Preload during Spinal Anaesthesia for Caesarean Section: Comparison between Crystalloid and Colloid Solutions

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Abstract

Background: Maternal hypotension after spinal anaesthesia for caesarean delivery remains a major problem. Different techniques are used to counteract this deleterious effect. Different studies showed that colloid is a better preload solution in comparison to crystalloid for the prevention of post-spinal hypotension. The aim of the current study was to find the effects of volume preload with either crystalloid or colloid on changes in maternal blood pressure and neonatal outcome during elective caesarean section.

Materials and and methods: This open-label Randomized clinical trial was carried out in the Obstetrics and Gynaecology Department of Chittagong Medical College Hospital (CMCH) during the period January-December 2017. One hundred and ten subjects, who were admitted for the elective caesarean section, were selected as per inclusion and exclusion criteria, and randomly assigned to one of the two groups after written informed consent had been obtained from each patient. Fifty-five subjects in each group received preload either with Hartman's solution (Group A) or hydroxyethyl starch 6% (Group B) before induction of spinal anaesthesia. The incidence of hypotension (Systolic blood pressure 20% to 30% fall from baseline) and the amount of ephedrine used to treat hypotension were compared. Neonatal outcome was measured by Apgar score at 1 and at 5 minutes after delivery.

Results: There was no difference in the demographic and gestational characteristics between the two groups. Baseline blood pressure was also comparable between the two groups. The sample size was 108 (53 in Group A and 55 in Group B) because 2 patients inGroup A spinal induction failed. Incidence of hypotension (43.39% vs. 29.09%) and required dose of ephedrine (12.19mg vs. 10 mg) was more in the crystalloid group than colloid but these differences were not statistically significant ($p>0.05$). The frequency of perioperative nausea and vomiting was also similar in both groups ($p>0.05$). Apgar scores of all babies were more than 7 at 1 and 5 minutes after delivery. There was no significant difference in Apgar score between the two groups ($p>0.05$).

Conclusion: The results of the present study concluded that there was no significant difference between crystalloid and colloid groups in development of post-spinal hypotension during caesarean section.

Key words: Caesarean section, Hydroxyethyl starch, Crystalloid, Spinal anaesthesia, Blood pressure.

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Introduction

Up to 70% to 90% of mothers have hypotension after spinal anaesthesia during a caesarean section.[1] Hypotension is caused by a decrease in systemic vascular resistance, aortocaval compression and a decrease in venous return as a result of increased venous capacitance. Hypotension reduces placental blood flow, which may jeopardise foetal oxygenation because uterine blood flow is dependent on perfusion pressure. In addition, hypotension can result in vomiting, dizziness, tinnitus, fainting and spinal cord ischaemia in mothers.[2,3]

This problem can be minimised by using an elastic Esmarch bandage to the lower limb, left-sided uterine displacement, and fluid preload.[4] Volume preloading has been advised to combat spinal-induced hypotension, however, there is still disagreement over the best preloading regimens.[5]

Preloading refers to the intravenous fluid given 30 minutes before spinal anaesthesia in order to fill capacitance vessels and reduce the relative hypovolemia caused by spinal-induced vasodilation and subsequent hypotension.[6]

With crystalloid, the impact lasts less than 20 minutes since 75% of the infused fluid diffuses

into the interstitial space.[7] It takes three to four times the lost volume to replace the intravascular volume with crystalloid, compared to only 2.5 to 3 times in colloid solution.[8,9]

In contrast, colloids' lengthy half-lives cause them to stay in the bloodstream for longer. 100% infused colloids have a longer-lasting effect on blood pressure because they stay in the intravascular space for 30 to 60 minutes. However, colloids are costly, can cause an allergic reaction, and disrupt blood coagulation.[10] Once more, research has cast doubt on the benefit of preloading with crystalloid to shield patients having caesarean sections from spinal-induced hypotension.[11]

The purpose of this randomised clinical experiment was to assess the impact of preloading with HES 6% and Hartmann's solution for preventing hypotension after spinal anaesthesia during elective caesarean sections at the Department of Obstetrics and Gynaecology, CMCH.

Materials and methods

This Randomized Clinical Trial (RCT) was conducted in the Obstetrics and Gynaecology Department of Chittagong Medical College Hospital from January 2017 to December 2017.The age of the patients ranges from 19 to 38 (Avg-26). A total of 110 patients, who were admitted for elective caesarean section were included in this study. Inclusion criteria were Healthy pregnant women at term admitted for elective caesarean section (For different indications like Previous history of caesarean section, Contracted pelvis, Malpresentation, Bad obstetric history, Elderly primigravida etc.) under spinal anaesthesia. Patients above 40 or below 18, patients in labour, patients with co-morbid disease –DM, thyroid disorder etc, or patients with pregnancy complications–eclampsia, preeclampsia, placenta previa were excluded. Randomization was done by the simple lottery method. Fifty-five subjects in each group (Two patients from group A excluded from the study due to failed spinal anaesthesia who were managed with GA) received preload either with 1Litre Hartman's solution (Group A) within 30 to 40 minutes beforeor 500ml Hydroxyethyl starch 6% (Group B) within15 to 20 minutes before induction of spinal anaesthesia. The incidence of hypotension (decrease in systolic blood pressure to 20% from the baseline) and the amount of ephedrine used to treat hypotension were compared. Neonatal outcome was measured by Apgar score at 1 and at 5 minutes after delivery. Blood pressure was measured just after spinal anaesthesia and then every 5-minute interval up to the delivery of the baby and at 10-minuteintervals thereafter until the end of surgery. Following the delivery of the baby intravascular oxytocin 5IU bolus was given. Those patients who developed moderate hypotension (20% to 30% fall of SBP from baseline) were managed by 10 mg intravenous boluses of ephedrine then 5 mg was repeated after 5 minutes in case of persistent or recurrent hypotension along with Hartmann's solution infusion to maintain blood pressure. The total fluid infusion was recorded. The primary outcome measure studied was the incidence of hypotension. The secondary outcome measures were per-operative and postoperative maternal nausea and vomiting, Apgar score at 1 and 5 minutes after birth, dose of ephedrine and total input of fluid. A pre-designed data collection sheet was utilized to record each participant's information. SPSS (Statistical Package for Social Sciences) for Windows version 23 software was used for the analysis. Continuous variables were reported as the means ± SD and categorical variables were reported as percentages. Numerical data were demographic characteristics (Age and weight) hemodynamic parameters, Apgar score, quantity of ephedrine requirements. Categorical data were (Side effects) hypotension, nausea, vomiting. Baseline characteristics were compared by either Student's t-test for continuous variables or the χ^2 test (Fisher's exact test when the expected value is <5) for categorical data. For non-normally distributed data we used the Mann-Whitney U test for comparison of continuous variables. Independent sample t test was used to compare the mean differences of the repeated measures within groups. Statistical significance was defined as $p < 0.05$ and confidence interval set at 95% level. The study was approved by ethical committee and review committee of Chittagong Medical College.

Results

A total of 110 patients were included in the study. Two patients from Group A were excluded due to failed spinal anaesthesia and were managed with General Anaesthesia (GA). Mean age in Group A 26.02 ± 3.88 and in Group B 27.16 ± 4.07. Most patients were housewives (A=88% and B=89%). Most patients were multigravida (A=88.7%, B=94.5%). Baseline blood pressure measurements were described in Table 1. It included SBP, DBP and MBP. These measurements were not statistically different between the two groups (p>0.05).

Table I Baseline (Before preload) blood pressures of two Groups (n=108)

Parameters	Assigned Group				Test statistics
	Group A (Crystalloid) (n=53)		Group B (Colloid) (n=55)		
	Mean	±SD	Mean	±SD	
SBP (mm of Hg)	114.02	±7.23	113.87	±6.83	0.914*
DBP (mm of Hg)	74.25	±7.15	73.51	±6.69	0.582*
MBP (mm of Hg)	87.50	±6.52	86.96	±6.08	0.657*

SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, MBP: Mean Blood Pressure, *: Not significant by independent sample t-test.

There was no significant difference between the two groups in terms of per-operative bleeding, time from uterine incision to delivery and time from spinal anaesthesia to delivery (p>0.05). Regarding total fluid input for the patients, significantly more fluid was required in the crystalloid group (p<0.001). Out of 53 patients in Group A 23 (43.39%) developed hypotension at some point during operation after spinal anaesthesia and post operative two hours (Figure 1). The corresponding value in Group B was 16 (29.09%) (Figure 2). Though incidence of hypotension was higher in crystalloid group, the difference was not statistically significant (p>0.05).

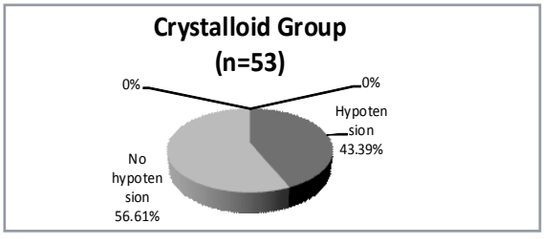

Figure 1 Incidence of hypotension in Group A

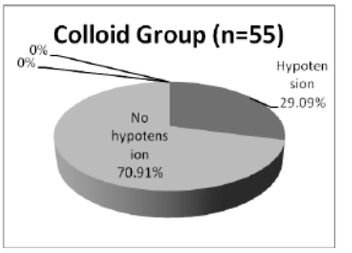

Figure 2 Incidence of hypotension in Group B

Maternal blood pressure changes after spinal anaesthesia were described in Table I. There was no statistically significant difference in minimal SBP in both groups after spinal anaesthesia (p>0.05). The groups were also comparable with regards to SBP and MBP.

Table II Maternal blood pressure change just after anaesthesia by Groups

Parameters	Assigned Group				Test statistics
	Group A (Crystalloid) (n=53)		Group B (Colloid) (n=55)		
Minimal SBP (mmHg)	96.02	±9.88	93.34	±8.53	0.135*
Percent decrease in SBP	15.59	±8.85	17.82	±7.98	0.169*
Minimal MBP (mmHg)	69.67	±7.75	68.09	±5.51	0.225*
Percent decrease in MBP	20.07	±9.63	21.33	±8.21	0.465*

Data are shown as mean ±SD or frequency (Percent)
*: Not significant by independent sample t test.
SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.
MBP: Mean Blood Pressure, bpm: Beat per minute.

There was no significant difference in total ephedrine dose and the interval between spinal injection and requirement of ephedrine injection. per-operative nausea and vomiting comparable in two groups.

Maternal BP changes after operation were recorded for two hours. It showed a higher incidence of postoperative hypotension in crystalloid group. But the difference was not significant (p>0.05).There was no significant difference between the two groups in Apgar score at minute 1 and minutes 5 (p>0.05). Blood pressures were monitored every five minutes interval till delivery after spinal anaesthesia. Comparing the per-operative SBP between the groups after spinal anaesthesia to delivery, there was no significant difference at any point of these succeeding time intervals (p>0.05). After delivery

of the baby blood pressure was monitored every 10 minutes interval till the end of operation. SBP change was also similar at every succeeding time interval after delivery. Comparing the per-operative SBP between the groups after delivery, there was no significant difference (p>0.05).

Comparing the per-operative MBP between the groups after spinal anaesthesia to delivery, there was no significant difference (p>0.05). Comparing the per-operative MBP between the groups after delivery, there was no significant difference (p>0.05).

Blood pressures were monitored every 30 minutes interval after operation. Comparing the post-operative SBP between the groups, there was no significant difference at any point of these succeeding time intervals (p>0.05). Blood pressures were monitored every 30 minutes interval after operation. Comparing the post-operative DBP between the groups, there was no significant difference at any point of these succeeding time intervals (p>0.05). Blood pressures were monitored every 30 minutes interval after operation. Comparing the post-operative MBP between the groups, there was no significant difference at any point of these succeeding time intervals (p>0.05).

Discussion

In this study, 55 subjects were enrolled in each Group. Two subjects from group A were excluded from the final analysis because of failed spinal. So, the effective sample size was 108 (53 in the Crystalloid Group and 55 in the Colloid Group). Both the groups were comparable in terms of age, weight, gestational age and gravidity. The overall age range of the present study population was 19 to 38 years and the mean age was 26.52±4.03 years is comparable with the study done by Tawfik et al. but slightly lower than the study done in Western countries.[7,9,12] Early age of marriage and early age at first childbirth may be responsible for this lower age distribution than that of Western countries. The mean age distribution of our study population is similar to other studies done in our country among patients of repeat caesarean section.[13]

Baseline SBP was 114 ±7 mm of Hg in group A and 113.87±6 mm of Hg in group B, which was more or less comparable with the study done by Rout et al. where SBP was (121 vs 117 mm of Hg) in crystalloid and colloid group respectively.[14]

Incidence of hypotension was 43.39% in group A and 29.09% in group B, which was comparable with the study done by Shahriari et al. where incidence of hypotension was 47.2% in crystalloid group and 22.2% in colloid group.[3] Though the rate of hypotension was lower in colloid group it was not statistically significant (p>0.05). Apparent greater efficacy of colloid given in smaller volumes may be related to the slower redistribution of colloid. 100% colloid persists in the circulation for 30-60 minutes, but 75% infused crystalloid diffuse into the interstitial space within 20 minutes.[9] It is also important to note that, although almost all therapeutic measures had been taken (Preload, uterine shift to the left) the incidence of maternal hypotension in both groups was high. More frequent blood pressure measurements and earlier hypotension correction would partly explain this higher incidence. However, in spite of the high incidence of hypotension, significantly low incidence of nausea and or vomiting was observed. We were unable to measure at which level of hypotension, nausea and or vomiting occurred. It was due to rapid treatment of hypotension with intravenous ephedrine. Per operative nausea was higher in group A (32% versus16%) but it was not statistically significant (p>0.05). Post operative hypotension, nausea and or vomiting was also lower in both groups. It was due to maintenance of adequate hydration in post operative period.

In our study ephedrine requirement was 12 ±3 mg in group A and 10± 2 mg in group B, and the difference was not statistically significant between two groups. Our study result is almost similar the study done by Romdhani et al. where ephedrine requirement was about 16 mg in crystalloid group and about 13 mg in colloid group.[15] Abdullah et al. showed that ephedrine requirement was 7.7 mg in crystalloid group and 9.8 mg in colloid group.[16] This dissimilarity was probably due to the difference in loading dose.[16] We used 10 mg ephedrine as loading dose and Abdullah et al. used 5 mg ephedrine as loading dose. Majority of our patient required single dose of ephedrine for treatment of hypotension. Time of first ephedrine requirement was 17.25±9.48 minute and 17.17±-- 8.3 minute in group A and group B respectively, which was not statistically significant.

Mean time from uterine incision to delivery was 2.21 minutes in group A and 2.05 minutes in group B, which was consistent with the study done by Shahar et al. where mean time was 2 minutes and 1.5 minutes in colloid and crystalloid group respectively.[11] Time from spinal anaesthesia to delivery was 11±3 minutes in group A and 10±3 minutes in group B. A study conducted by Romdhani et al. found that corresponding time was 15 ±6 minutes in crystalloid group and 17±5 minutes in colloid group.[15] Spain et al. concluded after analysis of a cohort of 812 patients underwent caesarean section, that overall, duration from uterine incision to delivery for caesareans of non-anomalous term infants was not associated with an increase in risk of hypoxia-associated morbidities.[17] There was a significantly increased risk of hypoxic morbidity in those delivered >6 minutes compared with those in ≤ 60 seconds in caesarean sections. Other studies found that if delivery occurred within 3 minutes of uterine incision there was no adverse effect on Apgar score.

In the present study,thetotal fluid requirement was 2500 ± 220 ml in group A and 1974 ± 260 ml in group B, more fluid intake was in group A. A study done by Abdullah et al. found that total fluid intake was 2013.22 ml in the crystalloid group and 2028.89 in the colloid group.[16]

Apgar scores at 1 and at 5 minutes were similar in both crystalloid and colloid groups ($p>0.05$). Apgar scores of all babies were greater than 7 at 1 minute and at 5 minutes after delivery. This result was consistent with several studies and it can be due to rapid treatment of hypotension.[3,11] It seems that transient maternal hypotension if recognized and treated promptly, may not be associated with neonatal morbidity.This once more suggests that the well-being of foetuses under regional anaesthesia is more dependent on the prevention of prolonged hypotension periods than on the type of solution used for preload.

Our findings indicated that preloading with fluid in pregnant women for caesarean section under spinal anaesthesia prevents the incidence of spinal-induced hypotension and there was no significant difference in the development of hypotension between crystalloid and colloid solutions, though the incidence rate was lower in the colloid group in comparison to crystalloid group. No intervention either colloid or crystalloid preloading has been shown to eliminate the need to treat maternal hypotension during spinal anaesthesia. Our result agreed with Yokoyama et al. who failed to notice any significant difference in the development of hypotension, systolic blood pressure and Apgar score at 1 and 5 minutes after delivery among the two groups.[18] Ourresult was not in agreement with the study by Melchor et al. where 227 clinical trials were analysed, 11 RCTs including 990 patients were included.[1] They found that a significant decrease (p 0.01) inthe development of hypotension was observed in the colloid group compared to the crystalloid group.

Limitation

Single centred study that might not represent the whole community.

Conclusion

The results of the present study concluded that there was no significant difference ($p>0.05$) in the development of hypotension between crystalloid and colloid groups. The required dose of ephedrine was more in crystalloid group than colloid group, but these differences were not statistically significant ($p>0.05$).

Recommendation

Multicentred study to be recommended for actual picture.

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Contribution of author

FA-Acquisition of data, drafting & final approval.

SC-Conception, critical revision & final approval.

SNR-Design, conception, critical revision & final approval.

JJ-Data analysis, interpretation of data, drafting & final approval.

MN-Data analysis, interpretation of data, drafting & final approval.

YAB-Acquisition of data, drafting & final approval.

Disclosure

All the authors declared no conflict of interest.

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