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Research article

Minimum effective volume of bupivacaine in spinal anesthesia for elective cesarean section. Does it differ with height? A non-randomized parallel study

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ABSTRACT

Background: Spinal anesthesia is the preferred anesthetic technique for elective Cesarean deliveries. Hypotension is the most common side-effect and has both maternal and neonatal consequences. This study aims to determine the minimum effective volume of hyperbaric bupivacaine 0.5% with fentanyl in 90% of parturients (MEV90) with different height groups undergoing cesarean section.

Patients and Methods: Parturients scheduled for elective cesarean section under spinal anesthesia were divided into 3 groups according to their height (ht), group 1 including those with height between 150 and 159 cm, group 2 with ht between 160 and 169 cm and group 3 patients with ht between 170 and 179 cm. The starting volumes were 2.5, 2.6 and 2.7 ml respectively. We identified 3 responses to the injected volume and the volume given to each parturient depends on the response of the previous one. Every patient was assessed for hemodynamics, degree of sensory and motor blocks.

Results: Demographically, all the groups were comparable. The study was completed after recruiting 201 patients. The MEV90 for group 1 was approximately 2.62 ml (95% CI, 2.59–2.65 ml), 2.76 ml for group 2 (95% CI, 2.73–2.77 ml) and 2.80 for group 3 (95% CI, 2.76–2.81 ml). None of the babies had an Apgar score below 7 at 1 and 5 min after birth in the 3 groups.

Conclusion: The volumes of hyperbaric 0.5% bupivacaine with fentanyl which produced effective spinal block in 90% of parturients undergoing cesarean deliveries were 2.62, 2.76 and 2.8 ml in the 3 different height groups respectively.

1. Introduction

Spinal anesthesia (SA) is popular for Cesarean section (CS) because of the ease, effectiveness, and rapidity. It is the preferred anesthetic technique for elective Cesarean deliveries. However, it is associated with some undesirable side effects like severe hypotension, respiratory distress, nausea, vomiting and delayed motor block recovery. These are common especially with higher doses of 0.5% hyperbaric bupivacaine. Hypotension is the most common side-effect and has both maternal and neonatal consequences [1].

The use of a lower dose aims to decrease maternal side-effects, reduce the time to discharge from the post- anesthesia care unit, and improve maternal satisfaction.

Low dose is associated with fewer adverse effects but lower anesthetic efficacy, such a strategy could compromise the adequacy of anesthesia, and require supplementary analgesia, with possible neonatal consequences and may require conversion to general anesthesia [2].

Effective surgical anesthesia is the primary objective of the spinal technique, it must be accomplished while minimizing maternal and neonatal side-effects. The volume of local anesthetic injected affects the extent and the level of the block. Over the past few years there was a substantial interest in determining the Minimum Effective Anesthetic Volume (MEAV) necessary to accomplish surgical anesthesia.

Also, clinical trials have confirmed that patient height is an important factor in determining the final block level [3,4].

The aim of this prospective study was to determine the minimum effective volume of hyperbaric bupivacaine 0.5% with fen-

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tanyl in 90% of parturients (MEV90) with different height groups undergoing cesarean section.

2. Patients and methods

This prospective, double-blind study was performed between January and October 2013, in Ain Shams University Hospital. After obtaining the local ethical committee approval and a written informed consent from all participating patients, we allocated parturients scheduled for elective cesarean section under spinal anesthesia to one of 3 groups according to their height (ht), group 1 including those with height between 150 and 159 cm, group 2 with ht between 160 and 169 cm and group 3 patients with ht between 170 and 179 cm. This is a non-randomized study in which the participants were allocated to the study groups according to their height. All the included parturients were ASA I or II having a singleton beyond 36 weeks' pregnancy.

We excluded all those with ht below 150 or above 179 cm, those with body mass index (BMI) above 30, with essential or pregnancy-induced hypertension, any neurological diseases, and those receiving any medications affecting the cardiovascular system. We also excluded those with polyhydramnios, multiple gestation, having fetus with congenital anomalies and those with any contraindication to spinal anesthesia.

Inside the induction room, a 16 G venous cannula was inserted under local anesthesia and according to our department protocols; 500 ml of hydroxyethyl starch (Voluven®) solution was given over 10 min to every female as a preload. All of them were premedicated with 1 mg of granisetron intravenously. In the operating theatre, standard monitors were applied in the form of 5 leads ECG, non-invasive blood pressure and pulse oximetry for SpO_2; baseline readings were recorded. All the procedures were done while the patient was in the sitting position. After sterilization of the back, the L3-4 intervertebral space was identified and local skin infiltration with lidocaine was done, failure to perform the procedure through this intervertebral space was a cause of patient exclusion from the study. Spinal anesthesia was performed using a 25-G Quincke spinal needle and after aspiration of 0.5 ml of CSF, the predetermined volume of local anesthetic was injected over 10 s. In all parturients, the volume injected is 0.5 ml (25 μg) fentanyl added to a certain volume of hyperbaric 0.5% bupivacaine (Marcaine Spinal Heavy; Astra Zeneca, Lund, Sweden) which is determined according to the response of the previous patient as will be discussed later. Then, the patient was immediately turned to supine position with a 15° left lateral tilt and a pillow below the patient's head and neck making an angle about 30° with the bed. Intraoperative fluids were given according to standard protocols.

Every patient was assessed for blood pressure, heart rate and SpO_2 every 2 min for 20 min. Any drop in the systolic blood pressure of more than 20% below the baseline or systolic blood pressure below 100 mmHg, provided that the patient is asymptomatic, was treated with 250 ml of hydroxyethyl starch (Voluven®) given under pressure and if there is no response within 5 min, increments of 6 mg of ephedrine were given intravenously. However, if the drop in blood pressure is associated with nausea, vomiting, sense of dizziness or dyspnea, ephedrine 6 mg is given along with the fluid bolus. Any ephedrine given was recorded. Also, any drop in the heart rate below 50/min was treated with atropine 1 mg intravenously. Oxygen mask at 8 l/min was given through face mask if SpO_2 drops below 95% or if there is a sense of respiratory distress.

Also, the upper level of sensory block, determined by the loss of cold sensation in the mid-clavicular line, was assessed bilaterally every 2 min together with the time needed to reach the T4 dermatome bilaterally. Failure to reach this level 10 min after the spinal injection necessitates the assessor to make a 10° head down tilt. Surgical incision was allowed only when the sensory block reaches the T4 level. Any sense of discomfort or pain during surgery was managed with increments of 25 μg of fentanyl intravenously up to 100 μg together with increments of 1 mg of midazolam up to 3 mg. In case of failure of these maneuvers, general anesthesia was given.

The degree of motor block using the Bromage scale (see Table 1) every 2 min and the time needed to reach grade 3 were assessed.

According to the observed blood pressure, heart rate, onset of sensory and motor blocks, the response to the volume injected was classified as either positive, negative or exaggerated. The criteria for each response are shown in Table 2.

Assessment was done by another anesthesiologist who was, along with the patient, blinded to the volume given.

After delivery of the baby, oxytocin infusion started, and the baby was assessed by Apgar score at 1 and 5 min post-delivery by the attending neonatologist.

In the recovery period, the patients were assessed hemodynamically and then followed up in their wards for the regain of sensory and motor functions.

2.1. Statistical analysis

The main goal of this study is to estimate the MEV90 of bupivacaine 0.5% and fentanyl given for spinal anesthesia for different height groups of parturients undergoing cesarean section. Volume assignment was carried out using a biased coin design (BCD) up-and-down sequential method (UDM) [6], where the volume given to each parturient depends on the response of the previous one. The starting volumes in groups 1, 2 and 3 were 2.5, 2.6 and 2.7 ml respectively. These starting volumes were based on our routine clinical practice. Subsequent volumes given were based on the response of the previous patient. In case of negative response, the next subject received a higher volume (defined as the previous volume with an increment of 0.06 mL). These fractions of the milliliter were prepared by an insulin syringe.

Table 1
Description of the Bromage score [5].

Grade	Criteria	Degree of block
I	Free movement of legs and feet	Nil (0%)
II	Just able to flex knees with free movement of feet	Partial (33%)
III	Unable to flex knees, but with free movement of feet	Almost complete (66%)
IV	Unable to move legs or feet	Complete (100%)

Table 2
Criteria for each response.

Negative response:
1. Failure to reach T4 sensory level or Bromage grade III or both within 10 min
2. The need to 10° head down tilt
3. The need to fentanyl supplementation
4. Conversion to general anesthesia

Positive response:
1. T4 sensory block and Bromage grade III within 10 min
2. No need to change table position
3. No hypotension or hypotension corrected with fluids only
4. No medications were needed (atropine, ephedrine, fentanyl)

Exaggerated response:
1. Sense of nausea or vomiting
2. Ephedrine was needed to correct hypotension
3. Atropine given to treat bradycardia
4. Need for O_2 or sense of respiratory distress