

# Vascular Injuries Associated with Major Liver Trauma: A Management Challenge

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## Abstract

Major vessel injuries (like inferior vena cava and hepatic veins) can be associated with severe liver injuries and are potentially devastating and associated with high mortality. Generally, major vascular injuries with hepatic trauma are caused by stabs and penetrating wounds, but we encountered two cases last year where severe liver injuries after blunt trauma were associated with injuries of the inferior vena cava in one and of inferior vena cava with hepatic veins in the other case. Emergency repair of inferior vena cava was done in the first case and initial packing followed by planned re-exploration after 24 hours was done in the second case after taking proper proximal and distal control. The first patient died on the seventh postoperative day due to multiorgan failure while the second patient recovered well without any residual complication. The cases are being reported to emphasize the fact that injuries of the retrohepatic vena cava and the hepatic veins still remain a challenge for the skills of even an experienced surgeon.

## INTRODUCTION

The liver is at high risk of injury and is the commonest organ to be injured after blunt trauma, since it is the largest parenchymatous organ. Very severe liver injuries (grade V) can be associated with concomitant injury to the hepatic veins or to the retrohepatic IVC and are more fatal despite advances in pre-hospital and in-hospital critical care. Should the patient survive and reach the hospital, the inaccessibility of the hepatic veins and the retrohepatic vena cava renders their surgical isolation and control extremely difficult. In such situations, the patient can be saved from exsanguinations only by tamponade achieved by tight sponge packing followed by planned re-exploration later. Knowledge of anatomy and exposure techniques for different parts of the IVC are important, not only for vascular surgeons but for general surgeons as well.

## CASE REPORTS

Case 1: A 25-year-old male was admitted to the emergency department with a history of blunt abdominal trauma by the handle of a motorbike. Since the patient was not haemodynamically stable, immediate midline exploratory laparotomy was done with a provisional diagnosis of haemoperitoneum. During exploration, about 2.5 litre blood was present in the peritoneal cavity, a deep laceration in the liver was noticed which was not bleeding actively but a torrential

venous bleed was seen from the retrohepatic portion of the IVC. A tight sponge packing and compression of the liver was done for about 10 minutes for stabilisation of the vital parameters. In the meantime, Kocherisation of the duodenum was done and suprarenal IVC control with vascular clamps was carried out. After removal of the packing, a Foley's catheter was inserted in the rent and the balloon was inflated by 30 ml normal saline, but adequate haemostasis for exposure and repair could not be achieved. Incision was extended to right anterior thoracotomy, the pericardium was opened and clamping of the supradiaphragmatic IVC was done just below the junction to the right atrium after diaphragmatic incision up to the vena cava hiatus and after complete division of the triangular, coronary and falciform ligaments of the liver. Pringle's maneuver was also applied.

After applying these measures, an oval clean rent of 1x3 cm was identified in the anterior wall of the retrohepatic IVC, which was repaired by direct continuous sutures by 5-0 prolene. Total occlusion time was 15 minutes. Adequate haemostasis was achieved. All three hepatic veins were normal. The rest of the abdominal cavity was normal except for a liver laceration with contusions. During this procedure a total of seven units of whole blood were transfused. Recovery from general anaesthesia was delayed for about 12 hours because of pulmonary oedema developing as a result

of rapid infusion of intravenous fluids and blood. The patient was kept in the respiratory intensive care unit (RICU) for intense care and close monitoring. He developed oliguria on the third postoperative day and developed full-blown ARDS by the fifth postoperative day for which he was reintubated. The patient could not be saved and succumbed to the secondary complications of major surgical exploration and exsanguinations leading to death on the seventh postoperative day.

Case 2: A 28-year-old male sustained blunt abdominal injury in a road side accident, when his car banged into a truck. He was brought to the emergency department of our hospital within one hour of the accident. On examination, he was pale and his blood pressure was 90mm of Hg. A provisional diagnosis of haemoperitoneum was made and immediate laparotomy was planned. On exploration, about two litres of blood were found in the abdominal cavity with a deep laceration in the liver with some amount of active bleeding. Bleeding from liver lacerations was controlled by packs, then the liver was retracted downwards and a gush of venous blood was seen emanating from the central area posterior to the liver. So a presumptive diagnosis of retrohepatic IVC injury was made and bleeding was immediately controlled by tight sponge packing behind the liver, followed by temporary abdominal closure. The patient was shifted to the ICU, resuscitated, rewarmed and preparations were started for definite surgery.

After 24 hours, the patient was reexplored with same midline incision in an elective operation theatre under optimal O.T. conditions. Incision was extended to right thoracotomy and the pericardium was opened for supradiaphragmatic control of the IVC. The rest of the procedure was similar to that of case 1. In this case, there was a 2cm rent in the anterior wall of the IVC with rents of about half a centimeter each in the right and middle hepatic veins. All these injuries were repaired by 5-0 prolene sutures by direct continuous suturing in two stages. First, the rent of the IVC was repaired for which occlusion time was 10 minutes, then all clamps were released and the area was packed again for 10 minutes. Next, the hepatic veins were repaired after removal of the packs, occlusion time for which was about 15 minutes. Adequate haemostasis was achieved. During both explorations and resuscitation in the ICU, a total of nine units of whole blood were consumed. Recovery from general anaesthesia was smooth, but the patient was kept in ICU for close monitoring for two days, after which he was shifted to the general ward. Postoperatively, he had a biliary leak from the lacerated liver

bed, which healed spontaneously after three weeks.

### **DISCUSSION**

Extensive liver lacerations, i.e. grade V injuries, are often associated with major vascular injuries, i.e. injuries of hepatic veins or of the retrohepatic vena cava. When they occur after BAT, these injuries are potentially fatal but because of better facilities of transport and better prehospital care many of them have started reaching the hospital. Before World War II, major liver injuries were treated by packing only. Kennedy and Madding recommended liver resection as a primary treatment for major hepatic injuries.<sup>1</sup> In the next few years, large trauma centers reported their extensive experiences with hepatic resections but mortality rates were very high and averaged ~ 50%. As a consequence of high mortality associated with resection, packing was reintroduced in the 1980s.<sup>1</sup> Recently, two significant events have changed the approach to major hepatic trauma. As a result of pioneer work in surgical anatomy of the liver, there has been a surge of elective hepatic resections. The second factor influencing liver surgery has been the liver transplant operation, which has particularly influenced the surgeons' ability to perform hepatic isolation procedures.<sup>2</sup>

Overall, the IVC is the most commonly injured intra-abdominal vessel accounting for 25% of all vascular injuries; blunt trauma accounts for 10% of these injuries and the remaining ones are caused by penetrating injuries.<sup>3</sup> Isolated injuries of the IVC are rarer after blunt trauma because of its protected position deep within the abdominal cavity and generally are associated with major liver trauma. An injury of the IVC can occur in two regions: infrarenal and suprarenal or retrohepatic vena cava. It is the retrohepatic vena cava, which is typically injured in blunt abdominal trauma and it is this portion of the IVC which is most difficult to expose. This segment receives the hepatic veins, which are short and fragile. Exposure can be achieved by Kocherisation of the duodenum, medial mobilisation of the ascending colon and division of hepatic ligaments. Extension of the laparotomy to median sternotomy or right thoracotomy with radial incision of diaphragm up to the vena cava hiatus is sometimes required, as in our cases.<sup>4</sup>

In our opinion, extension towards right thoracotomy is easier and gives adequate control and exposure for the RA-IVC junction. Median sternotomy needs electric saw and time for arrangements and does not add to exposure for control. Complete isolation of the liver from the circulation for hepatic venous bleeding prevention is achieved by occluding

the hepaticoduodenal ligament with a clamp or fingers, Pringle's maneuver.<sup>5</sup> For vascular isolation of the liver, various techniques and modifications have been described, but none seems to be satisfactory as far as survival is concerned.<sup>6</sup> One should not hesitate to cross-clamp the vein proximally and distally since a reversal of flow has already occurred as a result of massive venous injury distally.<sup>7</sup>

The crucial factor in the management of IVC injuries is rapid and effective control of bleeding, whether from caval or associated injuries. The mortality rates in such injuries are very high, ranging from 60-70% and death after reaching the hospital is generally caused by intraoperative exsanguination.<sup>6</sup> Prolonged operative time and persistent bleeding lead to the lethal triad of coagulopathy, acidosis and hypothermia, resulting in very high mortality, as happened in our first case. The most reliable method for immediate control of venous bleeding and to prevent these lethal complications is tamponade achieved by tight sponge packing followed by temporary closure. The patient is then resuscitated to normal physiology in the ICU and subsequent re-exploration with definitive repair is done after 24 hours, as was done in the second case of our study. This approach, i.e. rapid initial control of haemorrhage, resuscitation to normal physiology in the ICU followed by re-exploration and definitive repair later, is known as Damage Control Surgery and it significantly reduces mortality in these cases.<sup>8</sup>

In the end, it is concluded that:

- Management of patients with major hepatic trauma associated with retrohepatic IVC and hepatic veins injury remains a challenge to the skills of even an

experienced surgeon.

- Knowledge of the anatomy and exposure techniques for different parts of the intraabdominal IVC is very important to all surgeons.
- Emergency Damage Control Surgery, i.e. immediate packing, appropriate resuscitation and definitive repair after 24 hours, definitely reduces mortality in such cases.

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