

Crystalloid Co-Load: A Better Option Than Crystalloid Pre-Load For Prevention Of Postspinal Hypotension In Elective Caesarean Section

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Citation

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Abstract

Background: Spinal anaesthesia is widely used for elective and emergency caesarean delivery. However its main drawback is hypotension which can cause nausea, vomiting, cardiovascular collapse and loss of consciousness in mother as well as fetal hypoxia and acidosis due to placental hypoperfusion. Acute hydration with crystalloid prior to initiation of block for prevention of post spinal hypotension has been established as a routine, however this practice is currently challenged because various studies have revealed that 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 colloid at the time of induction of spinal anaesthesia (co-load) is associated with less hypotension than preload. The secondary outcomes of the study were ephedrine requirement for maintaining maternal blood pressure and neonatal outcome in terms of fetal APGAR score.

Methods: 100 patients of ASA I and II with singleton pregnancy were randomly allocated to equal groups of 50 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 a decrease of systolic arterial pressure to less than 90-100mm/Hg as absolute value, which was treated by boluses of ephedrine in doses of 5mg.

Results: Regarding the incidence of hypotension between the pre-load and the co-load group, maximum episodes were found in pre-load group (70%) and only 44% in the co-load group. The difference was statistically significant ($P=0.008$). Vasopressor doses needed in the co-load group were also significantly less with a p value of $.008$. No adverse neonatal outcome was seen in the study.

Conclusion: A significantly lower incidence of post spinal hypotension was found in co-load group than preload group and parturient in the co-load group required significantly less vasopressor doses than the pre-load group.

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 anaesthesia¹. Besides being economical, the advantages include rapid onset of action, better quality of sensory and motor block², ease of administration compared to epidural anaesthesia and avoiding complications and risks associated with general anaesthesia¹ 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.³

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%⁴. The sympathetic blockade after spinal anaesthesia causes arterial and venodilatation resulting in hypotension⁵. In pregnancy, this is further aggravated by the effect of gravid uterus and subsequent aorto-caval compression⁵. Besides, this is related to increased sensitivity to local anaesthetics in pregnancy due to higher progesterone levels^{6,7} as well as due to mechanical effects of epidural venous engorgement leading to compression of subarachnoid space⁸. 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 hypoperfusion⁹. 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 usually used as a surrogate index of cardiac output.¹⁰

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.¹¹ Several measures have been used to reduce the incidence of hypotension following spinal anaesthesia. The use of mechanical or pneumatic compression of lower limbs¹² to reduce the peripheral pooling and increase venous return, a slight head down tilt^{12,13} after giving spinal anaesthesia, prophylactic use of vasopressor infusion¹⁴ 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 Wollman¹⁵. 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 challenged¹⁶ 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^{16,17,18}. 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 edema¹⁹.

An alternative approach is to administer fluid bolus starting at the time of intrathecal injection of local anaesthetic. This practice has been termed "coload"¹⁰. 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 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 were severity of hypotension, ephedrine requirement for maintaining maternal BP, maternal nausea/vomiting and neonatal outcome in terms of fetal APGAR₂₀ scores. Of particular importance was the analysis of ephedrine requirement pre-delivery, the time period during which the risk of maternal hypotension and consequent fetal acidosis is greatest.

MATERIAL & METHODS

This prospective randomized controlled study was done after institutional ethics committee approval and written informed consent on 100 patients of ASA grade I & II, aged 20-35 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 50 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 pre-medication 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.

The patients of preload group (group P) received 20ml/kg of Ringers lactate over a period of 20 minutes before spinal anaesthesia and no additional fluid was given other than that required to keep iv peripheral cannula patent.

Spinal anaesthesia was administered in both groups using 3ml of 0.5 % of hyperbaric bupivacaine, injected slowly over 20 seconds at the L3-4 level with a 25 gauge Sprotte pencil-point needle under all aseptic precautions.

Patients of co-load group (group C) received identical fluid load of 20ml/kg via a pressurized giving set to administer the fluid at the maximum possible rate at the time of identification of CSF.

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 and no additional fluid was given other than that required to keep the iv line patent.

Non-invasive BP measurements were recorded in both groups at three-minute intervals from the start of the regional block for the first 20 minutes, and then at five-minute intervals until the completion of surgery. At least two further readings were taken three minutes apart after completion of surgery, and if ephedrine was still required, readings were continued until at least 10 minutes had passed without vasopressor. If surgery would be concluded in less than 30 minutes, readings would be continued each three minutes until at least 30 minutes or until no further vasopressor was required. Pulse oximetry and electrocardiograph monitors were also used.

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 90–100mmHg as absolute value and was treated by boluses of ephedrine in doses of 5mg.

At delivery all patients received 20 IU of inj. oxytocin IV and no further oxytocin was given intra-operatively. APGAR scores were recorded at birth, 1 min & 5 min after delivery to assess fetal outcome.

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. If the systolic arterial blood pressure decreased to less than 80% of the calculated baseline value, 5 mg ephedrine doses were administered every minute until systolic arterial pressure recovered to within 80% of the starting value. If the blood pressure decreased to less than 70% of the calculated baseline value, ephedrine 10 mg boluses were administered until BP returned to within 80% of the baseline. 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 following indices were taken and statistically analyzed:

- Systolic blood pressure - baseline, at 3 minutes intervals up to 21minutes, after that at 5 minutes intervals up to 60 minutes.
- Diastolic blood pressure - baseline, at 3 minutes intervals up to 21minutes, after that at 5minutes intervals up to 60

minutes.

- Mean arterial pressure - baseline, at 3 minutes intervals up to 21minutes, after that at 5 minutes intervals up to 60 minutes.
- Need for vasopressors(Ephedrine) between two groups.
- Neonatal assessment by Apgar score at birth, at 1 minute and at 5 minutes.

The statistical analysis of the data was done by using student's t-test for difference of means and chi-square test using statistical package for social sciences (SPSS version 11.5) and referenced for p-value for their significance. Any p-value less than 0.05 ($p < 0.05$) was taken as significant.

RESULTS

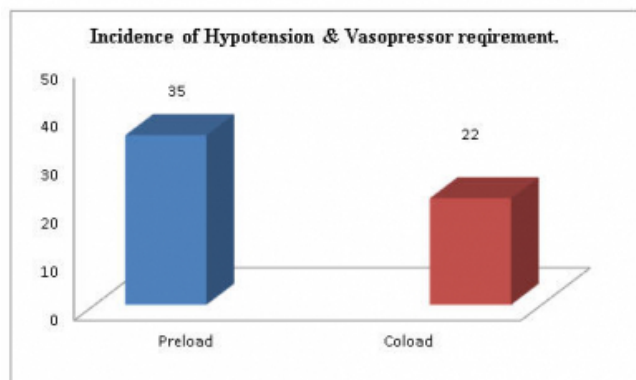
The two groups were comparable with respect to age, parity and duration of surgery. The average age of patients in Preload group was 25.06 years as compared to 25.56 years in coload group. In group P 44% of patients were primi gravida as against 51% in group C. Similarly the average duration of surgery in group P patients was 49.58 minutes and 48.54 minutes in group C. No statistically significant difference was observed in these variables between the two groups. No statistically significant difference was observed in the height of block achieved between the two groups. In preload group 4% of patients achieved sensory level of T3, 34% T4, 26% T5 and 36% T6, while as in coload group 4% patients achieved sensory level of T3, 36% T4, 26% T5 and 34% T6.

APGAR score at birth and at 1 and 5 minutes after birth in the two groups was statistically insignificant. In group P, average Apgar score at birth was 7.92, at 1 minute 9, at 5 minutes 9.64 while as in group C Apgar score at birth was 8.02, at 1 minute 9, at 5 minutes 9.64.

There was a significant difference (p value = .0081) in incidence of hypotension and subsequent vasopressor requirement between the two groups. Maximum episodes of hypotension were found in preload group. About 70% of the parturients developed hypotension in that group while as in coload group only 44% parturients develop hypotension.

Figure 1

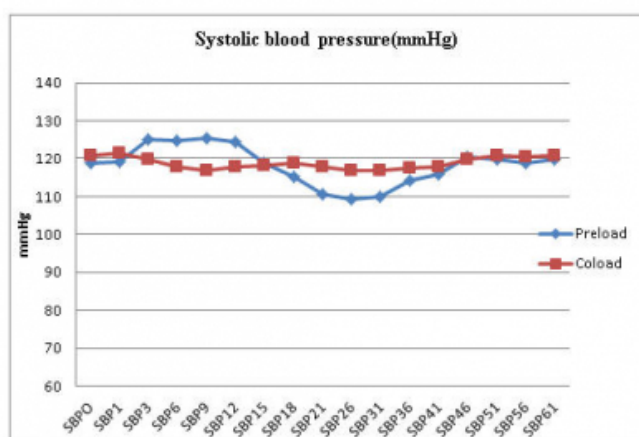
Incidence of hypotension & vasopressor requirement.



On comparing systolic blood pressure between the two groups at baseline, at 3 minute intervals up to 21 minutes and after that at 5 minute intervals till end of surgery in preload group(group P) and in coload group(group C),the difference was statistically insignificant.

Figure 2

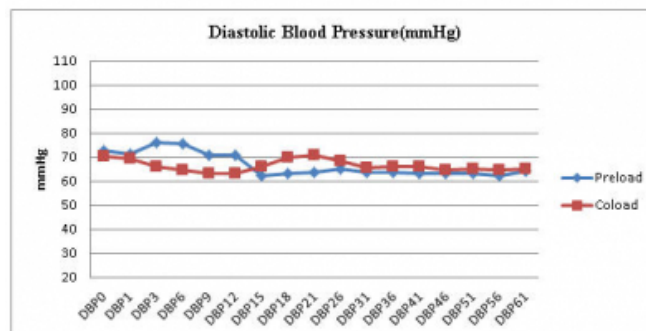
Difference in systolic blood pressure.



On comparing Diastolic blood pressure between the two groups at baseline, at 3 minutes intervals up to 21 minutes and after that 5 minutes interval till end of surgery in preload group(group P) and in coload group(group C),the difference was statistically insignificant.(NS).

Figure 3

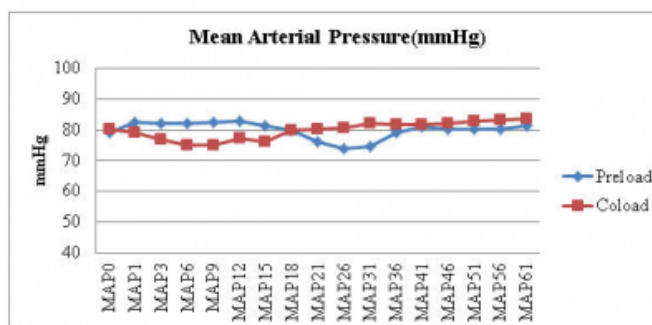
Difference in diastolic blood pressure.



On comparing the Mean arterial pressure(mm Hg) between the group P and group C at baseline and at different intervals till the end of surgery, no statistically significant difference was observed.

Figure 4

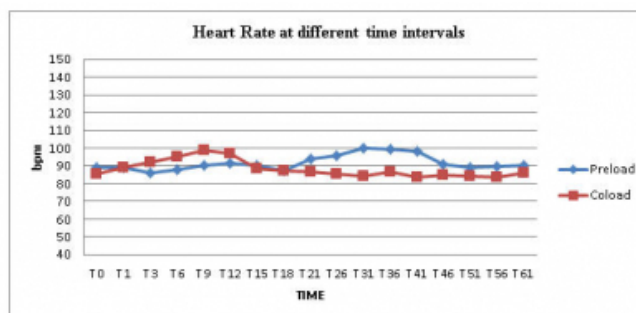
Difference in mean arterial pressure.



Statistically no significant difference was observed in heart rate persisted, at baseline, at 3 minutes intervals upto 21 minutes and also no statistically difference was observed at 5 minutes interval till the end of surgery between the group P and group C.

Figure 5

Difference in heart rate.



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 anaesthesia¹. Moreover the quality of analgesia is better and blood loss is minimized².

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 discomfort⁹.

Several preventive measures like use of mechanical or pneumatic compression of lower limbs¹² to reduce the peripheral pooling and increase venous return, a slight head down tilt^{12,13} after giving spinal anaesthesia, prophylactic use of vasopressor infusion,¹⁴ crystalloid or colloid preload or crystalloid coload have been used to reduce the incidence 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%²⁰ to 80%²¹.

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 secondary outcomes studied were ephedrine requirement for maintaining maternal blood pressure and neonatal outcome in terms of fetal APGAR score. 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 value or less than 90mmHg. Our study revealed that the incidence of hypotension was lesser in coload group (44%) as compared to the preload group (70%) and the difference was statistically significant ($p=0.008$) (Fig.1). This result was comparable to that found in the studies by Mojica et al²² and Kamenik et al²³. 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%). Other studies comparing crystalloid preloading and coload in obstetric population have reported variable incidence of hypotension.

All these studies revealed higher incidence of hypotension in preload group than in coload group which was comparable to that found in our study. In contrast to these findings, Bouchnak et al²⁴, reported higher incidence of hypotension in the coload group (96.6%) than in the preload group (86.6%) while comparing 20ml per kg of crystalloid as coload or preload in obstetric population. The wide variations in the incidence of hypotension in these studies may be explained by differences in the definition of hypotension used in the studies, the different volumes of crystalloids used and the differing rates of administration of the crystalloids.

Keeping the above facts in view, the concept of "coload" was introduced for prevention of spinal induced hypotension. The rationale for effectiveness of coload 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^{25,26}. Preloading before commencement of spinal anaesthesia may be effective but with considerable risk of volume overload. But coload makes available extra fluid in intravascular space during period of the highest risk of hemodynamic changes due to spinal anaesthesia²⁵. So it leads to timely compensatory changes in cardiovascular system and limits fluid redistribution and excretion²⁷ with reduced risk of fluid overload. So coload is physiologically more appropriate and rational approach for parturients as has been proved in our study also.

In busy operating room²⁸ schedules with rapid turnover of cases coload 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, immediately following preload there was a small increase in mean arterial pressure (Fig.4). This could be explained by the fact that parturients in preload group received almost 1 liter of crystalloid prior to the onset of sympathetic block. This additional fluid volume enhanced the preload 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 coload group recorded a decline in mean arterial pressure from the baseline due to earlier onset of sympatholysis with relatively lesser volume of fluid administered, in comparison to preload group, to compensate for the vasodilation. The fall in MAP was sustained for 10 minutes after which the MAP reached the base line values as more of fluid was administered at maximum possible rate (Fig.4). Despite these differences, the MAP between the two groups was statistically non-significant at all measured intervals. Moreover, the systolic and diastolic blood pressure of the two groups followed a trend (Fig 2,3) comparable to the mean arterial pressure with a statistically insignificant difference between the two groups.

In our study, heart rate changes reflected trend inverse to that of mean arterial pressure (Fig 5). In the preload group heart rate was maintained around the baseline value till the induction of block 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 coload group there was early onset of rise in heart rate which persisted for about 10 minutes and touched the baseline sooner than the preload group. In our study, there was statistically insignificant decrease in heart rate at all measured intervals between the preload group and the coload group.

Crystalloid coload has been reported to decrease ephedrine requirement to maintain the maternal blood pressure.¹¹ In our study, the mean number of supplemental ephedrine doses (6mg boluses) administered and the mean total dose of ephedrine administered was more in the preload group than in the coload group and the differences in the mean number of bolus doses and the total dose of ephedrine used were statistically significant among the groups (p value = 0.008). Our study revealed that despite 40-70% incidence of hypotension in the predelivery period, neonatal outcome in terms of Apgar score was similar in both preload as well as coload group and the difference was not statistically significant at birth, 1 min and 5 min after birth with the p value of 0.563, 1.000 and 0.69 respectively. Although studies have shown poor correlation between the degree of hypotension during spinal anesthesia and neonatal umbilical acid-base status and utero-placental perfusion²⁹, current evidence supports that the Apgar score is a better predictor of neonatal outcome than umbilical cord blood gas analysis^{30,20}. None of the groups showed Apgar score < 7,

despite a difference in the incidence of hypotension among the groups. This suggests that if we maintain maternal arterial blood pressure after spinal anesthesia with either crystalloid or vasopressors, the outcome would be the same after spinal anaesthesia. This reflects previous experience that transient decreases in blood pressure rapidly treated by vasopressor do not usually effect the fetal outcome³¹. Our study had several limitations. The lack of a control group or placebo group precluded determination of an absolute reduction in the incidence of hypotension. We chose to omit it as withholding fluids would not have been in keeping with our clinical practice. Adoption of non-blinding methodology was another drawback. Also, we did not investigate the correlation between umbilical artery pH and spinal-delivery interval, uterine incision-delivery interval and duration of hypotension by means of regression analysis, as did Dyer et al¹⁰. Moreover Apgar score was taken for rapid evaluation of fetal outcome in place of umbilical blood pH and blood gas status as the same was not readily available in our obstetric facility.

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