Original Article

Crystalloid Pre-Load or Co-Load In Prevention of Spinal Anaesthesia Induced Hypotension In Caesarean Section-A Comparative Study

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Summary

This single blind Randomized Controlled clinical trial was carried out in Gynaecology and Obstetrics Department in Dhaka Medical College Hospital in collaboration with Anaesthesia, Analgesia & Intensive care department in the same Hospital, during January' 2013 to December' 2014 to measure the changes in systolic arterial pressure (SAP), diastolic arterial pressure (DAP) and mean arterial pressure (MAP) in the parturient pre-loaded or co-loaded with crystalloid who undergone spinal anaesthesia and to assess the changes in the heart rate (HR) in both the groups and also to find out the adverse effect of spinal anaesthesia in both the groups as well as to compare the APGAR score of the newborn in both the groups. For this purpose, a total of 90 patients admitted in the above mentioned hospital for delivery were enrolled in this study, out of which 45 patients received Crystalloid pre-load (group I) and the rest 45 patients received co-load (group II). Parturient with singleton, uncomplicated pregnancy undergoing caesarean section with spinal anaesthesia were the inclusion criteria. The incidence of hypotension was 17(37.8%) in group I (co-load) and 27(60.0%) in group II (pre-load), which was significantly (p<0.05) higher in group II. The frequency of hypotension was more in group II (27). One incidence of hypotension was 6 in group I and 5 in group II. Two incidences of hypotension was 8 in group I and 11 in group II. Three incidences of hypotension was 3 in group I and 9 in group II. More than three incidences of hypotension was 2 in group II. Ephedrine required 17(37.8%) in group I (co-load) and 27(60.0%) in group II (pre-load). The difference was statistically significant (p<0.05) between the groups. Adrenaline required 1(2.2%) in group I (co-load) and 2(4.4%) in group II (pre-load). The difference was not statistically significant (p>0.05) between the groups. Nausea was 31.1% in group I (co-load) and 26.7% in group II (pre-load). Vomiting was 6.7% in group I and 20.0% in group II. Light headedness was 22.2% in group I and 24.4% in group II. Shivering was 20.0% in group I and 26.7% in group II. These differences was not statistically significant (p>0.05) between groups. APGAR score at 1 minute d"7 was 18(40.0%) in group I (co-load) and 28(62.2%) in group II (pre-load). APGAR score at 5 minutes d"7 was 6(13.3%) in group I and 3(6.7%) in group II. APGAR score at 1 minute d"7 was significantly (p<0.05) higher in group II.

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Introduction

Spinal anaesthesia is undoubtedly has become the most popular technique of anaesthesia for elective and emergency caesarean section. It is relatively cheaper and rapidly acting technique, which has better quality of sensory and motor block and can be easily administered compared to epidural anaesthesia. It also avoids complications and risks associated with general anaesthesia like failed intubation, aspiration of gastric contents and its depressant effects on neonates. However spinal anaesthesia is not without disadvantages[12,22,25]. It is associated with high incidence of hypotension, which is more common and profound in pregnant population that can result in both maternal and neonatal morbidity. Spinal anaesthesia causes sympathetic blockade, thus reduces in systemic vascular resistance resulting in hypotension. There is also veno dilatation in the lower part of the body. In pregnancy, this is further aggravated by the effect of gravid uterus and subsequent aorto-caval compression. All these results in decreased venous return and decrease in cardiac output and blood pressure. The resulting hypotension can cause nausea, vomiting, cardiovascular collapse and loss of consciousness in the mother. As uterine blood flow is pressure dependent, prolonged hypotension can cause fetal hypoxia and acidosis resulting in lower APGAR score[9,16].

Several measures have been used to reduce the incidence of hypotension following spinal anaesthesia. However no technique successfully eliminated hypotension. The practice of volume loading, that is rapid infusion of crystalloid before induction of spinal anaesthesia, dates from 45 years ago, apparently reduced the high incidence of hypotension in obstetric patients. Wollman and Marx (1968) advocated pre-emptive infusion of 1 liter of crystalloid for prevention of hypotension following spinal anaesthesia[8]. The aim of administration of fluid before spinal anaesthesia is to increase venous return and to restore central blood volume and cardiac output, as they decrease after subarachnoid block[22,25]. However, studies that are more recent found that traditional pre-loading techniques before spinal anesthesia for cesarean delivery are relatively ineffective, and their role in the prevention of hypotension has been questioned. One of the possible reasons for the decreased efficacy of crystalloid solutions as prophylaxis against spinal induced hypotension is that, as much as 75% of any crystalloid diffuses into the interstitial space. Pouta et al. (1996) suggested that crystalloid preload is rapidly redistributed and may induce atrial natriuretic peptide secretion resulting in peripheral vasodilatation followed by an increased rate of excretion of the preloaded fluid.

Drawbacks of pre-loading signifies the alternate timing in using crystalloid infusion. Rapid infusion of fluid bolus immediately after spinal anaesthetic drug administration has been termed 3 co-load”. It may be more rational & physiologically more appropriate because the maximum effect can be achieved during the time when the block and consequent vasodilatation are evolving. This may be more effective, as it maximizes intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution[8,17]. As this is a newer approach, experience is not so vast. A significantly lower incidence of post spinal hypotension and bradycardia was found in co-load than pre-load and patients in the co-load group required significantly less vasopressor than the pre-load group[1]. Hetastarch co-loading is as effective as pre-loading for the prevention of hypotension after spinal anesthesia for cesarean delivery[6]. Co-loading delayed the onset of hypotension in caesarean section[2].

The aim of this study was to compare the efficacy of crystalloid pre-loading and co-loading for prevention of spinal anaesthesia induced hypotension. The secondary outcomes from the study was the severity of hypotension, requirement of vasopressor for maintaining maternal BP, maternal nausea, vomiting, light-headedness, shivering and neonatal outcome in terms of fetal APGAR scores[13]. The particular importance was the time just after spinal anaesthesia and at the time of baby delivery, during which the risk of maternal hypotension was high[9].

Volume preloading with crystalloid solutions for the prevention of spinal anaesthesia induced hypotension received rapid acceptance since it was first introduced by Griess and Crandell (1965). Earlier studies demonstrated immense success of crystalloid preloading in prevention of maternal hypotension after spinal anaesthesia. However, the results of these studies have been questioned by other investigators, who showed that even large volumes of crystalloid have minimum preventive effect on the incidence of hypotension. The practice of preloading in obstetric patients undergoing caesarean section has now been abandoned by several anaesthesiologists. In the recent past, co-loading has generated interest for the prevention of spinal-induced hypotension. Mercier et al. (2007) suggested that applying fluid loading at the time of administering the spinal anaesthetic agent (co-load) may be more rational approach for the prevention of post spinal hypotension. Co-load might be physiologically more appropriate because the maximum effect can be achieved during the time of the block. This might increase intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution and excretion. This study is designed to test the hypothesis that rapid administration of crystalloids at the time of induction of spinal anaesthesia (co-load) is associated with less hypotension than the rapid administration of an equivalent volume of crystalloid pre-load. The secondary outcomes of the study are ephedrine requirement for maintaining the maternal blood pressure, maternal nausea, vomiting, light headedness and shivering and fetal APGAR scores in these patients.

Observations and Results

Distribution of study patients by age are as following:

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
	f	%	f	%	
≤ 30	38	84.4	37	82.2	0.211^{ns}
>30	7	15.6	8	17.8	
Mean±SD	24.4±4.		25.5±4.0		
Range (min-max)	(18-35)		(19-36)		

Group I-Co-load
Group II-Pre-load
f-Frequency

Table II *Distribution of the study patient according to weight (n=90)*

Weight (kg)	Group-I (n_1=45)		Group-II (n_2=45)		P value
	f	%	f	%	
40-49	17	37.8	9	20.0	
50-59	20	44.4	29	64.4	
60-69	6	13.3	6	13.3	
^{3}70	2	4.4	1	2.2	
Mean±SD	51.8 ±6.5		52.3±6.1		0.707^{ns}
Range	38-72		40-80		

Group I-Co-load
Group II-Pre-load
f=Frequency

Table III *Distribution of the study patients by gravida (n=90)*

Gravida	Group-I (n_1=45)		Group-II (n_2=45)		P value
	f	%	f	%	
1	19	42.2	18	40.0	
2	20	44.5	16	35.6	0.583^{ns}
3	5	11.1	9	20.0	
4	1	2.2	2	4.4	

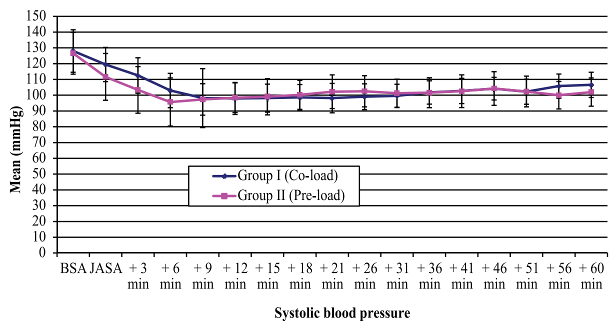

Fig. 1 *Line diagram showing systolic blood pressure of the patients*

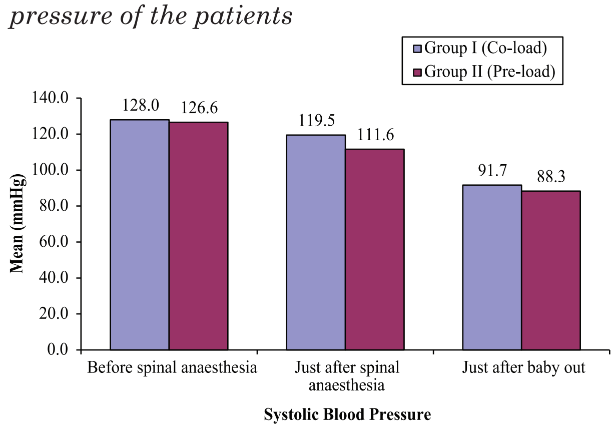

Fig 2 *Bar diagram showing mean systolic blood pressure of the study patient*

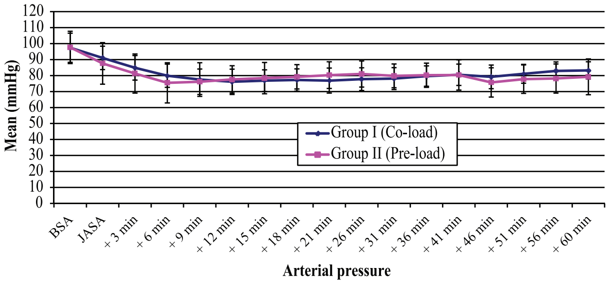

Fig 3 *Line diagram showing mean arterial pressure of the patients*

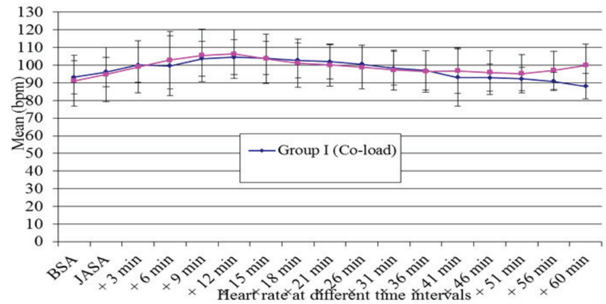

Fig 4 *Line diagram showing mean heart rate at different time intervals*

Table IV *Distribution of the study patients by duration of surgery (n=90)*

Duration of surgery (min	Group-I (n_1=45)		Group-II (n_2=45)		P value
	f	%	f	%	
≤60	40	88.9	39	86.7	
>60	5	11.1	6	13.3	
Mean±SD	53.56 ±7.76		53.24 ±5.72		0.839^{ns}
Range (min-max)	(44-78)		(40-66)		

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

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

Table VI *Distribution of the study patients by occurrence of hypotension (n=90)*

Incidence of hypotension	f	One occurrence	Two occurrence	Three occurrence	More than three occurrence
Group I	17	6	8	3	0
Group II	27	5	11	9	2

Table VII *Distribution of the study patients by ephedrine requirement (n=90)*

Ephedrine requirement (mg)	Group-I f	Group-II f	P value
Mean±SD	9.2±3.6	11.5±4.3	0.007^{s}
Range (min,max)	5,15	5,20	

Table VIII *Distribution of the study patients by adrenaline requirement (n=90)*

Adrenaline requirement	Group-I (n_1=45)		Group-II (n_2=45)		P value
	f	%	f	%	
Not required	44	97.8	43	95.6	0.500^{ns}
Required	1	2.2	2	4.4	

Table IX: *Distribution of the study patients by complications (n=90)*

Complications	Group-I (n_1=45)		Group-II (n_2=45)		P value
	f	%	f	%	
Nausea					
Present	14	31.1	12	26.7	0.641^{ns}
Absent	31	68.9	33	73.3	
Vomiting					
Present	3	6.7	9	20.0	0.062^{ns}
Absent	42	93.3	36	80.0	
Light headedness					
Present	10	22.2	11	24.4	0.803^{ns}
Absent	35	77.8	34	75.6	
Shivering					
Present	9	20.0	12	26.7	0.454^{ns}
Absent	36	80.0	33	73.3	

Table X *Distribution of the study patients by APGAR score (n=90)*

APGAR score	Group-I (n_1=45)		Group-II (n_2=45)		P value
	f	%	f	%	
1 minute					
≤7	18	40.0	28	62.2	0.034^{s}
>7	27	60.0	17	37.8	
5 minutes					
≤7	6	13.3	3	6.7	0.242^{ns}
>7	39	86.7	42	93.3	

Discussion

Hypotension is the most common side effect after spinal anesthesia. In this present study it was observed that incidence of hypotension was found 17(37.8%) in group I (co-load) and 27(60.0%) in group II (pre-load), which was significantly (p<0.05) higher in group II. In Jacob et al. (2012) study, 60 % of patients in the preload group developed hypotension. Previous studies using 15 ml/kg of lactated Ringer's as pre-load in the obstetric population have reported the incidence of hypotension as 55% (Gajraj et al. 1993) and 45.5% (Tercanli et al. 2002). Similarly, in Oh et al. (2014) study comparing systolic blood pressure between the two groups at baseline, with 1 minute interval, hypotension occurred 83% in pre-load group and 53% in the co-load group with p-value 0.026, which was statistically significant. In Khan et al. (2013), 70% hypotension occurred in the pre-load group and 44% in the co-load group, which was also statistically significant (p value .008).

Many studies have now questioned the value of traditional pre-loading techniques on prevention of spinal anesthesia induced hypotension during cesarean section. One of the possible reasons for the decreased efficacy of crystalloid solutions as prophylaxis against spinal induced hypotension is that as much as 75% of any crystalloid diffuses into the interstitial space[5]. Paula et al. (1996) suggested that pre-load is rapidly redistributed and may induce atrial natriuretic peptide secretion resulting in peripheral vasodilatation followed by an increased rate of excretion of the preloaded fluid. Mercier et al. (2004) compared one litre of crystalloid as pre-load and co-load and reported the incidence of hypotension as 62.5% and 50% respectively. Dyer et al. (2004) compared 20 ml/kg of RL solution (administered over 20 min) in parturients and reported 84% hypotension in the pre-load group and 60% in the co-load group. Cardoso et al. (2004) compared 10 ml/kg of RL as co-load and pre-load in parturients and reported the incidence of hypotension as 22.5% and 25% in the co-load and pre-load groups respectively. Maximum episodes of hypotension were found in preload group (Khan et al. 2013) It was also observed that systolic blood pressure significantly declined in both group just after spinal anaesthesia (Group-I 119.5 mm of Hg, Group-II 111.6 mm of Hg) and after baby out (Group-I 91.7 mm of Hg, Group-II 88.3 mm of Hg), more declined in group II (pre-load) than group I (co-load), which indicated that hypotension developed more in group II (pre-load).

In this study, the frequency of hypotension is more in group II. One incidence of hypotension was 6 in group I and 5 in group II. Two incidences of hypotension was 8 in group I and 11 in group II. Three incidences of hypotension was 3 in group I and 9 in group II. More than three incidences of hypotension was 2 in group II. This result was comparable to that in the studies by Mojica et al (2002); Kamenik & Paver-Erzen (2001).The rationale for effectiveness of co-loading can be explained by timing of hemodynamic events after spinal anaesthesia. Sympathetic nerve blockade is completed within the first 10 minutes after administration of bupivacaine in the subarachnoid space. There are high chances of hemodynamic changes like hypotension and bradycardia in this period[7,23]. Pre-loading before commencement of spinal anaesthesia may be effective but with considerable risk of volume overload. But co-loading makes available extra fluid in intravascular space during period of the highest risk of hemodynamic changes due to spinal anaesthesia[23]. So it leads to timely compensatory changes in cardiovascular system and limits fluid redistribution and excretion with reduced risk of fluid overload[3]. So co-loading is physiologically more appropriate and rational approach for parturients as has been proved in this study also. In busy operating room schedules with rapid turnover of cases ,co-loading would be a more efficient method to prevent spinal induced hypotension than pre-load[1]. So valuable time need not be wasted in pre-loading the parturients as pre-loading alone is not effective for the prevention of maternal hypotension during a caesarean section under spinal anaesthesia.

In this study it was observed that mean arterial pressure reduced in group I (co-load) just after spinal anaesthesia and baby out, but significantly more reduced in group II (pre-load), which indicate that hypotension developed more in group II (pre-load). In Oh et al. (2014) and Khan et al.(2013) study, showed immediately following pre-load there was a small increase in mean arterial pressure. This could be explained by the fact that parturients in pre-load group received almost 1 liter of crystalloid prior to the onset of sympathetic block. This additional fluid volume enhanced the pre-load and consequently improved the mean arterial pressure which lasted up to the time of initiation of block. After the induction of spinal anaesthesia, mean arterial pressure dropped below the baseline values due to intense vasodilation induced by the spinal block and lasted for around 10 minutes. Afterwards the mean arterial pressure settled to the base line value with the ongoing fluid administration. Soon after the intrathecal block, the co-load group recorded a decline in mean arterial pressure from the baseline due to earlier onset of sympatholysis with relatively lesser volume of fluid administrated, in comparison to pre-load group. The fall in MAP was sustained for 10 minutes after which the MAP reached the base line values as more of fluid was administrated at maximum possible rate.

In this study it was observed that comparatively higher heart rate observed in group II (pre-load), but this is statistically not significant. However, just after spinal anaesthesia & baby out the heart rate was significantly higher in group II (pre-load).

Crystalloid co-load has been reported to reduce the ephedrine requirement to maintain the maternal blood pressure[8]. In this current study it was observed that ephedrine required 17(37.8%) in group I (co-load) and 27(60.0%) in group II (pre-load). Mean ephedrine required was found 9.2±3.6 mg in group I and 11.5±4.3 mg in group II. The difference was statistically significant ($p<0.05$) between two groups. In Oh et al. (2014) 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 the differences in the mean number of bolus doses and the total dose of ephedrine used were statistically significant among the groups (p 0.015). Jacob et al. (2012) showed that the mean number of doses of ephedrine required (2.6 in group P and 1.8 in group C) and the total dose of ephedrine used (14.2 mg and 12.6 mg in groups P and C respectively) in the groups were comparable statistically.

In this series it was observed that adrenaline required 1(2.2%) in group I (co-load) and 2(4.4%) in group II (pre-load). The difference was not statistically significant (p>0.05) between two groups.

However main consequences of hypotension can cause nausea, vomiting, light headedness, shivering, cardiovascular collapse and loss of consciousness in mother as well as fetal hypoxia and acidosis due to placental hypoperfusion .Oh et al.(2014) showed nausea 60% in the pre-load group and 27% in the co-load group. In this present study it was observed nausea 31.1% in group I (co-load) and 26.7% in group II (pre-load). Vomiting was 6.7% in group I and 20.0% in group II. Light headedness was 22.2% in group I and 24.4% in group II. Shivering was 20.0% in group I and 26.7% in group II. The difference was not statistically significant (p>0.05) between two groups. Jacob et al. (2012) mentioned in their study that more number of patients developed nausea 19 versus 10 (P<0.05) and vomiting 14 versus 6 (P<0.05) in group P as compared to group C and these values were statistically significant.

In this current study APGAR score at 1 minute d”7 was 18(40.0%) in group I (co-load) and 28(62.2%) in group II (pre-load). APGAR score at 5 minutes d”7 was 6(13.3%) in group I and 3(6.7%) in group II. APGAR score at 1 minute d”7 was significantly (p<0.05) higher in group II. APGAR score at 5 minutes after birth in the two groups was statistically insignificant. Khan et al. (2013) study revealed that despite 40-70% incidence of hypotension in the predelivery period, neonatal outcome in terms of APGAR score was similar in both pre-load as well as co-load group and the difference was not statistically significant at birth, 1 min and 5 min after birth. This suggests that if it maintains maternal arterial blood pressure after spinal anesthesia with either crystalloid or vasopressors, the outcome would be the same after spinal anaesthesia.

Conclusion

This study was undertaken to compare the effectiveness of crystalloid co-load with pre-load in prevention of spinal anaesthesia induced hypotension with crystalloid pre-load in caesarean section. Age, gravida, duration of surgery, adrenaline requirement and complications were almost similar in both the groups. Comparatively higher heart rate was observed in group II (pre-load), but not statistically significant. Hypotension, ephedrine requirement and poor APGAR score was more in patients received crystalloid pre-load. Crystalloid co-load was effective in the prevention of spinal anaesthesia induced hypotension.

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