



## Impact comparison between Voluven and Hartmann's solutions administered before anesthesia on blood glucose level induced by general anesthesia and surgery

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### Abstract

To assess the effects of preoperative administration of Hartmann's and Voluven 6% solutions on perioperative blood glucose level during general anesthesia and surgery. Our prospective, randomized and double-blind study included 126 patients, of both sexes, aged 34-52years, classed I physical status by the American society of anesthesiologists (ASA) and scheduled for various elective intermediate type of surgical interventions performed under general anesthesia at Prince Hashem bin Abdullah the second hospital, Aqaba, Jordan, during the period Dec.2012-Oct.2014. Patients were divided into three groups in a random fashion according to the preoperative administered solution. Group I patients (n=43) received preoperative Voluven 6% solution (hydroxyethyl starch) with infusion rate of 10 ml/kg body weight/hour during 30 minutes, group II patients (n=41) received preoperative Hartmann's solution (compound sodium lactate) with infusion rate of 10 ml/kg body weight/hour during 30 minutes and group III patients (n=42) received preoperative normal saline 0.9% with infusion rate of 10 ml/kg body weight/hour during 30 minutes. Blood glucose readings were recorded before solution administration (0h, I), at the end of solution administration (0h, II) and at ½ h intervals during 2hours of general anesthesia. Analysis of variance test was used to test statistical significance and P<0.05 was considered significant. The Hartmann's and Voluven solutions increased significantly the perioperative blood glucose levels compared to Normal saline (P<0.05). Voluven increased significantly perioperative blood glucose level compared to Hartmann's solution (P<0.05). Voluven 6% and Hartmann's solutions produce a significant increase in perioperative blood glucose levels.

**Keywords:** Blood glucose level: perioperative; general anesthesia; solutions: Hartmann's, Voluven, Saline.

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### Introduction

In the surgical theatre, fluid management is an important part of general and regional anesthesia protocol during different types of surgery whether minor, intermediate or major. Endogenous catecholamine release after surgical stress reaction can result in a limited secondary increased level of

glucose [1]. This secondary hyperglycemia induced by the metabolism of intravenous fluids may cause harm to the patient if not managed seriously. Various synthetic colloids are administered during patient stay in the theatre for different beneficial effects as enhancing oxygenation and reducing postoperative nausea and vomiting [2]. Voluven 6% is a hydroxyethyl starch built of big ethylated starch or glucose polymers. Hydroxyethyl starch is metabolized by serum amylases resulting in small starch polymers and glucose molecules. Metabolism of hydroxyethyl starch may result in increased production of glucose. Intravenous injection of these substances may increase blood glucose levels in acute circumstances [3].

Spinal cord, heart, brain and kidneys can have ischemic changes accelerated by hyperglycemia. Hyperglycemia may decrease wound

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healing by disruption of white blood cell function [1]. These actions are detrimental in fluid management during neurosurgical interventions, cardiopulmonary resuscitation, uncontrolled diabetes mellitus and cardiopulmonary bypass procedures. The above adverse effects of perioperative hyperglycemia on patients can adversely affect the outcome of surgery. Surgery has classical neuroendocrine and cytokine reactions according to the size and metabolic injury. Minor procedure induces a minimal stress reaction but not major procedure. There are two essential parts of the stress reaction to operation: the neuroendocrine and the cytokine reactions. The neuroendocrine reaction is triggered by painful afferent neural activation of CNS. The cytokine part is activated by the local tissue insult at surgery location. The stimulants of neuroendocrine and cytokine reactions postoperatively are: noxious afferent activation, local tissue inflammatory, pain and anxiety, starvation, hypothermia and shivering, bleeding, acidosis, hypoxia and infection. There is concern that stress reaction is risky and is accompanied with morbidity after operation. It induces side effects on important systems, including respiratory, gastrointestinal, endocrine and cardiovascular systems. The aim of our investigation was to evaluate the impact of Voluven 6% compared to Hartmann's solutions on blood glucose levels during surgery under general anesthesia.

## Materials and Methods

This prospective, randomized and double-blind study included 126 subjects, of both genders, aged 34-52 years, classed I physical status by the American society of anesthesiologists (ASA) and assigned for different elective intermediate type of surgical procedures, of 120 minutes duration, performed under balanced intravenous general endotracheal anesthesia using propofol 2mg/kg, fentanyl 2mcg/kg and cisatracurium 0.15mg/kg, at Prince Hashem bin Abdullah the second hospital, Aqaba, Jordan, during the period Dec.2012-Oct.2014, after obtaining written informed consent from all participants and approval from our local ethical and research board review committee of the Jordanian royal medical services.

Subjects were divided into three groups in a random manner according to the preoperative administered solution. Group I patients (n=43) were infused intravenously with preoperative Voluven 6% solution (hydroxethyl starch) (Hes 130/0.4, 1L contains 60g poly (O-2-hydroxyethyl) starch, molar substitution

0.38-0.45, molecular weight 130000, osmolarity 308mOsmol/l, P<sup>H</sup> 4-5.5, half life in plasma: 17 days, maximum dose 50ml/kg/day, Fresenius Kabi-Deutschland GmbH-Homburg-Germany) with infusion rate of 10 ml/kg body weight/hour during half an hour, group II patients (n=41) were infused intravenously with preoperative Hartmann's solution (compound sodium lactate) (Ringer lactate, 1L contains sodium lactate 3.2g equivalent to bicarbonate (as lactate) 29mmol/L, osmolarity 278 mOsmol/l, P<sup>H</sup> 5-7, Pharmaceutical solutions industry-Jeddah-Saudi Arabia) with infusion rate of 10 ml/kg body weight/hour during half an hour and group III patients (n=42) were infused intravenously with preoperative normal saline 0.9% (sodium chloride, osmolarity 308mOsmol/l, P<sup>H</sup> 4.5-7, pharmaceutical solutions industry, Jeddah-Saudi Arabia) with infusion rate of 10 ml/kg body weight/hour during half an hour. Patients on preoperative glucocorticoids and with perioperative allergic responses were ruled out from the investigation. Patients were monitored perioperatively for heart rate, non-invasive blood pressure, oxygen saturation and end tidal CO<sub>2</sub>.

Blood glucose levels were recorded using a glucocheck before solution administration (0h, I), at the end of solution administration (0h, II) and at ½ h perioperative intervals during 2 hours duration of general anesthesia. All patients in the three groups received intraoperative isotonic normal saline 0.9%, 10ml/kg/h.

**Statistical analysis:** Analysis of variance test was used to test statistical significance and P<0.05 was considered significant.

## Results

There were no significant differences between the three groups in terms of the characteristics of patients including age, weight, sex and ASA. There was no significant between the groups regarding the mean duration of surgery and distribution of surgical interventions. Table I. There was no significant discrepancy between the groups according to the mean blood glucose level recorded before administration of study solution (0h I). This was 86.64, 85.81 and 86.12mg/l in Voluven, Hartmann's and Saline solutions, respectively (P >0.05).

In Voluven solution group, the higher increase in blood glucose level was at the perioperative end of the first and half an hour recording 111.37mg/l. The difference of blood glucose level between 0h I reading and 3/2h reading

Mustafa washdeh HA. (January 2016). Impact comparison between Voluven and Hartmann's solutions administered before anesthesia on blood glucose level induced by general anesthesia and surgery. Jour of Med Sc & Tech; 5(1); Page No: 1 – 4. was 24.73mg/l. P<0.05. The increase in blood glucose level at 3/2h was followed by a reduction to 101.53 mg/l at 2h. The difference of blood glucose level between 0h I reading and 2h reading was 14.89 mg/l. (P <0.05). (Table II).

In Hartmann's solution group, blood glucose level was highest 1h (101.27mg/l) from 0h I reading with an increase of 15.46 mg/l. P <0.05. This blood

glucose level began to decrease from 3/2 h to 2h until it reached 99.37 mg/l with a discrepancy of 13.56mg/l from 0hI reading (P <0.05). (Table II).

In Saline solution group, blood glucose level increased from 87.33mg/l at 0h II reading but not significantly throughout the surgery until 3/2h when it began to decrease until it reached 86.38mg/l at 2h.

|  | G I        | G II       | G III       |
|--|------------|------------|-------------|
| <b>n</b>   | <b>43</b>  | <b>41</b>  | <b>42</b>   |
| <b>Preoperative study solution</b>                 | Voluven 6% | Hartmann's | Saline 0.9% |
| <b>Age(yr) mean</b>                                | 38.5       | 43.4       | 41.4        |
| <b>Sex</b>   |            |            |             |
| <b>M</b>   | 32         | 29         | 33          |
| <b>F</b>   | 11         | 12         | 9           |
| <b>ASA I</b>                                       | 43         | 41         | 42          |
| <b>Weight(kg) mean</b>                             | 68.5       | 71.4       | 73.7        |
| <b>Distribution of surgical interventions (no)</b> |            |            |             |
| <b>General surgery</b>                             | 22         | 20         | 19          |
| <b>Gynecology-obstetrics</b>                       | 21         | 21         | 23          |
| <b>Duration of anesthesia (min) mean</b>           | 110.5      | 108.4      | 106.4       |

**Table I: Demographic characteristic features of Patients demographics.**

| Interval(h)  | G I    | Difference | G II   | Difference | GIII  | Difference |
|--------------|--------|------------|--------|------------|-------|------------|
| <b>0h I</b>  | 86.64  |            | 85.81  |            | 86.12 |            |
|              |        | 13.3       |        | 2.8        |       | 1.21       |
| <b>0h II</b> | 99.94  |            | 88.61  |            | 87.33 |            |
|              |        | 16.18      |        | 11.26      |       | 2.14       |
| <b>½ h</b>   | 102.82 |            | 97.07  |            | 88.26 |            |
|              |        | 19.94      |        | 15.46      |       | 3.39       |
| <b>1 h</b>   | 106.58 |            | 101.27 |            | 89.51 |            |
|              |        | 24.73      |        | 14.46      |       | 2.67       |
| <b>3/2 h</b> | 111.37 |            | 100.27 |            | 88.79 |            |
|              |        | 14.89      |        | 13.56      |       | 0.26       |
| <b>2h</b>    | 101.53 |            | 99.37  |            | 86.38 |            |

**Table II: Perioperative blood glucose levels outcome (mean).**

## Discussion

Increased blood glucose level and insulin intolerance are important parts of the stress reaction which can stay for few days postoperatively. These are due to high serum concentration of catecholamines, cortisol and glucagon. Sympathetic

nervous system activation by release of catecholamines of adrenal medulla, also induce former effects. The above hormones depress insulin and glucose uptake in muscle, fat and liver. There is reduced sensitivity of muscle and liver to insulin during the stress reaction. Blood glucose can increase by 10mmol/l with glycosuria and osmotic diuresis

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[4]. Hyperglycemia should be avoided in neurosurgery, coronary arterial bypass graft surgery and during cardiopulmonary resuscitation. In the same time colloids should be administered to replace deficits and maintenance needs. Starch solutions are well known for their effects as volume expanders and on blood coagulation profile [5]. In the last years, it became clear from their pharmacodynamic profile that they may increase serum blood glucose level when administered intravenously using subarachnoid block as the anesthetic of choice for all patients [6]. Other investigations compared the effects on blood glucose level between Hestar 6% - 450 and pentastarch 200 during intrathecal block anesthesia and found that both solutions increased significantly the blood glucose level peaking at 2h with the former and at 3h with the latter [7].

In our investigation, it was demonstrated that Hartmann's solution can increase serum blood glucose level when administered intravenously by transforming lactate to glucose through the Cori's cycle [8], although other investigations found that same solution couldn't increase significantly blood glucose level [7]. We used general anesthesia in all patients of the three groups to prevent bias and we also administered normal saline intraoperatively in all patients of the three groups to replace the deficit and maintenance needs. The stress response of anesthesia and surgery was almost equal in all the groups although the surgical interventions were different but they all took 2h as mean duration and were classified by the surgeons depending on the Hoehn classification as intermediate grade.

Abhiruchi P, et al [6] found that Hartmann's and hydroxyethyl starch 6% 450 increased significantly the blood glucose level peaking at 45 minutes in the former and at 1h in the latter. In our study, at the end of study fluid administration and before the start of anesthesia and surgery, group II patients experienced a 2.8mg/l increase in blood glucose level ( $P>0.05$ ) while patients in group I experienced a 13.3mg/l, a significant increase in blood glucose level ( $P<0.05$ ). The least increase was found in patients receiving saline which was 1.21mg/l. The results were similar in groups I and II during solution infusion but there was a significant early increase in blood glucose level in group I. The mean blood glucose levels at 2h in groups I and II were significantly more than the mean readings at 0h I interval. Enzyme systems and metabolic proceedings are important to maintain cellular

function and depend on surroundings with stable electrolyte and hydrogen concentration. Homeostatic issues may maintain internal environment and avoids cellular disability.

## Conclusion

Hartmann's and Voluven 6% solutions may increase significantly the blood glucose levels at accepted physiological values in patients under anesthesia and surgery.

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