COMPARATIVE STUDY OF HEMODYNAMIC EFFECTS OF CRYSTALLOID PRELOADING VERSUS COLOADING DURING SPINAL ANAESTHESIA FOR CAESAREAN SECTION

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ABSTRACT ***Aims:*** *To compare the efficacy of crystalloid preload versus coload for prevention ofspinal anesthesia induced hypotension in patients undergoing lower segment caesarean section.* ***Materials and Methods:*** *Fifty four parturients belonging to American Society ofAnesthesiologist (ASA) physical status 1 or 2, with singleton, uncomplicated pregnancies scheduled for cesarean section under spinal anesthesia were randomized into two groups. Subjects in group P received 20ml/kg of crystalloid solution as preload over 10 min before the placement of spinal block, while those in group C received 20ml/kg of crystalloid solution over 20 min, starting as soon as CSF was tapped. The heart rate, systolic, diastolic and mean arterial pressures were monitored continuously. The dose of mephentermine and atropine required to treat hypotension and bradycardia was recorded. Neonatal Apgar scores at 1 and 5 minutes were also recorded.* ***Statistical Analysis Used:*** *Student'st-test, Chi-square test.* ***Results:*** *The number of parturients developing hypotension in group P and C was 18 and12 respectively and was comparable statistically (p=0.1). The mean number of doses of mephentermine required (1.4 in group P and 1.0 in group C) and the total dose of ephedrine used (4.2 mg and 3 mg in groups P and C respectively) in the groups were comparable statistically.* ***Conclusions:*** *Both preloading and coloading with 20ml/kg of crystalloid solution, whenused as a sole technique are ineffective in the prevention of hypotension in the obstetric population receiving spinal anesthesia. We suggest that valuable time need not be wasted in preloading the parturient especially in case of urgency. It should be kept in mind that hydration only is not sufficient for the prevention of maternal hypotension and vasopressor should be always prepared to be administered.*

Key words: *Anesthesia, preload, coload, hypotension, spinal.*

INTRODUCTION AND OBJECTIVES

The technique of spinal anesthesia was introduced by Karl August Bier in 1898. Since then it is widely being used as a popular method of anesthesia for lower abdominal and lower limb surgeries[1].In caesarean sections, both general anesthesia and the regional anesthetic technique can be used. Spinal anesthesia (SA) provides complete sensory and motor blockade to conduct cesarean section. Further it avoids the risk of pulmonary aspiration of gastric contents and the depressant effect of drugs on fetus both of which are associated with general anesthesia.Maternal hypotension is the most common disadvantage with spinal anesthesia and this can have adverse effect on neonatal and maternal outcome. It has been reported that the incidence of hypotension during spinal anesthesia is 75 –85%[2].

The risk of hypotension is increased in a parturient due to the higher level of block (T_4) required for the cesarean section, unique anatomic and physiologic changes of pregnancy and increased susceptibility to the effects of sympathectomy due to reduced sensitivity to the endogenous vasoconstrictors coupled with increased synthesis of endothelium-derived vasodilators.. Several measures can be taken to reduce the effect of maternal hypotension which includes left uterine displacement, trendelenburg position, leg compression, iv fluids and administration of vasoconstrictors[3,4] .

Preloading ie, fluid administration before SA for the prevention of spinal anesthesia induced hypotension(SIH) is a common and traditional practice in anaesthesia since it was first introduced by Griess et al[5] and earlier studies showedsuccess of crystalloid preloading in prevention of maternal hypotension after spinal anesthesia[6,7]. But later the results of these studies have been questioned by other studies, which showed that even large volumes of crystalloid have minimum effect in preventing hypotension[8,9]. The recent studies have showed coloadingie, administration of iv fluid at the time intrathecal administration of anesthetic is more effective for the prevention of spinal-induced hypotension. Mercier et al[10] suggested that coloading may be a more rational approach for the prevention of post spinal hypotension.

The present study was undertaken to compare the efficacy of crystalloid preload versus coload for prevention of spinal anesthesia induced hypotension in patients scheduled for lower segment caesarean section.The primary objective of present study is to compare the effect of crystalloid preload and crystalloid coload on the maternal blood pressure and heart rate during caesareansection under spinal anesthesia

METHODS

After getting approval from the institutional ethics committee, 54 patients belonging to ASA physical status I or II, scheduled for elective caesarean section under subarachnoid block, were included. Patients were included in the study after proper pre-anaesthetic evaluation. Some patients were excluded based on the exclusion criteria.They are Pregnant women with any kind of:Infections,Pre-term and post-term pregnancies, multiple pregnancies, diagnosed placentalanomalies, Uncorrectedanemia, diagnosedpreeclampsiaandeclampsia, haemoglobinopathies, Coexisting Neurologic, Cerebrovascular, Cardiopulmonary, Renal, Metabolic,Psychiatric disorders bleeding of more than 750ml intraoperatively.

After obtaining informed consent, the data (Height in centimeters, Weight in kilograms, Heartrate, Non-invasive blood pressure: systolic, diastolic and mean arterial pressure,Respiratoryrate,Oxygen saturation (SpO_2), Time of subarachnoid block,Time of hypotension,Number of doses of vasopressor given,Time of baby delivery,Total iv fluid infused,Urineoutput,Volume of blood loss,APGAR score)were collected from each patient. Sampling was consecutive till sufficientnumber of samples (ie, 27 patients in each group) were obtained.

Selected patients were given oral ranitidine 150mg on the night before and on the morning of the surgery. An 18G iv cannula was placed in the forearm under aseptic precautions. Fetal heart rate was monitored till the cleaning and draping of the patient. Monitors like Pulse oximeter probe, ECG electrodes, automated noninvasive blood pressure cuff were attached and all readings were taken before initiating anesthesia and surgery.

Patients who were preloaded (Group P) was given 20ml/kg of intravenous crystalloids over 10 minutes, prior to subarachnoid block. Subarachnoid block was given in the left lateral position using a fixed volume 2ml of 0.5% heavy bupivacaine at L3-L4 or L2-L3 interspinous space using a 25G Quincke needle. The patients who were coloaded (Group C) was given 20ml/kg of intravenous crystalloids over 10 minutes starting right away after giving spinal anaesthesia. A small wedge was used to provide left uterine displacement of 15 to 20 degrees. Oxygen was administered 4L/min by a face mask. The level of sensory block was assessed by loss of cold sensation after 5 minutes of spinal anaesthesia. Patients with T6 level of sensory block will be included in the study. Systolic and diastolic blood pressure were noted every 2 minutes after administration of spinal anesthesia till next 30 minutes, then every 5 minutes for the next 30 minutes and then every 15 minutes for the next 30 minutes. Heart rate and any cardiac rhythm disorders were monitored using Lead II. The hypotensive episodes were managed by 3mg boluses of mephentermine. Time from intrathecal administration of bupivacaine to development of hypotension, to delivery of baby and duration of surgery were noted. Time of first dose of the mephentermine and number of doses were be noted. Bradycardia if any, was treated with bolus intravenous injection of atropine 0.6mg. Apgar score for neurobehavioral assessment were noted at 1 minute and 5 minutes of delivery. Prostoglandin F2α or methyl ergometrine was administered if instructed by the obstetrician.

RESULTS OF THE STUDY

Both the groups were comparable in their basic anthropometric parameters like mean age, body weight and height with the difference in mean being statistically not significant ($p>0.05$) as analyzed using the students unpaired t-test. The baseline heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and peripheral oxygen saturation were comparable between the two groups with the difference in mean values being statistically not significant ($p>0.05$) as analyzed by students unpaired t- test.

The time to delivery of the fetus and the average height of the block was also comparable between the two groups ($p>0.05$). These variables were analyzed by student‟s unpaired t- test.

Comparison of basic parameters between group C and P

- The mean values of maternal baseline heart rate in group C and P are 96.22 ± 13.11 and 97.15 ± 13.719 respectively ($p>0.05$).
- The mean values of baseline SBP in group C and P are 118.81 ± 12.326 and 112.00 ± 22.673 respectively ($p>0.05$).
- The mean values of baseline DBP in group C and P are 73.19 ± 11.369 and 71.93 ± 10.598 respectively ($p>0.05$).
- The mean value of baseline MAP in group C and P are 82.04 ± 9.804 and 81.37 ± 8.266 respectively ($p>0.05$).
- The mean value of baseline respiratory rate in group C and group P are 14.56 ± 0.89 and 14.64 ± 0.88 respectively ($p>0.05$).

Thus, the two study groups were comparable with respect to the baseline parameters as analyzed by Student‟s unpaired t-test.

The difference in mean heart rate at all time points between the two study groups was compared student t test and was found to be comparable(p value>0.05). There was a downward trend of trend of heart rate towards the end surgery. This may be because of the relief of anxiety and aortocaval decompression by delivery.

The trend of mean SBP was comparable between the two study groups as analyzed by student t test at all points of time. The time of onset of hypotension and the minimum mean SBP values recorded in both study groups was also comparable(p value>0.05).

The trend of mean Diastolic Blood Pressure was comparable between the two study groups as analyzed by student t test at all points of time. The time of onset of hypotension and the minimum mean Diastolic Blood Pressure values recorded in both study groups was also comparable(p value>0.05).

The trend of mean MAP was comparable between the two study groups as analyzed by student t test at all points of time. The time of onset of hypotension and the minimum mean MAP values recorded in both study groups was also comparable(p value>0.05).

Comparison of mean SPO2 between the two study groups by students t test found no statistically significant difference at all points time (p value>0.05).

Comparison of mean respiratory rate in group C and group P at all times by student t test found no statistically significant difference between the groups.

Table 1: Comparison of mean Apgar scores

GROUP		N	MEAN	SD	T	DF	P VALUE
APGAR 1	C	27	8.26	0.45			
	P	27	8.41	0.51	-1.147	52	0.2565
APGAR 5	C	27	9.22	0.43			
	P	27	9.44	0.51	-1.749	52	0.0862

There was no statistically significant difference in the mean Apgar scores as compared by the student t test. The mean values at minute 1 was 8.26 ± 0.45 in group C vs 8.41 ± 0.51 in group P and at minute was 9.22 ± 0.43 in group C vs 9.44 ± 0.51 in group P.

Table 2: Comparison of no of patients developing hypotension

No. of patients developing hhypotention	Group		Total
	C	P	
No	15	9	24
Yes	12	18	30
Total	27	27	54
PEARSON CHI- SQUARE	VALUE	DF	P VALUE
	2.700[A]	1	0.100

Table 3: Comparison of mean no of doses mephentermine used

NO BOLUSES GIVEN	C	GROUP P	TOTAL
0	15	9	24
1	5	6	11
2	3	7	10
3	1	3	4
4	2	1	3
5	1	1	2
TOTAL	27	27	54

	CHI-SQUARE TESTS		
	VALUE	DF	P VALUE
CHI-SQUARE	4.524	5	0.477
LIKELIHOOD RATIO	4.639	5	0.462
NO OF VALID CASES	54		

The number of patients developing hypotension in group C and group P was 12 and 18 respectively and difference between these was found statistically insignificant by Pearsson chi square test(p=0.1). The mean number of boluses of mephentermine required in group C was 1.0 as compared 1.4 in group P but this difference was not statistically significant(p=0.477). The comparison between the mean of total dose of mephentermine required(3mg in group C vs 4.2mg in group P) also was found to be statistically insignificant.

The comparison of the mean time taken since the induction of subarachnoid block to the baby delivery (12.63 ± 3.49 in group C vs 12.48 ± 3.94 in group P) was also comparable between the study groups(p value>0.05)

Table 4: comparison of mean volume of iv fluid used

GROUP		N	MEAN	SD	T	DF	P
IV FLUID TOTAL USE	C	27	2033.33	216.62	-2.496	52	0.016
	P	27	2170.37	185.67	-2.496	51	0.016

The difference in the mean blood loss (613.33 ± 81.994 in C vs 612.96 ± 81.562 in P) and average total iv fluid used (2096.30 ± 153.125 in C vs 2162.96 ± 180.060 in P) was not statistically significant(p value >0.05) ensuring the comparability between the two study groups.

DISCUSSION

Hypotension is the most common side effect after spinal anesthesia. In our study, 66.7 % of patients in the preload group developed hypotension. This is slightly higher than the previous studies which used 15 ml/kg of RL as preload in the obstetric population have reported the instance of hypotension as 45.5%[11] and 55%[12]. Many studies have now questioned the value of traditional preloading techniques for prevention of spinal anesthesia induced hypotension during cesarean section. The first study to challenge the role of preloading was that of Clark et al[13] who studied the use of fluid loading, both with and without uterine displacement, comparing them with controls with neither prophylactic measure. One of the 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[14]. Pautaet al[15] 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.

The effects of different volumes crystalloid preload prior to SA were studied by Park et al[8] who compared 10, 20 and 30 ml/kg crystalloid preload and showed that there was no significant difference in the incidence of hypotension. Although crystalloid administration is safe in most patients, there is experimental evidence to suggest that large volumes of crystalloid preload can be counterproductive as they can induce hemodilution and can predispose the susceptible parturient to the development of pulmonary edema possibly because of an increase in the lung water during pregnancy.

The incidence of hypotension in the coload group in our study was 44.4%. This was almost similar to previous studies done by J J Jacob et al[16] and Ah Young Oh et al[17] which found the incidence of SIH to be 53% and 46% respectively. The relative reduction in the incidence of SIH in our study was may be because of the higher volume(20ml/kg) of crystalloid used as compared to 15ml/kg in these studies. Volume kinetic studies of lactated Ringers solution during spinal and general anesthesia by Ewaldssonet al[18] suggested that the arterial pressure is better maintained by a fluid bolus just after the induction of anesthesia than by fluid boluses prior to anesthesia. Studies done by Mercier F J et al[10] suggested that loading fluid at the time of administering the intrathecal local anesthetic (coloading) might be a physiologically more appropriate and rational approach as the maximal expansion of the intravascular compartment can be achieved during vasodilation from the sympathetic block and thus can limit the fluid redistribution and excretion.

The results of our study showed that the incidence of hypotension was lesser in the coload group as compared to the preload group (44.4% vs 66.7%) but this difference was not statistically significant. Earlier studies comparing crystalloid preloading and coloading in obstetric population have reported variable incidence of hypotension in the preload and coload groups. Mercier F J et al[10] compared one litre of crystalloid as preload and coload and reported the incidence of hypotension as 50% and 62.5% in the coload and preload groups respectively. Cardoso et al[19] compared 10 ml/kg of RL as coload or preload in patients undergoing elective cesarean section and reported the incidence of hypotension as 22.5% and 25% in the coload and preload groups respectively. Contrary to these findings, Bouchnak et al[20] reported a higher incidence of hypotension in the coload group (96.6%) than in the preload group (86.6%) while comparing 20 ml/kg of crystalloid which was given over 15 min as coload or preload in the obstetric population. In the study done by Mojica et al, they found that incidence of SIH was similar in both preload

and coload groups(12.1% vs 12.7%). The wide variations in the incidence of hypotension among these studies may be explained by differences in the definitions of hypotension used in the studies, the varying rates of fluid administration and the different volumes of crystalloids used.

Now, it is a well understood fact that persistent hypotension has adverse effects on the maternal well-being in the form of nausea, vomiting, dizziness decreased the uterine blood flow[7] resulting in deleterious effects on the fetus. The earlier similar studies showed a close association between the incidence of maternal nausea and vomiting and persistent maternal hypotension. Since our study was designed to observe the hemodynamic parameters only, we don't have data on this context.

Crystalloid coload has been reported to decrease the requirement of vasopressors to maintain the maternal blood pressure. In our study, the mean number of mephentermine boluses administered(1 vs 1.4) and the mean total dose of mephentermine administered(3mg vs 4.2mg) was more in the preload group than in the coload group but the differences in the mean number of boluses (p=0.1) and total dose of mephentermine used (p=0.477) were not statistically significant among the groups. There was no significant difference in the mean Apgar scores, the median scores at 1 and 5 minutes were 8 and 9 respectively for both groups indicating overall neonatal well being by both preloading and coloading. The neonatal outcome was consistent with previous studies like Bannerjeeet al[21] etc.

The lack of a control group and non-blinding study design are the drawbacks of our study. The attending anesthesiologist was allowed to administer crystalloid boluses along with intravenous mephentermine to treat the episodes of hypotension, which may have led to more volume being given to patients in the preload group who experienced a higher incidence of hypotension. Although we did observe that patients in the preload group received a slightly higher total volume of crystalloids as compared to those in the coload group, this difference was not statistically significant(p=0.149).

CONCLUSIONS

1. Both preloading and coloading with 20ml/kg of crystalloid solution, when used as a sole technique are ineffective in the prevention of hypotension in the obstetric population receiving spinal anesthesia.
2. Hydration alone is not sufficient for maintaining maternal blood pressure, vasopressor should always be kept ready to be administered.
3. We suggest that valuable time need not be wasted in preloading the parturient especially in case of urgency.
4. Prompt recognition of hypotension by frequent measurement of blood pressure in the subjects and administration of vasopressors for maintaining the maternal blood pressure close to the baseline can ensure better maternal and neonatal outcome.

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