

## ORIGINAL RESEARCH

# A Comparative Study of Crystalloid and Colloids as Preloading for Prevention of Spinal Hypotension in Cesarean Section

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## ABSTRACT

**Introduction:** Spinal anesthesia is one of the safest technique. The present study was conducted to assess effectiveness of preloading with crystalloid (Ringer's Lactate) and colloid (Haemaccel) in equal volumes for prevention of spinal hypotension in cesarean section.

**Material and Methods:** A total of 60 parturient of ASA grade I, scheduled for elective or emergency cesarean section were selected to participate in this clinical study. Patients were randomized to receive 7ml/kg ringer's lactate for group I and 7ml/kg haemaccel for group II within 15 minutes prior to induction of spinal anesthesia. Vital parameters (PR, SBP, DBP, and MAP) were recorded. Incidence of hypotension in both groups was noted and requirement of vasopressors to treat hypotension and total intravenous fluid required intraoperatively was also recorded.

**Results:** After induction of spinal anesthesia SBP decreased in both the groups, decrease in SBP was more severe in group I as compared to group II. The incidence of hypotension was lower with colloid preloading than with crystalloid preloading. Maternal cardiovascular status was better with colloid group than crystalloid group. In group I, 33.33% patients required mephenteramine to treat spinal hypotension compared to 80% in group II. Intraoperatively requirement of IV fluid in crystalloid group was 1050±263.05 ml and in colloid group was 527±301.12 ml.

**Conclusion:** We concluded that colloid (haemaccel) 7 ml/kg volume preload was better choice for prevention of hypotension following spinal anaesthesia in caesarian section in comparison to ringer's lactate solution.

**Keywords:** Preloading, Crystalloid, Colloid, Ringer lactate, Hetastarch, Hypotension, Spinal anaesthesia

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## INTRODUCTION

Spinal anesthesia is a rapid, simple and reliable technique of anesthesia for parturients undergoing cesarean section. It has become the method of choice for anaesthesia for elective caesarean delivery because of higher maternal morbidity and mortality associated with general anaesthesia.<sup>1</sup> Though spinal anesthesia has several advantages like excellent surgical analgesia, inhibits stress response, post operative analgesia, good skeletal muscle relaxation, airway instrumentation can be avoided, reduced chances of post operative deep vein thrombosis and pulmonary embolism.<sup>2</sup> However, a higher incidence of hypotension is one of disadvantages of this technique. Maternal hypotension is a common side effect after spinal anesthesia for cesarean delivery, with an incidence of up to 83%.<sup>3</sup>

Several measures have been advocated to decrease the severity of spinal induced hypotension like use of prophylactic vasoconstrictor, leg compression, trendelenberg position, left sided uterine displacement, but fluid preloading is commonly practiced.<sup>4-8</sup> Various types of crystalloid and colloid have been used as preloading fluid for prevention of spinal hypotension. Different crystalloids commonly used in preloading are Ringer lactate, normal saline and colloids that are used in preloading are gelatin, dextran, hetastarch, pentastarch, tetrastarch.

Volume preloading with crystalloid solutions for the prevention of spinal-induced hypotension received rapid acceptance since it was first introduced by Griess et al.<sup>9</sup> Although pre loading with ringers lactate or N.S was routine practice for prevention of hypotension, but it is not very efficient in preventing hypotension as only 1/3 of administered dose of RL or NS will remain in the intravascular compartment which may explain why hypotension associated with spinal anaesthesia cannot be completely eliminated by crystalloid preloading. And also the value of preloading has been questioned from time and time again. Too much crystalloids cause overloading of pulmonary circulation resulting in signs of over hydration<sup>10</sup> to prevent this small volumes of colloids are tried. The aim of present study was to compare the clinical efficacy of a crystalloid to that of colloids in equal volumes for prevention of spinal hypotension, requirement of vasopressors and requirement of total fluid given during surgery to maintain stable hemodynamics.

## MATERIALS AND METHODS

After obtaining the institution ethical committee approval and written informed consent from all the patients. The study was a prospective, randomized double blind. Two groups parallel study was conducted in 60 parturient, age between 20–30 years of ASA grade I scheduled for elective or emergency cesarean section. This clinical study was carried out in Department of Anaesthesiology at Shri Vasantrao Naik Government Medical College and Hospital, Yavatmal, Maharashtra. Patients were consecutively assigned into either group I (n=30) or group II (n=30) depending upon the preloading fluid used. The patients having allergic reaction to drug, food or having bronchial asthma, obese patients (weight more than 90 kg), patients having height less than 150 cm, patients of foetal distress, hydraomnios, sever PIH, IUGR, hand or cord prolapsed were excluded from study. A detailed pre-anaesthetic evaluation including history and a thorough general and systemic examination and all relevant investigations were done for all the patients. Premedication was not given in any of the cases.

On operation table, baseline pulse rate, blood pressure and respiratory rate were measured. And intra venous access was taken with 18 G intracath, now patients in the group I received 7ml/kg crystalloid (Ringer's lactate) solution and those in the group II received 7 ml/kg colloid (haemaccel) solution. Amount of the fluid was calculated according to the body weight. Both these solutions were infused over a period of 15 minutes before performance of subarachnoid block. After preloading, all patients received Ringer's lactate solution (4 ml/kg) for fluid maintenance. Pulse rate, blood pressure and respiratory rate were recorded after preloading was over.

Under all aseptic precautions, lumbar puncture was performed with 23-gauge disposable needle through midline approach with patient in left lateral decubitus position at third or fourth Lumbar intervertebral space. After free flow of CSF, 1.2 ml of 5% hyperbaric xylocaine (with 7.5% dextrose) was injected into subarachnoid space. Immediately after the injection, the spinal needle was withdrawn and patient

turned to supine position. Sensory level was achieved at T6 level and blockade was checked using pin prick method. The time required to achieve maximum sensory level was noted. After the induction of spinal anesthesia pulse rate and blood pressure were recorded every minute for first 10 minutes, then every 5 minutes for next 20 minutes and then after every 15 minutes until operation was over. Respiration and urine output also monitored throughout operative procedure. Patients were observed for nausea, vomiting, shivering rash, itching, hypotension, bronchospasm and anaphylaxis. Hypotension was considered when decrease in systolic blood pressure 20% more of baseline or less than 90 mmHg and was treated with leg elevation, 100% O<sub>2</sub> mask, fast infusion of Ringer's lactate solution (100-200 ml/min). Patient received mephenteramine 3 mg if above treatment fails. If hypotension is not treated within 60 sec then injection mephenteramine is repeated. Bradycardia is treated with injection atropine 0.6% mg. All patients received oxytocin or methylergometrine IM or IV. For sedation injection pentazocine 15 mg and Midazolam 1mg were administered intravenously after delivery of baby.

Postoperatively all patients observed for any complications like nausea, vomiting, hypotension and any neurological complications, sensory level of analgesia were noted at the end of surgery.

## STATITICAL ANALYSIS

Statistical analysis was performed using ANOVA, paired t test and chi square test.

## RESULTS

A total of 60 parturient who underwent elective or emergency caesarean section were enrolled for the study and were randomly divided into two groups. The demographic profiles of the patients in both the groups were comparable with regards to age, weight and height, difference was statistically non significant. The distribution as per ASA status was similar and mean duration of surgery was comparable in both the groups, (Table 1). Table 2 describes the difference in vital parameters before and after preloading in both crystalloid and colloid groups was not significant.

After spinal anaesthesia, we found no significant change in mean pulse rate in both the groups. Table 3 describes that after induction of spinal anesthesia systolic blood pressure in the crystalloid group decreases to minimum after 9 minutes and rises again at the end of surgery. In colloid group systolic

Variable	Group – I	Group –II
Age ( yrs)	24.63±3.49	23.33±2.92
Weight (kgs)	54.10±3.65	55.20±3.29
Height (cms)	154.53±2.92	155.20±3.57
Duration of surgery (min)	57.93±11.85	60.76±8.28

**Table-1:** Comparison of demographic data in both the groups (Demographic data i.e. age; weight, height and duration of surgery in Group I and Group II were statistically comparable)

Variable	Group – I		Group –II	
	Before	After	Before	After
Pulse Rate/min.	94±10.41	93.47±10.06	95.20±11.10	95.09±11.02
Systolic Blood Pressure (mmHg)	127.33±9.66	126.27±9.03	124.86±13.27	125.20±12.95

**Table-2:** Comparison of vital parameters before and after preloading (The difference was not statistically significant. Both groups were comparable before and after preloading.)

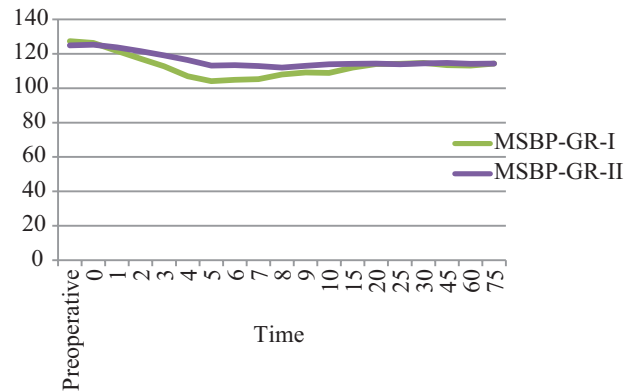
blood pressure constantly decreases throughout the surgery. Table suggests there was definite fall in the blood pressure in both groups. Calculating P value in different time intervals, it was seen that severity of fall in SBP was significantly more in group I as compared to group II. Mean systolic blood pressure at various times interval was at lower level in group I than group II (figure1). The overall incidence of hypotension was 28.33. In group I, 12 (40%) patients and in group II, 5(16.67%) patients had developed hypotension after spinal anaesthesia, (Figure 2).

Intraoperatively requirement of IV fluid (Ringer’s lactate) in crystalloid group was higher (1050±263.05 ml) as compare to in colloid group (527±301.12 ml). In the crystalloid group, 33.33% patients (Out of 12 patients) while in colloid group 80% patients (Out of 5 patients) required mephenteramine in addition to intravenous fluid to treat spinal hypotension. The mean dose of mephenteramine required in group I and in group II were found to be 7.5±3.35 and 4.5±1.5 mg respectively. Two patients from group I and one patient from group II required atropine to treat spinal hypotension associated with bradycardia. Table 4 shows that comparison of intraoperative complications like hypotension, nausea, vomiting,

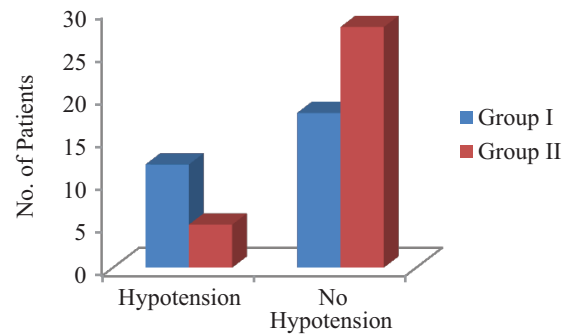
bradycardia between both the groups.

**DISCUSSION**

Hypotension during spinal anaesthesia is the most common



**Figure-1:** Change in systolic blood pressure after induction of spinal anaesthesia



**Figure-2:** Graphical presentation of incidence of spinal hypotension

Complications	Group - I	Group -II	Total
	No. (%)	No. (%)	No. (%)
Hypotension	12 (40)	5 (16.67)	17 (23.33)
Nausea	5 (16.67)	2 (6.67)	7 (11.67)
Vomiting	4 (13.33)	2 (6.67)	6 (10)
Bradycardia	2 (6.67)	1 (1.33)	3 (5)
Rash	0	2 (6.67)	2 (3.33)

**Table-4:** Comparison of intraoperative complications between two groups

Time (min)	Pulse rate (mean ±SD)		SBP (mean ±SD)	
	Group I	Group II	Group I	Group II
Preoperative	94 ±10.41	95.20±11.10	127.33±9.66	124.86±13.27
0	93.47±10.06	95.10±11.02	126.27±9.03	125.20±12.95
1	92.80±9.80	95.20±10.15	121.60±9.27	123.66±11.32
2	93.40±10.20	95.33±10.93	117.13±10.07	121.46±9.99
3	93.33±13.50	96.86±11.25	112.83±9.66	119.09±10.56
4	94.33±14.45	96.33±11.83	107.00±10.74	116.33±13.19
5	94.60±15.95	95.93±15.07	104.13±10.73	113.09±14.15
6	93.20±16.72	97.33±13.76	104.93±9.69	113.40±12.47
7	92.06±16.81	97.93±13.70	105.33±12.40	112.80±9.87
8	93.73±13.91	97.66±13.34	108.06±7.87	111.93±8.41
9	93.26±13.10	98.86±11.76	109.13±6.76	112.93±7.82
10	93.93±12.92	98.40±12.27	108.93±6.44	113.80±7.47
15	93.20±11.60	97.53±11.52	111.93±6.10	114.06±7.03
20	91.60±10.07	95.83±10.80	114.06±6.07	114.20±8.94
25	89.93±8.14	95.00±11.01	114.20±6064	113.86±8.94
30	90.00±8.10	94.46±11.09	114.67±6.18	114.40±8.34
45	89.06±8.27	94.20±10.90	113.47±6.10	114.67±7.90
60	88.73±8.77	93.33±11.05	113.13±6.16	114.06±8.41
75	88.67±8.76	91.93±10.00	114.26±6.82	114.20±8.38

**Table-3:** Comparison of pulse rate and blood Pressure in both groups at different time interval intraoperatively (Above table suggests there was definite fall in the blood pressure in both groups.)

and an immediate complication which is due to sympathetic blockade leading to decrease in venous return. Spinal induced hypotension may be associated with significant patients discomfort and even mortality. As it decreases uteroplacental blood flow, it adversely affects the foetal and maternal outcome. So it is very important to prevent any fall in blood pressure after spinal anaesthesia. Various measures have been tried for prevention of hypotension induced by spinal anaesthesia.

- 1) Volume preloading<sup>11,12</sup>
- 2) Trendelenberg position<sup>12</sup>
- 3) Left lateral tilt in obstetric patient
- 4) Leg compression by inflatable splint<sup>6</sup>
- 5) Prophylactic use of vasopressors<sup>13-15</sup>

All measures have their own limitations. Volume preloading has emerged as the single most important and effective technique to counter the resultant hypotension. Different crystalloid and colloid have been used as preloading fluid for prevention of spinal hypotension. In a study by Yokoyama N et al<sup>16</sup> the authors found that in healthy patients with full-term pregnancy, volume preloading has little effect on maternal hemodynamics and neonatal outcomes, suggesting that stable perioperative management is possible with or without volume preload before spinal anaesthesia. However, they opined that preloading may be needed for prevention of hypotension in emergency cases. Many studies have now questioned the value of traditional preloading techniques for prevention of spinal anaesthesia induced hypotension during cesarean section. The first study to challenge the role of preloading was that of Clark et al<sup>13</sup> who studied the use of fluid loading, both with and without uterine displacement, comparing them with controls with neither prophylactic measure.

Though preloading with crystalloid solution is mainstay in prevention of spinal hypotension results are unsatisfactory. The crystalloids can be used to maintain water and electrolytes and to expand intravascular volume. 75% of its volume diffuses into interstitial space; hence its effect in expanding plasma volume is only transient. Ringer lactate is used as a preloading fluid because it is most physiological fluid, its osmolality is similar to plasma and most of the authors have selected it in their studies as preloading fluid.<sup>17-21</sup> According to Park et al<sup>22</sup> and Rout et al<sup>23</sup> rapid administration of crystalloid preload did not change the maternal haemodynamics and hypotension cannot be eliminated by volume preloading in supine wedged parturient.

Hence colloid preloading offsets hypotension and hypovolemia more effectively than is achieved with crystalloid solution. The advantages of colloids over crystalloids are— increase in plasma oncotic pressure, produced by colloids helps to expand plasma volume and by remaining in intravascular compartment for a longer time counteract the hypovolemic effect. For preloading crystalloid requires 3 to 4 times more than colloid to achieve the same degree of expansion of plasma volume. Wennberg EF et al<sup>24</sup> demonstrated that colloid solutions contain large molecules that do not

immediately redistribute throughout the extra cellular fluid compartment. So they do not decrease plasma colloid oncotic pressure as much as crystalloid solution, and intravascular volume is better maintained.

We selected ringer lactate (crystalloid) and haemaccel (colloid) in equal volumes as preloading fluid before giving spinal anaesthesia. Volume of preload infusion was significantly higher in crystalloid group (1050±263.05 ml) than colloid group (527±301.12 ml).

After induction of spinal anaesthesia change in mean pulse rate at various time intervals was not significant from its preoperative and after preloading values. Decrease in pulse rate occurred in both the groups at the end of surgery. Our result correlates with the study of Rout et al,<sup>23</sup> Baraka et al,<sup>25</sup> Karinen et al.<sup>26</sup>

According to Lee JA, Atkinson RS and Watt JW, fall in SBP of 20 mm of Hg from baseline value is considered as physiological effect of spinal anaesthesia.<sup>27,28</sup> Fall in SBP between 20-30 mm of Hg from baseline considered as mild hypotension and fall in SBP >30 mm of Hg is considered as severe hypotension. We found no significant change in systolic blood pressure after preloading in both the groups. After induction of spinal anaesthesia SBP decreased in both groups. Decrease in blood pressure from their control values was more in group I than group II. This finding compares with Baraka et al<sup>25</sup> and Karinen et al.<sup>26</sup> In their study, they found no significant difference in mean control SBP value as well as decrease in mean systolic arterial pressure in both groups. In present study hypotension was defined as decrease in systolic blood pressure to both to less than 80% of baseline value of less than 90 mmHg. The overall incidence of hypotension in ringer lactate group was 40% and in haemaccel group hypotension was 16.67%. This finding and results regarding requirement of extra ringer's lactate solution and vasopressor to treat hypotension were comparable with study of Satproedprai et al,<sup>17</sup> Baraka et al,<sup>25</sup> Karinen et al<sup>26</sup> and Riley et al.<sup>29</sup> They reported that the incidence of spinal hypotension for elective caesarean section was less in colloid group as compared with crystalloid group. Hallorwath et al<sup>30</sup> was found that combination of crystalloid and colloid solutions preloading offset hypotension of epidural anaesthesia during caesarean section more effectively than crystalloid alone. Karinen J, Ransen et al<sup>26</sup> studied the effects of crystalloid 1 litre or colloid 500 ml as pre loading fluids. Their results showed higher incidence of hypotension in crystalloid group (62%) and lower incidence of hypotension in the colloid group (38%). Gajraj NM,<sup>31</sup> Tercanli S<sup>32</sup> studies using 15 ml/kg of ringer's lactate as preload in the obstetric population have reported the instance of hypotension as 55% and 45.5%. Carrey. JS<sup>33</sup> Shows 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. Pauta et al<sup>34</sup> suggested that 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. In a study by Duggal et al<sup>35</sup> found that preloading reduces the incidence of hypotension after spinal anaesthesia and preloading with 6% HES (colloid) better prevents the hypotension as compared to Ringer lactate (crystalloid). Allergic or anaphylactic reactions were not observed in both the groups. Incidence of nausea was 16.67% and 6.67% for group I and group II while the incidence of vomiting was 13.33% and 6.67% for group I and group II respectively. Rash which observe in group II only was 6.67%. These findings compare with study of Hallworth et al,<sup>30</sup> Buggy et al,<sup>36</sup> and Chan et al.<sup>37</sup>

## CONCLUSION

From the observations in the present study, it can be concluded that colloid (haemaccel) 7 ml/kg as volume preload before spinal anaesthesia was useful in attenuating incidence of spinal hypotension in ASA grade I parturients undergoing caesarean section and its routine use for preloading before spinal anaesthesia for caesarean section can be considered.

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