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Original Research Article.

To Compare the Effectiveness of Preloading Using Crystalloid or Colloid with Co-Loading Using Crystalloid or Colloid in Preventing Spinal Hypotension

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ABSTRACT

Background: Spinal anaesthesia is a popular technique for lower abdominal, pelvic & orthopaedic surgeries & offers a quick, prolonged and symmetrical sensory and motor blockade. Hence, the study compares the effectiveness of preloading, using crystalloid or colloid with co-loading, using crystalloid or colloid in preventing post spinal hypotension.

Materials and Methods: This prospective, comparative, randomized study was conducted in Department of Anaesthesia, B.K.L. Walawalkar Rural Medical College, Kasarwadi, Ratnagiri, Maharashtra, India. A total of 120 patients were enrolled into study. Patients were randomized into 4 groups i.e. Group A-preloading with ringer lactate, Group B -co-loading with ringer lactate, Group C-preloading with 6% hydroxyethyl starch, Group D-co-loading with 6% hydroxyethyl starch. Baseline arterial pressure, mean arterial pressure and heart rate were recorded. Spinal anesthesia was administered. After induction of spinal anesthesia HR, SBP, DBP, MAP was recorded every two mins till first ten minutes and every 5 min thereafter till 45 minutes from administration of spinal anesthesia. The number of clinically significant hypotension and bradycardia were recorded along with total dosage of ephedrine used over a period of 45 minutes to treat these episodes. The data was statistically analyzed using software SPSS (Statistical Package for Social Sciences Software Version 15)

Results: The results showed that Demographic variables like age, weight, sex, ASA status, duration of surgery were comparable in both the groups, Preoperative vital parameters like heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure were comparable in all 4 groups, Pre-operative medical history was comparable in all 4 groups, Maximum patients sensory level achieved was T6, comparable in all 4 groups, Maximum motor level achieved was bromage III, similar in all 4 groups, Fall in intraoperative heart rate was significant in all 4 groups, Maximum fall was noted in group B, After 45 minutes, mean heart rates in groups A, B, C &D were 69.7, 69.4, 71.6 and 79.5 respectively, Fall in blood pressure was comparable in all 4 groups at 0,2,4,6,8,10,15,20,25,30,35,40,45 mins. Incidence of hypotension noted in 79 patients, Maximum fall in blood pressure is noted in group B and minimum in group C, Intraoperative MAP-Fall in MAP was comparable in all 4 groups. Mean values at the end of 45 minutes are 84.3,89.8,91.9,90.5 in each group respectively, Mean values are higher in group C as compared to other groups, Out of 120 patients, 40 patients required ephedrine.

Conclusion: Our study concludes that Fluid infusion is an effective method for treatment of spinal hypotension. Both colloid (6% HES) and crystalloid (RL)can be used for preventing spinal hypotension. In both 6% HES preload and 6% HES coload groups, vasopressor requirements are lesser. To prevent spinal hypotension, 6% HES preload is better than RL preload, RL coload and 6% HES coload. The greater effectiveness of colloid is a result of greater effect for increasing central venous pressure and cardiac output caused by slower redistribution out of the intravascular space.

Keywords: Colloid, Crystalloid and Spinal Anaesthesia.

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INTRODUCTION

Spinal anaesthesia has become increasingly popular for inpatient surgery, but, until recently, its use has been limited in ambulatory surgery by the lack of a safe, licensed short-acting local anaesthetic agent. An ideal intrathecal agent for ambulatory surgery should have a rapid onset of motor and sensory blockade, predictable regression within an acceptable time frame, and a low incidence of adverse effects. Historically, lidocaine was the preferred agent in this setting, providing a dense block with rapid

recovery, but the identification of a high incidence of transient neurologic symptoms (TNS) has effectively excluded it from use.[1,2] Until recently, the only local anaesthetic preparations licensed for intrathecal use have been hyperbaric bupivacaine alone in the USA, and hyperbaric bupivacaine and plain levobupivacaine in the UK. Both drugs are of limited utility in the ambulatory setting because of their long duration of action. Low-dose bupivacaine and 'unilateral' blocks have been used in an attempt to reduce block duration, with limited success.[1] August Bier and his assistant August Hildebrant on 15th August 1898, in Keil, Germany, used Quinke's method of entering the intrathecal space and injected 5-15 mg of cocaine to produce spinal anaesthesia in 6 cases for operation on lower part of body. Bier thought that it would not replace general anaesthesia due to side effects such as nausea, vomiting, dizziness and headache. He proposed that these side effects could be due to escape of cerebrospinal fluid out of dural sac.[3] Cushing in 1903, demonstrated routine blood pressure measurement, he observed severe hypotension could occur after spinal anaesthesia.[3] The aim of this study is to compare the effectiveness of preloading using crystalloid or colloid with co-loading using crystalloid or colloid in preventing spinal hypotension.

MATERIALS AND METHODS

This prospective, comparative, randomized study was conducted Department of Anaesthesia, B.K.L. Walawalkar Rural Medical College, Kasarwadi, Ratnagiri, Maharashtra (India) after obtaining approval from institutional review board. A total of 120 patients were enrolled into our study after obtaining their written informed consent. Patients with ASA physical status 1 or 2, Age between 18-60yrs, Weight 50-90 kgs, Height >150cm, Lower abdominal, gynecological and orthopedic surgery were included in the study.

Patients with height less than 150 cm, ASA Grade 3&4, Contraindication to spinal like patient refusal, coagulation disorders, local infection and allergy to drugs used in the study., All patients were premedicated with tab. Ranitidine 150 mg at night & morning 8 am and Tab. Alprazolam 0.5 mg at night, Standard NPO guidelines were followed. In the operating room, standard monitoring including ECG, Pulse oximetry, and NIBP was instituted and intravenous access was secured with 18 G cannula were excluded from the study. Patients were randomized into 4 groups i.e. Group A -preloading with ringer lactate, Group B -co-loading with ringer lactate, Group C-preloading with 6% hydroxyethyl starch, Group D-co-loading with 6% hydroxyethyl starch. Baseline arterial pressure (by non-invasive arterial pressure monitor), mean arterial pressure and heart rate were recorded. Patients in preloading group (group A & C) were loaded with either ringer lactate or hydroxyethyl starch 6% at the rate of 15 ml/kg 20 minutes before procedure. Patients in co-loading group (group B & D) received ringer lactate or hydroxyethyl starch 6% at the rate of 15 ml/kg, initiated at the time of identification of cerebrospinal fluid. Intravenous administration set, pressurized to 250 mm Hg was used in all patients to administer the fluid at the maximum possible rate. Spinal anesthesia was administered under aseptic precautions after explaining the procedure to the patient. Patient in left lateral position, 2cc of local anaesthetic 2% lignocaine infiltrated in L3-L4 interspace. Spinal anesthesia was administered with 3- 3.5 cc of 0.5 % heavy bupivacaine as per procedure, using 25 G Quinkes needle. The local anesthetic was injected over 30 seconds. The level of spinal block was assessed by using a ether soaked cotton swab. After induction of spinal anesthesia HR, SBP, DBP, MAP was recorded every two mins till first ten minutes and every 5 min thereafter till 45 minutes from administration of spinal anesthesia. Spinal induced hypotension was defined as decrease in systolic arterial pressure > 30 % of baseline which was treated with bolus of 6 mg ephedrine repeated every five minutes as per requirement. Decrease in heart rate >20 % from baseline value was considered significant and was treated with 0.6 mg of IV atropine. The number of clinically significant hypotension and bradycardia were recorded along with total dosage of ephedrine used over a period of 45 minutes to treat these episodes. Observations were completed 45 minutes after administration of spinal anesthesia though patient management was continued thereafter as per requirement. The data was statistically analyzed using software SPSS (Statistical Package for Social Sciences Software Version 15)

Table 1: Demographic data-I

GROUP		AGE	HEIGHT	WEIGHT
A	**Mean**	49.37	165.60	62.63
	Std. Deviation	9.908	7.582	8.079
B	**Mean**	46.30	163.50	64.43
	Std. Deviation	10.590	8.382	10.345
C	**Mean**	50.10	167.80	61.50
	Std. Deviation	11.318	8.899	8.764
D	**Mean**	49.57	164.30	70.43
	Std. Deviation	11.224	7.349	11.443
All	**Mean**	48.83	165.30	64.75
	Std. Deviation	10.742	8.140	10.226
F value		0.762	1.622	4.993
df		3	3	3
P value		**0.518**	**0.188**	**0.030**

Table 2: **Demographic Data-II**

Group		Female	Male	Total
A	**Number**	9	21	30
	Percentage	30.0	70.0	100.0
B	**Number**	8	22	30
	Percentage	26.7	73.3	100.0
C	**Number**	7	23	30
	Percentage	23.3	76.7	100.0
D	**Number**	9	21	30
	Percentage	30.0	70.0	100.0
ALL	**Number**	33	87	120
	Percentage	27.5	72.5	100.0

Chi square (X^2) value – 0.460; degree of freedom(df) – 3; 'P' value – 0.9

Table 3: Showing distribution of cases based on ASA status

Group		ASA STATUS		Total
		I	II	
A	**Number**	16	14	30
	Percentage	51.1	48.9	100.0
B	**Number**	15	15	30
	Percentage	50.0	50.0	100.0
C	**Number**	17	13	30
	Percentage	52.3	47.7	100.0
D	**Number**	15	15	30
	Percentage	50.0	50.0	100.0
ALL	**Number**	73	57	120
	Percentage	55.9	44.1	100.0

Chi square (X^2) value – 15.227; degree of freedom (df) – 3; 'P' value – 0.027

Table 4: Preprocedure heart rate, systolic BP, diastolic BP, Mean arterial pressure.

GROUP		Duration of surgery (min)	Baseline HR	Baseline SBP	Baseline DBP	Baseline MAP
A	**Mean**	109.00	75.40	129.20	80.47	97.57
	Std. Deviation	30.581	11.000	15.533	9.160	11.723
B	**Mean**	89.67	83.33	129.20	82.63	96.53
	Std. Deviation	28.766	18.861	19.468	13.257	15.741
C	**Mean**	100.50	71.10	134.33	80.63	101.13
	Std. Deviation	29.313	10.277	15.470	8.422	10.602
D	**Mean**	97.70	83.37	136.87	85.00	102.10
	Std. Deviation	27.312	20.372	21.157	12.739	15.419
All	**Mean**	99.22	78.30	132.40	82.18	99.33
	Std. Deviation	29.476	16.465	18.158	11.114	13.591
F value		2.267	4.462	1.352	1.094	1.189
df		3	3	3	3	3
P value		**0.084**	**0.050**	**0.261**	**0.354**	**0.317**

Table 5: Distribution of cases based on sensory level achieved post spinal anaesthesia

Group		Sensory level achieved			Total
		Upto 4	5	6 and above	
A	Number	5	12	13	30
	Percentage	16.7	40.0	43.3	100.0
B	Number	2	7	21	30
	Percentage	6.7	23.3	70.0	100.0
C	Number	7	6	17	30
	Percentage	23.3	20.0	56.7	100.0
D	Number	5	9	16	30
	Percentage	16.7	30.0	53.3	100.0
ALL	Number	19	45	56	120
	Percentage	15.8	37.5	46.7	100.0

Fishers exact test value – 16.414; 'P' value – 0.010

Table 6: Distribution of cases based on motor level achieved post spinal anaesthesia

Group		Motor level achieved-bromage scale.		Total
		Level 3	Level 4	
A	Number	20	10	30
	Percentage	66.7	33.3	100.0
B	Number	16	14	30
	Percentage	53.3	46.7	100.0
C	Number	24	6	30
	Percentage	80.0	20.0	100.0
D	Number	24	6	30
	Percentage	20.0	80.0	100.0
ALL	Number	66	54	120
	Percentage	55.0	45.0	100.0

Chi square (X^2) value – 24.108; degree of freedom(df) – 3; 'P' value – 0.063

Table 7: Preprocedure heart rate, systolic BP, diastolic BP, Mean arterial pressure.

GROUP		Duration of surgery (min)	Baseline HR	Baseline SBP	Baseline DBP	Baseline MAP
A	Mean	109.00	75.40	129.20	80.47	97.57
	Std. Deviation	30.581	11.000	15.533	9.160	11.723
B	Mean	89.67	83.33	129.20	82.63	96.53
	Std. Deviation	28.766	18.861	19.468	13.257	15.741
C	Mean	100.50	71.10	134.33	80.63	101.13
	Std. Deviation	29.313	10.277	15.470	8.422	10.602
D	Mean	97.70	83.37	136.87	85.00	102.10
	Std. Deviation	27.312	20.372	21.157	12.739	15.419
All	Mean	99.22	78.30	132.40	82.18	99.33
	Std. Deviation	29.476	16.465	18.158	11.114	13.591
F value		2.267	4.462	1.352	1.094	1.189
df		3	3	3	3	3
P value		**0.084**	**0.050**	**0.261**	**0.354**	**0.317**

Table 8: Distribution of cases based on Ephedrine administration

Group		Ephedrine administrated		Total
		No	Yes	
A	Number	20	10	30
	Percentage	66.7	33.3	100.0
B	Number	16	14	30
	Percentage	53.3	46.7	100.0
C	Number	24	6	30
	Percentage	80.0	20.0	100.0
D	Number	20	10	30
	Percentage	66.7	33.3	100.0
ALL	Number	80	40	120
	Percentage	66.7	33.3	100.0

Chi square (X^2) value – 4.800; degree of freedom (df) – 3; 'P' value – 0.187

Figure 1: Graphical representation showing trend of mean heart rate over time in all 4 groups

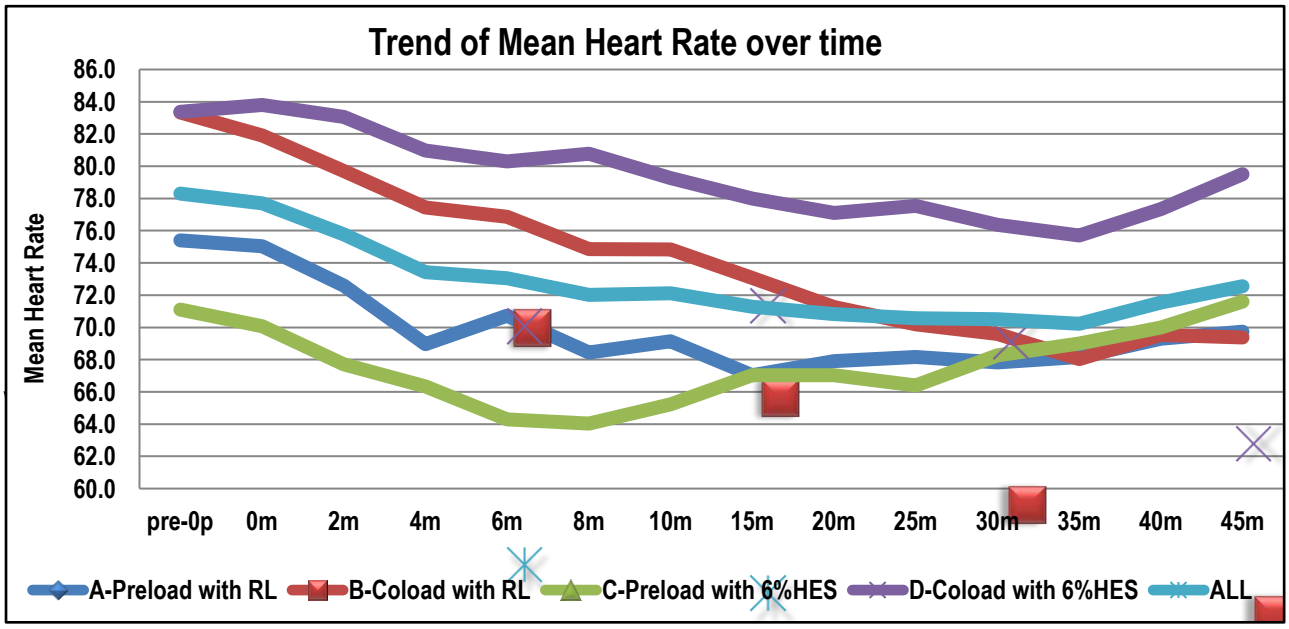


Figure 2: Graphical representation showing trend of mean systolic BP over time in all 4 groups

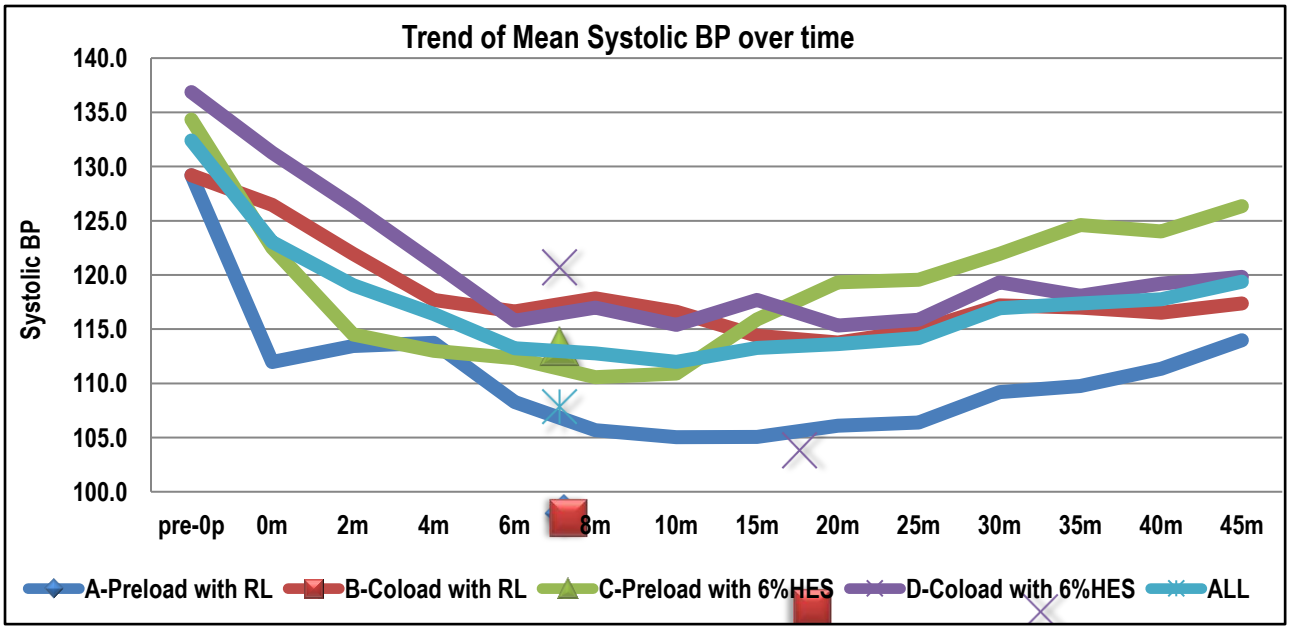


Figure 3: Graphical representation showing trend of mean diastolic BP over time in all 4 groups

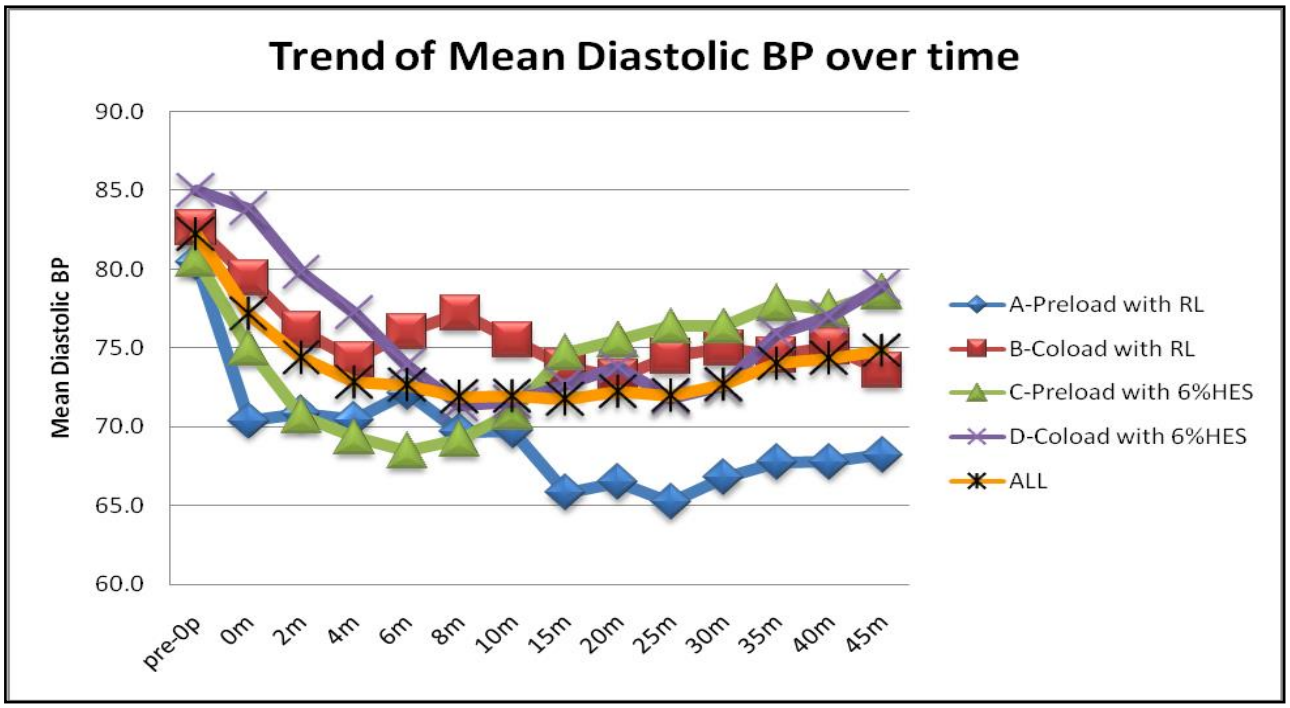
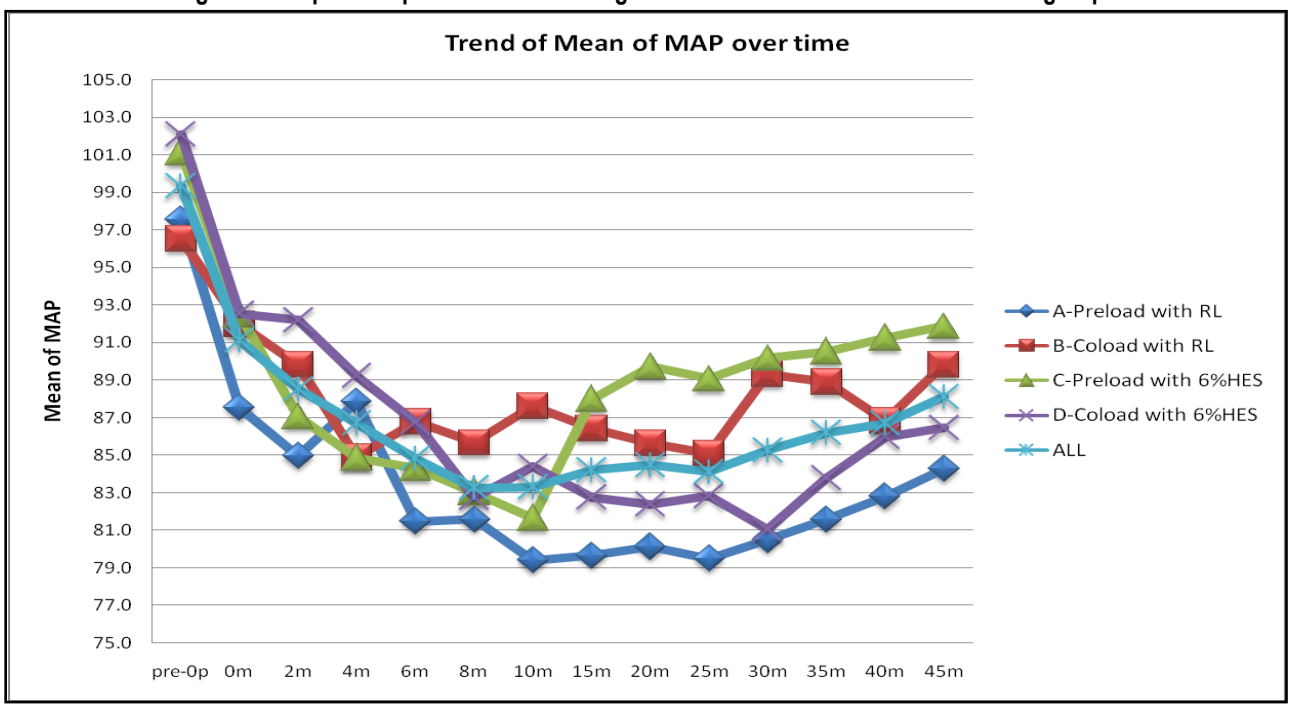


Figure 4: Graphical representation showing trend of mean of MAP over time in all 4 groups



RESULTS

One hundred and twenty patients were enrolled in the study. The demographic data with respect to age, weight and height is comparable in all four groups with a p value being statistically not significant.

Sex distribution is comparable in all 4 groups with p value being statistically not significant.

The ASA grading was also comparable between the four groups.

The pre-procedure heart rate, systolic BP and diastolic BP, Mean arterial pressure in the groups was also comparable, statistically insignificant as seen with the p values.

Table 5 shows that most of the patients in above groups achieved maximum sensory level of T6. The onset and progression of sensory blockade is comparable in all 4 groups.

The onset and scale of motor blockade according to bromage scale is comparable in all 4 groups with no statistical difference.

The pre-procedure heart rate, systolic BP and diastolic BP, Mean arterial pressure in the groups was also comparable, statistically insignificant as seen with the p values.

Table 8 shows number of ephedrine doses given in each group.10 patients in group A ,14 patients in group B, 6 patients in group C and 10 patients in group D received ephedrine.

DISCUSSION

The present study aims to determine the most effective intravenous fluid and timing of fluid infusion to prevent post spinal hypotension. Patients were randomly allocated in 4 groups. The demographic data with respect to age, weight, height, sex and ASA grading were comparable in all 4 groups. p value being not significant for any group.

In a study conducted by Manu Bose et al[4] they analysed independent variables responsible for spinal induced hypotension and showed that for each segment increment in block height, the risk of hypotension increased by 25%. Therefore, our study attempted to achieve a sensory block level of T6 and motor blockade of Bromage scale-III which is appropriate for lower abdominal and limb surgeries.

Out of 120 patients, 23 patients had positive medical history. Although patients with positive history of hypertension and diabetes mellitus were included in this study, both diseases were well controlled. Hence incidence of exagerated hypotension due to uncontrolled hypertension or due to autonomic dysfunction in diabetics was not reported.

In all 4 groups, a decrease in heart rate as compared to baseline values were noted. We observed that groups A and B showed a steeper decrease in heart rate from baseline as compared to groups C and D in which decrease in heart rate was more gradual. Heart rate was almost equal to the baseline values at the end of 45 minutes in groups C and D. But in group A and B heart rates did not come back to baseline. This can be explained by the fact that, we used 6% HES for preloading and coloading in groups C and D respectively.6 % HES being a colloid solution, remained in intravascular space for longer duration as compared to RL and this vascular space expansion by 6% HES compensated for the reduction in systemic vascular resistance caused by spinal anesthesia. These findings can be explained by the fact that sympathetic nerve blockade is completed within first 5-10 minutes after intrathecal administration of bupivacaine. This period corresponds with the maximum risk of cardiovascular side effects like hypotension and bradycardia.[5,6]

Baseline systolic blood pressure values in groups A,B,C and D were 118.0,126.5,122.5 and 121.3 respectively. Fall in systolic blood pressure values were noted in all 4 groups and changes were significant at 2,4,10,15,20,25,30,35,40,45 minutes. Baseline diastolic blood pressure values in group A,B,C and D were 79.4,70.4,75.0 and 76.8. p value being statistically significant.

This can be explained as follows, hypotension immediately after spinal anaesthesia results principally from preganglionic sympathetic blockade after administration of local anaesthetic. This results in rapid fall in blood pressure in first 20 minutes.. After that, blood pressure value gradually returns to baseline value as spinal level recedes. Hence values obtained at the end of 45 minutes are higher as compared to the values at the end of 20 minutes. In our study maximum fall is noted in group B.

Comparison of preloading with RL and co-loading with RL showed that hypotension was noted in both groups at the end of 20 minutes but persisted in co-loading group as compared to preloading group at the end of 45 minutes. We found that preloading using RL was more effective than co-loading with RL.

Comparison of preloading with 6% HES (group C) and co-loading with 6% HES (group D) showed that BP is better maintained in preloading with 6% HES.

In a study conducted by O'Neill[7], he suggested that excessive colloid may cause fluid overload. But in a study conducted by Karinen et al[8], they attempted to measure central volume by measuring CVP. They noted significant increase in central venous pressure after preloading which returned to normal after induction of spinal anesthesia. There were no reports of pulmonary oedema. In our study too, no patient suffered from fluid overload. Hence, we observed that preloading using 6% HES was more effective than co-loading.

From the above intergroup comparisons, we observed that preloading with RL and 6%HES was better than coloading with both. Then we compared group A and C to find out the better fluid from RL and 6% HES for preloading. In our study fall in BP was more in group A as compared to patients in group C at the end of 45 minutes showing that preloading with 6 % HES was better than RL.

Clark et al[9] challenged this practise by suggesting that although crystalloid prehydration may reduce the incidence of spinal hypotension, it does not reliably prevent it. They suggested that this practise is relatively ineffective since crystalloid preload is rapidly redistributed into the interstitial space.

Ogata et al[10] suggested that this method of crystalloid preloading may induce atrial natriuretic peptide secretion resulting in peripheral vasodilation followed by an increased rate of excretion of preloaded crystalloid fluid. Our results are similar to results we found in the above study. This can be explained as follows.

A physiological explanation of differences between crystalloid and colloid can be found in Ueyama et al study.[11] This study showed that at the end of 30 min, only 28 % of ringer lactate remained in intravascular space compared with 100% HES solution in patients posted for Caesarean section. Thus, the maximum expansion of the intravascular volume with prehydration using colloid at the time of induction of spinal anesthesia and immediately after induction, when vasodilation is evolving, is a method of choice for preventing post spinal hypotension. Hence, our study has similar results with study conducted by Ueyema et al.

Another study was conducted by Ekbote, Shridhar N.[12] They studied preloading and relative efficacy of ringers lactate and pentastarch 6% as preloading solution prior to spinal anesthesia in caesarean section. They observed that Pentastarch 6% is an ideal agent for preloading as it is safe and effective in preventing spinal-induced hypotension of parturients. Also, its duration of volume expansion matches with that of duration of spinal anaesthesia.

In our study, we conclude that preloading with 6% HES was most effective in preventing post spinal hypotension.

Fall in intraoperative mean arterial pressure was comparable in all 4 groups. The decrease in mean arterial pressures as compared to the baseline is statistically significant in all 4 groups. We observed that groups A and B showed a steeper decrease in MAP from baseline as compared to groups C and D in which decrease in MAP was more gradual. MAP was almost equal to the baseline values at the end of 45 minutes in groups C and D. But in group A and B the values did not come back to baseline.

In a study conducted by Karmik et al[13] the results of MAP were similar with our study. They compared effect of ringer lactate infusion in preloading and co-loading group with no infusion group. After spinal anesthesia MAP decreased in all 3 groups.

Number of patients with ephedrine doses were comparable in all 4 groups. Results showed that maximum amount of ephedrine was

used in group B and minimum in groups C. Preloading using 6% HES in group C minimised use of ephedrine. While in group B, co-loading with RL caused maximum use of ephedrine as seen by downward trends in blood pressure seen in RL group.

Hence judicious use of ephedrine and preloading with colloid can be considered in preventing hypotension.

Another study was done by Huang et al.[14] They studied Gelatine combined with ephedrine for spinal anesthesia in prevention of hypotension. They recommended that rapid intravenous infusion of Succinylated Gelatin combined with ephedrine can effectively prevent the hypotension induced by caesarean section. In our study also, we noted effective prevention of hypotension in 6% HES preloading group combined with ephedrine.

CONCLUSION

Our study concludes that fluid infusion is an effective method for treatment of spinal hypotension. Both colloid (6% HES) and crystalloid (RL)can be used for preventing spinal hypotension. In both 6% HES preload and 6% HES coload groups, vasopressor requirements are lesser. To prevent spinal hypotension, 6% HES preload is better than RL preload, RL coload and 6% HES coload. The greater effectiveness of colloid is a result of greater effect for increasing central venous pressure and cardiac output caused by slower redistribution out of the intravascular space.

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