Bile Leak Following an Elective Laparoscopic Cholecystectomy: The Role of Hepatobiliary Imaging in the Diagnosis and Management of Bile Leaks

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CASE PRESENTATION

A 39-yr-old white male underwent an elective laparoscopic cholecystectomy because of a 1-yr history of symptomatic cholelithiasis. The procedure was completed without apparent complication and the patient was discharged from the hospital on the first postoperative day in good condition. He did well until the fourth postoperative day when he developed nausea, vomiting and right upper quadrant pain. He was admitted to a local hospital for 48 hr but was discharged after an abdominal CT scan showed no significant abnormality. He was readmitted to our institution when his symptoms worsened over the next three days.

Past medical history was notable for hypertension, gout and coronary artery disease. He had a myocardial infarction in March 1989 and coronary angioplasty in September 1989. His medications included atenelol, nifedipine and aspirin.

On physical examination he was noted to be a well-developed, well-nourished man. His vital signs were within normal limits and he was afebrile. He was not jaundiced. The only significant physical finding was mild right upper quadrant abdominal tenderness. No peritoneal signs were appreciated and there was no drainage from the small incisions made during the laparoscopic cholecystectomy.

Laboratory studies were notable for a total bilirubin of 1.4 mg/dl (0.0–1.2), ALT of 18 U/liter (0–40), GGT of 58 U/liter (0–40), and an alkaline phosphatase of 116 U/liter (35–125). The CBC, electrolytes, BUN, and creatinine were all within normal limits. The presumptive diagnosis was a postoperative bile leak. The patient was treated with broad spectrum intravenous antibiotics and received no oral medications.

A CT scan was performed with 10-mm contiguous slices through the region of the liver and pancreas before and after the administration of intravenous contrast (Fig. 1). The study demonstrated small bilateral pleural effusions and subsegmental atelectasis at the lung bases. A small amount of ascites was present. There was no evidence of a collection in the region of the gallbladder fossa. There were no stones appreciated in the region of the bile ducts and there was no intra- or extrahepatic ductal dilatation.

A DISIDA scan also was obtained. Static images of the abdomen were acquired serially in the anterior projection after the intravenous administration of 5.4 mCi of ^{99m}Tc-DISIDA (Fig. 2). There was good extraction of the radiopharmaceutical by the liver and almost complete clearance of the blood-pool activity at 30 min. There was rapid excretion of the tracer into the small bowel. A focal area of increasingly intense activity was seen in the region of the gallbladder fossa, suggesting a bile leak confined to that area. There was no evidence of free intraperitoneal fluid.

Endoscopic retrograde cholangiography was performed and demonstrated extravasation of contrast into the subhepatic space, especially the gallbladder fossa (Fig. 3). No calculi or ductal dilatation were seen. The leak into the gallbladder fossa was thought to arise from an accessory duct originating from the right hepatic system.

On the following day, the patient was taken to the operating room to explore the site of the bile leak and to place a drain. At laparotomy, 700 cc of bile were evacuated from the upper abdomen, primarily from under the diaphragm. A slow continuous ooze of bile was noted from the gallbladder bed, but no single source could be identified or ligated. There was no leakage from the major extrahepatic ductal system. A surgical drain was placed into the gallbladder fossa.

Three hundred cubic centimeters of bile were drained from the wound during the first postoperative day, but

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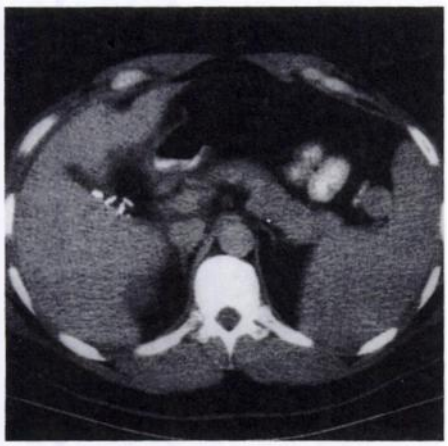

FIGURE 1. A CT scan performed on the 8th postoperative day demonstrated a small amount of ascites, but no collection in the region of the gallbladder fossa was detected.

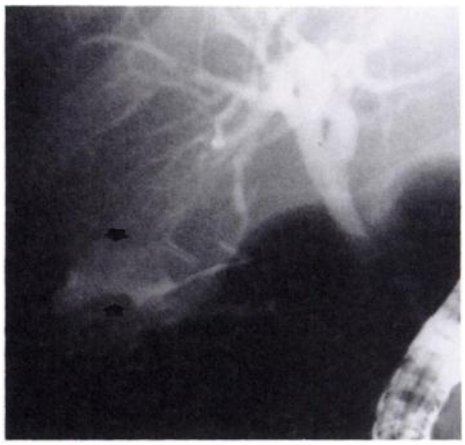

FIGURE 3. An endoscopic retrograde cholangiogram demonstrated extravasation of contrast in the subhepatic space (arrows) in the region of the gallbladder fossa, confirming the scinitgraphic findings.

this rapidly diminished. The patient made an uneventful recovery and was discharged on the fifth postoperative day. His drain was subsequently removed and he has had no further complications.

DISCUSSION

Injury to the biliary tree is an uncommon medical problem that most frequently occurs inadvertently during surgery. The complications of bile duct injury can be devastating, thus timely diagnosis and appropriate management are crucial. The diagnostic tools currently available include ultrasonography, CT scanning, hepatobiliary scintigraphy, and either percutaneous or endoscopic cholangiography. Each has its own inherent advantages and disadvantages. In those patients whose clinically significant bile leaks do not resolve spontaneously, surgery is frequently employed for proper management. However, recent technical advances in interventional radiology and endoscopy have fostered the successful management of biliary leaks using these less invasive modalities.

Causes of Biliary Leaks

The vast majority of bile leaks occur as a complication of a surgical procedure in the area of the biliary tree. Other less common etiologies include trauma to the abdomen, spontaneous perforation of the gallbladder, and diagnostic procedures such as percutaneous liver biopsy (*1*).

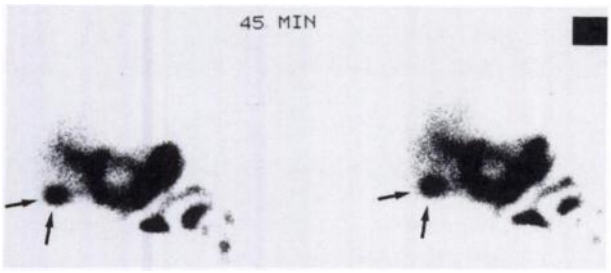

FIGURE 2. A ^{99m}Tc-DISIDA scan revealed a focal area of intense activity (arrows) in the region of the gallbladder fossa suggesting a bile leak confined to that area.

Although 95% of the reported cases of bile duct injury are of iatrogenic origin, the incidence of such complications during abdominal surgery is very low. The incidence rate of an accidental lesion of the common bile duct during routine cholecystectomy at 51 Swedish hospitals from 1975–1981 was recently reported to be only 0.07% (*2*).

Injury to the liver occurs frequently after blunt abdominal trauma, but disruption of the biliary tree is very rare. A review of the English literature in 1985 revealed only 94 cases (*3*). The majority (65%) were a result of motor vehicle accidents. Other causes included job-related injuries (10%), falls (7%), and blows sustained during fights (8%).

Clinical Manifestations

Clinically insignificant postoperative extravasation of bile is not unusual after surgery involving the biliary tract or liver. In a study designed to evaluate the usefulness of routinely placing subhepatic drains after uncomplicated cholecystectomy, 25 patients underwent ^{99m}Tc-imminodiacetic acid (IDA) scintigraphy (*4*). On arrival in the recovery room, each patient was given 5 mCi of ^{99m}Tc-DISIDA. The patients were scanned from 2 to 4 hr after injection. Forty-four percent of the patients had evidence of bile leakage, defined as the presence of radiopharmaceutical in the subhepatic space but outside of the biliary and gastrointestinal tracts. However, only one of these patients developed a clinically significant bile leak.

Intra-abdominal bile leaks, if sterile, small, and adequately drained are of little consequence and will usually heal spontaneously. However, if the defect in the bile duct is large and the majority of the bile stream enters the peritoneum, further intervention often will be necessary. The consequences of bile extravasation include biliary peritonitis, subhepatic fluid collection, abscess formation and fistula formation. A clinically significant bile leak

should be suspected in any patient who has recently sustained abdominal trauma or surgery and develops fever, jaundice, abdominal pain or bilious drainage from an incision or drain. The time interval between the onset of bile leakage and the development of symptoms can range from 24 hr to 1 wk and may be dependent on whether or not the bile is infected (*5*).

Diagnosis

Documenting the presence and extent of a leak can pose a difficult diagnostic challenge. Real-time ultrasonography and CT scanning are two readily available and noninvasive techniques for diagnosing fluid collections within the abdomen (*1*). The main advantage of ultrasonography is its optimal anatomic resolution, particularly for space-occupying lesions deep within the liver. CT scan provides even higher resolution and the opportunity to make density measurements. Unfortunately, the differentiation of fluids with the same density as water (e.g., bile, serous ascites, lymph and urine) is not possible. Therefore, although ultrasound and CT scans can identify fluid collections within the abdomen, they cannot demonstrate whether they contain bile or freely communicate with the biliary tree.

Imaging techniques that use ^{99m}Tc-IDA derivatives provide a noninvasive, physiologic means of detecting and evaluating bile drainage and therefore bile leaks. Although the primary role of ^{99m}Tc-IDA cholescintigraphy has been the evaluation of cystic duct patency in patients with suspected acute cholecystitis, it also demonstrates the physiologic route of bile flow and can diagnose a bile leak and its relation to the collections detected by the other means.

After intravenous injection, IDA analogues are efficiently cleared from the blood stream by the hepatocytes and are excreted unchanged into the biliary system and ultimately the intestines. High photon flux allows excellent images of the common bile duct, gallbladder and small intestine to be obtained (*5*).

Technetium-99m-IDA scintigraphy has been shown to be an important tool for detecting extravasation of bile. There are many case reports in the literature documenting its usefulness in the assessment of damage to the biliary tree after trauma or surgery (*3–8*). Technetium-99m-IDA scintigraphy has many advantages (*6*):

- It is noninvasive and physiologic and therefore causes no changes in the existing condition in the biliary system.
- It can be performed in the face of hyperbilirubinemia.
- It also allows for a smaller concentration of the tracer to be detected than the concentration of iodine needed for visualization by conventional radiographic techniques.

Unfortunately, there have been no studies to establish the sensitivity and specificity of the test in diagnosing bile leaks and no large scale comparisons of scintigraphy with radiographic studies such as percutaneous transhepatic cholangiography (PTC) or endoscopic retrograde cholangiopancreatography (ERCP) have been performed.

Technetium-99m-IDA scintigraphy has been shown to be particularly useful in diagnosing bile leaks that occur during abdominal trauma. Small bile duct injury, often deep within the liver parenchyma, frequently occurs when the liver is damaged. Intrahepatic bile duct injury and biloma formation may not be recognized for days or weeks until fever or bilious drainage occurs. Zeeman has performed Tc-IDA scintigraphy on 21 patients suspected of having hepatobiliary trauma—6 due to penetrating trauma and 15 due to blunt trauma (*8*). All of the patients with penetrating trauma underwent emergency exploratory laparotomy, while the 12 patients with blunt trauma eventually had surgery. Although no biliary injuries were identified at laparotomy in these patients, eight of them had parenchymal defects on postoperative IDA scintigraphy. In five of these cases, radioactive bile eventually was seen within the defect, indicating an intrahepatic biliary leak. The authors suggest that the routine preoperative use of Tc-IDA scintigraphy in patients who have sustained abdominal trauma will expedite the diagnosis of occult intrahepatic bile duct leaks.

Several authors have made recommendations to improve the sensitivity of Tc-IDA scintigraphy in the diagnosis of bile leaks. Weissman has noted that it is essential to obtain delayed views when looking for bile leaks. In six of nine patients she had evaluated, the bile leak was only apparent in those films obtained after 1 hr (*6*). Lette has noted that it can be difficult to differentiate right upper quadrant pathology, including bile leaks, from radiopharmaceutical in the small intestine (*7*). He has recommended standing views to overcome this problem. Other techniques to differentiate true pathology from enteric radiotracer activity include supplementary oblique views and the use of water ingestion to dilute the tracer.

Although Tc-IDA is a sensitive way to detect the presence of a bile leak, it has limited anatomic resolution. Injection of radiographic contrast material directly into the biliary tract using PTC or ERCP is the best way to establish the exact site of extravasation.

Management

There are three therapeutic options available for those patients with bile leaks who do not respond to conservative therapy or develop fistulous tracts: (1) surgery; (2) percutaneous transhepatic biliary drainage (PTBD); and (3) endoscopic sphincterotomy and stent placement.

Clearly, those bile duct injuries detected intraoperatively should be repaired surgically. Bile leaks discovered postoperatively can also be repaired during a second surgical procedure, but this is often difficult because of inflammation. The incidence of postoperative bile duct stricture or the need for further intervention is high after reparative biliary surgery. Sixty-nine percent of the patients in

Andren-Sanberg's review required additional surgery either from a postoperative biliary complication or because they developed a biliary stricture. The best surgical results are obtained when the repair is made by creating a Roux-en-Y choledocho- or hepaticoenterostomy (*2,9*).

The morbidity associated with the surgical repair of bile duct leaks has been an impetus in recent years for the development of alternative techniques to treat these injuries. Kaufman reported a series of 12 patients with bile leaks or fistulas who were managed with PTBD (*10*). In seven patients, the leak stopped with drainage alone; five patients required additional surgery. Although PTBD has been used successfully to control bile leaks, it has a number of disadvantages. The catheter can be uncomfortable and inconvenient for the patient. It may also serve as an avenue for bacteria to enter the biliary tract. Continuous biliary drainage may also produce fluid and electrolyte disturbances, particularly in elderly patients. In addition, PTC is often difficult in patients with nondilated ducts, a frequent problem encountered in patients with biliary leaks.

The most recent advance in the management of biliary leaks and fistulas has been the introduction of endoscopic sphincterotomy and the insertion of stents and nasobiliary drainage catheters. Iatrogenic bile duct injuries are most commonly located in the extrahepatic biliary tree and are well suited for endoscopic management. In 1986, Smith and Sauerbruch each reported the successful treatment of postoperative biliary fistulas with endoscopic biliary drainage (*11,12*). Leakage from various locations, including the common hepatic duct, cystic duct stump, common bile duct and T-tube sites, were successfully managed with only endoscopic techniques.

Although it was originally believed that stents induced healing by bridging the hole at the site of extravasation, recent reports suggest that these maneuvers help by decreasing the pressure gradient across the ampulla and relieving obstruction if it is present (*13*). The largest series of patients with endoscopically treated biliary fistulas was reported by Ponchon in 1989 (*13*). His team treated 24 patients with persistent biliary fistulas, most as a result of previous surgery. Eleven of the patients had distal bile duct obstruction. Twelve of the patients were managed by sphincterotomy alone and nine were cured by this method. Success was achieved in 7 of the remaining 12 patients, all of whom were managed with either endoprostheses or nasobiliary drainage. The only complication noted was bleeding from one sphincterotomy.

Ponchon noted four factors that influence the outcome of endoscopic treatment: (1) the type of distal biliary obstruction; (2) the size of the bile duct injury; (3) the location of the injury; and (4) the presence of associated lesions. In those patients where sphincterotomy alone was sufficient to reduce the pressure gradient between the common bile duct and the duodenum, a successful outcome could frequently be achieved without the use of an endoprosthesis or external drainage. Those patients with duct injuries larger than 0.5 cm did not heal. Intrahepatic lesions responded less well than extrahepatic lesions. Finally, a poor outcome was noted in patients with hepatic abscesses unless they were diagnosed and adequately drained.

Goldin has reported the successful endoscopic treatment of two patients with peripheral intrahepatic bile leaks without bridging the site of extravasation (*14*). Sphincterotomy and stent placement through the papilla sufficiently decreased the pressure within the biliary tree to allow the site of disruption to heal.

Laparoscopic Cholecystectomy

As previously stated, injury to the biliary tree is an uncommon problem. With incidence rates of less than 0.1% after routine biliary surgery, only a few cases per year would be expected, even at large university centers. However, with the rapid emergence of laparoscopic cholecystectomy, bile duct injury may become a more common problem.

Over the past two years laparoscopic cholecystectomy has emerged as an alternative to traditional open cholecystectomy. It offers the advantage of a shorter postoperative hospital stay, less postoperative pain, a shorter convalescent period, and a more acceptable cosmetic result (*15*). Although preliminary data suggests that laparoscopic cholecystectomy is a safe alternative to conventional cholecystectomy, the true incidence of complications has not yet been determined. To date, seven series (a total of 758 patients) have appeared in the literature (*15–21*). In these reports, complication rates have ranged from 0% to 5%.

Four patients have required conversion to an open cholecystectomy because of bile duct injury during the laparoscopic procedure. Peters reported one patient with an inflamed gallbladder who suffered an intraoperative tear of the common bile duct (*16*). Phillips noted one patient with unsuspected subacute cholecystitis who suffered a bile duct injury that was sutured during laparotomy (*17*). Salky noted a laceration of the common bile duct in a patient in whom the cyctic duct originated from the right hepatic duct (*18*). The fourth case was a common hepatic duct injury reported by Zucker (*19*).

Bile leaks have also been the major postoperative complication described after laparoscopic cholecystectomy. In the reported series, seven patients currently have been noted to have postoperative bile leaks: two from the cystic duct, two from the hepatic duct, two from small biliary radicals entering the gallbladder fossa, and one from the gallbladder bed (*15,16,20*). Five of these patients required additional surgery. The two patients with leakage from small biliary radicals were both successfully treated with endoscopically placed stents. Kozarek and Traverso have also reported a case in which a cystic duct leak after laparoscopic cholecystectomy was successfully managed with endoscopic stent placement (*22*).

In addition to the patient presented in this article, we

have seen two other patients at this institution with bile leaks after laparoscopic cholecystectomy. One leak originated from the cystic dump stump and the other probably from an accessory bile duct. We have also seen four patients who underwent laparoscopic cholecystectomy at other medical centers who developed biliary obstruction after sustaining bile duct injuries (23).

During the 758 laparoscopic cholecystectomies reported in the literature to date, six patients have sustained injuries to the hepatic or common bile ducts, an incidence rate of 0.8%. This figure is higher than those that have been reported after traditional open cholecystectomy (*2*). Additional data must be accumulated to determine if this increase in bile duct injury simply reflects inexperience with this new technique or an inherent risk of removing the gallbladder using the laparoscope.

CONCLUSION

Injury to the biliary tree is an uncommon medical problem that is most likely to occur during surgery or other types of trauma. The extravasation of a small quantity of bile occurs commonly after biliary surgery and is of little clinical significance. However, patients who develop fever, jaundice, abdominal pain, or profuse bilious drainage should be suspected of having a significant bile leak.

Ultrasonography and CT scanning are useful for detecting the presence of fluid collections in these patients, but they cannot demonstrate if the collection communicates with the biliary tree. Technetium-99m-IDA scintigraphy is a noninvasive and physiologic means of evaluating patients suspected of having bile leaks. It will document communication between a fluid collection and the biliary tree and will also establish the primary route of bile flow (i.e., through the leak or into the small intestine). Those patients with preferential flow into the small intestine will generally respond well to conservative management, including drainage of the fluid collection. Those patients with preferential flow through the bile leak frequently have biliary obstruction and require more invasive therapy. Injection of radiographic contrast directly into the biliary tree via either PTC or ERCP is the best means of localizing the anatomic site of the leak and diagnosing possible underlying biliary obstruction.

Those leaks detected intraoperatively are best treated by surgical repair. Postoperative leaks may also be repaired surgically, but the incidence of postoperative complications and stricture formation is significant. PTBD can be used to manage bile leaks but is fraught with drawbacks such as discomfort, inconvenience and infection. Endoscopic sphincterotomy and biliary endoprostheses have recently been employed in the successful management of both intra- and extrahepatic bile leaks and fistulas. Although the short-term results of these nonsurgical techniques are encouraging, the incidence of long-term complications such a biliary stricture has not yet been determined.

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