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Effect of position on maternal haemodynamics during elective caesarean delivery under spinal anaesthesia

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Abstract

Background. Spinal anaesthesia for caesarean delivery is frequently associated with adverse effects such as maternal hypotension and bradycardia. Patient position has variable effects on the incidence of hypotension after spinal anaesthesia. We studied the effect of three different postures for spinal anaesthesia on the haemodynamic response and side effects following spinal anaesthesia in healthy ASA I pregnant women undergoing elective caesarean delivery. The primary outcome hypotension was defined as a systolic blood pressure < 75% of baseline. ***Methods.*** This study included 195 parturient randomly allocated into three groups (n = 65): the sitting position (SP), right lateral decubitus (RLDP) and left lateral decubitus position (LLDP). Demographic, obstetric, intraoperative timing and anaesthetic variables were assessed at 16 time points. Anaesthetic variables assessed included blood pressure, heart rate, oxygen saturation, nausea, vomiting, electrocardiographic changes, skin flushing, discomfort or pruritus and vasopressor requirements. ***Results.*** The incidence of hypotension was 60.0%. There were no differences ($P = 0.09$) in the number of patients with hypotension: 33 patients (50.7%) in the SP, 39 patients (60.0%) in the LLDP and 45 patients (69.2%) in the RLDP. We found no differences in ephedrine ($P = 0.06$) or phenylephrine ($P = 0.07$) requirements and the number of patients with adverse effects. ***Conclusions.*** The spinal anaesthesia performed in the sitting position with hyperbaric bupivacaine and fentanyl does not influence on the incidence of arterial hypotension and requirements of ephedrine and phenylephrine or haemodynamic profile significantly different than the lateral decubitus positions. *Anestezjologia i Ratownictwo 2015; 9: 22-29.*

Keywords: position, spinal anaesthesia, hypotension, caesarean delivery

Background

Spinal anaesthesia is the most widely used anaesthetic technique for caesarean delivery. However, it is frequently associated with maternal hypotension that may be associated with maternal nausea and vomiting and in severe cases unconsciousness, pulmonary aspiration and placental hypoperfusion with foetal hypoxia, acidosis and neurologic injury.[1] Although there is no single definition for hypotension, most authors agree that hypotension is present when the systolic blood pressure (SBP) decreases below < 90-100 mmHg or when there is a reduction in SBP from baseline of < 20-30% [1,2]. The incidence of hypotension after spinal anaesthesia is 33% in non-obstetric patients [3] and approximately twice this rate in the obstetric population [1].

Several strategies, including uterine displacement, lower legs compression, administration of fluids, vasopressors and ondansetron have been

used to decrease the occurrence of hypotension [1,4]; however none has been shown to eliminate the need to treat it. In contrast, patient position has had variable effects on the incidence of hypotension after spinal anaesthesia [5-7].

Regional anaesthesia may be conducted with the parturient in the sitting or lateral position. In this study, we evaluated the effect of three different postures for spinal anaesthesia (the sitting position, right lateral decubitus and left lateral decubitus position) on the haemodynamic response and side effects following spinal anaesthesia in healthy ASA I pregnant women (American Society of Anesthesiologists physical status classification system category I, healthy person) undergoing elective caesarean delivery. The primary outcome hypotension was defined as a systolic blood pressure < 75% of baseline. We selected this definition because we believe it is the most accurate way to establish the existence of real arterial hypotension. SBP of 90-100 mmHg could be normal values in some women, so we preferred to individualise the criteria for every woman, according to her own characteristics. The SBP reduction of 20-30% from baseline has been described previously as maternal hypotension [1,2]. We used the mean value of both accepted limits; a fall of 25%, so, the definition of hypotension in this study is a SBP < 75% of baseline.

Methods

After institutional ethical committee approval, 252 ASA I women scheduled for lower segment caesarean delivery under spinal anaesthesia were assessed for elegibility during anaesthesia consultation or early in the third trimester. Written informed consent was obtained from all patients to participate in this study. Exclusion criteria (57 women were excluded) included refusal to participate, contraindication to spinal anaesthesia, age < 20 or > 45 years, obesity (body mass index (BMI) at term > 30 kg/m^2), ASA ≥ 2 and previous fluid therapy.

Women included in the study (n = 195) were fasted for eight hours before surgery. They did not receive premedication. Peripheral venous access was secured with an 18-gauge cannula. Ten minutes after arrival in the operating room, baseline values for oxygen saturation, electrocardiography and non-invasive blood pressure were recorded in the supine position with 15 degrees left tilt. These were considered the baseline data.

Women were previously randomly allocated by our Statistical Department into three groups according to the position during spinal anaesthesia.

Spinal anaesthesia was induced at the L3-4 or L4-5 interspace, with a 27-gauge Whitacre (Braun, Germany) needle in the sitting position (group SP), right lateral decubitus position (group RLDP) or left lateral decubitus position (group LLDP). We administered 0.5% hyperbaric bupivacaine (Inibsa, Spain), according to the following formula: bupivacaine (mg) = height (cm) x 0.06, with fentanyl (Kern Pharma, Spain) 20 μg. Following injection, patients were immediately placed in supine with 15 degrees left tilt. All women were rapidly co-loaded with hydroxyethyl starch (Voluven®, Fresenius Kabi, Barcelona, Spain) 8 mL/kg.

Sensory block level growth was checking by assessing the perception of coldness using an alcohol swab, and motor block using the Bromage scale [8], both seven and 15 min after intrathecal injection.

Hypotension was defined as SBP < 75% of baseline [1,2] and in this case, treatment was initiated with intravenous ephedrine (Genfarma Laboratorios, Spain) 10 mg or phenylephrine (Dr. Carreras, Spain) 50 μg (if the maternal heart rate was > 95 beats/min, given over 30 s to avoid bradycardia). Intravenous atropine (Serra Pames, Spain) 0.01 mg/kg was administered if the maternal heart rate was < 45 beats/min.

The anaesthetist recorded demographic data (age, height, body mass index), obstetric data (indication for caesarean delivery, gestation, number of previous pregnancies, caesarean deliveries, uterine pathology), intraoperative timing (time from spinal anaesthesia to skin incision, time from skin incision to delivery, total time of the surgery) and anaesthetic variables, (SBP, diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), oxygen saturation (SaO_2), adverse effects (nausea, vomiting, electrocardiographic changes (arrhythmias, ST changes or ECG modifications compared to baseline), skin flushing, discomfort, pruritus) and the need for atropine, ephedrine or phenylephrine. Anaesthetic variables were recorded 1 minute before the selected position and the at 2 min intervals for 15 min and 5 min intervals for a further 30 min after intrathecal injection, as well as at the end of surgery (Figure 1).

Our protocol allowed the administration of intravenous acetaminophen (Fresenius Kabi, Spain) 1 g and supplementary doses of fentanyl (Kern Pharma, Spain) 50 μg (maximum of three doses) if the patient

felt pain during surgery. General anaesthesia could be administered if anaesthesia was still inadequate. The protocol dictated that women requiring supplementation analgesia were removed from the study.

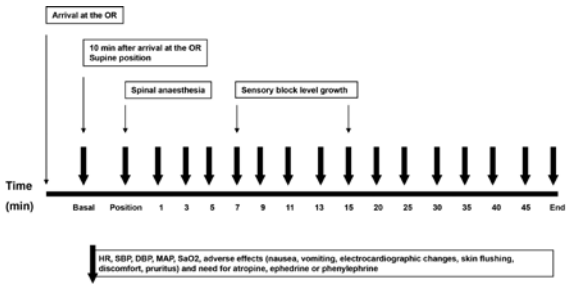


Figure 1. Flowchart of measures in time

Statistical analysis

Data were analysed using IBM SPSS 21 statistical software package (IBM, New York, USA). Comparison of means of independent samples was performed using ANOVA, followed by Dunnett's test for post hoc testing, and repeated measures ANOVA was used for paired data. Association between qualitative variables was performed using the chi-square test with Fisher's exact test where appropriate. Trends were studied with the chi-square for linear trend test. A P value < 0.05 was considered significant. Haemodynamic data (SBP, DBP, MAP, heart rate and oxygen saturation), were re-plotted using a format where all values were expressed as the correspondent percentage related to the baseline value (considered as 100%) to reveal a more discrete pattern of change so that each patient served as her own control.

Results

A total of 195 women were recruited into the study, 65 in each group. Demographic and anaesthetic data are presented in Tables I and II. No differences between groups were observed in obstetric data including gestational age, previous pregnancies and caesarean deliveries.

The incidence of maternal hypotension in this study was 60.0%. There were no differences (P = 0.09) in the number of patients with hypotension: 33 patients (50.7%) in the SP group, 39 patients (60.0%) in the LLDP group and 45 patients (69.2%) in the RLDP group. As a single patient could have more than one hypotensive episode, we analysed the percentage of time points with systolic hypotension: these were 17.7% in the SP group and 18.8% and 12.0% in the RLDP and LLDP groups, respectively. These differences were not statistically significant (P = 0.3).

Maternal arterial pressures (SBP, MAP and DBP) are shown in Figure 2. We found differences in SBP at position for spinal anaesthesia, 1 min and 3 min (P = 0.004, P = 0.01 and P = 0.002 respectively) for group SP *vs.* RLDP and SP *vs.* LLDP. We also found differences in DBP at position for spinal anaesthesia, 1 min and 3 min (P = 0.01, P = 0.03 and P = 0.02

Table I. Demographic data

	SP (n = 65)	RLDP (n = 65)	LLDP (n = 65)	*P* value
Age (years)	35.5 ± 5.0	34.7 ± 5.1	34.6 ± 5.5	0.54
Weight (kg)	75.6 ± 11.4	73.7 ± 13.7	75.4 ± 11.3	0.61
Height (cm)	161.8 ± 5.8	160.9 ± 7.0	162.2 ± 6.2	0.51
Body mass index (kg/m^2)	28.9 ± 4.6	28.4 ± 5.2	28.6 ± 3.9	0.84

Data are mean ± SD

Table II. Anaesthetic and obstetric data

	SP (n = 65)	RLDP (n = 65)	LLDP (n = 65)	*P* value
Dural puncture to skin incision (min)	10.3 ±2.5	9.0 ± 2.3	9.5 ± 2.7	0.008
Skin incision to foetal extraction (min)	11.8 ± 3.5	10.8 ± 4.2	11.9 ± 5.3	0.25
Total time (min)	48.9 ± 10.2	49.0 ± 11.2	49.9 ± 11.3	0.85
Sensory block height 15 min after intrathecal injection T3-4 T5-6	 44 (67.7%) 21 (32.3%)	 49 (75.4%) 16 (24.6%)	 47 (72.3%) 18 (27.7%)	0.61

Data are mean ± SD or number (%)

respectively) comparing group SP *vs.* LLDP and MAP ($P = 0.007$, $P = 0.01$ and $P = 0.006$ respectively) for group SP *vs.* RLDP and SP *vs.* LLDP. There were no differences between groups in HR and SaO_2 values.

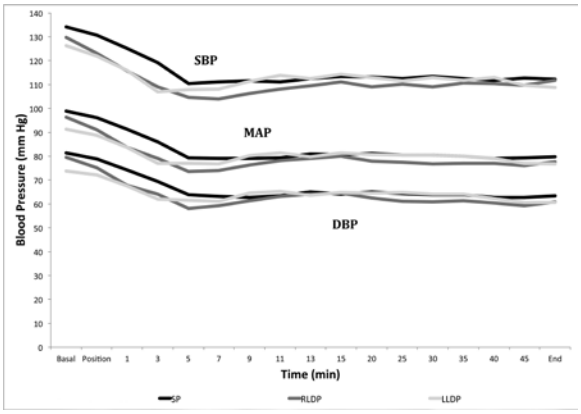


Figure 2. Maternal brachial arterial blood pressure

Differences between groups were observed between groups SD and LLDP in the variation of SBP (Figure 3), DBP and MAP (Figure 4) from baseline: SBP at 11 min ($P = 0.01$), 15 min ($P = 0.02$), and 40 min ($P = 0.005$), the variation of DBP at 9 min ($P = 0.002$), 11 min ($P = 0.002$), 15 min ($P = 0.002$), 20 min (P = 0.01), 25 min (P = 0.006), 30 min (P = 0.007), 35 min (P = 0.008) and 40 min (P = 0.03) and also in the variation of MAP at 9 min ($P = 0.009$), 11 min ($P = 0.002$), 13 min ($P = 0.04$), 15 min ($P = 0.002$), 20 min (P = 0.01), 25 min (P = 0.007), 30 min (P = 0.007), 35 min (P = 0.01) and 40 min (P = 0.007). There were no differences between groups in the variations from baseline of HR and SaO_2.

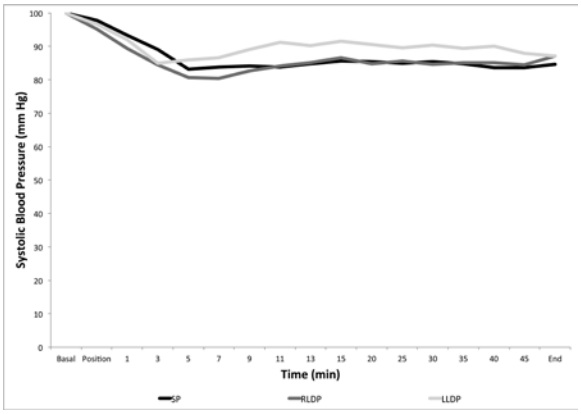


Figure 3. Variation in systolic blood pressure compared to baseline

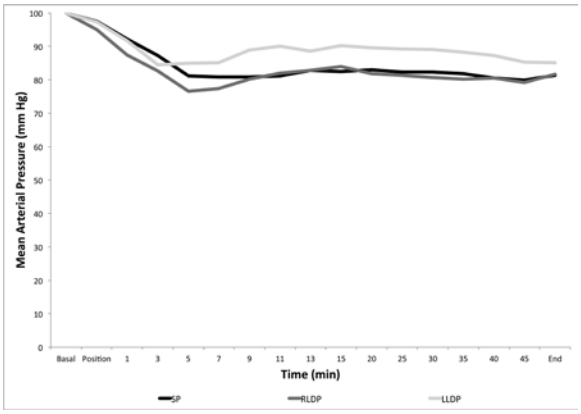


Figure 4. Variation in mean blood pressure compared to baseline

We found no differences between groups in the number of patients requiring ephedrine ($P = 0.06$) or

Table III. Requirements of ephedrine and phenylephrine

	SP (n = 65)	RLDP (n = 65)	LLDP (n = 65)	*P* value
Ephedrine	21 (32.3%)	34 (52.3%)	29 (44.6%)	0.067
Phenylephrine	5 (7.7%)	9 (13.8%)	14 (21.5%)	0.078

Data are number (%)

Table IV. Adverse effects

	SP (n = 65)	RLDP (n = 65)	LLDP (n = 65)	*P* value
Electrocardiogram changes	0	0	1 (1.5%)	0.36
Nausea	7 (10.7%)	13 (20.0%)	17 (26.1%)	0.07
Vomiting	2 (3.0%)	5 (7.6%)	7 (10.7%)	0.23
Pruritus	0	1 (1.5%)	0	0.36
Skin flushing	6 (9.2%)	2 (3.0%)	5 (7.6%)	0.34
Discomfort	5 (7.6%)	10 (15.3%)	14 (21.5%)	0.08

Data are number (%)

phenylephrine ($P = 0.07$) (Table III). No atropine was needed. The lowest value of heart rate was 40 beats/min at 3 min in one patient in the LLDP group who also had hypotension (a fall of 27.8% from baseline SBP) and received ephedrine.

There were no differences between groups in the number of patients with adverse effects (Table IV).

Discussion

There are several factors that could influence the appropriate sensory nerve block and the incidence of hypotension in Caesarean deliveries. The effect of the position on haemodynamic has been previously reported. However, differences in the studies designs make difficult to achieve a general conclusion to establish the best position (Table V) [5-16]. We consider that the anaesthetic technique is the most important factor that might account for the difference between the studies, specially the local anaesthetic dose. Anaesthesia textbooks recommend bupivacaine in a dose of between 12 and 15 mg [17]. However, the use of this dose range has been associated with an incidence of maternal arterial hypotension of 69% to 80%, resulting in maternal and neonatal morbidity [18].

We propose a protocol close to the usual daily procedures: that is, to realize the spinal anaesthesia (with a standardised dose of bupivacaine plus fentanyl) and immediately lie down the parturient in the same position that is going to maintain during the surgery, avoiding unnecessary movements.

The preferred maternal posture for providing spinal anaesthesia varies among anaesthetists and lack of familiarity with certain maternal positions might influ-

Table V. Reported effect of position on haemodynamics in Caesarean delivery

Author	n	Tech	Dose	Position	Definition of hypotension	Result
Coppejans et al.[7]	60	CSE	H-BUP 6.6 mg + sufentanil 3.3 µg	SP, RLDP	SBP < 75% baseline or < 95 mm Hg	Incidence of ephedrine supplementation not different, but SP required less ephedrine
El-Hakeem et al.[5]	120	Spinal	H-BUP 10 mg + fentanyl 20 µg	SP (0 or 5 minutes)	SBP < 80% baseline or < 100 mm Hg	Sitting up for five minutes rather than laying down immediately decreased intraoperative ephedrine requirements
Gori et al.[8]	46	Spinal	Iso-LBUP 12.5 mg	SP (0 or 2 minutes)	SBP < 75% baseline or < 90 mm Hg	No significant difference in the incidence of ephedrine supplementation
Hallworth et al.[9]	150	Spinal	H-BUP, iso-BUP or h-BUP 10 mg	SP, RLDP	SBP < 80% baseline or < 90 mm Hg	Hypotension incidence and ephedrine use increased with decreasing baricity. h-BUP + SP had the most frequent incidence
Hartley et al.[10]	40	Spinal	H-BUP 10 mg + diamorphine 0.2 mg	supine, SP, LP	SBP < 80% baseline	No significant difference in maximum SBP fall or ephedrine requirement.
Hwang et al.[11]	86	Spinal	H-BUP 8 mg + fentanyl 15 µg	RLDP (0 or 6 minutes)	MAP < 80% baseline	No significant difference in the incidence of hypotension.
Jeon et al.[12]	66	Spinal	H-BUP 8 mg + fentanyl 15 µg	SP, RLP	SBP < 80% baseline	Preoperative positional blood pressure change is correlated with the decrease in SBP and ephedrine requirement
Law et al.[13]	60	Spinal	H-BUP 11 mg + fentanyl 15 µg	RLDP, LLDP	SBP < 80% baseline or < 100 mm Hg	No clinical difference between RL and LL positioning
Loubert et al.[14]	89	Spinal	H-BUP, iso-BUP or h-BUP 10 mg	SP (0 or 5 minutes)	SBP < 75% baseline or < 90 mm Hg	No statistical differences in hypotension
Rucklidge et al.[15]	100	CSE	H-BUP 12.5 mg with fentanyl 10 µg	SP, LLDP or Oxford (OP)	SBP < 80% baseline or SBP < 90 mm Hg	More hypotension or requirement for ephedrine (LLDP = OP) more than SP. OP has no advantage over the SP or LLDP
Yun et al.[6]	22	CSE	H-BUP 12 mg with fentanyl 10 µg	SP, lateral recumbent position	SBP < 70% baseline or SBP < 100 mm Hg	The severity and duration of hypotension were greater in the SP compared with the lateral decubitus position

Tech: Neuraxial technique

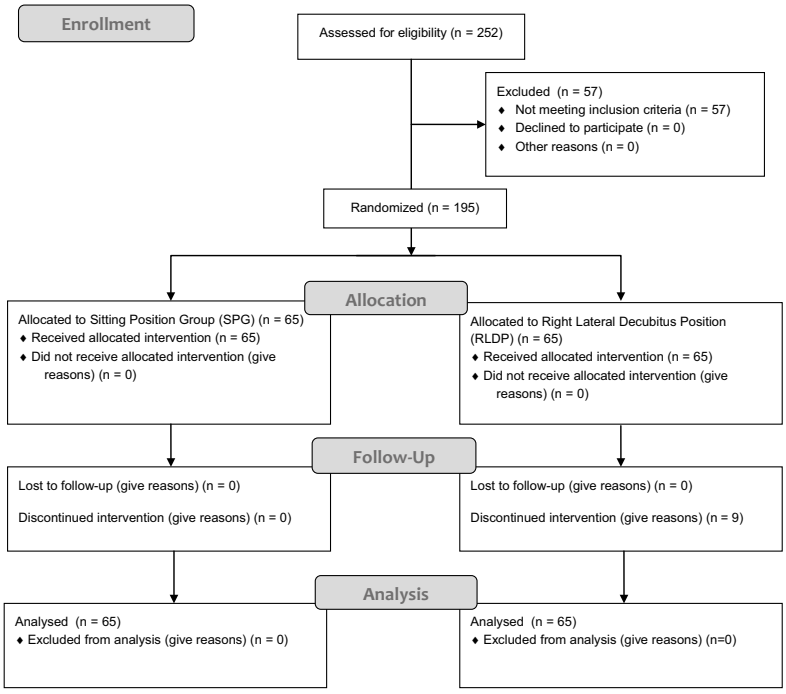
CSE: combined spinal-epidural anaesthesia.

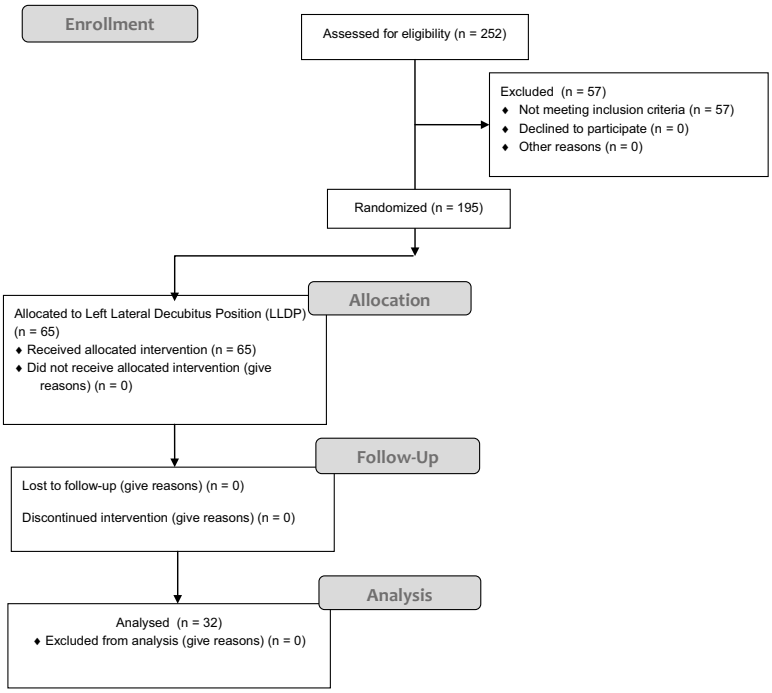
Dose: BUP (bupivacaine), LBUP (levobupivacaine), Iso (isobaric), H (hyperbaric), h (hypobaric).

Position: SP (sitting position), RLDP (right lateral decubitus position), LLDP (left lateral decubitus position).

Definition of hypotension: SBP (systolic blood pressure), MAP (mean arterial pressure).

CONSORT Flow Diagram





ence their performance. The majority of anaesthetists who took part in this study usually favoured the sitting position, possibly because it facilitates the technical aspects of performing a spinal anaesthesia by making the midline easier to identify [16]. However, all of them were experienced in providing spinal anaesthesia in both the lateral and sitting positions, so, their skills are not a factor that could influence on our results: 50.7% hypotension in the SP group, 60.0% in the LLDP group and 69.2% in the RLDP group ($P = 0.09$). We did not find a significant statistical difference but more patients in the lateral decubitus groups had arterial hypotension compared with the sitting position. The same happens with the requirements of ephedrine ($P = 0.06$) and phenylephrine ($P = 0.07$). So, after analysing other colleagues' reports [5,7-16] and our data (specially the evolution of SBP, DBP and MAP in the period of time from the 1st to 20th minutes) we prefer the sitting position for spinal anaesthesia in Caesarean deliveries, because it is easier for the anaesthetist to perform (with less patient's discomfort) and probably causes lower incidence of arterial hypotension than lateral decubitus positions. There is only one study [6] that described greater severity and duration of hypotension in the sitting position compared with the lateral decubitus position.

Other modified postures have also been studied such as the Oxford position [16] (left lateral position with a 3 litre inflatable bag under the shoulder and 3 pillows supporting the head) or the head elevated ramped position [19], without clear advantages over the sitting position.

The problem with the sitting position could be in case of combined spinal-epidural anaesthesia. After conventional spinal anaesthesia, parturient are immediately placed supine, but if we have problems with the epidural catheter placement there will be a delay in assuming the recumbent position, and this may increase the incidence of hypotension after intrathecal injection of the local anaesthetic. The results are quite different between the groups about this concern. Gori et al. [9] reported no significant difference in the incidence of ephedrine supplementation maintaining the sitting position for two minutes (isobaric levobupivacaine), Loubert et al. [15] described no statistical differences in hypotension with the sitting posture maintained for five minutes (hypobaric bupivacaine resulted in sensory block levels that were higher compared with isobaric and hyperbaric bupivacaine) whereas El-Hakeem et al. [5] found that sitting up for five minutes rather than lying down immediately decreased intraoperative ephedrine requirements (hyperbaric bupivacaine). So, we need further investigations about this.

In **conclusion**, we have not found statistical differences between the groups. The spinal anaesthesia performed in the sitting position with hyperbaric bupivacaine and fentanyl does not influence on the incidence of arterial hypotension and requirements of ephedrine and phenylephrine or haemodynamic profile significantly different than the lateral decubitus positions. However, the sitting position is easier for performing spinal anaesthesia and more comfortable for the parturient, so this posture might be the first choice for spinal anaesthesia in Caesarean deliveries.

Conflict of interest
None

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