Successful repair of injured hepatic veins and inferior vena cava following blunt traumatic injury, by using cardiopulmonary bypass and hypothermic circulatory arrest

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Abstract

Traumatic injury to the retrohepatic veins continues to carry high mortality rates. In the last few decades various management strategies have been proposed. However, treatment of such injuries still remains highly variable and technically challenging due to the surgically inaccessible location of these vessels and the consequent difficulty controlling bleeding. We report a successful repair of complete transection of the two main extraparenchymal hepatic veins and laceration of the retrohepatic inferior vena cava using cardiopulmonary bypass (CPB) and hypothermic circulatory arrest (HCA) following blunt abdominal trauma. Immediate CPB with or without HCA can be life-saving and should be considered for patients with complex isolated retrohepatic venous injuries.

Keywords: Retrohepatic venous injury; Cardiopulmonary bypass; Hypothermic circulatory arrest; Inferior vena cava injury; Hepatic vein injury

1. Introduction

Injuries to the retrohepatic veins, that is, the retrohepatic vena cava or the major hepatic veins are highly fatal and represent a huge challenge due to the surgically inaccessible location of these vessels as well as the difficulty of controlling the bleeding in this area [1]. More than half of these patients are pronounced dead on arrival to the hospital, and it is not surprising that of those who reach the hospital with signs of life, mortality rates are also very high [2, 3].

This report describes a successful repair of complete transection of the two main extraparenchymal hepatic veins and laceration of the retrohepatic inferior vena cava (IVC) using cardiopulmonary bypass (CPB) and hypothermic circulatory arrest (HCA) following blunt abdominal trauma.

2. Case report

A 29-year-old Caucasian male was involved in a high-speed motor vehicle accident. At admission to the referring hospital, his vital signs included a pulse of 124 beats/min and blood pressure of 95/50 mmHg, which shortly afterwards dropped to 70/40 mmHg. The thoracic and abdominal computed tomography (CT)-scan showed peri-hepatic hematoma. CT head and spine were normal. In view of the hemodynamic instability of the patient, the general surgeons proceeded to urgent exploratory laparotomy to control the hemorrhage. The attempt was abandoned because it was impossible to control the bleeding due to large retrohepatic vessels involvement. The bleeding area was packed and the patient was immediately transferred to our hospital and was taken directly to the operating room. An attempt was made to remove the packs but profuse uncontrollable bleeding prohibited accurate evaluation. Pringle’s maneuver was attempted but failed to control the bleeding, thus retrohepatic venous injury was suspected. In view of the hemodynamic instability of the patient despite aggressive resuscitation, the area of injury was re-packed and preparations were made for initiation of CPB. Atrio-caval shunting was not attempted because the operating surgeon had lost two patients with a similar injury in the past. A median sternotomy incision was joined to the previous abdominal incision. An aortic cannula was placed in the ascending aorta, and two venous cannulas were inserted; one into the superior vena cava (SVC) and the other into the left femoral vein (Fig. 1). Two caval tapes, one in the SVC and the other in the proximal IVC, encircled the cavae and were secured with a tourniquet in order to occlude both cavae. Once CPB was established, the blood loss was reduced and the vascular injuries were assessed following mobilization of the liver by taking down the right and left triangular, coronary and falciform ligaments. The IVC was extensively lacerated with a 3 x 6 cm defect in the anterolateral walls. The two main extraparenchymal hepatic veins, right and left, were found to be completely transected. Most of the lower smaller hepatic veins had also been lacerated and were ligated with sutures.

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The 20-mm PTFE graft was distally anastomosed to the IVC, enclosing in the anastomosis the rim of the left hepatic vein, and was proximally anastomosed to the proximal IVC. (2) The 10-mm PTFE ring graft was anastomosed distally to the right hepatic vein and proximally to the right atrium, next to the atrial appendage. (3) An aortic cannula was inserted into the ascending aorta. (4) A venous cannula was inserted into the left femoral vein. (5) A venous cannula was inserted into the left femoral vein. (6) The proximal IVC was encircled with a tape, which was secured with a tourniquet. PTFE, polytetrafluoroethylene; IVC, inferior vena cava; SVC, superior vena cava.

Fig. 1. A schematic illustration showing the use of cardiopulmonary bypass and the end result of the two anastomoses. (1) The 20-mm PTFE graft was distally anastomozed to the IVC, enclosing in the anastomosis the rim of the left hepatic vein, and was proximally anastomozed to the proximal IVC. (2) The 10-mm PTFE ring graft was anastomozed distally to the right hepatic vein and proximally to the right atrium, next to the atrial appendage. (3) An aortic cannula was inserted into the ascending aorta. (4) A venous cannula was inserted into the SVC. (5) A venous cannula was inserted into the left femoral vein. (6) The proximal IVC was encircled with a tape, which was secured with a tourniquet. PTFE, polytetrafluoroethylene; IVC, inferior vena cava; SVC, superior vena cava.

Fig. 2. Abdominal CT-scan with contrast at two years postoperatively showing patent IVC graft (2), and the anastomosis with the left hepatic vein (1). The right hepatic–atrial graft (3) is completely occluded. CT, computed tomography; IVC, inferior vena cava.

It was deemed appropriate to proceed to HCA in order to adequately expose the retrohepatic veins for repair. The head was packed with ice and the patient was cooled to a nasopharyngeal temperature of 20 °C. Circulatory arrest commenced and the retrohepatic veins were exposed in a bloodless field. Grafting repair was initiated because primary repair was considered unfeasible. The lacerated segment of the IVC was repaired using a 20-mm polytetrafluoroethylene (PTFE) synthetic graft. The graft was distally anastomozed to the IVC, enclosing in the anastomosis the rim of the left hepatic vein (Fig. 1). It was planned for the right hepatic vein to be anastomozed to the right atrium using a 10-mm PTFE ring synthetic graft. In anticipation of this anastomosis the right hemidiaphragm was earlier divided for better exposure as well as to prevent any kinking or tension applied to the graft. The distal anastomosis of the 10-mm PTFE graft to the right hepatic vein was performed, and after 35 min, HCA was discontinued. During the re-warming period the proximal anastomoses were performed to the proximal IVC and the right atrium (Fig. 1). Before closing the laparotomy and median sternotomy incisions, the right hemidiaphragm was repaired around the 10-mm PTFE ring graft. Systemic heparin was used throughout the CPB and HCA period. In total, the patient received 18 units of packed red blood cells, six units of fresh frozen plasma as well as 14 units of platelets.

Postoperatively, the patient was started on anticoagulant medication (warfarin) with a target International Normalized Ratio (INR) 2–3 and had an uneventful recovery. He was discharged home in good health at day 20 and returned to his normal life activities after three months. Thoracic and abdominal CT-scan with contrast at one month and two years postoperatively showed patent IVC graft. Unfortunately, the right hepatic–atrial graft was only partially patent after one month and completely occluded after two years (Fig. 2). This, however, did not affect the venous drainage from the liver and liver function tests remained within normal limits.

3. Discussion

Isolated reports have described the use of CPB as an alternative strategy to direct suture repair of the venous injury with or without attempts at vascular isolation, aiming to decrease the blood return to the operative field, while maintaining the perfusion of the body [4, 5]. Total HCA has also been utilized in cases where a completely bloodless operative field was required [6–8]. Zogno et al. reported a successful repair of a traumatic rupture of the retrohepatic veins by performing a hepato–atrial anastomosis using CPB and HCA [8].

Based on the literature, our experience and the high mortality rates associated with the commonly used vascular isolation techniques, it was felt that in our case, their use...
would not adequately manage the uncontrolled bleeding, and the safest option would be to proceed straight to CPB. After CPB was established and the assessment revealed a complex retrohepatic venous injury, we realized that a bloodless field and superior exposure was required for rapid and safe repair with grafting. Several surgical techniques have been used for reconstruction of the IVC including patchy angioplasty and saphenous vein grafting but our decision to use PTFE grafts was based on their superior patency rates and rapidity of the repair [9, 10]. In addition, preoperative head, thoracic, abdominal and pelvic CT did not reveal any associated injuries that might have restricted the use of anticoagulation required intraoperatively and postoperatively.

In conclusion, we believe that immediate CPB with or without HCA can be life-saving and should be considered for patients with complex isolated retrohepatic venous injuries. These techniques should be used only when tamponade of the injuries has been induced by manual compression or gauze packing, giving thus sufficient time for the CPB to be established.

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