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Original Article

Preoperative measurement of maternal abdominal circumference relates the initial sensory block level of spinal anesthesia for cesarean section: An observational study

Chi-Hang Kuok [a, *], Chung-Hsin Huang [a], Pei-Shan Tsai [a], Yuan-Pi Ko [a], Wei-Shih Lee [a], Yung-Wei Hsu [b], Fang-Yu Hung [c]

[a] Department of Anesthesiology, Hsinchu Mackay Memorial Hospital, Hsinchu City, Taiwan
[b] Department of Anesthesiology, Mackay Memorial Hospital, Taipei City, Taiwan
[c] Department of Obstetrics and Gynecology, Hsinchu Mackay Memorial Hospital, Hsinchu City, Taiwan

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ABSTRACT

Objective: Lumbosacral cerebrospinal fluid volume is decreased as the enlarging uterus compresses the inferior vena cava during pregnancy. A subsequent greater cephalad spread of sensory blockade is observed. Gravid uterus plays a crucial role in affecting the spinal anesthesia level. We hypothesized that maternal abdominal circumference can reflect compressive effect of the uterus and investigated the relationship between abdominal circumference and the level of sensory blockade, and incidence of hypotension following spinal anesthesia with hyperbaric bupivacaine in term parturients.

Materials and Methods: Forty-two term parturients scheduled for elective cesarean section were studied. Abdominal circumference was measured before spinal anesthesia; 0.5% hyperbaric bupivacaine (2 mL, 2.2 mL, or 2.4 mL) was injected in to the subarachnoid space at the L3–L4 intervertebral level according to the parturient's height. The level of sensory blockade was assessed using an ice cube 1 minute, 5 minutes, 10 minutes, and 15 minutes after the spinal injection. The level of sensory blockade at the 15th minute was defined as the level of maximum sensory blockade. Statistical correlation coefficients were evaluated with Spearman's rank correlation.

Results: The correlation coefficient between the abdominal circumference and spinal level measured by cold sensation loss at 5 minutes after spinal anesthesia was significantly positive (right side $\rho = 0.43$, $p = 0.005$; left side $\rho = 0.46$, $p = 0.003$). No significant correlation was found between abdominal circumference and the level of maximum sensory blockade, the incidence of hypotension, ephedrine dosage, nausea, and vomiting after spinal anesthesia.

Conclusion: Parturients with greater abdominal circumference value have a higher level of sensory blockade at 5 minutes after spinal anesthesia. Abdominal circumference cannot predict the maximum sensory blockade level and the incidence of hypotension.

Introduction

Spinal anesthesia is widely used in parturients for cesarean section (C/S). Although it is considered a safe anesthetic method, nausea, vomiting, and hypotension are frequently reported after spinal anesthesia despite prehydration and left uterus displacement [1]. This is attributed to the greater aortocaval compression and greater cephalad spread of sensory blockade by an enlarged uterus [2,3]. Onuki et al [4] used magnetic resonance imaging and reported gestation-related reduction in cerebrospinal fluid (CSF) volume and dural sac surface area associated with the engorged veins in the epidural space [4]. Some studies also demonstrated a negative correlation between CSF volume and maximum sensory block level following spinal anesthesia with hyperbaric bupivacaine by magnetic resonance imaging in nonparturients [5,6]. Although a

* Corresponding author. Department of Anesthesiology, Hsinchu Mackay Memorial Hospital, Number 690, Section 2, Guangfu Road, Hsinchu City, Taiwan, ROC.
E-mail address: kuok5051@yahoo.com.tw (C.-H. Kuok).

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similar study has not been conducted in parturients, increased cephalad spread of local anesthetics has been reported in twin pregnancies compared with singleton pregnancies [7]. The speculated mechanism for this was that a larger gravid uterus caused greater engorgement of the epidural venous and resulted in a smaller CSF volume. Therefore, gravid uterus plays a crucial role in affecting the spinal anesthesia level for parturients.

Abdominal circumference (AC) correlates with intra-abdominal volume. Maternal AC increases during pregnancy, and it is influenced by fetus size, amniotic fluid, and uterus. These factors can have a compressive effect on the inferior vena cava (IVC) [8]. We hypothesized that maternal AC can reflect the degree of the compressive effect of an enlarged uterus, and we investigated the relationship between AC and the level of sensory blockade after spinal anesthesia. The secondary aims were to investigate the potential relationship between AC and the incidence of hypotension, nausea or vomiting, and the doses of ephedrine following spinal anesthesia with hyperbaric bupivacaine.

Materials and methods

After obtaining Mackay Memorial Hospital Institutional Review Board approval for this study, we obtained written informed consent from all participants. We prospectively enrolled 42 parturients with term pregnancy, with American Society of Anesthesiology physical status Class I or II, aged 20–40 years, and who were scheduled for elective C/S under spinal anesthesia. The exclusion criteria were obesity (body mass index > 30), multiple gestation, gestational diabetes mellitus, onset of labor, premature rupture of membrane, hemoglobin < 10 g/dL, any contraindication to neuraxial anesthesia, preeclampsia, pregnancy-induced hypertension, height of < 155 cm or > 170 cm, as well as history of spinal deformity or spinal surgery. All study participants were informed about the purpose of the study and the method used to measure the level of sensory blockade prior to anesthesia.

When the parturient arrived at the operating room, AC was measured by the same investigator while the patient was in the supine position. We measured the AC at the level of the umbilicus. These data were not revealed to the anesthetist, who was set to perform the spinal anesthesia later. Then standard monitors were installed, including an automated noninvasive blood pressure device, a pulse oximetry monitor, and an electrocardiography monitor. Baseline blood pressure and heart rate were recorded after an intravenous hydration of 1000 mL Lactated Ringer's solution over 15–20 minutes. After the hydration, we turned the parturient to the right lateral decubitus position on a horizontal operating table for spinal anesthesia. Spinal anesthesia was performed by the same anesthetist in all patients using the median approach through the L3–L4 intervertebral space. A Quincke 27-gauge spinal needle (Becton Dickinson S.A., Madrid, Spain) was inserted with its bevel oriented parallel to the dural fibers and then rotated 90° to direct the bevel cephalad. Then, 0.5% hyperbaric bupivacaine was injected into the subarachnoid space. No other adjunct was added. The dose of bupivacaine was determined by the parturient's height. Thus, 0.5% hyperbaric bupivacaine (2.0 mL) was administered when the height was between 156 cm and 160 cm; 0.5% hyperbaric bupivacaine (2.2 mL) was administered when the height was between 161 cm and 165 cm; and 0.5% hyperbaric bupivacaine (2.4 mL) was administered when the height was between 166 cm and 170 cm. A similar clinical management was found in other studies [9–11]. After the spinal injection, the patients were immediately returned to the supine position. A left uterine displacement of about 15° was maintained by inserting a folded blanket placed under the patient's right hip. No attempt was made to influence the level of sensory blockade by manipulating the operating table.

The blood pressure was measured at 1-minute intervals for 5 minutes and then at 2-minute intervals for 10 minutes after the spinal injection. Hypotension was defined as a drop in systolic blood pressure to below 100 mmHg, or a decrease of more than 30% in the baseline mean arterial blood pressure (MAP). Intravenous ephedrine (8 mg) was administered when hypotension was noted. Intravenous atropine (0.4 mg) was given when the heart rate was less than 60 beats/min. We checked the right and left side level of cold sensation loss by using an ice cube at 1 minute, 5 minutes, 10 minutes, and 15 minutes after spinal anesthesia. The level of sensory blockade at 15 minutes after spinal injection was defined as the level of maximum sensory blockade. Loss of cold sensation was assessed by asking the patient to report when the cold stimulus appeared similar to a reference point (forehead skin). The stimulus was advanced in a cranial direction on the foot until a sensation similar to the forehead skin was perceived. The dermatomal level below the detected stimulus was recorded as the level of sensory blockade. We also recorded the doses of ephedrine given and the incidence of nausea and vomiting during 15 minutes after spinal anesthesia.

Statistical analysis

Given that no previous study examined the correlation between block height and AC, we used CSF volume to estimate the sample size instead. The sample size determination was based on the correlation coefficient of −0.69 between CSF volume and peak sensory block level reported by Higuchi et al [5]. Given a two-tailed alpha level (α) of 5% and a power of 95% ($\beta = 5\%$), the minimum required sample size was 22. To consider the possibility of attrition data, 20% of the sample size was added, resulting in a total of 27 participants. In this study, we enrolled a total of 42 parturients to study the relationship between AC and the level of sensory blockade and hypotension after spinal anesthesia.

The clinical characteristics of the study participants are presented as means and standard deviation for continuous variables or number and percentage for categorical variables. Statistical correlation coefficients were evaluated with Spearman's rank correlation for the spinal anesthesia level, hypotension, and the doses of ephedrine, nausea or vomiting, and maternal AC. The spinal anesthesia level was measured at several time points (1 minute, 5 minutes, 10 minutes, and 15 minutes) and in both sides for which inflation of Type I error might emerge. Therefore, we used Bonferroni adjustment to set the statistical significance to a more strict level ($0.05/8 = 0.0063$) when conducting analyses of the spinal anesthesia level. All data analyses were performed using SPSS 15 (SPSS Inc., Chicago, IL, USA).

Results

Data were collected at Hsinchu Mackay Memorial Hospital from January 2014 to June 2014 at the operating room. A total of 42 parturients were enrolled in the study. Two of them were excluded because of spinal anesthesia failure and subsequently needed repeat spinal anesthesia. The demographic data of these 40 parturients are shown in Table 1. The mean AC was 98.4 ± 6.8 cm. The median level of sensory blockade by ice cube at 1 minute, 5 minutes, 10 minutes, and 15 minutes after spinal anesthesia are shown in Table 2. The correlation coefficients between the AC and the level of sensory blockade measured by using an ice cube were significantly positive at 5 minutes after spinal anesthesia (right side $\rho = 0.43$, $p = 0.005$; left side $\rho = 0.46$, $p = 0.003$; Table 3). The relationship is depicted in Figure 1. No correlation was found between AC and the level of maximum sensory blockade.