Labor Pain at the Time of Epidural Analgesia and Mode of Delivery in Nulliparous Women Presenting for an Induction of Labor

Yaakov Beilin, MD, Diana Mungall, BS, Sabera Hossain, MS, and Carol A. Bodian, DrPH

OBJECTIVE: To assess whether the degree of labor pain at the initiation of neuraxial analgesia is associated with mode of delivery.

METHODS: Nulliparous women who presented to the labor department for an induction of labor, who were between 37 and 41 weeks of gestation, and who requested labor epidural analgesia with a pain score of 0–3 (low pain) and a cervical dilatation less than 4 cm were assessed retrospectively. Maternal and neonatal outcome including mode of delivery and duration of labor were compared with a similar group of women with pain scores of 4–6 (moderate pain), and 7–10 (severe pain). Assessing whether there was an association between pain level at the time of epidural and operative delivery rates was analyzed using a χ^2 test for trend and by logistic regression to include potentially relevant covariates.

RESULTS: We found 185 nulliparous women with low pain and compared them with a randomly selected equal number of women in each of the other pain groups. There was no significant association between pain groups in terms of duration of the first or second stage of labor or mode of delivery. Women with low pain had an operative delivery rate (instrumental assisted vaginal delivery plus cesarean delivery) of 49%, compared with 45% and 45% in those with moderate and severe pain, respectively (P=.40).

CONCLUSION: We did not find an association between the degree of labor pain at initiation of epidural analgesia and mode of delivery or duration of labor.
(Obstet Gynecol 2009;114:764–9)

LEVEL OF EVIDENCE: II

The cesarean delivery rate in the United States has increased from approximately 5% in 1964 and 20% in 2000, to greater than 30% in 2005, and it will likely continue to increase.[1] Morbidity and mortality are greater for women who deliver via cesarean delivery compared with those who deliver vaginally.[2]

A possible association between neuraxial labor analgesia and mode of delivery has been studied. Although most did not find that epidural analgesia influenced the cesarean delivery rate, an association was found between epidural analgesia and the instrumental vaginal delivery rate.[3,4] Other studies have focused on whether the timing of epidural analgesia in relation to cervical dilatation influences mode of delivery, but again, most concluded that there is no association in those who present in spontaneous labor[5,6] and in those who present for an induction of labor.[7]

In 1989, Wuitchik et al[8] reported that women who presented in spontaneous labor and experienced considerable pain early in labor had longer labors, an increased incidence of dystocia, and an increased operative delivery rate (instrumental assisted vaginal delivery plus cesarean delivery) when compared with women who experienced less pain. Information on labor neuraxial analgesia was not analyzed in this study. In addition, their findings have not been confirmed or refuted. The purpose of the present study is to assess whether the degree of labor pain at the initiation of neuraxial analgesia is associated with mode of delivery.

From the Departments of Anesthesiology and Obstetrics, Gynecology & Reproductive Sciences, Mount Sinai School of Medicine of New York University, New York, New York.

Supported solely by the Department of Anesthesiology, Mount Sinai School of Medicine.

Presented in part at the 40th Annual Meeting of the Society for Obstetric Anesthesia and Perinatology, Chicago, IL, April 30 to May 4, 2008, and the 41st Annual Meeting of the Society for Obstetric Anesthesia and Perinatology, Washington, DC, April 29 to May 3, 2009.

Corresponding author: Yaakov Beilin, MD, The Mount Sinai Medical Center, Department of Anesthesiology, Box 1010, One Gustave L. Levy Place, New York, NY 10029-6574; e-mail: Yaakov.beilin@mountsinai.org.

Financial Disclosure
The authors did not report any potential conflicts of interest.

ISSN: 0029-7844/09

METHODS

After approval by the institutional review board of the Mount Sinai School of Medicine, nulliparous women who presented to the labor floor between July 2005 and September 2008 for an attempted vaginal delivery, were between 37 and 41 weeks of gestation, requested labor neuraxial analgesia when they reported a pain score of 0–3 (low-pain score group) on a scale of 0–10, and had a cervical dilatation less than 4 cm were identified through our Anesthesia Information Management System. Data collection started shortly after installation of the Anesthesia Information Management System. Initial review of these records revealed that approximately 95% received epidural analgesia (not a combined spinal epidural anesthetic) and 90% presented for an induction of labor. We therefore limited subsequent analysis to those who presented for an induction of labor and received labor epidural analgesia (n=185).

We chose two groups from the Anesthesia Information Management System database to compare with the low-pain group: those with pain scores of 4–6 (moderate-pain score group) and those with pain scores of 7–10 (high-pain score group). For each comparison group, we identified all nulliparous women who presented at term for an induction of labor and had a cervical dilation less than 4 cm when they received epidural analgesia. We found 1,840 women with moderate pain and 4,020 women with high pain who met our selection criteria. From each of these cohorts we randomly selected 185 women for entry into the study. Randomization was accomplished by assigning each patient a unique number identifier by group (1 thru 1,840 and 1 thru 4,020 for the moderate and high-pain score groups, respectively). Those numbers were entered into a computer-generated randomization schedule, and the first 185 from each group were selected.

Each selected medical record was then manually reviewed, by an individual blinded to group assignment, in the Department of Obstetrics computer record system (Quantitative Sentinel Clinical Information System; GE Healthcare Integrated IT Solutions, Barrington, IL) for maternal demographics (age, height, and weight), neonatal data (birth weight, Apgar scores at 1 and 5 minutes, and neonatal intensive care unit admission), and labor characteristics (initial cervical examination, medication used to induce labor, duration of first and second stages of labor, indication for induction, and mode of delivery). The obstetrician group who cared for the mother was also noted.

The first stage of labor was defined as the time from the initiation of painful contractions, or time from epidural placement if the patient received her epidural with a pain score of 0 and thus did not experience any labor pain, to 10-cm cervical dilatation; the second stage of labor was defined as the time from 10-cm cervical dilatation to delivery. Mode of delivery was noted as vaginal delivery, instrumental-assisted vaginal delivery, or cesarean delivery.

The standard protocol at The Mount Sinai Hospital is that labor epidural analgesia is administered upon patient request regardless of pain score or cervical dilatation. Epidural anesthetics are initiated with a 15-mL bolus of bupivacaine 0.0625% with 2 micrograms/mL of fentanyl and maintained with an infusion of the same mixture at 10 mL/h. Pain scores are routinely documented by the anesthesiologist at the time of anesthetic placement by asking the patient to rate her pain on a verbal 0–10 scale.

The induction of labor is initiated with cervical ripening as indicated. This is generally achieved with intravaginal administration of misoprostol. If regular contractions have not been established, intravenous (IV) oxytocin is administered. The epidural anesthetic is administered at patient request, sometimes given before the induction agent and sometimes after. An active management of labor protocol is used. This practice involves early amniotomy and aggressive use of oxytocin. Oxytocin is started at 1–2 milliunits per minute and increased by 1–2 milliunits per minute every 20–30 minutes until contractions occur every 2–3 minutes. During the second stage of labor, the mother is encouraged to "bear down" during contractions to aid with fetal head descent. If after 3 hours the baby has not delivered vaginally, either an instrumental-assisted vaginal delivery (outlet or low forceps, or vacuum) or cesarean delivery is performed, as indicated, at the discretion of the obstetrician.

All data were entered in an Excel database (Microsoft, Redmond, WA), and converted to a SAS file for statistical analysis (SAS Institute Inc., Cary, NC). Group characteristics were compared using linear regression for quantitative measurements, unless they were skewed, in which case the Jonckheere-Terpstra Test[9] was used and was implemented with StatXact 7 (Cytel Software Corporation, Cambridge, MA).

The primary end-point of the study, to assess whether there was an association between pain level at the time of epidural and operative delivery rates (cesarean or instrumental-assisted vaginal delivery) was analyzed using a χ^2 test for trend and by logistic regression to include potentially relevant covariates.[10] The association with pain score was tested indepen-

Table 1. Patient Demographics and Neonatal Outcome

Group	Pain Score 0–3	Pain Score 4–6	Pain Score 7–10	*P*
n	185	185	185	
Pain scores	2 (0–3)	5 (4–6)	8 (7–10)	
Age (y)	31 (17–50)	31 (16–45)	30 (16–46)	.004
Ethnicity				.24
Caucasian	128 (72)	117 (64)	111 (61)	
African American	16 (9)	16 (9)	18 (10)	
Hispanic	23 (13)	30 (16)	39 (22)	
Other*	10 (6)	19 (10)	13 (7)	
Body mass index (kg/m^2)	28.2 (17.9–74)	28.3 (19.4–66.7)	28.2 (17.0–53.7)	.52
Birth weight (kg)	3,303 (1,860–4,625)	3,363 (1,765–4,510)	3,348 (2,025–4,410)	.37
Required NICU admission	14 (8)	15 (8)	17 (9)	.57
Apgar score (1 min)	9 (3–9)	9 (4–9)	9 (2–9)	.87
Apgar score (5 min)	9 (6–9)	9 (8–9)	9 (6–9)	.99
Apgar score less than 7 at 5 min	0	1 (0.5)	1 (0.5)	.99

NICU, neonatal intensive care unit.
Data are median (range) or n (%).
* Asian and American Indian.

dent of obstetrician group and again accommodating the correlated data due to obstetrician group using generalized estimating equations. $P<.05$ was considered statistically significant.

The number of patients in this retrospective study was determined in part by the available number (185) in the group of primary interest: nulliparous women who presented for an induction of labor at term and who requested neuraxial analgesia at the time their pain score was 0–3. An equal number were selected at random from each of two comparison groups, those with presenting pain scores of 4–6 and 7–10. These numbers provide 80% statistical power to find a significant trend among the groups if the outcomes changed uniformly by .07 between adjacent groups.

RESULTS

During the time period of the study, approximately 3,650 nulliparous women presented for an induction of labor, and 3,250 of them received labor neuraxial analgesia. Of these, 185 women were in the low-pain score group. They were compared with 185 women with moderate pain scores and 185 with high pain scores.

There were no statistically significant differences among the three pain groups in maternal demographics, ethnicity, gestational age, body mass index or neonatal outcome except that maternal age was younger in the high-pain group (Table 1). The reason for induction was unknown for 200 cases. Among the 355 cases with known reason for induction, the distributions did not differ significantly ($P=.63$), with most (45%) documented as an elective induction (Table 2).

The women in the study were cared for by 24 separate obstetrician groups, of which 14 were solo practitioners. Eight of these groups cared for fewer than six eligible patients each. These eight groups were combined in the statistical analyses, resulting in 17 groups. We found a statistically significant association between obstetrician group and pain group,

Table 2. Reasons for Induction of Labor*

Reasons	Pain Score 0–3	Pain Score 4–6	Pain Score 7–10
n	185	185	185
Elective	58 (45)	51 (46)	50 (44)
Oligohydramnios	13 (10)	18 (16)	19 (17)
Elevated blood pressure	14 (11)	8 (7)	11 (10)
Suspected macrosomia	10 (8)	13 (12)	4 (4)
IUGR/SGA	8 (6)	6 (5)	5 (4)
Preeclampsia	8 (6)	4 (4)	7 (6)
Diabetes	8 (6)	3 (3)	6 (5)
Heart rate decelerations	4 (3)	0 (0)	2 (2)
Other†	6 (5)	9 (8)	10 (9)
Total known	129 (70)	112 (61)	114 (62)
Total unknown	56 (30)	73 (39)	71 (38)

IUGR, intrauterine growth restriction; SGA, small for gestational age.
Data are presented as n (%).
* There was no statistically significant difference in indication for induction among groups, $P=.63$.
† Other includes decreased fetal movement; high alpha-fetoprotein; polyhydramnios; unstable fetal lie; pyelonephritis; low platelets; positive beta Streptococcus per vagina; thrombocytopenia; proteinuria; hyperemesis; cholestasis; reduced fetal growth; calcified placenta; high-risk delivery; and hemolysis, elevated liver enzymes, and low platelets syndrome. Each one of these etiologies only occurred once or twice per group.

P=.006. For example, the proportion of patients who received neuraxial anesthesia with a pain score of 0–3 was obtained for each of the obstetrician groups and it ranged from 0% to 65%. The initial cervical examination did not differ significantly, either in terms of cervical dilatation or percent effacement. The median time between the cervical examination closest to the epidural and the placement of the epidural was 2.2 hours, 1.9 hours, and 1.7 hours, in the low-, moderate-, and high-pain score groups respectively, *P*=.08. There was no significant association with pain groups in the agent (neither, misoprostil, oxytocin, or both) used to induce labor, but there was some evidence that the induction agent was started before the epidural more commonly in the low-pain group, *P*=.06. The median duration between the time the induction medication was administered and epidural catheter placement was similar, regardless of when the induction agent was given relative to the epidural. More women received an IV analgesic before the epidural in the high-pain score group (n=17) than in the moderate (n=8) or low-pain score group (n=0), *P*<.002. The most commonly used IV analgesic was butorphanol (n=21) followed by meperidine (n=4), *P*=not significant. There were 16 epidural catheters that needed to be replaced, four in the low and moderate-pain group and eight in the high-pain score group, *P*=.21. Women in the low-pain score group required additional doses of epidural medication more often than those in the other two groups, *P*<.001 (Table 3).

The primary outcome of this study, operative delivery rates, were 49%, 45%, and 45% in the low-, moderate-, and high-pain score groups, respectively, *P*=.40 (Table 3). The results were similar when controlling for maternal age in a multiple logistic regression analysis. The *P* values for maternal age and pain group in logistic regression analysis were .024 and .46, respectively. When the correlated data within obstetrician group was taken into account using generalized estimating equations, the 95% confidence interval for difference in operative delivery rates between the low-pain score group (49%) and the moderate- or high-pain score groups (45%) is −4.8% to 12.9%. The spontaneous vaginal delivery rate in the low-pain group was 51%, compared with 55% in both the moderate- and the high-pain score groups. Cesarean delivery rates were

Table 3. Labor Characteristics and Mode of Delivery by Group

Group	Low Pain Score	Moderate Pain Score	High Pain Score	*P*
n	185	185	185	
Pain scores	0–3	4–6	7–10	
Initial cervical examination				
Dilatation (cm)	1 (0–3.5)	1 (0–3.5)	1 (0–3.5)	.62
Effacement (%)	50 (0–100)	50 (0–100)	50 (0–100)	.65
Agent used for induction				.23
Neither	0	1 (0.5)	1 (0.5)	
Oxytocin (alone)	147 (79)	133 (72)	131 (71)	
Misoprostol (alone)	3 (2)	8 (5)	7 (4)	
Both	36 (19)	43 (23)	46 (25)	
Received induction agent prior to epidural placement	46 (26)	30 (16)	37 (20)	.06
Time from start of induction until epidural placement (h)*	3.1 (0.4–22.7)	4.1 (0.3–15.8)	3.8 (0.2–28)	.79
Time from placement of epidural until start of induction (h)†	1.7 (0.1–21.1)	1.2 (0.2–10.4)	1.5 (0.2–19.3)	.79
Epidural catheters that failed and required replacement	4 (2)	4 (2)	8 (4)	.21
No. of supplemental epidural doses during labor for breakthrough pain	2 (0–7)	1 (0–7)	1 (0–8)	<.001
Duration from start of induction (h) until delivery	11.9 (0.7–46.9)	12.3 (2.5–52.3)	11.6 (1.5–84.3)	.54
Duration from start of epidural until delivery (h)	9.1 (1.3–35.6)	7.9 (0.9–41.3)	7.6 (1.1–29.4)	.07
Duration of first stage of labor (h)	8.7 (1.6–23.2)	8.6 (3–23.4)	9 (2.4–23.2)	.50
Duration of second stage of labor (h)	1.1 (0.08–4.6)	1.2 (0.12–4.1)	0.9 (0.12–5.0)	.60
Mode of delivery				.24
Vaginal delivery	94 (51)	101 (55)	102 (55)	
Instrumental delivery‡	15 (8)	17 (9)	21 (11)	
Cesarean delivery	76 (41)	67 (36)	62 (34)	
Operative delivery§	91 (49)	84 (45)	83 (45)	.40

* In those who had the induction agent started prior to epidural placement.
† In those who had the epidural placed prior to starting the induction agent.
‡ Low outlet forceps or vacuum-assisted vaginal delivery.
§ Instrumental or cesarean delivery.

41%, 36%, and 34% in the low-, moderate-, and high-pain score groups, respectively.

Other obstetric outcomes, including the durations of the first and second stages of labor and the time from the start of the induction until delivery, were similar among groups. The time between placement of the epidural catheter until delivery was longest in the low-pain group, but the association did not reach statistical significance (P=.07).

DISCUSSION

We did not find a statistically significant difference in the operative delivery rate in nulliparous women who presented for an induction of labor between 37 and 41 weeks of gestation, whose cervix was dilated less than 4 cm, based on the amount of pain the woman was experiencing at the time of epidural catheter placement. These findings were unchanged when differences in maternal age and obstetrician group were accounted for in the analysis. We also did not find significant differences among groups for other outcomes, including duration of labor and neonatal outcome.

Because there are many patient and practitioner factors known to affect mode of delivery,[11–18] we limited our analysis to nulliparous women at term, with a cervical dilatation less than 4 cm, who were admitted for an induction of labor. We chose a cervical dilatation of less than 4 cm to indicate latent phase labor.[19] Further analysis revealed that the groups were similar not only in terms of initial cervical dilation but also in terms of initial percent cervical effacement. It would have been best to have a full Bishop score for each patient, but these data are not routinely assessed and documented in our institution. We chose our pain groupings based on data from Collins et al[20] who linked categorical pain intensity and numerical pain scores, and found that a pain score less than 4 was considered low pain. Although we could not control for the reason for induction, the known reasons were consistent among groups.

We found a significant association between obstetrician group and pain group that was accounted for in the statistical analysis, and it did not impact our results. We focused on the obstetrician group rather than the individual obstetrician because the obstetricians tend to work together. We found a statistically significant difference among groups in maternal age, but controlling for this variable did not alter the lack of significant differences in operative delivery rates.

The effect of epidural analgesia on the risk of cesarean delivery has been the subject of controversy. The greatest concern is when the anesthetic is placed early in relation to cervical dilatation.[21] However, studies that have specifically addressed this issue have not found an association in those presenting in spontaneous labor[5,6] and in those who presented for induction of labor, although the cesarean delivery rate is greater in those presenting for an induction of labor.[7] We too found a greater cesarean delivery rate in this study (37%) compared with those who present to our hospital in spontaneous labor (approximately 15–20%). Other studies have focused on the specific concentration of epidural local anesthetic with most finding a decrease in instrumental deliveries in those who receive smaller concentrations.[22]

Preemptive analgesia has been found to decrease postoperative pain and accelerate recovery from many surgical procedures.[23,24] Interestingly, some have found that significant pain during labor may be associated with cesarean delivery, but avoiding pain by offering early neuraxial analgesia was not addressed.[25,26] Our results indicate that there is at least no detriment to offering labor analgesia at a low pain score in terms of mode of delivery, duration of labor, or neonatal effects.

At The Mount Sinai Hospital, neuraxial analgesia is administered upon patient request. Although we are not aware of any relevant data, we have the impression that most women generally wait for labor to become painful before requesting labor analgesia. This decision may be based on prior experience with painful situations, cultural beliefs, or advice from friends, family, the individual obstetrician, or other health care providers.

Another interesting finding was that the duration of both the first and second stages of labor was unaffected by pain score at placement of neuraxial analgesia. Other studies have found conflicting results, but these differences may be related to anesthetic technique. Those who studied epidural analgesia have found a prolongation of labor,[27] but those who studied the combined spinal epidural technique have found shorter labors.[6,28] The reason for this difference is unclear, but it may be related to an imbalance in the autonomic nervous system that is more pronounced with epidural analgesia.[29] We tend to use very low concentrations of local anesthetics, bupivacaine 0.0625%, which may mitigate any influence from the epidural. Also, in our study, all women were of similar cervical dilatation and percent effacement at admission, which also may diminish any association. Another interesting finding was that those in the low-pain group required supplemental epidural medication more commonly. This is probably related to the greater expectation for less pain in this group

rather than a failure of the epidural catheter that did not differ among groups.

There are several limitations to this retrospective investigation. Our patient population represents a unique group of parturients and obstetricians who are willing to attempt an induction of labor and an aggressive management of labor including induction, early amniotomy, and early analgesia. Also, the time between cervical examination and epidural catheter placement is variable and could not be controlled in this retrospective study, but this parameter turned out to be similar among groups. Another limitation is that pain scores were assessed by the anesthesiologist at the time labor analgesia is requested. The method was the same for all three groups, but it was not standardized, and neither the patients nor the anesthesiologists were specifically trained in the use of the pain scale. Finally, our study provided 80% statistical power to find a significant trend among the groups of $\pm 7\%$ around the average. Although finer discrimination would be preferable, the observed operative delivery rates were similar among the groups (49%, 45%, 45% in the low-pain, moderate-pain, and severe-pain groups, respectively) suggesting that enrolling more patients would be of limited value.

REFERENCES

1. Martin JA, Hamilton BE, Sutton PD, Ventura SJ, Menacker F, Kirmeyer S, et al. Births: final data for 2005. Natl Vital Stat Rep 2007;56:1–104.
2. Liu S, Liston RM, Joseph KS, Heaman M, Sauve R, Kramer MS. Maternal Health Study group of the Canadian Perinatal Surveillance System. Maternal mortality and severe morbidity associated with low-risk planned cesarean delivery versus planned vaginal delivery at term. CMAJ 2007;176:455–60.
3. Sharma SK, McIntire DD, Wiley J, Leveno KJ. Labor analgesia and cesarean delivery: an individual patient meta-analysis of nulliparous women. Anesthesiology 2004;100:142–8.
4. Halpern SH, Leighton BL, Ohlsson A, Barrett JF, Rice A. Effect of epidural vs parenteral opioid analgesia on the progress of labor: a meta-analysis. JAMA 1998;280:2105–10.
5. Chestnut DH, McGrath JM, Vincent RD Jr, Penning DH, Choi WW, Bates JN, et al. Does early administration of epidural analgesia affect obstetric outcome in nulliparous women who are in spontaneous labor? Anesthesiology 1994;80:1201–8.
6. Wong CA, Scavone BM, Peaceman AM, McCarthy RJ, Sullivan JT, Diaz NT, et al. The risk of cesarean delivery with neuraxial analgesia given early versus late in labor. N Engl J Med 2005;352:655–65.
7. Wong CA, McCarthy RJ, Sullivan JT, Scavone BM, Gerber SE, Yaghmour EA. Early compared with late neuraxial analgesia in nulliparous labor induction: a randomized controlled trial. Obstet Gynecol 2009;113:1066–74.
8. Wuitchik M, Bakal D, Lipshitz J. The clinical significance of pain and cognitive activity in latent labor. Obstet Gynecol 1989;73:35–42.
9. Lehmann EL. Nonparametrics: statistical methods based on ranks. San Francisco, CA: Holden-Day, Inc; 1975. page 233.
10. Agresti A. Categorical data analysis. New York: Wiley; 1990 page 100.
11. Watson WJ, Stevens D, Welter S, Day D. Factors predicting successful labor induction. Obstet Gynecol 1996;88:990–2.
12. Heffner LJ, Elkin E, Fretts RC. Impact of labor induction, gestational age, and maternal age on cesarean delivery rates. Obstet Gynecol 2003;287–93.
13. Peipert JF, Bracken MB. Maternal age: an independent risk factor for cesarean delivery. Obstet Gynecol 1993;81:200–5.
14. Turner MJ, Rasmussen MJ, Turner JE, Boylan PC, MacDonald D, Stronge JM. The influence of birth weight on labor in nulliparas. Obstet Gynecol 1990;76:159–63.
15. Glantz JC. Elective induction vs. spontaneous labor associations and outcomes. J Reprod med 2005;50:235–40.
16. Lopez-Zeno JA, Peaceman AM, Adashek JA, Socol ML. A controlled trial of a program for the active management of labor. N Engl J Med 1992;326:450–4.
17. Segal S, Blatman R, Doble M, Datta S. The influence of the obstetrician in the relationship between epidural analgesia and cesarean section for dystocia. Anesthesiology 1999;91:90–6.
18. Beilin Y, Friedman F Jr, Andres LA, Hossain S, Bodian CA. The effect of the obstetrician group and epidural analgesia on the risk for cesarean delivery in nulliparous women. Acta Anaesthesiol Scand 2000;44:959–64.
19. Bailit JL, Dierker L, Blanchard MH, Mercer BM. Outcomes of women presenting in active versus latent phase of spontaneous labor. Obstet Gynecol 2005;105:77–9.
20. Collins SL, Moore RA, McQuay HJ. The visual analogue pain intensity scale: what is moderate pain in millimetres? Pain 1997;72:95–7.
21. Thorp JA, Hu DH, Albin RM, McNitt J, Meyer BA, Cohen GR, et al. The effect of intrapartum epidural analgesia on nulliparous labor: a randomized, controlled, prospective trial. Am J Obstet Gynecol 1993;169:851–8.
22. Comparative Obstetric Mobile Epidural Trial (COMET) Study Group UK. Effect of low-dose mobile versus traditional epidural techniques on mode of delivery: a randomised controlled trial. Lancet 2001;358:19–23.
23. Gottschalk A, Smith DS, Jobes DR, Kennedy SK, Lally SE, Noble VE, et al Preemptive epidural analgesia and recovery from radical prostatectomy: a randomized controlled trial. JAMA 1998;279:1076–82.
24. Sekar C, Rajasekaran S, Kannan R, Reddy S, Shetty TA, Pithwa YK. Preemptive analgesia for postoperative pain relief in lumbosacral spine surgeries: a randomized controlled trial. Spine 2004;4:261–4.
25. Hess PE, Pratt SD, Soni AK, Sarna MC, Oriol NE. An association between severe labor pain and cesarean delivery. Anesth Analg 2000;90:881–6.
26. Panni MK, Segal S. Local anesthetic requirements are greater in dystocia than in normal labor. Anesthesiology 2003;98: 957–63.
27. Sharma SK, Sidawi JE, Ramin SM, Lucas MJ, Leveno KJ, Cunningham FG. Cesarean delivery: a randomized trial of epidural versus patient-controlled meperidine analgesia during labor. Anesthesiology 1997;87:487–94.
28. Tsen LC, Thue B, Datta S, Segal S. Is combined spinal-epidural analgesia associated with more rapid cervical dilation in nulliparous patients when compared with conventional epidural analgesia? Anesthesiology 1999;91:920–5.
29. Leighton BL, Halpern SH, Wilson DB. Lumbar sympathetic blocks speed early and second stage induced labor in nulliparous women. Anesthesiology 1999;90:1039–46.