A COMPARISON OF USING CRYSTALLOID PRE-LOADING AND CO-LOADING IN CAESAREAN SECTION OPERATION UNDER SPINAL ANAESTHESIA AND ITS ASSOCIATION WITH SPINAL ANAESTHESIA INDUCED HYPOTENSION AND HEART RATE VARIABILITY

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Abstract:

Context: *There is lack of evidence on comparison of crystalloid pre-loading and co-loading in parturients undergoing cesarean section operation under spinal anesthesia in Bangladesh. Hence, the present study was designed to compare the efficacy of crystalloid pre-loading and co-loading in preventing spinal anesthesia induced hypotension and heart rate variability during caesarean delivery.*

Methods: *This single blinded randomized controlled clinical trial was conducted in the Department of Anaesthesia, Analgesia & Intensive Care, Dhaka Medical College Hospital, Dhaka, Bangladesh, from January 2013 to December 2014. A total of 90 patients were selected - 45 patients of group I received co-loading with Ringer's lactate solution, while another 45 patients of group II received a pre-loading with the same fluid. Blood pressure and heart rate were recorded in both the groups with 3-minute intervals from the beginning of the subarachnoid block for the first 20 minutes, and then with 5-minute intervals up to one hour. Ephedrine was used as the primary rescue drug to treat hypotension. When ephedrine failed to treat hypotension, adrenaline was administered as a potent vasopressor.*

Results: *The incidence of hypotension was 17 (37.8%) in group I (co-loading group) and 27 (60%) in group II (pre-loading group), which was significantly higher in group II ($p<0.05$). Comparatively higher heart rate was observed in group II, but not statistically significant. Ephedrine was required in 17 cases (37.8%) in group I and 27 cases (60%) in group II. Mean ephedrine required was 9.2±3.6 mg in group I and 11.5±4.3 mg in group II. The difference was statistically significant ($p<0.05$). Adrenaline was administered in 1 case (2.2%) in group I and in 2 cases (4.4%) in group II, which was not statistically significant ($p>0.05$).*

Conclusion: *Severity of hypotension and increased ephedrine requirement were evident in patients who received crystalloid pre-loading (group II), which means crystalloid co-loading (group I) was more capable to prevent spinal anaesthesia induced hypotension.*

Key words: *Crystalloid infusion, spinal anaesthesia, blood pressure, heart rate, spinal anaesthesia induced hypotension.*

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Introduction:

Spinal anaesthesia has become a popular technique for elective and emergency caesarean section operation, as it is relatively cheaper, easily administered and rapidly acting technique, having good quality of sensory and motor block[1], however, it is associated with high incidence of hypotension[2]. Rapid fluid administration is being practiced for a long time as a method of choice to use as prophylaxis for spinal anaesthesia induced hypotension. Volume preloading with crystalloid solutions for the prevention of spinal-induced hypotension received rapid acceptance since it was first introduced by Griess & Crandell[3]. The goal of administering fluids before spinal block is to increase venous return and preserve central blood volume and cardiac output[4,5], both of which decrease as a consequence of sympathetic blockade in spinal anesthesia[6]. Nevertheless, several literatures questioned the efficacy traditional pre-loading techniques prior to the administration of spinal anaesthesia for caesarean section and found the procedure relatively ineffective in preventing hypotension[7-10]. Preloading is rapidly distributed and may induce atrial natriuretic peptide (ANP) secretion, causing further peripheral vasodilatation and increased rate of excretion of the preloaded fluid[11]. Evidence suggested that loading of fluid at the time when local anaesthetic is starting to act on the patient (termed as co-loading), would be a more rational approach[12-13]. This might maximize intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution and excretion[12]. Several studies have been done to date to compare the effectiveness of pre-loading and co-loading of crystalloid solution in different countries. However, no such reports are available in our country. Given the circumstances, the present study was designed with the aim to test the hypothesis that rapid administration of crystalloid at the time of induction of spinal anaesthesia i.e. co-loading is associated with less hypotension than the administration of an equivalent volume as preloading over 20 minutes, in a Bangladeshi population. We tried to analyze the relevance of the timing of the fluid administered by comparing the two above mentioned procedures in two randomly selected groups of patients in terms of the duration and episodes of hypotension (by measuring changes in systolic blood pressure and mean arterial pressure), heart rate variability, and pre-delivery requirements of ephedrine and adrenaline during caesarean delivery under spinal anaesthesia.

Methods:

This single blinded randomized controlled clinical trial was conducted in the Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine Care, Dhaka Medical College Hospital, Dhaka, from January 2013 to December 2014. Our study population was all the patients admitted in Department of Obstetrics & Gynaecology in the same teaching hospital who underwent caesarean section operation during that period. However, the patients were selected after fulfilling the following inclusion and exclusion criteria:

Inclusion criteria:

1. Patients (pregnant women) with singleton, uncomplicated pregnancy who underwent caesarean section done under spinal anaesthesia.

Exclusion criteria:

1. Patients with congenital heart disease, chronic hypertension, gestational hypertension, pre- eclampsia, eclampsia;
2. Patients contraindicated for spinal anaesthesia; and
3. Patients refused to participate in the study.

After fulfilling the inclusion and exclusion criteria, finally 90 pregnant women were allocated into two groups with 45 in each group. They were grouped by odd and even number and allocated to receive either crystalloid pre-loading or co-loading during caesarean section operation. The co-loading group was named group-I and pre-loading group was named group-II. Group II (pre-loading group) received of 20 ml/kg of Ringer's lactate solution (intravenous fluid containing sodium 131 mmol/l, potassium 5 mmol/l, calcium 2 mmol/l, chloride 111 mmol/l and lactate 29 mmol/l,

having P^H is 5-7, which is widely used as the crystalloid of choice for extracellular fluid replacement), over a period of 20 minutes before spinal anaesthesia and group I (co-loading group) received 20ml/kg of Ringer's lactate solution after the spinal anaesthesia by pressurized infusion pump. In the operation theatre, blood pressure, heart rate was measured, heart and lung were examined and recorded. The anaesthesia procedure was explained to the patient. Intravenous access was secured with 18G IV cannula. Ringer's lactate solution was infused at the rate of 5 drops per minute to keep the cannula patent and monitoring of electrocardiogram and pulse oximetry was applied. The patients of group II (pre-loading group) received 20 ml/kg Ringer's lactate solution over a period of 20 minutes before spinal anaesthesia. Spinal anaesthesia was conducted with the patient in the right lateral position. With all aseptic precautions, spinal anaesthesia was given using 2.5 ml of 0.5% of hyperbaric bupivacaine, injected slowly over 12 seconds at the L2-3 or L3-4 level with a 25G Quincke needle. Patients of group I (co-loading group) received same fluid load of 20 ml/kg fluid by pressurized infusion pump after observing the free flow of cerebrospinal fluid. After spinal anaesthesia injection, dressing was applied and immediately put into supine position. Urinary catheter was inserted in all patients, and a wedge was placed for 15 degree left lateral tilt. Once the fluid bolus was given, infusion rate decreased to a maintenance rate of 100 ml/hour. The quality of the sensory block was assessed by swab soaked in alcohol. Surgery was proceeded after confirmation of block to T4 level. Blood pressure and heart rate were recorded in both the groups with 3-minute intervals from the beginning of the subarachnoid block for the first 20 minutes, and then with 5-minute intervals up to one hour.

Spinal anaesthesia induced hypotension was defined as a decrease in the systolic arterial pressure (SAP) by >20% from the baseline reading or a decrease of SAP to <80 mmHg as an absolute value. Hypotension was treated by boluses of ephedrine in doses of 5mg. If the systolic arterial blood pressure decreases to <80 mm of Hg or <80% of the calculated baseline value, 5 mg ephedrine doses were administered until systolic arterial pressure recovered to normal limit. The patients who did not respond with ephedrine, inj. adrenaline was given in doses of 10µg.

Statistical analyses were done using the SPSS version 19.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The mean values were calculated for continuous variables. Chi-Square test was used to analyze the categorical variables, while Student t-test was used for continuous variables. Statistical significance was assumed at a P value of <0.05. The present study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

Results:

Most of the patients belonged to age d"30 years in both groups. The mean age was 24.4±4.4 years in group I (co-loading group) and 25.5±4.0 years in group II (pre-loading group). Mean age difference was not statistically significant between the groups (Table-I). The incidence of hypotension was 17 (37.8%) in group I (co-loading group) and 27 (60%) in group II (pre-loading group), which was significantly higher in group II ($p<0.05$) (Table-II). Single episode of hypotension was observed in 6 cases in group I and 5 cases in group II. Two episodes of hypotension was 8 in group I and 11 in group II. Three episodes of hypotension was observed 3 in group I and 9 in group II. More than three episodes of hypotension was observed in 2 cases in group II (Table-III). Systolic blood pressure started to decline in both group I (co-loading) and group II (pre-loading) and just after spinal anaesthesia; however, lowering of blood pressure was more evident in group II, which indicates that duration and episodes of hypotension were more in group II (Fig. 1). Lowering of mean arterial pressure was also evident in both groups; however, it was more significant in group II (Fig. 2). Due to hypotension, the heart rate changed to maintain the haemodynamic status of the patients. Comparatively higher heart rate was observed in group II than group I; however, the difference was not statistically significant (Fig. 3). Ephedrine was required in 17 cases (37.8%) in group I and 27 cases (60%) in group II. Mean ephedrine required was 9.2±3.6 mg in group I and 11.5±4.3 mg in group II. The difference was statistically significant ($p<0.05$) (Table-IV). Adrenaline was administered in 1 case (2.2%) in group I and in 2 cases (4.4%) in group II. However, the difference was not statistically significant ($p>0.05$) (Table-IV).

Table I

Distribution of the study patients by age (n=90)

Age (years)	Group-I (n_1=45)		Group-II (n_2=45)		P value
	Frequency	%	Frequency	%	
d"30	38	84.4	37	82.2	0.211^{NS}
>30	7	15.6	8	17.8	
Mean±SD	24.4±4.4 (18-35)		25.5±4.0 (19-36)		

Figures in the parentheses indicate range. NS = not significant.

Table II

Distribution of the study patients by hypotension (n=90)

Hypotension	Group-I (n_1=45)		Group-II (n_2=45)		P value
	Frequency	%	Frequency	%	0.034^{S}
No hypotension	28	62.2	18	40.0	
Hypotension occurred	17	37.8	27	60.0	

S = significant; P value reached from chi-square test.

Table III

Distribution of the study patients by episodes of hypotension (n=90)

Episodes of hypotension	Frequency	One episode	Two episodes	Three episodes	More than three episodes
Group I	17	6	8	3	0
Group II	27	5	11	9	2

Table IV

Ephedrine and adrenaline requirement in management of hypotension (n=90)

Medication	Group I	Group II	P value
Ephedrine Requirement	17 (37.8%)	27 (60.0%)	0.034^{S}
Mean Ephedrine Requirement (mg)	9.2±3.6	11.5±4.3	0.007^{S}
Adrenaline Requirement	1 (2.2%)	2 (4.4%)	0.500^{NS}

Figures in the parentheses indicate percentage. S = significant, NS = not significant;
P value reached from unpaired Student-t test.

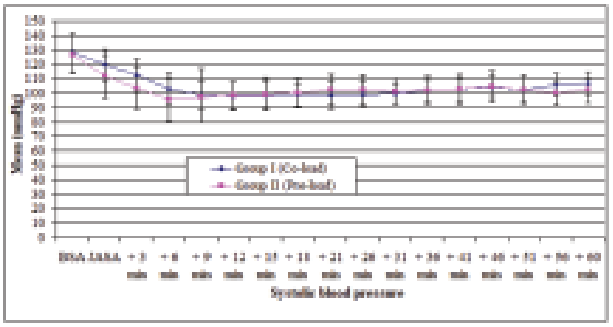

Fig. 1: *Line diagram showing systolic blood pressure of the patients (BSA = Before spinal anaesthesia; JASA = Just after spinal anaethesia)*

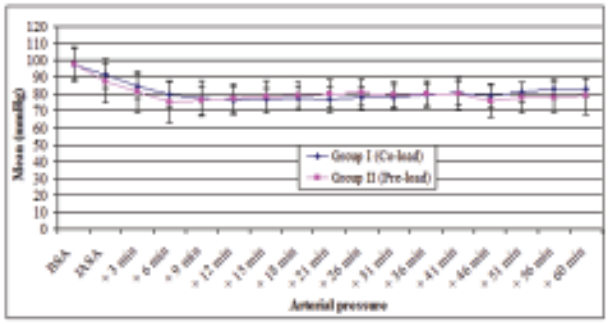

Fig. 2: *Line diagram showing mean arterial pressure of the patients (BSA = Before spinal anaesthesia; JASA = Just after spinal anaethesia)*

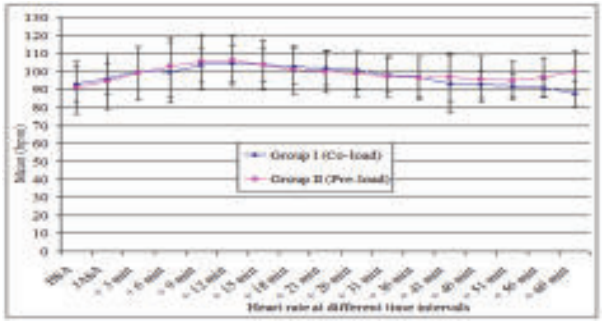

Fig. 3: *Line diagram showing mean heart rate at different time intervals (BSA = Before spinal anaesthesia; JASA = Just after spinal anaethesia)*

Discussion:

In this present study, most of the patients belonged to age d"30 years in both groups. The mean age was 24.4±4.4 years in group I (co-loading group) and 25.5±4.0 years in group II (pre-loading group). The difference was not statistically significant (p>0.05) between two groups. Dyer et al.[12] reported mean age 26.8±4.9 and 27.4±6.0 years for pre-load and co-load respectively, while Jacob et al.[14] found mean age 26.9±2.4 years in co-load and 26.7±2.6 years in pre-load group. Oh et al.[15] showed the mean age of patients in co-load group 33.7±4.0 years as compared to 33.5±3.5 years in pre-load group. The differences were not statistically significant in those studies and the results were found similar to the present study.

In this present study, we observed episodes of hypotension more in group II (pre-loading) in comparison to group I (co-loading), which was statistically significant. Jacob et al.[14] reported that 60% of patients in the pre-loading group developed hypotension. Previous studies using 15 ml/kg of lactated Ringer's as pre-load in the obstetric population reported the incidence of hypotension as 55%, as studied by Gajraj et al.[16] and 45.5%, as found by Tercanli et al.[17]. However, Oh et al.[15] studied comparing systolic blood pressure between the two groups at baseline, with 1 minute interval and found that hypotension occurred in 83% cases in pre-loading group and 53% in the co-loading group, which was statistically significant (P=0.026).

In our study, the heart rate changed to maintain the haemodynamic status after spinal anaesthesia. Comparatively higher heart rate was observed in group II than group I; however, the difference was not statistically significant. Similar results were observed by Dyer et al.[12], and Oh et al.[15]. In the pre-loading group heart rate was maintained around the baseline value till the induction of block and after which the heart rate increased considerably for around 10 minutes corresponding to interval of fall in mean arterial pressure. After this period, the heart rate settled to the base line values. In co-loading group there was early onset of rise in heart rate which persisted for about 10 minutes and touched the baseline sooner than the pre-load group.

In the present study, crystalloid co-load has been reported to reduce the ephedrine requirement to maintain the maternal blood pressure. Similarly, Dyer et al.[12] reported that the patients of co-load group required a lower median dose and a lower median number of ephedrine doses for the treatment of maternal hypotension than those receiving a conventional preload (P<0.05). Jacob et al.[14] showed that the mean number of doses of ephedrine required (2.6 in pre-load group vs 1.8 in co-load group; P<0.05) and the total dose of ephedrine used (14.2 mg vs 12.6 mg; P>0.05) were comparable statistically. Oh et al.[15] study, the mean number of supplemental ephedrine doses administered and the mean total dose of ephedrine administered was more in the pre-load group (15.2±11.9) than in the co-load group (7.5±8.6) and mean number of bolus doses and the total dose of ephedrine used were also found more; the differences were statistically significant.

There are several limitations of this study. This was a single-centre trial. The study population was selected from an urban hospital for a short period of time in Dhaka city. Hence, the results of the study may not be generalized and does not necessarily reflect the overall picture of the country. Small sample size was another limitation of the present study. Moreover, the lack of a control group or placebo group precluded determination of an absolute reduction in the incidence of hypotension; however, we did not include a placebo or control group (neither with pre-loading nor with co-loading) for ethical reasons.

Conclusion:

In summary, severity of hypotension and increased ephedrine requirement were evident in patients who received crystalloid pre-loading group (group II), which means crystalloid co-loading group (group I) was more capable to prevent spinal anaesthesia induced hypotension. However, further studies with larger sample and multi-centre trials along with high technical back up are recommended.

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