

# CASE REPORTS

## THE RIPPED CAVA

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**Lacerations of the inferior vena cava are associated with a high mortality and may be difficult to repair. The majority of injuries are due to penetrating trauma. Rapid transportation to definitive surgical care with effective resuscitation may improve mortality. Surgical management includes adequate treatment of hypovolemic shock due to blood loss. Placement of intravenous infusion sites below the level of the diaphragm may be effective. Operative control of the inferior vena cava can be accomplished by directed digital compression followed by a proximal and distal control. Injuries of the inferior vena cava above the level of the renal veins are associated with an increased mortality. Retrohepatic and subdiaphragmatic injuries are highly lethal. This article discusses appropriate surgical approaches for repair of the inferior vena cava above and below the diaphragm. (*J Natl Med Assoc.* 1995;87:305-307.)**

**Key words** • vena cava • inferior vena caval injury

The ripped vena cava is a surgical challenge, and lacerations of this large venous conduit are associated with a high rate of mortality.<sup>1</sup> Many victims will succumb prior to rescue and definitive treatment. Of those who survive, mortality is approximately 37%.<sup>2</sup>

The majority of injuries to the inferior vena cava (IVC) are due to penetrating trauma.<sup>3</sup> Only 10% of

these injuries will be caused by blunt trauma. This may be due to the fact that the IVC is a retroperitoneal organ and is therefore relatively protected from injury. Injury as a result of blunt trauma would only result from a force of great magnitude. For this reason this type of injury probably is underrepresented among hospital admissions.

It has been speculated that an effective paramedic system may deliver more potentially salvageable patients with severe injuries, since a blood pressure of 60 mm Hg or less recorded in the emergency department is associated with early management of shock with aggressive fluid administration and rapid transportation for definitive care by surgeons.

### ANATOMY

The inferior vena cava lies within the retroperitoneum of the abdomen for most of its course. It is longer than the aorta and begins just below the aortic bifurcation, posterior to the right common iliac artery. It runs in close proximity to the lumbar spine, and receives four pairs of short, thin-walled lumbar veins posterolaterally. Also, the inferior vena cava overlies the right crus of the diaphragm behind the bare area of the liver, before piercing that structure at approximately the eighth thoracic vertebra. The supradiaphragmatic IVC is short and terminates in the right atrium after entering the pericardium.

The major lateral tributaries of the inferior vena cava include the common iliac veins, the right gonadal veins, the renal veins, and the right adrenal vein. There are no anterior tributaries except for the three hepatic veins.

### SURGICAL MANAGEMENT

Initial management involves the treatment of hypovolemic shock due to blood loss with adequate volume replacement. The traditional approach dictates the use of at least two large bore venous cannulas in the upper extremities. Balanced salt

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solution is recommended for initial use. If there is limited response, then packed red blood cells are given as standard practice. Clinical experience and animal studies have indicated that lower limb venous access may be effective even with an inferior vena cava laceration.<sup>5</sup> As with any case of exsanguinating intraabdominal hemorrhage, left thoracotomy with cross clamping of the descending thoracic aorta may allow partial resuscitation of the deeply hypotensive patient.<sup>6</sup> Success will depend on a number of factors, which include the ability to maintain adequate coagulation parameters, avoidance of hypothermia, and correction of acidosis. A search for and control of associated active arterial hemorrhage should be a first priority before addressing the suspected injury of the inferior vena cava.

Signs of and injury of the vena cava may be subtle, as there may be a partially tamponading hematoma surrounding the vessel in the retroperitoneum. This will mask the injury until unroofed. Alternately, there may be no doubt of the source of hemorrhage, as evidenced by the welling up of copious quantities of venous blood from the retroperitoneal area.

Current principles encourage exploration of all retroperitoneal hematomas above the level of the pelvis. If there is suspicion that the inferior vena cava is lacerated, it would be advantageous to have obtained prior proximal and distal control of the vessel.

Practically speaking, this may entail digital pressure over the suspected area of the injury followed by dissection and occlusion of the vessel proximally and distally. Occasionally, this can be accomplished through the root of the mesentery of the right colon. Better security may be gained, however, by more extensive exposure. This is obtained by mobilizing the right colon from the right paracolic gutter and elevating the duodenum by a Kocher maneuver. If the aorta has been explored on the left, this may allow limited access to the IVC across the midline.

There is a clear distinction between injuries which have occurred below the renal veins and those above. In a study of 77 patients with IVC injury at Grady Memorial from 1972 to 1983, the mortality of infrarenal and suprarenal injuries was 22% and 33%, respectively. Retrohepatic and supradiaphragmatic injuries each had a 67% fatality.<sup>7</sup>

Burch et al,<sup>8</sup> in reviewing an 11-year experience with 31 patients sustaining juxtahepatic venous injuries, including injuries to the vena cava, emphasized that these injuries are highly lethal.

### **Infrarenal IVC Injuries**

Infrarenal lacerations are best controlled proximally and distally with vascular loops, with care being taken to avoid damage to the lumbar veins. Repair is best accomplished by lateral venorrhaphy. The suture of choice for all repairs to the inferior vena cava is 4-0 nonabsorbable vascular monofilament. If repair cannot be accomplished, the infrarenal vena cava may be ligated. This may result in lower limb venous hypertension, but the morbidity associated with this is often short-lived.

### **Suprarenal IVC Injuries**

Suprarenal injuries, similarly, should be repaired. Control will necessitate dissection of the renal veins and encirclement with vascular loops. Posterior lacerations in the vena cava are best repaired through an anterior aperture, which may often be created by extending the corresponding traumatic laceration.

### **Retrohepatic IVC Injuries**

Retrohepatic injuries technically are the most challenging. These injuries present difficulties with exposure, since they are located behind the liver in an area of vessel, which is difficult to mobilize. Techniques to allow vascular isolation of the region, without embarrassing venous return to the heart, have involved the placement of various types of shunts. Most commonly, an atrio-caval shunt is fashioned from a perforated length of tubing and is secured with tourniquets placed above the diaphragm and above the renal veins. This necessitates a thoracotomy for placement.<sup>9</sup> Alternatively, a balloon-caval shunt may be introduced via the femoral vein in the groin.<sup>10</sup> More adventuresome techniques, such as mobilization of the liver by transecting the suprahepatic vena cava and rotating the liver anteromedially, have been proposed, but have not achieved clinical success to date.<sup>11</sup>

### **Complications**

Venous complications after repair, as well as long-term mortality, are rare. Venous thromboembolism has been recorded.<sup>12</sup>

### **CONCLUSION**

Injuries of the inferior vena cava continue to provide trying experiences for even the accomplished trauma surgeon. Lacerations of this vessel indicate a profound level of injury, and despite continued advances in technical capability, the resulting mortality remains high.

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