Original Article

A Comparison of Crystalloid Preloading and Co-Loading to Prevent Spinal Anaesthesia Induced Hypotension in Caesarean Section

M Masudul Haque[1], Mohammad Abdul Aleem[2], Arif Imtiyaz Chowdhury[3], Atiqul Islam[4]

[1]Professor (Col) and Classified Specialist in Anaesthesia, Combined Military Hospital (CMH) Chittagong, [2]Professor (Col) and Classified Specialist in Anaesthesia, Combined Military Hospital (CMH) Chittagong, [3]Graded Specialist in Anaesthesia, Combined Military Hospital (CMH) Chittagong, [4]Associate Professor of Anaesthesia, Mansur Ali Medical College, Sirajgonj

Corresponding Author: M Masudul Haque, E-mail: masud661@gmail.com

Abstract

Background: *Preloading of crystalloid is a traditional practice to prevent spinal anaesthesia induced hypotension. But co-loading seems to be more physiological and rational approach as effect was achieved during the time of spinal anaesthesia.*

Aims: *To compare the efficacy of crystalloid preloading and co-loading for prevention of hypotension during spinal anaesthesia in caesarean section.*

Methods: *This study was conducted in Department of Anaesthesia, Analgesia and Critical Care, Combined Military Hospital (CMH), Chittagong. Study was carried out over a period of six months from January to June 2017. Total 80 patients (40 in each group) were included in this study. Patients with ASA grade 1 & 2, aged 18-40 years were included. Patients with complicated pregnancy or failed spinal were excluded. Group-P (Preload group) received 15ml/kg Crystalloid solution (Hartmann's solution/lactated Ringer's solution), 20 min before administration of spinal anaesthesia. Group-C (Co-load group) received bolus of 15 ml/kg Crystalloid solution (Hartmann's solution /lactated Ringer's solution) at time of administration of spinal anaesthesia. Blood pressure was recorded at 1, 2, 3, 5 & 10 minutes. Patients received vasopressors when mean blood pressure reduced below 20 mm of Hg or systolic blood pressure dropped below 90 mmHg.*

Results: *Total study population was 80 patients underwent caesarean section. Mean age of the patients was 28.36±5.08 years and 28.25±5.06 years in group-P and C, respectively. Overall hypotension was noted in 23 patients (57.5%) of group-P and 19 patients (47.5%) of group-C. The difference between two groups was statistically insignificant (p=0.241). After induction of spinal anaesthesia at 1 minute hypotension was noted in 7 patients (17.5%) of group-P and in 13 patients (32.5%) of group-C, at 2 minutes in 21 patients (52.5%) of group-P and in 22 patients (55%) of group-C, at 3 minutes in 23 patients (57.5%) of group-P and in 24 patients (60.0%) of group-C, at 5 minutes in 17 patients (42.5%) of group-P and in 19 patients (47.5%) of group-C, at 10 minutes in 13 patients (32.5%) of group-P and in 7 patients (17.5%) of group-C hypotension was developed.*

Conclusion: *Both preloading and co-loading with 15 ml/kg of Crystalloid solution (Hartmann's solution /lactated Ringer's solution) when used alone, are ineffective for the prevention of hypotension in caesarean section receiving spinal anaesthesia. We recommend frequent monitoring of maternal blood pressure and prompt treatment of maternal hypotension with vasopressors for better neonatal outcomes.*

Keywords: *Caesarean section, Spinal anaesthesia, Crystalloid preload, Crystalloid co-load.*

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Introduction

Spinal anaesthesia is a popular and well-accepted technique for caesarean section. But hypotension following spinal anaesthesia is a common physiological complication with an incidence ranging from 25-75% among general population and a little higher in patients undergoing caesarean section, studies suggest that it develops in 80 % of cases[1]. Occasionally, spinal anaesthesia induced can result in important perinatal adverse outcomes, such as maternal nausea and vomiting, fetal acidosis and may be an important contributory factor for maternal death related to regional anaesthesia[2]. Mothers with pre-delivery hypovolaemia may be at risk of cardiovascular collapse because the sympathetic blockade may severely decrease venous return. As a consequence, prevention of spinal hypotension has been a key research area within the field of obstetric anaesthesia[3].

Many techniques are used to prevent or treat spinal anesthesia induced hypotension including preloading with fluids (colloid or crystalloid), avoidance of aortocaval compression (left uterine displacement) and administration of vasopressor drugs[4]. Intravenous fluids remain one of the most preferred modalities for prevention of spinal anaesthesia induced hypotension. Preloading takes time and many parturients reporting to operation theatre are emergent in nature. Preloading of crystalloid also rapidly redistributed, and may induce atrial natriuretic peptide secretion, resulting in peripheral vasodilatation followed by an increased rate of excretion of the preloaded fluid. A more rational approach might be to apply fluid loading at the time that spinal anaesthesia is starting to take effect. This might maximize intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution and excretion[5].

There are studies which show that there is not much difference between preloading and co-loading for prevention of spinal anaesthesia induced hypotension. Earlier studies showed that hypotension occurred in 68.4% of cases with crystalloid preload[6] and 59.3% of cases with co-load[7]. Another study reported 54.1% hypotension in crystalloid preload group and 46.9% in co-load group, which is not significant statistically[8]. The result of a study conducted locally was 44% hypotension occurred in crystalloid preload group and 36% in colloid preload group[9].

The present study was undertaken to compare the efficacy of crystalloid (Ringer lactate) preloading versus co-loading for prevention of spinal induced hypotension in caesarean section.

Materials and Methods

This study was conducted at Department of Anaesthesia, Analgesia and Critical Care, Combined Military Hospital (CMH), Chittagong from January to June 2017. After taking proper approval and written consent, patients of ASA grade 1 and 2 for cesarean section were included in the study. Patients were assigned randomly into two groups, group-P (Preload) and group-C (Co-load), by anaesthesiologist in charge of the case. One 18 gauze i/v cannulas were passed. Standard monitors like pulse oximeter and electrocardiogram were attached. Baseline pulse, blood pressure, temperature, respiratory rate, mean arterial pressure (MAP) by non invasive blood pressure (NIBP) technique measured before given preload or co-load to patients. Preload group-P received 15ml/kg Crystalloid solution (Hartmann's solution /lactated Ringer's solution), 20 min before administration of spinal anaesthesia. Co-load group-C received bolus of 15 ml/kg Crystalloid solution (Hartmann's solution /lactated Ringer's solution) at time of administration of spinal anaesthesia. Spinal anaesthesia was given in sitting position at L3/L4 space after aseptic measures with 0.5% hyperbaric 2.5 ml bupivacaine with 25 guage quinckie spinal needle. Pulse, blood pressure, mean arterial pressure (MAP) were measured after spinal anaesthesia at 1 minute interval till 3 minutes, then at 5 minutes and again at 10 minutes. All these readings were entered in a record form. Reduction of mean arterial pressure at least 20% from baseline after spinal anaesthesia was treated by injection of vasopressor (ephedrine or phenylephrine intravenous stat; nausea and vomiting if occur, were observed and treated accordingly).

All the data were entered in SPSS version 17 and analyzed using its statistical package. Mean±standard deviation was calculated for quantitative variables like age, systolic blood pressure, diastolic blood pressure and MAP at

baseline then follow up at 1 minute till 3 minutes, then at 5 minutes and 10 minutes following spinal anesthesia. Frequency and percentage of persons developing hypotension at 1-3 minutes, 5 minutes and 10 minutes were calculated in both the groups and was compared by applying Chi-square test. *P*-value of <0.05 was considered significant.

Results

Total 80 patients were included during the study period of six months from January to June 2017. Patients were divided into two groups (*40 in* each group). Group-P received Crystalloid preload and group-C was given Crystalloid co-load. Regarding age distribution, in group-P 25 patients (62.5%) and in group-C 27 patients (67.5%) were < 30 years of age while 15 patients (37.5%) in group-P and 13 patients (32.5%) in group-C were > 30 years old. Mean age of the patients was 28.36±5.078 years and 28.25±5.06 years in group-P and C, respectively (Table-1). Overall hypotension was noted in 23 patients (57.5%) of group-P and 19 patients (47.5%) of group-C. The difference between two groups was statistically insignificant (p=0.241) (Table-II).

After induction of spinal anaesthesia at 1 minute hypotension was noted in 7 patients (17.5%) of group-P and in 13 patients (32.5%) of group-C (Table-3), at 2 minutes in 21 patients (52.5%) of group-P and in 22 patients (55.0%) of group-C, at 3 minutes in 23 patients (57.5%) of group-P and in 24 patients (60.0%) of group-C, at 5 minutes in 17 patients (42.5%) of group-P and in 19 patients (47.5%) of group-C, at 10 minutes in 13 patients (32.5%) of group-P and in 7 patients (17.5%) of group-C hypotension was developed (Table III).

Table-I : *Distribution of cases by age (n=80)*

Age (Years)	Group-P (Pre-load)	Group-C (Co-load)
<30	25 (62.5%)	27 (67.5%)
>30	15 (37.5%)	13 (32.5%)
Total	40 (100%)	40 (100%)
Mean ± SD	28.36 ± 5.08	28.25 ± 5.06

Table-II: *Distribution of cases by overall hypotension (n=80)*

Hypotension	Group-P (Pre-load)	Group-C (Co-load)
Yes	23 (57.5%)	19 (47.5%)
No	17 (42.5%)	21 (52.5%)
Total	40 (100%)	40 (100%)

Chisquare= 1.36 P-Value= 0.241

Table-II: *Distribution of patients developing hypotension (n=80)*

Hypotension	Time	Group-P (Pre-load)	Group-C (Co-load)	*P*-value	Chi square
Yes	01Min	07 (17.5)	13 (32.5)	0.176	1.807
No		33 (82.5)	27 (67.5)		
Yes	02Min	21 (52.5)	22 (55.0)	0.716	0.052
No		19 (47.5)	18 (45.0)		
Yes	03Min	23 (57.5)	24 (60.0)	0.164	0.054
No		17 (42.5)	16 (40.0)		
Yes	05Min	17 (42.5)	19 (47.5)	0.184	0.058
No		23 (57.5)	21 (52.5)		
Yes	10Min	13 (32.5)	07 (17.5)	0.080	2.771
No		27 (67.5)	33 (82.5)		

Discussion

Hypotension following spinal anaesthesia is mainly occurs due to sympathetic blockade leading to peripheral vasodilatation and venous pooling of blood. As a result, there is decreased venous return and cardiac output leading to hypotension [10]. The risk of hypotension is increased in a parturient due to the higher level of block (T_4) required for the caesarean section, unique physiologic and anatomic changes of pregnancy and increased susceptibility to the effects of sympathectomy due to reduced sensitivity to the endogenous vasoconstrictors coupled with increased synthesis of endothelium-derived vasodilators. The spectrum of morbidity associated with hypotension may include but is not limited to a higher incidence of nausea, vomiting, dizziness, aspiration, syncope and cardiac arrhythmias[11]. The clinicians have used various methods and techniques such as leg wrapping, elastic stockings, optimizing patient's position, intravenous fluids and vasopressors from time to time to offset these hypotensive effects of spinal anaesthesia with varying degree of success. One of the foremost methods includes prophylactic administration of intravenous fluids before implementation of subarachnoid block to offset the hypotensive effects of sympathectomy by maintaining intravascular volume which is commonly called as pre-loading. The conflicting literary evidence and unequivocal results of the technique of pre-loading has made co-loading: A method of administration of intravenous fluid bolus immediately after the subarachnoid block equally popular [12].

In a bid to find the superiority of one methodology over the other, various studies have compared pre-loading and co-loading during spinal anaesthesia but have produced

inconsistent and mixed results without any substantial evidence of superiority of one method over the other. Majority of these clinical research studies have compared pre-loading with co-loading by administration of colloid solutions and concluded that the incidence of hypotension following spinal anaesthesia was similar as was the requirement of vasopressors in both the methodologies[13]. The results are almost similar when colloids have been replaced with crystalloids in studies of similar designs comparing the potential benefits of pre-loading and co-loading[14].

The efficacy of pre loading is questioned by the fact that pre-loading, especially with crystalloids, results in rapid redistribution of the fluid into the extravascular compartment thus offsetting the increase in the intravascular fluid volume. Also, this method may induce the secretion of atrial natriuretic peptide (ANP) which causes peripheral vasodilatation increasing the rate of excretion of pre-load fluid[15]. It has also been established that maternal hypotension occurs in the period just following the spinal injection and even the rapid bolus infusion of intravenous fluids in that period, a technique named 'co-load', does not prevent it while during the same period pre-load may be more beneficial[16] ·The various observational and prospective studies provide literary evidence from which it can be concluded that pre-loading may still be beneficial. However, there is another school of thought which has based their assumptions through numerous studies showing that even large volumes of intravenous fluids given as pre-load before spinal anaesthesia may not prevent spinal induced hypotension and therefore this practice has become less popular[17]. Co-loading is found to be a safer technique except for few concerns related to decreased oxygen carrying capacity and increased risk of pulmonary oedema in pregnant patients[18].

In one of the major meta-analysis involving 8 studies and a total of 518 patients, it was observed that incidence of hypotension was observed to be similar during comparison of pre-load and co-load. Even the spectrum of side effects was observed to be similar in two groups receiving pre-loading and co-loading as the incidence of nausea and vomiting have been found to be similar and is mainly due to reduced perfusion of the chemoreceptor trigger zone leading to hypoxia and its stimulation[19].

In present study, we have used Ringer Lactate solution for preloading and co-loading for spinal anaesthesia, as Ringer Lactate solution is the most commonly used fluid as a crystalloid in anaesthetic practice. However, the best method of preloading or co-loading, rate of administration, total volume of fluid remained controversial[2].

Studies have showed variable incidence of hypotension in the preload and co-load groups in obstetrical patients. In present study, hypotension developed in 57.5% and 47.5% of the patients in

preload group and co-load group, respectively (*P*-value = 0.241). Both groups of patients were required rescue doses of vasopressor. Our study confirms the finding of Manu Bose, et al[21]. They conducted a randomized study to compare the effect of preloading against co-loading with 15 ml/kg ringer lactate in preventing hypotension and bradycardia following spinal anaesthesia. They found that trend of heart rate and mean blood pressure at various time intervals was comparable for both preloading and co-loading groups. Number of incidence of bradycardia, 48.15% for both groups (*P*-value = 1). No. of incidence of hypotension was 14.52% for preloading group and 11.11% for co-loading group (*P*-value = 0.140). Incidence of nausea and giddiness were comparable between two groups (*P*-value = 0.239 and 0.491 respectively.

Concept of co-loading can be explained by the timing of hemodynamic events after spinal anaesthesia. Sympathetic nerve blockade is completed within the first 10 minutes after administration of bupivacaine in subarachnoid space. There are high chance of hemodynamic changes like hypotension and bradycardia in this period. Preloading before commencement of spinal anaesthesia may be effective but with considerable risk of volume overload. But, co-loading makes available extra fluids in intravascular space during period of the highest risk of hemodynamic changes due to spinal anaesthesia. So, it leads to timely compensatory changes in cardiovascular system and limits fluid redistribution and excretion with reduced risk of fluid overload. So, co-loading is physiologically more appropriate and rational approach[22,23].

Volume kinetic studies of Ringer Lactate solution during general and spinal anaesthesia by Ewaldsson et al[24] ,suggested that fluid administration at time of induction of anaesthesia better maintained the arterial pressure than by preloading, the incidence of hypotension as 62.5% and 50% in the crystalloid co-load and preload groups respectively when compare one liter crystalloid as preload versus co-load[24]. Dyer et al[25] who compared 20ml/kg crystalloid solution in parturients, reported that 64% hypotension developed in the preload group and 60% in the co-load group[25]. Cardoso et al[26] observed the incidence of hypotension as 22.5% and 25% in the co-load and preload groups respectively[26]. In contrast to above findings, Bouchnak et al[27] who compare 20 ml/kg of crystalloid as co-load or preload in the parturient noticed a higher incidence of hypotension in the co-load group (96.6%) versus preload group (86.6%)[27]. The differences in these studies may be due to the different amount of crystalloids used, definitions of hypotension used in the studies vary, height of block, drugs effect and the difference in the rates of administration of the crystalloids. The results of this study is close to the study of Bannerjee et al, a meta analysis, who noticed the incidence of hypotension 59.3% in the co-load group as compared with 62.4% in the preload group during spinal anesthesia in caesarean section. The difference between the two groups was statistically not significant[28].

Jacob, et al[29] conducted a study of crystalloid preload versus co-load for hypotension in 100 parturient scheduled for caesarean section under spinal anaesthesia and found that incidence of hypotension was 28 in preload and 23 in co-load group. High incidence of nausea (19 versus 10, p=0.0473) and vomiting (14 versus 6, p=0.0455) in preloading group as compared to co-loading group. The number of doses of vasopressor required and the total dose in the groups were comparable. They concluded that both preloading and co-loading with 15 ml/kg of Ringer Lactate solution were ineffective for spinal anaesthesia induced hypotension. Lastly, it is being emphasized that no single modality is effective for prevention of spinal anaesthesia induced hypotension in caesarean section alone and should be combined with timely and judicious use of vasopressors.

Conclusion

It is concluded that both crystalloid preloading and co-loading, when used alone, are not effective to prevent the spinal anesthesia induced hypotension in the obstetrical patients. We recommend frequent monitoring of maternal blood pressure and prompt treatment of maternal hypotension with vasopressors for better neonatal outcomes.

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