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Crystalloid Preload *Vs* Crystalloid Coloadfor the Prevention of Hypotension During Spinal Anesthesia

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Abstract

Introduction: Hypotension following Spinal Anesthesia (SA) is a common and troublesome Complication. Prophylactic fluid preloading with crystalloids is traditional practice to prevent hypotension. Timing of the infusion of the crystalloid is more important as its shorter intravascular stay. We hypothesized that crystalloid loading just after intrathecal injection compared to preload is more effective. *Methods:* 100 healthy adult patients of ASA 1 & 2, scheduled to undergo lower limb and abdominal surgery under spinal anesthesia, were studied. Patients in preload Group (A) were preloaded with RL at 15 ml/kg over 20 min periods prior to spinal anesthesia while in coload Group (B) received Ringer lactate 15 ml/kg as soon as spinal block is performed over 10 to 15 min. *Results:* The incidence of hypotension was low in coload group than compared to preload group. Mean arterial pressure at before spinal anesthesia was 100 mm Hg and 101 mm Hg, following subarachnoid block at 3 minutes dropped up to 85 mm Hg and 92 mm Hg, after 5 minutes 80 mm Hg and 88 mm Hg after 10 minutes 78 mm Hg and 90 mm Hg in preload and coload group respectively. *Conclusions:* In our study, we found that coload is more effective, than preload solution in prevention of hypotension in patients undergoing elective surgeries for abdomen and lower limb surgery under spinal anesthesia. So, it is unnecessary to spend time to deliver preload and delay surgery for the prevention of SA induced hypotension.

Keywords: Spinal anesthesia; Crystalloid; Preload; Coload.

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Introduction

Spinal anesthesia is the regional anesthesia obtained by blocking the spinal nerves in the subarachnoid space. The era of regional anesthesia dates back to more than a century ago (1884) when Koller discovered the local anesthetic properties of cocaine.[1] Subarachnoid block is one of the earliest forms of regional anesthetic techniques to be described.[2] The technique is now widely used by anesthetists.[3]

It has been shown that complication occurs during surgery like stress response to surgery, intraoperative blood loss, postoperative

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thromboembolism, morbidity and mortality in high-risk patients are reduced by spinal anesthesia.[4] Spinal anesthesia is a popular and well-accepted technique for surgery below umbilicus in adult patients.

Hypotension following Spinal Anesthesia (SA) is a common and troublesome Complication.[6] To reduce the incidence and severity of spinal hypotension various maneuvers have been used which includes preloading the patients with intravenous fluids with either crystalloid or colloid solution, and it is a common and traditional practice.[6]

Recently rapid fluid administration at the time of spinal block have been advocated because it expands intravascular volume at the time of maximum vasodilatation and avoids unnecessary delay in surgery.[7,8] Coload might be physiologically more appropriate because this might maximize intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution and excretion.[9] The present study was undertaken to compare the efficacy of crystalloid (Ringer lactate) preload *versus* coload for prevention of spinal anesthesia induced hypotension.

Materials and Methods

After obtaining institutional ethics committee approval and informed consent, 100 healthy adult patients of either gender, ASA 1 & 2, scheduled to undergo lower limb and abdominal surgery under spinal anesthesia, were included and studied. Patients who refused to give consent, H/o allergy to local anesthetis drugs, neurological problem, chronic hypertention, known stenotic heart disease, hematocrit less than 30%, altered coagulopathy, infection at local site were excluded. This prospective single blinded randomized controlled study was conducted on patients who were admitted at the Gujarat cancer and research institute, Ahmedabad, Gujarat, India.

Patients were admitted one day before the surgery and preoperative evaluation were performed with detailed history, physical examination including height, weight, evidence of spinal deformity and mental status of the patient. All the patients were kept nil per oral since 10 pm on previous day of surgery. Premedication like antacids and anxiolytics were given. Patients were randomly allocated into either preload or coload group with computerized Rendo Software.

Intravenous access was obtained by an 18 G IV cannula. Standard monitors like electrocardiography, pulse oximetry, noninvasive blood pressure were connected to the patient. The baseline Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP) and Oxygen Saturation (SpO_2) were recorded.

Patients in preload Group (A): Were preloaded with RL at 15 ml/kg over 20 min periods prior to spinal anesthesia, after which the IV infusion was slowed to a minimum rate throughout the study period.

Patient in coload Group (B): Received Ringer lactate 15 ml/kg as soon as spinal block is performed over 10 to 15 min and then after IV infusion is continued to minimum rate throughout study period.

With the patients in the left lateral position, under strict aseptic precautions, lumbar subarachnoid block was performed at L2-L3 or L3-L4 interspinous space using 23 G Quincke spinal needle. After the free flow of CSF was confirmed, 0.5% Bupivacaine hydrochloride heavy was injected. The patients were then immediately turned supine and pillow placed under shoulder and head low position given. The time of institution of subarachnoid block was noted. The level of spinal block at various intervals was checked by loss of pinprick sensation and the final level of the block was noted. Surgery was started when the sensory level of block reached to desired level according to surgery. Intraoperative monitoring includes basal heart rate, systolic blood pressure, diastolic blood pressure and mean arterial blood pressure, SpO_2 and respiratory rate. All the above parameters are recorded immediately after giving spinal block, at every 1 minute till 5 minute, than every 5 minute till 30 minute and then every 15 min till completion of surgery.

Hypotension was defined as a decrease in the systolic blood pressure by more than 25% from the initial baseline level. Incidence of hypotension, bradycardia, nausea and vomiting were noted. Total intravenous fluid, Urine Output (UO) and surgical blood loss were also noted. Hypotension is managed with Trendelenberg position, increase in fluid infusion rate and administering 100% oxygen by mask. If hypotension still persists, despite the above measures, Injection mephenteramine sulphate was administered IV 6 mg bolus at 1 minute interval until the blood pressure increased to acceptable levels. Bradycardia was defined as heart rate less than 50 minute. Bradycardia was

treated with intravenous injection atropine sulphate 0.6 mg. The number of doses atropine sulphate and mephenteramine sulphate drug was recorded

Statistics

The data were recorded on the patient's case record form and analyzed using MS Excel 2007 and SPSS version (Statistical Package for the Social Sciences). Student '*t*' test for independent group at 5% level of significance and *p*' value < 0.05 was considered significant.

Results

Fifty patients each in preload & coload group of both sex belonging to ASA Grade G I & II between 20 to 60 years of age were scheduled for surgeries under spinal anesthesia (Table 1).

There were no significant differences found in both the groups in relation to types of surgery (Table 2).

Table 1: Showing demographic data of both the group which were comparable and having no differences.

	Preload group	Coload group
Weight in kg		
41–50	23	24
51–60	19	19
61–70	8	7
Sex		
Male	22	22
Female	28	28
Age in years		
21–30	6	7
31–40	9	9
41–50	19	17
51–60	16	17

Table 2: Types of surgery

Type of Surgery	Preload Group	Coload Group
w.l.e. & s.t.g.	4	5
Below knee amputation	3	3
Groin dissection	2	3
Laparotomy	14	12
High inguinal orchidectomy	3	3
Mupit insersion	7	10
T.u.r.b.t.	9	8
Penectomy	2	3
Reduction & internal nailing	3	1
W.l.e. & curettage & cementing	3	2

Data were expressed as Number. Both group were compared by unpaired '*t*' test.

The mean Systolic Blood Pressure (SBP) before spinal anesthesia was 135 mm Hg in both the groups. Following subarachnoid block at 3 minutes SBP dropped up to 103 mm Hg and 122 mm Hg, after 5 minutes 97 mm Hg and 117 mm Hg after 10 minutes 97 mm Hg and 119 mm Hg in preload and coload group respectively. The fall in mean SBP is significant up to 60 minutes from spinal anesthesia. Number of patients in whom decrease in systolic blood pressure was more than 25% in preload group was 25 (50%) as compared to 17 (34%) in coload group, which was clinically significant. Incidence of hypotension in Preload group was higher when compared to Coload Group, which was statistically significant ($p < 0.05$) (Fig. 1 and Table 3).

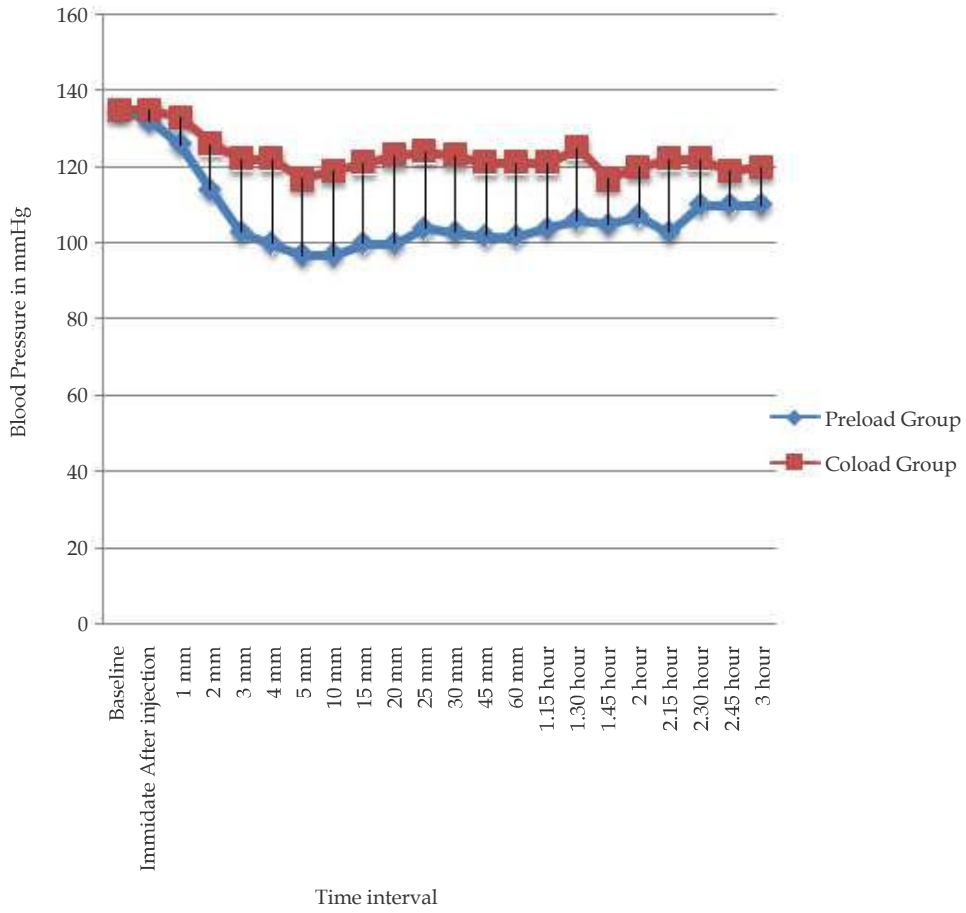

Fig. 1: Showing mean systolic blood pressure.

Table 3: Showing incidence of hypotension (fall in systolic blood pressure > 25% of base line).

Preload Group	Coload Group
25 (50%)	17 (34%)

The mean Diastolic Blood Pressure (DBP) before spinal anesthesia was 83 mm Hg and 84 mm Hg in preload and coload group respectively. Following subarachnoid block at 3 minutes DBP dropped up to 76 mm Hg and 77 mm Hg, after 5 minutes 71 mm Hg and 74 mm Hg after 10 minutes 70 mm Hg and 75 mm Hg and after 15 minutes 66 mm Hg and 75 mm Hg in preload and coload group respectively. The fall in mean DBP is significant up to 60 minutes from spinal anesthesia. There was significant difference in decrease in diastolic blood pressure between the two groups ($p < 0.05$) (Fig. 2).

The Mean Arterial Blood Pressure (MABP) before spinal anesthesia was 100 mm Hg and 101 mm Hg in preload and coload group respectively. Following subarachnoid block at 3 minutes MABP dropped up to 85 mm Hg and 92 mm Hg, after 5 minutes 80 mm Hg and 88 mm Hg after 10 minutes 78 mm Hg and 90 mm Hg in preload and coload group respectively. The fall in mean MABP is significant up to 60 minutes from spinal anesthesia. So, we conclude that there was significant difference in fall in mean arterial blood pressure in both the groups ($p < 0.05$) (Fig. 3).

We conclude that there was no significant change in Heart Rate in between Two Groups.

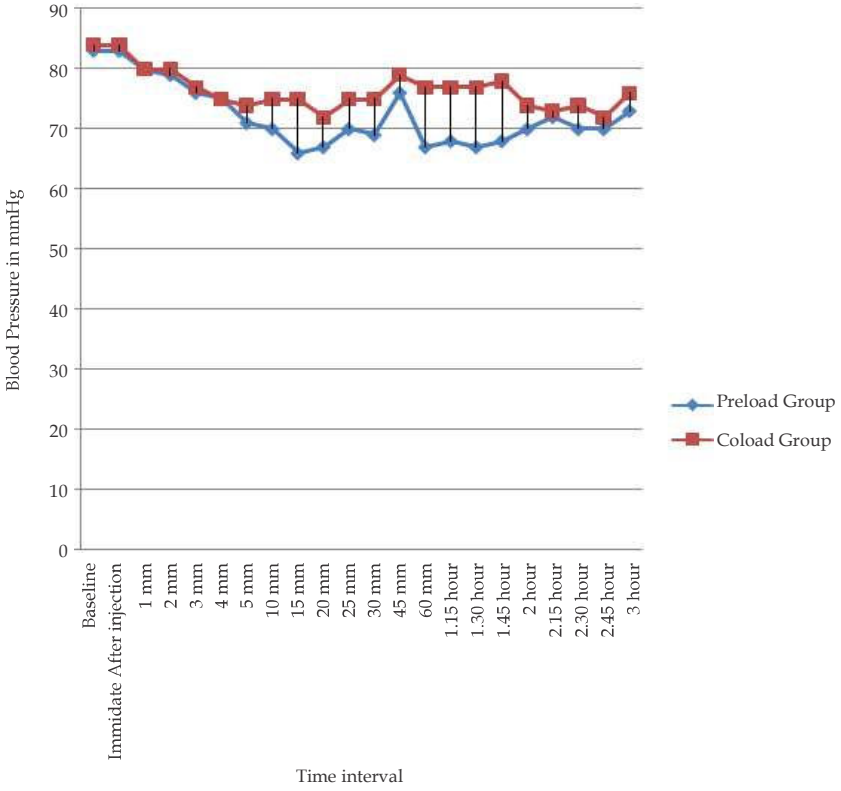

Fig. 2: Mean Diastolic blood pressure.

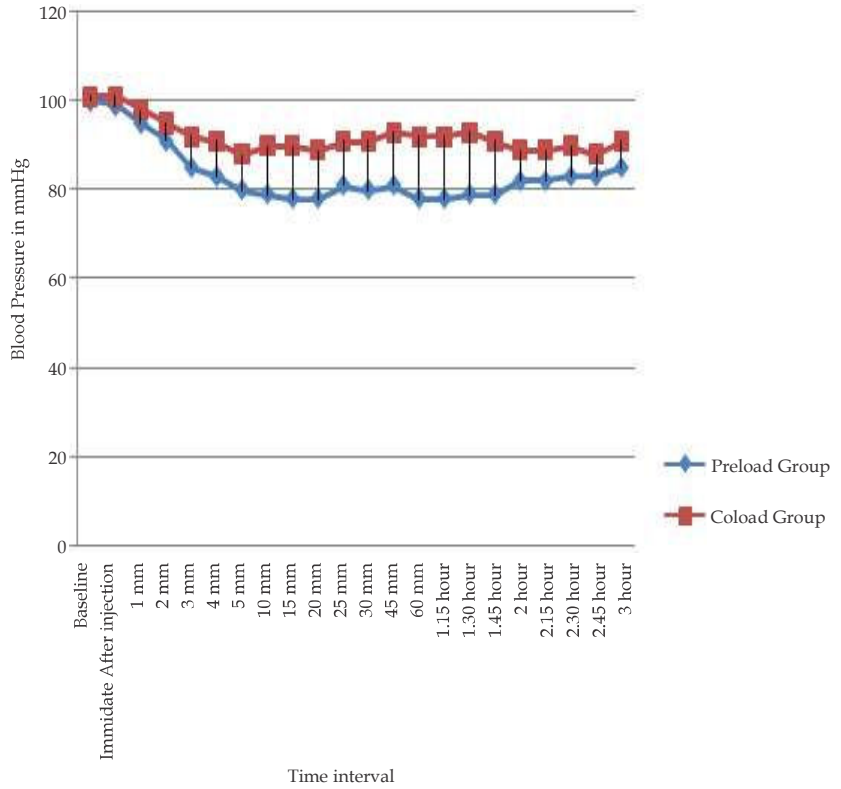

Fig. 3: Mean Arterial blood pressure.

Discussion

With the introduction of safe local anesthetic drugs and consequent reduction in the incidence of neurological complications, SA is still widely used in clinical practice. Due to its advantage such as rapid onset of action, uniformly distributed analgesia, profound muscle relaxation, maintenance of clear mentation intraoperatively, blunting of stress response, good postoperative recovery SA has replaced GA for lower abdominal and lower limb surgeries.[6] SA has proved to be extremely safe when managed well; however, there is still a risk of complications. Some of the complications of SA are hypotension, bradycardia, total spinal anesthesia and accidental intravascular injection. Hypotension is an important complication which may be preventable or avoidable.[7,8]

Various techniques have been used to prevent SA induced hypotension. Some of these are preloading with IV fluids, low-dose local anesthetics in SA with or without additives and use of vasopressors prophylactically.[8]

Of these preloading with IV fluids has been considered safe and effective method. Few studies have evaluated the value of crystalloid administration before spinal block *versus* no crystalloids in general surgical population. They found no significant difference in the incidence of spinal induced hypotension between patients receiving and not receiving crystalloids before spinal anesthesia. We have conducted a comparative study to compare efficacy of preloading and coloading of Ringer lactate solution in prevention of hypotension following spinal anesthesia. After subarachnoid block, there was progressive fall in blood pressure up to 20–30 minutes and maximum hypotension occurred between 5 and 15 minutes. In our study, incidence of hypotension has been found to be in 50% in patients of preload group and 34% in patients of coload group which were clinically significant.

Concept of coloading can be explained by the timing of hemodynamic events after SA. Sympathetic nerve blockade is completed within the first 10 minutes after administration of Bupivacaine hydrochloride in subarachnoid space. There are high chance of hemodynamic changes like hypotension and bradycardia in this period.[10,11] At same time, loading with fluid in intravascular space will decrease the chances of hypotension. Preloading before commencement of SA may be effective but with considerable risk of volume overload. But, coloading makes available extra fluids in intravascular space during period of the highest-risk of hemodynamic changes due to SA.[12] 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. Few studies, which compare the effects of preloading and coloading with RL in SA induced hypotension and support our study, are as follows:

In 2012, Siddharthkumar B et al.,[13] studied role of 20 ml/kg of RL as preload and coload in 30 patients in each group. They conclude that Coloading with 20 ml/kg of ringer lactate is as effective as preloading with same volume over 20 minutes in the context of prevention of spinal anesthesia induced hypotension in lower limb surgery. In our study, we found that coload with RL is better than preload for prevention of hypotension during SA.

In 2012 Jacob, et al.,[14] conducted a study of crystalloid preload *versus* coload for hypotension in 100 parturient scheduled for cesarean section under SA and found that incidence of hypotension was 30 in preload and 23 in coload group. They found high incidence of nausea (19 *versus* 10, p = 0.0473) and vomiting (14 *versus* 6, p = 0.0455) in preloading group as compared to coloading group. Frequent monitoring and prompt treatment with vasopressors were recommended. It is concluded that preloading before commencement of SA is not essential and coloading is equally effective for the prevention of SA induced hypotension.

In 2008 Manu Bose, et al.,[15] they conducted a randomized study to compare the effect of preloading against coloading with 15 ml/kg ringer lactate in preventing hypotension and bradycardia following spinal anesthesia in total 54 patients undergoing arthroscopies of lower limb. They found that trend of HR and MBP at various time intervals was comparable for both preloading and coloading groups. Incidence of hypotension was 18.52% for preloading group and 11.11% for coloading group. In our study, we found hypotention 50% in preload group and 34% in coload group.

In 2002 Jose L Mojica et al.,[16] conducted a randomized clinical trial to evaluate the efficacy of crystalloids in preventing spinal-induced hypotension and Cardiovascular Side Effects (CVSE) in total 404 surgical patients. Crystalloid administration at the time of spinal block resulted in an incidence of spinal induced hypotension almost identical to that seen in the Placebo Group, but led to a significant reduction in the risk of CVSE as compared with placebo (RR, 0.23; p = 0.019; number

needed to treat, 13) or with crystalloids administered before spinal block (RR, 0.26; p = 0.014; number needed to treat, 14). Administering crystalloids at the time of spinal block had a beneficial effect in preventing CVSE in general and specialty surgery patients undergoing spinal anesthesia as compared with administering crystalloids before spinal block or administering no crystalloids. This study favors the results of our study.

In 2001 Kamenik M et al.,[17] studied the effects of RL solution coload compared with preload on cardiac output after SA. They found that a sustained rise above baseline in coload group, whereas it returned to baseline in preload group and decreased in the group that received no fluid in general surgical population. They conclude that hypotention was more common in preload than soload group. This findings are similar to our study.

In 2001 Ewaldsson CA et al.,[18] found in their kinetic analysis of an IV infusion of RL as preload that a rapid fluid administration over two minutes after induction of spinal or general anesthesia for non-obstetric surgery might prevent hypotension caused by central hypovolemia. Similarly in our study, we found less hypotension in coload group. So, one should not spend valuable time to deliver preload before SA to prevent hypotension specifically in patients with ASA I & II risk patients and unnecessarily delay surgery.[14] Care must be taken for parturient and patients with ASA > III risk.

Conclusion

In our study, we found that coload is more effective, than preload solution in prevention of hypotension in patients undergoing elective surgeries for abdomen and lower limb surgery under spinal anesthesia. Coloading with 15 ml/kg of ringer lactate is more effective than preloading with same volume over 20 minutes in the context of prevention of spinal induced hypotension. So, it is unnecessary to spend time to deliver preload and delay surgery for the prevention of SA induced hypotension. However, we also concluded that incidence of hypotension was only reduced but not completely eliminated in this study.

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