However, there are already excellent data that demonstrate improved outcome in some selected but important areas. Deep venous thrombosis and blood loss following total hip arthroplasty are both clearly lessened by the use of regional anesthetic techniques. Epidural analgesia decreases the pulmonary compromise following upper abdominal or thoracic surgical procedures. With well conducted regional anesthetics, it is possible for the outpatient to be discharged earlier with fewer complications. The surgical stress response can be effectively attenuated and this may translate to improved outcome, although this has yet to be proven. Regional techniques for providing effective analgesia may extend the advantages to the postoperative period and may result in improved outcome and earlier discharge.

References

1. Urmey W, Stanton J, Peterson M, Sharrock N: Combined epidural anesthesia for outpatient surgery: Dose response characteristics of intrathecal isobaric lidocaine using a 27-gauge Whitacre spinal needle. Anesthesiology 1995; 83: 528-534
2. Lambert D, Hurley R: Cauda equina syndrome and continuous spinal anesthesia (case report). Anesthesia & Analgesia 1991; 72: 817-819
3. Rigler M, Drasner K, Krejce T, Yelich S, Scholnick F, DeFontes J, Bohner D: Cauda equina syndrome after continuous spinal anesthesia. Anesthesia & Analgesia 1991; 72: 275-281
4. Schell R, Brauer F, Cole D, Applegate R: Persistent sacral nerve root deficits after continuous spinal anaesthsia. Canadian Jouranl of Anaesthesia 1991; 38: 908-911
5. Schneider M, Ettlin T, Kaufmann M, Schumacher P, Urwlyer A, Hampl K, von Hochstetter A: Transient neurologic toxicity after hyperbaric subarachnoid anesthesia with 5% lidocaine. Anesthesia & Analgesia 1993; 76: 1154-1157
6. Tarkkila P, Huhtala J, Touminen M, Lindgren L: Transient irritation after bupivacaine spinal anesthesia. Regional Anesthesia 1996; 21: 26-29
7. Carpenter R: Hyperbaric lidocaine spinal anesthesia: Do we need an alternative? (editorial). Anesthesia & Analgesia 1995; 81: 1125-1128
8. De Jong R: Last round for a "heavyweight" (editorial). Anesthesia & Analgesia 1994; 78: 3-4
9. Hiller A, Rosenberg P: Transient neurological symptoms after spinal anaesthesia with 4% mepivacaine and 0.5% bupivacaine. British Journal of Anaesthesia 1997; 79: 301-305
10. Salazar F, Bogdanovich A, Adalia R, Basora M, Chabas E, Socias R, Gomar C: Transient neurologic symptoms after spinal anaesthesia using 2% isobaric mepivacaine vs 2% isobaric lignocaine (abstract). International Monitor on Regional Anesthesia 1997; 9: 156
11. Pollock J, Neal J, Stephenson C, Wiley C: Prospective study of the incidence of transient radicular irritation in patients undergoing spinal anesthesia. Anesthesiology 1996; 84: 1361-1367
12. Hampl K, Schneider M, Ummenhofer W, Drewe J: Transient neurologic symptoms after spinal anesthesia. Anesthesia & Analgesia 1995; 81: 1148-1153
13. Liu S, Pollock J, Mulroy M, Allen H, Neal J, Carpenter R: Comparison of 5% with dextrose, 1.5% with dextrose, and 1.5% dextrose free lidocaine solutions for spinal anesthesia in human volunteers. Anesthesia & Analgesia 1995; 81: 697-702
14. Manica V, AM B, Franeto R, Gilbertson L, Datta S: Anesthesia for in vitro fertilization: A comparison of 1.5% and 5% spinal lidocaine for ultrasonically guided oocyte retrieval. Anesthesia & Analgesia 1993; 77: 453-456
15. Toft P, Bruun-Mogensen C, Kristensen J, Hole P: A comparison of glucose-free 2% lidocaine and hyperbaric 5% lidocaine for spinal anesthesia. Acta Anaesthesiologica Scandinavica 1990; 34
16. Hampl K, Wiedmer S, Harms C, Schneider M, Drasner K: Incidence of transient neurologic symptoms after spinal anesthesia with prilocaine, lidocaine and bupivacaine (abstract). Anesthesiology 1997; 87: A778
17. Kubina P, Gupta A, Oscarrson A, Axelsson K, Bengtsson M: Two cases of cauda equina syndrome following spinal-epidural anesthesia. Regional Anesthesia 1997; 22
18. Salmela L, Aromaa U: Transient radicular irritation after spinal anesthesia induced with hyperbaric solutions of CSF-diluted 5% lignocaine, 4% mepivacaine or 0.5% bupivacaine (abstract). International Monitor on Regional Anesthesia 1997; 9: 158

19. Urmey W: Mepivacaine spinal anesthesia for lower extremity orthopedic surgery: An alternative to lidocaine or bupivacaine (abstract). Regional Anesthesia 1997; 22: 69
20. Liguori G, Zayas V, Chisholm M: Transient neurologic symptoms after spinal anesthesia with mepivacaine and lidocaine. Anesthesiology 1998; 88: 619-623
21. Knox P, North W, Stepher C: Pharmacologic and clinical observations with mepivacaine. Anesthesiology 1961; 22: 987-994
22. El-Shirbing A, Rasheed M, Elmaghraby A, Motahew M: Experiences with carbocaine in spinal anesthesia. Report of 20,000 cases. Acta Anaesthesiologica Scandinavica 1966; 10: 442-448
23. Lipton E, Sennot F, Batt B: Mepivacaine for spinal anesthesia in vaginal delivery. An objective comparison with tetracaine. American Journal of Obstetrics and Gynecology 1966; 96: 333-336
24. Henschel E, Remus C, Mustafa K, Jacoby J: Isobaric mepivacaine in spinal anesthesia. Anesthesia & Analgesia 1967; 46: 475-479
25. Lambert D, Lambert L: For spinal anesthesia, does specific gravity tell us anything about baricity (abstract). Anesthesia & Analgesia 1994; 78: S233
26. Lynch J, zur Nieden M, Kasper S, Radbruch L: Transient radicular irritation after spinal anesthesia with hyperbaric 4% mepivacaine. Anesthesia & Analgesia 1997; 85: 872-873
27. Morisaki H, Masuda J, Kaneko S, R O, Takeda J: Transient neurologic sequelae in 1,045 patients undergoing spinal anesthesia with 3% hyperbaric lidocaine (abstract). Anesthesiology 1997; 87: A781
28. Holmström B, Rawal N, Axelsson K, Nydahl P: Risk of catheter migration during combined spinal epidural block: percutaneous epiduroscopy study. Anesthesia & Analgesia 1995; 80: 747-753
29. Eldor J, Guedj P, Gozal Y: Combined spinal-epidural anesthesia using the CSEN (letter to editor). Anesthesia & Analgesia 1992; 74: 169-170
30. Forster S: Combined subarachnoid and epidural techniques (letter). Anaesthesia 1983; 38: 72
31. Joshi G, McCarroll S: Evaluation of combined spinal-epidural anesthesia using two different techniques. Regional Anesthesia 1994; 19: 169-174
32. Uncles D, Westbrook J: Needel compatibility and combined spinal-epidural anaesthesia (letter to the editor). Anaesthesia 1994; 49: 646
33. Casati A, D'Ambrosio A, De Negri P, Fanelli G, Tagariello V, Tarantino F: A clinical comparison between needle-through-needle and double segment techniques for combined spinal and epidural anesthesia. Regional Anesthesia and Pain Medicine 1998; 23: 390-394
34. Wildsmith J: Problems with combined spinal epidural anesthesia (editorial). Regional Anesthesia and Pain Medicine 1998; 23: 388-389
35. Herbstman C, Jaffee J, Tuman K, Newman L: An in vivo evaluation of four spinal needles used for the combined spinal-epidural technique. Anesthesia & Analgesia 1998; 86: 520-522
36. Brownridge P: Epiduarla and subarachnoid analgesia for elective Ceasarean section (letter to editor). Anaesthesia 1981; 36: 70
37. Sharrock N, Salvati E: Hypotensive epidural anesthesia for total hip arthroplasty. A review. Acta Orthopaedica Scandinavica 1996; 67: 91-107
38. Fan S-Z, Susetio S, Wang Y-P, Cheng Y-J, Liu C-C: Low dose of intrathecal hyperbaric bupivacaine combined with epidural lidocaine for cesarean section - a balance block technique. Anesthesia & Analgesia 1994; 78: 474-477
39. Ilahi O, Davidson J, Tullos H: Continuous epidural analgesia using fentanyl and bupivacaine after total knee arthroplasty. Clinical Orthopedics 1994; 299: 44-52

40. Pettine K, Wedel D, Cabanela M, Weeks J: The use of epidural bupivacaine following total knee arthroplasty. Orthopaedic Review 1989; 18: 894-901
41. Moiniche S, Hjorsto N, Hansen B, Bahl J: The effect of balanced analgesia on early convalescence after major orthopaedic surgery. Acta Anaesthesiologica Scandinavica 1994; 38: 328-335
42. Mahoney O, Noble P, Davidson J, Tullos H: The effect of continuous epiudral analgesia on postoperative pain, rehabilitation, and duration of hospitalization in total knee arthroplasty. Clinical Orthopedics 1990; 260: 30-37
43. Chambers W, Littlewood D, Logan M, Scott D: Effect of added epinephrine on spinal anesthesia with lidocaine. Anesthesia & Analgesia 1981; 60: 417-420
44. Urmey W, Stanton J, Sharrock N: Addition of epinephrine to isobaric lidocaine spinal anesthesia may be contraindicated for ambulatory surgery (abstract). Regional Anesthesia 1996; 21 (2S): 100
45. Chiu A, Liu S, Carpenter R, Kasman G, Pollock J, Neal J: The effects of epinephrine on lidocaine: a cross-over study. Anesthesia & Analgesia 1995; 80: 735-739
46. Neigh J, Kane P, Smith T: Effect of speed and direction of injection on the level and duration of spinal anesthesia. Anesthesia & Analgesia 1970; 49: 912-916
47. Urmey W, Stanton J, Bassin P, Sharrock N: Direction of Whitacre needle aperture affects extent and duration of isobaric spinal anesthesia. Anesthesia & Analgesia 1996; 84: 337-341
48. Beardsley D, Holman S, Gantt R, Robinson R, Lindsey J, Bazaral M, Stewart S, Stevens R: Transient neurologic deficit after spinal anesthesia: local anesethetic maldistribution with pencil point needles. Anesthesia & Analgesia 1995; 81: 314-320