ORIGINAL ARTICLE

Efficacy of Crystalloids and Colloids as Preloading Fluids to Prevent Hypotension in Spinal Anesthesia in Elective C-Sections

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ABSTRACT

Aim: To compare the efficacy of crystalloids and colloids in preventing hypotension in spinal anesthesia in elective caesarean sections.
Study Design: Randomized Control Trials.
Setting: Department of Gynae & Obs Lady Willingdon Hospital/K. E. Medical University Lahore
Duration of study: Six months
Methods: A total of 200 patients were divided into two equal groups, group [RL] receiving 20ml/kg of ringer lactate as crystalloid and group [H] receiving 500 ml of 3% heamaccel as preloading fluid 15 min prior to administration of spinal anesthesia for elective C-section.
Results: 200 pregnant females undergoing elective cesarean section under spinal anesthesia were included. The mean age of all the patients was 26.66±3.38years, 145 females were ASA class 1 while 55 females were ASA class 2. Mean drop in blood pressure was from 119.71±6.93mmHg to 87.66±10.19mmHg. BP was dropped from 119.37±7.02mmHg to 87.98±10.73mmHg in crystalloid group and in colloid group; it dropped from 120.04±6.85mmHg to 87.98±9.65mmHg. The overall efficacy was achieved in 140(70%) patients while in 60(30%) patients efficacy could not be achieved. In crystalloid group, 71 females showed efficacy and in colloid group, 69 females showed efficacy.
Conclusions: According to this randomized trial we did not find any significant difference between both groups for prevention of hypotension. In both groups, maximum patients had stable BP level.
Key words: Spinal anesthesia, caesarean section, systemic hypotension, preloading.

INTRODUCTION

Spinal anaesthesia is commonly used for C-section[1,2]. This technique compared to general anaesthesia is not only safe, convenient to administer but it also provides excellent analgesia in the post-operative period[3]. Studies conducted on maternal and fetal mortality indicate decreased morbidity and mortality when parturient are operated under spinal anaesthesia compared to general anaesthesia[4]. Inspite of all the benefits, the potential of spinal anaesthesia to cause maternal hypotension[5], predisposes the mother and fetus to adverse effects like nausea, vomiting, circulatory collapse, fetal hypoxia[7] and at times even death of mother & fetus[8].

The incidence of hypotension quoted in literature is quite as high as 85%[9]. Hypotension from spinal anaesthesia results from sympathetic blockade which causes vasodilatation and increase in capacitance vessels. This reduction in venous return to heart becomes further decreased in parturient, due to compression of graved uterus on inferior vena cava[10].

Frequently anesthetists' use preventive measures like positioning of the patient, administration of different types of fluids or vasoconstrictors, but none of these measures have a clear cut advantage over the other[12].

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Considering this underlying cause of Hypotension research workers used crystalloids for preloading the patients to obtain volume expansion and combat the effect of vasodilatation[6]. Early studies on pre loading fluids by Greiss[14], Marx[15] and Rout[13] found crystalloids effective in reducing incidence of hypotension. It was Clark[16] and later Rout[13] who raised questions on it.

Clark[16] studied patients who were not preloaded or given lateral tilt, with patients who were preloaded and given lateral tilt, and those who were preloaded but not given lateral tilt. He found incidence of hypotension 92%, 53%, 57% respectively in these three groups. In other studies by Rout[13] Jackson et al[17] and Norris[18] it was found that increasing the volume of ringer lactate form 10ml/kg^{-1} to 30ml/kg^{-1}[19] did not significantly affect hypotension. Rout`s preloaded vs. un-preloaded patients had 71% vs. 55% incidence of hypotension. Jackson compared two groups receiving 200ml or 1000ml ringer lactate and could not find any difference in incidence of hypotension (30% compared to 33%). Norris et al[18] increased preload volume up to 40 – 50 ml/kg^{-1} and G.E. Park et al increased preload up to 30ml/kg^{1} but incidence of hypotension did not decrease. Preloading volume to this extent can affect the parturient by causing fluid overload, hemo dilution, decreased oxygen carrying capacity and even pulmonary edema in de-compensated hearts[4].

Ueyama[20] studied effect of 1.5 liter ringer lactate with 0.5 liter and 1 liter 6% hydroxyl ethyl starch (HES) and found incidence of hypotension 75%, 58%, and 17% in the three groups respectively. He found that only 28% of the infused Ringer lactate was retained in the intravascular compartment compared to (HES), which was 100% retained. As ringer lactate has a short half-life of 20 – 30 minutes it is excreted or re distributed before the effect of spinal blockade is over so it does not prevent hypotension as effectively as colloids[3].

Colloids because of their greater molecular size and half life are retained intravascularly for a longer duration of time, so they are expected to decrease the incidence of hypotension due to spinal anaesthesia[20].

G.W.J French[6] compared pentastarch and ringer lactate and found incidence of hypotension 12.5% and 47.5% in both groups respectively. Similarly studies by Bharti Jalandhara et al[3], Mathru et al[9] and Riley ET et al[21] compared colloid and crystalloid groups and found incidence of hypotension 16.7%, 0%, 45% in their colloid groups and 40%, 29%, 85% in their crystalloid groups. Ngan[22] concluded that spinal induced hypotension could be reduced by infusing ringer lactate and concomitant use of vasoconstrictors.

Colloids other than their cost are also associated with allergic reactions and causing fluid over load in de-compensated hearts[3]. Studies by J. Karinen et al[11] and Sarah McDonald et al[35] found no difference in incidence hypotension or hemodynamic stability while measuring the effects of colloids or crystalloids infusion.

MATERIALS AND METHODS

This randomized control trials was conducted in the Department of Gynae & Obs, Lady Willingdon Hospital Lahore. A sample size of 200 cases;100 cases in each group was calculated with 95% confidence level,1% margin of error and taking expected percentages of prevention of hypotension to less than 70% of patients' baseline systolic pressure of crystalloids and colloids i.e. 52.5% and 87.5% respectively in patients undergoing spinal anesthesia for elective cesarean section. Non probability, purposive sampling technique was used.

Inclusion criterion: Parturient undergoing elective caesarean section under spinal anesthesia, ASA I and II, Age 20 – 35 years

Exclusion criterion: Known allergy to local anesthetics, patients of eclampsia and preeclampsia, known cases of hypertension, patients on anticoagulant therapy, known cases of thyrotoxicosis, known cases of severe stenotic valvular disease. Patients having infection i.e. bed sores or scabies at site of spinal injection, severe deformities of spine like scoliosis and kyphoscoliosis were excluded.

Data collection procedure: Parturient were randomly divided by lottery method into two groups; Group [RL] received ringer lactate, 20ml/kg body weight and Group [H] receiving 500ml of 3% heamccel. No patients were pre-medicated. Baseline readings of systolic blood pressure were taken prior to induction of anesthesia. Two wide bore intravenous cannulas were passed; one for medication and other for intravenous fluids. Patient was preloaded with the randomly assigned preloading fluid 15 minutes prior to spinal anesthesia. Spinal anesthesia was performed following asepsis with spinal needle no.23 G using standard technique for spinal anesthesia with hyperbaric Bupivacaine 0.75%. After achieving the desired level of block surgeon was allowed to start the procedure. Readings of systolic blood pressure were noted from the time of induction of spinal anesthesia to the time of umbilical cord clamping. All readings of blood pressure were entered in Performa. Decrease in blood pressure was treated with injection phenlephrine intravenous stat. Efficacy of colloid preloading was defined as the ability to prevent hypotension i.e., a fall in systolic blood pressure beyond 70% of patient's baseline systolic blood pressure after induction of spinal anesthesia, to the time of cord clamping in patient undergoing elective Caesarean section. Data was compiled and analyzed using SPSS-12. Descriptive statistics were employed to calculate the mean and standard deviation of age of patients. Efficacy (yes, no) was calculated as frequency and percentage. Efficacy was compared in both the groups by using Chi Square test. P value of <0.05 was considered as significant value.

RESULTS

In this study, 200 pregnant females, undergoing elective cesarean section under spinal anesthesia were included according to the calculated sample size and were randomly divided in two equal groups. The mean age of all the patients was 26.66±3.38 years with minimum and maximum age as 20 years and 32 years respectively. The mean age of females in group (RL) was 25.78±3.54years and mean age of females in group (H) was 25.54±3.24years. (Age range=12years in both group). On the basis of analysis, there were 145 females (76 in group RL 69 in group H) who were ASA 1 while 55 females (24 in group RL; 31 in group H) who were ASA 2. Considering both groups together baseline blood pressure was calculated as 119.71±6.93mmHg and at the time of cord clamping it was 87.66±10.19mmHg. The minimum blood pressure at baseline and cord clamping was 110mmHg and

68mmHg while maximum blood pressure at baseline and cord clamping was 130mmHg and 119mmHg respectively. In crystalloid RL group blood pressure of females was calculated from time after administration of spinal anesthesia till cord clamping and the baseline blood pressure was 119.37±7.02mmHg and at time of cord clamping it was 87.98±10.73mmHg. The minimum blood pressure at baseline and cord clamping was 110mmHg and 68mmHg while maximum blood pressure at baseline and cord clamping was 130mmHg and 118mmHg respectively. Blood pressure of females in colloid H group was calculated from time after administration of spinal anesthesia till cord clamping and the baseline blood pressure was 120.04±6.85mmHg and at time of cord clamping it was 87.98±9.65mmHg. The minimum blood pressure at baseline and cord clamping was 110mmHg and 70mmHg while maximum blood pressure at baseline and cord clamping was 130mmHg and 119mmHg respectively. The efficacy was achieved in 140(70%) patients while in 60(30%) patients efficacy was not observed. In group (RL), in 71 females, efficacy was achieved while in 29 females efficacy could not be achieved because of drop in BP. In group (H), in 69 females, efficacy was achieved while in 31 females, efficacy could not be achieved. The difference between both groups was statistically insignificant but there were more females in group RL in which efficacy was achieved. (p-value=0.758)

Table 1: Comparison of age and Blood pressure in both groups

BPmmHgbaseline	Group A	Group B	p-value
Age (years)	25.78 ± 3.54	25.54±3.24	0.0240
Base line	119.37±7.02	120.04±6.85	0.495
At time of cord clamping	87.98±10.73	87.33 ± 9.65	0.65
Overall change	92.38 ±9.60	91.90 ±9.13	0.48

Table 2: comparison of efficacy achieved in both groups

Efficacy	Group A	Group B
Yes	71 (71%)	69 (69%)
No	29 (29%)	31 (31%)

P value 0.758

DISCUSSION

Hypotension after spinal anaesthesia does not only cause inconvenience to the surgeon but the resulting nausea and vomiting may be distressing to the patient also[23]. Hypotension in the parturient females if not treated timely and adequately may adversely affect the outcome of the fetus and mother [8]. Keeping in view the etiology of spinal hypotension preemptive measures focused on left literal tilt infusing fluid before and at the time of giving spinal anaesthesia or using vasoconstrictive drugs to combat hypotension[2,24]. All these preventive and treatment modalities are known to prevent hypotension[15] yet others have questioned the use of an agent and weighed its advantages against its adverse effects[17,20,25].

Crystalloid preloading has been popularly used to prevent spinal hypotension.[15] Rout et al[13] in his study compared patients who were not preloaded with those who were preloaded .Incidence of hypotension in the un preloaded patients was 71% compared to 55% in preloaded patients.

Grace E park[19] and Rout found decreased incidence of hypotension with varying volume of ringer lactate, 10ml/kg^{-1} to 30 ml/kg^{-1} but, increasing the amount of fluid even further, could not decrease the incidence of hypotension as suggested by some studies[26].

Norris could not decrease incidence of hypotension below 74% although he used 40 – 50 ml/kg^{-1} ringer lactate. The use of excessive fluid to this extent can cause hemo dilution and circulatory overload[21,27-29] and adversely affect the heart[4] of patients especially due to placental auto transfusion which occurs in the third stage of labor. This is even more harmful in patients of pre eclampsia or myocardial in sufficiency[20-24]. Jewel J et al could not find any benefit of pre or co loading 15 ml /kg $^{-1}$ ringer lactate in decreasing incidence of hypotension in parturient[12]. Clark[16] questioned the role of preloading. His preloaded patients without lateral tilt had 53% incidence of hypotension and with lateral tilt without preloading the incidence of hypotension was 57%. Similarly Jackson found no difference in incidence of hypotension when 1000ml or 200ml of crystalloid was used[17].

Colloids are known to stay intravascularly for a longer duration of 4-12 hours and maintain intra vascular blood volume better than crystalloids depending upon their type whether albumin, starch or dextran is used[28].

Colloids, as they are not rapidly redistributed like crystalloid because of their large molecular size they stay intravascularly and keep the blood pressure more stable during the operative procedures[3,30,31,32].

Among Colloids albumin 5% is said to be most effective but its availability and cost limit its use[9]. Mathru compared 5% albumin with ringer lactate and found incidence of hypotension 0% and 29% respectively. Ngan compared two groups, in one he preloaded 4% gelatin 15mg/kg^{-1} and in the second group he did not give anything. He had incidence of hypotension 31% and 64% in both groups respectively. He concluded hemodynamic stability was albumin in addition they can cause anaphylactic reactions[30,31,32] and can interfere with coagulation profiles of the patients[25,26,27].

In our study we recruited 200 pregnant females to undergo elective c-section under spinal anaesthesia. Blood pressure of all the patients was noted after giving spinal anaesthesia till the clamping

of umbilical cord of the baby. Blood pressures calculated at base line were 119.71±6.93mmHg and at the time of cord clamping they were 87.66±10.19mmHg.

Blood pressure fell significantly from baseline till cord clamping but the decrease in blood pressure at baseline and cord clamping between the groups was insignificant. The blood pressure of both the groups was (RL Baseline 119.37±7.02mmHg) vs. (H Baseline 120.04 ± 6.85). At cord clamping (RL group 87.98 ± 10.73 mmHg) and at cord clamping (H group 87.98 ± 9.65 mmHg), overall efficacy was achieved in 70% of the patients i.e., they did not suffer from hypotension. In (RL) group 71 females and in (H group) 69 females did not have their blood pressure fall below 70%. This difference was not significant statistically. P value (0.495 at base line) and (0.65 at cord clamping) but more number of patients in RL group achieved efficacy.

Some studies have also found statistically insignificant difference between colloids and crystalloid preload as Cyna et al[33]. Different studies found that colloid preload did improve hemodynamic stability and prevented hypotension but considering their cost, allergic reactions and risks of fluid overload in diseased and de-compensated hearts crystalloids could be a better choice using low spinal techniques with judicious use of vasoconstrictors[25]. Michele zasa[12] compared two groups using lateral tilt in one and injection ephedrine only in the other. He observed no statistical difference in incidence of hypotension between the groups.

In our study we compared RL 20 mg/kg^{-1} with 500ml 3% haemaccel and the difference of hypotension between the groups, (RL) group and (H) group was insignificant.

Duggal[34] found incidence of hypotension 56% in crystalloid group compared to 22% in colloid group. This difference can be due to less volume of ringer lactate Duggal used compared to our study, moreover the hemaccel stayed intravascularly for a longer duration than RL (20 – 30 min)[20].

Results of Bahrti Jalandhara[3] are also not in agreement with ours. He compared 15 ml/kg^{-1} ringer lactate with gelatin 5 mg/kg^{-1} and found incidence of hypotension 40% and 16.7% in both groups respectively. His patients were general surgical patients with operation on lower abdomen and lower extremities. As our cases were c section, which are mostly completed in 30-45 min and cord clamping takes place around 15-20 min, ringer lactate may have still been in circulation so we did not find difference in B.P in both groups. Moreover as other surgical procedures take more time than elective c section the ringer lactate got distributed but gelatin stayed within the vessels which prevented fall of blood pressure in that group.

Ueyama et al[20] found incidence of hypotension 75% for 1.5 liter RL group, 58% for 500ml 6% HES and 17% for 1 liter HES 6%. This difference may have resulted from the colloid oncotic pressure of 6% hetastarch which is 30mmHg and its prolonged plasma half life compared to ringer lactate. Ueyama concluded that the preloading solution must stay intravascularly and increase blood volume to decrease incidence of hypotension. He found increase in blood volume of 8%, 10%, and 20% in his RL, 0.5 liter HES and 1 liter HES group respectively compared to their baseline blood volumes.

G.W.G et al[6] compared incidence of hypotension in C section patients using 15 ml/kg^{-1} pentastarch or 15 ml/kg^{-1} ringer lactate. They found incidence of hypotension in patients 12.5% in pentastarch group compared to 47.5% in Ringer lactate group. Pentastarch has colloid oncotic pressure of 40mm Hg and has a prolonged effect on plasma expansion (10 -12 hours). They used bupivacaine 0.5% 2.3 -3 ml, the mean age of their patients was 30.

F.J Mercier et al[25] found incidence of hypotension 36.6% vs. 55.3% when compared 500ml 6% HES + 500ml RL with one liter Ringer lactate.

Riley et al[21] also found incidence of hypotension 85% and 45% when compared 2 liter Ringer Lactate with 0.5 liter 6% HES+1000ml Ringer Lactate. In both these studies it was shorter intra-vascular stay of Ringer lactate compared to HES.

J. Karinen[11] et al studied 1 liter Ringer lactate and 0.5 liter hydroxyethyl starch (HES) and observed high incidence of hypotension in Ringer late group 62% and 32% in HES group .Although CVP increased with preload but its level fell shortly after induction of spinal anaesthesia. He suggested that sensitive and rapid hemodynamic regulation makes adjustments in utero placental circulation when maternal hemodynamic in stability occurs in response to external stimuli. He concluded that preloading with a colloid or a crystalloid was not sufficient to prevent maternal hypotension in parturient under spinal anaesthesia so effectiveness of preventive measures need re-evaluation.

Similarly Sarah[35] studied infusion of 1 liter Ringer lactate with 1 liter 6% HES and studied changes in cardiac output under spinal anaesthesia in obstetric patients. She found no difference in hemodynamic stability, cardiac output variables or vasopressor requirements and concluded that there was no benefit of using colloid over crystalloid when used at the time of spinal anaesthesia.

We can explain the results of our study considering C section is a brief procedure and we measured blood pressure till cord clamping. The difference in intravascular half life or redistribution of hemaccel and ringer lactate could not be appreciated as ringer lactate was still in the blood[20]. Similarly

Sarah could not find difference in patients when crystalloid or colloid were given at time of spinal anaesthesia.

CONCLUSION

According to this randomized trial we did not find any significant difference between both groups for prevention of hypotension. Maximum number of patients in both groups had stable blood pressure.

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