



A COMPARISON OF TWO PRIMING SOLUTIONS: RINGER'S LACTATE VERSUS HYDROXYETHYL STARCH SOLUTION

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ABSTRACT:

OBJECTIVE: To compare the effect on hemoglobin (Hb), blood sugar random (BSR), renal function, liver function and bleeding in ringer's lactate versus hydroxyethyl starch (HES) solution as a priming solution.

MATERIAL AND METHODS: A prospective comparative study was conducted at the Department of Cardiac Surgery, Punjab Institute of Cardiology, Lahore, from October 2012 to December 2012. The total number of patients included in the study was 100. Patients were categorized into group 1 (Ringer solution) and Group 2 (HES 130-0.4) with 50 patients in each group.

All the patients underwent coronary artery bypass grafting (CABG). Patients having heart diseases other than coronary artery disease and patients with renal failure were excluded from the study. Data was analyzed using SPSS (Statistical Package for Social Sciences). P-value <0.05 was considered significant.

RESULTS: Out of 100 patients, 38% were female and 62% were male. The mean age of the patients was 44.81 ± 18.319 years. There was an insignificant difference between risk factors in both groups (P-value >0.05). The outcome in terms of blood sugar random (BSR) was significant (P-value <0.05) in hydroxy ethyl starch (HES) group as compared to ringer lactate group whereas the effect on Hb, liver function, renal function and PT, APTT were insignificant (P-value >0.05).

CONCLUSION: Both Ringer's Lactate and HES solution lead to the same results in terms of Hb, liver function tests, renal function tests and PT, APTT when used as priming solutions in cardiopulmonary bypass in patients undergoing CABG, whereas BSR increases in HES group.

KEY WORDS: Priming solutions, Comparison, Ringer's Lactate, HES Solution.

INTRODUCTION:

Different priming solutions are used to prepare the perfusion circuit for the application of cardiopulmonary bypass. Ringer's lactate, starch solution, gelatin, mannitol or mixtures of these solutions are used in calculated ratio¹. Priming solutions lead to hemodilution that can have harmful as well as beneficial effects².

Hypovolemia can be treated with many solutions available i.e., human albumin, synthetic colloids (Dextrans, Gelatins, Hydroxyethyl starch), or crystalloids (Lactated Ringer's solution). HES has intermediate molecular weight (MW) and has already been approved in several countries for treating hypovolemia³.

Due to the effects on hemostasis, a new HES with a lower molecular weight (HES 130/0.4) has been introduced that has fewer effects on hemostasis. HES 130/0.4 has been preferred to HES 200/0.5 for plasma volume expansion in cardiac

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surgery patients⁴.

In this study we sought to compare hydroxyethyl starch solution and Ringer's lactate solution as priming solutions in cardiopulmonary bypass in patients undergoing coronary artery bypass surgery.

PATIENTS AND METHODS:

A total of 100 patients undergoing CPB on elective basis were included in the study. Written informed consent for participation was obtained from the hospital ethical committee. Patients with renal insufficiency preoperatively were excluded from this study. Also patients undergoing emergency CABG were excluded. Patients were categorized into group 1 (Ringer solution) and Group 2 (HES 130-0.4).

To begin with cardiopulmonary bypass in Group 1, 1500 ml Ringer solution + 200 ml mannitol + 60 ml sodium bicarbonate + 5000 units heparin was used as the priming solution. On the other hand, to begin with cardiopulmonary bypass in Group 2, 1500 ml HES 130-0,4 (Voluven®; Fresenius Kabi Deutschland GmbH, Bad Homburg, Germany) + 200 ml mannitol + 60 ml sodium bicarbonate + 5000 units heparin was used as

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the priming solution.

Patients were introduced to the cardiopulmonary bypass by applying 2.4 l/min/m² total systemic blood flow at moderate hypothermia of 28–30°C. The hematocrit value was kept at 21%–27%.

Variables recorded were age, sex, cross-clamp time, cardiopulmonary bypass duration, coronary bypass number, diabetes, chronic obstructive pulmonary disease, hypertension, hypercholesterolemia, preoperative coronary lesions, executed coronary bypass number and LIMA (Left Internal Mammary Artery) usage.

SURGICAL TECHNIQUE:

After median sternotomy, cardiopulmonary bypass was established through an aortic and right atrial cannulation. Antegrade cardioplegia was used in all the patients through the root of the aorta. Membrane oxygenator was used uniformly in all patients. The hematocrit values were between 21-27% and the flows of the CPB pump were 2.2-2.4 l/min/m². The flows were non-pulsatile in all the patients and mean arterial pressures were 50-65 mmHg. Rewarming was done until the nasopharyngeal temperature was 37 °C.

The study variables were measured at 12th and 24th hour and statistical analysis were done. Creatinine clearance was measured in all the patients and analyzed.

STATISTICAL ANALYSIS:

Data was analyzed using SPSS (Statistical Package for Social Sciences) Version 20.0. Continuous variables were presented as the mean ± standard deviation. Categorical variables were presented as frequencies and percentages. Qualitative characteristics for different groups were compared using Chi-square test and quantitative variables using t-test. P-value less than 0.05 was considered as significant.

RESULTS:

The mean age of the patients was 44.81 ± 18.319 years. Out of 100 patients, 38% were female and 62% were male. Table (1) shows that 33(66%) were male and 17(34%) were female in ringer lactate group. While 29(58%) were male and 21(42%) were female in HES group. The mean age of the group 1 was 44.58 ± 17.76 years while the mean age of the group 2 was 45.04 ± 19.09 years. Diabetes and smoking was the same in both groups (26% vs. 28%) and (26% vs. 24.5%). Hypertension 30 (60%) in group 1 and 22(44%) in group 2. Hyperlipidemia 1(2%) in group 1 and 2(4%) in group 2.

The effect of two priming solutions on renal function, liver function and PT, APTT was insignificant as (P-value>0.05), whereas the effect on BSR was more with HES (P-value 0.001).

The effect of the mean Hb was improved

Table-1: Demographical and clinical distribution of variables in two groups.

Variables	Group 1(50)	Group 2 (50)	P-value	
Gender	Male	33(66%)	29(58%)	0.536
	Female	17(34%)	21(42%)	
Age (years)	44.58±17.76	45.04±19.09	0.9010	
Weight (Kg)	63.24±14.77	64.56±17.44	0.68	
Hypertension	30(60%)	22(44.0%)	0.16	
Hyperlipidemia	1(2%)	2(4.0%)	1.00	
Diabetes mellitus	13(26%)	14(28.0%)	1.00	
Smoking	13(26%)	12(24%)	1.00	
Alcohol	0	1(2%)		
COPD	0	1(2%)		

Table-2: Outcomes in two groups (Ringer lactate Vs. HES).

Variables	Group	Outcome	P-value
Hb (g/dl)	Group 1	12.1±2.181	0.2011
	Group 2	12.82±3.30	
B. Urea (mg/dl)	Group 1	26.44±11.31	0.832
	Group 2	26.87±8.82	
Bilirubin (mg/dl)	Group 1	1.03±1.89	0.7619
	Group 2	1.182±2.99	
S. Creatinine (mg/dl)	Group 1	.87±.69657	0.557
	Group 2	.810±.21	
BSR (mg/dl)	Group 1	61.165±1.85	0.001
	Group 2	74.30±5.16	
ALT (iu)	Group 1	24.9±14.40	0.1878
	Group 2	29.63±20.7	
ALP (iu)	Group 1	61.93±30.8	0.0802
	Group 2	78.7±59.6	
PT	Group 1	11.72±6.13	0.069
	Group 2	15.17±11.79	
APTT	Group 1	39.4±9.85	0.556
	Group 2	37.92±14.7	

in both groups but statistically insignificant as (12.1 ± 2.181; 12.82 ± 3.30 g/dl.(Table 2)

DISCUSSION:

The optimum composition and types of fluid which are used for CPB priming solution is still a matter of debate. Oncotic pressure is maintained well by high molecular weight colloids and it also reduces fluid shifts, thus it seems a good option in CPB⁵. Literature does not show any significant difference in the clinical outcomes when colloid-based priming solutions are used. Clinical outcomes like duration of ventilation and in-hospital stay have not been shown to be significantly affected.

Volume replacement with colloids is considerably more expensive than with crystalloids. Clinical stud-



ies demonstrated that colloids and crystalloids have different effects on physiological measurements. The use of hypo-oncotic priming solution causes myocardial edema, and crystalloid volume loading may lead to a vicious cycle a slowed compliance necessitate higher filling pressure to preserve the same function. On the other hand hyper-oncotic colloid solution can dry the extracellular spaces to an extent that causes considerable vasopressin secretion. Literature shows that capillary perfusion and tissue oxygenation is significantly depressed in lactated Ringer's haemodiluted animals as it leads to interstitial edema⁶.

Bleeding is a well know complication after cardiac surgery. The rate of re-operations due to excessive bleeding after cardiac surgery in literature is 0.6-15%. Priming solution has been found a risk factor and this can be reduced by mannitol 20% 250mL, albumin 20% 150mL and Ringer's lactate 1100mL combined with ultrafiltration in the perioperative period⁷.

In our study, postoperative bleeding for both groups showed no difference

Winkelmayer and colleagues showed in their report that HES was independently associated with a decrease in the velocity of glomerular filtration at the 3rd and 5th postoperative day⁸. Our study showed that urea was $26.44 + 11.31$ mg/dl at the 12th postoperative hour in the Ringer group and for the HES group it was $26.87 + 8.82$ mg/dl. Similarly creatinine values were $0.87 + 0.69$ mg/dl for the Ringer group and $0.81 + 0.21$ mg/dl for the HES group at the 12th hour postoperatively. Thus no statistically significant difference was found between the two groups. Tiryakioglu O et al showed in a randomized trial that HES can be used as an alternative priming solution with no significant difference in the outcome⁹.

Our results showed that male group of patients undergoing CABG were higher indicating that male are at increased risk of CABG surgery (62% males Vs. 38% females) while it showed statistically insignificant difference between priming solution groups and male gender (66% in group 1 Vs. 58% in group 2). Tiryakioglu O et al found that CABG was more prevalent in male patients compared to female patients (85.71% vs. 14.28%).⁹ Skhirtladze Ket al 10 found that there was an insignificant difference between male genders in both priming solution group (64% in HES group vs. 77% in RL group). Present study demonstrated similar results.

Present results showed that mean age of the

patients in both groups was <50 years that is (44.58 ± 17.76 vs. 45.04 ± 19.09). In study by Tiryakioglu O et al⁹ mean age of the patients was > 50 years in both groups as (58 ± 7 vs. 56 ± 8). Skhirtladze K et al¹⁰ showed that in both groups mean age of the patients was > 50 years (66 ± 23 vs. 67 ± 28). In study by Alavi et al¹¹ mean age of the patients in both group was (59 ± 11 vs. 57 ± 10.4).

The main result of this study was that hemoglobin stability could be achieved after CABG surgery with HES than Ringer's solutions as (12.82 ± 3.30 vs. 12.1 ± 2.181). Alavi SM et al¹¹ reported that hemoglobin stability improved after CABG surgery with both HES and Ringer's solutions as (12.7 (8.1-15) vs. 12.3 (8.4-13.5)). Tiryakiolu O et al⁹ also reported similar results as (14 ± 1 vs. 14 ± 1).

The post-operative renal function after CABG was found to be improved after the use of HES and Ringer's solutions as B. urea (mg/dl) (26.44 ± 11.31 vs. 26.87 ± 8.82) and s. creatinine (mg/dl) (0.87 ± 0.69 vs. 0.81 ± 0.21). According to the Alavi SM et al¹¹ renal function was improved after the use of both HES and Ringer's solutions at first two days after CABG as urea (g/dl) 13 (9-23) vs. 15.5 (9-23) and creatinine (g/dl) 0.9 (0.7-1.04) vs. 1 (0.7-1). Further study by Tiryakiolu O et al⁹ found less renal damage after the use of HES and Ringer's solutions as Creatinine (mg/dL) 1 ± 0.2 vs. 1.1 ± 0.1 and Urea(mg/dL) 37 ± 10 vs. 38 ± 11 . Our study also showed similar results.

Tiryakiolu O et al⁹ examined that the liver function values i.e. INR (1.07 ± 0.12 vs. 1.04 ± 0.15), SGOT (U/L) (20 ± 2 vs. 26 ± 4), SGPT (U/L) (44 ± 10 vs. 43 ± 8) were found to be slightly similar in both Ringer's and HES group, these values were within the normal range and it was seen that they did not cause any serious liver damage and liver insufficiency. A study by Alavi SM et al¹¹ al reported that the post-operative liver function was found to be better in both solution groups while difference was statistically insignificant as PTT (30 ± 4.5 vs. 29 ± 5.0) and INR (1.1 ± 0.25 vs. 1.08 ± 0.16). Our study also showed, statistically insignificant difference among the two groups regarding the liver function tests, APTT (39.4 ± 9.85 vs. 37.92 ± 14.7) and PT (11.72 ± 6.13 vs. 15.17 ± 11.79).

Our study did have certain limitations. We have not excluded abnormal hepatic functions which can lead to decreased lactate metabolism and thus a secondary increase in lactate levels. Although performing the study in a single center is an additional limitation of our experiment, it provides



uniformity in the peri-operative handling of the patient population.

CONCLUSION:

Both Ringer's Lactate and HES solution lead

to the same results in terms of Hb, liver function tests, renal function tests and PT, APTT when used as priming solutions in cardiopulmonary bypass in patients undergoing CABG, whereas BSR increases in HES group.

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