*Original article*

# Crystalloid prehydration versus cohydration for prevention of hypotension during spinal anaesthesia for elective caesarean section

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## Abstract

**Background:** Hypotension during spinal anesthesia is a well known problem. Traditionally prehydration before the spinal block is one of the strategies used to prevent hypotension. Recently the efficacy of prehydration has been questioned. **Objective:** To compare the incidence of hypotension and vasopressor requirement with crystalloid prehydration and cohydration in women undergoing elective caesarean section. **Methods:** The prospective randomized study was carried out in 120 patients undergoing elective lower segment caesarian section under spinal anaesthesia. They were allocated to receive either 20ml/kg of lactated ringer's solution during 20 minutes prior to induction of spinal anaesthesia (prehydration group) or equivalent volume by rapid infusion immediately after administration of the local anaesthetic intrathecally (cohydration group). Vitals, incidence of hypotension, dose of mephenteramine used and complications were recorded. **Results:** Hypotension occurred in 19 of 60 patients (31.6%) in prehydration group whereas in 15 of 60 patients (25.0%) in cohydration group, but the difference was not significant (P>0.05). But significantly less patients in the cohydration group (2 of 60 vs 18 of 60) developed hypotension and required vasopressor therapy before delivery of baby (P<0.001). Similarly, parturients in the cohydration group required significantly less dose of mephenteramine for treatment of hypotension. **Conclusion:** Rapid crystalloid administration after the induction of spinal anaesthesia for elective caesarean section prevents hypotension before delivery and decreases vasopressor requirement.

**Keywords**: anaesthesia, cesarean section, hypotension, spinal

## Introduction

Systemic hypotension occurs in about 55% of cases undergoing spinal anesthesia for caesarean section.[1] One of the methods of treating arterial hypotension during anesthesia traditionally consists of the rapid infusion of large amount of fluids before onset of anesthesia, which restores the blood pressure by improving cardiac output as a result of increase in venous return.[2] This technique was introduced by Wollman and Marx and was subsequently known as prehydration.[2] However, crystalloid prehydration has poor efficacy for preventing hypotension due to its rapid redistribution.[3-5]As an alternative, administration of a fluid bolus starting at the time of intrathecal injection (cohydration) may be more physiologically appropriate because the maximum effect can be achieved during

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the time when the block is developing and the consequent vasodilatation is evolving. This would prevent cardiovascular side effects as it provides additional intravascular fluids in the period of maximum risk. We assessed the efficacy of crystalloid prehydration given over 20 minutes prior to spinal anaesthesia and cohydration given immediately after the institution of spinal block for the prevention of hypotension in parturients undergoing elective Lower Segment Caesarean Section (LSCS).

## Methods

This was a prospective randomized clinical study conducted on 120 parturient with term singleton normal pregnancy of ASA physical status I and II undergoing elective lower segment caesarean section under spinal anaesthesia at BPKIHS, Dharan for the period of one year from August 2008 to August 2009. Approval was obtained from BPKIHS ethical committee and written informed consent was taken for the procedure from all the patients. The exclusion criteria were patient's refusal, pre-eclampsia, eclampsia, fetal distress, patients requiring general anaesthesia, any contraindication to spinal anaesthesia or excessive perioperative bleeding requiring transfusion.

The patients were divided into two groups consisting of 60 patients in each group for the study. After obtaining informed written consent from patients randomization was done using a sealed envelope, which was opened 30 minutes before performing the spinal anaesthesia.

Group P – Women received 20ml/kg of lactated ringer's solution during the period of 20 minutes prior to induction of spinal anaesthesia (crystalloid prehydration group).

Group C – received 20ml/kg of lactated ringer's solution by rapid infusion at maximum possible rate immediately after administration of the local anaesthetic intrathecally (crystalloid cohydration group).

Demographic characteristics were recorded after randomization. Baseline haemodynamic parameters heart rate (HR), non-invasive blood pressure (NIBP) and respiratory rate (RR) were also recorded. A peripheral vein on the dorsum of hand was cannulated for administration of intravenous fluid with 16 G cannula. Fluid was administered according to the group distribution. In the operating room, with the patient comfortably at rest, in the left lateral tilt of 15º with a wedge under the right buttock, a non-invasive blood pressure, heart rate, oxygen saturation (SpO2), respiratory rate and continuous electrocardiography (ECG) were monitored. Subarachnoid block was performed in left lateral position with a 25–gauge spinal needle inserted at L2-3 or L3-4 interspace with 0.5% heavy bupivacaine 2.2ml. The patient was then turned to the supine position with at least 15º of left lateral tilt as before. Systolic diastolic and mean arterial pressures, heart rate, SpO2 and respiratory rate were recorded at 2.5 minute interval for first 15 minutes and 5 minute interval thereafter till the completion of the surgery and then at 15 min interval for 1 hr in the recovery room with life scope 12, Nihon Kohden monitor.

The dermatomal level of sensory loss was determined by pinpricks at the interval of five minutes. The maximum height of sensory blockade was recorded. Following the administration of prehydration or cohydration, lactated Ringer's solution at the rate of 6ml/kg/hr was given intravenously to the patients of both the groups as a maintenance fluid. The total amount of this maintenance fluid administered was noted. All patients received oxygen at the rate of 6L/ min via simple face mask after the spinal injection. After delivery of the baby all the patients received injection oxytocin (syntocinon, Novartis India Ltd) in lactated Ringer's solution at the rate of 20 to 40 milliunits per minute. Time of delivery of baby was recorded. Patient in whom hypotension (defined as 20% reduction in systolic blood pressure or decrease in systolic blood pressure below 90mmHg) developed was treated by incremental IV bolus doses of injection mephenteramine 3mg (injection termin, Neon Laboratories Ltd) at one minute interval till blood pressure returned to normal value. Number of doses and time were recorded.

Bradycardia, defined as heart rate less than 50 beats per minute, was treated with atropine 0.6mg IV. Neonatal condition was assessed by Apgar score at one and five minutes after delivery. Other side effects of spinal anaesthesia (e.g. nausea, vomiting, sweating, faintness, shivering) were noted.

Sample size was calculated considering the probability of a Type II error of 0.2. Similarly α error was considered to be 0.05. The incidence of hypotension reported previously was of 55%[1] and a relative 40% change was considered to be clinically significant. The sample size of 59 per group was required.

Continuous data were analyzed using Student's t-test. They were reported as mean±standard deviation. Blood pressure and heart rate were analyzed using a repeated measures analysis of variance model. Categorical data were reported as numbers and percentages and were analyzed using $\chi^2$ test. Nonparametric data were reported as median and range and were analyzed using Mann Whitney U-test. P value of ≤0.05 was considered significant. All analyses were performed using SPSS software (version 11.5; Chicago, IL).

## Results

One hundred and twenty patients were enrolled in the study (Figure 1).

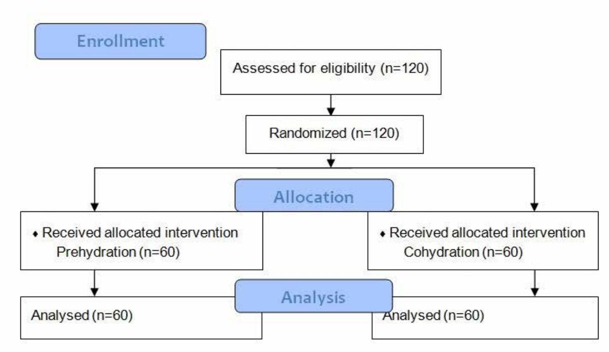


**Figure 1:** 2010 Consort Flow Diagram

There were no statistically significant differences between the groups with respect to demographic data (Table 1), the extent of sensory blockade, time from induction, skin incision or uterine incision to delivery of baby (Table 2) and baseline haemodynamic parameters (Table 3).

**Table 1: Demographic data**

| | Group P (n = 60) Mean ± SD | Group C (n = 60) Mean ± SD | p Value |
|---|---|---|---|
| Age (yrs) | 24.85 ± 3.45 | 24.43 ± 3.74 | 0.527 |
| Weight (kg) | 58.22 ± 5.39 | 58.17 ± 5.74 | 0.961 |
| Height (cm) | 153.95 ± 4.16 | 153.7 ± 4.01 | 0.738 |
| Gravidity median (range) | 2(1-4) | 2(1-4) | 0.848 |
| Parity median (range) | 1(0-3) | 1(0-3) | 0.192 |

**Table 2: Variables related to anaesthesia and surgery**

| Variables | Group P (n = 60) Mean ± SD | Group C (n = 60) Mean ± SD | p value |
|---|---|---|---|
| Median Level of block at 5 min (range) | T6 (T2-T8) | T6 (T2-T8) | 0.573 |
| Time of delivery of baby after induction of spinal anaesthesia (min) | 18.18 ± 1.86 | 18.47 ± 2.27 | 0.456 |
| ID interval (min) | 9.17 ± 1.61 | 9.37 ± 1.86 | 0.53 |
| UD interval (min) | 2.32 ± 0.62 | 2.5 ± 0.72 | 0.14 |
| Duration of surgery (min) | 37.5 ± 3.04 | 37.78 ± 2.45 | 0.576 |

**Table 3: Baseline haemodynamic parameters**

| | Group P (n = 60) Mean ± SD | Group C (n = 60) Mean ± SD | p Value |
|---|---|---|---|
| Mean heart rate (bpm) | 81.97± 7.72 | 84.78 ± 10.85 | 0.104 |
| Mean systolic BP (mm Hg) | 119.63 ± 7.33 | 120.13 ± 5.54 | 0.674 |
| Mean diastolic BP (mmHg) | 76.87 ± 7.63 | 77.43 ± 4.63 | 0.624 |
| Mean MAP (mmHg) | 90.6 ± 6.78 | 91.45 ± 4.42 | 0.418 |

The systolic blood pressure gradually decreased from baseline after the induction of spinal anaesthesia in both the Groups. Statistically significant difference in blood pressure was during the period from 10 to 15 minutes, when systolic blood pressure in Group C was significantly higher than in Group P. After 20 minutes, there was no significant difference in systolic blood pressure between the groups (Figure 2).

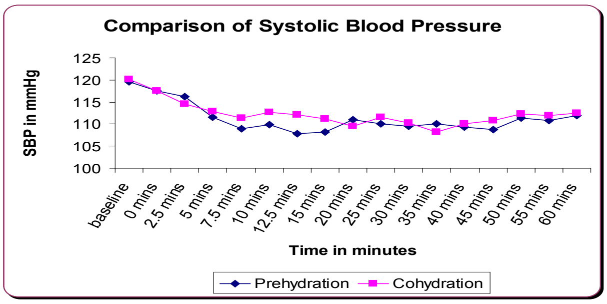


**Figure 2:** Comparison of systolic blood pressure

The mean heart rate gradually decreased from baseline after the induction of spinal anaesthesia in Group C but in Group P there was initial increase in heart rate from baseline at 0 minutes and then followed by the decrease. The difference in heart rate was statistically significant ($P<0.05$). After 20 minutes the heart rates in both the groups had increased above the baseline and were comparable thereafter.

The incidence of first episode of hypotension, defined as 20% reduction in systolic blood pressure or decrease in systolic blood pressure below 90mmHg, was much higher in patients who received Prehydration with Ringer Lactate infusion than those who received Cohydration (31.7% versus 25.0%). However, this difference was statistically not significant.

Similarly, 6 (10%) patients in Group P and 3 (5%) patients in Group C developed second episode of hypotension but this difference was also not significant. Two (3.33%) patients in Prehydration group had third episode of hypotension, whereas the same was not seen in patients who received cohydration. The time of occurrence of the first episode of hypotension in Group P (9.47 ± 4.75 minutes) was much earlier than in Group C (19.83 ± 4.06 minutes). Similarly, significantly less number of patients in Group C (2 vs 18) developed hypotension required vasopressor support before delivery of baby (Figure 3).

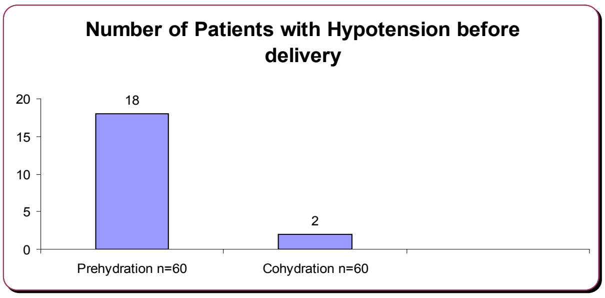


**Figure 3:** Comparison hypotension before delivery of baby

Before delivery, significantly lower median dose of mephenteramine was used in the hypotensive patients in Group C (3mg) as compared to Group P (6mg) (Table 4). The total median doses of mephenteramine used during hypotension were 9mg and 6mg in Group P and Group C respectively and the difference was statistically significant (Table 4). But, there was no difference in the dose of mephenteramine administered after delivery (Table 4).

**Table 4: Comparison of mephenteramine used**

| Dose of mephenteramine | Group P Median (range) | Group C Median (range) | p Value |
|---|---|---|---|
| Before delivery in mg | 6 (3-9) | 3 (3) | 0.014 |
| After delivery in mg | 6 (3-9) | 6 (3-9) | 0.117 |
| Total Median Dose mg | 9 (3-12) | 6 (3-9) | 0.002 |

There were no significant differences between the groups in blood loss, amount of maintenance fluid administered, APGAR scores at 1 minute and 5 minute, incidences of bradycardia, epigastric discomfort or shivering.

## Discussion

The main findings of this study are as follows: Cohydration with crystalloids rapidly after induction of spinal anaesthesia delayed the onset of hypotension, required lesser dose of vasopressors to treat the hypotension before delivery as compared to equivalent volume preloading during 20 minutes before the induction of spinal anaesthesia. The incidence of side effects of spinal anaesthesia and neonatal outcome were similar between the groups.

The preventive therapies for spinal hypotension have been described e.g. preloading with fluid (crystalloid, colloid or volume expander), vasoconstrictors, postural changes, application of constrictive bandages over lower limbs.[6] The treatment is directed to increase blood volume for the redistribution of blood to ensure adequate venous return. The concept of preloading attracted significant attention but failed to completely abolish hypotension,[3-5] so cohydration was introduced to treat hypotension.

While comparing hypotension, decline in blood pressure after spinal anaesthesia in the prehydration group of patients were similar to other studies[3,4,7,8] where crystalloid prehydration was used during spinal anaesthesia for caesarean delivery. All these studies showed gradual decline in the systolic blood pressures after induction of spinal anaesthesia. This decline in blood pressure is attributed to vasodilatory effect of sympathetic blockade caused by spinal anaesthesia.[9,10]

In our study, there was increase in mean heart rate after the infusion of loading volume in the prehydration group followed by decrease after induction of subarachnoid block. Similar result was seen in the previous studiestoo[7,8], where; there was initial increase in heart rate with fluid loading followed by a gradual decline in heart rate. However, the initial increase in heart rate was not seen in the cohydration group. The initial increase in heart rate in the prehydration group is the consequence of increase in right atrial filling which increases outflow from intrinsic chronotropic stretch receptors located in the right atrium and great veins.[9,10] The decrease in heart rate after subarachnoid block is attributed to blockade of the cardioaccelerator fibers arising from $T_1$ to $T_4$ and as a result of a fall in right atrial filling caused by venodilatation.[10]

In our study, the overall incidence of hypotension was less compared to other studies. In the study of Dyer et al[8], 16 of 25 (64%) patients in preload group required ephedrine before delivery. Rout et al[6] infused lactated Ringer's solution 20ml/kg body weight over 20 minutes and 10 minutes in ten patients each group undergoing elective cesarean section under spinal anesthesia. Seven of ten patients in 10 minutes group developed hypotension severe enough to require ephedrine compare with six of ten patients with 20 minutes group. According to Carpenter and colleagues[11], high level of sensory anaesthesia is one of the main risk factors for development of hypotension. The lower level of block height in our study (median level T6), when compared to the two studies, may be the reason for lower incidence of hypotension in our study population. We had included parturient for elective caesarean sections only and they are relatively better hydrated than those who undergo surgery after a prolonged period of labour. Mothers with pre-delivery hypovolaemia may be at risk of cardiovascular collapse because the sympathetic blockade may severely decrease venous return.[12] Moreover, we have used left uterine displacement with wedge under the right buttock. The combination of these techniques in elective parturient definitely reduces incidence of hypotension.

The number of hypotensive episodes and median dose of mephenteramine required for treatment of hypotension before delivery in the cohydration group in our study was significantly less than the prehydration group. The results of our study were similar to the study by Dyer and collegues[8] in this respect. Comparatively lesser number of patients in their study required a lower median dose of ephedrine before delivery in the cohydration group. This reduction in the incidence of hypotension before delivery and lesser need for vasopressor was beneficial in terms of preventing the fetus from adverse effects of hypotension and use of vasopressor. This beneficial effect is supported in previous studies by Ralston and colleagues[13] and Cooper and colleagues[14]. The former study[13] showed that uncorrected hypotension during spinal anaesthesia results in fetal and neonatal acidosis and the latter[14] study suggests that the use of vasopressor may be associated with poor neonatal outcome during spinal anaesthesia for caesarean section. But, despite higher vasopressor requirements in the prehydration group, there are no differences between the groups in neonatal outcome in our study and in the study done by Dyer and colleagues[8]. In our study, although, prehydration had similar overall incidence of hypotension, redistribution of loading volume during the initial phase of spinal anaesthesia caused earlier occurrence of the first episode of hypotension before the delivery of baby and larger median dose of vasopressor was required to treat the hypotension. The rapid administration of crystalloid after the spinal block was beneficial in terms of delaying the onset of hypotension and preventing fetus from the adverse effects of hypotension and the vasopressor since the infused crystalloid volume remained in the circulation at the time when effect of subarachnoid block was developing.

In 2014, an editorial was published highlighting the importance of vassopressor use for prevention of maternal hypotension during caesarean delivery.[12] The editorial states that the timing of fluid administration (pre-loading vs co-loading) does not seem to impact on the incidence of spinal hypotension, which is reflected in our results too. However, the editorial did not mention the fact that cohydration delays the timing of maternal hypotension, a key finding of our study. In our study, hypotension occurred after delivery of baby in most of the cases in the cohydration group preventing the newborns from deleterious effects of decreased uterine blood flow.

Not including a control group is the main limitation of the study.

## Conclusion

Our study shows crystalloid cohydration administered immediately after the induction of spinal anaesthesia for elective lower segment caesarean section is associated with a lesser incidence of hypotension before delivery and the need for vasopressor than conventional prehydration regimen.

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