Anesthesiology
2000; 92:387-92

Walking with Labor Epidural Analgesia

The Impact of Bupivacaine Concentration and a Lidocaine-Epinephrine Test Dose

Sheila E. Cohen, M.B, Ch.B., Julie Y. Yeh, M.D.,† Edward T. Riley, M.D.,§ Tracey M. Vogel, M.D.§*

Background: **Regional analgesia techniques for labor that permit ambulation are popular among parturients. This study evaluated the influence of bupivacaine bolus concentration and a 3-ml 1.5% lidocaine–epinephrine test dose, on analgesic effectiveness and the ability to walk after block placement.**

Methods: **Using a randomized double-blind study design, epidural analgesia was initiated in 60 parturients undergoing labor as follows: Group TD/B.0625 received a 3-ml lidocaine–epinephrine test dose + 12 ml bupivacaine, 0.0625%; group TD/B.125 received a 3-ml test dose + 12 ml bupivacaine, 0.125%; group B.0625 received 15 ml bupivacaine, 0.0625% (no test dose); and group B.125 received 15 ml bupivacaine, 0.125% (no test dose). Initial boluses in all groups contained 10 μg sufentanil. Bupivacaine, 0.0625%, with 0.33 μg/ml sufentanil was infused throughout labor at 13.5–15 ml/h. Analgesia balance, proprioception, motor block, and patient ability to stand and walk were evaluated at various intervals.**

Results: **A bolus of 0.125% bupivacaine containing sufentanil, without a previous test dose, proved to be optimal with respect to analgesia and early ambulation. When a test dose was given before bupivacaine, 0.125%, fewer women walked within 1 h of block placement. Bupivacaine, 0.0625%, with sufentanil, with or without a test dose, provided inadequate analgesia, necessitating additional bupivacaine, which impaired the ability to walk. A high percentage of women in all groups (73–93%) walked at some stage during labor.**

Conclusions: **Omitting a lidocaine–epinephrine test dose and using 0.125% bupivacaine for the initial bolus should permit ambulation in the early postblock period for most parturients who elect this option. (Key words: Ambulation; obstetric anesthesia; motor block.)**

This article is featured in "This Month in Anesthesiology." Please see this issue of ANESTHESIOLOGY, page 5A.

* Professor of Anesthesia.

† Fellow in Obstetric Anesthesia.

§ Assistant Professor of Anesthesia.

Received from the Department of Anesthesia, Stanford University School of Medicine, Stanford, California. Submitted for publication May 19, 1999. Accepted for publication September 17, 1999. Support was provided solely by institutional and/or departmental sources. Presented in part at the Annual Meeting of the Society for Obstetric Anesthesia and Perinatology, Vancouver, British Columbia, Canada, April 30, 1998.

Address correspondence to Dr. Cohen: Department of Anesthesia, H3582, Stanford University School of Medicine, Stanford, California 94305. Address electronic mail to: secohen@leland.stanford.edu

Reprints will not be available.

MANY women express the desire to walk during labor, disliking immobility associated with dense regional blockade and believing that walking facilitates the progress of labor. Combined spinal-epidural (CSE) analgesia performed with intrathecal opioids (with or without local anesthetic) causes minimal motor block and has been referred to as the "walking epidural." However, some complications of spinal opioids (*e.g.*, respiratory depression, fetal bradycardia, pruritus) may occur more frequently than with current epidural techniques, and some investigators question the need to breach the dura.[1] Provided very dilute local anesthetic-opioid solutions are used, parturients also can walk with conventional epidural analgesia,[2,3] although inadequate analgesia may be a problem with such low drug concentrations. This study was designed to evaluate analgesic effectiveness and the ability to walk after a bolus of either bupivacaine, 0.0625%, or bupivacaine, 0.125% (with sufentanil), with or without previous administration of the traditional lidocaine-epinephrine test dose.

Methods

After approval of the study by the Human Subjects Committee, written informed consent was obtained from 60 healthy parturients in active labor who requested epidural analgesia for labor, who had a visual analog pain score of 3 or greater (0- to 10-cm scale, where 0 = no pain and 10 = the worst pain imaginable), and in whom cervical dilation was between 1 and 6 cm. All participants responded affirmatively when asked

Table 1. Group Treatments

Group		Study Solutions
TD/B.0625	(n = 15)	3-ml Test dose + 12 ml bupivacaine, 0.0625%
TD/B.125	(n = 15)	3-ml Test dose + 12 ml bupivacaine, 0.125%
B.0625	(n = 15)	3 ml + 12 ml bupivacaine, 0.0625%
B.125	(n = 15)	3 ml + 12 ml bupivacaine, 0.125%

Test dose = 1.5% lidocaine with 1:200,000 epinephrine.

whether they wished to ambulate during labor. A multiorifice epidural catheter (Braun Perifix, B. Braun McGaw, Irvine, California) was introduced 4 to 5 cm into the epidural space at the L2–L3 or L3–L4 interspace using a loss-of-resistance technique with the patient sitting. The catheter was aspirated carefully using a 1-ml tuberculin syringe to detect blood or cerebrospinal fluid.

Parturients were assigned randomly in a double-blind fashion to one of four treatments, which were designated in sealed, consecutively numbered, opaque envelopes. All patients received a 3-ml epidural injection (the 1.5% lidocaine-epinephrine test dose or bupivacaine), and, 3 min later, 12 ml bupivacaine with 10 μg sufentanil injected in two increments 3 min apart. The study treatments were as shown in table 1. After the initial 3-ml injection and until 3 or 4 min after slow injection of the 12 ml bolus, parturients were questioned regarding symptoms of dizziness, sedation, palpitations, or tachycardia, and maternal heart rate was monitored using a pulse oximeter. Approximately 5 min after completion of the bolus injection, patients were asked to report any changed sensation or weakness in the legs. If the presence of blood or cerebrospinal fluid in the catheter was confirmed or suspected, or if the patient reported systemic symptoms, tachycardia, or numbness or motor block in her legs, the study was discontinued and the patient was treated at the discretion of the attending anesthesiologist. All parturients received an epidural infusion of 0.0625% bupivacaine with 0.33 μg/ml sufentanil at a rate of 13.5–15 ml/h. If pain relief was unsatisfactory (pain score = 3) at 20 min, 10 ml bupivacaine, 0.125%, was injected epidurally. If pain persisted 15 min later, an additional 5 ml bupivacaine, 0.25%, was given. Any patient who required more than one supplemental bolus was examined to determine whether inadequate analgesia could be explained by the rapid progress of labor. If not, the possibility of an intravascular catheter was considered. In this circumstance, the protocol dictated revealing the identity of the study drug and administering a 3-ml lidocaine-epinephrine test dose if the patient had not already received one because of group assignment (*i.e.*, B.0625 and B.125 groups).

Maternal blood pressure and visual analog pain score were recorded before study drug administration and after completion of the bolus injection at 5, 10, 15, 20, and 30 min and 1 h, and then hourly for 4 h or until delivery. The need for additional local anesthetic boluses and ephedrine was noted. Data relating to ambulation, balance, proprioception, and motor block were collected at baseline, 30 min, 1 h, and then hourly until delivery. Standing, walking, and performing the Romberg test and a knee bend were not attempted in women who received an additional bupivacaine bolus in the previous 30 min (these women were classified as "ineligible") or in those who thought they were unable to walk because of weakness or sensory changes. If the patient thought she was able to walk and could get out of bed without assistance, she was first asked to stand and then walk several steps with someone at each side, ready to support her should she become unsteady. Ability to walk across the room with no or minimal assistance (*i.e.*, no more than a hand lightly touching the patient's arm) was rated as "yes" or "no." Patients usually walked around their room or to the bathroom, where they usually attempted to void, spending approximately 5–10 min out of bed on each occasion. After attempting ambulation, the following were assessed: proprioception (the great toe was moved up and down and the patient was asked to state its position); modified Bromage score (0–3, where 0 = ability to fully flex the knees and feet; 1 = just able to flex the knees; 2 = able to move feet only; and 3 = inability to move feet or knees); Romberg test (positive when the patient swayed or toppled when standing with eyes closed and feet close together); and ability to perform a deep knee bend with 90° of flexion (rated as yes or no). We performed these tests after attempting ambulation because we wanted to evaluate the association with successful walking. Had these tests been known to be impaired, this might have influenced the decision to attempt ambulation, thereby precluding the appropriate assessment as a predictor of safe walking. The upper level of sensory blockade to pinprick also was recorded at the same intervals as the previous measurements after completion of the other assessments.

Successful attempts to void either in the toilet or using a bed-pan were noted. On the day after delivery of the neonate, we evaluated overall satisfaction with analgesia and with walking using a verbal scale of 0–10, where 0 = completely dissatisfied and 10 = extremely satisfied.

Table 2. Group Characteristics

	TD/B.0625 (n = 15)	TD/B.125 (n = 15)	B.0625 (n = 15)	B.125 (n = 15)
Age (yr)	33 ± 4	33 ± 6	33 ± 4	31 ± 5
Height (cm)	165 ± 9	168 ± 7	165 ± 7	168 ± 12
Weight (kg)	75 ± 8	77 ± 12	78 ± 7	75 ± 10
Gestational age (week)	40 ± 1	39 ± 1	40 ± 1	40 ± 1
Cervical dilation (cm)	3 ± 1	3 ± 2	3 ± 1	2 ± 1
VAPS preblock (0–10)	6.7 ± 13	5.8 ± 16	5.8 ± 25	6.1 ± 14
Nulliparas*	5	8	7	7
Mode of delivery*				
Spontaneous	11	11	12	13
Forceps/vacuum	0	1	0	2
Cesarean	4	3	3	0
Neonatal weight (g)	3708 ± 409	3398 ± 441	3793 ± 352	3662 ± 113

Values are mean ± SD unless noted otherwise. No significant differences among the groups.

* Number of women.

VAPS = visual analog pain score.

Statistical Analysis

Comparisons among the four groups were performed using analysis of variance for continuous data and the Kruskall-Wallis test for noncontinuous or categoric data. Repeated-measures analysis of variance was used for overall comparison among the groups of early analgesia (visual analog pain score up to 60 min) and blood pressure measurements during the same period. Intergroup differences with analysis of variance were defined further using the Scheffé F test. Proportions were compared using the chi-square or Fisher exact tests as appropriate, with the Bonferroni correction for multiple comparisons. A P value of 0.05 was considered statistically significant.

Results

The groups were similar with respect to age, height, weight, gestational age, the number of nulliparous women, cervical dilation and visual analog pain score before block placement, mode of delivery, and neonatal weight (table 2). Similarly, there were no significant differences among the groups in the number of segments blocked by the initial bolus (9–11) and the incidence or progression of postblock hypotension to a systolic blood pressure less than 90 mmHg (group TD/B.0625: 33%; groups TD/B.125 and B.125: 7%; and group B.0625: 20%). However, the need for ephedrine differed significantly among the groups ($P < 0.01$), with one third of the TD/B.0625 patients requiring a vasopressor compared with none in groups TD/B.125 and B.125 and with 7% in group B.0625.

No catheters were intrathecal or intravascular, and satisfactory bilateral analgesia developed with the study regimen (obviating the need to break the code and possibly administer a lidocaine-epinephrine test dose) in all parturients. Pain scores differed significantly among the groups during the first 60 min ($P = 0.004$, two-factor repeated-measures analysis of variance), with the highest scores in group B.0625 (fig. 1). Also, more women in the B.0625 group required an additional bolus of local anesthetic at 20 min to obtain satisfactory analgesia (table 3). Analgesia was similar in all groups throughout the remainder of labor.

Proprioception remained intact in all women throughout the study. Results of the Romberg test remained negative throughout in the majority of patients eligible

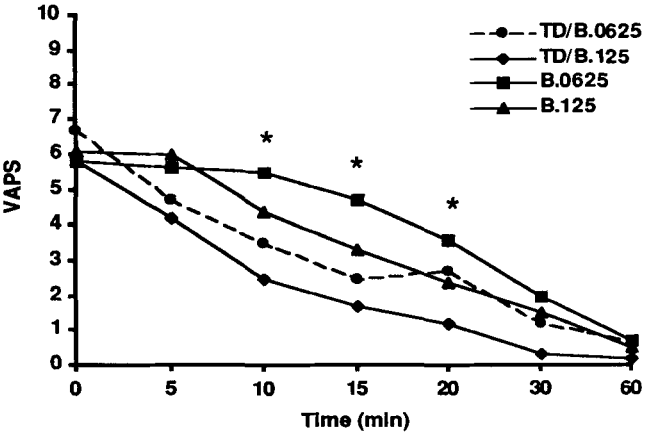

Fig. 1. Visual analog pain scores (0–10 cm, where 0 = no pain and 10 = worst pain imaginable). Values are the mean (SD omitted for clarity). *$P < 0.05$ *versus* TD/B.125 group.

Table 3. Initial Requirement for Analgesic Supplement and Ability to Walk and Void

	TD/B.0625	TD/B.125	B.0625	B.125
Required bolus to achieve analgesia	3/15 (20)	1/15 (7)	8/15 (53)†	1/15 (7)
Walked at 30 min	9/15 (60)	5/14 (36)	8/15 (53)	12/14 (86)‡
Walked at 60 min	7/12 (58)	7/14 (50)	8/10 (80)	11/12 (92)
Walked at any time during labor	12/15 (80)	11/15 (73)	12/15 (80)	13/14 (93)
Voided during labor*	10/14 (71)	7/15 (47)	7/9 (78)	11/12 (92)

Values are fraction of patients remaining in the study (percentages in parentheses), excluding those with obstetric contraindications to walking or voiding (*e.g.*, rapid progress of labor or delivery, fetal distress).

* $P = 0.07$ for overall difference among the groups; includes only patients who attempted voiding.

† $P < 0.05$ *versus* TD/B.125 and B.125 groups.

‡ $P = 0.058$ *versus* TD/B.125.

to be tested (*i.e.*, those who received no supplemental bolus within the previous 30 min). Three women had a positive Romberg sign, indicating impaired balance at 30 min (two in the TD/B.0625 group and one in the TD/B.125 group), and eight had a positive test result at 60 min (three in the TD/B.0625 group and five in the TD/B.125 group). All positive Romberg test results occurred in women who received a test dose. Motor block, as reflected by the Bromage score, was absent or mild (score of 0 or 1) and was similar among the groups throughout the study.

The B.125 group contained the greatest number of women who walked at 30 min (table 3), with the difference achieving borderline statistical significance ($P = 0.058$) in the four-group comparison. Failure to walk resulted both from ineligibility because of a required additional local anesthetic bolus and from the subject's feeling she could not walk (or the inability to walk safely) because of weakness or sensory changes. (One patient in the B.0625 group ambulated despite receiving a supplemental bolus.) Hypotension was not a cause for failure to ambulate. By 60 min, differences did not approach statistical significance. Intergroup comparisons were not made for individual periods after the first hour because too many patients dropped out because they were near delivery, felt tired and did not want to ambulate, were not permitted to do so for obstetric reasons, or had too much motor block. The majority of women in all groups walked at some stage during labor (table 3), unless prohibited for obstetric reasons (one woman in the B.125 group was never allowed to ambulate because of fetal heat rate abnormalities).

To specifically assess the influence of the test dose on each bupivacaine concentration, we separately compared the ability to walk after 0.0625% or 0.125% bupivacaine, with and without a test dose. The test dose given before administration of 0.0625% bupivacaine did not significantly affect the number of eligible women walking at 30 min, whereas fewer eligible women walked when a test dose preceded administration of 0.125% bupivacaine (TD/B.125 *versus* B.125, $P < 0.05$). A greater number of women in groups TD/B.0625 and TD/B.125 (all of whom received a test dose) cited motor block as the reason for not ambulating during the first 2 h after administration of the initial bolus (not significant).

None of the tests of motor function perfectly predicted who could walk, although 90% of women who could perform a deep knee bend ambulated safely. Because 37% of those who "failed" this test were able to walk safely, this screening test may be overly conservative. Even before receiving epidural analgesia, some parturients had difficulty performing this maneuver without losing their balance because of their large abdominal size. We observed that most women who walked could perform a partial knee bend (flexing approximately 30° at the knee), but we did not systematically collect these data.

The ability to void did not differ statistically among the groups ($P = 0.07$; table 3). Overall, significantly more of the women who walked at some time during labor voided after block placement compared with those who never walked (80 *versus* 22%; $P < 0.001$). Satisfaction with analgesia was high in all groups (range of mean scores, 9-9.4), with no differences among the groups. Similarly, satisfaction scores for walking did not differ among the groups (range of mean scores, 6-7.5).

Discussion

In this population of healthy parturients, a bolus of 0.125% bupivacaine with sufentanil, without a lidocaine-

epinephrine test dose, proved optimal in providing analgesia while preserving the ability to ambulate. Bupivacaine, 0.0625%, produced inadequate analgesia, necessitating additional bupivacaine that precluded early ambulation. The test dose given before administration of 0.125% bupivacaine caused so much additional weakness that the fewest parturients in this group walked in the early postblock period. When given before administration of 0.0625% bupivacaine, the test dose did not significantly influence either analgesia or the ability to walk compared with 0.0625% bupivacaine alone. A *post hoc* power analysis indicated that the study groups contained an adequate number of patients to detect a 50% difference between any two of the four groups in the proportion of patients requiring a supplemental bolus or of those walking or voiding, with 50% power and a P value of 0.0083 (*i.e.*, applying the Bonferroni correction for all six possible comparisons among the four groups to the desired P value of 0.05). For the *a priori* planned separate comparisons of each bupivacaine concentration with and without the test dose, the study had 80% power to detect a 50% difference, and 50% power to detect a 30% difference, with a similar risk of a type 1 error.

The dosage regimens studied were selected because they cause minimal motor blockade and are thought not to adversely affect obstetric outcome.[4,5] However, our results might have differed had we administered larger volumes of bupivacaine or added more sufentanil to the bolus. Larger volumes (and thus, higher doses) may cause more rapid onset of analgesia and more effectively block sacral segments in advanced labor. Sufentanil causes a dose-dependent reduction of the minimum local analgesic concentration (the ED_{50}) for bupivacaine[6] and should not increase the degree of motor block. We preferred not to exceed a 10-μg bolus dose of sufentanil because this is associated with an acceptable incidence of sedation, nausea, and pruritus.

It is difficult to compare our data with those of other studies of ambulation during regional analgesia in which different doses, volumes, or drugs were used. Breen *et al.*[3] reported a 92% rate of satisfactory labor analgesia, with 68% of women walking at some time during labor after a lidocaine-epinephrine test dose, followed by a 15-ml bolus and hourly infusion of 0.04% bupivacaine, 1.7 μg/ml epinephrine, and 1.7 μg/ml fentanyl. The influence of the inclusion of epinephrine is unclear, with the α_2 agonist potentially improving analgesia but intensifying local anesthetic-induced motor blockade. Collis *et al.*,[7] using a CSE technique initiated with intrathecal fentanyl, 25 μg, and bupivacaine, 2.5 mg, and maintained with epidural boluses of 0.1% bupivacaine with 2 μg/ml fentanyl, reported 100% successful analgesia within 20 min, with 51% of women ambulating during labor. In another study of CSE using sufentanil alone, 66% of women ambulated.[8] As in the current investigation, walking in these studies usually was restricted to the patient's room or the bathroom, may have occurred only once, was performed with the assistance of nursing staff, and often was of relatively brief duration.[3,7,8] Our results compare favorably with these studies, particularly those for the B.125 group, in which 93% of women with no obstetric contraindications walked at some point during labor.

In the past, an epidural test dose was thought to be essential to avoid serious consequences of intrathecal or intravascular injection of local anesthetic. Although the test dose might have no demonstrable effect when administered before more concentrated local anesthetic solutions, incremental sensory or motor block may be unmasked when very dilute agents are used for the initial bolus. Buggy *et al.*[9] found that 66% of parturients had impaired dorsal column function after receiving 15 ml bupivacaine, 0.1%, with 2 μg/ml fentanyl during labor, an effect the authors believed precluded safe ambulation. Critics of this study pointed out that all participants received a 3-ml bupivacaine, 0.5%, test dose, which might have affected sensory and motor function.[10] In a subsequent study using an identical epidural bolus but no test dose, Parry *et al.*[11] found abnormal dorsal column function in only 7% of parturients, a similar incidence to that in their control group that received intrathecal fentanyl-bupivacaine as part of a CSE technique. Our data support the contention that a test dose may cause incremental blockade or impair balance, thereby adversely affecting the ability to walk safely in the early period after block placement.

Many anesthesiologists have abandoned routine use of a lidocaine-epinephrine test dose during labor epidural analgesia when using multiorifice catheters and dilute local anesthetics, regarding the entire first dose as a test dose.[12] Injection of the first several-milliliter increment of dilute bupivacaine should reveal intrathecal placement within minutes, whereas unrecognized intravascular injection, although less easily detectable, would not harm the patient because the dose is so small. Effective bilateral analgesia confirms correct epidural injection of the bolus. Determining the safety of this practice was not the goal of this investigation, and, although no complications occurred, the study had inadequate power to address this issue.

Whether any real benefits result from walking during labor is controversial. Although a better obstetric outcome has been claimed in association with ambulation during labor,[1,13] recent clinical investigations have concluded that walking has no effect on labor and delivery.[1,8,14,15] The current study contains too few women to evaluate delivery outcome, although the small number of operative vaginal deliveries suggests that maternal expulsive powers were maintained during the second stage of labor in all groups. In practice, many women lose interest in prolonged walking after they obtain pain relief or approach delivery.[1] However, when given the opportunity, most women will try to walk to the bathroom to attempt to void and thus avoid catheterization.[7] The ability to void may be the major benefit of ambulation during labor, along with the mother's feeling of self-control and satisfaction with the labor experience.[7,15]

Controversy persists regarding which criteria predict safe ambulation. Various criteria have been proposed as prerequisites for ambulation, including bilateral straight leg raising, preservation of hip flexion, the ability to perform a deep or partial knee bend, intact proprioception, and a subjective feeling that safe walking is possible.[1-3,7,9-11] The current study did not further illuminate this subject, except to suggest that performance of a deep knee bend was too strict a requirement. Adequate motor power, sensation, proprioception, vestibular function, and visual acuity all contribute to safe walking.[2] However, deficits in one or more of these faculties can be compensated for by the others.

In summary, the ability to ambulate with regional analgesia during labor is not restricted to the CSE technique. With appropriate epidural dosage regimens and the encouragement of nursing staff, most women can walk (and void) with epidural analgesia. Among the regimens studied, a bolus of 0.125% bupivacaine without a previous test dose provided the best analgesia with the greatest ability to ambulate in the early postblock period. Our data support the general principle that an inadequate initial bolus may necessitate additional local anesthetic boluses, thus defeating the purpose of administering extremely low concentrations to minimize sensory and motor blockade.

The authors thank Jerry Halpern, Ph.D., Senior Scientist, Department of Health, Research and Policy, Stanford University, for statistical expertise.

References

1. Douglas MJ: Walking epidural analgesia in labor. Can J Anaesth 1998; 45:607-11

2. Elton SD, Ali P, Mushambi MC: "Walking extradurals" in labour: A step forward? Br J Anaesth 1997; 79:552-4

3. Breen TW, Shapiro T, Glass B, Foster-Payne D, Oriol NE: Epidural anesthesia for labor in an ambulatory patient. Anesth Analg 1993; 77:919-24

4. Chesnut DH, Laszewski LJ, Pollack KL, Bates JN, Manago NK, Choi WW: Continuous epidural infusion of 0.0625% bupivacaine-0.0002% fentanyl during the second stage of labor. ANESTHESIOLOGY 1990; 72:613-8

5. Sharma SK, Sidawi JE, Ramin SM, Lucas MJ, Leveno KJ, Cunningham G: Cesarean delivery. A randomized trial of epidural versus patient-controlled meperidine analgesia during labor. ANESTHESIOLOGY 1997; 87:487-94

6. Polley LS, Columb MA, Wagner DS, Naughton NN: Dose-dependent reduction of the minimum local analgesic concentration of bupivacaine by sufentanil for epidural analgesia in labor. ANESTHESIOLOGY 1998; 89:626-32

7. Collis RE, Baxandall ML, Srikantharajah ID, Edge G, Kadim MY, Morgan BM: Combined spinal epidural analgesia: Technique, management, and outcome of 300 mothers. Int J Obstet Anesth 1994; 3:75-81

8. Nageotte MP, Larson D, Rumney PJ, Sidhu M, Hollenbach K: Epidural analgesia compared with combined spinal-epidural analgesia during labor in nulliparous women. N Eng J Med 1997; 337:1715-9

9. Buggy D, Hughes N, Gardiner J: Posterior column impairment during ambulatory extradural analgesia in labour. Br J Anaesth 1994; 73:540-2

10. Fernando R, Price CM: Posterior column sensory impairment during ambulatory extradural analgesia in labour. Br J Anaesth 1995; 74:348-50

11. 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

12. Norris MC, Fogel ST, Dalman H, Borrenphohl S, Hoppe WH, Riley A: Labor epidural analgesia without an intravascular "test dose." ANESTHESIOLOGY 1998; 88:1495-501

13. Flynn M, Kelly J, Lynch PF: Ambulation in labour. BMJ 1978; 2:591-3

14. Bloom SL, McIntire DD, Kelly MA, Beimer HL, Burpo RH, Garcia MA, Leveno KJ: Lack of effect of walking on labor and delivery. N Engl J Med 1998; 339:76-9

15. Cefalo RC, Bowes WA: Managing labor—Never walk alone. N Engl J Med 1998; 339:117-8