

Colloid Co-load versus Colloid Pre-load in a Parturient Undergoing Caesarean Delivery with Spinal Anaesthesia and Its Effects on Maternal Haemodynamics

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ABSTRACT

Background: cesarean section is the surgical delivery of a baby that involves making an incision in the mother's abdominal wall and uterus. Spinal anesthesia is considered the "gold standard" technique for cesarean section. Hypotension is the most common side effect of neuraxial blocks in the obstetric patient with an incidence rate reported as high as 83%. This has remained a significant concern for the anesthesiologist during management of this patient.

Aim of the work: This study will be performed to compare the effects of colloid pre-load and colloid co-load on maternal haemodynamic changes during spinal anaesthesia for cesarean section.

Patient's and Methods: A comparative cross sectional study was conducted at Ain Shams Maternity Hospital. After obtaining approval of research ethical committee and patients' informed consents at which 105 women with full term singleton pregnancies were scheduled for elective cesarean section and received spinal anesthesia. The patient's age were between 18 -42 years, of ASA physical status. In our study 3 groups of patients were compared; each group is formed of 35 patients **Group 1**; patients were pre-loaded with 500 ml of 6% HES(hydroxyethyl starch 130/0.4) 20 minutes before induction of anesthesia. **Group 2**; patients were co-loaded with 500ml of 6% HES (hydroxyethyl starch 130/0.4) during injection of bupivacaine. **Group 3**; patients were pre-loaded with 500ml lactated ringer solution 20 minutes before induction of anaesthesia.

Results: There was a decrease in SBP, DBP,MAP and HR in the 3 groups where the lowest values were recorded in group 3 between 6-15 minutes and there was a high statistical difference $p < 0.0001$ while the intergroup comparison of the groups 1 and 2 showed no statistical significance as regards SBP,DBP,MAP and HR. **Conclusion:** In this study it was found that colloid co-load was somewhat how equal to colloid pre-load in prevention of hypotension in a parturient undergoing cesarean section under spinal anesthesia in addition it was found that crystalloid pre-load was inferior to colloid co-load or pre-load in maintaining blood pressure during spinal anesthesia in parturients .

Keywords: HES: Hydroxyethyl starch, ASA, American Society of Anesthesiologists, SBP, Systolic Blood Pressure, DBP, Diastolic Blood Pressure, MAP, Mean Arterial Pressure, HR, Heart Rate.

INTRODUCTION

Spinal anesthesia is the popular route of anesthesia for elective cesarean section. Maternal hypotension is a common complication after spinal anesthesia for cesarean delivery. Prevention and treatment of post spinal hypotension (PSH) in cesarean delivery have been frequently investigated⁽¹⁾.

This hypotension with or without bradycardia have detrimental effects on both the mother (nausea, vomiting, dyspnea etc) and fetus (acidosis, neurologic injuries, etc). This complication can be managed by several approaches like fluid therapy, use of vasopressor or simultaneous use of fluid therapy and vasopressor⁽²⁾.

Fluid infused before or at the time of induction of anesthesia is referred to as pre-loading and co-loading respectively. Early reports suggested that this problem could be prevented by infusing a bolus of fluid before induction of anesthesia, but this strategy has met with limited success. Recently,

some authors have suggested that fluid administration should take place at the time of induction of anesthesia for cesarean delivery⁽³⁾.

PATIENTS AND METHODS

A comparative cross sectional study was conducted at Ain Shams Maternity Hospital. After obtaining approval of research ethical committee and patients' informed consents at which 105 women with full term singleton pregnancies were scheduled for elective cesarean section and received spinal anesthesia. The patient's age were between 18 -42 years, of ASA physical status I-II. In our study all patients were assigned randomly to one of three equal group 35 (thirty five) parturients in each group. **Group 1**; patients were pre-loaded with 500 ml of 6% HES(hydroxyethyl starch 130/0.4)20 minutes before induction of anaesthesia. **Group 2**; patients were co-loaded with 500ml of 6% HES (hydroxyethyl starch 130/0.4)during injection of

bupivacaine. *Group 3*; patients were pre-loaded with 500ml lactated ringer solution 20 minutes before induction of anaesthesia. **The study was approved by the Ethics Board of Ain Shams University.**

Exclusion criteria

1. Patient refusal,
2. Coagulopathy,
3. Cardiac, renal, hepatic and neurological diseases,
4. Local infection,
5. Allergy to bupivacaine or fentanyl.

METHODS

Pre-anesthetic examination was done for all parturients before the operation. All patients were assessed for concurrent medical, family, allergy, drugs and previous anesthesia history, patients with hypotension or hypertension, asthma, diabetes, coagulopathy, neuropathy, renal or liver diseases, local infection or septicemia were excluded. Upon arrival to the operating room intravenous insertion of 16G venous catheter. Monitors included electrocardiography, non invasive blood pressure measurement and pulse oximetry to measure peripheral oxygen saturation (Spo₂). Intravenous injection of 1 mg granisetron and 50mg ranitidine were given 20 minutes before spinal anesthesia. Basal measurement of systolic diastolic and mean arterial pressure were recorded in the left lateral position, with cuff positioned at the level of the heart also basal heart rate and oxygen saturation were recorded. The patient sat down and the back was sterilized, local infiltration of the skin and the subcutaneous tissue were done at the level of L3-L4 by 3ml lignocaine 2%, finally 27G needle (Quincke's needle) was used and 2.2ml bupivacaine 0.5% and 25 mcg fentanyl were injected intrathecal after confirming the flow of CSF then the patient was rapidly directed to the left lateral position. After pre-loading all the patients received ringer's lactate solution for fluid maintenance at a rate 15 ml/kg. Urinary catheter was inserted for all patients. Non-invasive blood pressure measurement were recorded in the 3 groups every 3 minutes from the start of spinal anesthesia for 30 minutes then every 5 minutes for the completion of surgery. Also the heart rate and spo₂ are going to be recorded in the 3 groups every 3 minutes for 30 minutes then every 5 minutes for the completion of the surgery. The height of the sensory block was assessed using cold sensitivity. Surgery was allowed to proceed after a block to T5 has been established. Before starting the operation parturients were instructed to tell if they feel nauseated. Sedation wasn't done for any

patients. Interventions were as follows the incidence of hypotension was determined in the 3 groups and also the time of intrathecal injection to the 1st episode of hypotension and patients who developed hypotension defined as 20% decrease in mean arterial blood pressure or SBP less than 90 or 100 mmHg received an ephedrine bolus of 10mg and increase in fluid infusion rate or giving additional fluid boluses of 250ml and administering 100% oxygen via face mask until blood pressure returned to acceptable level. Then the total number of ephedrine boluses were calculated. Time periods recorded were: Time of intrathecal injection to skin incision, time intrathecal injection to uterine incision, time of intrathecal injection to delivery, duration of surgery. At delivery all patients received 5 IU of oxytocin intravenous. Maternal urine output was noted also incidence of nausea and vomiting was noted. Apgar scores were recorded at 1 and 10 minutes. Patients were observed for signs of fluid overload like respiratory distress or crepitations in chest. Also they were observed for any signs of allergic reactions to fluids.

C . Data collection

Hypotension is defined as 20% decrease in mean arterial blood pressure (MAP) or decrease in systolic blood pressure to less than 90 Or 100 mmHg Parameters of assessment included:

1. Demographic data.
2. Haemodynamic parameters included: heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and Spo₂ will be measured every 3 minutes from the start of spinal anesthesia for 30 minutes and then every 5 minutes for the completion of surgery.
3. The time of intrathecal injection to the 1st episode of hypotension.
4. The incidence of hypotension.
5. The number of ephedrine boluses and the total amount of ephedrine administered
6. The incidence of nausea and vomiting
7. Block height
8. Urine output (UOP).
9. Duration of anesthesia and duration of surgery.
10. Neonatal outcome (APGAR score) at the 1st and 10th minutes

Statistical Method: Statistical presentation and analysis of the present study was conducted, using the mean, standard Deviation, unpaired student t-test was used to compare between two groups in quantitative data, Analysis of ANOVA test was used for comparison among different times in the same group in quantitative data) and chi-square are computed for 2x2 tables in qualitative data using

data (*IBMSPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.*).

>0.05 Non significant <0.05* significant

<0.001** highly significant Mean = $\frac{\sum x}{n}$

Where \sum = sum & n = number of observations.

Standard Deviation [SD] :

$$SD = \sqrt{\frac{\sum |x - \bar{x}|^2}{n - 1}}$$

Student t-test [Unpaired]:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{SE_1^2 + SE_2^2}}$$

Where:

\bar{X}_1 = Mean of the first group .

\bar{X}_2 = Mean of the second group .

SE1 = Standard error of the first group.

SE2 = Standard error of the second group.

Unpaired Student T-test was used to compare between tow groups in quantitative data.

Analysis of variance [ANOVA] tests.

According to the computer program SPSS for Windows. ANOVA test was used for comparison among different times in the same group in quantitative data.

Chi-square

The hypothesis that the row and column variables are independent, without indicating strength or direction of the relationship. Pearson chi-square and likelihood-ratio chi-square. Fisher's exact test and Yates' corrected chi-square are computed for 2x2 tables.

RESULTS

Table 1: Demographic data:

	Group 1 (n=35)	Group 2 (n=35)	Group 3 (n=35)	Tests	
				f/X ²	P-value
Age(yrs)	27.1 ± 4.6	26.1 ± 6.2	27.3 ± 4.7	0.531	0.589
Weight(kg)	68.3 ± 11.1	71.4 ± 10.8	72.4 ± 12.4	1.219	0.300
Height(cm)	161.6 ± 6.5	158.3 ± 6.8	159.3 ± 6.6	2.277	0.108
Gravidity	2.15 ± 0.64	2.14 ± 0.73	2.08 ± 0.68	0.107	0.899
Parity	1.16 ± 0.52	1.2 ± 0.49	1.14 ± 0.47	0.134	0.875
ASA					
I	32 (91.4%)	33 (94.3%)	33 (94.3%)	0.306	0.858
II	3 (8.6%)	2 (5.7%)	2 (5.7%)		

There was no statistical difference (p>0.05) in the 3 groups regarding the age, weight and height. Also there was no difference regarding the gravidity and parity (table1).

Regarding the ASA status there was no significant difference between the 3 groups (table1).

Table 2: Baseline characteristics

	Group 1 (n=35)	Group 2 (n=35)	Group 3 (n=35)	ANOVA	
				f	P-value
Systolic (mmHg)	121.18 ± 10.33	123.22 ± 9.18	124.03 ± 8.78	0.845	0.433
Diastolic (mmHg)	75.24 ± 8.33	73.71 ± 9.83	72.18 ± 9.85	0.934	0.396
Mean ABP (mmHg)	90.32 ± 12.17	89.66 ± 13.1	89.12 ± 11.22	0.085	0.918
Oxygen saturation %	98.32 ± 0.68	98.56 ± 0.82	98.33 ± 0.65	1.243	0.293
Heart rate (bpm)	96.65 ± 13.3	97.35 ± 12.8	96.71 ± 12.8	0.031	0.969
Urine out put	181.22 ± 88.21	168.18 ± 92.11	152.17 ± 78.10	0.994	0.374

There was no statistical difference (p >0.05) between the 3 groups (table2) regarding their baseline characteristics.

Table 3: Operative and Surgical data

Variables / (min.)	Group 1 (n=35)	Group 2 (n=35)	Group 3 (n=35)	ANOVA	
				f	P-value
Time of intra thecal injection to skin incision	10.71 ± 2.1	10.2 ± 1.4	9.82 ± 2.6	1.595	0.208
Time of intra thecal injection to uterine incision	18.22 ± 4.33	17.6 ± 4.22	17.21 ± 3.75	0.538	0.585
Time of intrathecal injection to delivery	19.77 ± 5.35	18.86 ± 5.46	18.82 ± 4.98	0.364	0.696
Duration of surgery	44.61 ± 10.32	43.89 ± 11.54	44.12 ± 10.64	0.040	0.961

Regarding time of intra thecal injection to skin incision time of intra thecal injection to uterine incision, time of intra thecal injection to delivery and duration of surgery there were no statistical difference ($p > 0.05$) between the 3 groups (table3). Level of sensory block was similar in the 3 groups without statistical significant difference.

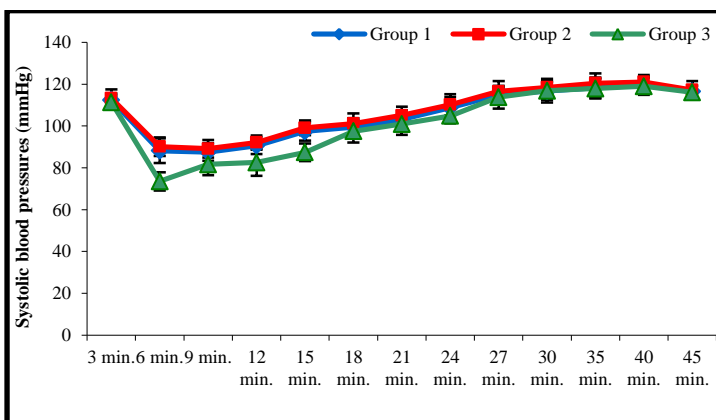


Fig. (1): Intra-operative trends in systolic blood pressure

Regarding SBP the lowest blood pressure from 6 -15 minutes recorded in group 3 and the statistical difference was highly significant ($p < 0.001$) between the 3 groups. Although the SBP dropped in groups 1 and 2 with respect that the SBP was lower in group 1 compared to group 2 but there was no statistical difference between them (p more than 0.05).

From 18-24 minutes still the SBP was lower in group 3 in comparison with group 1 and 2 and this was statistically significant ($p < 0.05$). From 27-45 minutes the SBP returns to the normal range and there was no statistical difference between the 3 groups ($p > 0.05$) (figure1).

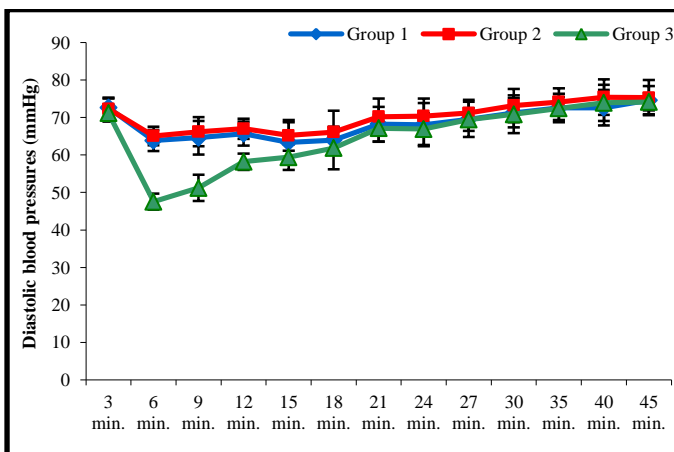


Fig. 2: Intra-operative trends in diastolic blood pressure

As regards the mean DBP, group 3 showed the Lowest DBP among the 3 groups from 6-15 minutes and there was a high statistical significant difference ($p < 0.001$) between the 3 groups while groups 1 and 2 showed no statistical significant difference ($p > 0.05$) between them regarding their DBP although that DBP in group 1 was lower than group 2. The DBP from 18-24 minutes there was statistical significant difference ($p < 0.05$) between the 3 groups, while groups 1 and 2 revealed no significant difference.

From 27-45 minutes the DBP comparison of the 3 groups revealed no statistical significant difference between the 3 groups (p value > 0.05) (figure2).

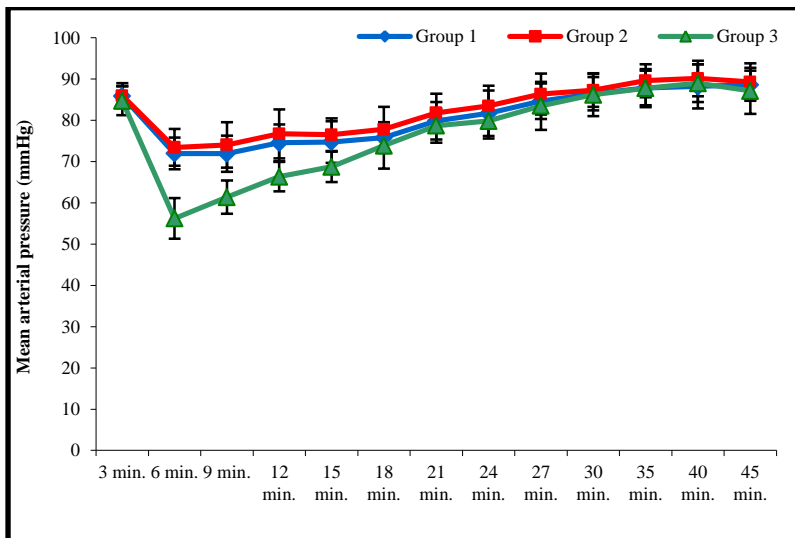


Fig. (3): Intra-operative trends in mean arterial pressure

As regards the MAP it was found that there was a high statistical significant difference ($p < 0.001$) between the 3 groups where the lowest MAP was found in group 3 between 6-15 minutes and groups 1 and 2 showed that there was no statistical difference ($p > 0.05$) between these 2 groups regarding their MAP although MAP in group 2 was slightly higher as compared to group 1. Between 18-24 minutes there was a statistical significant difference between the 3 groups ($p < 0.05$) and there was no statistical significant difference between groups 1 and 2. Between 27-45 minutes comparison of the 3 groups revealed no statistical significance ($p > 0.05$) (figure3).

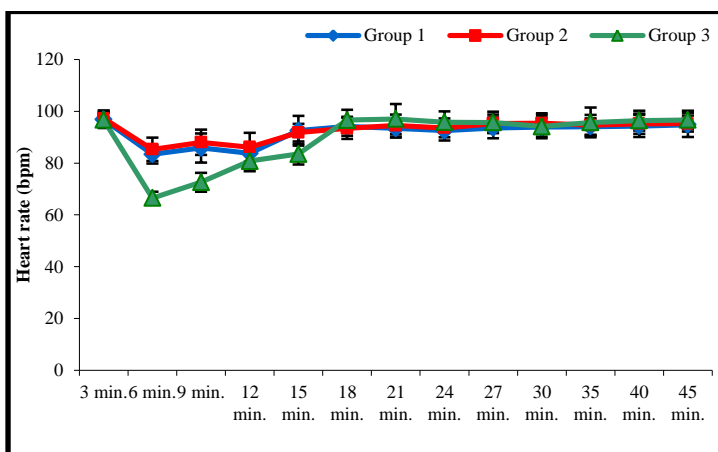


Fig. (4): Intra-operative trends in heart rate

The mean values of the HR showed that the HR dropped as compared to the baseline in the 3 groups and the lowest HR was recorded in group 3 at 6-15 minutes and this showed a highly significant statistical difference ($p < 0.001$). While in groups 1 and 2 there was no statistical difference ($p > 0.05$). Between 18-27 minutes the HR started to increase in group 3 in comparison with groups 1 and 2 and this was statistically significant. Groups 1 and 2 revealed no significant statistical difference. Between 27-45 minutes there was no statistical significant difference between the 3 groups (figure4). The SPO2 was also recorded but there was no difference in their mean values as they were not affected by hypotension.

Table 4: Incidence of Hypotension, incidence of nausea and vomiting and time of intra-theal injection to 1st episode of hypotension

	Group 1 (n=35) No of patients	Group 2 (n=35) No of patients	P-value (1&2)	Group 3 (n=35) No of patients	P-value (1&2&3)
The incidence of hypotension	10 (28.57%)	6 (17.14%)	0.255	35 (100.0%)	<0.001**
The incidence of nausea and vomiting	10 (28.57%)	6 (17.14%)	0.255	35 (100.0%)	<0.001**
Time of intrathecal injection to the 1st episode of hypotension					
3min.	0 (0.0%)	0 (0.0%)	1.000	0 (0.0%)	1.000
6min.	8 (22.86%)	6 (17.14%)	0.550	15 (42.86%)	0.041*
9min.	2 (5.71%)	0 (0.0%)	0.151	18 (51.43%)	<0.001**
12min.	0 (0.0%)	0 (0.0%)	1.000	2 (5.71%)	0.130
15min.	0 (0.0%)	0 (0.0%)	1.000	0 (0.0%)	1.000

Regarding the incidence of nausea and vomiting it was found that the highest incidence was in group 3 with incidence 100% compared to 28.57% and 17.14% in groups 1 and 2 respectively and this showed high statistical significance.

While the comparison between groups 1 and 2 showed no statistical significant difference. As for the incidence of hypotension it was found that group 3 had the highest incidence of hypotension (100%) in comparison of groups 1 and 2 whose incidence was 28.57% and 17.14% respectively and this showed highly significant statistical difference. Although the incidence of hypotension was lower in group 2 compared to group 1 but there was no statistical difference between the 2 groups Regarding the time of intra thecal injection to the 1st episode of

hypotension it was found that the 1st episode of hypotension occurred after 6 minutes with the highest number of patients who developed hypotension after 6 minutes were found in group three(15 patients=42.86%) in comparison with group one (8 patients = 22.86%) and group 2 (6 patients=17.14%) and this showed a statistical significant difference between the 3 groups ($p < 0.05$). After 9 minutes group 3 showed hypotension in 18 of the patients (51.43%) compared to group 1 and 2 that showed 2 patients (5.7%) and 0 patient(0%) respectively and this was highly significant statistically. After 12 minutes group 3 showed that 2 patients (5.71%) developed hypotension while no other patients developed hypotension in the other 2 groups and this was statistically insignificant (table4).

Table 5: The number of ephedrine boluses

The number of ephedrine bolus (Bolus=10mg)	Group 1 (n=35) No of patients	Group 2 (n=35) No of patients	P-value (1&2)	Group 3 (n=35) No of patients	P-value (1&2&3)
1	8 (22.86%)	6 (17.14%)	0.550	5 (8.5%)	0.264
2	2 (5.71%)	0 (0%)	0.151	24 (74.28%)	<0.001**
3	0 (0%)	0 (0%)	1.000	6 (17.14%)	0.002*
Block height (Median range)	T3	T3	1.000	T3	1.000

As regards the number of ephedrine boluses given the highest number of boluses were given to group 3 where 3 boluses were given to 6 patients, while no patients received 3 boluses in groups 1 and 2 and this was statistically significant. Most of the patients of group 3 received 2 boluses, 24 patients in group 3 compared to 2 and zero patients in group 1 and 2 respectively and this showed high statistical difference and finally 5 patients in group 3 received 1 bolus compared to 8 and 6 patients in groups 1 and 2 respectively and this was statistically insignificant (table 5).

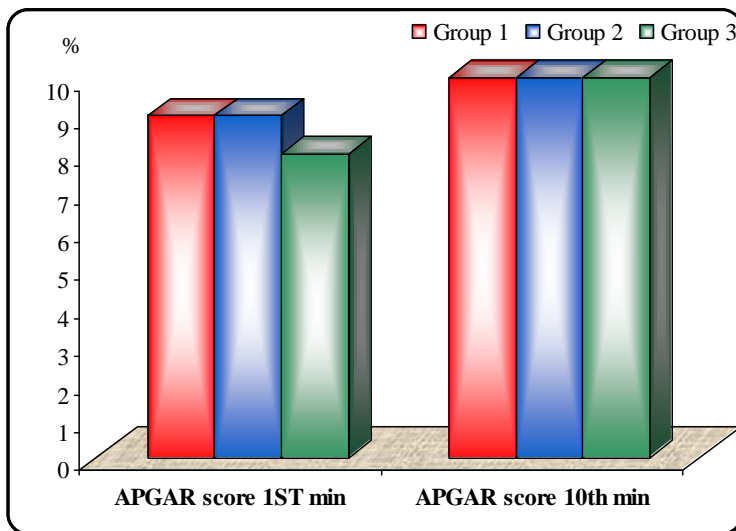


Fig 5: The APGAR score

Regarding the APGAR score there was no statistical significant difference between the 3 groups in the 1st and 10th minute (figure5)

DISCUSSION

Spinal anesthesia is the regional anesthesia obtained by blocking the spinal nerves in the subarachnoid space. It is the most widely practiced anesthetic technique and has become immensely popular in the last century⁽⁴⁾.

Spinal-induced hypotension (SIH) is considered the most common intraoperative anesthetic complication during cesarean section. It is considered to be due to a combined effects of reduced cardiac output and decreased systemic vascular resistance (SVR), secondary to sympathetic blockade during the spinal anesthesia. Various methods were used to prevent and treat hypotension, IV (intravenous) fluid boluses and left uterine displacement are considered as a conventional prophylactic measures to increase the venous return (thereby cardiac output). Vasopressors are also required to treat any significant decrease in systemic vascular resistance (SVR)⁽⁵⁾.

Pre-loading with crystalloids has been a commonly used technique to counteract spinal induced hypotension in parturients undergoing cesarean section. This technique was first described by Wollman and Marx in 1968, in which they reported that using 10 -20 ml/kg of crystalloid around 30 minutes before spinal anesthesia resulted in significant reduction in the incidence and severity of spinal induced hypotension (SIH) in parturients receiving spinal anesthesia for a cesarean delivery. Based on these findings pre-loading has become the standard of practice for many anesthesia practitioners⁽⁶⁾.

This Pre-loading with intravenous fluids offset the vasodilating effects of sympathectomy caused by spinal anesthesia thereby maintaining the venous return and thus the drop in blood pressure is prevented⁽⁷⁾.

However, there is a concern regarding the safety and efficacy of the pre-load technique as there are studies which suggest no benefit of crystalloid pre-loading. In addition too much amount of fluid pre-loading may cause pulmonary edema⁽⁸⁾.

A more rational approach is to administer the fluid bolus at the time that the local anesthetic block is starting to produce its effect. This might maximize intravascular where volume expansion during vasodilatation from the sympathetic block and limit fluid redistribution and excretion. This practice has been termed Co-load⁽⁹⁾.

The controversies regarding the crystalloid and colloids have been never ending. Crystalloid solutions', being of lower molecular weight, enters the interstitial space due to lack of intrinsic colloid osmotic pressure and may result in pulmonary edema which interferes with tissue oxygen exchange. On the contrary, colloids having higher molecular weight than crystalloids have similar osmolality as plasma remain confined to intravascular space with little expansion of interstitial space⁽¹⁾.

In Our study we compared colloid co-loading versus colloid and crystalloid pre-loading for the prevention of spinal induced hypotension in a parturient undergoing cesarean section, 105 women with full term singleton pregnancies were

included in our study and they were divided into 3 groups. The patient's ages were between 18 -42 years, of ASA physical status I-II.

The 3 groups were compared as regards their age, weight and height and ASA status where there was no statistical difference ($p > 0.05$) between the 3 groups. Also there was no statistical difference when comparing the 3 groups regarding the gravidity and parity.

As regards the baseline characteristics comparing the 3 groups showed no statistical difference ($p > 0.05$).

As regards the operative and surgical data when comparing the 3 groups regarding time of intra thecal injection to skin incision time of intra thecal injection to uterine incision, time of intra thecal injection to delivery and duration of surgery there were no statistical difference ($p > 0.05$) between the 3 groups. Level of sensory block was similar in the 3 groups without statistical significant difference.

In our study when comparing the systolic and diastolic blood pressures the lowest blood pressure was recorded in group 3 from 6 -15 minutes and the statistical difference was highly significant ($p < 0.001$) between the 3 groups. Although the SBP and DBP dropped in groups 1 and 2 with respect that the SBP was lower in group 1 compared to group 2 but there was no statistical difference between them ($p > 0.05$). From 18-24 minutes still the SBP was lower in group 3 in comparison with group 1 and 2 and this was statistically significant ($p < 0.05$). From 27-45 minutes the SBP, DBP returned to the normal range and there was no statistical difference between the 3 groups ($p > 0.05$).

The minimum systolic, diastolic and mean arterial blood pressure obtained during the intra-operative period were higher in group 2 as compared to group 1 unlike that in the study done by Varshney et al who compared colloid co-load and colloid preload under low dose spinal anesthesia in 42 parturient ASA I-II underwent cesarean section under spinal anesthesia in which there was minimum systolic, diastolic and mean blood pressure was higher in the pre-load group⁽¹⁰⁾.

The significant fall in blood pressure in group 3 is the same as that obtained by **Salio et al.** who compared colloid pre-load, co-load and crystalloid pre-load in 75 parturient who were scheduled for cesarean section under spinal anesthesia. There was a significant fall of blood pressure in the group pre-loaded with crystalloid and this was explained by one or more of these; it was claimed that higher fluid load dilutes plasma

proteins thus decreasing the colloid osmotic pressure to greater extent thereby leading to a greater extravasation of fluid into the extra cellular fluid compartment, causing hypotension. Other cause includes that crystalloid administration increases the central venous pressure in the first few minutes of pre-loading then declines rapidly by redistributing to the extravascular space causing fall in blood pressure. The volume of crystalloid, colloid administered can cause release of atrial natriuretic peptide leading to vasodilatation⁽¹¹⁾.

As regards the MAP, in our study it was found that mean arterial pressure (MAP) decreased in all three groups after administration of spinal anesthesia and the lowest MAP was recorded at 6-9 minutes in the three groups and this showed high statistical significant difference however MAP in group 3 was the lowest in at most time intervals. The intergroup comparison between groups 1 and 2 showed no statistical significant difference ($p > 0.05$). These results were the same as those obtained by Arora et al where they studied 3 groups each group composed of 30 parturient, they compared colloid pre-loading, colloid co loading and crystalloid pre-loading, in their study the MAP decreased in all the 3 groups with the lowest MAP recorded at 10 minutes⁽⁸⁾.

In our study The mean values of the heart rate (HR) showed that it dropped as compared to the baseline in the 3 groups and the lowest HR was recorded in group 3 at 6-15 minutes and this showed a highly significant statistical difference ($p < 0.001$) while in groups 1 and 2 there was no statistical difference ($p > 0.05$). Between 18-27 minutes the HR started to increase in group 3 in comparison with groups 1 and 2 and this was statistically significant and groups 1 and 2 revealed no significant statistical difference. Between 27-45 minutes there was no statistical significant difference between the 3 groups. This was against a study conducted by Arora et al who compared colloid pre-loading, colloid co-loading and crystalloid pre-loading in 90 parturient underwent cesarean section under spinal anesthesia where they found that the mean heart rate (HR) decreased in all 3 groups however mean HR was greater in the crystalloid pre-load as compared to colloid pre-load and co-load. This may be due to that in our study the level of the block reached T3 thus losing the sympathetic innervation of the heart and that's why the heart rate was the lowest in group 3 from 6-15 minutes until the effect of ephedrine started to take over⁽⁸⁾.

As for the incidence of hypotension it was found that group 3 had the highest incidence of

hypotension (100%) in comparison with groups 1 and 2 whose incidence was 28.57% and 17.14% respectively and this showed highly significant statistical difference ($p < 0.0001$). Although the incidence of hypotension was lower in group 2 compared to group 1 but there was no statistical difference between the 2 groups.

Preloading with crystalloids may be unsuccessful in reducing the incidence of hypotension for a number of reasons. Early fluid loading may not effectively increase the intravascular volume at the time of maximum vasodilatation. Volunteer studies have shown that a rapid infusion of lactated Ringers solution increases the intravascular volume by about 10%. This decreases rapidly when the infusion is discontinued⁽¹²⁾.

Other reason is that preload is rapidly redistributed and may induce atrial natriuretic peptide secretion resulting in peripheral vasodilation followed by an increased rate of excretion of the preloaded fluid⁽⁸⁾.

Ewaldson and Hahn concluded that arterial pressure is better maintained by a fluid bolus just after the induction of anesthesia than by pre-loading⁽¹³⁾.

The ineffectiveness of pre-loading with crystalloid was also reported by **Hofmeyer *et al.*** who compared 102 patients who received intravenous pre-loading before epidural analgesia during labour with a control group (dummy or no pre-loading) he reported that there is no benefit of pre-loading with 1 liter ringer lactate even in parturient who were given low dose spinal anesthesia and this was the same as the results obtained by our study in which the greatest incidence of hypotension was in group 3 which was pre-loaded with crystalloids⁽¹⁴⁾.

Dahlgren *et al.* also compared crystalloid with colloids for pre-loading where he studied 110 patients presenting for elective cesarean section who received either 1000 ml acetated ringer's solution or 1000 ml 3% dextran 60 solution immediately before spinal anesthesia and found that hypotension was significantly reduced with colloid infusion and that colloid pre-loading is superior to crystalloid in reducing the incidence of spinal induced hypotension and this was the same as obtained by our study where the incidence of hypotension was more in the crystalloid group than the colloid groups⁽¹⁵⁾.

Also the superiority of colloids to prevent hypotension has been reported by **Riaz *et al.***, who compared colloid pre-load and crystalloid pre-load in 100 parturient undergoing cesarean section he

reported that pre-loading with colloid is more effective than crystalloids⁽¹⁶⁾.

Mercier *et al.*⁽¹⁷⁾ showed that loading fluid at the time of administering the intrathecal local anesthetic (co-loading) might be a physiologically more appropriate and rational approach as the maximal effect can be achieved during the time of the block. In our study the same was obtained as the incidence of hypotension was lower in group 1 compared with group 2

Although the incidence of hypotension in group 1 was lower than group 2 but there was no statistical significant difference this was the same as the results of the study obtained by **Carvalho *et al*** who compared colloid pre-loading with heta starch versus colloid co-loading in 46 term healthy parturient scheduled for cesarean delivery he reported that the incidence of hypotension was similar in Groups receiving colloid Preload and colloid co-load⁽¹⁸⁾.

Also the present finding is comparable with that of **Siddik *et al.*** where they recruited 178 parturient to receive 500 ml of hydroxyethyl starch either before or right after the administration of local anesthetic in spinal anesthesia in which they found that there was no difference in the incidence of colloid co-load and pre-load for elective cesarean delivery undergoing spinal anesthesia⁽¹⁹⁾.

Dyer *et al.*⁽²⁰⁾ Suggested that co-loading might increase intravascular volume expansion during vasodilatation from the sympathetic blockade and limit fluid redistribution and excretion

Young *et al.*⁽²¹⁾ compared crystalloid pre-load with crystalloid co-load in 60 parturient ASA I undergoing cesarean delivery under spinal anesthesia they reported 83.3% incidence of hypotension in the crystalloid pre-loading versus 100% in our study this may be attributed to the amount of pre-load infused in our study 500 ml of ringer's solution whereas in the other study they infused 15ml/kg of ringer's solution.

The possible reasons for the less efficacy of crystalloid solutions in prevention of spinal induced hypotension are that the crystalloid solutions have short intravascular half-life and rapidly leak into the extra cellular space⁽²²⁾.

In our study the incidence of hypotension in group 2 (the co-load group) was 17.14% and in group 1 (the pre-load group) was 28.57%. In a study done by **Varshney *et al*** who compared 42 parturient divided in 2 groups one group received colloid pre-load and the other received colloid co-load it was found that the incidence of hypotension in the pre-load group was 10% compared with 25% in the co-load group. The low incidence of hypotension in the

previous study may be due to using low dose spinal anesthesia (5.5mg), in our study we used 11mg bupivacaine⁽¹¹⁾.

Also when comparing the incidence of hypotension between the co-load and pre-load groups in our study it was found that it was less in the co-load group unlike that was obtained by **Varshney et al.** which demonstrated that the incidence of hypotension was lower in the pre-load group. This may be due to that in our study we used 16 gauge cannula which transfuse more amount of fluids so the co-load is given at the time of vasodilatation from the sympathetic block compared to the 18 gauge that was used in the previous study that delivers fluid at slower rate⁽¹¹⁾.

The incidence of hypotension in groups 1 and 2 was 28.57% and 17.14% respectively. While in a similar study done by Arora et al who compared colloid pre-loading co-loading and crystalloid pre-loading in 90 parturient undergoing cesareans section under spinal anesthesia the incidence of hypotension in the group pre-loaded with colloid was 36.6% and that in the group co-loaded with colloid was 40% and this difference can be attributed to that in our study the patients received ringer's solution as a maintenance 15 ml/kg in addition to the hydroxyethylstarch⁽⁸⁾.

In the present study it was found that the highest ephedrine consumption was in group 3 however group 1 and 2 didn't consume much ephedrine in comparison with group 3 and the intergroup comparison between group 1 and 2 regarding the number of ephedrine boluses was statistically insignificant. These findings correspond to those of Dahlgren et al who reported that ephedrine requirements were lower in the colloid than in the crystalloid group⁽¹⁶⁾.

Arora et al.⁽⁸⁾ reported that there was no statistical significant difference between ephedrine administration in the pre-load and the co-load group.

Regarding the time of intra thecal injection to the 1st episode of hypotension it was found that the 1st episode of hypotension occurred after 6 minutes with the highest number of patients who developed hypotension after 6 minutes were found in group three, 15 patients (42.86%) in comparison with group one 8 (22.86%) and group two (6 17.14%) and this showed a statistical significant difference between the 3 groups ($p < 0.05$). After 9 minutes group 3 showed hypotension in 18 of the patients (51.43%) compared to group 1 and 2 that showed 2 (5.7%) and 0 (0%) respectively and this was highly significant statistically. After 12 minutes group 3 showed that 2 patients (5.71%) developed

hypotension while no other patients developed hypotension in the other 2 groups and this was statistically insignificant.

There is no doubt that persistent hypotension has adverse outcomes on the maternal well-being in the form of nausea, vomiting, dizziness and it decreases the uterine blood flow resulting in deleterious effects on the fetus. The deleterious effects of hypotension during our study were observed as an increased incidence of maternal nausea and vomiting. A constant observation during earlier similar studies is that the incidence of nausea and vomiting during spinal anesthesia was in close association with hypotension. This was observed during our study as the higher incidence of nausea and vomiting was found in group 3, in comparison with group 1 and 2 and this showed high statistical significant difference. Although the incidence of nausea and vomiting was higher in group 1 but there was no statistical significant difference. These results support the suggestion that the mechanism of the nausea alone or along with vomiting may be maternal hypotension and hypoxemia in the chemoreceptor trigger zone as a consequence of the maternal hypotension. These results were the same as obtained by Jacob et al who studied 100 parturient undergoing cesarean delivery under spinal anesthesia where one group received crystalloid pre-load and the other received crystalloid co-load and he demonstrated the higher incidence of nausea and vomiting in the group pre-loaded with crystalloid⁽²³⁾.

In our study there was no difference regarding the APGAR score at 1st and 10th minute in groups 1 and 2 and it was slightly lower in group 3 but this was statistically insignificant and this was the same as found by **Lotfy et al.**⁽⁹⁾, who studied 75 parturient undergoing emergency cesarean section and they were divided in to 3 groups one group was co loaded with crystalloid the second group was co-loaded with colloid and the third group were co-loaded with colloid and crystalloid. The study found that Regarding neonatal outcome, there was no significant difference between groups as evidenced by Apgar score. It had been reported that, neonatal outcomes are a major consideration for Cesarean parturients under neuraxial anesthesia due to the threat from hypotension. However, recent literatures showed that despite the high prevalence of maternal hypotension, term infants can tolerate this placental blood perfusion challenge without any major negative consequences.

CONCLUSION

In this study it was found that colloid co-load was somewhat how equal to colloid pre-load in

prevention of hypotension in a parturient undergoing cesarean section under spinal anesthesia in addition it was found that crystalloid pre-load was inferior to colloid co-load or pre-load in maintaining blood pressure during spinal anesthesia in parturient.

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