The Effect of Starch VS Crystalloid Administration of Cardiopulmonary Bypass Prime Solution on Tissue and Organ Perfusion and Coagulation Status

Mohammad Abbasi MD, Hamid Hoseinikhah Manshady * MD, Aliasghar Moinipoor MD, Nahid Zirak MD, Mahmoud Hosseinzade Maleky MD, Ahmad Amozeshy MD

Background: We evaluated the effects of tissue and organ perfusion and Coagulation status and hemorrhage in open heart surgery with the use of Cardiopulmonary Bypass with Starch (colloid) or crystalloid (Lactated ringer's) as prime solution.

Methods: In this prospective randomized-controlled trial study, 40 patients undergoing on-pump open heart surgery were randomly assigned to receive either colloid (Starch) or crystalloid (Lactated ringer's) as prime solution, for initiation of cardiopulmonary bypass machine procedure. Tissue and organ perfusion markers and Coagulation test including lactate, and renal function tests and PTT , INR were measured sequentially

Results: Although the differences in PTT/INR/ Cr/ Plt Count between two groups was not significant but Bleeding and drainage in 6 and 24 interval after operation was higher in Starch group and also Urine Out Pout during operation in Ringer Lactate group was higher than Starch group.

Conclusion: In Tissue and Organ perfusion variable there was no Statistical differences but Priming with Starch have tendency to excessive Bleeding and Coagulopathy.

Key words: Prime, Colloid, Crystalloid, Cardiopulmonary Bypass

Background:

Cardiopulmonary bypass (CPB) provides the extracorporeal maintenance of respiration and circulation at hypothermic and normothermic temperatures, despite its association with a number of profound physiological perturbations. The central nervous system, kidneys, gut, and heart are especially vulnerable to ischemic events associated with extracorporeal circulation.(1) The heart-lung machine (Cardiopulmonary Bypass Circuit) wad made first with Gibbon and then most of cardiac Operation have done with it. The heart-lung machine and the joined lines must be prepared before starting the cardiopulmonary bypass. Prime solutions are solutions which are used to prepare the extracorporeal perfusion line in cardiopulmonary bypass applications. Crystalloid (Ringer solution) as the base of prime solution is the classic method.(2) but other options exist for Prime Solutions like whole Blood, FFP, Albumin ,Gelatin , Starch, Voluven. Adult extracorporeal perfusion circuits require 1.5 to 2 lit of balanced electrolyte solution like Lactated Ringer. Before connection is made to the patient, the patient is recirculated through a micropure Filter to remove Particular matter and air. The Priming volume represents approximately 30 % to 35% of patient blood volume and reduces Hematocrit about two-third of the preoperative value. The addition of Cardioplegic cause further dilution.(3) The redistribution of circulation produces hypovolemia for which volume loading is necessary and which also takes advantage of the vasodilators by maintaining constant filling pressures. Colloid as well

*Correspondence to: Hamid Hoseinikhah Manshady
Email: hoseinikhah_hr@yahoo.com
Tell: 09153046163- 05118525307
Department of Cardiac surgery, Imam Reza Hospital of Mashhad University, Mashhad, Iran.

as crystalloid solutions is used for this purpose. As CPB is occasionally followed by capillary leaking, the qualities of the most preferable infusion solution are still being debated. (4) The use of colloid (Albumin, Gelatin, Dextran and Hetastarch) in priming volume is controversial. Colloid reduce the fall in colloid osmotic pressure and may reduce the amount of fluid entering the extracellular space. Postoperative clinical studies failed to document any significant clinical benefits with Albumin which is expensive and may have adverse effects. Hetastarch may contribute to postoperative bleeding. Volume replacement is essential in the management of cardiac surgery patients. Different intravascular volume replacement regimens have been proposed for providing hemodynamic stability in this situation, including blood and its components (e.g., human albumin), synthetic colloidal (dextrans, gelatins, hydroxyethyl starch [HES]), or crystalloids (e.g.,Lactated Ringer's solution). Various modifications of approved HES have different molecular weights (MWs) (450 kd, 200–260 kd, and 70 kd) and degrees of substitution (DSs) (0.7, 0.62, and 0.5). HES with an intermediate MW (130 kd) and a very low DS (0.4) has been developed that has already been approved in several countries for treating hypovolemia. (5) In this study we have examined Lactated Ringer's solution and Hetastarch for the prime of Cardiopulmonary bypass (CPB) circuit and evaluate the differences in tissue and organ perfusion factor and also bleeding and coagulopathy in two groups of patients.

Method and Material:

This was a randomized prospective investigation and included 40 patients candidated for Open heart surgery using CPB and those with renal or hepatic insufficiency (Cr> 2 mg/dl and ASTandALT>2.5×normal), low ejection fraction (EF<25%) and reoperation were excluded. The anesthetic drug doses were calculated according to body weight, and anesthesia was induced with midazolam 0.03-0.05 mg/kg, sufentanil 1.5-2.0 mcg/kg, and sodium thiopental 1-2mg/kg. Pancruniom bromide 0.15 mg/kg was administered to facilitate tracheal intubation. Anesthesia was maintained by continuous infusion of propofol 50-150 mcg/kg/min and remifentanil 0.1-1.0 mcg/ kg/min. Operation with standard median sternotomy was done in all of patients. Heparin (3mg /kg) was given for anticoagulation
before the initiation of CPB. CPB was introduced by arterial cannulation from the ascending aorta and by two stage venous cannulation or Bicaval cannulation from the auricle of the right atrium. Cardioplegia cannula was positioned into the root of the aorta and anterograde crystalloid cardioplegia was given to all the patients. For Priming of CPB in 20 patients we use 1500 ml Ringer solution plus 200 ml mannitol 10% and 60 ml sodium bicarbonate 5%, containing 150 IU/kg heparin was used as the prime solution. On the other hand, to begin the CPB on the second group of 20 subjects , 1500 ml HES 130-0,4 , 200 ml mannitol 10% , 60 ml sodium bicarbonate 5% and 150 IU/kg heparin was used as the prime solution. At moderate hypothermia (32° to 34°C rectal temperature), pump flows on CPB were adjusted to maintain a mean arterial pressure of more than 50 mm Hg and a flow rate of 2.2 L/min/m2 body surface area. Intravascular volume replacement was managed with equivalent amount of crystalloid and colloid solutions to maintain
a central venous pressure of 8-16 mmHg according to baseline values. The variable that we have recorded consist of Urine out pout (u/o) in operation Time and 6 hours after operation, bleeding and Drainage in 6 hours and 24 hours after operation and differences in Preoperative and Postoperative Value of Cr, PLT Count, PTT, INR.

Results:

In 20 patients of Ringer group 12 were female (80%) and in Starch group 10 patients were female (50%). The Mean age of patients in Ringer group was 50.5 and in Starch group it was 52.2. The Mean Drainage in 6 hours in Ringer Lactate group was 296 Ml and Mean Drainage in 6 hours in Starch group was 504 Ml with significant differences (P value = 0.005). The Mean Drainage in 24 hours in Ringer Lactate group was 668 Ml and Mean Drainage in 24 hours in Starch group was 1102 Ml with significant differences (P value = 0.004). The Mean of PTT difference (preoperative and postoperative value) in Ringer Lactate group was 28 s and in Starch group was 18 s. The Mean of INR difference in Ringer Lactate group was 0.5 s and in Starch group was 0.6 s. The Mean of Plt count difference in Ringer Lactate group was 105000 and in Starch group was 113000. The Mean of Cr differences in Ringer Lactate group was 0.19 mg/dl and in Starch group was 0.28 mg/dl. In statistical analysis, PTT and INR and Plt Count and Cr between two groups have no significant differences. The

Mean of urine out pout during operation in Ringer Lactate group was 780 ml and in Starch group was 460 ml with significant differences. (P value <0.04) The Mean of urine out pout in 24 hours later after operation in Ringer Lactate group was 1235 ml and in Starch group was 1283 ml with no significant differences.

Table 1:The Mean of Variable in two groups with Statistical analysis

	Ringer Lactate	Starch	P value
Dranage in 6 hours	296	504	0.005
Dranage in 24 hours	668	1102	0.004
PTT differences	28	18	0.2
INR differences	0.5	0.6	0.91
PLT Count differences	105000	113000	0.85
Cr differences	0.19	0.28	0.7
U/O during Operation	780	460	0.04
U/O in 24 hours PostOP	1235	1283	0.8

Discussion:

Optimal solution for Initiating of CPB circuit is still controversial and a topic with much debate. (6) Although Crystalloid was the first Prime solution used, but recently there are many options for priming solution especially various types of Colloids. Any priming solution has its own advantages and disadvantages and also we have selected them due to many factors of patients. Volume replacement with colloids is considerably more expensive than with crystalloids (7). Clinical studies 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 as lowered compliance necessitate higher filling pressure to preserve the same function. (8)

Colloids that were used are: Albumin, Gelatin, Dextran and Hetastarch. (9) Colloids reduce the fall in Colloid osmotic pressure and may reduce the amount of fluid entering the extracellular space. (8) The question is whether or not clinical outcome is improved. Prospective clinical studies have failed to document significant clinical benefits with albumin, which may be expensive and may have adverse side effects. Hetastarch may contribute to postoperative bleeding. (10,11 and 12) McKnight and colleagues found no influences of Prime composition on postoperative nitrogen balance. Capillary perfusion and tissue oxygenation were significantly depressed in lactated Ringer's haemodiluted animals, as a result of interstitial edema. We hypothesized that, persistent anaerobic metabolism is a marker of inadequate intraoperative myocardial protection and may predict early post- operative left ventricular dysfunction. (11)

Conclusion:

We conclude that HES (130/0.4) solution is an alternative colloidal priming agent in Priming of Cardio-Pulmonary Bypass Circuit . We believe that between Ringer Laactate and Starch for Priming we have no significant differences in Tissue and Organ perfusion but Starch for Priming is with Coagulopathy and Excessive bleeding.

References:

1. Cristina T.Mora-Mangano. cardiopulmonary bypass and the anesthesiologists.
2. In: Kaplan's cardiac anesthesia. 5th ed. Philadelphia/ PA: Saunders; 2006.p.893-927.
3. Tiryakioğlu O, Yildiz G, Vural H, Goncu T, Ozyazicioglu A, Yavuz , S. Hydroxyethyl
4. Starch versus Ringer solution in Cardiopulmonary Bypass Prime solution. J Cardiothorac Surg 2008;3:45.
5. Baraka A,Barody N, Harous S, et all:Continuous venous oximetry during cardiopulmonary Bypass: Influences of Temperature changes, perfusion flow and hematocrite level. J Cardiothorac Anesth 1990;4:35.
6. Karanko MS, Klossner JA, Laaksonen VO. Restoration of volume by crystalloid versus colloid after coronary artery bypass: hemodynamics, lung water, oxygenation, and outcome. Crit Care Med ;15:559-66. [2436856]
7. Lang K, Boldt J, Suttner S, Haisch G. Colloids versus Crystalloids and Tissue Oxygen Tension in Patients Undergoing Major Abdominal Surgery. Anesth Analg 2001;93:405-9.
8. Pearson DT: Bllod gas control during Cardiopulmonary Bypass. Perfusion 1988;31:113.
9. Shapira O, Aldea G, Treanor P: Reduction of allogenic blood transfusion after open heart operation by lowering cardiopulmonary bypass volume. Ann of Thorac Surg 1998;65:724.
10. Boldt J:Vollume theraphy in cardiac surgery : Does the kind of fluid matter? J Cardiothorac Vasc Anesth 1999;13:752.
11. Hoeft A, Korb H, Mehlhorn U, et all:Priming of CPB with human Albumin or Ringer Lactate : effect on colloid osmotic pressure and extravascular lung water. Bar J Anesth 1991;66:77.
12. London MJ, Franks M, Verrier ED, et all: The safety and efficacy of ten percent penta starch such as a CPB priming solution: a randomized clinical trial. J Thorac Cardiovasc Surg 1992;1992:104:284.
13. Marelli D, Paul A, Samson R, et all: Does the addition of albumin to the Prime solution in Cardiopulmonary Bypass affect clinical outcome? J thorac Cardiovasc Surg 1989:98:751.
14. Scott DA, Hore PJ, Cannata J. et all: A comparison of Albumin, Polygeline and crystalloid priming solution for CPB in patients having Coronary Artery bypass surger . Perfusion 1995;10:415.