



Comparative Study of 6% Hydroxyethylstarch-450 & Dextran-40 on Blood Sugar Levels During Surgery Under Spinal Anaesthesia

KEYWORDS

6% Hydroxyethyl starch-450, Capillary blood glucose, Dextran-40, Hyperglycaemia, Ringer's lactate, Spinal anaesthesia.

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ABSTRACT *Background and objectives: Fluid resuscitation with colloids and crystalloids as preloading fluids is done prophylactically to limit complications following spinal anaesthesia. Aim of this study was to examine and compare the effects of 6% hydroxyethyl Starch-450 and Dextran-40 on blood sugar level during surgery under spinal anaesthesia and their potential to induce or potentiate hyperglycaemia. Material and method: After obtaining permission from Institutional Ethics Committee (IEC), study was conducted in 90 non-diabetic patients of ASA-I, age 18-65 yrs posted for elective surgery under spinal anaesthesia in our institute. They were randomly divided into 3 groups (A,B,C) by computer generated random number table. Following fluids were administered iv over half an hour prior to the sub-arachnoid block: Group A- Ringer's Lactate, 20 ml/kg, Group B- Dextran - 40, 10 ml/kg Group C- Hestar 6% - 450, 10 ml/kg. Serial capillary blood glucose measurements were taken at regular intervals at 15, 30, 45, 60, 120, 180 and 240 minutes using a glucometer. Statistical analysis was done by ANOVA (one way) with Bonferroni's post hoc test to compare the two groups with reference to the control group. Result: Ringer's lactate and Hestar 6% - 450 increased the capillary blood glucose levels which was statistically significant ($p < 0.05$) but the rise with Dextran - 40 was sustained and statistically highly significant ($p < 0.001$). With Ringer's Lactate, maximal mean blood glucose levels of 95.16 ± 16.421 mg/dl were found at 45 minutes. With Hestar 6% - 450, maximal blood glucose levels of 105.26 ± 16.197 mg/dl were found at the end of 1 hour. With Dextran - 40, maximal blood glucose level of 215.43 ± 45.159 mg/dl were found at 45 minutes. Conclusion: Under stressful conditions, Ringer's lactate and Hestar 6%-450 significantly raise the blood sugar level within physiological limits whereas Dextran-40 raises the blood sugar to a level well above the physiological limit, causing a sustained and significant rise in peri-operative blood sugar levels.*

Introduction

Fluid resuscitation for hypovolaemic shock is an integral part of the acute medical management in a critical care setting or inside an Operation theatre, and, commercially available synthetic colloids are widely used to serve this purpose, having been recommended in a number of resuscitation guidelines and intensive care algorithms.¹⁻³

Dextrans are normally broken down completely to CO₂ + H₂O by enzyme Dextranase. Under stressful conditions or as a result of catecholamine response to shock, these dextrans are likely to elevate blood glucose levels to potentially harmful limits following intravenous administration due to rapid degradation of glucose polymers to free glucose residues.⁴⁻⁵

6% Hydroxy ethylstarch-450 made up of large ethylated starch or glucose polymers, is metabolised by serum amylase to produce smaller molecules of starch polymers and free glucose residues. They also carry a potential to increase blood glucose levels following intravenous administration under stressful conditions.⁶⁻⁷

Stress response to surgery and the catecholamine release following it, induce some amount of hyperglycaemia, but this remains confined to a limited extent. An additive hyperglycemic response, secondary to the metabolism of infused intravenous fluids can thus prove harmful to the patient if ignored.

Hyperglycaemia potentiates ischaemic damage to the brain, spinal cord, kidneys and the myocardium. It also impairs wound healing by interfering with the white blood cell function.⁸⁻⁹

These effects could prove to be even more harmful in fluid resuscitation of uncontrolled diabetics, during neurosurgical procedures, in the event of cardiopulmonary resuscitation or when colloids are included in priming fluids during cardiopulmonary bypass surgeries, using cardioplegia.

Considering these potential ill-effects of hyperglycaemia, in the peri-operative period, on the well-being of patients and on the outcome of surgery, we carried out the following study, with an objective to examine and compare the effects of 6% Hydroxy ethyl starch-450 and Dextran-40, on blood sugar levels, during surgery under sub-arachnoid block, and their potential to induce or potentiate hyperglycaemia.

Aim of the study:

To examine and compare the effects of 6% hydroxy ethylstarch-450 and dextran-40 on blood sugar during surgery under sub-arachnoid block and their potential to induce or potentiate hyperglycaemia.

Methodology

This prospective, randomized, single blinded study was carried out, following an approval from the institutional ethics committee. Patients included in this study were informed about the procedure and a written informed consent was taken from all of them.

90, ASA grade 1, non-diabetic patients, 18 to 65 years of age, weighing 40 to 70 kg, undergoing elective lower limb or lower abdominal surgical procedures, which were anticipated to complete within two hours, were selected and randomly divided into three groups, These patients were preloaded with either Ringer's Lactate (group A) 20 ml/kg, Dextran-40 (group B) 10 ml/kg, or 6% Hydroxyethyl

starch-450 (group C) 10 ml/kg, respectively, over a period of 30 minutes, prior to spinal anaesthesia, through an 18-gauge intravenous cannula.

Patients on regular use of steroids and ascorbic acid were excluded from the study, as also patients with a low haematocrit (PCV < 30%). All the procedures, which were prolonged due to anaesthetic or surgical complications, or those requiring blood transfusion due to more than predicted intra-operative blood loss were excluded as well.

All patients were thoroughly evaluated pre-operatively. Necessary and relevant laboratory investigations were carried out. Baseline pulse rate and blood pressure were recorded and under vigilant monitoring of vital parameters and appearance of skin rash, preloading with the assigned fluid was carried out.

Preloading was immediately interrupted on evidence of an allergic reaction and symptomatic treatment was promptly given. Patients developing an allergic reaction to the study fluids were excluded from the study. Prior to the onset of preloading, a baseline capillary blood glucose reading was measured using glucometer. Subsequent readings were taken at 15, 30, 45, 60, 120, 180 and 240 minutes from the baseline reading. After preloading, all the patients received normal saline as the maintenance I.V. fluid till the final blood glucose reading was taken.

A sub-arachnoid block was given immediately after completion of the preloading procedure with hyperbaric bupivacaine 0.5% and the level of sensory block after fixation of the drug was noted in each case.

Statistical analysis was done with Analysis of Variances (ANOVA) with Bonferroni's post-hoc test (p < 0.05-significant, p < 0.001-highly significant).

Observation and results

The demographic data in all the three groups was comparable, the mean age being 40.7 ± 15.6318 years in group 1, 45.866 ± 14.0901 years in group 2 and 48.0 ± 9.4200 years in group 3. The mean weights in the three groups were 51.333 ± 10.5285 kg, 51.566 ± 3.3803 kg and 51.533 ± 3.7299 kg, respectively.

The baseline mean blood glucose levels at onset of preloading in all the 3 groups were 80.6±16.932 mg/dl (group A), 78.56±22.661 mg/dl (group B) and 81.43±16.239 mg/dl (group C), which were comparable.

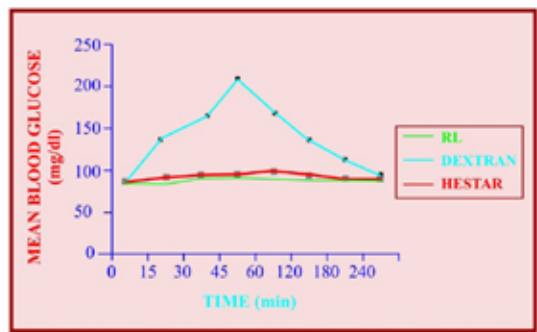
In group A (Ringer's Lactate), maximal mean blood glucose levels of 95.16 ± 16.421 mg/dl were found at 45 minutes from onset of preloading, indicating an increase of 14.56 ± 0.511 mg/dl from the baseline which was found to be a statistically significant rise (P < 0.05). After this peak at 45 minutes, the blood sugar levels gradually settled to a mean value of 93.26 ± 12.224 mg/dl at the end of four hours, with a difference of 12.66 ± 4.708 mg/dl from baseline, which was still a statistically significant difference (P < 0.05).

In group B (Dextran-40), peak mean capillary blood glucose levels were attained at the end of 45 minutes. The rise in mean capillary blood glucose levels at 45 minutes in group B was by a huge difference of 136.87 ± 67.820 mg/dl. This leap from the baseline value of 78.56 ± 22.661 mg/dl to a mean capillary blood glucose value of 215.43 ± 90.481 mg/dl at 45 minutes, was found to be statistically

highly significant (P < 0.001). After this peak at 45 minutes, the mean capillary blood glucose levels gradually fell to a value of 105.5 ± 54.083 mg/dl at the end of 4 hours. The difference between the former and latter value was of 25.94 ± 31.422 mg/dl, which was still statistically significant (P < 0.05).

Group C (Hestar450-6%) showed a maximum rise in the mean capillary blood glucose level at the end of the 1st hour. The difference from the baseline mean capillary blood glucose reading at that time was seen to be 23.83 ± 0.042 mg/dl, which was found to be statistically significant (P < 0.05). This was followed by a gradual fall up to 95.42 ± 41.111 mg/dl at the end of 4 hours. The difference between the reading at the end of four hours and the baseline reading was of 13.99 ± 2.218 mg/dl. This difference was found to be statistically significant (P < 0.05).

Figure: 1 Line diagram showing mean capillary blood glucose levels in all the three groups.



A Line Diagram showing Comparison between mean Blood Glucose levels

Table 1: Difference in mean blood glucose levels at various time intervals

Time (minutes)	Ringer lactate (1)	Dextran (2)	Hestar (3)
15	1.9 ± 0.944	55.87 ± 20.220**	12.40 ± 1.382*
30	10.36 ± 1.857*	89.26 ± 13.899**	15.287 ± 1.966*
45	14.56 ± 0.511*	136.87 ± 67.820**	19.04 ± 6.014*
60	13.56 ± 0.299*	90.99 ± 60.300**	23.83 ± 0.042*
120	13.16 ± 4.609*	64.80 ± 50.260**	16.79 ± 0.977*
180	10.93 ± 5.690*	42.01 ± 38.490**	14.90 ± 1.957*
240	12.66 ± 4.708*	25.94 ± 31.422*	13.99 ± 2.128*

*P < 0.05

**P < 0.001

Discussion

Spinal anaesthesia was used as the technique of choice in all the patients so as to standardize the stress response due to anaesthesia and surgery in all the 3 groups. Also normal saline was used in all the patients as the maintenance IV fluid.

Ringer's Lactate used as a control in our study has also been shown to possibly cause hyperglycaemia due to conversion of lactate to glucose via the Cori's cycle.¹⁰

Murty et al., in 2004, studied the effects of 6% Hestar-450, Pentastarch 200 and Ringer's lactate as preloading fluids in spinal anaesthesia, on blood sugar levels. They concluded that both the starches significantly elevated the blood sugar levels ($p < 0.05$), with peaks at the end of two hours with Hestar 6%-450 and at the end of three hours with Pentastarch 6%-200. However, in their study, Ringer's lactate did not significantly elevate blood sugar levels.⁶

Our study demonstrated a sustained and statistically significant rise ($P < 0.05$) in BSL from the baseline, with the infusion of both RL and Hestar 6%-450, which peaked at the end of 45 minutes and at the end of one hour, respectively. Dextran 40, on the other hand demonstrated a steep and statistically highly significant rise ($P < 0.001$) in mean capillary BSL from the mean baseline reading, which peaked at 45 minutes.

In the first 15 minutes of infusion, when there was no stress due to anaesthesia or surgery, there were different trends seen in the 3 study groups. In group A (RL), the rise in mean capillary blood glucose level was only 1.9 ± 0.944 mg/dl, which was statistically not significant, whereas in group B (Dextran), increase in mean blood glucose levels in the first 15 minutes was 55.87 ± 20.220 mg/dl, which was statistically highly significant ($P < 0.001$). In group C (Hestar) the difference in mean blood glucose levels at 15 minutes from baseline was 12.40 ± 1.382 mg/dl ($p < 0.05$).

The clinical data obtained in group C (Hestar) was comparable with that of group A (RL) throughout the period of infusion, except the early rise in blood glucose level seen with the Hestar group.

When the trends in group B (Dextran) were compared with those seen in group C (Hestar), a statistically highly significant rise was seen in the difference in mean blood glucose readings from the baseline values, at various time intervals in group B as compared to group C ($P < 0.001$). The mean blood glucose reading at the end of four hours in group C was 95.42 ± 14.111 mg/dl, while in group B it was 104.5 ± 54.083 mg/dl, the difference between the two being statistically significant ($P < 0.05$).

The mean readings at the end of four hours in all the 3 study groups were significantly higher than their respective mean baseline blood glucose readings.

Conclusion

Under stressful conditions, Ringer's Lactate and Hydroxyethylstarch 6%-450 significantly raise the blood sugar level but within physiological limits whereas Dextran-40 raises the blood sugar to a level which is well above the physiological limit.

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