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Is Combined Spinal–Epidural Analgesia Associated with More Rapid Cervical Dilation in Nulliparous Patients When Compared with Conventional Epidural Analgesia?

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Background: **The combined spinal–epidural technique provides rapid onset of labor analgesia and, anecdotally, is associated with labors of shorter duration. Epidural analgesia, by contrast, has been suggested to prolong labor modestly. It is unclear, however, whether more rapid cervical dilation in patients who receive combined spinal–epidural analgesia is a physiologic effect of the technique or an artifact of patient selection. The authors hypothesized that anesthetic technique may influence the rate of cervical dilation, and we compared the effects of combined spinal–epidural with those of epidural analgesia on the rate of cervical dilation.**

Methods: **One hundred healthy nulliparous parturients in spontaneous labor with singleton, vertex, full-term fetuses were enrolled in a double-blinded manner when their cervical dilation was less than 5 cm. The patients were randomly assigned to receive analgesia *via* a standardized combined spinal–epidural (n = 50) or epidural (n = 50) technique. Data were collected on cervical dilation, pain, sensory level, and motor blockade.**

Results: **When regional analgesia was induced in comparable groups at a mean of 3 cm cervical dilation, the mean initial cervical dilation rates were significantly faster in the combined spinal–epidural group (mean values, 2.1 ± 2.1 cm/h *vs.* 1 ± 1 cm/h; $P = 0.0008$). Five parturients in the combined spinal–epidural group had a very rapid (> 5 cm/h) rate of mean initial cervical dilation, compared with none of the women in the epidural group. Overall mean cervical dilation rates in patients who achieved full cervical dilation were 2.3 ± 2.6 cm/h and 1.3 ± 0.71 cm/h ($P = 0.0154$) in the combined spinal–epidural and epidural groups, respectively.**

Conclusions: **In healthy nulliparous parturients in early labor, combined spinal–epidural analgesia is associated with more rapid cervical dilation compared with epidural analgesia. Further study is needed to elicit the cause and overall effect of this difference. (Key words: Obstetric analgesia; progress of labor.)**

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THE combined spinal–epidural (CSE) technique is used with increasing frequency in labor analgesia, because of its rapid onset of excellent analgesia.[1] We observed that parturients who received this form of analgesia had more rapid deliveries, although this may have resulted from the common practice of administering CSE analgesia to parturients who were multiparous or in more advanced stages of labor. In contrast, some authors have suggested that epidural analgesia may prolong labor in nulliparas, especially if administered early in labor,[2] although the effect is probably modest.[3] We performed this randomized study to compare the potential effects of CSE with those of epidural analgesia on cervical dilation in a group of nulliparous women in early spontaneous labor.

Materials and Methods

The Brigham and Women's Hospital Committee on Human Subjects approved the study, and all participants gave written informed consent. A total of 100 parturients, all nulliparous and classified as American Society of Anesthesiologists physical status 1 or 2 in spontaneous labor with singleton, vertex, full-term fetuses, were en-

rolled when their cervical dilation was <5 cm. The patients were informed of the study on arrival to the labor floor. When they requested analgesia, they were randomized in a double-blinded manner by sequentially numbered, opaque, shuffled envelopes to receive labor analgesia by a standardized CSE or epidural technique at the L3-4 or L4-5 interspace. After a 1,000-ml bolus of lactated Ringer's solution, the parturients were placed in the left lateral recumbent position, and a sterile preparation with povidone-iodine solution was performed. After local infiltration with 1% lidocaine, the epidural space was located with a 17-gauge Weiss–Touhy epidural needle using the loss-of-resistance-to-air technique.

In the CSE group (n = 50), a 25-gauge Whitacre needle was placed *via* the shaft of the epidural needle as described previously[4]; the dura was punctured; and when the flow of cerebral spinal fluid was confirmed, bupivacaine 0.25% (1 ml) with sufentanil (10 μg in 0.2 ml) was given. This was followed by the placement of a 20-gauge multihole epidural catheter, 3 cm into the epidural space. Then the parturient was repositioned in the supine position with left uterine displacement. A continuous infusion pump was connected to the epidural catheter and appropriate settings for later use were entered, but the unit was turned off. This was done in attempt to blind the observers in the room. No epidural drug was given until discomfort returned, at which time patients received 6 ml 0.25% bupivacaine in divided doses to achieve a bilateral T10 sensory level, and an infusion of 0.125% bupivacaine with 2 μg/ml fentanyl was started at 10 ml/h.

In the epidural group (n = 50), a 25-gauge Whitacre spinal needle was placed *via* the shaft of the epidural needle, without puncturing the dura, and "dosed" with an empty syringe; this was done in an attempt to blind any observers to the technique being used. This was followed by the placement of a multihole epidural catheter 3 cm into the epidural space. Then, after the parturient was repositioned supine with left uterine displacement, 12 ml bupivacaine, 0.25%, in divided doses was administered. A continuous infusion pump was connected and the standardized infusion of bupivacaine, 0.125%, with 2 μg/ml fentanyl was started immediately at 10 ml/h. The patient, labor nurse, and obstetrician were not informed of the technique used.

After the initial epidural bupivacaine in the epidural and CSE groups, any request for additional analgesia was fulfilled with 6 ml bupivacaine, 0.25%, in the absence of a T10 sensory blockade to pinprick or if unblocked sacral nerves were detected. In the presence of a bilateral T10 level and an adequate sacral block, 50 μg fentanyl in 10 ml sterile saline was given. In the presence of a block higher than a T10 sensory level, a Bromage score of 3 (no motor ability), an obstetrician or patient request for a less extensive block, or both, the rate of epidural infusion was decreased to 6 ml/h, with a patient reevaluation performed 1 h later. Standardized protocols for pruritus, nausea, and hypotension were established.

Data on labor progress and outcome were recorded for each patient, including all cervical examinations, use and maximum dose of oxytocin administered, and mode of delivery. Cervical examinations were performed at the discretion of the obstetrician, but general labor and delivery practice guidelines at our institution dictate periodic examinations every 2–4 h or with changes in maternal or fetal status. Study entry criteria included a request for analgesia and the obstetrician's clinical judgment that the patient was in active labor with a cervical dilation <5 cm. Patients for whom analgesia was requested, but who were not in active labor, were excluded from study participation. Because cervical examinations at fixed intervals were not part of our study design, we estimated the "cervical dilation rate" by linear interpolation between two examinations[5]:

$$\frac{C_a - C_b}{T_a - T_b}$$

where C_a and C_b and T_a and T_b represent the results and timing, respectively, of two cervical examinations. Using this method to estimate rates of labor progress, we calculated two indices as principal outcome measures: (1) the initial cervical dilation rate, derived from the most immediate cervical examinations before and after the initiation of analgesia, and (2) the first-stage cervical dilation rate, derived from the cervical examinations at analgesia initiation and full dilation. Because the precise onset of active labor is difficult to determine, we arbitrarily defined the first stage of labor as the interval between the initiation of analgesia until full dilation. The second stage of labor was defined as the interval between full cervical dilation and delivery of the neonate.

Additional data were obtained for each patient to ensure that analgesia and other parameters were comparable between the groups. These included maternal demographics, fetal characteristics (gender, birth weight, and Apgar scores), and details of anesthetic management.

Visual analog scale pain scores, sensory level to pin prick, and motor blockade were assessed by a blinded observer at study entry, immediately after the onset of

Table 1. Progress of Labor

	Combined Spinal–Epidural	Epidural
Onset of labor to analgesia (h)	10.0 ± 5.2	11.6 ± 8.9
Analgesia to full cervical dilation (h)	3.8 ± 2.6	5.1 ± 2.6*
Full cervical dilation to delivery (h)	1.8 ± 1.2	2.2 ± 1.5
Initial cervical dilation rate (cm/h)†	2.1 ± 2.1	1.0 ± 1.0*
Mean cervical dilation rate‡	2.3 ± 2.6	1.3 ± 0.7*
Mode of delivery (%)		
Spontaneous vaginal	68	66
Instrumental vaginal	16	16
Cesarean section	16	18

Times and cervical dilation rates are shown as mean ± SD.

* $P < 0.05$ for difference between analgesic groups (see text for statistical details).

† Initial cervical dilation rate = (first cervical examination after analgesia − last cervical examination before analgesia)/time between examinations.

‡ Mean cervical dilation rate = (10 − last cervical examination before analgesia)/time between examinations.

analgesia, 60 min later, and at 90-min intervals thereafter. Visual analog scores were determined using an unmarked 100-mm sliding scale indicator (Astra Laboratories, Worchester, MA). Motor strength determinations used a modified Bromage score (0 = full flexion of knees and ankles, 1 = partial flexion of knees, full flexion of ankles; 2 = inability to flex knees, partial flexion of ankles; 3 = inability to flex knees and ankles). In addition, identical determinations were made at any anesthetic intervention, including evaluation of analgesia or side effects (hypotension, pruritus, nausea, and so forth).

Initial cervical dilation and first-stage dilation rates between groups were compared by analysis of variance. Because *post hoc* plots of these parameters suggested that their distribution may not be normal, they were also compared using the nonparametric Mann–Whitney U test. Maternal and fetal demographics were tested by analysis of variance (for continuous data) or chi-square analysis (for categorical data), as appropriate. Visual analog scale scores were evaluated by analysis of variance for repeated measures. Statistical significance was assumed when $P < 0.05$. For a 50% reduction in the observed initial cervical dilation rates, the expected sample size requirement for 80% power and alpha = 0.05 was 41 per group.

Results

All 100 women completed the study. Table 1 and figure 1 show data on cervical dilation and mode of delivery. Cervical dilation did not differ at study entry (*i.e.*, the most recent cervical examination before analgesia initiation), but the initial cervical dilation rate (surrounding the onset of analgesia) and first-stage dilation rate (last examination before analgesia to full dilation) were both faster in the CSE group. This result was identical when cervical dilation was analyzed with parametric (analysis of variance) or nonparametric (Mann–Whitney U) statistics. Equal numbers of patients achieved full cervical dilation in each group (88% in the CSE and 92% in the epidural groups, respectively; P = NS). Five patients in the CSE group, compared with none in the epidural group, had initial cervical dilation rates of 5 cm/h or greater ($P = 0.007$).

There was substantial variation between patients in the interval between the two cervical examinations used to calculate the initial cervical dilation rate. However, the average interval did not differ between the groups (CSE group = 2.4 ± 1.4 [mean ± SD] h; epidural group = 2.8 ± 1.4 h; $P = 0.19$). Figure 1 shows the actual examination times and dilations for each patient and the mean for each treatment group. To diminish the possibility that the majority of cervical dilation occurred before analgesia initiation, a second analysis was performed that excluded those patients whose initial cervical examination was performed >2 h before analgesic onset. Analysis of these 79 patients (those excluded were equally distributed between the two groups) yielded nearly identical results.

Maternal demographics (table 1) and labor management (table 2) were comparable between the groups. No patient required intervention for hypotension, nausea, pruritus, or excessive block in either group. Analgesia was comparable throughout labor (fig. 2). Sensory level (median dermatomal level to pinprick) was T10 at every time point in both groups. Mean motor block (Bromage scale) was 0 at all time points in both groups. Second-stage time and mode of delivery did not differ between the groups (table 3). Neonatal birth weight, gender, and Apgar scores did not differ between the groups.

Discussion

The CSE technique has gained popularity as an alternative to conventional epidural analgesia, because of its rapid onset of analgesia and minimal motor blockade.[6] Although it provides excellent labor analgesia, regional analgesia may affect the progress and outcome of labor. Epidural analgesia may decrease,[2] have no effect,[7] or increase[8] the rate of cervical dilation in the first stage of

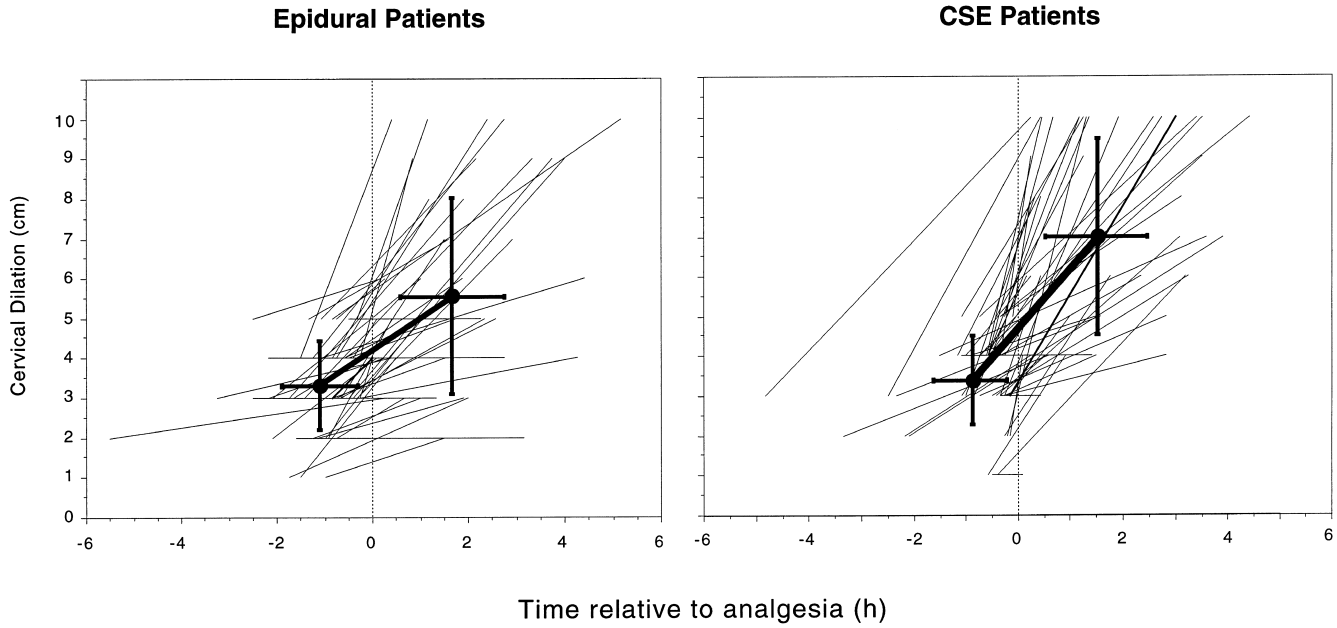

Fig. 1. The initital cervical dilation rate for each patient are shown. Lines connect the most recent cervical examination before and the first cervical examination after analgesia. The heavy plot symbol and lines indicate the mean and SD for each group. The slopes of the mean lines equal the mean initial cervical dilation rates (see the text and table 1 for details).

labor. Many anesthesiologists have anecdotally noted apparently faster cervical dilation when the CSE technique is used in preference to conventional epidural analgesia. Unfortunately, because CSE analgesia is often selected for women whose labors are already perceived to be progressing quickly, these observations may be an artifact of patient selection. Two randomized trails that compared CSE with epidural analgesia found no difference in the mode of delivery, but they did not examine the rate of cervical dilation.[9,10] Furthermore, both of these studies were confounded by different epidural analgesia regimens for the CSE and epidural groups.

We designed this study to evaluate the hypothesis that CSE and epidural analgesia would be associated with different cervical dilation rates. By blinding the obstetrician, the labor nurse, the anesthesiologist evaluating the

Table 2. Maternal Demographics

	Combined Spinal–Epidural	Epidural
Maternal age (yr)	31.1 ± 0.7	29.4 ± 0.7
ASA physical status I (% of patients)	88	78
Height (cm)	163 ± 0.76	165 ± 0.76
Weight (kg)	72.8 ± 9.2	78 ± 12.2*
Gestational age (weeks)	39.3 ± 0.9	39.4 ± 0.9
Cervical examination at study entry (cm)		
Median	3	3
Interquartile range	3,4	3,4

All values are mean ± SD unless otherwise noted.

* $P < 0.05$ for difference between analgesic groups (see text for statistical details).

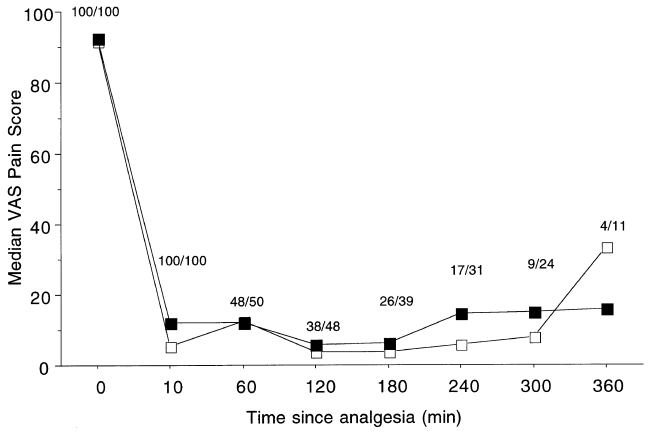

Fig. 2. Median visual analog scale scores for undelivered patients. N at each time point is indicated as N in the combined spinal–epidural (CSE) group/N in the epidural group. Open symbols indicate CSE patients; filled symbols represent epidural patients. There were no significant differences between the groups (analysis of variance for repeated measures, $P = 0.025$).

Table 3. Labor Management

	Combined Spinal–Epidural	Epidural
Oxytocin use		
Overall (%)	80	86
Before analgesia (%)	64	54
Maximum dose (mU/min)	11.0 ± 5.6	12.1 ± 7.6
Rupture of membranes		
Artificial (%)	42	55
Before analgesia (%)	80	76
Time ruptured before analgesia (h)	7.5 ± 5.6	5.9 ± 6.0
Total time ruptured (h)	11.2 ± 7.2	11.3 ± 6.7

Values shown as percent of mean ± SD. There were no significant differences between the groups.

analgesia, and the patient to the analgesic regimen, we reduced the likelihood that our results could be explained by variations in observer bias, obstetric management, or nursing care. Furthermore, in the CSE group, by using identical epidural regimens in the CSE and epidural groups (after the spinal portion of the technique), we eliminated another variable complicating other studies. In the current investigation, despite similar cervical dilation at entry, similar maternal and fetal demographics, analgesia, and labor management, the CSE group experienced a mean initial dilation rate twice that of the epidural group. Furthermore, the effect persisted in the cervical dilation rate for the entire first stage of labor, shortening the time to full cervical dilation by 78 min in the CSE group. No significant differences were found during the second stage of labor or in the mode of delivery.

The mechanism by which CSE analgesia is associated with a greater rate of cervical dilation relative to conventional epidural analgesia is unknown, but several possibilities exist. First, the spinal analgesia of a CSE technique allows, at least initially and potentially during the course of labor, for a reduction in local anesthetic exposure when compared with epidural analgesia. In our study, for instance, eight parturients delivered with spinal analgesia alone. This difference in local anesthetic exposure may have an effect on uterine activity. When exposed to local anesthetics *in vitro*, uterine muscle strips have been noted to increase tone but decrease the rate and strength of contractions.[11] *In vivo*, epidural bupivacaine has been suggested to directly slow uterine activity.[12] Second, the dramatic and rapid onset of pain relief with CSE analgesia may allow for an equally rapid and altered profile in maternal catecholamines. Substantial evidence indicates that maternal epinephrine and norepinephrine levels increase during painful labor,[13] and that effective pain relief decreases epinephrine but leaves norepinephrine unchanged. Laboratory studies suggest that these changes can increase uterine activity,[14] and clinical studies further support the proposition that maternal epinephrine may be tocolytic and its reduction therefore able to stimulate uterine contraction.[15] This mechanism may be a link to the reports of uterine hypertonia and fetal bradycardia that have been reported to follow labor analgesia.[16] The catecholamine-reducing effects of epidural have been compared directly with those of CSE analgesia, and a more rapid decrease in epinephrine was found in the CSE group.[15] However, the difference in catecholamine levels between the CSE and epidural groups was transient,[15] so this mechanism may only partly explain the difference in cervical dilation that we observed.

Our study may be criticized because, while the parturients were randomized to the type of analgesia, the obstetricians did not perform cervical examinations at regular timed intervals. The mean initial cervical dilation rate data in our study, therefore, could have suffered from two potential problems. First, the examination before analgesia may have been performed earlier in one group, thus allowing greater cervical changes to occur before, and without, analgesia. Second, the examination after analgesia may have been performed later in one group, thus allowing any analgesic influence, or even the natural process of labor, to have more of an effect. We do not believe either of these concerns affected our data. Although we noted substantial variation among the patients (fig. 1), the mean time between the initial cervical examination and analgesia onset and the time between the cervical examinations immediately before and after analgesia were not different between the two groups.

An additional potential weakness is the uncertainty with which we could establish the time of full cervical dilation, and thus the mean cervical dilation rates for the entire first stage of labor. Although this is a valid concern, an analysis of our data suggests that the parturients in both groups were examined in a routine, systematic manner every 2–4 h, as is our institutional practice, for all examinations up to and including full cervical dilation. Thus, a potential bias would unlikely to be applied consistently to only one group. Furthermore, it is possible that denser epidural analgesia during the second stage of labor in one group may have allowed more time to pass in the fully dilated state before being recognized by the obstetrician. We believe this is unlikely, because VAS pain scores were comparable between the two groups throughout the study (fig. 2).

Although not a primary aim of our investigation, for

the sake of completeness we have included data on the mode of delivery, which did not show a difference between the analgesic techniques used. At least three reasons can explain why no difference was observed. First, the power of our study was too low to detect modest changes in cesarean delivery rates. Approximately 500 patients would need to be studied to detect even a 50% reduction in abdominal delivery rates with 80% power, many times more than we enrolled. A second explanation may be that CSE rather than epidural analgesia may not have an effect on the mode of delivery, as found in other studies.[13,14] Finally, we did not standardize obstetrical management, including indications for operative delivery. Substantial evidence indicates that obstetric practice style is far more important than analgesic regimens or even patient risk factors in determining cesarean birth rates.[17–21]

In conclusion, we found that CSE analgesia, when administered to nulliparous parturients in early labor, results in significantly more rapid cervical dilation compared with standard epidural analgesia. The mechanisms and clinical significance of this more rapid cervical dilation remain to be determined in future studies.

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