

PRELOADING BEFORE SPINAL ANAESTHESIA IN CAESAREAN SECTION: A COMPARISON BETWEEN COLLOID AND CRYSTALLOID***YA Olurode,*BO Bolaji, *IK kolawole, **OT Orewole**

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ABSTRACT

BACKGROUND: Regional anaesthesia has become the preferred technique for caesarean delivery compared to general anaesthesia. Regional anaesthesia is associated with reduced maternal mortality, the need for fewer drugs, faster neonatal maternal bonding, decreased blood loss and excellent postoperative pain control. However maternal hypotension has remained the commonest serious problem following spinal anaesthesia. Volume preloading has been recommended for the prevention of spinal induced hypotension.

AIMS AND OBJECTIVES: This study is a randomized comparative study to determine the effect of crystalloid preloading using 30ml/kg of normal saline compared with 500ml of 6%hydroxyethylstarch.

PATIENTS AND METHODS: A total of 88 parturient belonging to either ASA I or II were studied. Forty four patients who received 30ml/kg body weight of normal saline as preload were compared with forty four patients who received 500ml of 6% hydroxyethylstarch (HES) as preload before spinal anaesthesia for caesarean section.

RESULTS: Twenty nine patients (65.90 %) developed hypotension in the crystalloid group compared with nine patients (20.45%) in the colloid group. Seven patients (15.91%) developed mild hypotension out of which six (13.64%) were in the crystalloid group. Fourteen patients (31.82%) had moderate hypotension, nine (20.45%) of which were in the crystalloid group. Fourteen (31.82%) and three patients (6.82%) developed severe hypotension in the crystalloid and colloid groups respectively. This was statistically significant. (p= 0.004).Volume of fluids used to maintain maternal haemodynamics were

more in the crystalloid group compared with the colloid group 4.4 ± 9.9 and 1.2 ± 0.7 litres respectively. This difference was statistically significant ($p=0.033$). The mean dose of ephedrine given to the hypotensive patients was 6.62mg and 6mg in the crystalloid and colloid groups respectively.

Although, Incidence of side effects of hypotension were more in the crystalloid group when compared with the colloid group, neonatal outcome as assessed by Apgar scores were comparable in the two groups studied.

CONCLUSION: This study showed that 6% HES as a preload before spinal anaesthesia for caesarean section is better in reducing the incidence of hypotension when compared to 0.9% saline (normal saline). It also showed that 6% HES provides better expansion of intravascular space and reduces the incidence of severity of hypotension better than 0.9% saline. No adverse effects associated with 6% HES was recorded in this study.

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INTRODUCTION

Maternal hypotension is one of the serious problems following spinal anaesthesia for caesarean section with an incidence up to 83%¹⁻². The hypotension is caused by a decrease in cardiac output due to reduction in venous return resulting from an increase in venous capacitance, aortocaval compression and a reduction in systemic vascular resistance. Because uterine blood flow is dependent on perfusion pressure, hypotension results in reduced placental blood flow with a potential compromise in fetal oxygenation. Maternal nausea, dizziness, tinnitus, fainting, spinal cord ischaemia and vomiting may also occur.²⁻⁷

Volume preloading has been recommended for prevention of spinal induced hypotension. Left uterine displacement and application of elastic Esmarch bandage to the lower limb, combined with fluid preload have been found to minimize the problem.^{3, 6-15} However controversies regarding different preloading regimes have remained unresolved.³

Preloading is the administration of intravenous fluid 15-20 minutes before intrathecal injection to fill up capacitance vessels and as such limit the relative hypovolemia caused by the spinal induced vasodilatation and subsequent hypotension.¹⁶

Seventy-five percent of any crystalloid infused, diffuses into the interstitial space and its effect is short-lived lasting less than 20 minutes. Replacing the intravascular volume with crystalloid requires three to four times the volume lost.¹⁷⁻¹⁹

Colloids remain in the circulation longer because of their long half life, thereby exerting longer influence on blood pressure. They however, interfere with blood coagulation, carry a risk of anaphylactoid reaction and are expensive.²⁰

Studies have questioned the advantage of preloading with crystalloid in the prevention of spinal induced hypotension in patients undergoing caesarean section. Giving up to 2litres of crystalloid solution may reduce but not eliminate hypotension^{1, 8}.

Norris⁸ in a study used an average fluid administration of 3.3 ± 0.1 litres of 0.9% saline (40-50ml kg⁻¹) to stabilize maternal arterial pressure before the delivery of the baby. Despite such large volume the incidence of hypotension was 74% and neonatal status of hypotensive mothers in this study did not differ from that of non-hypotensive mothers.

Mathru et al²¹ have shown that hypotension is eliminated in the albumin preloaded parturient compared with a 30% incidence of hypotension in crystalloid preloaded patients and the clinical and biochemical status of the neonates improved in the colloid treated group.

In a study in patients undergoing caesarean section under spinal anaesthesia, it was revealed that preloading with 500ml of hyperoncotic colloid (hydroxyethylstarch 10%) resulted in a lower incidence and severity of hypotension than that following crystalloid preloading.¹ Also the ephedrine requirements were lower in the hydroxyethylstarch group than in the crystalloid group.

In another related study by Ueyama et al,²² 36 healthy parturient scheduled for an elective cesarean section during spinal anaesthesia were randomly allocated to one of three groups receiving 1.5litres lactated Ringer's solution (RL; n = 12), 0.5litres 6% hydroxyethylstarch solution (0.5L HES; n=12) and 1.0litre 6% hydroxyethylstarch solution (1.0L HES; n = 12) respectively. Blood volume and cardiac output were measured before and after volume preloading with indocyanine green (ICG). The ICG whole blood concentration was monitored non-invasively with pulse spectrophotometry. The result of this study revealed a significant increase in blood volume in all the three groups. The incidence of hypotension was 75% RL group, 58% for 0.5L HES group and 17% for 1L HES group respectively. Although two groups received 6% HES, the incidence of hypotension developed

in 1.0L HES group was significantly lower than that in RL and 0.5L HES. This shows that greater volume expansion resulted in less hypotension.

This result showed that augmentation of blood volume with preloading regardless of fluid used must be large enough to result in a significant increase in cardiac output for effective prevention of hypotension²².

The aim of this study was to compare the efficacy of crystalloid and colloid in the prevention of hypotension due to spinal anaesthesia during caesarean section in parturient at the University of Ilorin Teaching Hospital.

AIM AND OBJECTIVE OF THE STUDY

AIM OF THE STUDY

The aim of the study was to find the most appropriate intravenous infusion to use as preload in preventing maternal hypotension during spinal anaesthesia for caesarean section.

GENERAL OBJECTIVE

To compare the effects of preloading with colloid and crystalloid in preventing maternal hypotension following spinal anaesthesia for caesarean section at the University of Ilorin Teaching Hospital.

SPECIFIC OBJECTIVES

1. To determine the haemodynamic effect of colloid preloading in the prevention of maternal hypotension during spinal anaesthesia for caesarean section using 500ml of 6% hydroxyethylstarch solution.
2. To determine the haemodynamic effect of crystalloid preloading in the prevention of maternal hypotension during spinal anaesthesia for caesarean section using 30ml per kilogram body weight of normal saline.
3. To compare the haemodynamic effect of colloid and crystalloid preloading in the prevention of maternal hypotension during spinal anaesthesia for caesarean section.
4. To compare the immediate neonatal outcome in babies delivered by caesarean section following crystalloid and colloid preloading using Apgar score.

METHODOLOGY

Following approval by the Ethics and Research Committee of the University of Ilorin Teaching Hospital and National Postgraduate Medical College of Nigeria, a prospective

randomized study was carried out to determine the most appropriate intravenous infusion to use as preload in preventing maternal hypotension during spinal anaesthesia for caesarean section. Informed consents were obtained from pregnant women, weighing between 48 and 90kg who were scheduled for an elective caesarean section. Patients were randomly allocated into crystalloid group (CR) by picking CR or colloid group (HES) by picking HES in a sealed envelope.

The minimum sample size n was calculated using the formula below.

$$n = \frac{z^2 pq}{d^2} \quad \text{Where } q = 1 - p$$

d = degree of accuracy desired usually set at 0.05 or occasionally at 0.029

z = normal deviate usually set at 1.96 which corresponds to 95% of confidence level.

n : the desired sample size when the target population is greater than 10000

p : is the population in the target population estimated to have this problem.

p was calculated thus;

Total number of pregnant women who presented for Antenatal clinic at University of Ilorin Teaching Hospital in 2006 = 5599

Number of pregnant women who had caesarean section the same year = 405

$$\text{Population at risk (P)} = \frac{405}{5599} = 0.07$$

$$\begin{aligned} \text{But } q &= 1 - p \\ &= 1 - 0.07 \\ &= 0.927 \end{aligned}$$

Sample size (n) when the target population is greater than 10,000 was

Calculated thus:

$$\begin{aligned} n &= \frac{z^2 pq}{d^2} \\ n &= \frac{3.482 \times 0.07 \times 0.927}{0.0025} \\ &= 90.447 \end{aligned}$$

But the population at risk is less than 10,000.

$$\text{Sample size } n_f = n / (1 + n/N)$$

$$\begin{aligned}nf &= \frac{90}{1 + \sqrt{90/5,599}} \\ &= 90/1.016 \\ &= 88.565\end{aligned}$$

Sample size = 88

In other to account for the drop-out during the study period, the sealed envelope or the ballot paper that was allotted to patients with failed spinal anaesthesia or patients withdrawn from the study for other reasons was returned to the pool for reallocation.

Inclusion criteria were patient in the category of American Society of Anaesthesiologist ASA I and II, age above 18 years and below 40years (yrs).All normal pregnant women scheduled for elective caesarean section under spinal anaesthesia and suspected to be delivered of a live neonate.

The exclusion criteria were, age above 40yrs and below 18yrs, patient refusal of spinal anaesthesia and participation in the study, patient with contraindication to spinal anaesthesia, patient with history of allergies, ASA higher than II, height less than 152 centimeters (cm), diabetes mellitus (DM), pregnant induced hypertension (PIH), chronic hypertension, Heart disease, multiple gestation, systolic blood pressure less than 80mmHg and patients with Ante partum haemorrhage (APH).

PREOPERATIVE ASSESSMENTS, INVESTIGATION AND PREPARATION

All patients were reviewed the night before surgery. Thorough history, general physical examinations were carried out. Patients were classified in accordance with American Society of Anesthesiologists (ASA). Fasting guidelines were instituted and all patients were fasted for 6 hours. Packed cell volume (PCV) and urinalysis were ordered. Patients were placed on ranitidine tablets 150mg and metochlopramide 10mg to be taken at bedtime and at 6am in the morning of the surgery. Weight and height of patients were measured and recorded.

On arrival in the operating room, the patients were placed in a supine position with a left lateral tilt at an angle of 15° and a patient multi-parameter monitor, Nellcor Puritan Bennett model NPB 4000, was attached for the following baseline vital signs which were taken non-invasively and recorded: arterial oxygen saturation (SaO₂), heart rate (HR) and blood pressure (BP). Intravenous access was established using a large bore size 16G canula. The investigator was blinded to the preloading fluid by having an assistant conceal it within a black polythene bag. Following administration of 500ml 6% hydroxyethylstarch or 30ml/kg

of normal saline as a preload, spinal anaesthesia was then established by injecting 15mg of 0.5% heavy bupivacaine into the subarachnoid space via L3–L4 interspaced with patient in the sitting position using 25-gauge pencil-point spinal needle. After the injection, patients were positioned supine with a left lateral tilt at 15°. Blood pressure and heart rate were measured immediately non-invasively every minute for the first 20 minutes and at five minutes interval thereafter until the end of surgery. The height of block was assessed using loss of sensation to cold. Uterine incision to delivery time and spinal injection to delivery time were recorded. Oxygen was administered by nasal prongs throughout the surgical procedure at 3litres per minutes. Following the delivery of the baby intravenous oxytocin 10i.u boluses were given while another 40 iu in 500ml of 0.9% saline were titrated to achieve adequate uterine contraction. For the purpose of this study the following definitions were used.

- Mild hypotension—a decrease in systolic pressure of 20% from the baseline.
- Moderate hypotension— a decrease in systolic pressure of 20-30% from baseline.
- Severe hypotension— a decrease in systolic pressure of greater than 30% from the baseline.

The incidences of hypotension and its side effects such as nausea, yawning and vomiting were monitored. Following delivery of the baby, neonatal outcome was assessed by the attending paediatrician using Apgar score at one and five minutes interval.

For the purpose of this study, the following Apgar score limits were adopted⁴:

- Normal – 7-10
- Fairly low –4-6
- Critically low –3 and below

Hypotension was treated with rapid infusion of normal saline and 3mg intravenous boluses of ephedrine which were repeated after 2minutes if hypotension persists. Blood loss during surgery was assessed by visual estimate of gauze, drapes, loss on table, spills, linen and content of suction bottles. The study was discontinued if level of block was found to be inadequate necessitating supplemental analgesia or conversion to general anaesthesia. Other drugs given and their doses and total fluid given were recorded.

At the end of surgery, patients were transferred to recovery room with continued monitoring. while postoperative analgesia was maintained with 1-2mg/kg body weight intravenous tramadol hydrochloride 6 hourly and 10mg/kg body

weight intravenous paracetamol 8 hourly. Patients were transferred to the ward after they were considered stable.

Data were entered onto a proforma and analyzed with Statistical Package for Social Sciences SPSS version 15. Data obtained were subjected to statistical analysis using student t-test for continuous variables. While chi square test was used for non-parametric variables as appropriate. Demographic characteristics and intraoperative data were presented as means \pm SD and proportions. Value of $p < 0.05$ were considered significant.

RESULTS

Eighty eight patients were studied with forty four in each group. All the patients were scheduled for elective caesarean section.

TABLE I: DEMOGRAPHIC CHARACTERISTICS OF THE PATIENTS

Characteristics	Crystalloid Group (n= 44)	Colloid Group(n = 44)	P-Value
Age (Yr.) (Mean \pmSD)	29.8 \pm 4.7	28.4 \pm 4.4	0.173
Weight(Kg) (Mean \pm SD)	68.9 \pm 10.6	68.7 \pm 9.6	0.965
Height (m) (Mean \pm SD)	1.58 \pm 0.0	1.54 \pm 0.1	0.279

Table I shows the maternal demographic characteristics. The patients' ages ranged between 18 and 40 years with a mean of 29.79 ± 4.7 years in the crystalloid group and 28.4 ± 4.4 years in the colloid group. Their weights ranged from 48–90kg with mean 68.9 ± 10.6 kg and 68.8 ± 9.6 kg in the crystalloid and colloid group respectively. The patients' heights ranged from 1.50 to 1.71 metres with mean 1.5 ± 0.0 m and 1.5 ± 0.2 m in the crystalloid and colloid group respectively. There was no significant difference in the demographic features between the two groups.

The majority of the patients were in the ASA class 1 with the ratio of ASA I: ASA II being 3:1.

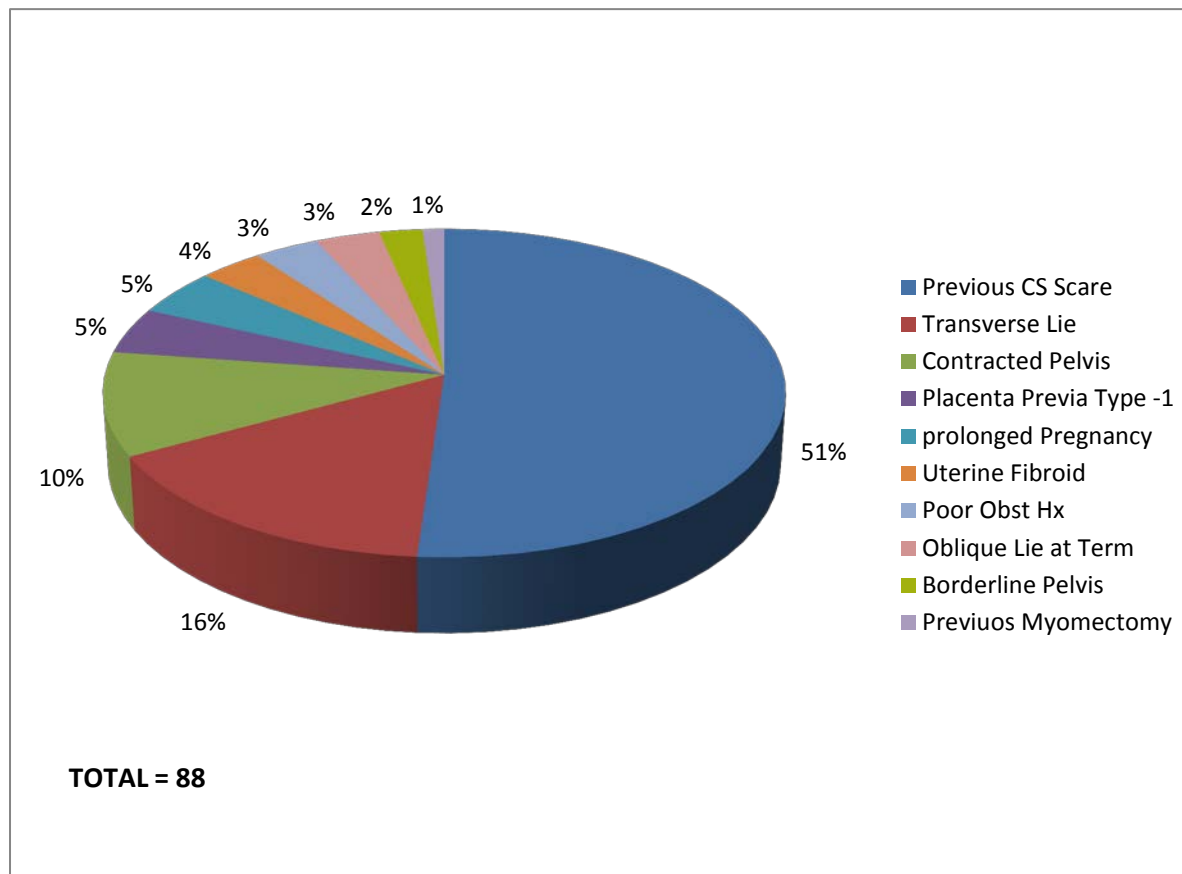


Figure 1: INDICATIONS FOR CAESAREAN SECTION.

The indications for surgery are shown in figure 1. The commonest indication for surgery was previous caesarian section 45 (51.00%) followed by transverse lie 14 (16%), contracted pelvis 9 (10%), prolonged pregnancy 4 (5%), placenta previa 4 (5%), oblique lie 3(3%) and uterine fibroid 3(3%) While border line pelvis was 2(2%), poor obstetric history was 3(3%) and previous myomectomy 1(1%).

The mean preoperative heart rate (HR) was 96.16 ± 13.1 and 95.6 ± 13.4 mmHg in the crystalloid and colloid groups respectively. This shows no difference statistically. The preoperative mean systolic blood pressures (SBP) were 124.14 ± 9.3 and 116.7 ± 9.1 mmHg in the crystalloid and colloid groups respectively. The mean preoperative diastolic blood pressures (DBP) were comparable between the two groups with 73.82 ± 8.6 and 69.89 ± 8.3 mmHg in crystalloid and colloid groups respectively. While the mean

preoperative mean-arterial pressures were 90.66 ± 7.9 and 85.41 ± 5 mmHg in the crystalloid and colloid group respectively.

A total of 23 patients had T-6 block in the crystalloid group while twenty patients had similar block in the colloid group. However, T-7 block was recorded in 21 and 22 patients in the crystalloid and colloid groups respectively. This shows no significant difference statistically ($p=0.534$).

TABLE II: INTRA OPERATIVE DATA

Intraoperative Data	Crystalloid (n= 44)	Colloid (n = 44)	P- Value
Mean Spinal injection to delivery time (minutes)	24.27 ± 9.3	23.96 ± 11.1	0.867
Mean Uterine incision to delivery time (minutes)	4.45 ± 1.2	4.70 ± 4.0	0.695
Mean Blood Loss (litres)	0.619 ± 0.4	0.549 ± 0.2	0.277
Mean Total fluid given (litres)	4.4651 ± 0.9	1.238 ± 0.7	0.033

The intra-operative data are shown in Table II. The mean spinal injection-to-delivery intervals were similar and were 24.27 ± 9.3 and 23.96 ± 11.2 minutes in crystalloid and colloid groups respectively.

The mean uterine incision to delivery intervals were 4.4 ± 1.2 and 4.7 ± 4.0 minutes in the crystalloid and colloid groups respectively and this was found to be similar in both groups. Blood loss during surgery ranged from 0.25—1.4 litres with mean of 0.619 ± 0.4 and 0.54 ± 0.2 litres in crystalloid and colloid groups respectively with no significant difference statistically ($P=0.277$). The mean total volume of fluids given was 4.4 ± 9.9 and 1.2 ± 0.7 in the crystalloid and colloid groups respectively. This is statistically significant ($p=0.033$).

TABLE III: CHARACTERISTICS OF HAEMODYNAMIC CHANGE

Parameters	Crystalloid (n= 44)	Colloid (n = 44)	P-Value
Incidence of Hypotension n (%)	29 (%)	9 (%)	0.000
Timing of Hypotension (minutes) (mean \pm SD)	5.60	5.83	0.901
Duration of Hypotension (minutes) (mean \pm SD)	5.33 \pm 1.8	4.73 \pm 2.8	0.630
Mean Dose of Ephedrine bolus given to hypotensive patient (mg)	6.62 \pm 1.9	6 \pm 1.5	0.964
Number of patient who developed mild hypotension	6 (13.64%)	1(2.27%)	0.056
Number of patient who developed moderate hypotension	9(20.45%)	5(11.36%)	0.283
Number of patient who developed severe hypotension (%)	14(31.82%)	3(6.82%)	0.019
Number of hypotensive patient not requiring. Ephedrine bolus	3	1	

Table III shows the characteristics of haemodynamic changes in the study group. Hypotension occurred in 29 (65.91%) and 9(20.45%) patients in the crystalloid and colloid group respectively. Six (13.64%) and one (2.27%) patient had mild hypotension in the crystalloid and colloid group respectively. Moderate hypotension was recorded in nine and five patients in the

crystalloid and colloid groups respectively. Severe hypotension was recorded in seventeen patients out of which fourteen were in the crystalloid group. The mean duration of hypotension was 5.33 ± 1.8 and 4.73 ± 2.8 minutes in the crystalloid and colloid groups respectively. The mean doses of ephedrine given to the hypotensive patient were 6.62 ± 1.9 and 6.00 ± 1.5 mg in the crystalloid and colloid groups respectively. Hypotension occurred at a mean time of 5.60 minutes after establishment of subarachnoid block in crystalloid group and 5.83 minutes in the colloid group. The duration of hypotension ranged from 1 to 8 minutes in the colloid group while the range was 1 to 10 minutes in the crystalloid group. Three patients did not require ephedrine bolus in the crystalloid group while one patient was recorded for such in the colloid group.

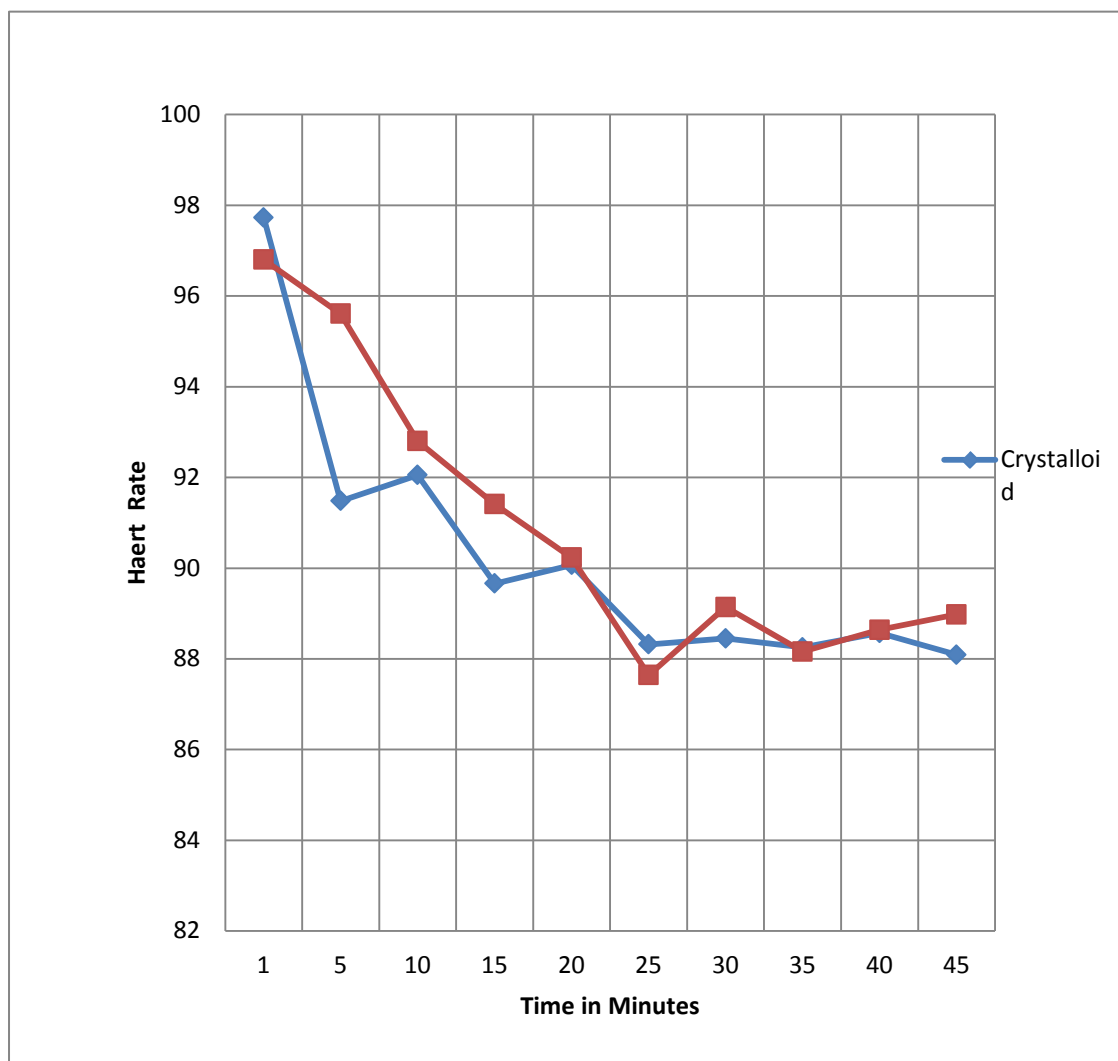


Figure 2: Comparisons of Heart Rate Trends (Crystalloid / Colloid).

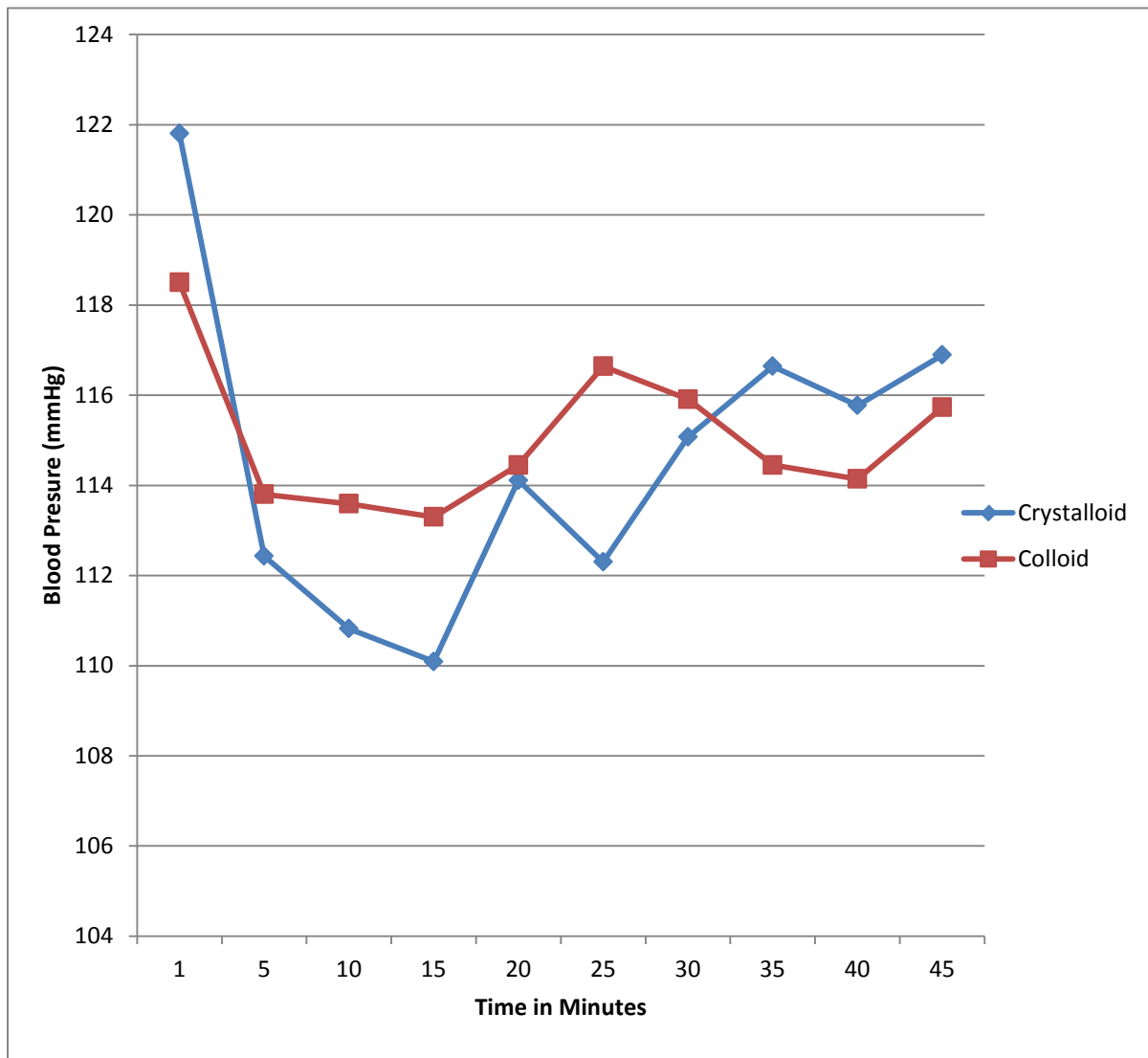


Figure 3: Mean Systolic Blood Pressure trend (Crystalloid / Colloid).

Fig 2 shows the trends in the HR between the two groups. Figure3 shows the comparison of the mean SBP trends between the two groups. The lowest drop in mean SBP occurred at 5min in the colloid group (from 119 to 114mmHg i.e. 5mmHg) while the lowest drop in mean SBP occurred at 15min in the crystalloid group (from 122mmHg to 110mmHg i.e. 12mmHg).

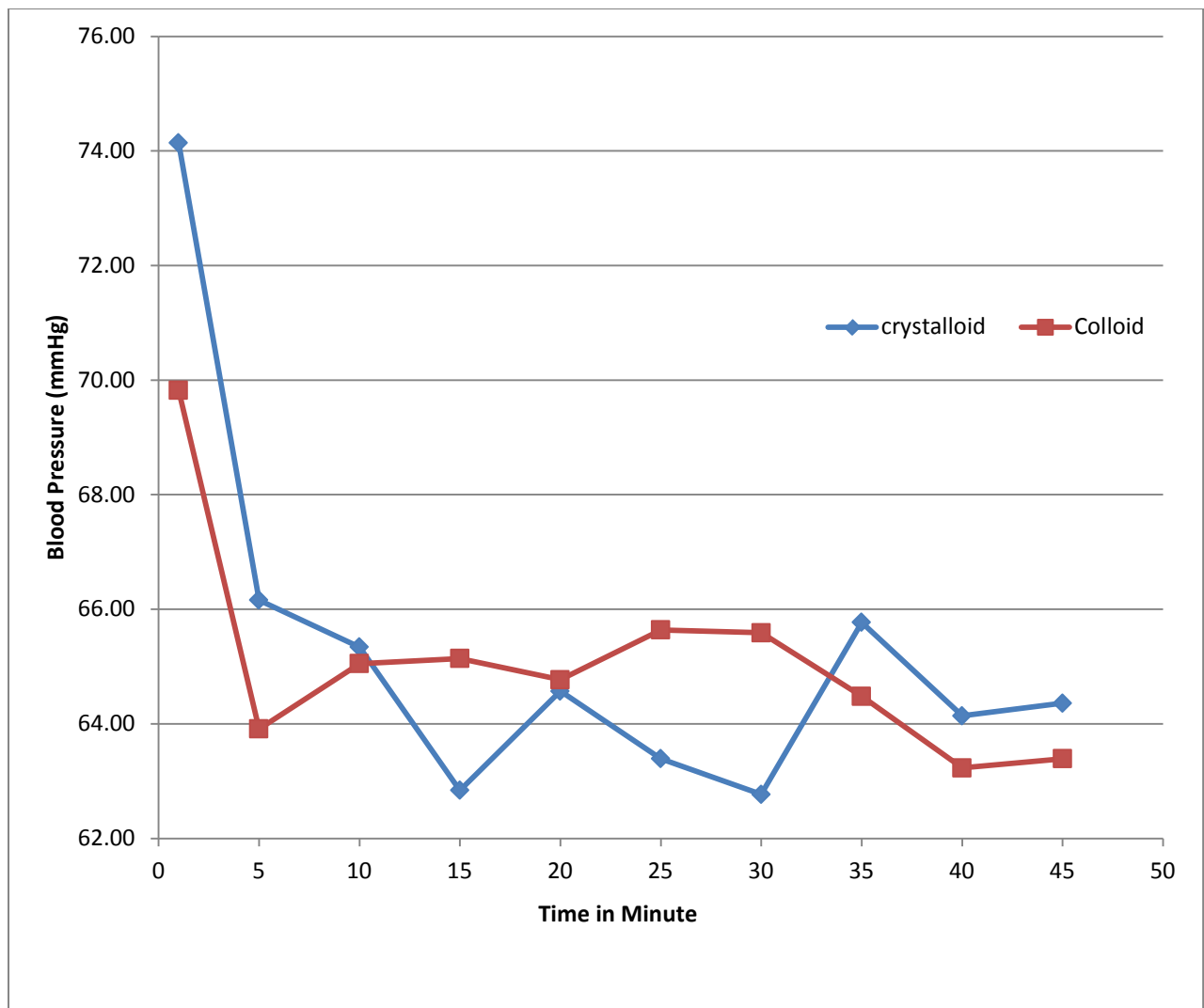


Figure 4: Mean Diastolic Blood Pressure trend (Crystalloid / Colloid).

Figure 4 shows the comparison of the mean DBP trends between the two groups. The lowest drop in the mean DBP occurred at 15min with the crystalloid group (from 74mmHg to 63mmHg i.e. 11mmHg) while the lowest drop in mean DBP occurred at 5min in the colloid group (from 70mmHg to 64mmHg i.e. 6mmHg). Thereafter there was an increase in diastolic blood pressure which stabilizes at 10 minutes. This is probably the onset time of hydroxyethylstarch to recruit fluid from extravascular to intravascular compartment. Generally, the SBP and DBP were more stabilized in the colloid group when compared with crystalloid group.

TABLE IV RELATIVE INCIDENCE OF THE SYMPTOMS OF HYPOTENSION IN THE PATIENTS

Symptoms	Crystalloid	Colloid	P-value
Nausea	13 (29.55%)	5 (17.36%)	0.034
Vomiting	3 (6.8%)	2 (4.55%)	0.645
Tinnitus	1 (2.27%)	0	0.315
Tingling sensation of the finger	1 (2.27%)	0	0.315
Dizziness	7 (15.9%)	0	0.006
Yawning	17 (38.63%)	6 (13.63%)	0.008
Restlessness	17 (38.64%)	4 (9.1%)	0.001

The relative incidence of the symptoms of hypotension in the study group was shown in table IV. Yawning was the commonest side effect of hypotension occurring in 23 patients out of whom 17 were in the crystalloid group. This was followed by restlessness occurring in 21 patients, 17 of which were in the crystalloid group. The next common side effect of hypotension was nausea occurring in 18 patients 13 of which were in the crystalloid group. Dizziness was recorded in 7 patients while vomiting occurred in 5 patients. Tinnitus, tingling sensation of the fingers were recorded in 1 patient in each group. The incidences of nausea, dizziness, yawning and restlessness were significantly more in the crystalloid than in the colloid group ($p=0.034$, 0.006 , 0.008 and 0.001 respectively).

TABLE V: NEONATAL STATUS

Parameters	Crystalloid (n = 44)	Colloid (n = 44)	P-Value
Weight of Baby (Kg) (Mean \pm SD)	3.06 \pm 0.4	3.09 \pm 0.4	0.70
One Minute APGAR Score < 7	12	16	0.546
≥ 7	32	28	
Five Minute APGAR Score < 7	0	0	1
≥ 7	44	44	

Table V shows the neonatal status at delivery. The median weight of babies at birth were 3.06 ± 0.4 kg and 3.09 ± 0.4 kg in the crystalloid and colloid groups respectively with no statistical difference. The first minute Apgar scores were less than 7 among twelve and sixteen babies in the crystalloid and colloid group respectively. While it is greater than 7 among thirty two and twenty eight babies in the crystalloid and colloid group respectively. The fifth minute Apgar score was greater than 7 in all the babies in both groups.

DISCUSSION

The current study has shown that preloading with 6% hydroxyethylstarch was more effective than crystalloid for preventing hypotension in parturient undergoing spinal anaesthesia for elective caesarean section.

A higher incidence of hypotension was demonstrated in the crystalloid group, 65.91% compared with the colloid group which was 20.45% in this study. This result is in agreement with previous reports.^{1, 23}

Levels of sensory block to T5 and T6 have been used successfully to provide adequate anaesthesia for caesarean section.¹⁴ Higher levels of block lead to block of more sympathetic nerves and more precipitous drop in blood pressure.²⁴ In this study, the levels of block in the two groups were comparable and therefore did not contribute to any difference seen in the incidence and severity of hypotension.

Hypotension is likely to occur in dehydrated or hypovolemic patients.²² Patients scheduled for elective surgery are often dehydrated due to aggressive fasting guidelines and this may worsen the degrees of hypotension if it occurs. In this study, all the patients in both groups were fasted for a period of six hours. Therefore fasting could not have contributed for the difference observed in the hypotension.

Sidik et al¹ also presented evidence that colloid preloading with 500ml hydroxylethylstarch10% was more effective than 1L of crystalloid in reducing the incidence of hypotension (40% versus 80%). Although the study recorded higher incidence of hypotension in the crystalloid group while the present study recorded a lower value, this may be because the former used a fixed volume as preload (1000ml of crystalloid) regardless of body weight of the patients while this study employed 30ml/Kg body weight of crystalloid for pre-hydration.

Ueyama et al²² studied 36 healthy parturient who were allocated into three groups receiving 1.5L Ringers lactate, 0.5L 6% HES and 1L 6% HES respectively. The incidence of hypotension was 75% for Ringers lactate group, 58% for 0.5L HES group and 17% for 1L HES group respectively. The incidence of hypotension was significantly lower in the 1L HES group than in the Ringers lactate group, showing that greater volume expansion results in less hypotension. The incidence of hypotension in the 0.5L 6% HES group compares with findings in this study while it is higher when compared with 1L HES group because greater intravascular volume expansion results in less hypotension.

Vercauteren et al²⁵ were able to maintain the most optimal haemodynamic stability in patients receiving high volume HES 6% - crystalloid combination (up to 1L HES 6% with 1L Ringers lactate). Hypotension occurred in 10% of the patients. Also, Riley et al²³ reported

45% incidence of hypotension in patients who received 500ml 6% HES plus 1L Ringers lactate versus 85% in those who received 2L of Ringers lactate. The incidence of hypotension recorded in the colloid group of their study is lower than the findings in this study. This was probably because the greater volume expansion resulted in less hypotension while the higher incidence of hypotension recorded in the Ringers lactate group was probably because the present study used crystalloid volume based on kilogram body weight of the patient. Meanwhile their study employed a fixed volume of 2L Ringers lactate for all the patients in this group.

Multiple studies have failed to show sustained and predictable blood pressure maintenance after prophylactic crystalloid administration.^{7, 17, 23} Blood pressure and cardiac indices transiently increase but these effects are short lived because crystalloid solutions remain intravascularly for only a limited period of time.

In a study of preload comparing pentastarch with crystalloid, French et al²⁵ also demonstrated a reduction in the incidence of hypotension in the colloid group (12.5% Vs 45%). Again there was no major difference in the neonatal outcome. Colloids that have been used include 10% Pentastarch, 6% and 10% HES and albumin. Pentastarch is a waxy starch amylopectin with average molecular weight of 250,000 Daltons. It produces 1.5 times volume expansion, which lasts approximately 12 hours. HES is also an amylopectin but with an average molecular weight of 450,000 Daltons. It is hyperoncotic with greater than 100% volume retaining effect. HES produces a plasma expansion of 140% by recruiting an additional 0.4ml from the extravascular to the intravascular compartment for every 1ml infused. Maximum effect occurs in 10-15mins and plasma expansion effect may last for 36 hours. In contrast, crystalloid distributes throughout the extracellular fluid and 1L results in expansion of the plasma volume by only 250- 300ml. Thus we need about 3000ml of crystalloid to result in the expansion of the plasma volume equivalent to that achieved by 500ml HES 6%.

Colloids are however expensive and may induce anaphylactoid reactions especially with the dextrans and gelatins. Allergic potential of HES is seven times lower (1/2100) than that of the gelatins²⁰. Adverse reaction to HES was not observed in this study. Colloids also affect blood coagulability. Nevertheless the high oncotic pressure of these solutions reduces the risk of pulmonary oedema²⁶.

The present study shows that the incidence of nausea is lower in patients preloaded with HES 6% than in the patients preloaded with crystalloid (11.6% versus 29.55%). Nausea and vomiting are common side-effects of spinal anaesthesia. Although the mechanism is unclear, it may be due to maternal hypotension that in turn decreases cerebral blood-flow. Intraoperative emetic symptoms during abdominal surgery under regional anaesthesia have multifactorial origin. Factors such as hormonal changes, psychological changes (anxiety), arterial hypotension, abrupt visceral movement and concomitant opiate administration may have influence on them. Additionally, there is higher predisposition to intraoperative nausea and vomiting among patients at the end of their pregnancies as a consequence of increased abdominal pressure and hormonal changes. Lussol et al²⁷ believed that intraoperative nausea and vomiting after delivery are rather related to surgical manipulation of uterus, abdominal visceral and peritoneum even in the presence of adequate sensori-motor blockade. Abdominal surgery and the physical manipulation of abdominal visceral may cause release of humoral substances including 5-HT which may stimulate 5-HT₃ receptors on different vagus nerves. Its incidence relating to spinal anaesthesia range from 14-45% but treatment of hypotension often results in disappearance of the symptoms.²⁸

Incidence of nausea and vomiting varies widely within other studies. Amata²⁹ recorded 28% incidence of nausea and 5% of vomiting in 100 patients despite preload with 1000mls saline and I.V ephedrine when hypotension occurred. Jackson¹⁹ observed 12.5% incidence of nausea despite different preload volume. While Desalu and Kushimo²⁴ recorded (40%) nausea in the two groups studied and the incidence of vomiting was not significantly different. The incidence of nausea and vomiting in this present study compares well with findings of Amata et al³⁰. However nausea often resolves with treatment of hypotension.^{19, 24}

Despite the decrease in the incidence and severity of hypotension in the HES group compared to the crystalloid group, neonatal outcome as shown in the Apgar score were good and not different between the two groups. This is similar to previous studies that transient decrease in blood pressure rapidly treated with vasopressors or fluid infusion do not usually affect fetal acid base status.^{19,23,24} The Apgar score is determined at one and five minutes after delivery. It is therefore a rapid way to evaluate the physical condition of newborn babies. Of the two scores, the five minutes score has come to be regarded as a better predictor of survival in infancy.³¹ In the present study, the five minutes Apgar score was above 7 in both groups. Although umbilical cord blood gas analysis provides a better assessment of neonatal outcome at birth, however this facility was not readily available at the time of this study.

The mean doses of ephedrine used in this study were 6 and 6.6mg in the colloid and crystalloid groups respectively. The mean dose of ephedrine associated with good neonatal outcome was 8mg, while that associated with poor neonatal outcome was 26.3mg. This probably reflects that parturient with severe hypotension require greater dose of ephedrine. This emphasizes the importance of rapid treatment of hypotension associated with spinal anaesthesia.²⁴

The uterine incision delivery interval in this study is longer when compared to previous findings.^{24,28} During spinal anaesthesia for caesarean section prolongation of the interval between the uterine incision and delivery of the baby has been shown to be an important factor influencing neonatal outcome. A uterine incision delivery interval of more than 3 minutes has been associated with a significantly higher incidence of low Apgar scores and increasingly acidotic infants.²⁸

Outcome is probably due to the lengthened period of disruption of the uterine perfusion with resultant intrauterine distress and fetal hypoxia. The sympatho-adrenal system in fetus is mobilized during the period of intrauterine distress. Significantly higher catecholamine concentration has been demonstrated in infants who have suffered fatal hypoxemia at the time of delivery as determined by low umbilical arterial pH values or low Apgar score.^{24, 28}

The same relationship between the uterine incision to delivery interval and fetal pH has not been shown to exist for infants delivered by caesarian with epidural anaesthesia.^{24, 28}

The findings of an association between prolonged uterine incision to delivery interval under either epidural or spinal anaesthesia and a significant increase in fetal arterial norepinephrine concentration and a decrease in fetal arterial pH values may reflect the fetal distress experienced with longer disruption of uteroplacental blood flow. This result emphasizes the importance of minimizing the uterine incision to delivery interval regardless of the type of anaesthesia used. In this study the uterine incision-to-delivery intervals were 4.45 ± 1.2 and 4.70 ± 1.0 min. in crystalloid and colloid group respectively. There is no significant difference statistically ($p=0.695$). Desalu and Kushimo²⁴ recorded 2.9 ± 1.2 min. and 3.0 ± 1.4 min. in uterine incision-delivery interval in the pre-hydration and ephedrine group studied while Bader et al²⁸ reported 1.68 ± 0.2 and 2.067 ± 0.2 in the two groups studied. However, neonatal outcome were comparable to the findings in this study despite the fact that the surgeries were done under spinal and epidural anaesthesia respectively. The uterine

incision to delivery intervals is longer in this study. This is probably because a large percentage of our patients have had previous caesarean sections with its associated extensive adhesion which usually takes some time to release before the baby could be delivered.

CONCLUSION

The conclusions drawn from this study were:

HES 6% (colloid) stabilize SBP and DBP better than 0.9% normal saline (crystalloid) when used as a preload during spinal anaesthesia for caesarean section.

6% HES as a preload before spinal anaesthesia for caesarean section reduces the incidence of hypotension significantly when compared to normal saline, 63.64% and 22.73% in the crystalloid and colloid group respectively ($p=0.0001$).

6% HES was a better solution for expansion of intravascular volume during spinal anaesthesia for caesarean section as reduced volume was required for the maintenance of maternal haemodynamics.

The mean dose ephedrine required in the maintenance of maternal haemodynamics is lower in the colloid group when compared with crystalloid group.

6% HES reduces the incidence of side effect of hypotension better than crystalloid. Yawning was the commonest side effect of hypotension with 38.63% occurring in the crystalloid group compared to 13.63% in the colloid group. This is statistically significant ($p=0.008$).

The neonatal outcome as assessed by Apgar score was similar in both groups. The five minute Apgar score was greater than 7 in the two groups studied.

The administration of colloid (6% hydroxyethylstarch) offered a better protection against spinal induced hypotension in obstetrics during elective caesarean section.

RECOMMENDATIONS

Neuroaxial anaesthesia results in a block of preganglionic fibres, causing vasodilatation, reduced venous return and cardiac output which result into hypotension. The hypotension is worsened in the parturient because of aortocaval compression while in supine position. Commonest maternal symptoms of hypotension are nausea and vomiting and if un-intercepted it can cause reduced uteroplacental blood flow and acidaemia in the neonate.

The incidence, severity and duration of hypotension should therefore be limited so as to produce a favourable maternal and neonatal outcome.

It is recommended that fluid preload not less than 30mls/kg of crystalloid or 500ml 6% hydroxyethylstarch should be given before spinal anaesthesia during caesarean section. This is because fluid preload produces generally less incidence of hypotension. However, colloid preload should be preferred if available as it produce significantly less incidence of hypotension. This is even more important in a cardiac patient who may not be able to tolerate excess fluid preload.

Aortocaval compression should be avoided in the parturient by ensuring 15⁰ left lateral tilt as this has been found to reduce the incidence of hypotension.

The level of block should not exceed T5 so as to prevent severe hypotension, bradycardia and diaphragmatic paralysis due to block of cardiac sympathetic and diaphragmatic fibres. Maternal cardio-respiratory vital sign should be monitored every minute in order to identify sudden deterioration and effect prompt intervention. However, if hypotension occurs, it should be promptly treated using rapid I.V fluid administration and I.V boluses of a vasopressor.

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