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Case Report

Severe hypoalbuminemia complicating a successful atrial switch operation (Senning) with cardiopulmonary bypass - report on a rare case

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ABSTRACT

Post-operative hypoalbuminemia has been reported in 12% of neonates and 20% of infants; 97% occurs in the first 48 hours in neonates and infants undergoing cardiac surgery with cardiopulmonary bypass (CPB). Perioperative hypoalbuminemia is not independently associated with any post-operative morbidity. However, when analysed as a continuous variable, lower serum albumin levels have been reported to be associated with increased post-operative morbidity. Pre-operative low serum albumin level is independently associated with increased odds of post-operative hypoalbuminemia, and prolonged length of hospital stay. Immediate post-CPB (0-24 hour), lower serum albumin level is independently associated with an increased duration of mechanical ventilation. There is a relative paucity of literature on the impact of hypoalbuminemia in the paediatric population. Hypoalbuminemia is a marker of poor outcome in critically ill children and those undergoing a wide range of medical interventions. Albumin infusions may be an effective therapy for fluid resuscitation and for patients with severe hypoalbuminemia. We present a successful perioperative management of a 3 months old-male child, weighing 3.5 kg with dextro-transposition of great arteries (D-TGA) with regressed LV undergoing an atrial switch (Senning) procedure, and uneventful intraoperative course i.e. easy weaning from CPB. However, in the ICU, the baby suffered an unusual complication as severe hypoproteinaemia resulting in acute kidney injury (AKI) with complete anuria, generalized anasarca, hypotension requiring inotropes and vasopressors, and difficult weaning from ventilator.

Keywords: D-TGA, Atrial switch procedure, CBP, Hypoalbuminemia, AKI, Hypotension, Pleural effusion, Albumin therapy

INTRODUCTION

Perioperative hypoalbuminemia can result in infants undergoing cardiac surgery using cardiopulmonary bypass. The predictors for development of hypoalbuminemia are preoperative hypoproteinaemia, large crystalloid prime volume, long duration of cardiopulmonary bypass (CPB), chronic kidney disease, previous cardiac surgery, and sepsis.[1,2] Severe hypoproteinaemia can result in acute kidney injury, sepsis, and difficult weaning from mechanical ventilation, and is a marker of poor postoperative outcome in the neonates and infants after cardiac surgery. Hypoalbuminemia following neonatal or infant cardiac surgery can be avoided by minimizing the prime volume to 75 ml to 95 ml, using albumin or fresh frozen plasma or blood for priming the CPB circuit. In addition, MUF can eliminate excess water and ameliorate inflammatory reactions, and considerable increases platelet count, haematocrit, plasma protein, prothrombin, factor VII, and fibrinogen levels

which may influence the complications, duration of mechanical ventilation, intensive care unit (ICU) stay, inotropic support, blood transfusions, and total hospitalization after complex congenital cardiac surgeries.[3] We describe a successful management of a 3 months old-male child, weighing 3.5 kg with dextro-transposition of great arteries (D-TGA) with regressed LV undergoing an atrial switch (Senning procedure), who developed an unusual complication in the ICU, i.e. severe hypoproteinaemia resulting in acute kidney injury (AKI) with complete anuria, generalized anasarca, difficult weaning from ventilator, and systemic hypotension requiring inotropes and vasopressors.

CASE REPORT

A 3 months-old, male child weighing 3.5 kg presented with cyanosis and laboured breathing since birth. Transthoracic echocardiography revealed situs solitus, levocardia, D-TGA with regressed left ventricle (D-shaped), IVS and MV causing left ventricular outflow tract (LVOT) obstruction (PG- 30 mmHg), mild central MR, 5 mm OS ASD with bidirectional shunt, coronaries were originating from the facing sinuses, trivial TR, and RA and RV dilated, aortic valve annulus 8 mm, pulmonary valve annulus 7 mm, mitral annulus 14 mm, tricuspid annulus 16 mm, small subaortic membrane/ muscle bundle seen at coaptation point of MV and IVS, left aortic arch, no LSVC, confluent good size branch pulmonary arteries and no PAH. The baby was referred to the CTVS department of super speciality hospital for further urgent surgical management. Preoperative haematological analysis revealed an haemoglobin (Hb) of 19.2 gm%, blood urea 34.7 mg/dl, S. creatinine 0.5 mg/dl, total proteins 6.52 gm/dl, with an A/G ratio of 2.18, (4.47/ 2.05), total bilirubin of 1.61 mg/dl, blood sugar of 98.1 mg/dl, PT (INR) value of 1.21, and the blood group - A positive was confirmed for the availability of the sufficient blood products. In view of the regressed and D shape LV, and non- availability of ECMO support, he was posted for the atrial switch (Senning, s) procedure after obtaining an informed consent from the parents. In OR, pulse oximetry revealed an SaO_2 of 84% and heart rate (HR) of 154 bpm. Standard ASA monitoring for paediatric patients undergoing complex cardiac surgery under CPB was employed. Inhalational anaesthetic induction was performed using Sevoflurane (5-7%) in 100% oxygen till intravenous access was achieved with 22G canula, then sevoflurane was switched off and anaesthesia was supplemented with fentanyl (5 mcg/kg), etomidate (0.3 mg/kg), and vecuronium bromide was used as a muscle relaxant to facilitate the endotracheal intubation with 3.5 mm, cuffed tube for intermittent positive pressure ventilation. 22 G leader Cath was inserted in the left femoral artery for beat-to-beat blood pressure monitoring and serial arterial blood gas analysis. A 4.5 FG triple lumen catheter was inserted via the left internal jugular vein for the CVP monitoring and the administration of various inodilators and vasopressors. A balanced general anesthesia was maintained with intermittent fentanyl, midazolam, sevoflurane and vecuronium bromide. Heparin 3 mg/kg was used to achieve an ACT of >480 seconds. Senning repair was performed under standard moderate hypothermic CPB (28°C) and potassium enriched (Del-Nido) cardioplegic myocardial protection. Priming of the CPB circuit with 250 ml of blood and patients' own blood; retrograde autologous priming (RAP) was used to avoid the deleterious effects of the haemodilution during CPB. Tranexamic acid (20 mg/kg) was used as an antifibrinolytic to prevent the bleeding. On CPB perfusion pressure was maintained between 35-60 mmHg and haematocrit of 35-40%. A spontaneous sinus cardiac rhythm developed after rewarming, and the weaning from the CPB was easy using infusions of milrinone (0.35-0.5 mcg/kg/min), dobutamine (2.5-5 mcg/kg/min) and nor-epinephrine (0.025-0.05 mcg/kg/min). Total CPB time and ischemia time were 188 min and 140 min respectively, and total urine output was 200 ml on CPB. Heparin was neutralized with protamine (1:1.3 ratio). The patient tolerated usual chest closure and shifted to the cardiac ICU for elective ventilation. Postoperative, pain management was achieved with intravenous paracetamol (7.5 mg/kg) and dexmedetomidine (0.5 mcg/kg) infusions. In the ICU, the patient became awake within 4 hours, however started developing generalized oedema and anuria after 24 hours.

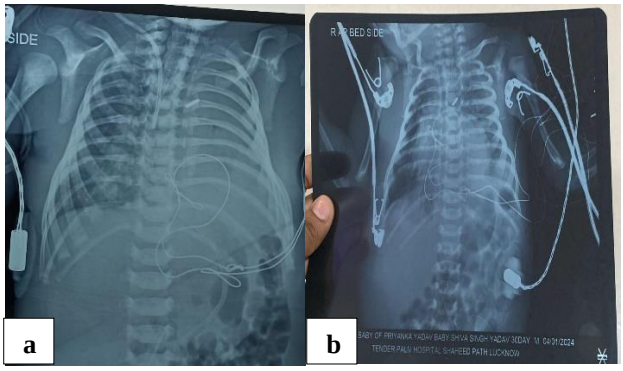

Figure 1: The postoperative chest X-ray (AP view) (a) taken after development of hypoalbuminemia syndrome shows left lung collapse along with pleural effusion, and mediastinum shifted to the right side requiring prolonged invasive and non-invasive (CPAP) mechanical ventilation and vigorous chest physiotherapy; and (b) shows almost normal lung fields without any collapse and pleural effusion, but cardiomegaly still can be observed. the recovery occurred after prolonged mechanical ventilation with IPPV and CPAP ventilation, and chest physiotherapy along with albumin therapy and inotropic support.

Transthoracic check echocardiography revealed good bi-ventricular functions and normal systemic and pulmonary venous baffle flows. However, serum proteins evaluation revealed severe hypoproteinaemia (2.1 gm%), precipitating the severe generalized anasarca and sudden anuria and so dopamine infusion @ 2.5 mcg/kg/min was also added along with 25% albumin with a maximum 2 g

of albumin per kg of weight per day. He also developed pleural effusion and pneumonitis and lung collapse requiring prolonged elective ventilation and intravenous antibiotic cover (Figure 1a) done in the postoperative period after development of hypoalbuminemia syndrome revealed evidence of left sided lung collapse and mediastinal shift to right side. In addition, peritoneal dialysis was also started in view of complete sudden anuria. On 3rd postoperative day urine output began and anasarca started regressing and tracheal extubation was performed on 5th postoperative day. However, the baby could not maintain the oxygen saturation and required an intermittent support with high flow non–invasive positive pressure ventilation for the next 2-3 days and His condition improved significantly, and finally weaned off ventilation and inotropes and vasopressors (Figure 1b). The chest X-ray (AP view) also revealed almost normal lung fields without any collapse and pleural effusion, but cardiomegaly still can be observed. The rest of the course was uneventful, and the patient was shifted to the step-down ICU on the 10th postoperative day.

DISCUSSION

Post-operative hypoalbuminemia has been reported in 12% of neonates and 20% of infants; 97% occurs in the first 48 hours in neonates and infants undergoing cardiac surgery with CPB.[1] The predictors of post cardiac surgery moderate to severe hypoalbuminemia are preoperative chronic kidney diseases, previous cardiac surgery, and long cardiopulmonary bypass time particularly in patients with cyanotic congenital cardiac anomalies. Large volume of crystalloid fluids in paediatric CPB priming causes marked hemodilution and fluid extravasation in patients undergoing cardiac surgery. On the contrary, priming with colloid solutions may reduce fluid overload because of a better volume expansion effect than crystalloids. The advancements in the pediatric oxygenators with integrated arterial filters; and miniature ultrafiltration devices allow flows up to 2 l/min, high rates of ultrafiltrate removal and significantly reduce cardiopulmonary bypass circuit surface areas and prime volumes. These advancements can reduce or eliminate the requirement for homologous red blood cells during or after surgery with reduction or eliminate bypass-related hemo-dilution, and inflammation. Predictors of moderate and severe hypoalbuminemia were preoperative chronic kidney disease, previous cardiac surgery, and longer CPB time.[2] Its potential causes may include haemodilution, destruction of immunoglobulin by CPB, and extravasation into the interstitial space due to systemic inflammation and capillary leak syndrome.[4] Pre-operative low serum albumin level has been independently associated with increased odds of post-operative hypoalbuminemia, and prolonged length of hospital stay. Extracorporeal oxygenation triggers a systemic inflammatory response that leads to endothelial damage and microcapillary leakage.[5] It is the main mechanism for capillary leakage of plasma, amino acids and protein into the extravascular space, which causes hypoalbuminemia. It is not known whether there is a concentration threshold for serum albumin levels below which clinical oncotic function is compromised; however, there is an agreement that oncotic activity remains physiologically acceptable at albumin levels greater than 2 g/dl and total proteins more than 3.5 g/dl. There is evidence that serum oncotic pressure close to 20 mmHg indicates a threshold below which the risk of complications increases.[6] We would like to conclude that human albumin or fresh frozen plasma may be necessary to prevent acute complications of haemodilution due to the prime solution but, it need future study for confirmation. Preoperative serum albumin levels <25 g/l has been associated with higher mortality risk (OR 2.0; 95% CI, 1.3–3.0; p=0.002) and a higher reoperation for bleeding. In addition, preoperative serum albumin levels <30 g/l has been as an independent risk factor for a prolonged ICU and in-hospital length of stay and a higher mortality compared with patients presenting normal albumin levels.[7] Immediate post-operative low serum albumin levels have been independently associated with an increased duration of mechanical ventilation, the postoperative tracheal intubation time, hospital stay, and significantly increased pulmonary infection.[8] The presented patient with severe postoperative hypoproteinemia also required a prolonged tracheal intubation and mechanical ventilation for approximately 72 hours, in addition he also developed the pulmonary infection and required antibiotics for two weeks. Some authors have reported that after cardiac surgery hypoalbuminemia can cause sepsis and AKI.[9] Davari and colleagues have measured serum albumin concentration prospectively in 300 children with congenital heart disease who underwent cardiac surgery and reported that hypoalbuminemia often occur on 2nd postoperative day, more common in male cyanotic children and a strong positive correlation between serum albumin levels and acute renal failure, pleural and pericardial effusion, seizures and death. However, in this study correlation between serum protein levels and delayed ICU and hospital stay could not be established.[10] This male baby also developed postoperative hypoalbuminemia within 24 hours, and pneumonitis, pleural effusion, lung collapse, systemic hypotension and acute AKI with complete anuria and generalized anasarca, and required peritoneal dialysis, multiple inotropes and prolonged mechanical ventilation for the management. In patients with AKI after cardiac surgery, renal replacement therapy should be performed as early as possible in order to achieve promising outcomes.[1] Henry et al have reported that post-operative hypoalbuminemia develops in 12% of neonates and 20% of infants; 97% occurs in the first 48 hours.[1] In a retrospective cohort study on on-pump cardiac surgery, the use of 5% albumin solution was associated with significantly decreased odds of in-hospital mortality and all-cause 30-day readmission rate compared with administration of crystalloids alone.[11,12] Kingeter et al and Vlasov et al have reported that both endogenous and exogenous albumin appear to be cardioprotective regarding CK-MBm release in on-pump cardiac surgery.[11,12] Albumin in CPB priming prevents CPB-

induced hypoalbuminemia and may reduce endothelial glycocalyx destruction and, thus, it may maintain better microcirculatory function.[13] In addition, such patients might develop severe systolic hypotension necessitates the administration of inotropes [epinephrine, dobutamine], calcium chloride [10 mg/kg] and a combination of vasopressors [noradrenaline, vasopressin] and reduction of doses of inodilators like NTG, milrinone, levosimendan and dobutamine to maintain the hemodynamics and tissue perfusion and to avoid the multi-organ failure. Matebele al have reported that 4% albumin exposure after cardiac surgery is not significantly associated with hospital mortality but has been associated with significant morbidity (bleeding, tamponade, return to theatre, and increased ICU and hospital LOS) and higher adjusted ICU and hospital costs.[14] A randomized controlled trial is required to determine whether albumin use is effective and safe in this setting.

The miniaturization of the pump circuit reduces the blood-circuit interface, leading to decreased CPB-related inflammation, lowered platelet aggregation, and activation of coagulation. The other miniaturization technique uses tubing with a minor diameter, such as the 1/8-inch, 3/16 inch, and 1/4-inch tubing usage in neonates. So, by employing these small tubing's priming volumes have reduced to 95 ml and 73 ml.[15,16] Such a perfusion protocol may be utilized in neonates and infants undergoing cardiac corrective surgeries to attenuate the development of perioperative hypoproteinaemia and its sequelae like the presented patient.

CONCLUSION

Occurrence and the degree of hypoalbuminemia in the postoperative of paediatric cardiac surgery is frequent and it may be associated with the development of several complications (especially sepsis or bleeding-related, AKI). This single case report suggests that post paediatric cardiac surgery severe hypoalbuminemia is a potential factor for development of anuria, generalised anasarca (AKI), systemic hypotension, pneumonitis, prolonged mechanical ventilation, ICU, and hospital length of stay. Such patients require more vigilant and aggressive intensive care management. Appropriately use of antibiotic, inotrope, vasopressors and 25% albumin administration, along with peritoneal dialysis and mechanical ventilation strategies play a great role for favourable outcome.

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REFERENCES

1. Henry BM, Borasino S, Ortmann L, Figueroa M, Rahman AKMF, Hock KM, et al. Perioperative serum albumin and its influence on clinical outcomes in neonates and infants undergoing cardiac surgery with cardiopulmonary bypass: a multi-centre retrospective study. Cardiol Young. 2019;29(6):761-7.
2. Berbel-Franco D, Lopez-Delgado JC, Putzu A, Esteve F, Torrado H, Farrero E, et al. The influence of postoperative albumin levels on the outcome of cardiac surgery. J Cardiothorac Surg. 2020;15(1):78.
3. Hu J, Li P, Chen X, Yan J, Zhang J, Zhang C. Effects of modified ultrafiltration and conventional ultrafiltration combination on perioperative clinical outcomes in pediatric cardiac surgery: A meta-analysis. Medicine (Baltimore). 2021;100(3):e24221.
4. Savluk OF, Ari A. OP04-1 - Clinical effects of serum albumin and globulin in pediatric cardiac surgery. J Cardiothorac Vasc Anesth. 2018;32(1):S41-2.
5. Liumbruno GM, Bennardello F, Lattanzio A, Piccoli P, Rossettias G. Italian Society of Transfusion Medicine and Immunohaematology (SIMTI). Recommendations for the use of albumin and immunoglobulins. Blood Transfus. 2009;7(3):216-34.
6. Russell JA, Navickis RJ, Wilkes MM. Albumin versus crystalloid for pump priming in cardiac surgery: metaanalysis of controlled trials. J Cardiothorac Vasc Anesth. 2004;18:429-37.
7. Koertzen M, Punjabi P, Lockwood G. Pre-operative serum albumin concentration as a predictor of mortality and morbidity following cardiac surgery. Perfusion. 2013;28:390-4.
8. Rapp-Kesek D, Stahle E, Karlsson TT. Body mass index and albumin in the pre-operative evaluation of cardiac surgery patients. Clin Nutr. 2004;23:1398-404.
9. Weimann A, Braga M, Carli F, Higashiguchi T, Hübner M, Klek S, et al. ESPEN guideline: clinical nutrition in surgery. Clin Nutr. 2017; 36:623-50.
10. Davari PN, MD, Tabib A, Ghaderian M, Givtaj N. Correlation of Post-Operative Hypoalbuminemia with Outcome of Pediatric Cardiac Surgery. Teh Univ Heart Ctr. 2009;4:234-9.
11. Kingeter AJ, Raghunathan K, Munson SH, Hayashida DK, Zhang X, Iyengar S, et al. Association between albumin administration and survival in cardiac surgery: a retrospective cohort study. J Can Anesth. 2018;65:1218-27.
12. Vlasov H, Talvasto A, Hiippala S, Suojaranta R, Wilkman E, Rautamo M, et al. Albumin and Cardioprotection in On-Pump Cardiac Surgery-A Post Hoc Analysis of a Randomized Trial. J Cardiothorac Vasc Anesth. 2024;38(1):86-92.
13. Zeng Y, Adamson R, Curry FR, Tarbell J. Sphingosine-1-phosphate protects endothelial glycocalyx by inhibiting syndecan-1 shedding. Am J Phys. 2014;306:H363-72.
14. Matebele MP, Ramanan M, Thompson K, Cornmell G, Naidoo RV, Shekar K, et al. Albumin Use After Cardiac Surgery. Crit Care Explor. 2020;2(7):e0164.
15. Redlin M, Huebler M, Boettcher W, Kukucka M, Schoenfeld H, Hetzer R, et al. Minimizing intraoperative hemodilution by use of a very low

priming volume cardiopulmonary bypass in neonates with transposition of the great arteries. J Thorac Cardiovasc Surg. 2011;142(4):875-81.
16. Boettcher W, Sinzobahamvya N, Miera O, Redlin M, Dehmel F, Cho MY, et al. Routine Application of Bloodless Priming in Neonatal Cardiopulmonary Bypass: A 3-Year Experience. Pediatr Cardiol. 2017;38(4):807-12.

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