# Comparison of the effects of pre loading with 6% hydroxy-ethyl starch 130/0.4 versus Ringer lactate in preventing spinal anaesthesia induced hypotension in Caesarean section

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## Abstract

**Background:** Hypotension after spinal anaesthesia is preventable by adequate pre-loading with colloids or crystalloids. Women posted for emergency caesarean section are more vulnerable for hypotension as they are not preloaded adequately due to time constraints. The idea of the study is to maintain haemodynamics by administering preload solution without any delay. Here 6% Hydoxyethyl starch (HES) is compared with Ringer lactate (RL) as a preloading solution.

**Materials and Methods:** 50 pregnant women posted for emergency caesarean section were randomly allocated into 2 groups – Group H of 25 women received 500 ml of 6% HES and Group R of 25 women received 500 ml of RL intravenously as preload prior to spinal anaesthesia. The requirement of ephedrine to counter hypotension and the changes in the haemodynamic parameters were noted. Statistical analysis was done using Student's 't' test, Fisher's test and Chi square test, and $p < 0.05$ was considered statistically significant.

**Results:** The requirement of ephedrine was less in 6% HES group ($p < 0.001$). The haemodynamical parameters were more stable in 6% HES group where there was minimal fall in blood pressure ($p < 0.001$) and minimal rise in heart rate ($p < 0.01$) compared to RL group.

**Conclusion:** The administration of 6% HES as a preloading solution before spinal anaesthesia in pregnant women undergoing Emergency Caesarean section is superior to Ringer lactate as it causes less incidence of hypotension and requires less ephedrine and intra-operative intravenous fluids.

**Keywords:** 6% Hydroxyethyl starch, Hypotension, Pre-loading, Spinal anaesthesia, Emergency caesarean section

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## Introduction

Regional anaesthesia (spinal and epidural) has been the preferred technique in majority of patients coming for caesarean section. Its advantage revolved around its simplicity of administration, its reliability of action and its minimal side effects. The danger of aspiration and foetal/neonatal depression associated with general anaesthesia were avoided.

Hypotension is a frequent and potentially serious complication of spinal anaesthesia. Various methods have been used to prevent and/or treat hypotension following spinal anaesthesia in obstetric patients. These include preloading with intravenous fluids, left uterine displacement and use of vasopressors such as ephedrine. Both crystalloid and colloid solutions have been used for preloading. Crystalloid solutions are cheaper but larger volumes must be given. Colloid solutions which are currently available are albumin, gelatin, dextrans and hydroxyethyl starch.

In our hospital emergency caesarean sections outnumber the elective caesarean sections. Usually the women posted for emergency caesarean sections are not adequately preloaded before spinal anaesthesia which leads to frequent incidences of hypotension which is more than the elective caesarean sections, where there is ample time for preparation of patient prior to surgery. So the women posted for emergency caesarean sections were considered more vulnerable for hypotension and it was decided to carry out this study in these patients. The idea of the study is to demonstrate the maintenance of stable haemodynamic status by administering preload solution without any delay before start of surgery. Malay Sarkar et al have done a study on pre-loading vs coloading with crystalloids on women who underwent emergency caesarean section.[1]

Hydroxyethyl starch (HES) is a starch composed of more than 90% high molecular weight amylopectin to which hydroxyethyl groups are added.[2] The addition of hydroxyethyl groups increases the resistance of the amylopectin to enzymatic hydrolysis by serum amylase, thus lengthening its intravascular stay time. Hydroxyethylation also enhances the water binding capacity and colloid osmotic pressure for effective plasma volume expansion. Hydroxyethyl starch 6% is an

iso-oncotic, isotonic solution with an osmolarity of 308 mosm/L. It increases the plasma volume by 100% of the infused volume for about 3 – 4 hrs and slowly drops to 72% after 8 hours. Being isosmotic to plasma, it does not alter maternal osmolality and thereby does not cause any shift of fluid into the foetal circulation. There is no significant transplacental transfer of HES. In our study we have used 6% HES 130/0.4/9:1 which is also called as Tetrastarch; where the molecular weight of the solution is 130 kD (kilodalton), 0.4 refers to the percentage of hydroxyethyl groups per glucose subunit and 9:1 refers to the number of hydroxyl ethyl group in C2 vs C6 of glucose subunits. HES is also available as hetastarch and pentastarch preparations where the degree of substitution is 0.7 and 0.5 respectively. Higher molecular weight preparations with 200 kD are also available.

Ringer lactate is iso-osmotic to plasma having an osmolarity of 273 mOsmol/L and having a pH of 6.5. It consists of sodium 130 mEq/L, potassium 4 mEq/L, calcium 2.7 mEq/L, chloride 109 mEq/L, and lactate 28 mEq/L.

A number of vasopressors, mostly sympathomimetic drugs have been used to treat the hypotension caused by sympathetic block. Ephedrine is the most commonly used vasopressor. It has weak alpha and beta adrenoreceptor agonist properties and an indirect action by release of noradrenaline. It increases the cardiac output, heart rate, systolic and diastolic arterial pressure. Ephedrine has a protective effect on uterine vasculature and is hence recommended for use in obstetrics.

We are comparing commonly used crystalloid like Ringer lactate with colloid 6% Hydroxyethyl starch 130/0.4 for their efficacy in preventing post spinal anaesthesia hypotension in Emergency caesarean section.

## Materials and Methods

After obtaining approval from the Institutional Ethics Committee and the Obstetrics and Gynaecology department of the hospital, 50 term pregnant women of ASA I E & II E posted for emergency Caesarean section were chosen to participate in the study. Informed consent was obtained from all the patients.

Sample size calculation was done using a study protocol and in order to achieve a power of 80% it was decided to enroll 25 patients in each group. Randomization was done using drawing of lots by a third person not connected with study.

They were randomly allocated into 2 groups – Group H of 25 women received 500 ml of 6% Hydroxyethyl starch 130/0.4 and Group R of 25 women received 500 ml of Ringer Lactate intravenously as preload prior to receiving spinal anaesthesia.

Indications for emergency caesarean section in our study group were moderate foetal distress, women in labour with CPD, in active labour with malpresentations like breech, failed induction and failure to progress. Since the patients were in labour they were posted for emergency caesarean sections instead of elective surgery.

Exclusion criteria were– weight below 35 kg or above 90 kg, height less than 140 cm, gestational diabetes, pregnancy induced hypertension, heart disease, renal impairment, multiple gestation, bad obstetric history and severe foetal distress.

In all cases, the attending obstetrician was consulted to assess the degree of foetal distress so as to decide on the anaesthetic technique to be adopted. As soon as the patient arrived in the operating room and clinical examination done, continuous electrocardiogram, noninvasive blood pressure monitor and a pulse oximeter were attached to the patient. Baseline heart rate, blood pressure and oxygen saturation recordings were taken. The patient was received from the labour room with a 16G or 18G intravenous cannula in place and an indwelling urinary catheter. Immediately the drawing of lots was done to decide the preloading solution and the pre-loading was started without delay. The preloading was done over a period of 10-15 min at a flow rate around 50ml/min. By the time the operation theatre and the concerned personnel including the surgeons were ready, the pre-loading was completed.

After the preloading was completed, time for the same was noted and a spinal subarachnoid block was performed. All the patients were put in the left lateral position and spinal anaesthesia was given with a 25G Quincke needle at the L3 – L4 spinal interspace and all patients uniformly received 1.8 cc of 0.5% Bupivacaine (heavy) injected into the subarachnoid space. The patient was turned supine and left uterine displacement maintained by placing a wedge under the patient's right buttock. Oxygen was administered with a facemask throughout the surgery.

A sensory block atleast upto T6 level, immediately after drapping the patient and prior to start of surgery, was considered as adequate spinal block. Then the surgeon was asked to proceed and the level of block was noted. Crystalloid solutions were administered in the post spinal anaesthesia period. Heart rate, blood pressure and oxygen saturation recordings were made at 2 min, 5 min, and thereafter every 5 min until the surgery was completed.

Hypotension was defined as a drop in systolic pressure of 25% or more from the baseline value and each episode of the same were treated with in administration 6 mg ephedrine and additional intravenous fluids. It was decided to maintain the target MAP within 25% from the baseline value. Any fall more than 25% was considered as an incidence of hypotension.

After the delivery of the baby, the patient received 15 units of oxytocin in 500 ml of crystalloid solution, prophylactic metoclopramide and an appropriate

antibiotic intravenously. The APGAR scores of the newborn at 1 min and 5 min after birth were noted.

Blood loss was assessed from the volume in the suction bottle and by the number of soaked sponges. At the end of surgery, the level of spinal block was noted and the patient shifted to the recovery room where she was monitored until the spinal anaesthetic showed signs of wearing off as evidenced by ability of the patient to move her legs.

As per the protocol of the obstetricians in our hospital, the patients were kept nil per oral for 24 hours after surgery. The urine output and intravenous fluid requirement over the next 24 hours was noted in the ward records.

The cost benefit analysis was done considering the following costs incurred by the patient from the start of anaesthesia till 24 hours post operatively. Common costs like cost of spinal anaesthesia kit and surgical consumables were excluded.

| Parameter | Cost per patient |
|---|---|
| Cost of pre-loading with 6% HES | Rs.360 |
| Cost of pre-loading with RL | Rs.15 |
| Cost of using ephedrine | Rs.22 |
| Cost of 1 pint i.v fluid (RL/NS/DNS) | Rs.15 |

The arithmetic mean and standard deviation of the various parameters were calculated. Statistical analysis was done using Student's 't' test and Fisher's test.

## Results

Fifty patients took part in the original study. Of them, 25 received 500 ml 6% HES 130/0.4 (Group H) and 25 received 500 ml Ringer Lactate (Group R) as preload.

The results presented are analyzed from these 50 patients.

**Table 1: Demographic characteristics and ASA distribution**

| Variables | | Group H (HES) | Group R (RL) |
|---|---|---|---|
| Age in Yrs (Range) | | 24.56±2.97 (21-33) | 24.56±3.12 (20-33) |
| Weight in Kg (Range) | | 51.28±3.92 (44-58) | 57.52±9.01 (48-80) |
| Height in cm (Range) | | 154.16±5.84 (144-162) | 154.08±6.04 (145-167) |
| ASA GRADE | I E | 18 (72%) | 20 (80%) |
| | II E | 7 (28%) | 5 (20%) |

All the ASA IIE patients were classified so because of their blood haemoglobin values which were below 10 g/dl.

**Table 2: Time for preloading**

| | Group H (HES) | Group R (RL) | p value (Fisher test) |
|---|---|---|---|
| Time (min) (Range) | 13.12±2.07 (9-18) | 17.52±2.49 (13-23) | 0.37419 |

Depending on the patency of the i.v cannula there were slight variations for the time taken for preload within the groups. Group H required less time for preloading – 13.12 min as compared to Group R – 17.52 min. The time for preloading ranged from 9-18 min in Group H and 13-23 min in Group R. Since the p value >0.05 it is statistically not significant.

**Table 3: Level of sensory block**

| Level of Block | Group H (HES) | Group R (RL) | p value (Fisher test) |
|---|---|---|---|
| Onset of block | T7 (±1.1 segment) | T6 (± 1.4 segment) | 0.20004 |
| Maximum level attained | T4 (± 0.79 segment) | T4 (± 0.71 segment) | 0.62693 |
| End of Surgery | T8 (± 1.4 segment) | T8 (± 1.8 segment) | 0.19890 |

The level of sensory block at the onset of block in Group H was T7±1.1 segments and in Group R was T6±1.4 segments. The maximum level of sensory block achieved in Group H was T4±0.79 segments and in Group R was T4±0.71 segments. The level of sensory block at the end of surgery in Group H was T8±1.4 segments and in Group R was T8±1.8 segments.

Since p value >0.05 there is no statistical significance between the two groups.

**Table 4: Time from SAB to delivery of baby**

| | Group H (HES) | Group R (RL) | p value (Fisher test) |
|---|---|---|---|
| Time from SAB to delivery of baby (min) (Range) | 7.72±1.17 (6–10) | 7.84 ±0.98 (6-10) | 0.40183 |

The time taken from sub-arachnoid block (SAB) to the delivery of baby is more or less around 7-8 minutes. There was no significant delay in the baby delivery time in both groups. Since p value >0.05 it is not statististically significant.

**Table 5: Mean duration of surgery and intraoperative blood loss**

| Variables | Group H (HES) | Group R (RL) | p value (Fisher test) |
|---|---|---|---|
| Blood loss (ml) (Range) | 356.00±66.65 (250-500) | 348.00±69.28 (250-500) | 0.85083 |
| Duration (min) (Range) | 58.40±14.20 (25-90) | 52.20±12.75 (25-90) | 0.60412 |

The surgical time ranged from 25-90 min in both groups. The mean surgical time in Group H was 58.40 min, while in Group R was 52.20 min.

The intraoperative blood loss ranged from 250 to 500 ml in both groups. The mean blood loss in Group H was 356.00 min and in Group R was 348.00 min.

The differences between the two groups are not statistically significant.

**Table 6: Requirement of ephedrine bolus dose**

| Variables | Group H (HES) | Group R (RL) | 'p' value (Chi square test) |
|---|---|---|---|
| No. of patients not requiring Ephedrine | 22 | 8 | p < 0.001 |
| No. of patients requiring Ephedrine | 3 | 17 | |
| Number of episodes of hypotension needing ephedrine bolus dose | 3 | 23 | p < 0.001 |

3 patients out of 25 in Group H required ephedrine and 17 patients out of 25 in Group R required ephedrine (Fig. 1a). The requirement of ephedrine was 12% in Group H and 68% in Group R. This difference is highly significant (p < 0.001).

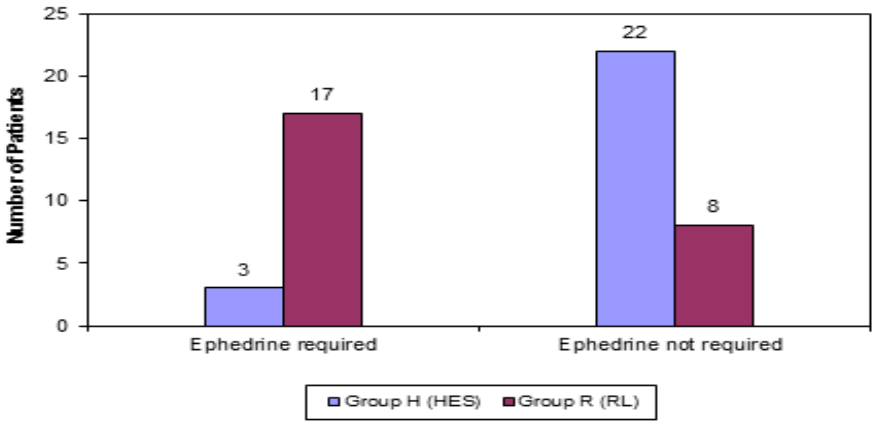


**Fig. 1a: Requirement of Ephedrine Bolus dose**

There were 3 episodes of hypotension requiring treatment among the 25 patients in Group H and 23 episodes of hypotension requiring treatment among the 25 patients in Group R (Fig. 1b). This difference is statistically significant (p<0.001). The earliest episode of hypotension following spinal anaesthesia was at 10 min in Group H and at 5 min in Group R.

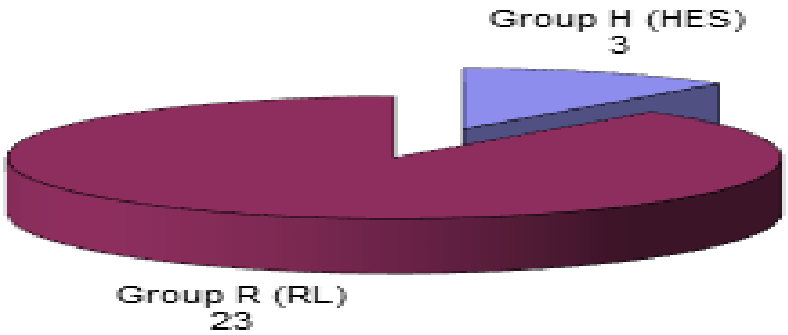


**Fig. 1b: Number of bolus doses of ephedrine given**

**Table 7: Changes in systolic blood pressure (SBP)**

| Variables | Group H (HES) | Group R (RL) | 'p' value (Student 'T' test) |
|---|---|---|---|
| No. of patients who had Hypotension | 3 (12.0%) | 17 (68.0%) | p < 0.001 |
| Basal SBP (mmHg) (Range) | 120.32±7.65 (106-130) | 119.84±6.03 (108-136) | Not Significant |
| Lowest SBP (mmHg) (Range) | 101.84±8.37 (84-120) | 90.96±8.87 (80-110) | p < 0.001 |
| % fall in SBP (Range) | 16.200±7.878 (3.6-33.3) | 23.624±7.280 (8.3-35.7) | p < 0.001 |

The basal systolic blood pressure ranged from 106-136 mmHg in both groups. The mean basal systolic blood pressure in Group H was 120.32 mmHg while in Group R was 119.84 mmHg. The difference between the two groups was not statistically significant.

The lowest systolic blood pressure following spinal anaesthesia ranged from 84-120 mm Hg in Group H and from 80-110 mm Hg in Group R. The mean minimum systolic blood pressure in Group H was 101.84 mmHg and in Group R was 90.96 mmHg.

The difference was highly significant (p < 0.001).

The basal systolic blood pressure and minimal systolic blood pressure in the two groups is represented in Fig. 2a.

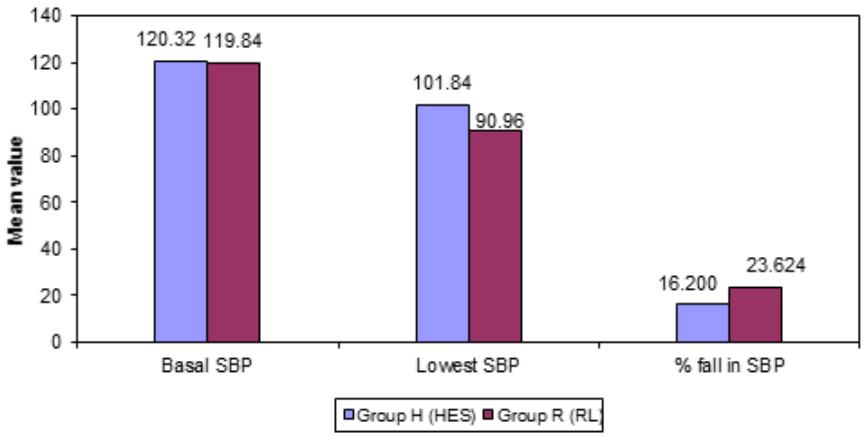


**Fig. 2a: Changes in systolic blood pressure (SBP) in mmHg**

The percentage fall in systolic blood pressure ranged from 3.6-33.3% in Group H and from 8.3-35.7% in Group R. The mean percent fall in systolic blood pressure in Group H was 16.200% and in Group R was 23.624%. The difference was highly significant (p < 0.001).

Fig. 2b shows the trend of mean systolic blood pressure in the two groups.

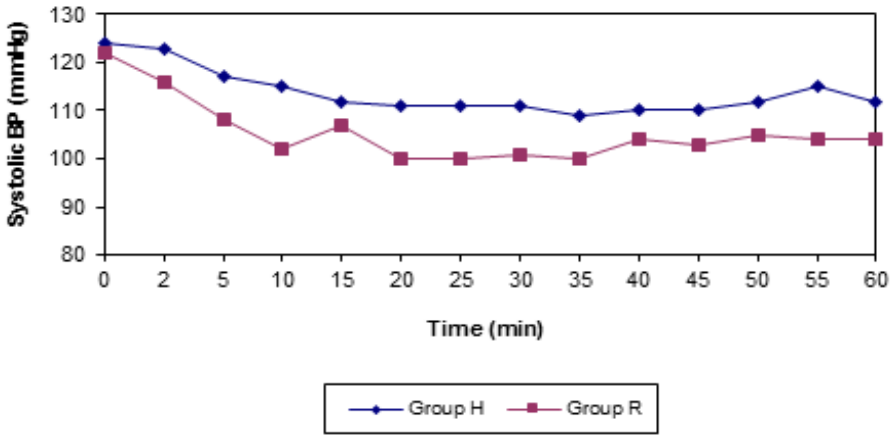


**Fig. 2b: Trend of mean systolic blood pressure**

Group H who received 6% Hydroxyethyl starch shows a more stable trend of mean systolic blood pressure as compared to Group R who received Ringer Lactate. In the second group, there is an initial steep fall and later a slow fall in the mean systolic blood pressure.

**Table 8: Changes in heart rate (HR) (beats per min)**

| Variables | Group H (HES) | Group R (RL) | 'p' value (Student 'T' test) |
|---|---|---|---|
| Basal HR (/min) (Range) | 89.20±4.43 (80-98) | 87.36±13.01 (60-112) | 0.5083 (Not Significant) |
| Maximal HR (/min) (Range) | 103.44±6.39 (92-120) | 108.24±9.39 (90-126) | $p < 0.05$ |
| % rise in HR (Range) | 16.452±6.294 (4.2-30.4) | 24.342±13.328 (3.1-50.0) | $p < 0.01$ |

The basal heart rate varied from 60-112 beats/min in both groups. Group H had a mean basal heart rate of 89.20/min and Group R had a mean basal heart rate of 87.36/min. The maximal heart rate ranged from 90-126 beats/min in both groups. Group H had a mean maximal heart rate of 103.44/min and Group R had a mean maximal heart rate of 108.24/min. This difference is statistically significant ($p<0.05$). The percentage rise in heart rate ranged from 3.1-50.0% in both groups. Group H had mean percent rise in heart rate of 16.452% and Group R had a mean percent rise in heart rate of 24.342%. This difference is statistically significant ($p<0.01$).

The basal heart rates and maximum heart rates in the two groups are represented in Fig. 3a.

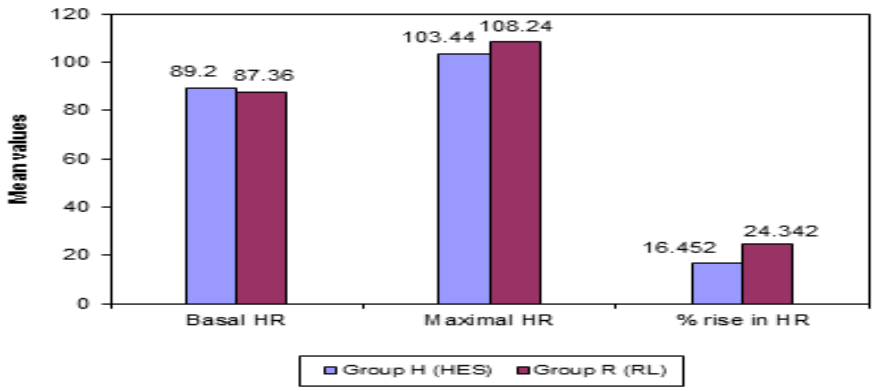


**Fig. 3a: Changes in heart rate (HR) in beats/min**

Fig. 3b shows the trend in the mean heart rate of the two groups. The initial rise in heart rate following spinal anaesthesia is more in Group R as compared to Group H but after 25 minutes the trend in both the groups is more or less uniform.

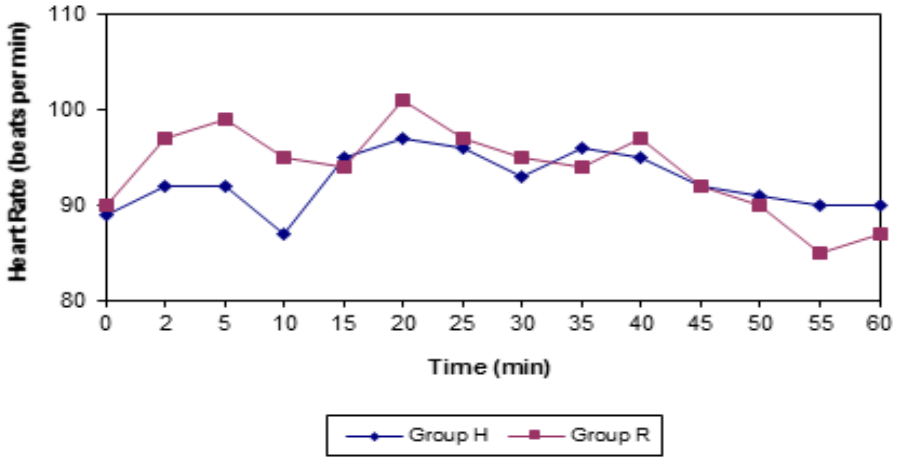


**Fig. 3b: Trend of mean heart rate**

The number of patients without hypotension in Group H and Group R at various time intervals are represented in Fig. 4.

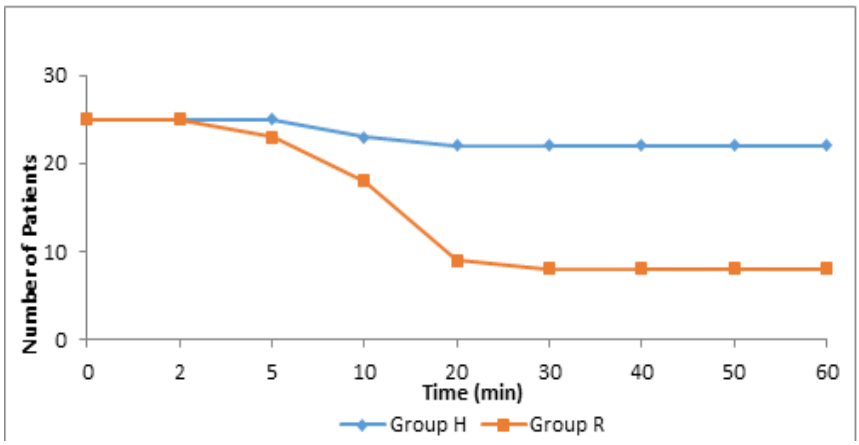


**Fig. 4: Number of patients without hypotension at varying time intervals**

Patients in Group H became hypotensive after about 10 minutes after the spinal anaesthesia (SA) whereas patients in Group R became hypotensive as early as 5 minutes after SA. Maximum incidence of hypotension in this group was between 10-20 minutes after SA. Group H had more normotensive patients as compared to Group R in the same interval after SA.

At every time interval after SA, Group H had more normotensive patients as compared to Group R.

Table 9 shows the volume of intravenous fluids received by the patients during the surgery following administration of spinal anaesthesia.

**Table 9: Volume of postspinal intravenous fluid**

| | **Group H (HES)** | **Group R (RL)** | **p value (Student 'T' test)** |
|---|---|---|---|
| Volume of Post spinal IV fluids (ml) (Range) | 826.00±192.09 (450-1200) | 934.00±196.17 (600-1400) | 0.18082 (Not significant) |

The intraoperative intravenous fluid received following spinal anaesthesia ranged from 450-1200 ml in Group H and 600-1400 ml in Group R. The mean intraoperative fluid received in Group H was 826.00 and in Group R was 934.00.

The difference is not statistically significant. Patients in Group R received more fluids following spinal anaesthesia.

Table 10 shows the fluids received by the patients and urine output in the 1st 24 hours following surgery.

**Table 10: Intake/output over 24 hours**

| Variables | Group H (HES) | Group R (RL) | 'p' value (Student 'T' test) |
|---|---|---|---|
| Volume of IV fluids (ml) (Range) | 3076.00±275.80 (2500-3600) | 3272.00±254.17 (3000-3800) | p < 0.001 |
| Urine Output (ml) (Range) | 2314.00±191.77 (1850-2600) | 2351.60±182.29 (2050-2800) | 0.4808 (Not Significant) |

As per the protocol of OG department in our hospital, all the patients were kept nil per oral for 24 hours after the emergency caesarean section. The NPO for 24 hours, as per protocol, is kept for the patient to recover completely from subarachnoid block and it also helps in any surgical intervention in the event of any post-partum bleeding after caesarean section within 24 hours. For that period, 2 ml/kg i.v fluids RL/DNS/NS were given and the systolic BP was maintained above 100mmHg. The volume of intravenous fluid received in the 1st 24 hours postoperatively ranged from 2500 ml to 3800 ml in both groups. Patients in Group H received a mean volume of 3076.00 ml and patients in Group R received a mean volume of 3272.00 ml. The differences are statistically significant (P < 0.001).

Group H had a lower mean urine output of 2314.00 ml as compared to Group R with mean urine output of 2351.60 ml. This difference is not statistically significant. (See Fig. 5).

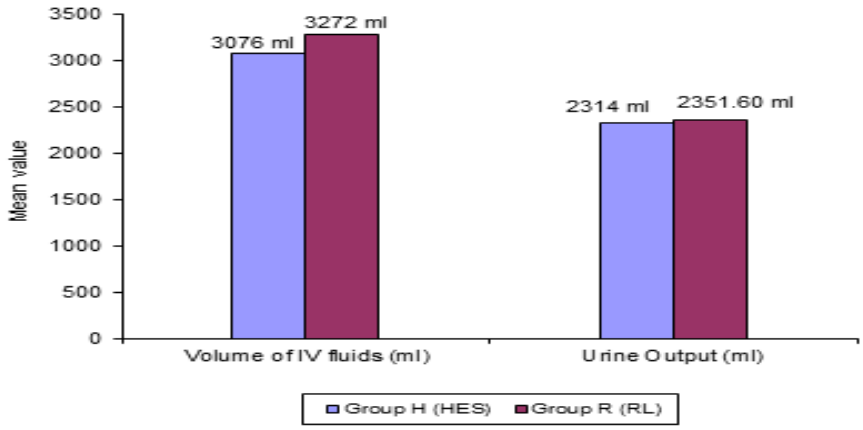


**Fig. 5: Intake/output over 24 hours**

**Table 11: APGAR 1 min and 5min**

| APGAR 1 min | Group H (HES) (n=25) | Group R (RL) (n=25) |
|---|---|---|
| 4-7 | 21 | 20 |
| >7 | 4 | 5 |
| **APGAR 5 min** | | |
| 4-7 | 5 | 4 |
| >7 | 20 | 21 |

There were no significant differences between the APGAR scores of the newborn in the two groups. 1 newborn in Group H had Apgar score of 4 in 1st min and 6 in 5th min but it had multiple congenital anomalies. The lowest Apgar score among the others was 6 at 1st min and 7 at 5th min.

There were no significant differences in the incidence of nausea and vomiting between two groups.

**Table 12: Cost benefit analysis**

| | Group H (HES) | Group R (RL) | p value (Student 'T' test) |
|---|---|---|---|
| Cost per patient (Rs.) (Range) | 488.64±15.01 (465-517) | 162.56±18.12 (135-202) | <0.001 |

The cost incurred from preloading and use of ephedrine and i.v fluids to counter hypotension is considered for each patient and the mean is calculated. Even though the incidences of hypotension are few in 6% HES compared to pre-loading with RL, the cost factor plays a deterrent in using the 6% HES.

## Discussion

The value of intravenous preloading before spinal anaesthesia in a parturient has been in debate for a long time. Intravenous hydration before the administration of a regional block in obstetrics serves both to prevent sympathetic block induced hypertension and to improve uteroplacental blood flow.[3] The ideal intravenous fluid for the parturient during regional anaesthesia should expand the blood volume to maintain hydrostatic pressure in the uteroplacental vessels during sympathetic block without passing into the foetal circulation. Most authors favour the role of preloading in preventing or minimizing the incidence of postspinal hypotension.[4,5,6,7,8,9] In our institution preloading is routine before a regional anaesthesia. But studies by Rout CC et al, Jackson R et al have questioned the role of volume loading in Caesarean patients,[10,11] especially the use of a massive fluid load just prior to regional anaesthesia (Uchida T et al).[12] The risks of fluid loading pointed out by these authors include pulmonary oedema in the mother and foetus (Park GE et al)[13] and foetal bradycardia as a result of decrease in foetal osmolality due to translocation of the fluid from the maternal to the foetal circulation (Karinen J et al)[14]. This is especially so with crystalloid solutions like Ringer Lactate and less likely with iso-osmotic colloid solutions. Mathru M et al, Riley ET et al, Vercauteren MP et al have reported the value of colloid preloading over crystalloid preloading in Caesarean patients.[4,7,9] Of all the colloid solutions studied, only 5% albumin has been shown to completely prevent spinal induced hypotension in Caesarean section.[4] However all of these studies were done in elective Caesarean deliveries where there was ample time available for preloading.

Hydroxyethyl starch (HES) is extensively used in adult and paediatric cardiac surgery, resuscitation in polytrauma, critically ill patients in intensive care settings, urological procedures, vascular and orthopedic surgery and in burns and sepsis patients. Its use is contraindicated in patent's with renal failure and in those with known sensitivity to the drug. The incidence of anaphylactic reactions to hydroxyethyl starch is much less than with gelatins and dextrans (0.006%, 0.038% and 0.008% respectively).[15] In terms of cost, performance and low incidence of side effects 6% HES is an adequate alternative to 5% albumin. For the above reasons, we chose 6% HES as our study fluid.

In our centre, emergency Caesarean sections outnumber elective Caesarean sections. Unless contraindicated, these patients receive spinal anaesthesia. In case of emergency Cesarean section with foetal distress, the time factor is of great importance and the duration taken for preloading may adversely affect the foetal outcome. In our study preloading with 6% HES took significantly less time than preloading with Ringer Lactate. Although the volume of 6% HES used was same as that of Ringer Lactate, 6% HES being a colloid solution with more viscosity than the crystalloid solution ringer Lactate would have been expected to run in more slowly.

There has been no consensus among others on the definition of hypotension or more importantly the level at which treatment is required. Some have chosen a value of systolic blood pressure less than 100 mm Hg as that requiring treatment,[4,5,16] others have deferred treatment until the systolic blood pressure fell below 90mm Hg,[17,18] and yet other have defined hypotension requiring treatment as a 20-30% decrease from baseline values.[19,20,21] We defined hypotension as a decrease in maternal systolic blood pressure of 25% or more from the baseline value. We were not able to completely prevent spinal block induced hypotension by preloading with either 6% HES or Ringer Lactate. But patients who received 6% HES had a much lower incidence of hypotension (12%) as compared to those who received Ringer Lactate (68%).

The incidence of hypotension in both the group is less than that reported by other authors' who have shown similar results.[7] This is probably because all our patients were in labour and had the benefit of maternal auto transfusion of about 300 ml of blood with each uterine contraction augmenting maternal cardiac output. We did not wait to achieve the maximum level of sensory block before surgery but started the procedure once T6 was blocked which was achieved during the time of drapping the patient. Therefore the level of sensory block at the onset of surgery in our study was lower than compared to study by Riley ET et al ($T_6$ versus $T_{3-4}$).[7]

Patients who received 6% HES had significantly less number of hypotensive episodes requiring treatment with ephedrine as compared to the patients who had received Ringer Lactate. The first episode of hypotension occurred as early as 5 min after the subarachnoid block in the Ringer lactate group whereas the earliest hypotensive episode in the 6% HES group occurred 10 min after the subarachnoid block. In a study by Mercier FJ et al the incidence of hypotension was significantly lower in HES group than RL group which were about 36.6% vs 55.3%.[22] Total phenylephrine requirements were also not significant in that study [median (range): 350 (50-1800) vs 350 (50-1250) µg]. But in our study the incidence of hypotension between Group H and Group R were 12% vs 68%. Moreover the ephedrine requirements were more in Group R than Group H which was also statistically significant (p value <0.001). In the study by Subbalakshmi et al the incidence of hypotension in HES group was 16% whereas in RL group was 56%.[23] In the study by Sheikh Imran et al 36.4% of patients in HES Group and 63.6% patients in RL Group needed rescue doses of Inj.mephentermine.[24]

Hydroxyethyl starch remains longer in the intravascular compartment than any crystalloid solution and is also able to maintain greater colloid osmotic pressure in the maternal circulation.[6] About 75% of any crystalloid given diffuses into the interstitial space and 2.5 to 3 times the volume of crystalloid is needed to

achieve the same degree of plasma expansion. Extravascular redistribution of crystalloids may be so rapid that it may be impossible to infuse them fast enough to maintain the intravascular volume and avoid hypotension during spinal anaesthesia.[10] We may have been able to reduce the incidence of hypotension by giving larger volumes of crystalloid solutions. But this would have required more time to preload and would have placed both parturient and foetus at a greater risk of fluid overload. It has been shown that increasing the volume of intravenous crystalloid preload greater than 20 ml/kg in the parturient does not offer any added benefit (Sahar M. Siddik et al).[25]

With 6% HES we were able to achieve a mean minimal systolic blood pressure of 101.84 mmHg following spinal anaesthesia in HES group whereas the mean minimal systolic blood pressure was 90.96 mmHg in the crystalloid group - a difference of more than 10mm Hg. Similar results have been reported earlier by Riley ET et al[7], indicating that Hydroxyethyl starch is more effective than Ringer Lactate in maintaining maternal blood pressure following sympathetic blockade. In the study by Mercier FJ et al the minimum systolic arterial pressure attained in HES group vs RL group was 98 mmHg vs 94 mmHg.[22] In a study by Subbalakshmi TD et al the minimum systolic BP recorded in HES group vs RL group was 100mmHg vs 94mmHg.[23] The lowest parameters were observed in a study by Sheikh Imran et al where the minimum MAP in HES group vs RL group were 77mmHg vs 71 mmHg.[24] In the study by Singh J et al where they used pre-loading vs no pre-loading, there was significant fall in systolic, diastolic and mean BP in the group with no pre-loading.[26]

There was no significant difference in the maximum heart rates among the two groups of patients in our study. In our study it was about 103.44/min in HES group whereas it was 108.24/min in RL group. This is in contrast to the study done by Riley ET et al which has shown more heart rate stability with Hydroxyethyl starch.[7] In the study by Subbalakshmi et al the maximum heart rates in HES group vs RL group were 93/min vs 86/min.[23] In the study by Singh J et al there was fall in the heart rate from the baseline after 30 minutes in both the study and control groups.[26]

The patients in the 6% HES group required less intravenous fluid intraoperatively as compared to the Ringer Lactate group. There was no significant difference in the amount of fluids received postoperatively between the two groups. All the patients had indwelling urinary catheters maintained for 24 hours postoperatively. The urine output was significantly more in the Ringer Lactate group than in the 6% HES group as would be expected.

We were not able to establish any relationship between the number of hours in labour and the incidence of hypotension. There was no difference between the two groups in the incidence of nausea and vomiting intraoperatively.

We had assessed the Apgar scores of the newborn because the simplicity with which Apgar scoring can be done. Other neurobehavioural tests are available which better prognostic indicators of neurological function are but these are complex and difficult to perform. Our study did not show any big difference in the Apgar scores and it was not statistically significant. Although there was more incidence of hypotension among the patients receiving Ringer Lactate, prompt treatment of the episodes with ephedrine and fluids must have contributed to the foetal well-being in both groups. It has been well documented that prolonged and severe maternal hypotension can cause serious adverse foetal and neonatal effects.[27] It would have been unethical on our part and definitely hazardous for the patient to wait till the blood pressure dropped to the lowest level before administering treatment. No adverse reactions to 6% HES occurred in this study.

The dangers posed by severe maternal hypotension to foetal and maternal well-being in the form of brain damage and cardiac arrest respectively are well known.[27,28] The incidence and severity of such life threatening events may be reduced by the routine use of colloid preload in patients coming for Caesarean section.

The cost benefit factor acts as a deterrent for the use of 6% HES as the cost incurred are high. Comparatively RL group incurred less cost even when there was usage of ephedrine and i.v fluids to counter the hypotension.

The study by Singh et al concluded that administering preload fluid had no beneficial effect in preventing hypotension after spinal anaesthesia.[26] But from the observations in our study, it is clear that preloading with 6% Hydroxyethyl starch is superior to the standard preload to Ringer Lactate in preventing post spinal hypotension. The most worthwhile advantage is that even if hypotension does develop, it occurs only after the foetus is delivered and for that reason alone the use of 6% Hydroxyethyl starch is preferable to a crystalloid like Ringer Lactate as the preloading solution emergency Caesarean section under spinal anaesthesia.

## Conclusion

Our study shows that the administration of 6% Hydroxyethyl starch 130/0.4 as the preloading solution before spinal anaesthesia in pregnant women undergoing Emergency Caesarean section is superior to the administration of 500 ml of Hartmann's Ringer Lactate solution in preventing the incidence of hypotension.

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