Original Research Article

Comparative study of preloading with ringer's lactate and 6% hydroxyethyl starch for prevention of hypotension following spinal anaesthesia

Vinay Dandemmanavar[1], D Pavan Kumar[2*], Pratibha Omkar[3], K Pratyusha[4]

[1,2]Assistant professor, [4]post graduate /Junior resident, Department of Anaesthesiology, Kamineni Institute of Medical Sciences Sreepuram, Narketpally, Nalgonda, Telangana -508254, Andhra Pradesh INDIA.
[3]Assistant Professor, Department of Pharmacology, Kamineni Institute of Medical Sciences Sreepuram, Narketpally, Nalgonda, Telangana - 508254, Andhra Pradesh INDIA.
Email: dr.vinaypd@gmail.com

Abstract

Background: Hypotension during spinal anaesthesia is common and can cause significant morbidity and mortality. Preloading with crystalloid and various types of colloids are one of the important measures for prevention of hypotension with spinal anesthesia. **Aim:** To compare the efficacy of crystalloid, Ringer's lactate, to colloid, 6% Hetastarch, for prevention of hypotension following spinal anaethesia. **Material and Methods:** This study included 100 patients belonging to both sexes undergoing elective lower abdominal surgeries under spinal anaesthesia. Patients were randomized into 2 groups of 50 patients each**: Group H:** Patients receiving preloading with 10ml/kg of 6% Hetastarch and **Group R:** Patients receiving preloading with 10ml/kg of Ringer's Lactate. Heart rate, blood pressure (BP), oxygen saturation was measured. **Results:** The incidence of hypotension in group H was 20% and 40% in group R. The requirement of vasopressor Mephentermine to counter hypotension was significantly less in group H when compared to group R. Group H required significantly lesser dose than group R. **Conclusion:** Colloids offset hypotension and hypovolemia more effectively than crystalloids in patients scheduled for elective lower abdominal surgeries under spinal anaesthesia.

Key Word: Spinal anaesthesia, Hypotension, Ringer's lactate, Hetastarch, Mephentermine

***Address for Correspondence:**
Dr. D Pavan Kumar, Staff quarters, SVP/304, Kamineni Institute of Medical sciences, Sreepuram, Narketpally, Nalgonda District, Telangana-508254, Andhra Pradesh, INDIA.
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INTRODUCTION

introduction of local anaesthetic solutions into subarachnoid space produces spinal anaesthesia. Spinal anaesthesia has several advantages as compared to general anaesthesia. However, spinal anaesthesia does have some drawbacks, especially of having high incidence of hypotension in up to 80 to 90% of cases. Hypotension during spinal anaesthesia is common and can cause significant morbidity and mortality. Preloading with crystalloid and various types of colloids are one of the important measures for prevention of hypotension with spinal anesthesia.[1,2] Crystalloid solutions like Ringer's lactatehave short intravascular time and are poor plasma volume expanders, which may explain why hypotension associated with spinal anaesthesia cannot be completely eliminated by crystalloid preloading. Large volumes of crystalloid fluid can also decrease oxygen-carrying capacity.[12]Crystalloid solutions, being of lower

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molecular weight, enters the interstitial space due to lack of intrinsic colloid osmotic pressure, and may result in pulmonary edema which interfere 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. Hetastarch (6% hydroxyethyl starch) is asynthetic colloidles cheaper than 5% albumin with a mean molecular weight of 4,50,000D. It is widely used for intravascular volume expansion in patients with trauma, shock or sepsis. This study was done to compare the efficacy of crystalloid to colloid in reducing the incidence and severity of spinal induced hypotension.

MATERIAL AND METHODS

This prospective comparative study included 100 patients belonging to both sexes undergoing elective lower abdominal surgeries under spinal anaesthesia.

Inclusion criteria

- ASA physical status class 1 and 2
- Age between 25 and 70 years
- Weight between 40 and 70 Kg

Exclusion criteria

- Emergency surgeries
- Severe anaemia, coagulation abnormalities and bleeding disorders
- Patients with previous history of surgeries on the spine
- Patients with spinal deformities
- Patients with history of chronic backache
- Patients with active skin lesions over lumbosacral region
- Patients with obesity, chronic hypertension, diabetes, and heart disease.
- Infection at the injection site.

Pre-anaesthetic Evaluation: After obtaining approval from the institutional ethics committee, a thorough pre-anaesthetic evaluation was done with special emphasis on cardio-respiratory, nervous system and endocrinal abnormalities. Previous anaesthetic exposure and drug sensitivity were enquired. A thorough general and systemic examination was carried out for baseline vital parameters, airway assessment, cardio-respiratory and CNS abnormalities. Special attention was paid for any kind of spinal deformities, active skin lesions over the lumbosacral area. Height and weight were recorded. Written informed consents were taken and following investigations were recorded. All routine laboratory investigations were done.

Preparation of Patients: Patients were advised to be nil orally from 10 p.m. onwards and were pre-medicated with oral alprazolam 0.5 mg on the previous day of surgery.

Patients were randomized into 2 groups of 50 patients each:

- Group H: Patients receiving preloading with 10ml/kg of 6% Hetastarch
- Group R: Patients receiving preloading with 10ml/kg of Ringer's Lactate.

Procedure: Patients were shifted to operation theatre, connected to multichannel monitor and 18G iv cannula was introduced. Baseline heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were measured in supine position. The study fluids were administered at the rate of 10ml/kg body weight prior to spinal anaesthesia over aduration of 20 minutes. After intravascular administration, Heart rate and blood pressure were measured. With all aseptic precautions and patients in lateral position, spinal anaesthesia was performed in L3-L4 interspace with a 25G spinal needle using 3ml of 0.5% hyperbaric bupivacaine. The patient was turned to supine position, and the level of anaesthesia determined by pinprick method, bilaterally, after 5 minutes of intrathecal injection. Heart rate, systolic and diastolic blood pressures were recorded at 2-min intervals for the first ten minutes and then for every five minutes for 1-hour duration. ECG and Oxygen saturation were monitored continuously throughout the procedure. Hypotension was defined as a decrease in systolic blood pressure by more than 20% from the initial baseline value. Hypotension was treated with increase in fluid infusion rate, administering oxygen by Hudson's face mask and leg elevation after the fixation of local anaesthetic. If hypotension still persisted, intravenous bolus of 6mg mephenteramine was given and repeated as necessary until the blood pressure increased to >20 % of the baseline value. Bradycardia (heart rate less than 50/min) when encountered was treated with 0.6 mg of atropine. After preloading, all patients were given Ringer's Lactate at the rate of 1.5 ml/kg/hr as maintenance fluid. The number of patients developing hypotension as well as the mean dose of mephenteramine required for treatment was noted.

Statistical analysis: The analysis of data was done using SPSS version 15.0 computer software. Numerical variables like Heart rate, SBP, DBP and MAP were presented as mean and standard deviation. The t-Test has been used to find the significance between the two groups.

RESULTS

The mean age of patients in Group H was 39.9±12.20 years while it was 42±12.3 years in Group R. Demographic data were comparable in all three groups (Table 1).

Table 1: Distribution of demographic characteristics between two groups

Characteristics	Group H	Group R
Age distribution		
25 – 40 years	30	25
41 - 55 years	12	15
56 – 65 years	08	10
Mean ± SD	39.9±12.20	42±12.3
Sex		
Male	27 (54%)	26 (52%)
Female	23 (46%)	24 (48%)
Weight (Kgs)		
40-50 Kgs	29	27
51-60 Kgs	21	22
61-70 Kgs	00	01
Mean ± SD	49.9±2.78	50.9±4.07

Table 2 shows the trend of mean heart rate changes during the study. It was observed that the baseline heart rate values for the two groups were similar and were statistically not significant. There was a slight increase in the heart rate values in both groups after preloading and in the first twenty to thirty minutes after spinal anaesthesia. However, there was no statistically significant change in mean heart rate values in the two groups. The group R patients had the maximum increase in the mean heart rate after spinal anaesthesia, though not significant.

Table 2: Comparison of Heart Rate between the two groups

HR at different time intervals	Group H (Mean ±SD)	Group R (Mean ±SD)	Significance
Baseline	76.6±7.36	76.2 ±7.05	P =0.78(NS)
After pre loading	81.38±7.41	79.9 ±7.18	P=0.31(NS)
1 minute	83.42±7.35	81.5 ±7.32	P=0.1937(NS)
2 minutes	83.5±7.82	81.5 ±7.62	P=0.1983(NS)
4 minutes	83.26±8.88	81.4 ±8.12	P=0.27(NS)
6 minutes	82.28±8.00	81 ±7.9	P=0.42(NS)
8 minutes	81.84±7.59	81 ±7.4	P=0.57(NS)
10 minutes	80.54±7.61	79 ±7.33	P=030(NS)
15 minutes	78.7± 7.51	80 ±7.35	P=0.27(NS)
20 minutes	76.6 ±7.02	75 ±7.4	P=0.27(NS)
25 minutes	76.28±8.03	73.9±6.97	P=0.11(NS)
30 minutes	75.28± 7.00	73.2 ±6.22	P=0.11(NS)
35 minutes	72.78 ±6.11	73.3 ±6.1	P=0.69(NS)
40 minutes	72.06 ±6.33	71.5 ±6.15	P=0.65(NS)
45 minutes	71.4 ±5.82	69.5 ±10.7	P=0.27(NS)
50 minutes	70.92 ±5.45	71 ±5.4	P=0.94(NS)
55 minutes	70.72 ±4.86	70.6 ±4.82	P=0.90(NS)
60 minutes	71.28 ±4.05	71± 4.20	P=0.73(NS)

There was no significant difference between the SBPs of the two groups in the first six minutes. At eight minutes after spinal, the fall in SBP in group R was greater than in group H, which was statistically significant (p=0.07). In the tenth and fifteenth minute interval, group R had a significant fall in SBP when compared to H (p=0.04, p=0.01) which was statistically significant. In the twentieth minute interval it can be seen that group R again had a significant fall in SBP when compared to group H (p=0.05).In the 20th and 35th minute interval group R again had a significant fall in SBP when compared to group H (p=0.41) (p=0.15).

Table 3: Mean pattern of systolic blood pressure (SBP) of the two group

Systolic blood pressure	Group H (Mean ±SD)	Group R (Mean ±SD)	Significance
Baseline	128.44± 6.25	128.5±6.98	P = 0. 96(NS)
After preloading	131.64± 5.94	131±6.47	P = 0.60(NS)
1 minute	131.84±6.08	131±6.63	P =0.51(NS)
2 minutes	128.0±5.65	128.1±5.82	P= 0.93(NS)
4 minutes	124.88± 5.74	125±5.87	P=0.91(NS)
6 minutes	122.12±5.63	123.5±5.69	P=0.22(NS)
8 minutes	119.64 ±3.68	122±4.87	P=0.07(NS)
10 minutes	118±4.57	120±5.39	P=0.04*
15 minutes	107.7 ±6.78	113±6.53	P=0.01**
20 minutes	108.16 ±7.88	111±6.9	P=0.05
25 minutes	110.16 ±6.74	112±6.88	P=0.17(NS)
30 minutes	112.16 ±5.35	113±4.83	P=0.41(NS)
35 minutes	111.72 ±4.49	113±4.35	P=0.15(NS)
40 minutes	112.56 ±3.65	113±4.25	P=0.57(NS)
45 minutes	114.2 ±4.24	114±4.57	P=0.82NS)
50 minutes	114.65 ±4.02	114±4.18	P=0.43(NS)
55 minutes	114.42 ±4.07	114±3.94	P=0.60(NS)
60 minutes	114.83 ±3.64	115±3.45	P=0.81(NS)

* Statistical Significance at 5%: ** Statistical significance at 1%: NS Not significant There was no significant change in DBP in two groups in the first 8 minutes after spinal anaesthesia. At 10th minute and 15th minute there was significant fall in DBP in group R compared to Group H.

Table 4: Mean pattern of diastolic Blood Pressure (DBP) of the two group

Diastolic blood pressure	Group H [Mean±SD]	Group R [Mean±SD]	Significance
Base line	76.2±4.37	76.64±4.67	p=0.6277(NS)
After preload	78.12±4.75	78.08±4.74	p=0.9665(NS)
1 minute	77.12±4.33	77.16±4.43	p=0.9637(NS)
2 minutes	74.28±4.25	75±4.44	p=0.4095(NS)
4minutes	71.44±4.27	72.52±4.55	p=0.2239(NS)
6minutes	69.02±4.29	70.32±4.59	p=0.1466(NS)
8minutes	67.16±3.83	68.6±4.34	p=0.0817(NS)
10minutes	65.56±3.75	67.24±4.37	p=0.0418*
15minutes	61.72±2.97	63.16±3.84	p=0.0387*
20minutes	61.74±4.26	63.24±3.81	p=0.0665(NS)
25minutes	63.14±3.44	64.12±3.37	p=0.1533(NS)
30minutes	64.16±3.01	64.76±2.68	p=0.2951(NS)
35minutes	64.36±2.81	64.8±2.65	p=0.4225(NS)
40minutes	65±2.29	65.2±2.32	p=0.6654(NS)
45minutes	65.72±2.25	65.78±2.29	p=0.8951(NS)
50minutes	66.28±2.25	66.12±2.47	p=0.7356(NS)
55minutes	66.72±2.54	66.68±2.51	p=0.937(NS)
60minutes	67.92±2.45	67.96±2.47	p=0.9354(NS)

There was no significant change in MAP in the two groups in the first two minutes after spinal anaesthesia. In the 4th and 6th minute interval after spinal, there was no significant change in MAP in the two groups. In the 8th and 10th minute interval after spinal, group R had a greater fall n MAP when compared to group H which was statistically significant (p=0.04) (p=0.02). In the 15th minute interval, group H had a significant lesser fall in MAP when compared to groups R (p=0.008).In the 20th, 30th, and 35th minute interval after spinal, group R had a statistically significant fall in MAP when compared to group H (p=0.01), (p=0.009) (P=0.02). There was no statistically significant difference between group H and group R after 30 to 35 minutes.

Table 5: Mean pattern of Mean Arterial Pressure (MAP) of the two group

MAP	Group H	Group R	P value
Baseline	93.45±3.95	93.83±4.55	P=0.65(NS)
After pre loading	95.96±4.20	96±4.40	P=0.86(NS)
1 minute	95.57±3.53	95.13±4.05	P=0.56(NS)
2minutes	91.77±5.48	92.69±3.87	P=0.33(NS)
4 minutes	89.22±4.04	90.17±4.12	P=0.24(NS)
6 minutes	86.67±3.96	88.04±4.13	P=0.09(NS)
8 minutes	84.62±3.75	86.15±3.89	P=0.04*
10minutes	81.83±7.27	85.14±7.44	P=0.02**
15 minutes	77.64±3.77	79.84±4.37	P=0.008**
20 minutes	77.07±5.52	79.64±4.24	P=0.01**
25 minutes	80.06 4.00	78.48 3.62	P=0.0410*
30 minutes	80.93 2.65	79.45 2.95	P=0.0097*
35 minutes	80.86 2.49	79.57 2.96	P=0.0204*
40 minutes	80.85±2.24	81.28±2.26	P=0.34(NS)
45 minutes	83±2.44	84.28±2.54	P=0.41(NS)
50 minutes	82.38±2.30	82.07±2.39	P=0.51(NS)
55 minutes	82.60±2.96	82.42±2.38	P=0.91(NS)
60 minutes	83.90±3.43	83.64±2.21	P=0.65(NS)

The occurrence of hypotension in Group H was 18% compared to Group R which was 54%.Table 6 shows the requirements of mephentermine boluses in treating hypotension. In group H, out of 50 patients, only nine patients required treatment with mephentermine and no patients required a repeat bolus.

Table 6: Requirements of mephentermine for treating hypotension

Dose in mg	No of patients		Significance
	Group H	Group R	Group H vs Group R
No Dose requirement	41(82%)	23(46%)	-
Single Bolus (6 mg)	9(18%)	22(44%)	P=0.005**
> one bolus	-	5(10%)	P=0.050*
Total Dose requirement	9(18%)	27(54%)	χ2=14.063 p<0.001**
Inference	Group H is significantly better than Group R with respect todose requirement.		

In group R, a total of 27 patients required mephentermine. In addition, one of them required a repeat dose of mephentermine. When compared to the first group, in group R, 54% of the patients required treatment with mephentermine. Twenty-two patients were treated with a single bolus dose of mephentermine whereas five patients required an additional bolus. It was shown that the findings were statistically significant. Group H was better in terms of lesser requirement of mephentermine boluses to treat hypotension in comparison to Group R.

DISCUSSION

Spinal anaesthesia is more commonly administered procedure for pelvic, lower abdominal and lower limb procedures. It is popular because of simplicity and reliability of the technique as well as the relative rapidity with which adequate anaesthesia can be established. Satisfactory analgesia for abdominal surgeries under spinal block requires sensory block from T6 to S5. This level of high thoracic block induces widespread vasodilatation with resultant hypotension. A significant number of patients suffer from disturbing hypotension and relative hypovolemia during this procedure. Many authors suggest that crystalloid preloading is not effective in reducing the incidence of hypotension after spinal anaesthesia,[9-11] as 75% of the infused fluid diffuses into interstitial spaces, and it's efficacy in expanding plasma volume is only transient. Elderly patients subjected to lower abdominal or lower limb surgery under spinal anaesthesia and preloading with crystalloid solutions did not experience any benefit as regards the incidence of hypotension.[2] Attempts to correct the hypotension with crystalloid solutions may result in large volumes of infusion,[44]which can be hazardous for the individual. Furthermore, it has been observed that the infusion of even a small amount of crystalloid such as one liter of normal saline increases the closing volume and decreases the dynamic compliance of the lungs. Theoretically, a colloid solution is the more logical choice in preventing hypotension since it remains in the circulation for a

longer period because of its oncotic pressure. Hydroxyethyl starch being hyper oncotic has the ability to withdraw fluid from interstitial into intravascular space. Extent of volume expansion is 150%. Duration is 24 hours. In our study, 100 patients were divided into two groups with 50 patients each. Group H received 10ml/kg of HES, group R received 10 ml/kg of Ringer's lactate. Patients receiving HES had a lower incidence of hypotension when compared to Ringer's Lactate. Group H patients had a incidence of 18% of hypotension whereas Ringer's Lactate group had the maximum incidence of hypotension of 54%. Also the mean dose of mephentermine required was less in the colloid group compared to the Ringer's Lactate group. Group H patients required a mean dose of 1.08 mg and group R received a mean dose of 4.08 mg which was statistically significant. These findings are consistent with the findings of others who have compared colloid and crystalloid preloading prior to spinal anaesthesia. A study by Sharma *et al*[39] has shown that intravenous infusion of 500 ml of 6% hetastarch is more effective than 1000 ml of lactated Ringer's solution in attenuating spinal anaesthesia induced hypotension in women undergoing postpartum tubal ligation. Incidence of hypotension was 52% in the lactated Ringer's solution and 16% in the hetastarch group. Karinen *et al*[3] study in 1995 aimed to compare the effect of Ringer's lactate and Hydroxyethyl starch preloading on the hemodynamic state during spinal anaesthesia on patients undergoing caesarean section. The study showed high incidence of maternal hypotension in the crystalloid (62%) group as compared to the colloid group (38%). In our study the incidence of hypotension in Ringer's Lactate group was 54% and it was 18% in the hydroxyethyl group. Baraka *et al* study[29] in 1994 compared intravascular administration of polymerized gelatin and isotonic saline before spinal anaesthesia for prevention of spinal anaesthesia induced hypotension. They reported a 11% incidence of hypotension after administration of 7 ml/kg of 3% gelatin compared with 52% after same volume of crystalloid in males undergoing transurethral resection of prostate under spinal anaesthesia. Mathru *et al*[3] has previously shown that intravascular administration of 50% albumin is more effective than intravascular crystalloid administration.[3] Shapira *et al*[7] study in 1991 aimed to determine different aspects concerning hypotension and its prevention following spinal anaesthesia by preloading the patients with haemacel and Ringer's lactate respectively. They found that the systolic blood pressure decrease was significantly greater in the crystalloid group. The average decrease in systolic blood pressure in the haemacel group was 6 mm hg and in the Ringer's group it was 16 mmHg. Mortelmans *et al* (1995)[4] conducted a study to determine the effects on intravascular volume and coagulation of 2000 ml of the two iso oncotic artificial colloids: 6% hydroxy ethyl starch (HES) and 3% modified gelatin (GEL). Forty-two patients, scheduled for primary total hip replacement were allocated randomly to receive HES or GEL during acute normovolemic hemodilution. Blood samples were taken before and after 500 ml and 1000 ml of acute normovolemic hemodilution; intraoperatively after 20-ml/ kg of artificial colloid and at the end of colloid infusion. They quantified the following variables: coagulation variables, blood loss, hemodynamic stability, interstitial extravasation, and the percentage volume effect. The following differences were found (HES vs GEL, $p< 0.05$): 76% vs 56% intravascular volume expansion, 27% vs 29% haematocrit, 35 vs 45 g/L total serum protein, 4 vs 0 abnormal bleeding times. This study quantifies a poorer volume effect of GEL and a higher blood loss with hydroxyethyl starch. M.P. Vercauteren *et al* (1996)[36] studied 90 patients undergoing elective caesarian section under spinal anaesthesia who received Ringer's Lactate (LR) 1000 ml with upto 1000 ml of modified gelatin, LR 1000 ml with upto 1000 ml of hydroxyethyl starch 6%(HES) or only upto 1000 ml of 6% HES. Lumbar puncture was performed as soon as 500 ml of the colloid was infused. The incidence of hypotension, number of patients requiring a vasopressor and doses of ephedrine required to restore arterial pressure were significantly lower in favour of those receiving the crystalloid – HES combination. In our study, group H received HES and group R received Ringer's lactate. The incidence of hypotension was 18% in group H and 54% in the Ringer's lactate group. Also the mean dose of mephentermine required was significantly less in the HES group. Riley *et al*[33] conducted a study to determine whether preoperative administration of 6% hydroxyethyl starch decreases the incidence and severity of hypotension after spinal anaesthesia for elective caesarian section. Forty non laboring ASA grade I and II women having non urgent caesarian section were randomized to receive either 500 ml of 6% HES plus one liter of Ringer's Lactate(n=20), or two liter of Ringer's Lactate prior to induction of spinal anaesthesia. Hypotension occurred in 45% of patients who received HES Vs 85% of those who received only Ringer's Lactate ($p< 0.05$) and minimum systolic blood pressure was lower in the Ringer's Lactate group than in the HES group. In addition, the Ringer's Lactate group had a higher maximum heart rate, a shorter mean time to hypotension and required more 5 mg doses of ephedrine for treatment of hypotension than HES group. They concluded that 6% of HES plus Ringer's Lactate is more effective than Ringer's Lactate alone. In our study, the baseline values were not significantly

different in the two groups. There was an increase in the pulse rate immediately after preloading and upto 25-30 minutes after spinal anaesthesia in both groups, though statistically not significant. The SBP increased to about three to five mm hg after preloading in both the groups with no statistical significance. The fall in SBP to less than 100 mm of hg after spinal block was as early as six minutes in the Ringer's Lactate group whereas in the other group, SBP was maintained to a significantly longer time. The same trend was observed when MAP was taken into consideration.

CONCLUSION

It can be concluded that colloids offset hypotension and hypovolemia more effectively than crystalloids in patients scheduled for elective lower abdominal surgeries under spinal anaesthesia.

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