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Comparison of three neuraxial anesthesia approaches in parturient women with obesity and pregnancy-induced hypertension who underwent cesarean section

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Abstract

Objective: To compare the effectiveness of different approaches of neuraxial anesthesia in parturient women with obesity and pregnancy-induced hypertension (PIH) who undergo cesarean section (CS).

Methods: We retrospectively analyzed data from 108 parturient women with obesity and PIH who underwent CS. All women were divided into the following three groups according to the neuraxial anesthesia approach: spinal anesthesia (SA), epidural anesthesia (EA), and combined spinal–epidural anesthesia (CSE). Clinical variables were compared.

Results: The mean age of the patients was 27.3 ± 2.2 years. Women in the CSE group had a longer duration from puncture to surgery, smaller intraoperative change in mean arterial pressure, higher Apgar scores at 1 and 5 minutes, shorter surgery time, lower rates of nausea and vomiting, and lower rate of intraoperative hypotension compared with those in the SA and EA groups.

Conclusion: CSE takes longer to administer in parturient women with obesity and PIH who undergo CS compared with those who have SA or EA. However, CSE has several advantages over SA or EA, including a shorter surgery time, more stable intraoperative mean arterial pressure, lower rates of nausea, vomiting, and intraoperative hypotension, and better Apgar scores at 1 and 5 minutes.

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Introduction

The rate of obesity in the general population is increasing, particularly in women of childbearing age. In most developed countries, 14% to 20% of women of reproductive age are obese.[1] Obesity increases the risk of complications, such as pregnancy-induced hypertension (PIH), which can affect fetal and maternal outcomes.[2] Labor pain can lead to a dangerous rise in blood pressure, which can then result in cerebrovascular hemorrhage in parturient women with PIH. Concerns about possible serious complications during vaginal delivery complicate this process.[3] Additionally, because of the desire to complete delivery before the onset of complications, cesarean section (CS) is the first option for this population.

General anesthesia has a high chance of complications, such as a difficult intubation, rapid desaturation, greater chance of aspiration, and neonatal depression in elective CS.[4] Therefore, in the absence of contraindications, neuraxial anesthesia remains the gold standard for elective CS.[5]

Neuraxial anesthesia includes spinal anesthesia (SA), epidural anesthesia (EA), and combined spinal-epidural anesthesia (CSE). These three approaches are practiced in clinical situations for CS. However, there is no consensus on which modality is superior.[6,7] Furthermore, to the best of our knowledge, there is a lack of comparative studies of these different neuraxial anesthesia methods in parturient women with obesity and PIH who undergo CS. Therefore, this study aimed to compare the effectiveness of different approaches of neuraxial anesthesia in parturient women with obesity and PIH who undergo CS.

Patients and methods

Patients

The records of parturient women who received cesarean delivery between January 2012 and December 2020 were retrospectively analyzed. The inclusion criteria were as follows: neuraxial anesthesia, a normal singleton pregnancy with a gestational age of $\geq$37 weeks, confirmed diagnosis of PIH with a systolic blood pressure of $\geq$140 mmHg or a diastolic blood pressure of $\geq$90 mmHg occurring after 20 weeks of gestation, and a body mass index (BMI) of $\geq$30 kg/m^2 on the day before delivery.[8,9] Patients were excluded if they met the following criteria: emergency cesarean delivery, pregnancy with twins, use of general anesthesia, mean arterial pressure (MAP) of $<$70 mmHg upon presentation to the operating room, and incomplete medical records. All patients' details have been de-identified. All cases were handled by anesthesiologists and obstetricians with $>$5 years of clinical experience. This study was approved by the Clinical Ethics Committee of Ningbo Women and Children's Hospital (No. 2017-02, June 15, 2017). The patients provided written informed consent. The reporting of this

study conforms to the STROBE guidelines.[10]

Anesthesia approaches

Spinal anesthesia. SA was performed while the patient was in the lateral position. The L3–L4 or L2–L3 interspace in the midline was chosen for needle insertion. A single 2.5-mL injection of 0.5% ropivacaine was administered with a 25-gauge, 90-mm pencil-point needle after observing free flow of the cerebrospinal fluid. A T6–T8 dermatomal sensory level of analgesia was obtained.

Epidural anesthesia. EA was performed with the patient in the lateral position using a 16-gauge needle in the L1–L2 or L2–L3 intervertebral space. After aspiration, a test dose of 3 mL of 2% lidocaine plus 1/20 epinephrine was administered. If no epidural bleeding was detected, an additional dose of up to 14 mL of mixture was administered, and the target T6–T8 block height was obtained.

Combined spinal–epidural anesthesia. CSE was performed with the patients placed in the lateral position. A mixture of 1.5 mL of 1% ropivacaine and 0.5 mL of 10% glucose was injected into the subarachnoid space through the L2–L3 intervertebral space. An epidural catheter was inserted cephalically. The level of anesthesia was maintained between T6–T8. An additional 5 mL of 0.5% ropivacaine was administered via the epidural catheter if the surgery lasted longer than 2 hours.

Study design

All patients were divided into the SA, EA, and CSE groups according to different neuraxial anesthesia approaches. The demographics of the three groups were recorded, including the patient's age, BMI, gestational age, and MAP measured before anesthesia. Additionally, the following data were collected: the time from puncture to surgery; the change in intraoperative MAP; sedative use; intraoperative fluid infusion; the surgery time, Apgar scores at 1 and 5 minutes after birth; adverse events that comprised shivering, nausea, vomiting, paresthesia, radicular pain, backache, and headache after CS; and the maximum postoperative numerical rating scale score of the incision. Demographic, intraoperative, and postoperative data were compared among the three groups. An MAP of <70 mmHg or $>20\%$ decrease in systolic pressure from the initial value was defined as hypotension.

Statistical analysis

Continuous data are expressed as the mean $\pm$ standard deviation. The chi-square test was used to analyze categorical data. Analysis of variance was performed to compare continuous variables among the three groups. SPSS 17.0 (SPSS, Inc., Chicago, IL, USA) was used to perform statistical analyses, and statistical significance was set at $p < 0.05$.

Results

We included 108 parturient women in the study. The mean age of the patients was 27.3 ± 2.2 years, and the mean gestational age was 37.8 ± 0.9 weeks. There were 45, 32, and 31 patients in the SA, EA, and CSE groups, respectively. There were no significant differences in age, BMI, gestational age, or MAP between the groups (Table 1).

The rate of sedative use, intraoperative fluid infusion volume, rate of adverse events, maximum postoperative numerical rating scale score, and length of hospital stay were not significantly different between the groups (Table 2). However, women in the CSE group had a longer time from puncture to surgery ($p = 0.010$), a smaller intraoperative change in MAP ($p = 0.001$),

Table 1. Demography of the parturient women in the three groups.

Clinical data	SA group (n = 45)	EA group (n = 32)	CSE group (n = 31)	*F*	*p*
Age, years	27.1 ± 2.1	27.5 ± 2.2	27.6 ± 2.5	0.526	0.593
BMI, kg/m^2	31.2 ± 1.1	31.3 ± 1.3	31.7 ± 1.6	1.269	0.285
Gestational age, weeks	37.8 ± 0.9	37.7 ± 0.9	37.7 ± 0.9	0.086	0.918
MAP, mmHg	113.8 ± 3.9	114.1 ± 3.8	112.9 ± 3.7	0.794	0.455

Data are mean ± standard deviation.
SA, spinal anesthesia; EA, epidural anesthesia; CSE, combined spinal–epidural anesthesia; BMI, body mass index; MAP, mean arterial pressure.

Table 2. Comparison of intraoperative and postoperative data between the three groups.

Clinical data	SA group (n = 45)	EA group (n = 32)	CSE group (n = 31)	*F*	*p*
TPS, minutes	13.0 ± 2.3	13.7 ± 1.6	14.4 ± 1.7	4.838	0.010
Intraoperative change in MAP, mmHg	24.3 ± 1.8	23.3 ± 2.3	22.2 ± 3.1	7.100	0.001
Sedative use, n (%)	11 (24.4)	11 (34.4)	3 (9.7)	5.472	0.065
Intraoperative fluid infusion, mL	977.8 ± 183.2	953.1 ± 232.8	935.5 ± 249.7	0.356	0.702
Surgery time, minutes	52.2 ± 6.4	49.1 ± 7.8	46.1 ± 3.8	8.890	<.001
Apgar score					
1 minute	8.5 ± 0.7	8.6 ± 0.5	8.8 ± 0.5	3.300	0.041
5 minutes	9.5 ± 0.7	9.6 ± 0.5	9.8 ± 0.4	3.508	0.034
Intraoperative hypotension, n (%)	19 (42.2)	11 (34.4)	4 (12.9)	7.491	0.024
adverse events, n (%)					
Shivering	4 (8.9)	4 (12.5)	6 (19.4)	1.791	0.408
Nausea	20(44.4)	9 (28.1)	5 (16.1)	7.060	0.029
Vomiting	17 (37.8)	5 (15.6)	3 (9.7)	9.594	0.008
Paresthesia	6 (13.3)	8 (25.0)	7 (22.6)	1.898	0.387
Radicular pain	5 (11.1)	5 (15.6)	8 (25.8)	2.890	0.236
Backache	5 (11.1)	6 (18.8)	5 (16.1)	0.924	0.630
Headache	6 (13.3)	6 (18.8)	6 (19.4)	0.621	0.733
Maximum postoperative NRS score	3.9 ± 0.3	3.9 ± 0.3	3.8 ± 0.4	1.475	0.234

Data are mean ± standard deviation or n (%).
SA, spinal anesthesia; EA, epidural anesthesia; CSE, combined spinal–epidural anesthesia; TPS, time from puncture to surgery; MAP, mean arterial pressure; NRS, numerical rating scale.

higher Apgar scores at 1 and 5 minutes (both $p < 0.05$), and a shorter surgery time ($p < 0.001$) compared with those in the SA and EA groups. Additionally, women in the CSE group had lower rates of nausea ($p = 0.029$) and vomiting ($9p = 0.008$), and a lower rate of intraoperative hypotension ($p = 0.024$) compared with those in the SA and EA groups (Table 2).

Discussion

The rate of obesity in women of reproductive age has significantly increased since the 1980s.[11] Although the pathophysiology of PIH has not been fully determined, obesity is a risk factor for PIH.[1] PIH is an abnormality that causes considerable neonatal mortality and maternal complications.

PIH can cause placental hypofunction, fetal intrauterine growth retardation, and poor fetal tolerance to hypoxia. The temporary interruption of uteroplacental blood flow during uterine contractions aggravates the symptoms of fetal hypoxia and can easily lead to fetal death. CS rapidly removes the fetus from an adverse uterine environment, quickly alleviates fetal hypoxia, and effectively improves the fetal outcome. CS reduces the risk of neonatal death compared with vaginal delivery in parturient women with PIH.

The administration of general anesthesia in parturient women with PIH may cause an exaggerated hemodynamic response to endotracheal intubation, leading to an increase in catecholamines. This stress response can lead to cardiovascular decompensation, causing pulmonary edema, cerebral hemorrhage, and edema, thereby increasing morbidity and mortality in both the mother and fetus.[12] Additionally, neuraxial techniques are associated with better Apgar scores at 1 and 5 minutes compared with systemic opioids.[4] Therefore, neuraxial anesthetic techniques are preferable to general anesthesia for elective CS.

Neuraxial anesthesia for CS reduces serum catecholamine release and increases uteroplacental blood flow by decreasing uteroplacental resistance. The SA technique, which is widely used in CS, provides rapid anesthetic onset and requires a minimal amount of local anesthetic. In our study, the administration of SA took less time than that with EA or CSE, but SA provided the least hemodynamic stability. SA was also associated with intraoperative hypotension and the largest decrease in MAP. Hypotension is a frequent complication of SA in women undergoing CS, and it compromises the well-being of the mother and fetus, especially in obstetric patients with PIH.[13,14] This hypotension is believed to be due to the blockade of regional sympathetic activity, which results in reduced uteroplacental blood flow, and causes hypoxia and acidosis in the fetus.[15,16] Hypotension is also concerning because it can result in an increased incidence of nausea, vomiting, and fetal hypoxia. This problem is inherent to SA and is difficult to resolve. Alfan et al.[17] showed that, in obstetric patients with PIH who underwent CS, MAP was not significantly different by changing the method of anesthetic administration to SA (either fractioned dose injection or single-dose injection).

With regard to EA, the anesthetic dose of EA can be topped up during surgery as necessary. EA also provides extension and modification of the block level through an indwelling catheter while simultaneously maintaining hemodynamic stability.

Although CSE is a time-consuming technique compared with SA or EA, it offers rapid onset and better quality of anesthesia with the presence of an epidural catheter, allowing a top up for optimization and prolongation of the spinal block.[4] In our study, a more stable MAP was achieved during CSE compared with the other two anesthesia approaches, and only a small number of cases of vomiting and nausea was observed. Higher Apgar scores at 1 and 5 minutes were observed in neonates in the CSE group compared with those in the SA and EA groups. This finding can be explained by the smallest decrease in MAP during surgery in the CSE group, which resulted in reduced uteroplacental blood flow. Moreover, CSE was associated with the best fetal and neonatal status. Interestingly, our study showed that a significantly shorter surgery time was required in the CSE group because a better quality of anesthesia was attained, allowing obstetricians to rapidly operate in the presence of an epidural catheter.

Spinal epidural hematoma is a rare, but severe, complication of neuraxial anesthesia. PIH-induced preeclamptic parturient women are more frequently associated with underlying thrombocytopenia and coagulopathy.[18] Therefore, neuraxial anesthesia

should be avoided in this population, and evaluation of platelets and the activated partial thromboplastin time is necessary.

There are some limitations to our study. First, because of the retrospective nature and approach of this study, selection bias may have occurred because of the anesthesiologist's personal experiences. Second, the sample size was small. Therefore, prospective, randomized, controlled studies are required.

Conclusion

CSE takes longer to administer in parturient women with obesity and PIH who undergo CS compared with those who have SA or EA. However, CSE results in a shorter surgery time, more stable intraoperative MAP, less occurrence of nausea, vomiting, or intraoperative hypotension, and better Apgar scores at 1 and 5 minutes after birth compared with SA or EA.

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Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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