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Original Article

The application of DPE, CSEA, and EA in labor analgesia for nulliparous women and their impact on maternal and infant safety

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Abstract

This work compared the effects of dural puncture epidural (DPE), combined spinal epidural analgesia (CSEA) and epidural analgesia (EA) on labor analgesia for primiparae and their impacts on maternal and infant safety. A total of 204 primiparae in need of labor analgesia for vaginal delivery were allocated to DPE, CSEA and EA groups. At 10 min, 30 min and 1 h after analgesia, the DPE and CSEA groups showed lower VAS scores and quicker onset of action than EA group. There was no significant difference in the duration of analgesia and labor and fetal decelerations among the 3 groups. At 1 min and 5 min after childbirth, the neonatal Apgar scores showed no significant difference between the 3 groups. The Bromage scores of DPE and EA groups were lower than those of CSEA group. The incidence of pruritus, hypotension, and postpartum headache in DPE and EA groups were lower than those in CSEA group. To sum up, the efficacy of DPE in labor analgesia for primiparae is similar to that of CSEA, with no obvious effect on labor stage and neonatal Apgar score, no additional complications and less LLMB, pruritus, hypotension and postpartum headache.

Keywords: Primiparae, Labor analgesia, Dural puncture epidural, Combined spinal epidural analgesia, Epidural analgesia.

1. Introduction

The severe labor pain in primiparae, who lack experience, may prolong the duration of labor and increase physical consumption, thus changing the labor outcome. The primiparous psychological pressure caused by labor pain is one of the reasons behind the high cesarean section rate in primiparae [1]. Therefore, labor analgesia is of great significance in reducing labor pain, shortening the labor duration and improving the labor outcome. Nowadays, the methods for painless labor are relatively mature and widely used. It is generally believed that intraspinal block is the most effective way of labor analgesia, including epidural puncture of dural puncture epidural (DPE), combined spinal epidural analgesia (CSEA), epidural analgesia (EA) and others [2]. Among them, CSEA takes effect notably and quickly, but with high risks of adverse reactions, such as pruritus and fetal decelerations [3]. EA works with high safety and few adverse reactions, but its slow onset of action may cause incomplete anesthesia [4]. DPE is a new analgesic method, as puncturing through the dural with a spinal anesthesia needle to administer medications. It combines the advantages of CSEA and EA, with highly effective analgesia and reduced adverse reactions on maternal and neonatal, and may be more suitable for labor analgesia [5]. This study analyzed and compared the application effects of DPE, CSEA and EA in labor analgesia for primiparae and its impact on maternal and infant safety, and provided a reference for the subsequent improvement of labor analgesia in primiparae.

2. Materials and Methods

2.1. General information

A total of 204 primiparae in need of labor analgesia from March 2020 to February 2021 were selected and divided into DPE group, CSEA group and EA group using random number table. DPE group: age within 22-34 years old, mean age of 26.34±3.12 years old, prepregnant BMI 18.93-24.46 kg/m^2, mean prepregnant BMI 22.15±0.70 kg/m^2, pregnancy term 38-41 weeks, mean pregnancy term 39.21±0.42 weeks. All cases were classified according to American Society of Anesthesiologists (ASA) as [6]: I level (37 cases) and II level (31 cases). CSEA group: age within 23-32 years old, mean age of 26.11±2.97 years old, prepregnant BMI 19.43-24.75 kg/m^2, mean prepregnant BMI 22.06±0.67 kg/m^2, pregnancy term 38-40 weeks, mean pregnancy term 39.31±0.51 weeks. ASA levels: 35 cases of I level and 33 cases of II level. EA group: age within 24-33 years old, mean age of 25.96±2.57 years old,

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prepregnant BMI 19.27-24.88 kg/m^2, mean prepregnant BMI 21.98±0.72 kg/m^2, pregnancy term 37-41 weeks, mean pregnancy term 39.12±0.47 weeks. ASA levels: 38 cases of I level and 30 cases of II level. The general information of the 3 groups was statistically comparable (P > 0.05).

2.2. Inclusion criteria

(1) Full-term pregnancy;
(2) Ingleton in anterior position;
(3) Primiparae;
(4) Normal fetal movement and heart;
(5) Volunteered for trial of vaginal delivery.

2.3. Exclusion criteria

(1) Comorbidity and complications in pregnancy;
(2) Converted to cesarean section during labor;
(3) ASA grade > II level;
(4) Age > 35 years;
(5) Allergic to the drug used or with analgesic contraindications.

2.4. Allocation

The cervix was opened to 2 cm, and the puerperae who had no abnormality within 20 minutes of fetal heart monitoring and volunteered to request labor analgesia were sent to the anesthesia operation room of the delivery room for monitoring of blood pressure, heart rate, and electrocardiogram, and then the intraspinal block was performed for labor analgesia.

DPE group: The puerperae were treated with DPE for analgesia, punctured with 25G subarachnoid needle through the L2-L3 or L3-L4 intervertebral spaces. After successful puncture (cerebrospinal fluid outflow), the lumbar puncture needle was pulled out and the cranial epidural tube of 3-4 cm was placed. With no blood and cerebrospinal fluid in second drawing, 3 mL of 1.5% lidocaine (Shanxi Jinxin Shuanghe Pharmaceutical, H11022295) was injected. After 5 min, the anesthesia position was confirmed without total spinal anesthesia symptoms and anesthetic poisoning. Nine mL mixture [0.1% ropivacaine (Guangdong jiabo pharmaceutical, H20133178) + 0.4 μg/mL (Yichang, Chinese H20054171)] was injected. The puerperae were connected with PCA electronic infusion pump.

CSEA group: The puerperae were treated with CSEA for analgesia, punctured with 25G subarachnoid needle through the L2-L3 or L3-L4 intervertebral spaces. After successful puncture (cerebrospinal fluid outflow), 3μg sufentanil intravenousl citrate was injected into cavum subarachnoidale. The cranial epidural tube of 3-4 cm was placed. The puerperae were connected with PCA electronic infusion pump.

EA group: The puerperae were treated with EA for analgesia, performed with epidural puncture through the L3-L4 intervertebral spaces. The cranial epidural tube of 3-4 cm was placed. The puerperae were injected with 3 ml 1.5% Lidocaine and 5 min later injected with 9 ml mixture (same as DPE group). The puerperae were connected with PCA electronic infusion pump.

2.5. Outcome measures

Pain scale: At 10 min, 30 min and 1h after analgesia, Visual analogue scale (Visual analogue scale, VAS) [7] was used to assess maternal pain scale. VAS score ranges 0 -10 points, with 0 as no pain and 10 as unbearable.

(1) Degree of analgesia: The onset of action and maintenance of analgesia were recorded and compared between the 3 groups. Onset of action: The duration from analgesic administration to VAS score fell below 1. Maintenance time: The duration from analgesic administration to the end of the third stage of labor.

(2) Duration of labor: The duration of labor from the 3 groups were collected and compared.

Neonatal Apgar score [8]: At 1 min and 5 min after birth, the Apgar score of newborns was used to evaluate the degree of asphyxia. The full score was 10 points, including 5 items, with 2 points in each. It was generally considered 7-10 as normal.

Degree of lower limb motor block (LLMB): Thirty min after analgesic administration, the degree of LLMB was measured using the modified Bromage score scale [9], ranging 0-3, the higher score indicating the higher degree of block. 0: no LLMB; 1 point: unable to lift leg; 2: unable to bend knee; 3: unable to bend ankle.

(3) Complications: pruritus, hypotension, postpartum headache, fetal deceleration.

2.6. Statistical analysis

Data processing was performed using SPSS20.0 software, with data expressed as percentage form and x^2 used for test. The measurement data were tested with Shapiro-Wilk normality, with normal distributed measurement data expressed as $\bar{x} \pm s$. Comparisons between multiple groups were performed using a one-way ANOVA. Pairwise comparisons were performed using the LSD analysis. Non-normally distributed measurement data was expressed as median (interquartile) [M (P25, P75)]. Comparisons between multiple groups were tested using the Kruskal-Wallis H test. Pairwise comparisons were tested using the Pairwise Comparisons test. P <0.05 was considered to be statistically significant.

3. Results

3.1. Pain scale

Before analgesia, VAS scores were compared between

Table 1. The comparison of VAS scores before and 10 min, 30 min and 1 h after the analgesia between the 3 groups [M (P25, P75), score].

Group	Before	10 min	30 min	1 h
DPE (n = 68)	9.00 (8.00, 9.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	2.00 (2.00, 3.00)
CSEA (n = 68)	9.00 (8.00, 9.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	3.00 (2.00, 3.00)
EA (n = 68)	9.00 (8.00, 10.00)	1.00 (1.00, 1.00)[ab]	1.00 (1.00, 1.00)[ab]	3.00 (3.00, 3.00)[ab]
H	0.119	31.532	24.219	37.992
P	0.942	<0.001	<0.001	<0.001

a. P < 0.05 compared with the DPE group; b. P < 0.05 with the CSEA group.

the 3 groups without statistical significance (P > 0.05). At 10 min, 30 min and 1h after analgesia, VAS scores in DPE and CSEA groups were lower than that in the EA group with significant differences (P <0.05), but there was no significant difference between DPE and CSEA group (P > 0.05). The results are shown in Table 1.

3.2. Degree of analgesia

The onset of action of DPE and CSEA group was shorter than that of EA with significant difference (P < 0.05), but there was no significant difference between DPE and CSEA group (P > 0.05). The duration of analgesia had no significant difference between the 3 groups (P > 0.05). The results are shown in Table 2.

3.3. Duration of labor

The difference in the duration of labor between the 3 groups had no statistical significance (P > 0.05), as is shown in Table 3.

3.4. Neonatal Apgar scores

At 1 min and 5 min after birth, the neonatal Apgar scores were compared between the 3 groups. The results showed no significant difference, as shown in Table 4.

3.5. LLMB

The average Bromage score in the DPE group was 2.00 (1.00, 2.00) and EA group was 2.00 (1.00, 2.00), all lower than that of 2.00 (2.00, 3.00) in the CSEA group, with statistically significant difference (H = 59.508, P < 0.001), as shown in Table 5.

4. Discussion

In the process of labor, stress responses of puerpera may result from maternal vaginal expansion, uterine contractions, pelvic floor muscle compression and others. Especially for primiparae, who are in lack of labor experience and more likely to be nervous, the impact of labor pain on labor process and labor outcome may be expanded [10]. Therefore, it is more important to use reasonable labor analgesia to reduce pain, which is conducive to reducing the tension of primiparae, thus improving labor outcomes.

At present, the main methods of labor analgesia include DPE, CSEA and EA, among which CSEA works with notable effect and fast onset of action, but is also easy to cause complications [11]. EA shows efficacious effect,

Table 2. The comparison of analgesia degree between the 3 groups.

Group	Onset of action [M (P25, P75), min]	Duration ($\bar{x} \pm s$, min)
DPE (n = 68)	6.50(6.00, 7.00)	121.44±13.62
CSEA (n = 68)	6.00(6.00, 7.00)	118.46±12.94
EA (n = 68)	7.00(7.00, 8.00)[ab]	122.35±13.06
H/F value	H = 37.548	F = 1.619
P	<0.001	0.201

Table 3. The comparison of duration of labor between the 3 groups.

Group	First stage ($\bar{x} \pm s$, min)	Second stage ($\bar{x} \pm s$, min)	Third stage [M (P25, P75), min]
DPE (n = 68)	636.74±91.58	82.41±9.63	12.00(11.50, 13.00)
CSEA (n = 68)	642.57±88.53	81.65±8.93	12.00(11.00, 12.50)
EA (n = 68)	653.24±90.52	83.76±10.02	12.00(11.00, 13.00)
F/H value	F = 0.585	F = 0.859	H = 4.953
P	0.558	0.425	0.084

a. P < 0.05 compared with the DPE group; b. P < 0.05 with the CSEA group.

Table 4. The comparison of Apgar scores between the 3 groups [M (P25, P75), score].

Group	1 min	5 min
DPE (n = 68)	9.00 (9.00, 9.00)	9.00 (10.00, 10.00)
CSEA (n = 68)	9.00 (9.00, 9.00)	9.00 (10.00, 10.00)
EA (n = 68)	9.00 (9.00, 9.00)	9.00 (10.00, 10.00)
H	1.922	0.911
P	0.383	0.634

a. P < 0.05 compared with the DPE group; b. P < 0.05 with the CSEA group.

Table 5. The comparison of Bromage scores between the 3 groups [M (P25, P75), score].

Group	Bromage score
DPE (n = 68)	2.00 (1.00, 2.00)
CSEA (n = 68)	2.00 (1.00, 2.00)
EA (n = 68)	2.00 (2.00, 3.00)
H	59.508
P	< 0.001

relieves labor pain for puerperae with high safety and is more commonly used in labor analgesia. However, it has slow onset of action and is prone to cause perineal distending pain in the second stage of labor [12]. DPE is a modified analgesic method that has combined advantages of CSEA and EA [13]. Few studies were comparing the effects of these 3 analgesic methods on primiparae, which was, therefore, analyzed in our study. The results showed that after administration, DPE and CSEA groups had higher analgesic degrees and quicker onset of action than EA group, with no significant difference between them. The possible reason based on analysis is as follows: the separated epidural space may affect the anesthetic diffusion, causing incomplete diffusion and inefficient block and thus reducing the analgesic effect [14]. DPE injects anesthetics into the epidural space, which increases the lumen pressure, promotes the anesthetics to penetrate into the subarachnoid space through the puncture hole with a certain lumbar anesthesia effect and improves the analgesic effect [15]. Moreover, the lumbar anesthesia effect caused by the penetrating anesthetics accelerates the onset of action of analgesia [16]. Bakhet WZ et al [17] found that DPE was more effective in labor analgesia compared with EA. Our study found that there was no significant difference between the 3 groups in labor duration and neonatal Apgar score, indicating that the DPE technique had no significant effect on labor duration and neonates, which may be because the 3 analgesic methods were all effective in reducing maternal pain, so as to relieve the mental pressure and reduce physical consumption, making it smooth for the labor process [18]. Song Y et al [19] study confirmed that DPE has quick onset of action, with high safety and without side effects on labor duration and neonatal Apgar score, compared with traditional EA, which is consistent with our conclusion. Our results showed that DPE does not aggravate the degree of LLMB or increase the incidence rate of complications, compared with EA. The possible reason based on analysis is as follows: CSEA injects anesthetics directly in the subarachnoid space, which can easily cause pruritus hypotension, postpartum headache and other complications [20]. As a modified version of CSEA, DPE works by penetration through puncture hole on dural instead of direct injection into the subarachnoid space, thus reducing adverse effects such as complications [21]. Studies have confirmed that DPE has higher quality of block than EA and lower maternal and fetal side effects than CSEA, which is consistent with our study [22].

5. Conclusion

In conclusion, DPE achieved a balance between CSEA and EA, with the same result of labor analgesia for primiparae as CSEA, and no obvious effect on labor duration and neonatal Apgar score. It did not increase complications and compared with CSEA, it can reduce the degree of LLMB and incidence rate of pruritus, hypotension and postpartum headache.

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Conflict of interests

The author has no conflicts with any step of the article preparation.

Consent for publications

The author read and approved the final manuscript for publication.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Beijing Obstetrics and Gynecology Hospital. All participants provided written informed consent prior to enrollment in the study.

Availability of data and material

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Authors' contributions

KK conducted the experiments and wrote the paper; BY and GJ analyzed and organized the data; WY conceived, designed the study and revised the manuscript.

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