Management and Outcome of Patients With Combined Bile Duct and Hepatic Artery Injuries

Navyash Gupta, MD; Harvey Solomon, MD; Ralph Fairchild, MD; Donald L. Kaminski, MD

Background: Major bile duct injury is an important therapeutic problem that can be associated with simultaneous injury to the hepatic artery. Limited information exists regarding the course of patients who have combined bile duct and arterial injuries.

Objective: To compare the management and outcome of isolated bile duct injuries with bile duct and hepatic artery injuries.

Patients and Methods: Since 1991, 13 patients have undergone reconstruction of right and left hepatic confluence or proximal bile duct injuries. At the time of bile duct injury, 4 of these patients had simultaneous occlusion or extirpation of the right hepatic or common hepatic artery. All patients underwent reconstruction of the biliary tract with hepaticojejunostomies. The immediate and long-term outcomes of the patients with and without hepatic artery injury were compared.

Results: In the immediate postoperative period, 3 of 4 patients with combined injuries had hepatic necrosis and/or abscesses with 2 patients requiring transcutaneous or operative drainage. This problem was not diagnosed in patients with isolated bile duct injuries. None of the biliary anastomoses have failed in the patients with isolated bile duct injuries while 50% of the anastomoses in patients with combined injuries have caused recurrent problems following reconstruction.

Conclusion: Patients with major bile duct injuries should be evaluated for concomitant hepatic arterial injury as management and outcome may be influenced by the absence of arterial blood flow to the injured bile ducts and to the liver.

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REPORT OF CASES

CASE 1

A 44-year-old woman (patient 11) underwent laparoscopic cholecystectomy followed by laparotomy because the specimen appeared to include the common bile duct. The surgeon identified the injury and placed drains into the area and transferred the patient the next day. The surgeon did not describe bleeding during the procedure, did not mention hepatic artery injury, and an operative cholangiogram or videotape of the operation was not performed. The patient underwent an endoscopic retrograde cholangiopancreatography that demonstrated discontinuity of the common bile duct. The next day the patient underwent an operation during which the bile duct was found resected to the bifurcation as was a segment of the right hepatic artery that apparently had crossed over the proximal end of the bile duct and on both ends of the hepatic artery. No attempts were made to further evaluate the arterial injury. Both ends of the vessel were secured and bilateral hepaticojejunostomies were performed.

In the postoperative period, the patient had sepsis associated with multiple hepatic abscesses in the right lobe of the liver (Figure 2). The patient had a severe iodinated contrast allergy that restricted diagnostic studies. The patient underwent a technetium Tc 99m sulfur colloid liver scan that demonstrated the perfusion defect seen in Figure 2. Two separate percutaneous drains and a posterior rib resection and open drainage were required to eradicate the patient's hepatic abscesses. During the subsequent 2 years, the patient had marked atrophy of the right lobe and hypertrophy of the left lobe of the liver (Figure 2).

The patient has no identifiable drainage from the right ductal system and a patent left ductal system when evaluated by biliary scintigraphy. The patient’s serum bilirubin level is normal; however, her alkaline phosphatase and other liver enzyme levels remain elevated.

CASE 2

A 40-year-old woman (patient 9) underwent a laparoscopic cholecystectomy associated with an operative cholangiogram that demonstrated no proximal flow of contrast material. Exploratory surgery was performed and the patient was reported to have had several metallic clips on
CASE 3

A 48-year-old woman (patient 7) underwent laparoscopic cholecystectomy associated with intraoperative bleeding requiring a laparotomy to control the hemorrhage. A cholangiogram was not performed and bile duct or hepatic artery injury were not described in the operative note. With serum bilirubin levels progressively increasing, the patient was transferred to our institution 4 days later. Endoscopic retrograde cholangiopancreatography findings showed an obstruction of the common bile duct. The next day the patient underwent bilateral hepaticojejunostomies to treat a Bismuth type 4 bile duct injury. At the time of reconstruction, the patient was found to have the hepatic artery resected up to the level of the bifurcation of the right and left hepatic arteries. The ends of the arteries were occluded with metallic clips. There was no discernible flow in the distal hepatic artery system as seen by Doppler ultrasonographic evaluation, and the right and left hepatic arteries were believed to be thrombosed. The patient postoperatively had abscesses in the right and left lobes of the liver that were treated with transcutanous drainage and antibiotics (Figure 3). One year following this operation the patient’s serum bilirubin and liver enzyme levels increased. Right and left transhepatic cholangiograms revealed several areas of intrahepatic bile duct strictures and a long stricture of the left hepatic duct to the anastomosis with the jejunum. The left-sided primary strictures were dilated and a transhepatic stent was left through the left hepaticojejunostomy for 1 month. The right-sided bile duct strictures (Figure 3) have not been treated. A celiac arteriogram was performed to evaluate the patient’s condition for potential hepatic transplantation. As seen in Figure 3, there is evident development of collateral blood flow to the right and left hepatic arteries. Six months following management of bile duct strictures the patient has a normal serum bilirubin level with elevated liver enzyme levels, with alkaline phosphatase levels higher than 1000 U/L, and with intermittent episodes of cholangitis.

CASE 4

A 54-year-old man (patient 13) was seen at another hospital with acute onset of severe chest pain, abdominal pain, and lower extremity weakness. Chest x-ray films showed a thoracic aneurysm and the patient was transferred to our institution. An aortogram showed a dissecting thoracic aneurysm (type 3) with distal flow to only his right kidney. He underwent a femorofemoral cardiopulmonary bypass and the placement of a 34-mm interposition tube graft to reconstruct his descending aorta and produce reentry (performed by the cardiothoracic surgery service). Because of
his abdominal pain, surgical exploration of his abdomen was performed following the closure of the thoracic incision. He was found to have patchy gangrene of his stomach and a gangrenous gallbladder. He underwent cholecystectomy and was returned to the operating room 24 hours later. At that time, the patient's stomach, spleen, pancreas, duodenum, and distal bile duct were gangrenous. He had patchy necrosis of the right lobe of the liver; however, the remainder of the abdominal viscera were viable. He had satisfactory renal function with palpable pulses in both renal arteries. He underwent a splenectomy, total gastrectomy, total pancreatectomy, and resection of his distal common bile duct to 1 cm below the bifurcation. He had a right hepatic artery originating from his superior mesenteric artery that was a 2- to 3-cm thrombotic mass throughout its length. The artery was opened and contained only extraintimal thrombus with no clot in the lumen. Throm-
bectomy catheters could not be passed proximally or distally and the artery was ligated. The splenic artery had the same appearance. A Roux-en-Y esphagojejunostomy and hepaticojejunoscopy were performed. The patient had evident hepatic necrosis postoperatively (Figure 4) and had an anastomotic leak from the choledochojejunos- tomy (Figure 4) that was treated expectantly with clo-

The demographic and clinical characteristics of the patients are outlined in the Table. Most bile duct injuries occurred during laparoscopic cholecystectomy. Patients also experienced bile duct injuries during open cholecystec-
tomy and 1 patient had necrosis of the distal bile duct associated with a dissecting thoracic aneurysm. The only anas-
tomotic leak occurred in patient 13 (case 4) who had concomitant bile duct and hepatic artery injury. Three of the 4 patients with combined bile duct and hepatic artery injury had evident hepatic necrosis, abscess formation in the area of liver devoid of arterial blood supply, or both. The fourth patient who had the combined vascular and bile duct injury did not have any diagnostic studies to identify areas of hepatic necrosis in the immediate postinjury period. A computed tomographic scan or ultrasonographic scan of the liver was performed in 5 of 9 patients with isolated bile duct injuries in the immediate postinjury period; none of the patients with bile duct injuries without hepatic artery injury had evidence of hepatic necrosis.

Anastomotic patency was evaluated primarily by biliary nucleotide scintigraphy and, where indicated, by transhepatic cholangiography. A total of 18 anastomoses were at risk. There has been no anastomotic failure in the 13 anastomoses at risk with bile duct reconstruction without hepatic artery injury compared with anastomotic failure of 3 of 6 of the anastomoses at risk in the presence of both hepatic artery and bile duct injury. Liver function study results are presently normal in the 9 patients with isolated bile duct injuries. Three of 4 patients with combined hepatic artery and bile duct injury have normal liver function study results manifested primarily by alkaline phosphatase levels ranging from 333 to 1427 U/L and normal serum bilirubin levels.

The clinical course of the patients with combined hepatic arterial and bile duct injuries was associated with several differences when compared with the course of patients with isolated bile duct injuries. These differences are primarily hepatic necrosis and anastomotic or bile duct strictures. Many questions remain concerning the most appropriate management of such problems.

Hepatic artery thrombosis following liver transplantation is continuously being watched for and, if identified early, can be managed with thrombolytic therapy or operative revision with the potential of salvaging the transplanted liver. Although defined ischemia time is not uniformly agreed on which is associated with possible revascularization, the general time limit in these patients associated with successful revascularization seems to be measured in days. When patients have immediate identification of an isolated right hepatic artery injury during the performance of a cholecystectomy, the results of ligation have been satisfactory and recommendations are generally not to attempt to reconstruct the injured artery. Based on our experience, if a patient has immediate recognition of a combined hepatic artery and proximal bile duct injury, reconstruction of both the patient's arterial and bile duct injuries may prevent hepatic necrosis, choledochojejunal anastomotic leakage and late anastomotic and bile duct stricture. The technique of hepatic artery recon-

### RESULTS

The demographic and clinical characteristics of the patients are outlined in the Table. Most bile duct injuries occurred during laparoscopic cholecystectomy. Patients also experienced bile duct injuries during open cholecystectomy and 1 patient had necrosis of the distal bile duct associated with a dissecting thoracic aneurysm. The only anastomotic leak occurred in patient 13 (case 4) who had concomitant bile duct and hepatic artery injury. Three of the 4 patients with combined bile duct and hepatic artery injury had evident hepatic necrosis, abscess formation in the area of liver devoid of arterial blood supply, or both. The fourth patient who had the combined vascular and bile duct injury did not have any diagnostic studies to identify areas of hepatic necrosis in the immediate postinjury period. A computed tomographic scan or ultrasonographic scan of the liver was performed in 5 of 9 patients with isolated bile duct injuries in the immediate postinjury period; none of the patients with bile duct injuries without hepatic artery injury had evidence of hepatic necrosis.

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### Table

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<th>Patient No./Sex/Age, y</th>
<th>Interval Between Injury and Reconstruction</th>
<th>Bismuth Type Injury†</th>
<th>Hepatic Artery Injury</th>
<th>Mechanism of Injury‡</th>
<th>Hepatic Necrosis/ Abscess</th>
<th>Length of Follow-up, mo</th>
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*Minus sign indicates absent; plus sign, present. Patient 13 was the only one to have an anastomotic leak.

†Major bile duct injury was categorized by using Bismuth’s classification.‡LC indicates laparoscopic cholecystectomy; OC, open cholecystectomy; MC, minicholecystectomy; and AD, aortic dissection.
struction would depend on the nature of the hepatic artery injury. Should hepatic artery injuries associated with major bile duct injuries be revascularized when identified later? Should the hepatic artery injuries described in this report have been revascularized when encountered? It seems unlikely that revascularization would prevent hepatic necrosis. The possible benefits associated with revascularization would seem to be related to the long-term potential problems of bile duct and anastomotic strictures. It is possible that anastomoses using ischemic bile ducts are destined to long-term failure. Also, the collateralization that develops will potentially make reoperation more difficult (Figure 3). Contrariwise, the placement of an arterial anastomosis under a bile duct– jejunal anastomosis could result in false aneurysm formation and hemorrhage if the bile duct–jejunal anastomosis leaks. Similarly, some patients will do well in the presence of an occluded right hepatic artery (patient 7).

As 30% of right hepatic arteries cross anterior to the common duct, it would seem appropriate to evaluate the integrity of the hepatic artery whenever a proximal bile duct injury is being reconstructed. This is readily done by operative dissection and by use of intraoperative ultrasonographic Doppler evaluation. If a patient is going to undergo a bile duct reconstruction, preoperative arteriography would seem to have a limited role in providing information as the arterial anatomy distal to the injury is unlikely to be seen. If a patient is suspected of having an arterial injury and there is planned delay in reconstruction of the bile duct, the arterial injury could be confirmed arteriographically.

Hepatic necrosis and subsequent hepatic abscess were a notable problem in 3 of 4 patients with hepatic arterial and bile duct injuries. It is well recognized that most of the blood supply to the hepatic parenchyma is supplied by the portal vein. Hepatic artery ligation in managing traumatic liver injuries and hepatic malignant neoplasm has been described and relegated to be safe to perform if liver function is otherwise normal as extensive collateral arterial blood flow develops in addition to portal blood flow. The patients described in this article had intact portal veins as evaluated intraoperatively and intact hepatic ligaments, yet developed hepatic necrosis in the presence of a hepatic artery injury. Patients undergoing liver transplantation have a high probability of developing focal areas of hepatic necrosis and abscess formation in the presence of hepatic artery thrombosis. In such patients, the liver experienced an ischemic event associated with harvest and storage and the process may not be comparable to the situation described here. Hepatic abscess has occurred following elective hepatic artery ligation for tumor; however, it may be primarily related to tumor necrosis. In our article, 75% of the patients with bile duct injuries and hepatic artery injuries had hepatic necrosis.

Patient 13 in this series had a clinically evident bile duct leak. While bile duct anastomotic leaks have a high probability of closing spontaneously, it was unclear whether such an anastomotic leak would close in the presence of a hepatic artery injury. This anastomotic leak healed in a short time. An anastomotic leak proved fatal in a patient described by Brittain et al, who had a combined hepatic artery and bile duct injury. Majno et al have described a series of patients undergoing complex pancreatic resections who sustained hepatic artery injuries and bile duct–jejunal anastomoses that leaked and they have recommended that the anastomosis be revised involving more proximal bile duct.

It is evident that bile duct reconstructions can fail following long periods of patency. The patients in our series have been followed up for a short period and it is possible that these patients will have or without associated hepatic arterial injuries may eventually have anastomotic strictures. Based on the available information, short- and long-term patency of bile duct reconstructions in the presence of hepatic arterial injuries will be notably less than reconstructions of bile duct injuries with an intact arterial blood supply.

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REFERENCES