Fluid preloading versus ephedrine in the management of spinal anesthesia-induced hypotension in parturients undergoing cesarean delivery: a comparative study

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Introduction and objectives
Spinal anesthesia-induced hypotension in parturients undergoing cesarean delivery is a very common complication that has detrimental effects on both the mother and the fetus. The objective of our study was to compare the two therapeutic modalities, fluid preloading and ephedrine, in the management of spinal anesthesia-induced hypotension in parturients undergoing elective cesarean delivery.

Patients and methods
A total of 50 ASA I–II parturient women who presented for cesarean section under spinal anesthesia were enrolled in this study. They were randomly assigned into two groups: the F group ($n = 25$) (the fluid preloading group), which received 15 ml/kg of lactated Ringer's solution 10 min before spinal anesthesia, and the E group ($n = 25$) (the ephedrine group), which received prophylactic 5 mg ephedrine first and second minute and 1 mg every minute until 15 min after the block. Hemodynamic variables and any postoperative complication were recorded.

Results
Demographic data and duration of procedures were comparable. Systolic blood pressure was generally higher in the E group than in the F group. However, the result was not statistically significant, except at 4 and 22 min after spinal anesthesia. Heart rate was higher in the E group than in the F group; however, it was not statistically significant. The incidence of hypotension and rescue boluses of ephedrine was significantly higher in the fluid group.

Conclusion
The use of ephedrine is superior to that of fluid preloading in maintaining blood pressure after spinal anesthesia in cesarean section.

Keywords:
cesarean section, ephedrine, fluid preloading, hypotension, spinal anesthesia

Introduction

Spinal anesthesia is usually induced in cesarean section because of its rapid onset, a dense neuraxial block, low risk of local anesthetic toxicity, and little transfer of drugs to the fetus. However, a higher incidence of hypotension is one of the drawbacks of this technique, with its incidence varying from 70 to 80% [1]. Intravenous administration of fluids, left lateral tilt, and strict monitoring of blood pressure at frequent periods are measures taken for decreasing the risk for hypotension to varying degrees [2]. However, none of these measures have been shown to be 100% effective [3].

Hypotension becomes exaggerated by a deficiency of intravascular volume adding to sympathetic block by spinal anesthesia. Traditionally, preloading of fluids was recommended for the prevention of hypotension after spinal anesthesia. Hypotension and intraoperative nausea and vomiting are two major complications during spinal anesthesia for cesarean section. It is suggested that hypotension leads to cerebral hypoperfusion along with brainstem ischemia and stimulation of vomiting center [4]. Moreover, there is hypoperfusion of the gut leading to the release of emetogenic substances like serotonin [5]. Hypotension is traditionally treated with ephedrine, which has a strong b-adrenergic and a weaker a-adrenergic effect [6].

In this prospective randomized controlled trial, we hypothesized that administration of a vasopressor – namely, ephedrine – can be more effective compared with fluid preload, during vasodilatation induced by spinal anesthesia, and that ephedrine may be more useful for preventing hypotension during spinal block for cesarean section.

Patients and methods

Following approval of ethics committee and after obtaining written informed consent, 50 patients with ASA physical status I–II aged 20–40 years scheduled for elective cesarean delivery under spinal anesthesia in the obstetric theater in Kasr Al-Aini Hospital during the period between October 2013 and August 2014 were included in this study. Patients with a history of cardiac, hepatic, and renal diseases, tachycardia, and hypertension treated with β-adrenergic blockers, α-2-adrenergic agonists, or a-methyldopa, or known allergy to the used drugs were excluded.

In the preparation room under local anesthesia, an intravenous 18-G cannula was inserted. On arrival at the operating room, continuous monitoring was carried out with ECG, noninvasive blood pressure evaluation and pulse oximetry. No premedication was given. The patients were randomly divided into two groups of 25 patients each using computer-generated random numbers: group F received crystalloid preloading (Ringer lactate 15 ml/kg) 10 min before the procedure, and group E received 15 ml/kg of Ringer lactate simultaneously with the block (coload) and prophylactic 5 mg ephedrine intravenously at the first and the second minute, and 1 mg every minute thereafter for 15 min after the block; all patients were positioned with a left lateral tilt.

Spinal anesthesia was induced in the sitting position under complete aseptic precautions, with 2 ml of heavy bupivacaine 0.5% with 25 μg fentanyl, and then the patient was placed supine with a left lateral tilt. Conscious level, sensory block, and motor block were assessed. Heart rate and systolic blood pressure (SBP) were measured noninvasively at 1 min after spinal anesthesia and then every 3 min for the first 30 min and every 5 min later on. O_2 saturation was monitored using pulse oximetry continuously and recorded every 30 min. The incidence of hypotension, which is defined as 20% reduction in the baseline value, was treated with boluses of 5 mg of ephedrine. Nausea and/or vomiting was treated with 10 mg metoclopramide intravenously whether or not related to hypotension corrected with ephedrine boluses alone. In both groups, all patients received 10 IU oxytocin in 500 ml lactated Ringer's solution. All patients were assessed postoperatively for heart rate, SBP, oxygen saturation, hypotension, nausea, and vomiting.

Statistical analysis

Obtained data were presented as mean ± SD or median and interquartile range (interquartile range) or count and percentage, as appropriate. Comparisons were made using Student's *t*-test, the χ^2-test, or analysis of variance according to type of variance.

Data were analyzed using computer package SPSS (version 20, 2012; SPSS Inc., Chicago, Illinois, USA) and Microsoft Excel 2013.

A *P* value of 0.05 or less was considered statistically significant.

Sample size was calculated based on a previous study. Assuming an α-error of 0.05 and power of study 80%, a minimum of 50 participants (25 in each arm) was calculated as the sample size.

Results

There was no statistically significant difference between the two groups as regards demographic data (age, weight, height, ASA physical status, and parity) and duration of anesthesia (Table 1).

SBP was higher in the E group than in the F group; however, the results were not statistically significant, except at 4 and 22 min after spinal anesthesia (Fig. 1).
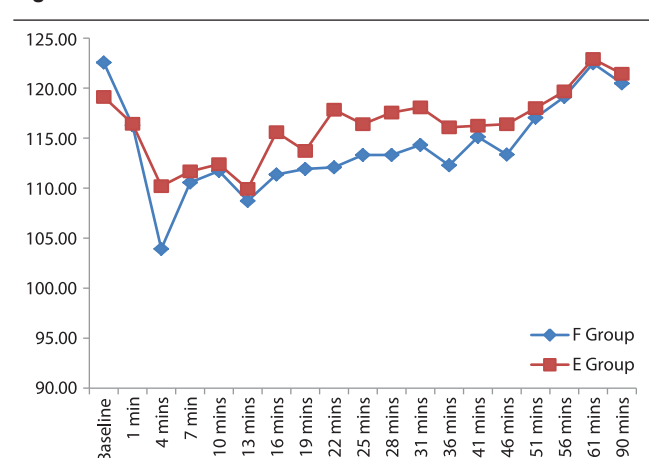
HR was higher in the E group than in the F group; however, it was not statistically significant (Fig. 2).

Table 1 Demographic data of patients included in the study

Variable	F group	E group	*P* value
Age	27 (20–39)	27 (20–40)	0.21
BMI	35.2 ± 1.7	35.3 ± 1.7	0.40
Height	162.7 ± 2.9	163.3 ± 3.7	0.24
Parity	2 (0–4)	1 (0–5)	0.44

Data are expressed as mean and SD or range.

Figure 1

Systolic blood pressure trends (data are presented as mean).

With regard to the incidence of complications, the incidence of hypotension was significantly higher in the F group than in the E group; the incidence of nausea and vomiting was higher in the F group than in the E group, but it was not statistically significant, and there were no chest symptoms in both groups (Fig. 3).

The number of boluses of ephedrine required to correct hypotension was significantly lower in the E group (the ephedrine group) than in the F group (the fluid preloading group) (Table 2). As regards oxygen saturation, there was no significant difference between the two groups.

Discussion

Spinal anesthesia is considered to be safe compared with general anesthesia for cesarean section. General anesthesia is associated with higher mortality rate in comparison with regional anesthesia. However, spinal anesthesia is not without risk. Hypotension during cesarean section under spinal anesthesia is very common, and if not prevented or treated it can induce complications for the mother and/or the fetus [7]. Intravenous preloading is the most popular nonpharmacological method to prevent spinal anesthesia-induced hypotension [7]. We found that the use of a low dose of ephedrine is associated with better control of maternal hypotension. Moreover, the incidence of nausea and vomiting was lower in the E

Table 2 Number of ephedrine boluses required to correct hypotension

Variable	F group	E group	P value
Number of boluses	0.6 ± 0.8	0.3 ± 0.54	0.046*

Data are presented as mean ± SD; *$P < 0.05$.

Figure 2

Mean heart rate trends against time (data are presented as mean).

group when compared with the F group; however, this was not statistically significant.

Gunusen *et al.* [8] tested the hypothesis that ephedrine infusion with crystalloid loading in spinal anesthesia could decrease hypotension and change neonatal outcome compared with fluid preloading. As regards the route of ephedrine administration, Rout and Rocke in their study on intramuscular ephedrine stated that it was difficult to predict both absorption and peak effect of intramuscular ephedrine and also observed reactive hypertension, particularly if spinal anesthesia was unsuccessful [9]. Prophylactic intravenous ephedrine administered either by means of infusion or bolus doses has been considered the gold standard for preventing hypotension for many years. The effect of an intravenous bolus of ephedrine on arterial pressure is transient and it lasts for only 10–15 min [10]. Therefore, we considered intravenous ephedrine to be able to prevent spinal anesthesia-induced hypotension and compared it with crystalloid preloading.

Bhovi and colleagues studied the efficacy of ephedrine in preventing hypotension in patients undergoing cesarean section under spinal anesthesia. A total of 100 female patients between 18 and 40 years of age undergoing elective cesarean section under spinal anesthesia were studied. They were randomly allocated to receive either ephedrine infusion (group A) or 20 ml/kg of Ringer's lactate solution as preloading solution before subarachnoid block (SAB) (group B). The incidence of hypotension was six of 50 (12%) in group A, and 30 of 50 (60%) in group B. The incidence of hypotension in the ephedrine group in this study was 12%, whereas in our study the incidence of hypotension in the ephedrine group was 24%. This difference may be due to the different doses of ephedrine used and the different volumes of infusion [11]. In contrast to
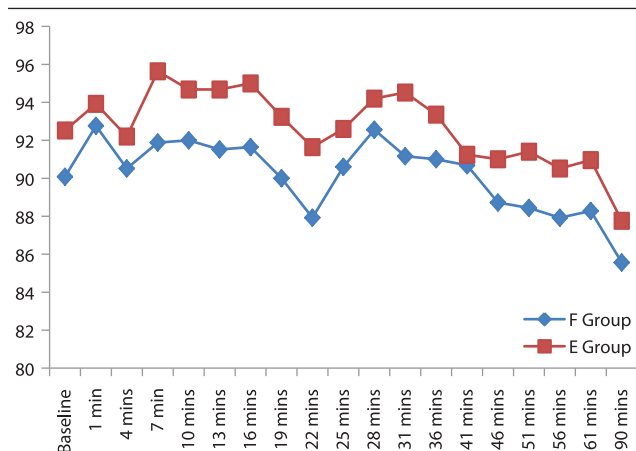
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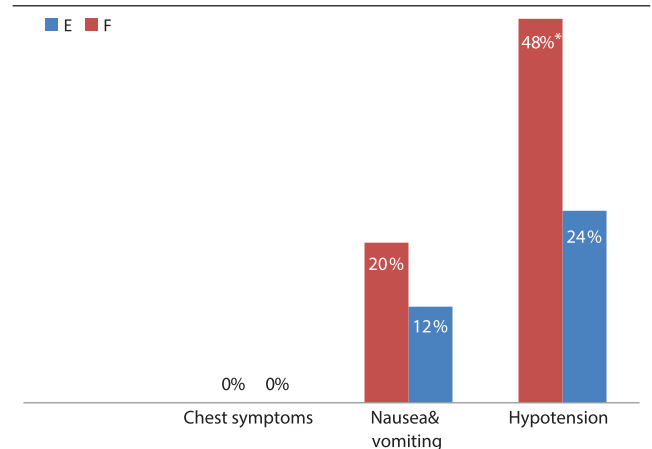
Incidence of complications (*statistically significant).

our study, Thiangtham and Asampinwat performed a concealed randomized study on 96 parturients who were divided into two groups: the study group received 18 mg of ephedrine (3 ml) added to 100 ml normal saline, and the control group received 103 ml of normal saline instead of ephedrine intravenous continuous infusion given over 10 min. All patients received preloading fluid with 20 ml/kg of lactated Ringer's solution 10 min before spinal block with 0.5% hyperbaric bupivacaine mixed with preservative-free morphine. The incidence of hypotension was 93.8% in the control group and 85.4% in the study group ($P = 0.181$), which was not statistically significant. This may be due to the small dose of ephedrine used and different infusion rate [12].

Conclusion

We concluded that ephedrine infusion is more effective compared with fluid preload in the prevention of hypotension due to spinal anesthesia for cesarean section without causing significant tachycardia or hypertension.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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