The effects of different epidural analgesia formulas on labor and mode of delivery in nulliparous women

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Abstract

Objectives: Patient-controlled epidural analgesia (PCEA) and continuous epidural infusion (CEI) are popular and effective methods for pain relief during labor; however, there are concerns about increasing rates of cesarean section (C/S) and instrumental delivery. This prospective study investigated the effect of PCEA and CEI with different formulas on labor and the mode of delivery in nulliparous women.

Materials and methods: A total of 480 nulliparous women were randomized into four groups, with 120 in each. Group A received a loading dose of 10 mL of 1 mg/mL ropivacaine with 2 µg/mL fentanyl, then an intermittent bolus of 5 mL with a background infusion of 5 mL/hour by PCEA. Group B received the same PCEA formula as Group A with 0.8 mg/mL bupivacaine. Group C received the same formula as Group A by CEI with 1 mg/mL ropivacaine at a rate of 10 mL/hour. Group D received the same formula as Group C with 0.8 mg/mL bupivacaine. The rates of C/S and instrumental delivery and the incidence of side effects were recorded.

Results: The rates of C/S were significantly different between Groups A and C, Groups A and D, and Groups B and D. The rates of instrumental delivery for normal spontaneous delivery were significantly different between Groups A and B, A and D, B and C, and C and D.

Conclusion: The C/S rate was higher in Groups C and D; however, the instrumental delivery rate was lower in Groups A and C. We conclude that PCEA with 1 mg/mL ropivacaine might provide the greatest benefit for labor analgesia.

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Introduction

Epidural analgesia is a popular and effective method for pain relief during labor [1–3]. Bupivacaine is a commonly used local anesthetic. Ropivacaine, an amino acid local anesthetic, is structurally related to bupivacaine but has less cardiac toxicity, less motor blockade, and a shorter duration than bupivacaine. It was recently introduced for labor analgesia [4–8]. However, local anesthetics have disadvantages such as maternal motor blockade and hypotension. Some studies have investigated the relative potency of ropivacaine and bupivacaine with or without opioids and the effects of motor and sensory blockade [9–14]. One study specifically addressed the mode of delivery with different epidural local anesthetics with regard to obstetric outcomes but did not find a difference between groups [15]. However, no study simultaneously evaluated the overall rates of cesarean and instrumental delivery in nulliparous women who received continuous epidural infusion (CEI) or patient-controlled epidural analgesia (PCEA) with bupivacaine or ropivacaine [16–19]. We might reasonably hypothesize that different epidural infusion channels with different local anesthetics could influence the mode of delivery. The primary purpose of this study was to compare the mode of delivery in nulliparous women receiving bupivacaine or ropivacaine for labor epidural analgesia. The incidence of side effects was also assessed.

Materials and methods

This is a prospective, randomized study to analyze American Society of Anesthesiology I or II nulliparous women at term labor...
using ropivacaine or bupivacaine with either PCEA or CEI at the National Taiwan University Hospital from 2005 to 2006. The protocol was approved by the National Taiwan University Hospital Institutional Review Board and written informed consent was obtained from each patient before the onset of labor pain. Exclusion criteria were multiparous women, contraindications for epidural analgesia, drug or alcohol abuse, known fetal abnormality, maternal obstetric complications (placenta previa and antepartum hemorrhage), previous uterine surgery, ineffective epidural labor analgesia [Verbal Pain Scale (VPS) \( \geq 4 \) after an epidural loading dose of 15 mL of the study regimen] and incomplete epidural labor analgesia (epidural analgesia duration <2 hours). All recruited women were in active labor with cervical dilation of 3–5 cm with regular uterine contractions, and none received parenteral opioids before epidural infusion. For randomization, patients blindly picked a sealed envelope which contained a group number. Group A received a loading dose of 10 mL 1 mg/mL ropivacaine with 2 μg/mL fentanyl, then an intermittent bolus dose of 5 mL with a background infusion rate at 5 mL/hour by PCEA. Group B received a loading dose of 10 mL 0.8 mg/mL bupivacaine with 2 μg/mL fentanyl, then an intermittent bolus dose of 5 mL with a background infusion rate at 5 mL/hour by PCEA. Group C received the same loading dose as Group A, followed by a continuous infusion dose of 1 mg/mL ropivacaine with 2 μg/mL fentanyl at 10 mL/hour. Group D received the same loading dose as Group B, followed by a continuous infusion dose of 0.8 mg/mL bupivacaine with 2 μg/mL fentanyl at 10 mL/hour.

Epidural analgesia was initiated after the women received 10–15 mL/kg crystalloid solution. The randomization sequence was generated by a table of random numbers. The results of randomization were sealed in an envelope and opened by a nurse not participating in the study. With the patient in the left lateral position, an epidural catheter was inserted at the L3–4 lumbar region using the loss of resistance technique; 3–4 cm of catheter was left...
in the epidural space. A test dose of 5 mL 1% lidocaine with epinephrine was administered through the epidural catheter. After 5 minutes of observation, the analgesia was started as described earlier in the four groups. If any patient in any group still complained of labor pain (VPS ≥ 4) after the first loading dose, another bolus of 5 mL of the study formula was provided. A patient would be excluded if labor pain (VPS ≥ 4) persisted after administration of a 15-mL loading dose from the study regimen.

We recorded and analyzed the rates of cesarean section (C/S) and normal spontaneous delivery (NSD) with and without instrument assistance, and also analyzed operative deliveries (NSD with instrument assistance and C/S) as the predefined primary study outcome. Vacuum delivery was used in operative vaginal delivery at our hospital throughout the study. Indications for vacuum use were limited to inadequate voluntary pushing, maternal intolerance due to health condition, dystonia without a contracted pelvis, and problems identified on the fetal heart rate tracing, regardless of the pain relief. Inadequate voluntary pushing was diagnosed at the bedside as a lack of descent due to inadequate maternal expulsive efforts [20]. Decisions about delivery methods were made by experienced obstetricians who did not know the study formula. There were no dramatic personnel changes among the supervisory obstetricians during the study period. During the labor analgesic period, complications such as nausea or vomiting, motor power weakness, central-type pruritus, urinary retention with catheterization and drowsiness were also recorded as the prede

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patient demographics.</th>
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<tbody>
<tr>
<td>Group</td>
<td>A</td>
</tr>
<tr>
<td>Number</td>
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</tr>
<tr>
<td>Age</td>
<td>30.17 ± 2.47</td>
</tr>
<tr>
<td>Height</td>
<td>159.32 ± 2.76</td>
</tr>
<tr>
<td>Weight</td>
<td>64.13 ± 4.16</td>
</tr>
<tr>
<td>BMI</td>
<td>25.26 ± 1.36</td>
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</table>

*BMI – body mass index.

Table 2 | Mode of delivery and analgesic groups.
| Mode of delivery | A | B | C | D |
| Cesarean section | 18 (15.0%) | 20 (16.7%) | 32 (26.7%)* | 34 (28.3%)* *** |
| NSD with instrument*** | 15 (12.5%) | 27 (22.5%)* | 17 (14.2%) | 29 (24.2%)* *** |
| Operative (cesarean + NSD with instrument)* | 33 (27.5%) | 47 (39.2%) | 49 (40.8%)* | 63 (52.5%)* |
| NSD without instrument*** | 87 (72.5%) | 73 (60.8%) | 71 (59.2%)* | 57 (47.5%)* *** |

*Statistical significance compared with Group A, p < 0.05.
**Statistical significance compared with Group B, p < 0.05.
***Statistical significance between Groups A + C and B + D, p < 0.05.
****Statistical significance compared with Group C, p < 0.05.
NSD – normal spontaneous delivery.

Table 3 | Side effects.
| A | B | C | D |
| Nausea or vomiting | 21 (17.5%) | 19 (15.8%) | 23 (19.2%) | 20 (16.7%) |
| Central-type pruritus | 74 (61.7%) | 70 (58.3%) | 68 (56.7%) | 66 (55.0%) |
| Urinary retention with catheterization | 8 (6.7%) | 10 (8.3%) | 18 (15.0%)* | 17 (14.2%)* |
| Drowsiness | 2 (1.7%) | 1 (0.8%) | 3 (2.5%) | 2 (1.7%) |
| Bromage grade ≥1 | 4 (3.3%) | 5 (4.2%) | 11 (9.2%) | 13 (10.8%)* |

*Statistical significance compared with Group A, p < 0.05.

Table 4 | Mode of delivery versus motor blockade.
<table>
<thead>
<tr>
<th>Mode of delivery</th>
<th>With/without motor blockade (Bromage grade ≥1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative delivery</td>
<td>4/29</td>
</tr>
<tr>
<td>C/S</td>
<td>3/15</td>
</tr>
<tr>
<td>NSD with instrument</td>
<td>1/14</td>
</tr>
<tr>
<td>NSD without instrument</td>
<td>0/87</td>
</tr>
</tbody>
</table>

There were statistical significant differences between mode of delivery in each group (p < 0.05). However, there was no statistical significant difference between groups. C/S – cesarean section; NSD – normal spontaneous delivery.

Results

We recruited 506 women into the study and excluded 26 women, mostly because of ineffective or incomplete analgesia. Each group contained 120 women. The randomization process is presented in Fig. 1. Patient demographic data are shown in Table 1. There were similar distributions of ages and weights between these four groups. The overall C/S rate (26.7%) was significantly higher in patients receiving CEI in Group C than those receiving PCEA in Group A (15.0%, p = 0.02); the C/S rate in Group D (28.3%) was also higher than in Group A (15.0%, p = 0.012) and Group B (16.7%, p = 0.030). However, there was no significant difference between Groups A and B, or Groups C and D.

The rate of NSD with instrument assistance in Group B (22.5%) was significantly higher than in Group A (12.5%, p = 0.04), while that in Group D (24.2%) was higher than in Group C (14.2%, p = 0.049). In addition, there was a significant difference between Groups A and D (p = 0.019). Group A (72.5%) had a higher rate of NSD without instruments than Group B with PCEA with bupivacaine/fentanyl (60.8%, p = 0.05), Group C with CEI with ropivacaine/fentanyl (59.2%, p = 0.029), and Group D with CEI with bupivacaine/fentanyl (47.5%, p < 0.001). Table 2 shows the modes of delivery in the groups.

Urinary retention with catheterization was significantly different between Groups A and C (p = 0.037), and Groups A and D (p = 0.05). There was no significant difference in nausea or vomiting, central-type pruritus, and drowsiness. The rate of motor weakness with Bromage grade 1 or above was similar in the groups except for Group D, which was significantly higher than Group A. Table 3 shows the side effects in the groups.

An analysis of motor blockade and the mode of delivery showed that those with operative deliveries had a higher Bromage grade (≥1) than those with NSD without instruments in each group (p < 0.05). However, there were no significant differences in the operative rate and motor blockade between groups (Table 4).
Discussion

Many published reports have compared the clinical efficacy of ropivacaine and bupivacaine under CEI or PCEA for labor analgesia [6,7,9,10,12,17,21–24]. Some studied the clinical impact on the labor course or analgesia with equivalent doses of ropivacaine and bupivacaine with or without opioids [9,10,21,22]. Others tried to elucidate the differences between epidural ropivacaine and bupivacaine on sensory and motor blockade using VPS and modified Bromage scores [6,7,23]. It is well-known that motor block, the chief complication of labor epidural analgesia, might result in prolonged labor and increase the rates of C/S and instrument-assisted delivery [25–28]. Nevertheless, we found no study that simultaneously compared the delivery mode for nulliparous women using PCEA and CEI with different epidural formulas. We therefore prospectively studied the difference among these four different epidural labor analgesia formulas.

In previous studies, the analgesic potency ratio between ropivacaine and bupivacaine was estimated to be 0.6:1.0 [29,30]. Motor blockade with ropivacaine was 65–76% as potent as that with bupivacaine [31]. In our hospital, we combine bupivacaine with fentanyl for labor analgesia; however, the use of ropivacaine with fentanyl through PCEA or CEI for epidural labor analgesia was a completely new experience for us. We adopted the four epidural formulas used in this study from those in previous studies [12,13,17,22] and some conducted pilot studies.

In this study, we found that patients using PCEA (Groups A and B) had lower rates of C/S and operative delivery compared with those using CEI (Groups C and D). However, there were no statistically significant differences in the C/S rate between patients using ropivacaine and bupivacaine (Groups A and B and Groups C and D). From this information, we might infer that under effective epidural labor analgesia, PCEA might be better than CEI for epidural labor analgesia, when comparing the rates of C/S. The instrument-assisted delivery rate was higher in NSD patients using bupivacaine (Groups B and D) than ropivacaine (Groups A and C). This finding matched some previous studies on the influence of epidural analgesia with ropivacaine or bupivacaine (with/without opioids) on the delivery mode [7,19]. However, other studies [16,17,22,26,30] contrarily showed no significant difference in delivery modes with these two drugs. Furthermore, the rate of NSD without instruments was lower in patients receiving bupivacaine than ropivacaine, regardless of whether they used PCEA or CEI. Possibly, this is because bupivacaine has a more intense motor blockade and longer effective duration, although there was no significant correlation between motor blockade and the mode of delivery. In addition, the incidence of urinary catheterization was higher in patients with CEI regardless of which local anesthetic they used. CEI might cause more motor blockade than PCEA, which could give this result. CEI with bupivacaine for labor analgesia could significantly increase the rates of C/S and instrument assistance in nulliparous women, whereas the use of PCEA with ropivacaine may significantly decrease these rates.

In summary, we conclude that PCEA with ropivacaine could be the best epidural labor analgesia regimen for nulliparous women when considering the rates of C/S and instrument assistance. Nevertheless, before we make definitive conclusions, more data and variables should be collected to elucidate the influence of local anesthetics on the delivery mode.

References

[10] Owen MD, Thomas JA, Smith T, Harris LC, D’Angelo R. Ropivacaine 0.075% and bupivacaine 0.075% with fentanyl 2 microg/mL are equivalent for labor epidural analgesia. Anesth Analg 2002;94:79–83.