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ROLE OF CRYSTALLOIDS VS. COLLOIDS IN PRELOADING IN CAESARIAN SECTIONS UNDER SPINAL ANAESTHESIA - A COMPARATIVE STUDY

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ABSTRACT: INTRODUCTION: Though spinal block has several advantages like sensory block, muscle relaxation, awake patient, the most common and serious problem with spinal anaesthesia for caesarian section remains rapid profound hypotension due to sympathetic blockade. Preloading is an established method to prevent hypotension due to spinal anaesthesia. **AIM:** This study is an attempt to compare the usefulness of hetastarch (colloid) with ringer lactate solution (crystalloid) for volume preloading in the prevention of spinal hypotension in caesarian sections. **MATERIALS AND METHODS:** Informed consent was taken from a total of 120 parturients of ASA grade I, I_E without maternal or fetal complications scheduled for elective or emergency for primary or repeat caesarian section at term, for this study in King George Hospital, Visakhapatnam. The study subjects were allocated into 3 groups of 40 each. Group A (40 parturients) - without preloading, Group B (40 parturients) - Crystalloid group - received preload infusion of Ringer lactate solution, 1000 ml, Group C (40 parturients) - Colloid group - received preload infusion of 6% Hydroxy Ethyl starch, 500 ml. **CONCLUSION:** From this study we conclude that 6% hydroxyethyl starch is better choice for prevention of hypotension following spinal anaesthesia in caesarian section in comparison to lactated ringer solution.

KEYWORDS: Crystalloid – Colloid – Ringer lactate – Hetastarch – Preloading – Spinal anaesthesia – Hypotension.

INTRODUCTION: Spinal block has several advantages like awake patient, sensory block, muscle relaxation. But the most common and most serious problem with spinal anaesthesia remains rapid and profound hypotension due to sympathetic blockade during caesarian section. Preloading is an established method to prevent hypotension due to spinal anaesthesia apart from measures like lateral tilt, leg elevation, strapping and vasopressors.

AIM: This study is an attempt to compare the usefulness of hetastarch (colloid) with ringer lactate solution (crystalloid) for volume preloading in the prevention of spinal hypotension in caesarian sections

MATERIALS AND METHODS: Informed consent was taken from a total of 120 parturient of ASA grade I, I_E without maternal or fetal complications scheduled for elective or emergency for primary or repeat caesarian section at term. The study was done in King George Hospital, Visakhapatnam, Andhra Pradesh.

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The study subjects were allocated into 3 groups of 40 each. Group A (40 parturients) - without preloading. Group B (40 parturients) - Crystalloid group, received preload infusion of Ringer lactate solution, 1000 ml. Group C (40 parturients) - Colloid group - received preload infusion of 6% Hydroxy Ethyl starch, 500 ml.

Premedication was not given in any of the cases. Parturients were transported to the operation theatre in left lateral position. Base line measurements of pulse rate, blood pressure, and arterial oxygen saturation were obtained. The non-invasive blood pressure cuff was applied to patients' right arm. Pre load was given by I.V infusion 15 minutes prior to administration of spinal anaesthesia. Again pulse rate, blood pressure, and arterial oxygen saturation were recorded. After recording base line values, patients are positioned in right lateral decubitus position. Using 25 gauge spinal needle, spinal puncture at L3-L4 level was done and 1.2 ml of 5% lignocaine hydro chloride with 0.1 mg adrenaline added given. To avoid aortocaval compression, patients were positioned supine with a wedge placed under right hip. T4 sensory level was obtained on testing with a pinprick and operation started. The arterial pressure, pulse rate and arterial oxygen saturation were recorded at 1, 3, 5, 7, 10, 15, 20, 25, 30, 40, 50, 60, 75 and 90 minutes after spinal anaesthesia.

Oxygen 4 lit/min was given to all patients by semi closed breathing circuit till baby was delivered. Oxytocin 20 units were given after delivery, and induction-delivery time noted. New born was assessed by APGAR score at 1 minute and 5 minutes interval. Any adverse effects like nausea, vomiting, allergic reactions were also noted. Hypotension – a decrease in systolic blood pressure of 30% or more from base line value noted and if observed, treated with 1000 ml of ringer lactate infusion and intravenous ephedrine 6 mg. Bradycardia - when pulse rate was less than 60 b.p.m. whenever necessary Atropine in a dose of 0.3 mg was used to control bradycardia. Results were analysed using ANOVA.

RESULTS: In the present study regarding the physical characteristics of the three parturient groups namely: Group A (Control group), Group B (Ringer's lactate group), Group C (Hetastarch group), there was no gross difference. We have not found any significant difference in the mean values of weight, height, age, and mean time of induction – delivery interval.

Group	Base line Pulse (beats per minute)	Maximum Pulse rate attained (bpm)	Pulse at 90 min (bpm)
Group A	82	85	78
Group B	82	86	76
Group C	84	93	76

Table 1: Pulse rate

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Group	Base line Syst. B.P	Minimum Syst. BP recorded	Syst. BP at 90 minutes
Group A	116 mm Hg	92 mm Hg	114 mm Hg
Group B	116 mm Hg	94 mm Hg	118 mm Hg
Group C	117 mm Hg	100 mm Hg	120 mm Hg

Table 2: Systolic arterial blood pressure

Group	Base line B.P	Minimum Diast. BP recorded	Diast. BP at 90 minutes
Group A	74 mm Hg	60 mm Hg	74 mm Hg
Group B	76 mm Hg	64 mm Hg	74 mm Hg
Group C	76 mm Hg	68 mm Hg	76 mm Hg

Table 3: Diastolic arterial blood pressure

Group	Base line MABP	Minimum MABP recorded	MABP at 90 minutes
Group A	88mm Hg	71 mm Hg	87 mm Hg
Group B	89 mm Hg	74mm Hg	89 mm Hg
Group C	90 mm Hg	79 mm Hg	91mm Hg

Table 4: Mean arterial blood pressure

	Group A	Group B	Group C
Hypotension present	76%	56%	16%
Hypotension absent	24%	44%	84%
Total No of Parturients	40(100%)	40(100%)	40(100%)

Table 5: Hypotension

	Group A	Group B	Group C
Bradycardia present	28%	16%	8%
Bradycardia absent	72%	84%	92%
Total No of Parturients	40(100%)	40(100%)	40(100%)

Table 6: Bradycardia

Parameters	Group A	Group B	Group C
Nausea / Vomiting	8%	4%	Nil
Shivering	7%	3%	1
Allergic reactions	Nil	Nil	Nil

Table 7: Incidence of side effects

Mean arterial oxygen saturation: There is no statistically significant change in the mean oxygen saturation among the three groups.

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DISCUSSION: Hypotension during spinal anaesthesia is a most common and serious problem which is due to sympathetic blockade. This is due to increase in intravascular space due to vasodilatation, leading to relative hypovolemia in turn leading to hypotension. Preloading is an established method to prevent hypotension resulting from spinal anaesthesia. Vasopressors, left lateral tilt, hydration are the other methods used to prevent spinal hypotension in parturients during caesarian section.

Crystalloids contain water and electrolytes. Crystalloids can be classified as Hypotonic salt solutions, Hypertonic salt solutions; and Balanced salt solutions. The crystalloids can be used to maintain water and electrolytes and to expand intravascular volume. 75% of its volume diffuses into interstitial space, hence its effect in expanding plasma volume is only transient. To compensate this, if crystalloids are given in large volumes, it may produce deleterious effects like pulmonary and peripheral edema. Crystalloids should be used 3 to 4 times the volume of blood lost. The electrolyte composition of ringer lactate solution is similar to that of extracellular fluid and hence it is a balanced salt solution. With respect to sodium it is hypotonic. The lactate of ringer lactate solution is metabolized by either gluconeogenesis or oxidation. Gluconeogenesis mostly occurs in liver and to some extent in kidney. Ringer lactate acts as a source of both glucose and alkalinizing agent in the form of bicarbonate which is produced from lactate metabolism.

Colloids remain in the intravascular compartment for longer duration. Colloids like 5% albumin, gelatin, hydroxyl ethyl starch can be used for this purpose. Hetastarch is a solution of ethoxylated amylopectin. Partial hydrolysis of insoluble amylopectin followed by substitution of hydroxyethyl groups at C₂, C₃ and C₆ positions on glucose molecules produces hetastarch. The solubility of hetastarch depends on the number of substitutions - the greater the number of substitutions, the greater the solubility. The molecular mass ranges from 10000 to 2000000 Daltons. PH of Hetastarch is 5.5. Its osmolality is 310 m.osm/L. Half-life of hetastarch in plasma is longer and decreases after 24-36 hrs. Hetastarch generates an osmotic pressure of 28 mm Hg. Allergic reactions and haemostatic alterations with Hetastarch administration are rare. A maximum adult daily dose of 1500 ml and a maximum child dose is 20 ml / kg.

Factors which contribute to hypotension after spinal anaesthesia are:

1. Preoperative blood volume status.
2. Position and age of the patient.
3. Physiological influences.
4. Paralysis of preganglionic sympathetic nerves with arteriolar dilatation.
5. Blockade of the preganglionic nerve fibres to the adrenal medulla.
6. Effects of operation.
7. A fall in venous return due to vasodilatation causing fall in cardiac output.
8. Circulatory effects of tranquilizers, hypoxia, hypercarbia.

Hypotension after spinal anaesthesia can be prevented by: Preloading with crystalloid or colloid solution as a prophylaxis. Crystalloid preloading with ringer lactate solution 10 ml/kg or colloid preloading such as 3.5% polygeline solution, 5% albumin or 6% hydroxyl ethyl starch are

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used to expand intravascular volume as they stay longer in the intravascular compartment than crystalloids.

Hypotension following spinal anaesthesia can be treated by:

- 1) Head down position – Simple and effective method as gravity helps in venous return of the heart which in turn results in increase stroke volume and cardiac output leading to rise in cardiac output.
- 2) Intravenous fluids – as volume expanders help in increasing intravascular volume and correct relative hypovolemia of spinal hypotension and improve circulation.
- 3) Administration of oxygen – this helps rising the oxygen content of blood. Particularly useful in situations like slowing of circulation in tissues and a wide arteriovenous oxygen difference
- 4) Vasopressor therapy – Useful when other measures fail to restore the blood pressure and improve the circulation.

In the present study over all incidence of hypotension in ringer lactate group was 56 % and in 6% hydroxyl ethyl starch hypotension was 16%. Karinen J. J. ransen et al¹ studied the effects of crystalloid 1 litre - Ringer lactate or Colloid 500 ml - Hydroxyethyl starch as pre loading fluids in 26 healthy parturients undergoing elective caesarian section under spinal anaesthesia. Their results showed higher incidence of hypotension in crystalloid ringer lactate group (62%) and lower incidence of hypotension - 38% in the colloid group.

In a similar study done by Sharma et al,² compared the efficacy 6% hydroxyethyl starch to that of crystalloid ringer lactate as preloading solutions. 40 ASA Gr I patients were taken up for study and they observed that incidence of hypotension was 51% in the ringer lactate group and 16% in hydroxyethyl starch group.

From the study by Riley ET et al³ on forty non laboring ASA class I and II women having non urgent cesarean sections hypotension occurred in 45% of patients who received hetastarch vs 85% of those who received only Lactated Ringer (P <0.05), and minimum systolic blood pressure was lower in the Lactated Ringer group than in the hetastarch group. In addition, the Lactated Ringer 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 the hetastarch group. They concluded that 6% Hetastarch plus Lactated Ringer is more effective than Lactated Ringer alone and that its routine use before spinal anesthesia for cesarean section should be considered.

In a study by Yokoyama N et al,⁴ the authors found that in healthy patients with full-term pregnancy, volume preloading has little effect on maternal hemodynamics and neonatal outcomes, suggesting that stable peri operative management is possible with or without volume preload before spinal anesthesia. However, they opined that preloading may be needed for prevention of hypotension in emergency cases.

Study by Madi-Jebara S et al,⁵ on thirty-nine patients in Gr II while 48 pts in Gr I, showed that Hydroxy Ethyl Starch (HES) 130/0.4 is more effective than RL to prevent hypotension following spinal anesthesia for Caesarian section.

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In a study by Dahlgren G et al⁶ on fifty-five healthy parturients scheduled for elective cesarean section under spinal anesthesia, the authors have preoperatively investigated with a supine stress test with measurement of maternal heart rate, blood pressure, right uterine artery pulsatility index and symptoms in the left lateral and supine positions. They were then randomized to receive a colloid or crystalloid preload before anesthesia. The authors found that pregnant women with a positive preoperative supine stress test constitute a subset at increased risk for clinically significant hypotension during cesarean delivery under spinal anesthesia. These women seem more likely to benefit from prophylactic colloid solution than women with a negative stress test.

In a study by Mercier FJ⁷, a total of 167 healthy parturients undergoing elective caesarean delivery under spinal anaesthesia were included in multicentre, randomized, double-blind study and the authors compared with a pure RL preloading, a mixed HES-RL preloading. HES-RL preloading significantly improved prevention of both hypotension and symptomatic hypotension based on early phenylephrine bolus administration and did not induce adverse effects.

In a study by Duggal et al,⁸ on 120 female patients of age group 18-35 years of ASA grade I & II, the authors randomly divided the patients into groups of forty each. In group I no preloading was done, in group II Ringer lactate 16 ml/kg body weight was infused and in group III 6% HES was infused. Baseline heart rate, systolic and diastolic arterial pressures were recorded. The same parameters were recorded at every 2 min. for first 20 min., at every 10 min. up to one hour and every 15 min till the end of surgery. They found that preloading reduces the incidence of hypotension after spinal anaesthesia and preloading with 6% HES (colloid) better prevents the hypotension as compared to Ringer lactate (crystalloid).

Not only in caesarian section, but studies on other category of patients also showed that prevention of hypotension is better with hydroxyethyl starch than pre loading with ringer lactate. In a study by Bharti Jalandhara et al⁹ on 60 patients scheduled for elective lower abdominal, lower limb and gynaecological procedures in a prospective, randomized, double-blind study, there was significant hypotension with crystalloid group intra operatively in spite of preloading and also intra operatively fluid requirement was high. The incidence of nausea, vomiting, rigors and postoperative hypotension was comparable in both groups.

CONCLUSION: From this study we conclude that 6% hydroxyethyl starch is better choice as a preloading solution for prevention of hypotension following spinal anaesthesia in caesarian section in comparison to lactated ringer solution.

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