CRISTALLOID CO-LOAD: A BETTER OPTION THAN CRYSTALLOID PRE-LOAD FOR PREVENTION OF HYPOTENSION DUE TO SPINAL ANAESTHESIA IN ELECTIVE CAESAREAN SECTION

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ABSTRACT

Background: Maternal hypotension, the most frequent complication of spinal anesthesia for caesarean section, can be associated with severe nausea and vomiting which can pose serious risk to mother and neonate. Acute hydration with crystalloid prior to initiation of block for prevention of hypotension has been established as a routine. Although volume prehydration may reduce the incidence of spinal induced hypotension, it does not reliably prevent it. In this context, the present study was designed to test the hypothesis that rapid administration of crystalloid at the time of induction of spinal anaesthesia (co-load) is associated with less hypotension than preload.

Objective: Comparison of crystalloid preloading and rapid crystalloid co-loading for control of spinal anesthesia induced hypotension during lower segment caesarean section.

Methods: 80 patients of ASA I and II with singleton pregnancy were randomly allocated to equal groups of 40 each to receive either crystalloid pre-load or a co-load. Hypotension was defined as a decrease in systolic arterial pressure of more than 20% from the baseline or to less than 100mmHg as absolute value, which was treated by rapid i.v. fluid, Oxygen and boluses of phenylephrine in dose of 1µg/kg if required.

Results: Regarding the incidence of hypotension between the pre-load and the co-load group, maximum episodes were found in pre-load group (72.5%) and only 27.5% in the co-load group. The difference was statistically significant (P < 0.01). Also there was no evidence of use of vasopressor required to correct hypotension in co-load group.

Conclusion: A significantly lower incidence of hypotension was found in co-load group than preload group and severity of hypotension demanding vasopressor use was noted only in preload group.

KEYWORDS: Co-load, Preload, Maternal hypotension, Spinal anaesthesia.

INTRODUCTION

Spinal anaesthesia is used widely for elective and emergency caesarean section and has become the method of choice for anaesthesia for elective caesarean delivery because of higher maternal morbidity and mortality associated with general anaesthesia. Besides being economical, the advantages include rapid onset of action, better quality of sensory and motor block; ease of administration compared to epidural anaesthesia and avoiding complications and risks associated with general anaesthesia like failed intubation, risk of aspiration of gastric contents, depressant effects of general anaesthetics on neonates. It has been shown to block the stress response to surgery, decreases intra operative blood loss, lower the incidence of post-operative thromboembolism, and decrease morbidity and mortality in high risk patients. However spinal anaesthesia is not without disadvantages. It is associated with hypotension which is more common and profound in pregnant population with the incidence of up to 80%. The sympathetic blockade after spinal anaesthesia causes arterial and venodilatation resulting in hypotension. In pregnancy, this is further aggravated by the effect of gravid uterus and subsequent aorto-caval compression. Besides, this is related to increased sensitivity to local anaesthetics in pregnancy due to higher progesterone levels as well as due to mechanical effects of epidural venous engorgement leading to compression of subarachnoid space. The resulting hypotension can cause nausea, vomiting, cardiovascular collapse and loss of consciousness in the mother, as well as fetal hypoxia and acidosis due to placental hypoperfusion. So the physiological objective during spinal anaesthesia for caesarean section is the maintenance of cardiac output, and more specifically utero-placental blood flow, although blood pressure is

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usually used as a surrogate index of cardiac output. Hence protocols that aim to prevent hypotension during spinal anaesthesia for caesarean section may result in better outcome than those designed to treat hypotension once it has occurred, as proved by Dutta et al.

Several measures have been used to reduce the incidence of hypotension following spinal anaesthesia. The use of mechanical or pneumatic compression of lower limbs to reduce the peripheral pooling and increase venous return, a slight head down tilt after giving spinal anaesthesia, prophylactic use of vasopressor infusion have all been advocated to prevent hypotension following spinal anaesthesia.

Acute hydration for prevention of post spinal hypotension has been established as a routine and was first studied in humans in 1968 by Wollman. Wollman and Marx et al. advocated pre-emptive infusion of 1 liter of crystalloid for prevention of hypotension following spinal anaesthesia. The goal of administration of fluid before spinal block was to increase venous return and preserve central blood volume and cardiac output, both of which decrease after subarachnoid block. This practice is currently challenged because a number of studies have revealed that, although volume prehydration may reduce the incidence of spinal-induced hypotension compared with no prehydration, it does not reliably prevent it. Also crystalloid preload may be disadvantageous in certain groups such as those with renal impairment or with cardiac dysfunction if infused in large volumes leading to cardiac failure and pulmonary edema.

An alternative approach is to administer fluid bolus starting at the time of intrathecal injection of local anaesthetic. This practice has been termed "coload". It may be more rational and physiologically more appropriate because the maximum effect can be achieved during the time when the block and consequent vasodilatation are evolving. This might maximize intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution and excretion. However, experience with this approach is limited. In this context, the present study was designed to test the hypothesis that rapid administration of crystalloids at the time of induction of spinal anaesthesia (coload) is associated with less hypotension than the administration of an equivalent volume of crystalloid preload over 20 minutes. The secondary outcomes studied was severity of hypotension demanding vasopressor (phenylephrine) for maintaining maternal BP.

**MATERIAL AND METHODS**

This prospective randomized controlled study was done after institutional ethics committee approval and written informed consent on 80 patients of ASA grade I and II, aged 18-35 years with a singleton pregnancy presenting for elective caesarean section under spinal anaesthesia. Patients with history of hypertension, congestive cardiac failure, or any active medication for cardiovascular disease, foetal distress and any contraindication to spinal anaesthesia were excluded from the study. Patients were randomly allocated to two groups of 40 each to receive either crystalloid preload or coload and designated as:

Group P: Received preload of 20ml/kg of Ringers lactate solution over a period of 20min. Group C: Received coload of 20ml/kg of Ringers lactate solution at the maximal possible rate by pressurized giving set. No premedication was given to any patient. On arrival in the operation theater, 18 gauge intravenous (IV) catheter was secured in a peripheral vein and Ringers lactate solution pre-warmed to a temperature of 38 degree Celsius was kept ready. Patient was placed in left lateral position and baseline non-invasive blood pressure and heart rate measurements were taken. Spinal anaesthesia was administered in both groups using 2ml of 0.5 % hyperbaric bupivacaine, at the L3-4 level with a 25 gauge Sprotte pencil-point needle under all aseptic precautions. After withdrawal of spinal needle an antiseptic seal was applied at the site of lumbar puncture and the patients were then positioned supine, with 15 degree left lateral tilt. SBP measurements were recorded in both groups at two-minute intervals from the start of the regional block for the first 10 minutes, and then at 10-minute intervals until the completion of surgery for maximum period of 90 min. Hypotension was defined as a decrease in the systolic arterial pressure (SAP) more than 20% from the baseline reading or a decrease of SAP to less than 100mmHg as absolute value and was treated by rapid fluid administration and boluses of phenylephrine in dose of 1µg/kg if required. At delivery all patients received 20 IU of inj. oxytocin IV infusion. The height of the sensory block was assessed using pin prick sensory method. Surgery was allowed to proceed after a block to T6 had been established and the block level at the end of surgery was documented. In the event of excessive blood loss (>800 ml as assessed by volume in suction bottle and weighing of swabs), the patient was excluded from the study and treated appropriately. The statistical analysis of the data was done by using student’s t-test for difference of means and chi-square test referenced for p-value for their significance.

**Statistical Analysis:** Being the primary outcome, power analysis was based on incidence of hypotension in both groups provided that we studied 40 cases in each group. If the true mean difference in incidence of hypotension between the two drugs was similar to our calculated difference, we will be able to reject the null hypothesis with 89.9% power. Student’s t-test was used in the analysis with type I error probability equals 0.05. Calculations were done using PS Power and Sample Size Calculations Software, version 3.0.11 for MS Windows (William D. Dupont and Walton D. Vanderbilt, USA). Results were expressed as means ± standard deviation of the means (SD) or number (%). Comparison between different parameters in the two studied groups.
was performed using unpaired t test. Comparison between categorical data was performed using Chi square test. The data were considered significant if p value was equal to or less than 0.05 and highly significant if p value < 0.01. Statistical analysis was performed with the aid of the SPSS computer program (version 12 windows).

RESULTS
The two groups were comparable with respect to age, weight, average blood loss and duration of surgery. The average age of patients in Preload group was 24.2 years as compared to 24 years in coload group (p= .725) The average weight of patient in group P 62.67 and in group C 62.53 ( P= .915). Similarly the average duration of surgery in group P patients was 49.38 minutes and 47.75 minutes in group C. No statistically significant difference was observed in these variables between the two groups.

There was a significant difference (p value < 0.001) in incidence of hypotension. Severity of hypotension demanding vasopressor use was noted only in preload group. Maximum episodes of hypotension were found in preload group. About 72.5% of the parturients developed hypotension in that group while as in coload group only 27.5% parturients developed hypotension.

Baseline SBP was comparable in both groups. Mean baseline SBP in group C 112.53mmHg and group P - 112.97mmHg (p= 0.685) The fall in SBP was more in group P than group C. The mean SBP fell by 19.46mmHg in group P and 9.83mmHg in group C. This difference in fall was statistically significant at 8 minutes (P=0.031) and 10 minutes (P<0.001) after spinal anaesthesia. Beyond 10 mins there was difference in SBP but the difference was not statistically significant.

<table>
<thead>
<tr>
<th>Group</th>
<th>Use of vasopressor</th>
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<tbody>
<tr>
<td>Group C</td>
<td>YES: 0</td>
</tr>
<tr>
<td>Group P</td>
<td>YES: 2</td>
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DISCUSSION
Spinal anaesthesia is frequently used for caesarean section because it is a simple technique which produces fast and highly effective anaesthesia whilst avoiding the morbidity and mortality associated with general anaesthesia. Moreover the quality of analgesia is better and blood loss is minimized. [2] The most important physiological response to spinal anaesthesia involves cardiovascular system. Spinal anaesthesia is associated with a high incidence of maternal hypotension which can result in fetal distress and maternal discomfort. [9] Several preventive measures like use of mechanical or pneumatic compression of lower limbs [12] to reduce the peripheral pooling and increase venous return, a slight head down tilt [13] after giving spinal anaesthesia, prophylactic use of vasopressor infusion, crystalloid or colloid preload or crystalloid coload have been used to reduce the incidence of hypotension in caesarean section.
of hypotension following spinal anaesthesia. Even with the use of these preventive measures the incidence of spinal hypotension in parturients can be as high as 53%\(^2\) to 80%\(^2\)\(^3\). In this context the present study was conducted to test whether rapid administration of crystalloids at the time of induction of spinal anaesthesia (coload) is associated with less hypotension than the administration of equivalent volume of crystalloid preload over 20 minutes. The demographic variables like age of patients, height of the patients, weight of the patients, the dosage of local anaesthetic used for the spinal block and average total fluid administered were comparable among the two groups. In our study hypotension was defined as systolic blood pressure less than 20% of the calculated baseline or less than 100mmHg. Our study revealed that the incidence of hypotension was lesser in coload group (27.5%) as compared to the preload group (72.5%) and the difference was statistically significant (p=0.008). This result was comparable to that found in the studies by Mojica et al\(^2\)\(^4\) and Kamenik et al\(^2\)\(^5\). They reported that rapid infusion of 20ml/kg lactated Ringer’s solution did not reduce the incidence of hypotension compared with a control group, although patients who received rapid fluid after induction had a lower incidence of hypotension (47%).

Keeping the above facts in view, the concept of “coloading” was introduced for prevention of spinal induced hypotension. The rationale for effectiveness of coloading 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 subarachnoid space. There are high chances of hemodynamic changes like hypotension and bradycardia in this period.\(^2\)\(^3\),\(^2\)\(^6\) Preloading before commencement of spinal anaesthesia may be effective but with considerable risk of volume overload. But coloading makes available extra fluid in intravascular space during period of the highest risk of hemodynamic changes due to spinal anaesthesia.\(^2\)\(^7\) So it leads to timely compensatory changes in cardiovascular system and limits fluid redistribution and excretion with reduced risk of fluid overload. So coloading is physiologically more appropriate and rational approach for parturients as has been proved in our study also. In busy operating room\(^2\)\(^8\) schedules with rapid turnover of cases coloading would be a more efficient method to prevent spinal induced hypotension than preload. So valuable time need not be wasted in preloading the parturients as preloading alone is not effective for the prevention of maternal hypotension during a caesarean section under spinal anaesthesia.

In our study, preload group received almost 1 litre of crystalloid prior to the onset of sympathetic block. This additional fluid volume enhanced the preload and consequently improved the arterial blood pressure which lasted up to the time of initiation of block. After the induction of spinal anaesthesia, blood pressure dropped below the baseline values due to intense vasodilation induced by the spinal block and lasted for around 10 minutes. Afterwards the blood pressure settled to the base line value with the ongoing fluid administration and with vasopressor use in severe cases. Soon after the intrathecal block, the coload group recorded a decline in arterial blood pressure from the baseline due to earlier onset of sympatholysis with relatively lesser volume of fluid administrated, in comparison to preload group, to compensate for the vasodilation. The fall in SBP was sustained for 10 minutes after which the SBP reached the base line values as more of fluid was administrated. The mean SBP fell by (19.46 ± 5.68) mmHg in preload group as compared to 9.83 ± 3.13) mmHg in coload group. This difference in fall was statistically significant, 8 minutes (P=0.031) and 10 minutes (P<0.001) after spinal anaesthesia (figure 2).

Variable effect on heart rate in both the groups can be explained by different volume loading strategies, altered haemodynamics of pregnancy, anxiety, fear and apprehension associated with peripartum period and shivering (figure 4).

In our study, in preload group out of 29 patients with hypotension, 2 patients showed severe hypotension that was corrected by inj. Phenylephrine (figure 3). One with SBP of 76 mmHg and another with 78 mmHg who received inj. Phenylephrine 65µg i.v. and 60 µg i.v. at the end of 8 minutes respectively. However there was no evidence of use of vasopressor required to correct hypotension in coload group. Hypotension in coload group was well compensated by ongoing i.v. fluid in the form of coloading which was partly counteracting the effect of peripheral vasodilatation triggered by spinal anaesthesia induced sympatholysis. This resulted in less severe hypotension which was correctable with i.v. fluids without any vasopressor requirement. Crystalloid coload has been reported to decrease vasopressor requirement to maintain the maternal blood pressure.

**CONCLUSION**

Thus with all above results we conclude that, significantly lower incidence of post spinal hypotension was found in co-load group than preload group and vasopressor doses to treat hypotension were required only in pre-load group.

**REFERENCES**

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