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Traumatic Suprahepatic inferior vena cava injury survival of a rare case

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ABSTRACT

Traumatic supra-hepatic inferior vena cava (IVC) injury is rare and nearly universally fatal. We report an excellent outcome from a case involving severe injury of the suprahepatic and intra-pericardial IVC utilizing emergency cardiopulmonary bypass (CPB) with deep hypothermic circulatory arrest.

The goal of this case report is to outline key factors that facilitated the patient's survival of extensive IVC injury. We conclude that aggressive prehospital fluid resuscitation, facile transfer to the operating room, early detection of anatomy and pathology of the injury, an early decision to call for perfusion and cardiothoracic surgery, and prompt blood transfusion were the key factors that allowed for the patient to survive without deficits.

Introduction

The inferior vena cava (IVC) is retroperitoneal and surrounding structures offer protection from trauma; however, should it sustain injury, its location can prove difficult for hemostasis and repair. Significant injury to the IVC carries exceedingly high mortality. Herein, we report a case of blunt trauma resulting in severe suprahepatic and retrohepatic IVC injury too extensive to be repaired with primary closure. Efficient prehospital care, trauma team activation, and operating room transfer led to quick diagnosis of the extent of the injury and need for cardiothoracic surgery assistance.

Case presentation

A 32-year-old man with history of left thoracotomy at age 6 for patent ductus arteriosus ligation was in a high-speed motorcycle crash. His rescue and transport to our Level I trauma center took approximately 1 h. Enroute he was given 1 l of crystalloid, 230 ml each of fresh frozen plasma and packed red blood cells, and 1 g of tranexamic acid. In our Emergency Department, blood pressure was 95/53 mmHg, heart rate was 118/min with normal sinus rhythm, Glasgow Coma Scale (GCS) score was 15. The patient complained of shortness of breath. Initial focused assessment with sonography for trauma (FAST) showed no significant intraabdominal free fluid but

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demonstrated a moderate pericardial effusion. Trauma series X-rays showed no significant findings except for mild superior mediastinal widening. Twenty minutes after arrival, the patient developed worsened shortness of breath and jugular veinous distention. Repeat FAST showed increased fluid in the pericardial space and the patient became hypotensive. The trauma team diagnosed cardiac tamponade pathophysiology, and the patient was taken to the operating room (OR).

Median sternotomy was performed immediately on induction of general anesthesia and blood in the pericardial space was evacuated. No injury was found on the anterior surface of the heart. Copious dark blood continuously welling up from the intra-pericardial IVC raised a clinical impression of a significant laceration of the IVC. The surgeon substantially decreased massive bleeding from the IVC by placing a hemostatic patch over the confluence of the IVC and the right atrium and holding it in place. The surgical team opened the abdomen and inspected liver, spleen, large and small intestine, but did not find any significant injury except for small lacerations of the liver. A supra-celiac aortic clamp was placed, and digital pressure was held over the IVC in the pericardium. The surgeon did not find any injury to the heart but noticed a large defect in the front of the IVC at its confluence with the right atrium. At that moment, the team realized the necessity of cardiopulmonary bypass (CPB) and called in a cardiothoracic surgeon (CT).

CPB was started immediately after the cardiac team arrived, and the IVC was explored (Fig. 1). The diaphragm was taken down to the caval hiatus to expose the entire supra-hepatic IVC. A substantial near-circumferential spiral tear was noted at the level of the diaphragm. Notably, the injury extended from the hepatic veins to the base of the right atrium at the level of the ostium of the coronary sinus (Fig. 2). There was no room to clamp the IVC, so deep hypothermic circulatory arrest (DHCA) was needed. While the patient was cooled to 18 °C, the CT surgeon started patching the posterior aspect of the IVC injury near the coronary sinus with a bovine pericardial patch. Once the target temperature was achieved, DHCA was initiated. A large Dacron tube graft segment was then used to reconstruct the IVC (Fig. 3). Care was taken not to introduce any redundancy or kinks in the patch. CPB was then restored with de-airing maneuvers and the patient was rewarmed to 36 °C. Once rewarmed, the patient was weaned uneventfully from CPB with support of epinephrine. Total CPB time was 130 min including 12 min of DHCA. Once hemostasis was achieved, the trauma team placed temporary abdominal and chest closure dressings.

During the surgery, a total of 13,000 ml of crystalloid, 13 units of PRBC, 13 units of FFP, 3 six packs of platelets and 1 dose of Prothrombin Complex Concentrate were given. Total urine output was 7000 ml, and estimated blood loss was 6000 ml. The patient was discharged to self-care with no lasting neurologic or physical deficits.

Discussion

IVC injuries from blunt trauma are rare, and the outcomes are poor. Supra-hepatic, intrapericardial IVC injuries are rarest among all types of IVC injury and are nearly universally fatal [1–4]. We attribute the successful outcome of this case to the following four factors:

1. Restrictive prehospital volume resuscitation with blood products. Vital sign stability on arrival is correlated with survival [1,2,5,6]. We believe this patient would have been more likely to die without early resuscitation. However, it is important to note that his resuscitation did not increase his systolic blood pressure above 96 mmHg, and we recognize that his management with a permissive hypotension strategy that favored blood products over crystalloids may be an important feature in his survival [7].
2. Early detection and treatment of tamponade. The ED team quickly recognized cardiac tamponade, which triggered the patient's rapid transition to the operating room.
3. Anticipation of cardiopulmonary bypass (CPB) and smooth transition from trauma to cardiothoracic surgery. Pericardial effusion is one of the clinical signs of supra-hepatic IVC injury, but is rare, especially in blunt trauma patients. However, the trauma team at our Level 1 trauma center has past experience with this injury pattern. The team used that experience to quickly transition to the use of CPB [8].

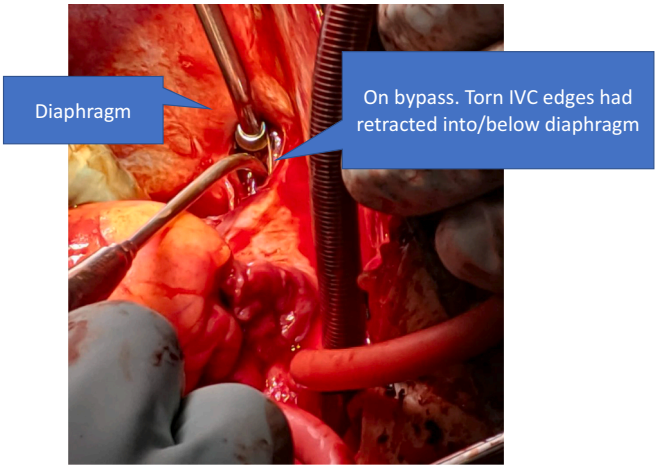

Fig. 1. View of injury at start of cardiopulmonary bypass (CPB).

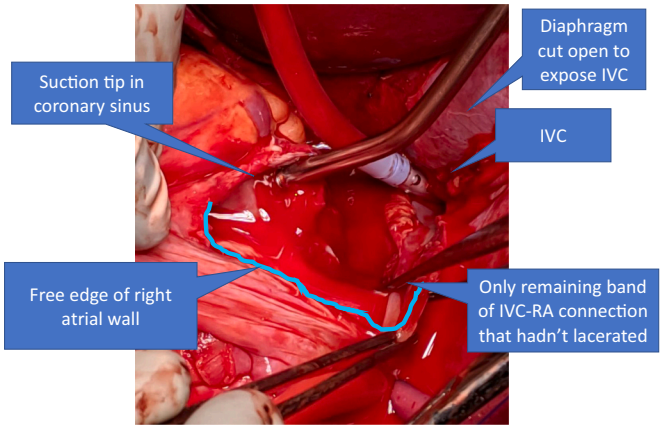

Fig. 2. Defining and exposing the extent of the inferior vena cava (IVC) injury on CPB.

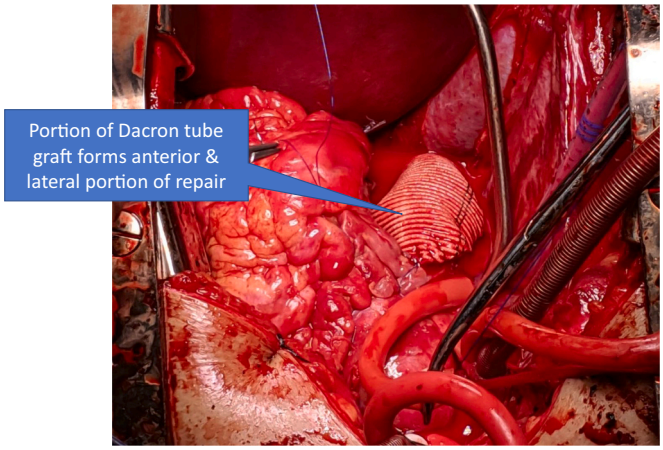

Fig. 3. Installation of the Dacron tube graft portion.

4. Aggressive intraoperative blood products administration based on 1:1:1 method and a low concomitant traumatic injury burden. The anesthesiologists initially guided blood product transfusion by laboratory data. However, the pathophysiology of this case changed quickly, and the laboratory data stopped reflecting real-time physiology. The anesthesiologists changed to a 1:1:1 ratio massive transfusion. The team gave 13 units of PRBC and FFP, 3 six packs of Platelets. It is still controversial whether 1:1:1 transfusion is superior to laboratory -guided transfusion in severe trauma [9]. However, it is likely that 1:1:1 transfusion contributed to a faster correction of coagulopathy.

The advantage and availability of CPB for life-threatening trauma cases in level 1 trauma centers has been reported [10], but is still controversial [8]. It must be noted that full dose heparinization is necessary for CPB, which may lead to significant bleeding from the other injuries in polytrauma patients. In this case, the trauma surgeon confirmed low risk for intraabdominal and pelvic hemorrhage by laparotomy, but intracranial bleeding risk was unknown. Since the patient had a GCS of 15 on arrival and IVC repair would not have been possible without CPB, we ultimately chose to proceed with heparinization.

Conclusion

Blunt traumatic injury to the supra-hepatic IVC is very rare, and survival rarer still. We conclude that relatively good health prior to injury and the key factors described above are essential for the survival. This case also highlights the need for efficient transfer to a trauma center capable of emergency cardiopulmonary bypass (CPB).

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