Original Article

Comparison Between Colloid and Crystalloid Infusions in the Prevention of Postspinal Hypotension in Cesarean Deliveries

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Abstract

Background and Aim: Hypotension is an important serious side effect of spinal anesthesia.

The aim of the study was to compare efficacy of administering colloid and crystalloid solution with spinal anesthesia during cesarean surgeries to prevent hypotension.

Materials and Methods: The study included 100 spinal anesthesia patients who underwent elective cesarean surgery in 4 groups. In groups 1 and 2, 7 cc/kg of colloid solution was injected 20 min before and during spinal anesthesia, respectively. In groups 3 and 4, 15 cc/kg of Ringer solution was injected 20 min before and during spinal anesthesia, respectively. The BP, heart rate changes, vasopressor dose, nausea, vomiting, chest discomfort, and Apgar score were evaluated.

Results: The BP decreased significantly when the patients changed position from supine to seating position (P = .001) and in the third minute after injecting the local anesthetic (P = .031) in all groups. Group 4 (23.5%) patients exhibited significant hypotension, whereas group 2 (15.9%) patients showed less hypotension. However, there was no statistically significant difference between the 4 groups (P = .31). There were no statistical differences between the 4 groups in the Apgar of the fifth minute, vomiting, vertigo, and chest discomfort.

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Conclusions: Owing to high cost and probable side effects, colloid solutions are not recommended; and emergency cesareans need not be postponed to perform hydration before spinal anesthesia.

Key Words: Cesarean delivery, fluid timing, spinal anesthesia, crystalloid, colloid, hypotension

Introduction

Spinal anesthesia is an easy, fast, trustworthy, and selective method for cesarean deliveries.[1] However, hypotension after spinal anesthesia in cesarean surgeries is still considered a frequent and serious side effect. The occurrence of hypotension has been reported in 25% to 80% of cases.[2] This can cause complications such as cardiovascular collapse, unconsciousness, and reduced uteroplacental blood flow, for both the mother and the fetus.[2]

One of the major difficulties specialists face in case of emergency cesarean section with very less time for spinal anesthesia is severe hypotension. If hypotension occurs during spinal anesthesia, it should be treated immediately to prevent side effects in the mother and the newborn.[3]

Hypotension during spinal anesthesia can be prevented by various methods, such as hydration, prophylactic administration of ephedrine, and changing the patient's position to left lateral or manually moving the uterus to the left side.[4] Hydration is the most common method to prevent and treat BP changes. There are different opinions on the serum type, volume, administration rate, and hydration time to prevent hypotension.[5] In healthy mothers, rapid infusion of crystalloid fluid up to 2 L helps manage hypotension.

Administration of colloid or crystalloid either before or during spinal anesthesia is controversial. On the other hand, apart from high cost, colloid fluids can also cause side effects such as anaphylactic reactions, coagulation disorders (in high volumes), heart failure exacerbation, and kidney disorders.

Aims

The objective of this study was to compare colloid and crystalloid solutions, time of infusion (before or simultaneously with anesthetic injection), and to find the best method for preventing postspinal hypotension and reduce the need to delay emergency cesarean.

To date, no study has compared fluid administration during spinal anesthesia both in terms of types and injection time.

Materials and Methods

Study design

The study protocol was approved by the local ethics committee (Imam Reza Training and Research Hospital, Mashhad, Iran). This prospective, randomized, controlled, double-blind study was performed on 100 parturients aged between 18 and 40 years who underwent elective cesarean from September 2012 to June 2013 (Figure 1). A written informed consent was obtained from all patients. In the operation theater (OT), the study patients were randomly divided (sealed envelope technique) into 4 equal groups. The solutions were provided in packed nontransparent numbered plastic bags. The anesthesiologist who administered the fluids and spinal anesthetic and the technician who evaluated hemodynamic status and spinal anesthesia characteristics were blinded to patient group allocation.

Exclusion criteria

The patients who had received IV fluids before entering OT; those with BMI > 35 kg/m^2; weight > 100 kg and height > 170 cm; patients with contraindications to spinal anesthesia such as infections and clotting disorders;

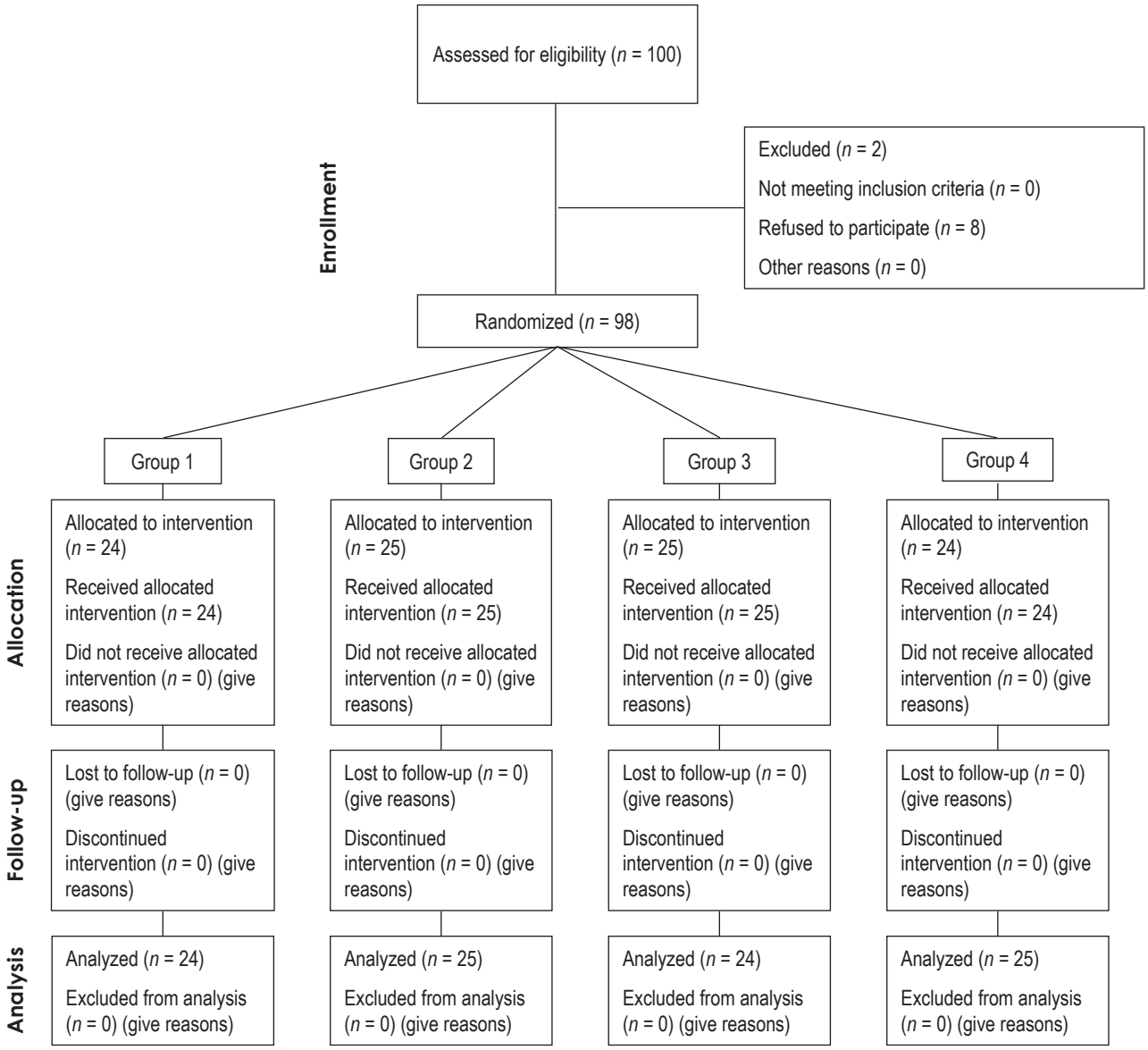

Figure 1. Study Flowchart

patients for emergency cesarean; those with severe bleeding, gestational hypertension, gestational diabetes mellitus; and those who were at risk of inertia were excluded from the study.

Study procedure

The BP, heart rate, peripheral oxygen saturation, and electrocardiogram (ECG) were noted in the beginning of the study. An 18G intravenous catheter was placed in the large antecubital vein of all the study patients. In groups 1 and 2, 7 cc/kg of colloid solution (Voluven, Fresenius Kabi AG, Bad Homburg, Germany) was infused. In group 1, colloid was infused 20 minutes before spinal anesthesia, and in group 2, colloid was infused simultaneously with spinal anesthesia.

In group 3, 15 cc/kg of Ringer solution (crystalloid) was infused 20 minutes before, and in group 4, the same

amount of Ringer solution was infused simultaneously with spinal anesthesia. The patients were made to sit, and 12 mg hyperbaric bupivacaine with 20 µg fentanyl was injected with a whitacre needle (number 25), after removing cerebrospinal fluid from L2-L3 or L3-L4.

Immediately after injecting the anesthetic solution, the patients were made to lie in the supine position and the beds were turned to left 10° to 15°. All the patients received oxygen through a nasal cannula. Ringer solution was used for all the patients by calculating maintenance fluids, deficit fluid, third space removal, and bleeding level during the surgery. After block level at T4-T6, surgery was permitted.

The patients' vital signs were monitored thrice every 3 minutes and then every 5 minutes until the end of the surgery. If systolic BP decreased > 20% of its base or if it was < 90 mm Hg, 5 mg of ephedrine was injected and replenished as required. After the neonate's birth and cord clamp, 1 mg of midazolam and 20 U of oxytocin were injected slowly. During the surgery, occurrence of nausea, vomiting, vertigo, chest discomfort, and first and fifth minute's Apgar score were evaluated by one of the technicians who was blind to the study group.

Statistical analysis

Collected data were analyzed using SPSS software (version 11.5) and a *P* value of < .05 was considered significant. Quantitative data were analyzed by ANOVA, repeated measures ANOVA; post hoc comparisons were done using Tukey test; and qualitative values were evaluated by X^2 test.

According to Mercier et al,[2] the 70% prevalence of hypotension with 95% confidence interval and 80% power and sample size were estimated in 84 cases; but it was extended to 100 patients for confirmation.

Results

In this study, 100 patients were enrolled in 4 groups, but 2 patients were excluded from the study—1 patient from group 1 because of unsuccessful spinal anesthesia and 1 patient from group 4 because of vasovagal shock. Demographic characteristics such as age, weight, height, BMI, and independent preoperative variables such as fasting time and obstetric history were compared (Table 1), and no statistically significant difference was seen between the groups.

Table 1. Demographic and Preoperative Independent Parameters of the Study Patients

Parameter	Colloid Preinduction (*n* = 24)	Colloid Coload (*n* = 25)	Crystalloid Preinduction (*n* = 25)	Crystalloid Coload (*n* = 24)	*P* Value
Age, y	31.1 (3.2)	29.1 (2.6)	29.9 (5.2)	30.3 (5.5)	.41
Weight, kg	81.6 (11.9)	72.2 (8.6)	78.6 (13.8)	75.1 (9.6)	.22
Height, cm	162.1 (4.8)	160.1 (3.6)	159.6 (4.4)	159.8 (6.4)	.30
BMI, kg/m^2	30.3 (3.7)	28.2 (3.6)	30.8 (5.2)	29.5 (3.6)	.12
Parity, *n*	1.9 (0.2)	1.9 (0.3)	2.2 (0.2)	2.2 (0.4)	.32
NPO, h	13.2 (1.9)	12.7 (2.1)	13.1 (2)	12.2 (2.4)	.36

Values are represented as mean (SD).
BMI, body mass index; NPO, nill per os.

In all 4 groups, BP decreased at 2 stages—during the change of the patients' position from supine to sitting ($P < .001$); and at the third minute after local anesthetsia administration ($P = .03$) (Figure 2). Hypotension was high in group 4 (to whom 15 cc/kg crystalloid was simultaneously injected; 23.5%) and the least hypotension was observed in group 2 (to whom 7 cc/kg colloid was simultaneously injected; 15.9%). Hypotension was detected in 18.9% and 17.6% of the patients in groups 1 and 3, respectively. However, there were no statistically significant differences between the 4 groups ($P = .31$).

Maternal hypotension improved at sixth minute in groups 2 and 4 (simultaneous injection of solution), but continued to sixth minute ($P = .02$) in groups 1 and 3 (infusion before anesthesia). Ephedrine requirement was more in group 3 (68%) and less in group 1 (40%). However, it was not significantly different between the groups ($P = .3$).

The patients' heart rate increased mildly during the change to the sitting position and injecting anesthesia, which was not statistically significant (Figure 3). Heart rate had significantly increased at the 9th and 14th

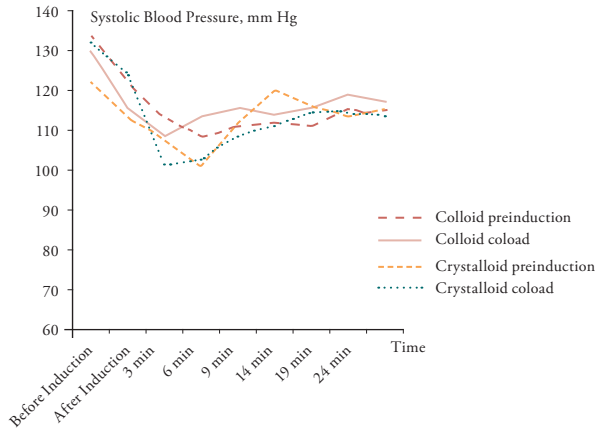

Figure 2. Systolic Blood Pressure Changes Between the 4 Groups During the Study

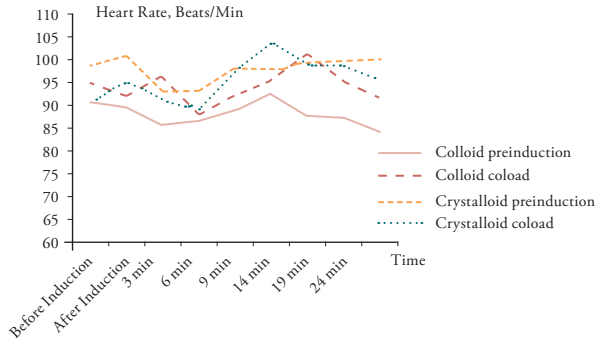

Figure 3. Heart Rate Changes Between the 4 Groups

minutes (P = .001 and P = .024, respectively); however, there was no significant difference between the 4 groups (P = .16), and they were related to ephedrine injection (P = .003 and P = .045, respectively). Heart rate did not change at other times significantly.

First-minute Apgar of newborns was significantly high in groups 1 and 3 than groups 2 and 4 (simultaneous injection) (P = .029); however, fifth-minute Apgar score was not significant between the 4 groups (P = .28). However, all newborns' Apgar score was between 8 and 10, and this difference was not clinically important (Table 2). Nausea was observed in 60% of patients in group 3, which was significantly higher than that of the other groups (P = .046). But there was no significant difference in vomiting, vertigo, and chest discomfort between the 4 groups (Table 2).

Table 2. Newborns' Apgar Score, Ephedrine Requirement, Nausea, Vomiting, Vertigo, and Chest Discomfort in 4 groups

Parameter	Colloid Preinduction (n = 24)	Colloid Coload (n = 25)	Crystalloid Preinduction (n = 25)	Crystalloid Coload (n = 24)	P Value
Ephedrine Requirement	10 (41.7)	14 (56)	17 (68)	15 (62.5)	.3
Apgar, Median (Min–Max)	10 (9–10)	9 (8–9)	10 (8–10)	9 (8–10)	.029
Chest Discomfort	2 (8.3)	8 (32)	4 (16)	4 (16.7)	.21
Vertigo	0 (0)	0 (0)	2 (8)	4 (16.7)	.34
Vomiting	0 (0)	3 (12)	2 (8)	2 (8.3)	.16
Nausea	8 (33.3)	8 (32)	15 (60)	6 (25)	.046

Apgar score is represented as median (min–max); other parameters are represented as n (%).

Discussion

Hypotension caused during spinal anesthesia, especially in cesarean delivery, can result in nausea, vomiting, diminished consciousness, and newborn's Apgar decrement. In the current study, effects of colloid and crystalloid administration before and during the spinal anesthesia of cesarean section on BP changes, nausea, vomiting, and newborn's Apgar were studied in 4 different groups. The BP reduced at 2 different times among the patients. Hypotension was observed during the change in the patients' position from supine to sitting (before injecting local anesthesia), and after spinal anesthesia at the third minute. The BP decrement was the same in all groups and there was no significant difference between them. The first episode of hypotension did not require vasopressor injection because the patients did not have any signs of nausea, vomiting, and vertigo. The only statistical difference between the groups was in the second episode of hypotension (after the induction of spinal anesthesia). Injecting colloid or crystalloid solutions before spinal anesthesia caused more and longer BP decrease.

To date, many studies have been conducted to analyze prevention of BP changes during spinal anesthesia injection;

however, it is still a controversial topic. Although administration of crystalloid fluid before the anesthesia in initial studies showed 71% effectiveness in preventing BP decrease,[6] its usage was diminished in the recent years because of insignificant crystalloid efficacy in reducing hypotension before the surgery.[7-9] In the present study, the prevalence of hypotension was 18.9% of those who were given crystalloid injection before anesthesia, and ephedrine requirement was more in these patients than other groups (68%).

Some studies have evaluated the efficacy of administering crystalloid fluid simultaneously and after administering spinal anesthesia. A study conducted by Gunusen et al[10] showed that simultaneous usage of crystalloid solution (20 cc/kg) was more effective than preanesthesia crystalloid or colloid (gelatin 500 cc before 15–20 min) infusion. However, ephedrine infusion was also used simultaneously with crystalloid infusion, and administering the combination of crystalloid solution and ephedrine concurrent with anesthesia was more effective in preventing severe and medium hypotension.[10]

In another study, crystalloid solution infusion before the surgery (10 cc/kg) which was continued during anesthesia induction (10 mg/kg) was more effective than crystalloid infusion before anesthesia per se (20 cc/kg).[11] In a study conducted by Oh et al,[3] 60 parturients were randomized to receive 15 cc/kg of crystalloid before (preload group) or after (coload group) inducing spinal anesthesia. The study results concluded that coload of crystalloid is more effective than preload to prevent maternal hypotension after spinal anesthesia.

In a study by Hasan et al,[12] the efficacy of 20 cc/kg of Ringer lactate, 8 cc/kg of hydroxyl ethyl starch 6%, and a combination of Ringer lactate (10 mg/kg) and hydroxyl ethyl starch 6% (4 cc/kg) before anesthesia infusion was compared. Hypotension and other complications were prevented in patients who were given the combination. Also, in a similar study, the prevalence of hypotension as well as ephedrine requirement in patients receiving a crystalloid preload showed a higher frequency of hypotension compared with the group that was given prophylactic colloid solution.[13] On the other hand, in some studies, no superiority was found between colloid and crystalloid groups and the prevalence of hypotension was the same in both the groups,[14] although in the first 10 min of surgery, the crystalloid–colloid combination demonstrated a better value in hypotension prophylaxis over the colloid-only regimen.[15]

A study conducted by Carvalho et al[16] reported that usage of hydroxyl ethyl starch before and simultaneously did not show any significant difference in the incidence of nausea, vomiting, and vasopressor requirement among patients. But the prevalence of hypotension was significantly less in those who were given hydroxyl ethyl starch usage simultaneously. Moreover, in a study conducted by Siddik-Sayyid et al,[17] there was no notable statistical difference in terms of hypotension, hypotension severity, and vasopressor requirement between the groups who were administered colloid or crystalloid before or simultaneously with spinal anesthesia. In some studies, cardiac output and stroke volume were also analyzed in addition to BP changes. In a study conducted by Teoh et al,[18] cardiac output and stroke volume increased in the first 5 minutes before anesthesia injection with phenylephrine in the colloid group. However, there were no significant differences in BP changes, ephedrine need, and newborns' Apgar score between the 2 groups. McDonald et al[19] compared the effect of crystalloid and colloid fluids during anesthesia injection and reported lack of significant difference in maternal cardiac output, hemodynamic effects, and vasopressor requirement.

A meta-analysis compared the prevalence of hypotension in the groups administered with colloid and crystalloid fluids before or simultaneously with spinal anesthesia injection in cesarean surgeries. The prevalence of hypotension was the same in all the groups and vasopressor was injected to a small percentage of patients.[4] However, in another meta-analysis, colloid fluid was reported to be more effective in terms of preventing hypotension and less need for vasopressor than crystalloid fluid. Cardiac output rate improved in the group in which colloid was used.[5] McDonald et al[19] investigated the factors that affect BP and hypotension after spinal anesthesia injection. In this study, crystal-

loid solution was not reported to be very effective, and colloid solution usage, specifically during spinal anesthesia injection, was more emphasized. Also, phenylephrine was reported to be more effective than ephedrine among different kinds of vasopressors.[19]

In the current study, in both the groups in which colloid or crystalloid solution were injected simultaneously with spinal anesthesia, hypotension duration was less compared with the other groups; but severity of changes in apgar score, vomiting, and chest discomfort and ephedrine requirement were same in all 4 groups. The reason for less duration of hypotension in simultaneous infusion groups was not studied; perhaps it could be because of the fast exit of fluids from systemic veins into the organs, especially in crystalloid group. In this study, 15 cc/kg of crystalloid was used; but in most of the other studies, twice more amounts were used. Hypotension was observed only when mothers were injected, which was not significant and needed no treatment.

A notable fact in this study was that newborns' Apgar score in preanesthesia infusion groups was better than those in simultaneous fluid infusion groups. However, clinical changes were not significant and the Apgar score was same at fifth minute. In other studies, heart rate did not change significantly. In this study, heart rate increased after changing the patients' positions, which was perhaps because of BP decrement and increased baroreceptor activity or sympathetic activity due to stress or fear of needle. Heart rate also increased at 9 and 15 minutes, which was related to ephedrine injection. Newborns' health was analyzed with the help of Apgar score at first and fifth minutes; however, measuring pH of the blood cord could be a better criterion.

Conclusions

Hypotension control after spinal anesthesia injection in cesarean delivery is still controversial. In the present study, no significant difference was observed in hypotension severity between the 4 groups and ephedrine requirement was still 40% to 68%. Hypotension duration was less in simultaneous infusion groups. Also, Apgar level in the preanesthesia infusion groups was significantly better in the first minute, but it was same in all groups at the fifth minute.

According to this study, delay in emergency cesarean section due to the receipt of fluids before spinal anesthesia is not necessary and simultaneous fluid infusion can be used instead. Crystalloids seem to be beneficial in avoiding hypotension due to spinal anesthesia in cesarean section compared with colloids because of cost and side effects. The only limitation of this study was refusal of a few patients for spinal anesthesia.

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