

Epidural Infusion Volume And Its Effect On Analgesia In Early Labor

N Connelly, A Cho, R Parker, K Morneault, M Lopez, H Sunkara, C Gibson

Citation

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Abstract

Purpose: It is not clearly known how volume affects the duration of clinically utilized epidural infusions in early labor. After achieving adequate labor analgesia with epidural fentanyl, the current study was performed. It was designed to determine whether there was a significant difference in the duration and quality of analgesia when patients received a standard amount of epidural bupivacaine and fentanyl while varying the concentrations and volumes of the epidural infusions.

Methods: Seventy-two laboring primigravid women received a 3 mL epidural test dose of lidocaine with epinephrine, followed by a fentanyl 100 µg bolus in 10 mL of diluent volume. Patients then received one of two continuous epidural infusions, in a randomized fashion, of either bupivacaine 1.25mg/mL with fentanyl 3µg/mL at 5 mL/hr or bupivacaine 0.417mg/mL with fentanyl 1µg/mL at 15 mL/hr. Pain scores and side effects were recorded for each patient.

Results: The mean duration of satisfactory analgesia prior to re-dose was 163 ± 67 min in the 0.125% group and 201 ± 88 min in the 0.0417% group ($P < 0.05$). One patient in the 0.5mL/hr group experienced a partial motor block.

Conclusion: After initiating epidural analgesia in early laboring patients, with 100 µg epidural fentanyl (after a lidocaine-epinephrine test dose), administration of 0.417mg/mL bupivacaine with fentanyl 1µg/mL at 15 mL/hr, compared to bupivacaine 1.25mg/mL with fentanyl 3µg/mL at 5 mL/hr, provided a longer duration of analgesia with no significant difference in pain scores or side effects.

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INTRODUCTION

We have previously shown in our institution that epidural fentanyl or sufentanil, after a lidocaine-epinephrine test dose, provides approximately 2h of analgesia, while allowing patients to ambulate (1,2,3,4,5,6,7,8). Furthermore we have shown that adding a continuous bupivacaine and fentanyl infusion to the initial fentanyl bolus increases the analgesic duration (3)

There is some evidence that varying the volume of the infusion has the potential to affect the duration of pain relief (9,10); however another study did not find this to be the case (11). The current study was designed to determine whether there is a difference in analgesia, side effects, or analgesic duration in patients who receive fentanyl 100mcg in 10 mL diluent when the volume of medication infused epidurally is

altered (while keeping the total mass of the medication constant).

METHODS

Before this study was initiated, Institutional Review Board approval was obtained. Seventy-two nulliparous ASA physical status I or II obstetric patients, at greater than 36 weeks of gestation, who had requested labor analgesia, gave written informed consent. Patients were excluded if cervical dilation was greater than 5 cm, if they had received opioid agonists or agonist/antagonists, had pre-eclampsia, or had a contraindication to the use of fentanyl or bupivacaine. A normal fetal heart rate pattern (including an absence of decelerations) was required for inclusion in the study. Patients' demographic data was collected.

Before the procedure was begun, the patients' vital signs (blood pressure, heart rate, and respiratory rate) were documented, and the patients were asked to relate any

symptoms of pruritus, nausea, or vomiting. Each patient also completed a baseline assessment using a 100-mm visual analog scale (VAS) for pain, with 0 representing no pain and 100 being the worst possible pain. Each patient received a minimum of 500 mL of Ringer's lactate solution intravenously. All procedures were performed with patients in the sitting position. A multiorificed lumbar epidural catheter was inserted approximately 5 cm into the epidural space by using a Tuohy-Schiff needle (B-Braun Medical, Bethlehem, PA). The patients then received a test dose of 3 mL of 1.5% lidocaine with 1:200,000 epinephrine. If the test dose was negative for intravascular injection (heart rate within 15 bpm of baseline values in 2 min of monitoring) and intrathecal injection (no evidence of neural blockade after 3 min of monitoring), the patient was given fentanyl 100mcg in 10mL volume. One of two continuous epidural infusions were then begun, within 10 minutes, in a double-blinded fashion determined by a computer generated randomization list. All of the patients received 6.25mg of Bupivacaine and 15 mcg of fentanyl per hour.

Group 1: Bupivacaine 1.25 mg/mL with fentanyl 3 mcg/mL at 5mL/hr

Group 2: Bupivacaine 0.417 mg/mL with fentanyl 1 mcg/mL at 15mL/hr

Patients were placed in the recumbent position with left uterine displacement. VAS scores and the severity of side effects were recorded at baseline and at 10, 20, 30 min after the administration of the study infusion, and every 30 min thereafter. Assessments were performed by an individual blinded to the infusion rate. The infusion pump was turned so that the investigator could not see the rate of infusion. At the time of each assessment, vital signs, modified Bromage motor scale scores ($_2$), pruritus, nausea, vomiting and sedation were evaluated. Motor block was defined as none, partial (just able to move the knees), almost complete (able to move the feet only), or complete (unable to move the lower extremities). Pruritus was rated as none, minimal (present with minimal symptoms), moderate (bothersome but not requiring therapy), or severe (requiring therapy). Nausea was rated as none, moderate, or severe. Vomiting was rated as present or absent.

Sedation was categorized as none (awake), mild (drowsy), moderate (sleepy) or severe (unarousable). The fetal heart rate pattern was evaluated at each interval, by an anesthesiologist, and any changes were documented. After the first 30 min, patients were allowed to ambulate with

assistance provided there was no detectable motor block and the fetal heart rate pattern was reassuring. The time at which each patient requested additional analgesia was recorded, vital signs were documented, and pain and side effect assessments were performed. Epidural anesthetics were subsequently managed by the anesthesia team, as appropriate, for the remainder of labor. The duration of labor, mode of delivery, incidence of post dural puncture headache (PDPH), and neonatal Apgar scores were recorded.

If adequate analgesia was not achieved 20 min after the initial study dose (patient stated that pain relief was not adequate), local anesthetic was administered via the epidural catheter, and the study was concluded. The patient's data was not included in the analysis.

Before this study was instituted, a power analysis was performed assuming: an analgesic duration of 198 ± 86 min ($_{3,5}$), a 60 minute analgesia duration difference; 80% power; and an alpha of 0.05. This yielded a required sample size of 72 total patients.

Demographic data were analyzed by using analysis of variance. Pain scores were analyzed by using the Mann-Whitney U-test. Presence or absence of side effects was analyzed by contingency testing. A Kaplan-Meier plot of the patients remaining comfortable over time was generated, and analyzed with Cox Mantel. Data are expressed as mean \pm SD. A Bonferonni adjustment was made for multiple comparisons. Significance was determined at the $p < 0.05$ level.

RESULTS

Seventy-seven patients were enrolled in the study. Five patients were dropped: one patient's infusion was connected, but never begun. Four patients did not get comfortable; they all received local anesthetic via the epidural catheter, without analgesia occurring. They required replacement of the epidural catheters in order to get comfortable. When analyzing the data, one patient in the 5 mL/hr group found to be 7 cm at time of epidural placement, and was removed from study. There were no significant differences in demographic variables, cervical dilation at the time of enrollment, rupture of membranes, or oxytocin use among the study groups (Table 1).

Figure 1

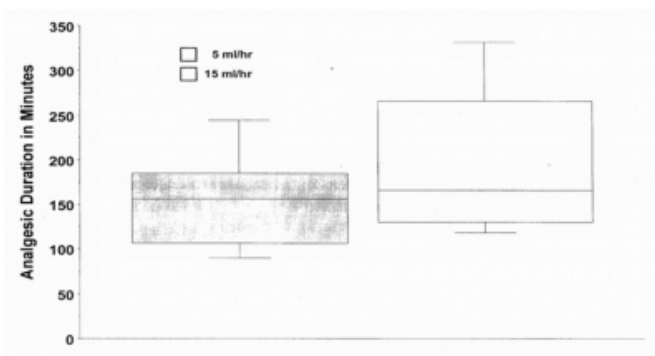
Table 1: The demographic and outcome data in the two groups. Data are expressed as mean \pm SD. There were not statistically significant demographic differences between the groups.

	Group (15 mL/hr)	Group (5 mL/hr)
Age (yrs)	28 \pm 6	26 \pm 6
Height (cm)	164 \pm 7	163 \pm 7
Weight (kg)	82 \pm 18	85 \pm 16
Gestational Age (weeks)	40 \pm 1	40 \pm 2
Cesarean Section (n)	9	11
Forceps/Vacuum (n)	3	1
Cervical Dilatation At Initial Dose	3 \pm 1	3 \pm 1
Cervical Dilatation At Re-dose	6 \pm 2	5 \pm 2

Baseline VAS pain scores and the incidence of nausea and pruritus were similar in the two groups. The median VAS scores were decreased 72 % and 71% by the 10-min evaluation in the 5 mL/hr group and the 15 mL/hr group, respectively (p = not significant). At 30 min, the respective VAS scores were reduced by 94% (5 mL/hr), 95% (15 mL/hr) (p = not significant). There was no significant difference in pain scores between the groups at any of the time points. The duration until re-dose was significantly longer in the 15 mL/hr group (201 ± 88 min; median 166 min) than in the 5 mL/hr group (163 ± 67 min; median 156 min) (Figure 1; $p < 0.05$).

Figure 2

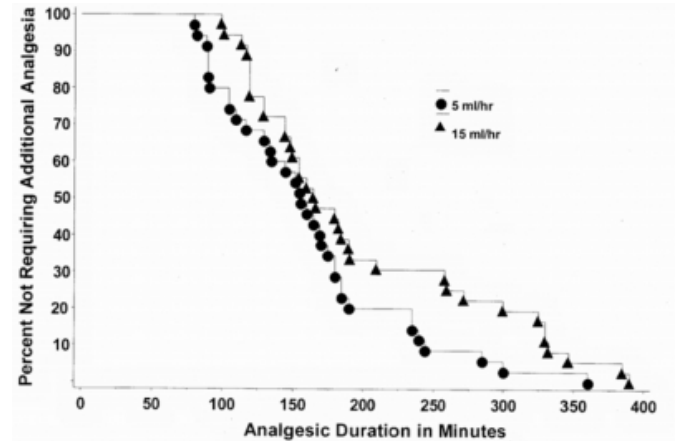
Figure 1: The analgesic duration for the two groups. The box represents the 25 -75 percentiles and the median is represented by the solid line. The extended bars represent the 10 -90 percentiles. The duration of the 15 mL/hr infusion was significantly longer than that of the 5 mL/hr infusion ($p < 0.05$).



The number of patients remaining comfortable over time was higher in the 15 mL/hr group than in the 5 mL/hr group ($p < 0.05$; Figure 2).

Figure 3

Figure 2: Kaplan-Meier plot of the percent of patients in each group who continued to remain comfortable. There were more patients remaining comfortable over time in the 15 mL/hr group (p



Before administration of the study analgesic, 16 patients had experienced nausea (8 in 15 mL/hr, 8 in 5 mL/hr had nausea) and 4 patients had vomited. During the entire study period, 17 patients experienced nausea (12 in 15 mL/hr, 5 in 5 mL/hr) and 5 patients vomited (3 in 15 mL/hr, 2 in 5 mL/hr). Twenty patients experienced mild sedation at least once during the study period (11 in 15 mL/hr, 9 in 5 mL/hr). No patient experienced moderate or severe sedation. At no time, did any patient experience severe pruritus. No patient required specific treatment for nausea, vomiting, or pruritus. Patients in the 15 mL/hr group experienced significantly more mild pruritus than the 5 mL/hr group (29 in the 15 mL/hr, 19 in the 5 mL/hr; $P < 0.04$).

Five patients delivered without the need for a re-dose (3 in the 15 mL/hr group and 2 in the 5 mL/hr group). The incidence of cesarean delivery (9 in 15 mL/hr, 11 in 5 mL/hr) and instrumented delivery (1 in 5 mL/hr, 3 in 15 mL/hr) was not significantly different between the groups. None of the patients required a cesarean delivery before the need for a re-dose. None of the patients had an inadvertent dural puncture. No patient experienced symptoms of post dural puncture headache. No patient had any clinically significant FHR tracing abnormalities during the evaluative period.

One patient (5 mL/hr) stated she had the sensation that her knee would buckle; she was not allowed to ambulate. One patient (in the 5 mL/hr group) had detectable motor weakness in the hip from 90 – 150 minutes. She was not allowed to ambulate. There was not a significant difference in ambulation; 15 patients in the 5 mL group ambulated (13

to bathroom, 2 in hall) and 16 patients in the 15 mL group ambulated (15 to bathroom, 1 in hall). Twenty-four patients in the 5 mL group and 21 patients in the 15 mL group received oxytocin; this was not significantly different. There were no significant differences in neonatal APGAR scores.

DISCUSSION

Epidural analgesia allowing ambulation during labor is increasingly popular, in part because of the perceived improvement in patient satisfaction by preserving motor power. We have successfully utilized epidural opioids following a lidocaine-epinephrine test dose to provide satisfactory analgesia without a significant motor block (1,2,3,4,5,6,7,8).

A number of studies of epidural labor analgesia have compared high volume/low concentration solution to low volume/high concentration have been reported. It has previously been shown that giving 0.08% bupivacaine at 25 mL/hr results in the need for less subsequent bolus administrations than does 0.25% bupivacaine at 8 mL/hr (10). This study did not utilize opioids as part of their infusions. Furthermore, it showed that diluent volume was important in both onset and duration of analgesia. Smaller injectate volumes required a longer onset time and resulted in a shorter duration of action, whereas larger volumes showed the opposite (9). In postoperative cesarean section patients, a lower volume of epidural meperidine resulted in longer onset time and higher pain scores (13). Although this study used only opioids, and not a combination of opioid and local anesthetic, and although pain control was for post-cesarean section as opposed to labor pain, the extrapolation can be made to our study in that more dermatomes are covered when a larger volume of drug is used in the epidural space. Increased volume of initial injectate has been shown to improve pain relief and increase analgesic duration of labor epidural analgesia when varying the bupivacaine concentration from 4 mL of 0.5% to 20 mL of 0.1% (14).

In contrast to these results, and those of our own study, in a study of thoracotomy patients who received mid-thoracic epidural analgesia, total dose of local anesthetic plus opioid (bupivacaine/sufentanil) was more important than the volume in which it was delivered (11). This difference may be due the location and nature of the painful stimuli in each study. A lumbar catheter may need more volume to cover all the dermatomes involved in labor (from low thoracic to sacral) where as a smaller number of dermatomes may be need to be covered with a incision-specific level epidural

catheter following a thoracotomy.

In a previously published study, varying the volume of initial epidural dose did not result in a difference in analgesic duration (15). However, this study compared two very high-dose bupivacaine concentrations (12 mL 0.25% bupivacaine diluted with either 2 or 8 mL fentanyl). We, on the other hand, were attempting to perform epidural analgesia which allowed the patients to ambulate, and thus utilized low concentrations of bupivacaine.

There were two patients in the 5 mL/hr group in whom ambulation was not allowed. One of these patients had the subjective sensation of a "weak knee" whereas the other patient had demonstrable motor weakness. This might be due to the more concentrated dose of bupivacaine being localized to a specific lumbar nerve root or roots. The more dilute infusion might avoid this by presenting a less concentrated dose of bupivacaine to any one nerve root.

In conclusion, the volume of continuous infusion is important in affecting analgesic duration, following fentanyl 100 µg in a 10 mL volume. This is true for early labor analgesia is initiated in nulliparous patients, but may not be applicable to women in more advanced labor or multiparous patients. This was not associated with any difference in nausea or vomiting. There were more patients in the higher volume groups who experienced mild pruritus; however no patient had moderate or severe pruritus or required specific treatment. We thus recommend utilizing a higher volume/lower concentration continuous infusion following a 100 µg fentanyl bolus.

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