

# Therapeutic Phlebotomy After Increased Central Venous Pressures During Pediatric Liver Transplantation

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## Abstract

A 16-year-old female was receiving a liver transplant for acute fulminant hepatic failure. During the post-hepatic phase there was an acute rise in central venous pressure (CVP) due to rapid reperfusion of blood from the dialysis machine. There was severe distention of the suture lines on the venous anastomosis. Immediate phlebotomy reduced the CVP and resolved the intravenous hypertension. Careful management of dialysis should prevent right heart failure during liver transplantation. Consideration should be given to phlebotomy in cases of severe acute elevation of CVP during liver transplantation.

## INTRODUCTION

Pediatric liver transplantation currently accounts for about 7.8% of all liver transplants in the United States (1). Central venous pressure (CVP) monitoring is essential to successful transplantation. Maintenance of low CVP by minimizing excessive intravenous fluids and transfusions decreases stress on venous suture lines and can lead to improved patient outcomes (2). Temporizing measures to reduce CVP include patient positioning, use of venodilators, and restriction of intravenous fluids and transfusion of blood components. Definitive treatment of a sudden CVP elevation is dependent upon the cause. In the case of an acute increase in CVP in conjunction with iatrogenic polycythemia, one possible treatment option is decreasing red blood cell volume (3). This can be emergently accomplished intraoperatively with therapeutic phlebotomy. We present the case of a 16-year-old girl who experienced sudden volume overload during a liver transplant and discuss the perioperative management of acute elevations in CVP.

## CASE DESCRIPTION

A 16-year-old female was admitted to the hospital with fulminant hepatic failure secondary to ibuprofen and iron tablet overdose. She presented with encephalopathy, AST/ALT > 25,000, INR >13.2, and oliguric renal failure for which continuous renal replacement therapy (CRRT) was started. The patient was evaluated and approved for status one liver transplant listing. A suitable organ became

available from a 35-year-old female who was injured in a motor vehicle accident. The patient was scheduled for cadaveric liver transplant and that evening was taken to the operating room. After induction of anesthesia and uneventful intubation, a large bore central line and right radial arterial line were placed.

During the transplant, the patient was placed on sustained low-efficiency dialysis (SLED) for renal failure thought to be secondary to hepatorenal syndrome (HRS). The transplant proceeded uneventfully, however during the neohepatic phase the case became complicated by increased bleeding. Surgical evaluation found significant bleeding at the splenic capsule. Despite multiple attempts at hemostasis and correction of any coagulopathy, the spleen was removed and the bleeding stopped. During abdominal closure, dialysis was discontinued. Without notification to either the surgical or anesthesia teams, the dialysis nurse re-infused all of the blood in the dialysis machine over 30 seconds. Central venous pressure (CVP) acutely increased from 10 to 24 mmHg. Due to tension at the site of the venous anastomosis, the surgeons requested maneuvers to immediately decrease the CVP. The patient was placed in reverse Trendelenburg position and 300 mL of blood was immediately withdrawn from the venous circulation using the internal jugular 9-french central line. The CVP rapidly decreased to 12 mmHg and the tension on the venous suture lines relaxed. The patient was taken back to the intensive care unit for postoperative care. Hematocrit at this time was 30%, which

was the target level.

## DISCUSSION

Central venous pressure (CVP) monitoring can provide important information regarding pressures in the venous circulation which are translated back to the newly transplanted liver, affecting the overall success of transplantation. This data can assist with intraoperative fluid management, optimizing transfusions and intravenous fluid restriction (2, 9). Studies have shown that maintaining low CVP (<5 cm H<sub>2</sub>O) during liver resections and liver transplantation reduces intraoperative blood loss, decreasing the need for transfusions and the risk of associated complications of fluid overload, such as right-heart failure, anastomotic compromise, and respiratory failure (3,5-9). Maintenance of a low CVP can be accomplished by minimizing intravenous fluids and blood products. Elevations in CVP should be recognized early and treatment to reduce the CVP should be expeditious. In this case the acutely elevated CVP was immediately recognized so a therapeutic option could be formulated. In various situations, phlebotomy has been increasingly used intraoperatively to decrease CVP and improve hemodynamically unstable states (2,8,9).

Polycythemia, a state of increased red blood cell mass, can be diagnosed when a patient's hematocrit reach levels of greater than 52% and 48% in men and women, respectively, or hemoglobin level of greater than 18.5 g/dL or 16.5 g/dL in men and women, respectively (8). Polycythemia in this case was due to iatrogenic administration of red blood cells from the rapid return of the volume in the dialysis circuit. Polycythemia can be problematic due to the associated hyperviscosity. Pathophysiologically in states of hyperviscosity, there is a reduction in blood flow often resulting in thrombosis and decreased capillary and organ perfusion, and thus organ congestion and failure. In the unanesthetized patient clinical signs of hyperviscosity include spontaneous mucosal membrane bleeding, visual disturbances, headache, vertigo, seizures, and even coma in severe cases. Under anesthesia most of these signs will not be apparent.

Polycythemia can have devastating consequences in general and specifically during liver transplantation. By promoting a pro-thromboembolic state, polycythemia and hyperviscosity can result in graft failure, cerebrovascular accidents, myocardial infarctions, renal failure, pulmonary embolism, splanchnic vessel thrombosis, and deep venous thrombosis.

A major concern of polycythemia and hyperviscosity during liver transplantation is hepatic artery thrombosis (HAT), resulting in graft loss and increased mortality. The overall incidence of HAT varies from 2% up to 9% and carries a 50% mortality with a 75% incidence of retransplantation (10). To avoid HAT, a normovolemic anemic state is desired during pediatric hepatic transplant with a goal to end the transplant with a hematocrit of 30%. Maintaining a normovolemic anemic state perioperatively not only reduces the incidence of HAT, but also minimizes the need for transfusions (6).

Therapeutic phlebotomy is an important treatment modality used for hyperviscosity caused by polycythemia (8). By decreasing blood viscosity within seconds to minutes, phlebotomy is a rapid and effective treatment modality during emergent situations such as described in this case. Phlebotomy has a role in many disease processes and has been in practice for years. Iatrogenic polycythemia due to massive overtransfusion treated with phlebotomy has been described in the literature (3). The use of intraoperative phlebotomy to emergently treat a sudden rise in CVP resulting from iatrogenic polycythemia during a pediatric orthotopic liver transplantation has not been described. Emergent intraoperative phlebotomy may be an effective and immediate treatment option for iatrogenic polycythemia resulting in elevated CVP during liver transplantation.

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