Hypothesis: Portoenterostomy may be an effective treatment for patients sustaining a thermal injury to the hepatic duct confluence during laparoscopic cholecystectomy.

Design: Case series.

Setting: A tertiary care referral hospital.

Patients: A consecutive series of 5 female patients referred and treated between November 13, 1991, and December 17, 1998. Ages ranged from 29 to 65 years. In addition to the ductal injuries at or above the hepatic duct confluence, 3 patients also had a major hepatic vascular injury. The patients were available for follow-up for 7 to 91 months postoperatively.

Interventions: All patients underwent a portoenterostomy (Kasai procedure) with suturing of a Roux limb to the hepatic tissue surrounding the transected hepatic ducts. Transhepatic stents were inserted either preoperatively or postoperatively for rising liver enzyme levels in 4 patients.

Main Outcome Measures: Symptoms and results of liver function tests.

Results: Stents remained in place for 9 to 25 months in 4 patients. All 5 patients were symptom free and functioning normally; 3 had normal liver functions; 2 had mildly elevated alkaline phosphatase levels only.

Conclusion: Portoenterostomy, usually in combination with postoperative stenting, may be an option to consider in life-threatening injuries involving the hepatic duct bifurcation in which standard biliary reconstruction techniques are not feasible.


LAPAROSCOPIC cholecystectomy is associated with an increased incidence of bile duct injury when compared with open cholecystectomy. The injuries accompanying laparoscopic cholecystectomy tend to be more serious and difficult to treat, as they are often proximal, are usually caused by thermal injury, may be unrecognized at the time of cholecystectomy, and may be associated with major hepatic vascular injury along with marked destruction and loss of the hepatic duct confluence. All of these factors compromise the surgeon’s ability to accurately reconstitute ductal-enteric continuity by standard techniques. Recently, we encountered 5 patients in whom a mucosa-to-mucosa hepaticojejunostomy was not possible because of intense scarring, inflammation, and loss of ductal tissue. Each patient underwent a portoenterostomy (Kasai procedure), and all 5 continue to do well. This report outlines their clinical course and outcome.

REPORT OF CASES

CASE 1

A 40-year-old woman underwent an elective laparoscopic cholecystectomy for gallstones on November 13, 1991. No cholangiogram was performed. Postoperatively, bile drained from one of her lateral port sites, and she was reoperated on on November 18, at which time 2 Jackson Pratt drains were placed in the subhepatic space. After continued drainage for 9 days, she was transferred to the Loyola Medical Center, Maywood, Ill.

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At that time, she was afebrile with a white blood cell count of 15.0 × 10⁹/L, a bilirubin level of 6.8 µmol/L (0.4 mg/dL), and an alkaline phosphatase level of 142 U/L. Findings at the time of operation on December 2 disclosed a clip on the distal common bile duct that measured 4
mm in diameter. More clips were removed from the right hepatic duct; the left hepatic duct drained freely. Probing disclosed that the right hepatic duct admitted only a 2-mm probe, while the left duct admitted only a 1-mm probe. The entire common hepatic duct and bifurcation had been excised, and the tiny left and right hepatic ducts were approximately 1 cm apart.

With these findings, it was judged to be impossible to perform a hepaticojejunostomy; a 61-cm Roux limb was fashioned with circumferential suturing of the opening in the side of the limb to the scarred and inflamed tissue surrounding the 2 ducts by means of 5-0 chromic suture material. A subhepatic drain was placed, which drained bile for 12 days postoperatively. Three months later, the patient was asymptomatic, with a bilirubin level of 3.4 µmol/L (0.2 mg/dL), an alkaline phosphatase level of 137 U/L, and an aspartate aminotransferase level of 62 U/L.

On May 29, the patient’s alkaline phosphatase level had risen to 318 U/L, but she remained asymptomatic. She became jaundiced 2 months later, with a bilirubin level of 205.2 µmol/L (12 mg/dL) (Figure 1). Left and right hepatic duct internal-external drains were placed percutaneously under fluoroscopic control, and her jaundice subsided (Figure 2). During the next 2 years, these tubes were changed every 3 months. In September 1994, the patient insisted that they be removed, and this was carried out. Since that time, she has had no symptoms, and her liver function test results remain normal.

CASE 2

A 48-year-old woman underwent an elective laparoscopic cholecystectomy for gallstones on September 4, 1996. An operative cholangiogram disclosed only the distal common bile duct. Despite this, the operation was concluded and she was discharged from the hospital, only to develop progressive abdominal pain necessitating readmission. Endoscopic retrograde cholangiopancreatography disclosed the distal common bile duct only. At the time of reoperation on September 12, she had extensive bile peritonitis, and a subhepatic drain was placed. At the time of her hospital transfer, she was afebrile and approximately 500 mL of bile was draining daily. She was discharged eating a regular diet, with plans made to readmit her in 6 weeks for biliary reconstruction. However, on October 24, she was readmitted with a decreased bile output and clinical jaundice.

At laparotomy, extensive scarring and inflammation were present. Ultimately, the opening of the right hepatic duct was found and purulent bile was noted to be coming from it (Figure 3). It was obvious that the hepatic duct bifurcation had been excised; no left ductal system was ever identified. A portoenterostomy was constructed by means of a 61-cm Roux limb and 4-0 polyglyconate sutures. A subhepatic drain was placed, which drained bile for 8 days.

The patient’s alkaline phosphatase level progressively rose postoperatively, and on December 16, she underwent transhepatic insertion of left and right internal-external biliary drains under fluoroscopic control, along with placement of a new subhepatic drain for a residual fluid collection (Figure 4). These stents were changed every 3 months, with balloon dilation of the narrowed distal ducts. The tubes were removed after 9 months. At that time, the patient was asymptomatic and the serum bilirubin and aspartate aminotransferase levels were normal. Her alkaline phosphatase level was 296 U/L and progressively decreased to 135 U/L. She currently has no symptoms and works regularly.

CASE 3

A 29-year-old woman underwent an elective laparoscopic cholecystectomy for cholelithiasis on October 16,
1996. Substantial hemorrhage was encountered, which necessitated conversion to an open operation and multiple transfusions. The cholecystectomy was completed and no ductal or arterial injury was identified. No drains were placed, and the patient was discharged from the hospital on the fifth postoperative day, only to be readmitted 4 days later with abdominal pain and distention. A computed tomographic scan disclosed intraperitoneal fluid, and the patient was reoperated on. Many liters of bile was present in the peritoneal cavity, and drains were placed. The patient made an uneventful recovery.

On November 19, 1996, she was transferred to our care in stable condition. Preoperatively, left and right transhepatic internal-external drains were placed, and at the time of laparotomy on December 4, 1996, no hepatic ducts could be identified, as considerable necrotic tissue and eschar were present (Figure 5). The liver was probed, and ultimately the right hepatic duct was entered. No left hepatic duct was found, and a portoenterostomy was performed by means of 4-0 polyglyconate sutures. Bile drained externally for 10 days, and the patient made a normal recovery. Postoperatively, guidewires were used to cross the biliary defects, followed by placement of internal-external biliary drains across the anastomosis in the Roux limb. Tube changes were then carried out every 3 months (Figure 6). The right tube was removed in February 1998, and the left tube in May 1998. The patient remains well, with no symptoms and normal results of liver function tests.

**CASE 4**

A 43-year-old woman underwent a technically difficult laparoscopic cholecystectomy for acute cholecystitis on July 11, 1997. No operative cholangiogram was performed. Postoperatively, she did poorly. She remained febrile, with abdominal pain and distention, and her hemoglobin level dropped to 40 g/L. Her bilirubin level rose to 68.4 μmol/L (4 mg/dL), with an alkaline phosphatase level of 2000 U/L. Endoscopic retrograde cholangiopancreatography disclosed a distal common bile duct containing stones with intraperitoneal extravasation from the transected duct (Figure 7). At the time of hospital transfer on July 27, she was febrile and toxic appearing and had marked coagulopathy. She had massive abdominal distention and 6 L of bile in her peritoneal cavity at lapa-
rotomy. The entire subhepatic space was inflamed, making identification of anatomy difficult. It appeared that the right hepatic artery had been clipped. Bile was noted coming from an eschar proximally. A Jackson Pratt drain was placed, and the patient made a slow recovery. Approximately 600 mL of bile drained daily, and a fistulogram demonstrated communication with the distal common bile duct and absence of the common hepatic duct up to and including a portion of the hepatic duct bifurcation, where it appeared that there was a stricture of the left hepatic duct suggestive of a cautery injury (Figure 8).

One month later, the patient underwent reoperation. Separate left and 2 right hepatic ductal openings were found and measured to be 2 to 4 mm in diameter. All tissues were inflamed and scarred, and a portoenterostomy was carried out with 4-0 polyglyconate sutures along with drainage of the subhepatic space. Bile drained externally for 10 days, and the patient’s postoperative course was normal. During the next 2 months, liver enzyme levels rose, and she underwent insertion of 2 right-sided and 1 left hepatic duct internal-external drains (Figure 9 and Figure 10). These were changed every 3 months and removed after 12 months. Since then, the patient has been asymptomatic and currently has an alkaline phosphatase level of 212 U/L.

CASE 5

A 65-year-old woman underwent an attempted laparoscopic cholecystectomy for acute cholecystitis on December 17, 1998. Substantial bleeding was encountered, and the surgeon recognized a bile duct injury. Unfortunately, at that time, he collapsed in the operating room and the patient was kept intubated and transferred by helicopter directly to our operating room. A total of 700 mL of blood was removed from the subhepatic space, and it was noted that the right hepatic artery originating from the superior mesenteric artery had been clipped and divided. The distal common bile duct measured 4 mm in diameter and was circumferentially dissected and transected, leaving 2 cm in place. The entire remaining common bile duct and common hepatic duct had been excised up to and including the hepatic duct confluence. The orifice of the right hepatic duct was 1 mm in diameter, and they were separated by approximately 1 cm. A portoenterostomy was carried out with 4-0 polyglyconate sutures. A subhepatic drain

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Figure 6. Patient 3, March 20, 1997. Cholangiogram showing progressive stricture of the right hepatic duct (arrow), presumably caused by thermal injury and ischemia.

Figure 7. Patient 4. Endoscopic retrograde cholangiopancreatogram showing contrast extravasation (solid arrow) and a transected common bile duct containing multiple stones (open arrow).

Figure 8. Patient 4. Fistulogram showing absence of common hepatic duct and bifurcation.
was placed and drained bile for 7 days. No postoperative biliary stenting was performed, and at the present time, the patient is asymptomatic with normal results of liver function tests.

COMMENT

It is generally agreed that the incidence of bile duct injuries is 2 to 3 times greater with laparoscopic than with open cholecystectomy, with rates of 0.4% to 0.6% noted in many large series.1,2 A collective literature review of more than 124,000 patients by Strasberg et al6 disclosed a rate of 0.5%. Although some reports initially mentioned a learning curve, with decreased injuries occurring with added experience,7 other series have indicated a rather fixed rate of ductal injuries with no conclusive evidence of a decreasing incidence.3,4,8

These injuries result from the loss of a 3-dimensional view of the relevant anatomy and also a loss of the tactile appreciation of the involved structures. In the most serious form of injury, the common bile duct is mistaken for the cystic duct, transected, and then dissected in a cephalad direction by means of electrocautery.9 This leads to a destruction of the duct by thermal injury, which often extends proximally to involve the confluence of the left and right hepatic ducts (Bismuth type 4 injury). For this reason, associated major vascular injuries often accompany this type of ductal injury.3,10 In one series, 18 (20%) of 88 patients with any form of bile duct injury had a concomitant vascular injury, as did 9 (17%) of the 53 who had a complete transection of the bile duct.11

These combined factors lead to a much more serious problem than bile duct injuries occurring during open cholecystectomy. These latter injuries are often noted at the time of operation, and immediate reconstruction can be carried out with fresh noninflamed and noninfected tissues. They also tend to be located in the common bile duct or distal common hepatic duct, with sparing of the hepatic duct confluence (Bismuth type 1 and 2 injuries). Also, many laparoscopic injuries are first diagnosed many days postoperatively, when the patient experiences either bile leakage or bile ascites.

In general, the principles of bile duct repair are agreed on. Direct duct-to-duct anastomosis should be avoided. A healthy, noninflamed, viable proximal duct should be used and sewn to an opening in a Roux limb by means of fine absorbable sutures and a mucosa-to-mucosa anastomosis.12 Patients who experience obstructive jaundice late after their operation can often fulfill these criteria. Likewise, some early injuries can be similarly managed if diagnosed promptly and operated on by experienced surgeons. Long-term results in these situations are excellent, with numerous series reporting 80% to 90% long-term successful outcomes.8,11,13,14 These uniformly good results contrast, however, with those obtained in acute laparoscopic injuries involving the hepatic duct confluence, where, even if preoperative transthepatic and subhepatic biliary drainage is used, the surgeon is faced with anastomosing small ducts in an inflamed and scarred field. In this situation, postoperative strictures, recurrent cholangitis, and persistently elevated liver enzyme levels are frequently noted.11,13,15 This process may be worsened by concomitant vascular injury or the progressive nature of the thermally induced ischemic injury,16,17 as noted in our patient 3.

To obviate this, some authorities have advocated the left hepatic duct exposure technique described by Hepp and Couinaud.14,18,19 This approach, however, depends on continuity of the left and right ductal systems at the confluence and is therefore not suitable for many patients with a Bismuth type 4 injury. Others have advocated individual dissection of as many as 6 separate ducts within the liver and separate anastomoses for each.10 Because these acute laparoscopic injuries may be progressive as a result of thermal destruction and tissue inflammation, both of these techniques may not yield good results on longer follow-up, and it is well recognized that the results of treatment of high biliary injuries do not approach the success of more distal reconstructions.8,14,15 Both the need for and duration of stenting...
have been controversial for years, with some authorities avoiding them altogether and others using them for either short or prolonged periods.10,13,20-22 Four of our 5 patients required stenting, and initially we were unsure how long these should remain in place. Our first patient insisted on removal after 2 years and has remained well, with normal results of liver function tests for more than 5 years since then. Subsequent patients had stenting for 9, 12, and 17 months; in this last patient, strictures were thought to be present after 1 year, and so an additional period of stenting and periodic dilations were recommended.

Although portoenterostomy has been used extensively by pediatric surgeons for infants with congenital biliary atresia since the first report in the English literature by Kasai et al in 1968,23 there are few reports of portoenterostomies performed for high biliary strictures in adults. In the report by Stewart and Way,11 2 patients underwent this procedure for injuries above the confluence and remained symptom free after dilation of postoperative strictures. Schlitt et al24 reported failure of this procedure in 3 patients with high ischemic strictures after liver transplantation, but it is not thought that this is a situation comparable to laparoscopic injury.

Experience with these 5 patients, who all presented early in the postoperative period with bile leakage and marked inflammatory changes and who had Bismuth type 4 injuries, has led us to a strategy that is still in evolution. It is unknown whether earlier stenting will prevent strictures that appear to be associated with this procedure. Despite this, we now believe that intrahepatic stents should be placed preoperatively if technically feasible. This, in addition to drainage of the subhepatic space, will allow some resolution of the inflammation so that cholangitis will be avoided and an elective repair can be carried out after 6 to 8 weeks. After performance of a portoenterostomy, these stents should be guided through the anastomosis after 2 to 3 weeks. If stents are not placed preoperatively, we now have a very low threshold for inserting them postoperatively and would recommend performing liver function tests monthly, with stent placement performed for any substantial increase in the patient’s serum alkaline phosphatase level. The optimal time stents should remain in place is controversial, but we note that 2 of our patients had stents in place for 17 and 25 months and currently have normal results of liver function tests, whereas the 2 patients with 9 and 12 months of stenting currently have some elevation of their alkaline phosphatase levels. In view of this, we now recommend that stents remain in place for 18 to 24 months.

Although 4 of our patients have been followed up for more than 2 years and remain symptom free, we believe a longer period of observation will be necessary to validate this procedure (Table). Although most recurrences of strictures after bile duct repair occur within the first 2 or 3 years,20,22 late recurrences can still occur, making long-term follow-up essential.11,26

In conclusion, in our series of 5 patients with catastrophic laparoscopic injuries involving the hepatic duct confluence, the best surgical option at the time appeared to be construction of a Roux-en-Y portoenterostomy. During this same period, we used conventional techniques, usually a Roux-en-Y hepaticojejunostomy, to treat more than 30 other patients with laparoscopic bile duct injuries. We believe that portoenterostomy may be appropriate for a small subset of patients who sustain potentially life-threatening biliary injuries in whom conventional techniques are less likely to prove successful.

**Patient Data***

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* LFT indicates liver function test; AP, alkaline phosphatase; and NA, not applicable.

Corresponding author: Jack Pickleman, MD, Department of Surgery, Loyola University Medical Center, 2160 S First Ave, Maywood, IL 60153 (e-mail: Jpickle@luc.edu).

**REFERENCES**


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Invited Critique

Bile duct injury is a very complicated situation for both patients and surgeons. With the present status of operative technology, in most instances a biliodigestive anastomosis in specialized and interested centers can be done; a Roux-en-Y hepatojejunostomy is the operation of choice. Stenting of the anastomosis is a matter of debate; there are experienced groups that have shown good results with and without a stent. Our personal preference is to place a stent according to the individual characteristics of each patient. If a wide (>0.5 cm), nonscarred, nonischemic, and noninflamed duct or ducts are found, we usually place no stents. If the opposite is found, we usually place a transhepatic stent.

The article by Pickleman et al describes a minor subset of dramatic, unfortunate cases, which all surgeons interested in biliary tract reconstruction have encountered: patients in whom no adequate ducts are found, although a high hilar dissection has been performed, including a partial liver resection, to obtain a better exposure.

In our series of more than 120 reconstructions over a 10-year period, we have found 3 of these cases in which it is virtually impossible to do a good and safe biliodigestive anastomosis. After several hours of fighting within the hepatic parenchyma, the surgeon has reached the decision proposed by Pickleman et al: constructing a portoenterostomy, with a transhepatic stent (placed with the aid of a preoperative percutaneous catheter). Probably, the best choice to prevent this uncomfortable situation is the preoperative visualization of the intrahepatic biliary tree by means of cholangioresonance and, better, with percutaneous cholangiography. Together with visualization of the biliary tree, small percutaneous catheters can be placed that allow the identification of the ducts intraoperatively. In some cases, it is a good practice to postpone the procedure several weeks (assuming that the biliary tree has been drained) to allow deinflammation at the hilar level. When inflammation has subsided, an elective anastomosis can be done safely using operative magnification.

Two of our 3 portoenterostomy cases did not have good long-term results: These patients developed chronic liver disease with mixed hyperbilirubinemia (obstructive and hepatocellular). No attempt to reoperate was made in these cases, as very small ducts with acceptable passage of contrast medium to the jejunum have been demonstrated. Portoenterostomy has recently been performed in the third case, with a transhepatic stent; the patient is doing well in the second postoperative month.

We also agree with the authors that this is another alternative for these very difficult cases, but some cautions need to be addressed: portoenterostomy cannot be recommended as a routine procedure. It is difficult to do a prospective, controlled, randomized trial to obtain irrefutable data, but our feeling is that it is no more beneficial than a mucosa-mucosa hepatojejunostomy. Perhaps, for these cases, a liver transplant could have better long-term results.

Biliary tract injuries have to be treated in tertiary care centers interested in this type of operations. The surgeon’s experience determines which approach is the best for a given patient in each scenario.

Hector Orozco, MD
Miguel Angel Mercado, MD
Mexico City, Mexico

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