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Comparison of Crystalloid Preload and Crystalloid Coload for Prevention of Maternal Hypotension During Spinal Anaesthesia for Elective Caesarean Section: A Prospective Comparative Study

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ABSTRACT

Background: Maternal hypotension is the predominant complication after spinal anaesthesia for caesarean delivery. Administration of intravenous crystalloids before spinal anaesthesia (preload) and concurrently with spinal injection (coload) are prevalent methods employed to mitigate hypotension. Recent evidence indicates that coload may enhance hemodynamic stability.
Aim: To evaluate the efficacy of crystalloid preload versus crystalloid coload in mitigating maternal hypotension during elective cesarean section under spinal anaesthesia.
Methods: A prospective comparative study was performed in the Department of Anaesthesiology at Shri Atal Bihari Vajpayee Medical College over six months. Eighty ASA I–II parturients scheduled for elective caesarean section under spinal anaesthesia were randomly assigned to two groups: Group P (Preload, n=40) received 15 ml/kg of Ringer Lactate before spinal anaesthesia, whereas Group C (Coload, n=40) received the identical volume immediately following intrathecal injection. The incidence of hypotension, the necessity for vasopressors, maternal adverse effects, and neonatal outcomes were analysed.
Result: The prevalence of maternal hypotension was markedly greater in Group P (55%) compared to Group C (27.5%) ($p=0.012$). The average ephedrine requirement was significantly higher in Group P (9.8 ± 5.1 mg) than in Group C (5.1 ± 3.4 mg) ($p<0.001$). The occurrence of nausea and vomiting was significantly greater in Group P (32.5%) compared to Group C (12.5%) ($p=0.031$). Neonatal Apgar scores at 1 and 5 minutes were similar between the groups ($p>0.05$).
Conclusion: Crystalloid coload was superior to crystalloid preload in mitigating maternal hypotension and decreasing vasopressor requirements during spinal anaesthesia for elective caesarean section, without impacting neonatal outcomes.

Keywords: *Caesarean section, spinal anaesthesia, crystalloid preload, crystalloid coload, hypotension.*

INTRODUCTION

Spinal anaesthesia is the preferred anaesthetic method for elective caesarean sections due to its rapid onset, profound neural blockade, minimal maternal morbidity, and negligible fetal drug exposure. [1,2]

Maternal hypotension, however, is the most prevalent complication, occurring in 60% to 80% of cases. Hypotension can result in maternal nausea, vomiting, dizziness, reduced uteroplacental perfusion, and negative neonatal outcomes if not swiftly addressed. [3,4]

Multiple strategies have been suggested to avert hypotension induced by spinal anaesthesia, such as left uterine displacement, vasopressor administration, and intravenous fluid loading. Historically, the administration of crystalloid

preload before spinal anaesthesia has been extensively utilised. Nonetheless, the rapid redistribution of crystalloids from the intravascular compartment to the interstitial space has raised concerns regarding the efficacy of preload. [5,6]

The notion of crystalloid coload originated from the recognition that fluid administration at the initiation of sympathetic blockade may more effectively counteract the vasodilation and venous pooling linked to spinal anaesthesia. Numerous randomised controlled trials have shown enhanced hemodynamic stability and diminished vasopressor requirements with crystalloid coload in contrast to preload. [7-11]

A meta-analysis conducted by Banerjee et al. initially indicated no significant difference between preload and coload strategies; however, the authors proposed that postponing surgery for fluid administration was unwarranted.[12]

A subsequent meta-analysis by Ni et al., involving 824 patients, revealed that crystalloid coload significantly decreased the incidence of maternal hypotension, vasopressor utilisation, and maternal nausea and vomiting in comparison to preload. [13]

Despite increasing evidence supporting coloading, discrepancies in institutional practices persist. This study was conducted to compare crystalloid preload and crystalloid coload in parturients undergoing elective caesarean section with spinal anaesthesia at Shri Atal Bihari Vajpayee Medical College and Research Institute.

MATERIALS & METHODS

Study Design: Prospective randomised comparative study.
Study Centre: Department of Anaesthesiology, Shri Atal Bihari Vajpayee Medical College.
Study Duration: Six months.
Sample Size: 80 patients.

Group Allocation

- Group P (Preload): 40 patients
- Group C (Coload): 40 patients

Inclusion Criteria

The study comprised parturients aged 18 to 35 years with singleton pregnancies scheduled for elective cesarean section under spinal anaesthesia. Only patients classified as American Society of Anesthesiologists (ASA) physical status Grade I or II were included in the study. All qualified participants provided written informed consent before inclusion.3rd

Exclusion Criteria

Individuals with pregnancy-induced hypertension (PIH) or preeclampsia, pre-existing cardiac conditions, multiple gestations, or any contraindications to spinal anaesthesia were excluded from the study. Contraindications to spinal anaesthesia encompass patient refusal, coagulation disorders, local infection at the injection site, severe hypovolemia, elevated intracranial pressure, and documented allergy to local anaesthetic agents. Moreover, patients with any condition that could affect maternal hemodynamic responses or confound the study outcomes were excluded.

Anaesthetic Technique: All patients received spinal anaesthesia using 2.0 ml of 0.5% hyperbaric bupivacaine.
Group P: RL 15 ml/kg before spinal anaesthesia.
Group C: RL 15 ml/kg immediately after intrathecal injection.

Statistical Analysis

The data were input into Microsoft Excel and analysed utilising Statistical Package for the Social Sciences (SPSS) software version 26.0. Continuous variables were represented as mean ± standard deviation (SD), whereas categorical variables were displayed as frequencies and percentages. Comparisons between the two study groups were conducted utilising the independent Student's t-test for continuous variables and the Chi-square test for categorical variables. A p-value below 0.05 was deemed statistically significant, and all statistical analyses were conducted at a 95% confidence interval.

Results

The demographic attributes of the study participants are delineated in Table 1. The average age of patients in Group P was 26.8 ± 3.9 years, whereas in Group C it was 27.1 ± 4.1 years. The disparity was not statistically significant ($p = 0.741$). The average body weight was similar in both groups, with Group P averaging 66.4 ± 7.2 kg and Group C averaging 67.2 ± 6.8 kg ($p = 0.612$). The average gestational age was 38.4 ± 1.1 weeks in Group P and 38.6 ± 1.0 weeks in Group C, indicating no statistically significant difference ($p = 0.394$).

The findings demonstrate that both groups were equivalent regarding baseline demographic and obstetric characteristics. The lack of statistically significant differences among the groups indicates effective randomisation and reduces the probability of confounding factors affecting the study results. Consequently, any discrepancies noted in maternal

haemodynamic parameters and other outcome measures can be ascribed chiefly to the fluid administration strategy rather than differences in patient characteristics.[Table 1]

Table 1: Demographic Characteristics

Variable	Group P	Group C	p value
Age (years)	26.8 ± 3.9	27.1 ± 4.1	0.741
Weight (kg)	66.4 ± 7.2	67.2 ± 6.8	0.612
Gestational Age (weeks)	38.4 ± 1.1	38.6 ± 1.0	0.394

The occurrence of maternal hypotension after spinal anaesthesia was markedly greater in Group P (crystalloid preload) than in Group C (crystalloid coload). Hypotension was observed in 22 patients (55%) in Group P, while only 11 patients (27.5%) in Group C experienced hypotension. In contrast, 18 patients (45%) in Group P and 29 patients (72.5%) in Group C exhibited stable hemodynamic parameters without the onset of hypotension.

Statistical analysis demonstrated a significant difference between the two groups ($p = 0.012$), indicating that crystalloid coload was more effective than crystalloid preload in mitigating spinal anaesthesia-induced hypotension during elective caesarean section. The diminished occurrence of hypotension in the coload group may be ascribed to the concurrent administration of intravenous fluids with the initiation of sympathetic blockade, thus facilitating enhanced intravascular volume expansion and hemodynamic stability. These findings align with prior research by Oh et al.[7] and Ni et al.[13], which indicated a reduced incidence of maternal hypotension with crystalloid coload in contrast to preload. Consequently, crystalloid coload seems to be a more effective approach for sustaining maternal blood pressure during caesarean delivery under spinal anaesthesia.[Table 2]

Table 2: Incidence of Hypotension

Hypotension	Group P	Group C	p value
Present	22 (55%)	11 (27.5%)	0.012*
Absent	18 (45%)	29 (72.5%)	

Table 3: Vasopressor requirement

Variable	Group P	Group C	p value
Ephedrine (mg)	9.8 ± 5.1	5.1 ± 3.4	<0.001*

The average ephedrine requirement was markedly greater in Group P (9.8 ± 5.1 mg) than in Group C (5.1 ± 3.4 mg). The difference was statistically significant ($p < 0.001$), indicating that patients administered crystalloid coload required reduced vasopressor support to sustain blood pressure. The results indicate that crystalloid coload offered superior haemodynamic stability and was more efficacious in preventing hypotension induced by spinal anaesthesia compared to crystalloid preload.[Table 3]

Table 4: Nausea and vomiting

Variable	Group P	Group C	p value
Nausea/Vomiting	13 (32.5%)	5 (12.5%)	0.031*

The prevalence of nausea and vomiting was markedly greater in Group P (32.5%) than in Group C (12.5%). The difference was statistically significant ($p = 0.031$), suggesting that crystalloid coload correlated with a reduction in maternal adverse effects, presumably due to enhanced haemodynamic stability and a diminished incidence of hypotension.[Table 4]

Table 5: Neonatal outcome

Variable	Group P	Group C	p value
Apgar 1 min	8.1 ± 0.7	8.3 ± 0.6	0.181
Apgar 5 min	9.2 ± 0.4	9.3 ± 0.3	0.278

The average Apgar scores at 1 minute and 5 minutes were similar between the two groups. At 1 minute, the average Apgar score was 8.1 ± 0.7 in Group P and 8.3 ± 0.6 in Group C ($p = 0.181$). At 5 minutes, the average Apgar score was 9.2 ± 0.4 for Group P and 9.3 ± 0.3 for Group C ($p = 0.278$). The differences were not statistically significant, suggesting that both fluid administration strategies yielded comparable neonatal outcomes and that crystalloid coload did not negatively impact neonatal well-being.[Table 5]

DISCUSSION

This study compared crystalloid preload and crystalloid coload in preventing hypotension induced by spinal anaesthesia in parturients undergoing elective caesarean sections. The occurrence of maternal hypotension was markedly reduced in the coload group (27.5%) compared to the preload group (55%). These findings substantiate the notion that the administration

of crystalloids during intrathecal injection more effectively mitigates the acute vasodilation induced by sympathetic blockade.[8,13]

Our findings align with the meta-analysis by Ni et al., which indicated a markedly reduced incidence of hypotension in patients administered crystalloid coload (47.1%) versus those receiving crystalloid preload (57.8%). The authors determined that coload is more effective than preload in diminishing maternal hypotension and the necessity for vasopressors during caesarean delivery with spinal anaesthesia.[13]

Oh et al. similarly demonstrated that crystalloid coload enhanced haemodynamic stability and decreased vasopressor usage compared to preload. The researchers indicated that the timing of fluid administration is critical, as crystalloids achieve optimal intravascular expansion immediately post-infusion.[7]

The average vasopressor requirement in this study was markedly reduced in the coload group. This observation aligns with research conducted by Dyer et al., Khan et al., Sharma et al., and Rao et al., all of whom documented diminished ephedrine requirements in patients administered crystalloid coload. Maternal nausea and vomiting were significantly more prevalent in the preload group. These symptoms frequently result from diminished cerebral and gastrointestinal perfusion linked to hypotension. Ni et al. evidenced a three-fold escalation in maternal nausea and vomiting among preload recipients, corroborating the findings of the current study. Neonatal outcomes assessed by Apgar scores at one and five minutes were similar across groups. Comparable results have been documented by Banerjee et al., Oh et al., Dyer et al., and Farid et al., who noted no significant disparities in neonatal well-being despite variations in maternal hemodynamics.[7, 12, 15, 16]

The results of this study reinforce the increasing evidence indicating that crystalloid coload is a straightforward, safe, and effective approach for mitigating maternal hypotension during caesarean sections performed under spinal anaesthesia. Due to its simplicity of administration and positive maternal outcomes, crystalloid coload may be advocated as the optimal fluid loading method in standard obstetric anaesthesia practice.[13, 17, 18]

CONCLUSION

Crystalloid coload was markedly more effective than crystalloid preload in mitigating maternal hypotension during spinal anaesthesia for elective cesarean section. It correlated with diminished vasopressor needs and a decreased occurrence of nausea and vomiting, while preserving similar neonatal outcomes. Consequently, crystalloid coload may be regarded as the optimal fluid administration approach during caesarean section under spinal anaesthesia.

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