Goodbye, Preload: Hemodynamic Compromise During Liver-Kidney Transplant in a Child with Poorly Described Superior Vena Cava Occlusion

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Introduction

- Liver transplantation consists of three distinct stages
  - Stage 1: Recipient hepatectomy
  - Stage 2: Anhepatic phase
  - Stage 3: Reperfusion
- Inferior vena cava (IVC) crossclamping at the start of the anhepatic phase results in sudden loss of venous return from the lower body
- During this phase, maintenance of cardiac output depends on:
  - Venous return from the superior vena cava (SVC)
  - Collateral venous circulation
  - Adequate circulatory volume
- SVC occlusion can cause obstruction of blood flow from the SVC to right atrium, which leads to reduced venous return from the head neck, upper extremities, and dependence on collaterals
- Collaterals can enter the IVC at any level

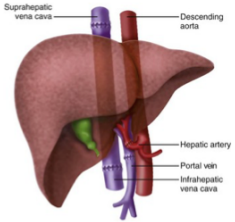

Figure 1. Classic interposition technique for orthotopic liver transplantation, with suture lines at suprahepatic and infrahepatic anastomoses of the IVC. From Starzl TE, Iwatsuki S, VanThiel DH, et al. Evolution of liver transplantation. *Hepatology* 1982, 2:614-36.

Case Description

A 6 year old, 17 kg female with liver failure secondary to congenital hepatic fibrosis and hemodialysis (HD)-dependent renal failure due to autosomal recessive polycystic kidney disease presented to our institution for a combined liver-kidney transplant. She was noted to have a stenotic SVC during a recent HD catheter exchange, attributed to multiple historic line placements. During transplant, preexisting vascular access was a tunneled right subclavian HD line. Induction of anesthesia was uneventful and femoral access was placed for intraoperative renal replacement therapy (RRT). Dopamine was started for hemodynamic support while volume was removed by RRT.

Case Description

After IVC clamping, oxygen saturation fell and pulse oximetry waveform became undetectable. This was accompanied by a decrease in end-tidal CO_2 from 28 mmHg to 13 mmHg. Mean arterial blood pressure decreased from 100 to 50 mmHg. These changes were communicated to the surgical team and an epinephrine infusion was started along with albumin volume resuscitation. Cardiology was called to perform an urgent transesophageal echocardiogram (TEE), which demonstrated underfilled right and left ventricles and normal systolic function, suggestive of insufficient preload. Additional albumin and packed red blood cells were given. Arterial blood gas showed pO2 within the normal range and a new metabolic acidosis, which was treated with sodium bicarbonate. Twenty minutes into the anhepatic phase, a waveform was detectable on pulse oximetry and end-tidal carbon dioxide and mean arterial pressures returned to pre-clamp values. After unclamping of the IVC, TEE showed normal biventricular size and global systolic function. The patient's subsequent postoperative course was uneventful.

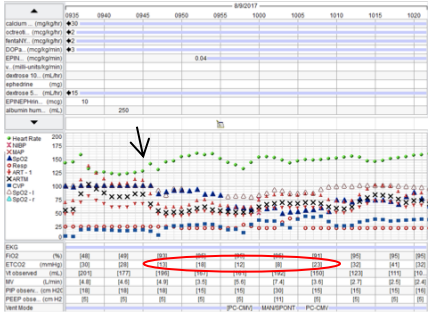

Figure 2. Patient's anesthetic record demonstrating sudden drop in blood pressure and end-tidal CO_2, decreased oxygen saturation readings, and CVP changes in response to IVC cross clamping. These changes consistent with hemodynamic collapse resolved after subsequent volume resuscitation.

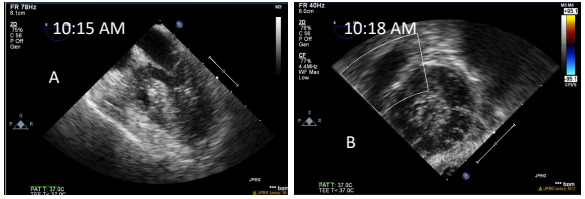

Figure 3. Intraoperative TEE images: Midesophageal four chamber view (A) and transgastric short axis view (B) demonstrating underfilled ventricles.

Discussion and Lessons Learned

- Multiple case reports describe SVC occlusion or syndrome complicating liver transplant
- Presence of SVC syndrome may warrant additional planning in cases when venous return is not expected to be sufficient
- TEE can be instrumental in guiding resuscitation and ruling out other causes of decreased cardiac output, such as air or pulmonary embolus
- Right heart catheterization and balloon occlusion test has been used for diagnosis and evaluation of congenital portosystemic shunts in children. This test could be used to predict the hemodynamic response to IVC clamping in such patients, however, this requires advance knowledge of SVC occlusion
- Veno-venous bypass or portocaval shunt are surgical management options that may be considered
- This case highlights the importance of an interdisciplinary approach to transplant evaluation in order to ensure comprehensive workup and timely consideration of surgical options and anesthetic plan

Figure 4. Demonstration of an IVC occlusion test using computed tomography angiography (sagittal view) in a patient with communication between superior mesenteric vein and IVC. The dotted circle shows the position of the balloon during the test. From Bernard O, Franchi-Abella S, Branchereau S, et al. Contenital Portosystemic Shunts in Children: Recognition, Evaluation, and Management. *Seminars in Liver Disease* 2012, 32(4): 273-287.

References

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