

# Traumatic Injury to the Portal Vein

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Traumatic injuries to the upper abdominal vasculature pose difficult management problems related to both exposure and associated injuries. Among those injuries that are more difficult to manage are those involving the portal vein. While occurring rarely, portal vein injuries require specific therapeutic considerations. Between January, 1968, and July, 1974, over 2000 patients were treated operatively for abdominal trauma at the Ben Taub General Hospital. Among these patients, 22 had injury to the portal vein. Seventeen portal vein injuries were secondary to gunshot wounds, 3 to stab wounds, and 2 to blunt trauma. Associated injuries to the inferior vena cava, pancreas, liver and bile ducts were common. Three patients had associated abdominal aortic injuries, two with acute aorto-caval fistulae. Nine patients died from failure to control hemorrhage. Eleven were long-term survivors, including two who required pancreatoduodenectomy as well as portal venorrhaphy. Late complications were rare. The operative approach to patients with traumatic injuries to multiple organs in the upper abdomen, including the portal vein, requires aggressive management and predetermined sequential methods of repair. In spite of innumerable associated injuries, portal vein injuries can be successfully managed in a significant number of patients using generally available surgical techniques and several adjunctive maneuvers.

**T**RAUMATIC INJURIES to the portal vein rarely have been reported alone, although they have been cited among reports of injuries to the aorta and vena cava.<sup>1,9,14,17</sup> Chisholm<sup>5</sup> reported three cases of traumatic injury to the portal vein with two survivors, and Fish<sup>7</sup> reported 38 patients with neoplasia or trauma involving the portal vein which required vascular reconstruction. The portal vein, surrounded by other major vessels, as well as the liver, duodenum, pancreas, stomach and colon, rarely is injured without extensive associated injury to surround-

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ing organs. This report summarizes experience with 22 such injuries over a 6½ year period.

## Clinical Material

Between January, 1968, and July, 1974, over 2000 patients were treated operatively for abdominal trauma at the Ben Taub General Hospital in Houston, Texas. Among these patients, 22 were found to have injuries to the portal vein. Nineteen were male, and the average age was 29 years. Gunshot wounds accounted for 17 of the injuries, stab wounds for 3, and blunt trauma was the etiology in 2 patients. They received an average of 14.4 units of blood. Fourteen of the 22 patients had blood pressures lower than 80 mmHg systolic at the time of arrival at the hospital. All patients had one or more associated injuries (Table 1). Repair was accomplished by lateral venorrhaphy in 12 patients, and the portal vein was ligated in 4. In 4 patients the portal vein was clamped or packed during unsuccessful resuscitation and repair was not attempted. In one patient an end-to-end anastomosis was performed, and a portocaval shunt was done in one patient (Table 2). In three patients intracaval shunts were helpful in control of exsanguinating hemorrhage, and in two patients a pancreaticoduodenectomy was required because of extensive associated injury to the head of the pancreas. Those organs most commonly injured in association with portal vein injury included the inferior vena cava, liver, pancreas, stomach, kidney and various vessels in close proximity to the portal vein (Table 3). Associated vascular injury occurred in 20 of the 22 patients, the inferior vena cava being the most commonly injured (Table 4). Three patients had associated abdominal aortic injuries, two with acute aorto-caval fistulae.

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TABLE 1. Number of Associated Organs Injured

Number of Injuries	Number of Patients
1	1 (0)
2	5 (2)
3	4 (3)
4	3 (2)
5	6 (3)
6	2 (0)
8	1 (1)

( ) = Survivors

### Results

Eleven of the 22 patients survived portal vein injury. The most common causes of death among the 11 patients who did not survive were failure to control hemorrhage and disseminated intravascular coagulopathy, the latter secondary to multiple organ system injury, massive blood transfusions and accompanying hypothermia. Six of 7 patients who arrived with no discernible blood pressure died, while 4 of 7 patients who arrived with blood pressures less than 80 mmHg systolic died. Severity of injury to associated organs, rather than the number of associated organs injured, contributed most significantly to deaths (Table 1). All patients who had packing, clamping or ligation of the portal vein in an attempt to control blood loss during resuscitation died of massive associated injuries. Seven complications occurred among 6 of the 11 survivors (Table 5). These included pancreatic pseudocyst, cholangitis, and respiratory insufficiency in one patient each. All 11 surviving patients were doing well when last seen in the clinic.

### Discussion

Oré,<sup>13</sup> in 1856, observed that sudden occlusion of the portal vein resulted in death in the experimental animal. Deaths following acute ligation of the portal vein were thought to result from systemic hypotension and portal congestion,<sup>2,8</sup> although, in the monkey, demonstrable collaterals rapidly developed with resultant survival.<sup>12</sup> In the human, ligation of the portal vein for both traumatic

TABLE 3. Associated Injuries

Injury	Number of Patients
Inferior vena cava	15
Liver	13
Pancreas	7
Stomach	6
Kidney	5
Renal Vessels	5
Superior Mesenteric Vessels	5
Aorta	3
Hepatic artery	3
Common bile duct	3
Small bowel	3
Duodenum	3
Spleen	2
Colon	2
Lung	1
Heart	1
Flail chest	1
Celiac axis	1
Hepatic vein	1
Gallbladder	1
Middle colic artery	1
Central nervous system	1

injury and following resection of tumor invasion has been reported.<sup>5,7</sup>

The portal circulation, the principal afferent blood supply to the liver provides up to 80% of the oxygen transport to the liver.<sup>16</sup> Child<sup>4</sup> postulated that 80% of human subjects could tolerate acute occlusion of the portal vein, and provided experimental observations of physiologic events which occur with portal vein ligation. These included immediate drop in blood pressure to 30 mmHg with return to normal in 30 minutes, an immediate increase in portal vein pressure to 35 cm of saline, and a decrease in liver volume. He further observed that 10 days after ligation there were normal liver function tests with normal liver biopsy and no thrombotic episodes. There was subsequent development of collaterals in his experimental models, consisting of pelvic collateralization immediately, small hepatic hilar vessel collateralization in one month, and large hilar collateralization in 4 to 6 months.

TABLE 2. Methods of Management

Method	Number of Patients
Lateral Repair	12 (9)
Intracaval shunt	3 (2)
Whipple operation	2 (2)
Ligation	4 (0)
Clamped or Packed	4 (0)
End-to-end Anastomosis	1 (1)
Portacaval Shunt	1 (1)

( ) = Survivors

TABLE 4. Associated Vascular Injury

Injury	Number of Patients
Inferior vena cava	12
Renal vein	4
Inferior vena cava and aorta	3
Superior mesenteric artery	3
Hepatic artery	3
Superior mesenteric vein	2
Renal artery	1
Hepatic vein	1
Middle colic artery	1
Celiac axis	1

TABLE 5. *Complications Among Survivors*

Complication	Number of Patients
Pancreatic fistula	2
Subphrenic abscess	2
Pancreatic pseudocyst	1
Cholangitis	1
Respiratory insufficiency	1

Portal hypertension may develop following ligation of the portal vein, as demonstrated experimentally by Child.<sup>4</sup> Patton<sup>15</sup> described two patients with portal vein injuries treated with apparent ligation who later required decompressive procedures to relieve portal hypertension. Occasionally, late bowel infarction may occur following portal vein ligation in human subjects and this has been attributed to mesenteric venous obstruction.<sup>4</sup>

Fish<sup>7</sup> reviewed 6 methods of reconstruction of the portal vein. These included lateral repair, end-to-end anastomosis, ligation, portacaval shunt, splenic vein to superior mesenteric vein anastomosis following ligation of the hepatic end of the portal vein, and prosthetic graft interposition. McClelland<sup>10</sup> has recommended use of autogenous vein graft interposition, portacaval shunt and use of ligation if the general condition of the patient does not permit complicated reparative techniques. With extensive destruction of the portal vein, an alternative to portacaval shunt might be ligation of the portal vein and insertion of a superior mesenteric vein to vena cava shunt using a Dacron prosthesis. However, 4 of 5 patients reviewed by Fish<sup>7</sup> who had portacaval shunts for portal vein reconstruction had either hepatic decompensation or encephalopathy. These late complications were not observed in patients with portal vein ligation alone.

When traumatic injury to the portal vein is encountered, a variety of treatment options are available. A flexible but programmed approach should be employed. lateral venorrhaphy is preferred, if possible, with portal-systemic decompression an alternate method of management. Should extensive associated injuries be present, ligation, clamping or packing of the portal vein may allow for salvage of the patient. Ligation of the portal vein, although it may result in portal hypertension, is compatible with patient survival in approximately 80% of the cases.<sup>4</sup>

As associated injuries are common,<sup>5,9</sup> early assessment of the injury, control of hemorrhage by available techniques including intercaval shunt,<sup>3</sup> temporary occlusion by Fogarty balloons<sup>10</sup> and the use of vascular clamps may be helpful while repairing other more crucially injured organs or vessels. Since portal vein injuries usually are associated with other major vascular injuries, a search should be made for such an injury in all cases of upper abdominal vascular trauma.<sup>11</sup> Likewise, in those

patients in whom a portal vein injury is found, assessment of all vessels in close proximity is mandatory, as unrecognized injury may result in delayed appearance of vascular fistulae.<sup>6</sup>

Adjunctive techniques may be helpful in the management of patients with portal vein injuries. Intracaval shunts aid in control of hemorrhage in the patient with massive liver, hepatic vein, and suprarenal vena caval injuries which occur in association with portal vein injuries.<sup>3</sup> Fine screen filtration\* of banked blood to reduce post transfusion pulmonary insufficiency and autotransfusion of shed blood have been useful in the management of patients with major vascular trauma.<sup>11</sup> Consideration of factors such as these and an aggressive sequential plan of management should allow salvage of a significant number of patients with portal vein injury.

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