COMBINED USE OF CRYSTALLOID PRELOAD AND LOW DOSE SPINAL ANESTHESIA FOR PREVENTING HYPOTENSION IN SPINAL ANESTHESIA FOR CESAREAN DELIVERY: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Background and objective: Spinal anaesthesia for caesarean section is commonly associated with hypotension and crystalloid preload is widely recommended. Low-dose spinal appears to cause less hypotension. The aim of this study was to investigate whether the combined use of crystalloid preload and low dose spinal anaesthesia might further reduce the rates of hypotension.

Methods: Sixty-two patients were randomly assigned to two groups: crystalloid preload anaesthesia (P): received a rapid infusion of 20 mL/kg lactated Ringer's solution (LR), and no preload anaesthesia (N). The incidence of hypotension and the amount of ephedrine used to treat it were compared. Spinal anaesthesia was performed with 0.5% isobaric bupivacaine 7.5 mg and fentanyl 10 μg and morphine 100 μg.

Results: The incidence of hypotension was similar in the P and N groups. Same doses of ephedrine were required to treat hypotension in the two groups.

Conclusion: Crystalloid preload combined with low-dose spinal anaesthesia do not reduce the incidence of hypotension nor its severity.

Keywords: Pregnancy, Caesarean section, Spinal anesthesia, Hypotension/prevention and control, Fluid Therapy, Crystalloid solutions.

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Introduction

Spinal anesthesia is commonly used for elective cesarean delivery. Maternal hypotension is the commonest serious problem following spinal anesthesia for cesarean section, with an incidence up to 80%[1]. Maternal hypotension may compromise the welfare of both mother and fetus[2]. Over the last decades several interventions, such as pelvic tilt and the prophylactic administration of fluids or ephedrine, have been proposed to reduce the incidence of maternal hypotension. Nonetheless, maternal hypotension and its associated symptoms, nausea and vomiting still persist, despite many efforts to improve their treatment and prevention. Rapid administration of crystalloid solutions before spinal anesthesia has been recommended by many anesthesiologists to prevent hypotension[3]. Although controversy still exists, there is accumulating evidence that crystalloid solutions are particularly ineffective in preventing hypotension after extensive sympathetic blockade associated with spinal anesthesia[4,5].

Recently, some investigators have examined the introduction of low dose spinal anesthesia with a combination of small amounts of local anesthetics and opioids[6,7]. Nevertheless, maternal hypotension is not always preventable and the use of vasopressors is still frequently required[8].

The aim of this study was to investigate whether the combined use of crystalloid preload and low-dose spinal anesthesia would produce a further decrease on the incidence of hypotension and nausea and vomiting in parturients.

Methods:

After obtaining approval from our institutional review board for clinical study and written consent from the patients, we recruited 62 ASA physical status I and II women with term singleton pregnancies who underwent elective cesarean section under spinal anesthesia. We excluded patients with pre-existing or pregnancy-induced hypertension, those with cardiac, renal or other end-organ disease, patients in active labor, placenta praevia, and those with contraindications to neuraxial block. Also excluded were patients presenting for emergency delivery.

The parturients were randomly assigned to 2 groups using a sealed-envelope technique: crystalloid preload anesthesia (P group) and no preload anesthesia (N group).

Before performing regional anesthesia, an 18-gauge intravenous catheter was inserted. Standard monitors of electrocardiography (ECG), pulse oxymetry and non invasive blood pressure were monitored and baseline values recorded.

P group received a rapid infusion of lactated Ringer's solution (LR) 1000-1500 mL (20 mL/kg) 15 min before the spinal block. N group did not receive any preload.

With the patient in the sitting position, a 25-gauge Whitacre spinal needle (Whitacre Spinal®. Becton Dickinson, Madrid, Spain) was inserted was inserted at what was estimated to be the L3-4 or L4-5 vertebral interspace. Patients received 7.5 mg of isobaric bupivacaine 0.5% (Bupicaine®, UNIMED, Tunis, Tunisia), 10 µg fentanyl and 100 µg morphine. Immediately after completion of the spinal injection, the patient was turned supine with the table tilted to the left. Oxygen was administered at a flow rate of 3 L/min through nasal cannula.

An independent investigator, blinded to the anesthetic technique used, recorded all variables. Maternal blood pressure, heart rate were recorded every two minutes for 30 min after the intrathecal injection, at 5-min intervals for the next 30 min and at 10-min intervals thereafter. Hypotension was defined as a 20% or more fall below the pre-induction level or systolic pressure below 100 mmHg, which was treated immediately with rapid fluid infusion and ephedrine 6 mg i.v. and repeated whenever necessary. Sensory level blocked was measured by pinprick at the left midclavicular line at 5, 10, 15, 20 and 30 min. Surgery was allowed to begin when anesthesia reached T5. The maximum height of the block attained during the procedure was assigned.

The times elapsed between spinal puncture, fetal delivery and end of surgery were noted. Adverse effects such as nausea and vomiting, shivering, pruritus and dizziness after induction of anesthesia were checked throughout the operation. Neonatal outcome was assessed using Apgar score at 1 and 5 min by a pediatrician who was unaware of group assignment.

Table 1
Patients and Block characteristics

	Group P (n=30)	Group N (n=30)	P
Age (years)	33 ± 12	33 ± 5	NS
Weight (kg)	78 ± 11	76 ± 10	NS
Height (cm)	163 ± 4	160 ± 4	NS
Gestational age(weeks)	37 ± 1	38 ± 1	NS
Parity	1 ± 1	2 ± 1	NS
Spinal injection- delivery (mn)	22 ± 4	20 ± 8	NS
Median upper sensory level	T4 (T2-T10)	T4 (T2-T10)	NS
Initial systolic blood pressure (mm HgmmHg)	126 ± 13	128 ± 16	NS
Initial heart rate (beats/min)	100 ± 16	104 ± 16	NS

Data are mean ± SD or median (range).
NS: not significant

The results were analyzed using t test for parametric data and chi- square and Fisher's exact tests for non parametric data. A p value < 0.05 was considered statically significant.

Results

Thirty-one patients were assigned to each group. One patient was excluded in each group because of inadequate sensory level (< T6). Each group included therefore thirty patients.

The two groups were comparable in age, weight, height, parity and gestational age and there was no significant difference in the level of sensory block, spinal injection-delivery, preinduction systolic blood pressures and heart rates (Table 1).

The incidence of hypotension after spinal anesthesia was similar in the P and N groups (80% vs. 83%).The minimum systolic blood pressure (SBP) mean value after spinal anesthesia was not different between the two groups. Also, SBP <90 mmHg was noted in 15 of 30 patients pre-loaded with LR compared with 18 of 30 patients without preload (p >0.05). The mean time to minimal hypotension was longer in N group (p<0.05). The maximum heart rate (HR) mean value was significantly higher in group N (p = 0.042). Because of the preload there was a highly significant difference in the amount of fluid infused up to the time of delivery (P <0.0001) for difference between the means is 1159 to 2130 ml (Table 2). This large difference in fluid administration between the groups had no effect on the amount of ephedrine required (Table 2).

There was no difference in the incidence of nausea and vomiting in the two groups. Nausea and/ or vomiting coincided with the maternal hypotension, and were successfully treated by correcting the hypotension with IV ephedrine and rapid fluid infusion (Table 3).

There were no differences between treatment groups in Apgar scores. Two neonates in each group had 1-min Apgar <7. In these cases, maternal

Table 2
Comparison of hemodynamic parameters

	Group P (n=30)	Group N (n=30)	P
Systolic blood pressure <100 mm HgmmHg*	24 (80)	25(83)	NS
Systolic blood pressure <90 mm HgmmHg*	15 (50)	18 (60)	NS
Minimum systolic blood pressure (mmHg)	80 ± 17	75 ± 18	NS
Maximum heart rate (beats /min)	112 ± 15	127 ± 18	0.042
Time to Minimum systolic blood pressure (min)	18 ± 8	8 ± 4	0.001
Mean ephedrine dose (mg)	22 ± 19	27 ± 24	NS
Total fluid administration (ml)	2130	1159	<0.0001
Fluid administration after spinal anesthesia (ml)	1210 ± 28	1160 ± 34	NS

Data are mean ± SD, or n (%).
NS: not significant.

hypotension was clinically significant. All newborns had five minutes score >7.0 (Table 3).

Discussion:

The main findings of the study are that combined use of low-dose spinal anesthesia and crystalloid preload did not offer better hemodynamic stability than low dose spinal anesthesia for cesarean delivery.

The efficacy of prehydration has been studied extensively in the prevention of hypotension following spinal anesthesia for cesarean delivery, but the optimum types and doses of preload solutions remain controversial. Rout et al[5] first challenged the benefit of a crystalloid preload in an open randomized comparison of 20 ml/kg and no preload. They noted that there was a 16% (from 71% to 55%) reduction in the incidence of hypotension in the preload group. This difference, although small was significant. Park et al used crystalloid preload volumes of 10, 20 and 30 ml/kg in a double-blind study[9]. Although there was a trend towards a reduced incidence of hypotension with the larger fluid preloads, this was not statistically significant and neither was there any difference in the amount of ephedrine use. Both the speed[10] and volume[9] of crystalloid preloading have also been shown to be unimportant. In line with the above studies, our results showed that the incidences of hypotension, associated nausea and vomiting and ephedrine consumption were similar in the preload and the no preload groups.

Crystalloid preloading is performed to augment blood volume in an attempt to compensate for the anticipated vasodilatation induced by subarachnoid block.

Investigations regarding the effects of fluid preloading on maternal hemodynamic factors such as cardiac output and systemic vascular resistance would be helpful for discussion of the meaning and usefulness of volume preloading. Ueyama et al[11] found that crystalloid preload had minimal effect on cardiac output and blood volume. As the half life of crystalloid solution in the vascular space is short, it fails to produce a sustained increase in blood volume.

Maximal heart rate, higher in no preload group (N) in our study could justify the administration of a modest crystalloid preload before spinal injection. Patients scheduled for elective cesarean delivery are often relatively dehydrated as fasting rules remain often more stringent in the pregnant population.

Typically, 12 of bupivacaine has been recommended for intrathecal block for cesarean delivery to prevent visceral pain and to ensure an adequate sensory block level and duration[12]. However, numerous recent studies have reported that a combination of opioids and local anesthetics permits the local anesthetic dose to be significantly reduced (7-13). The addition of intrathecal opioids acts synergistically with the local anesthetic in improving the quality of intraoperative anesthesia and analgesia, and has a local anesthetic-sparing effect.

Particularly, fentanyl, a short-acting lipophilic opioid, has been shown to improve intraoperative anesthesia in a dose of 6.25 µg or more[14].

Relatively low incidences of hypotension with bupivacaine 5 mg[6] and 6.6 mg[15-16] were reported. Ben-David et al[6] reported that this reduced intrathecal anesthetic requirement decreased the intensity and duration of sympathetic and motor blockade, and thus, lessened the severity of maternal hypotension. The result of our study, indicate ,however that the prevention of hypotension related to spinal anesthesia in subjects receiving cesarean section is not possible despite the low dose spinal anesthesia used. Thoren et al[17] compared intrathecal hyperbaric bupivacaine 7.5 mg without opioid in combined spinal-epidural analgesia with 12.5 mg via single-shot spinal anesthesia and showed no difference in the amount of hypotension.

Normally, the level of sympathetic bloc is two to six levels above the sensory block[18], however, the level of sensory block needs to rise to T4 in cesarean section to be comfortable during the operation. Thus even though the dose of local anesthetic is decreased, the development of sympathic block is inevitable as a result of the level of sensory block rising to T4. It is not possible to prevent completely hypotension by just decreasing the dose of local anesthetic.

A combination of techniques was used to prevent spinal-induced hypotension for cesarean delivery in studies by Vercauteren et al. and Ngan Kee et al[15,16,19].

In this study, despite of combination of two techniques (i.e. low dose spinal anesthesia and

crystalloid preload), the incidence of hypotension was important in the P group. In another study, the authors[20] expected the combination of colloid prehydration would have an added effect in the prevention of maternal hypotension. However, the combination of two methods failed to show a further decrease in the incidence of hypotension compared to each method separately. Kaya et al[8] concluded that it would be more beneficial to use a combination of low dose of bupivacaine, preloading with colloid and leg wrapping to reduce the incidence of spinal anesthesia-induced hypotension in patients undergoing cesarean section.

In conclusion, crystalloid preload when low-dose spinal anesthesia was used did not reduce the incidence and the severity of hypotension.

Acknowledgements

The authors thank:

- Benhamou Dan, MD, Department of Anaesthesiology and Critical Care, Assistance Publique-Hôpitaux de Paris, Hôpital de Bicêtre, Département d'Anesthésie-Réanimation; Universite Paris XI; France.

- Mercier Frederic J, MD, Department of Anaesthesia and Intensive Care, Groupe Hospitalier Paris Sud, Hôpital Antoine Béclère, Assistance Publique-Hôpitaux de Paris, Université Paris-Sud, Clamart, France.

for assistance in the preparation of the manuscript.

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