Chapter 24
Management of Bile Duct Injuries Within the First Forty-Eight Hours

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Introduction

The reemergence of bile duct injury (BDI) in the literature has followed the rapid increase in number of a laparoscopic cholecystectomies performed. In the 1990s, rates of BDI in laparoscopic cholecystectomy were reported between 0.4 and 0.6 % vs. 0.06 % in patients undergoing open cholecystectomy [1–5]. Though rates of BDI have decreased as laparoscopy has become the standard approach for cholecystectomy, a significant rate of BDI still occurs. From years 2000 to 2009, BDI rates were estimated at 0.3 % [6, 7]. Comparison between open and laparoscopic approaches is now biased by the infrequent use of the open procedure and selection for cases not amendable to laparoscopic intervention [8]. If not managed properly following BDI, patients are at significant risk from several physiologic sequelae, including intra-abdominal fluid collections, cholangitis, and hepatic dysfunction. These complications can culminate in severe sepsis and hepatic failure that lead to excessive morbidity and mortality as well as costs [5, 9, 10].

The first step in management of BDI is early recognition of the injury, yet achieving diagnosis within the first 48 h of injury has been proven difficult. Early recognition is instrumental in minimizing the complications associated with BDI. Once diagnosis is identified, steps should then be taken to determine biliary anatomy as well as refer to a hepato-pancreato-biliary (HPB) specialist. Importantly, it is the complications and their sequelae that will determine the appropriate timing of BDI

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repair. Intra-abdominal fluid collections will need to be drained, infections will require antibiotics, malnutrition must be addressed, and intra-abdominal inflammation may often delay the appropriate timing for formal biliary reconstruction. Given these key management principles, the first 48 postoperative hours following BDI is a critical time period for physicians to attain diagnosis and begin appropriate interventions to maximize chances for a successful early repair.

Patient Presentation

It has been unlikely for BDI to be identified during the index operation; between 68 and 87 % of patients with BDI will not be diagnosed until the postoperative setting [11–18]. In one cohort of 307 patients with BDI after laparoscopic cholecystectomy, only 28.9 % of cases diagnosed postoperatively were identified within 1 week of the index surgery [12]. Many factors can contribute to the delay in diagnosis. The laparoscopic cholecystectomy has become largely an outpatient procedure associated with routine protocols [19, 20]. Operative notes, discharge medications, and discharge instructions all likely follow a standard protocol. Further, when patients contact surgeons or their staff following discharge, routine responses may be given to complaints of mild nausea and pain. Given the frequent delay in BDI diagnosis, there is a need for higher vigilance in the immediate postoperative period.

Two common clinical scenarios should raise biliary injury into the clinician's differential when the patient presents in the first two postoperative days following cholecystectomy. In the first scenario, the surgeon experiences a difficult cholecystectomy and chooses to admit the patient for further observation. The degree of operative difficulty may be related to inflammation, bleeding, or anatomical variance that distort visualization and often leads to intraoperative uncertainty. In many of the cases, the primary surgeon may have chosen to convert from laparoscopic to open or leave a drain in the gallbladder fossa. On postoperative day one or two, the patient develops nonspecific signs and symptoms of abdominal pain and nausea with mild abdominal discomfort on exam.

While nonspecific, these clinical signs should prompt the possibility of BDI and any bilious drain output should raise definite suspicion. Of 151 patients referred for BDI repair in the Netherlands, initial diagnosis occurred postoperatively but during the initial hospitalization in 41 % [21]. Others have shown that the majority of patients discharged home that were later diagnosed with BDI had reported the presence of concerning symptoms during the index hospitalization [14]. Given the lack of evidence for routine cholangiography in preventing bile duct injuries, the rare use of cholangiography may lead to recognition of BDI more often in this postoperative period [7]. Even in cases where intraoperative cholangiography was performed, videotape review has shown that BDI cannot be ruled out in the postoperative setting due to error in operator interpretation or cholangiogram catheter placement [17, 22].

The second scenario involves a patient that is discharged home following uneventful cholecystectomy and subsequently contacts the surgeon or returns to the

emergency room with nonspecific symptoms of abdominal pain, nausea, anorexia, or fatigue [23]. These patients may not have developed any overt physical exam findings of jaundice and can show only mild abdominal discomfort on exam [13]. Again, these nonspecific signs should not be disregarded as benign and should be fully evaluated with the notion that a bile duct injury is possible.

These subtle clues are sometimes the only clinical information that will trigger the workup for BDI patients. Cholangitis, severe sepsis, or signs of peritonitis are unlikely to be presenting signs of patients with BDI during the first week [12–14, 21]. The outpatient origin of BDI diagnosis may be affected by pressure from reimbursement measures that use standardized assessment of medical necessity to qualify for in-patient hospitalization. The significance of BDI diagnosis in immediate postoperative setting is highlighted by the focus in malpractice cases. Delay in diagnosis of injury or complication is one of the most common causes of litigation following cholecystectomy and can lead to significant plaintiff payouts [24, 25]. Therefore, while BDI represents a rare event post cholecystectomy, clinical suspicion should develop early when patients present with postoperative signs or symptoms outside of the normal clinical course.

Diagnostic Work-Up: Initial Laboratory and Imaging Studies

In patients with post-cholecystectomy complications, diagnostic work-up should focus not only on defining the complication but also determining the extent of physiologic sequelae that have manifested as a result of the complication. These sequelae must be addressed in order to achieve clinical improvement. Laboratory workup should cover basic metabolic abnormalities, measures of hepatic and biliary dysfunction, nutritional markers, and systemic markers of infection. Laboratory results may show beginning signs of hepatic dysfunction such as transaminitis and hyperbilirubinemia [23]. Laboratory information alone will not define the complication. Further imaging is necessary to (1) assess for intra-abdominal fluid collections, (2) define biliary anatomy and patency, and (3) in select cases rule out hepatic vascular injury.

No specific order of imaging studies has been evaluated in the workup of BDI patients, yet the procedure-based nature of cholangiography may favor initial imaging for intra-abdominal fluid collections. Post-cholecystectomy intra-abdominal fluid collections can represent biloma, abscess, or hematoma. Biloma or abscess is a herald sign that a BDI may be present. Computed tomography (CT), ultrasound, magnetic resonance cholangiography (MRCP), or cholescintigraphy (HIDA scan) have been utilized to identify bilious fistula. HIDA scans, as opposed to CT, MRCP, and ultrasound, will not be able to determine the presence of abscesses. The usefulness in HIDA scans in assessing bile duct fistula may be limited to select circumstances such as determining the persistence of bile duct leak [23]. Though associated with significant cost and radiation exposure, CT imaging is often the preferred initial imaging modality for evaluation of BDI patients [26]. CT imaging has been

shown to have superior sensitivity (96 %) compared to ultrasound (70 %) or HIDA scan (64 %) for diagnosis of bilious ascites in the postoperative period [14]. In comparison, MRCP can reveal enhanced biliary anatomy with 95 % sensitivity for BDI as well as diagnose intra-abdominal fluid collections that would need to be addressed [27]. Thus MRCP can also be considered for initial imaging in evaluation of patients with concern for BDI.

Once fluid collections are identified, pursuit of drainage procedures is a key factor associated with successful BDI repair [12, 15]. Initial CT imaging will not only provide information about the presence of intra-abdominal fluid collection, but also will deliver information regarding approaches for interventional radiology to perform percutaneous drainage procedures as well as information regarding vascular patency and hepatic perfusion if arterial phase contrast is administered. In select cases BDI patients may present with diffuse biliary ascites, and percutaneous approach will provide insufficient drainage. For this situation, laparoscopic washout with drain placement will be indicated to minimize inflammation as well as infectious sources prior to biliary reconstruction.

Diagnostic Work-Up: Cholangiography

The multidisciplinary management of BDI patients is highlighted by the frequent need for percutaneous drainage procedures and by the critical role of complete cholangiography to define biliary anatomy. Cholangiography can be performed via endoscopic retrograde cholangiopancreatography (ERCP), MRCP, or percutaneous transhepatic cholangiography (PTC). MRCP is limited by lack of therapeutic capabilities in relation to ERCP and PTC. For all BDI, HIDA cholangiography alone will not be able to deliver the anatomical specificity needed to direct management. However, in the community setting, MRCP or HIDA may be the only tools readily available to determine the presence of a BDI and should be employed if necessary. If concern persists despite these tests, transfer to a facility with ERCP and PTC capabilities should be sought. Given availability of all modalities, we recommend initial evaluation with ERCP.

ERCP performed by a skilled endoscopist for symptomatic patients post cholecystectomy can play diagnostic and therapeutic roles. ERCP can differentiate between retained gallstones, cystic duct leaks, tumors causing biliary obstruction, and bile duct transections or stricture [22]. Therapeutic sphincterotomy, gallstone retrieval, and/or stent placement may be performed for retained gallstones, stricture, and compressive tumor [28]. In the case of Strasberg level A or D injuries, which include cystic duct leaks or lateral bile duct injuries, ERCP with endoscopic stent placement will allow the injury to heal with no need for further operative intervention [23, 29]. When ERCP identifies only distal biliary anatomy, PTC must be pursued to further define the injury as illustrated by Strasberg classification. In a patient with Strasberg type E1–5 injury, or complete bile duct transection, ERCP will show a blind end of the inferior bile duct with non-opacification of intrahepatic ducts;

PTC will be necessary to delineate the proximal extent of injury and will additionally offer proximal biliary drainage.

Lack of complete cholangiography has been shown to be associated was poor long-term success rates in bile duct repair [12, 15]. The potential harm of bile duct repair without cholangiography is illustrated by the case where a hasty surgeon pursues reoperation in a post-cholecystectomy patient found to have biloma with the assumption that the bile fistula is from a cystic duct stump or accessory duct leak that is in reality a common hepatic duct injury. Over sewing of the assumed incorrect structure due to lack of cholangiography would lead to a poor postoperative course in this patient [15]. In the case of high biliary injuries, bilateral PTC may be necessary to identify the location of the injury in relation to right and left hepatic ducts as well as injuries involving small ducts such as right posterior sector duct or an aberrant caudate duct. In such cases where only one lateralized PTC was placed, biliary reconstruction may not include a high injury on the hepatic duct opposite the PTC drain and inevitably lead to persistent bile duct fistula requiring subsequent reoperation.

Diagnostic Work-Up: Arteriography

Due to the proximity of the right hepatic artery to the common bile duct and right hepatic ducts, the right hepatic artery has been subjected to significant rates of injury in patients with BDI. Studies have found between 10 and 32 % of patients with BDI will have a concomitant hepatic artery injury, with the right hepatic artery most often implicated [12, 30–33]. Patient who are referred after failed management by the primary surgeon have illustrated even higher rates of concomitant hepatic artery injury [34]. The Strasberg level of injury is associated with the rate of hepatic artery injury; in a cohort of 28 patients with right hepatic duct injury, 18 (65 %) patients also had right hepatic artery injury suggesting the right hepatic artery may have been confused for the cystic artery [30]. Because of this high rate of rate of arterial injury, the role of routine arteriography by ultrasound, arterial phase CT angiography (CTA), or catheter-based angiography has been proposed.

Patients with BDI and hepatic arterial injury have higher rates of intraoperative or postoperative bleeding, hemobilia, abscess formation, and hepatic ischemia necessitating hepatectomy compared to patients with BDI alone [30]. In addition, there is concern that hepatic artery injuries may affect the long-term success rate of biliary reconstruction repairs due to poor arterial collateralization of the supraduodenal bile duct [34, 35]. Ischemic changes could impair biliary patency through anastomotic leaks or biliary strictures. Late hepatic necrosis could lead to abscess requiring drainage following an early BDI repair [32, 34–36]. When compared to patients with BDI alone, success rates of BDI repair in patients with right hepatic injury were significantly worse when performed by the primary surgeon. However, this difference was not seen when biliary specialists performed the repair [30]. The benefit of hepatic artery reconstruction is yet to be fully determined, but delivers

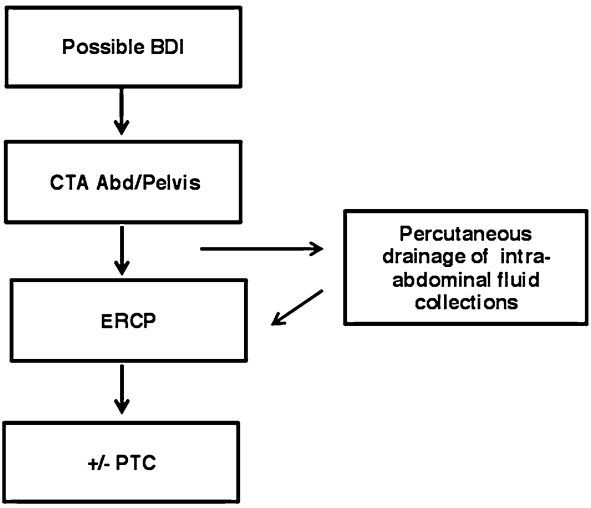

Fig. 24.1 Example of imaging sequence in work-up of patient with possible BDI

1. Pre-operative drainage of intrabdominal fluid collections
2. Complete cholangiography
3. Repair by HPB specialist
4. Surgical technique

Fig. 24.2 Key factor associated with successful BDI repair [15, 37, 38]

the most potential when the repair can occur within the first 48 h of injury [35]. Given these implications, further investigation of arterial injuries should be sought in BDI patients with high biliary injuries or when the primary surgeon conveys concern for vascular injury through anatomical uncertainty or amount of bleeding during the index operation. Use of triple-phase CTA during initial evaluation imaging of BDI patients can simultaneously diagnose this potential complication. An example of an imaging algorithm for work-up of patients with possible BDI patient is illustrated in Fig. 24.1.

Role of Early HPB Specialist Referral

Key factors shown to be associated with successful BDI repair, defined as durable restoration of biliary continuity, include preoperative biloma or abscess drainage, complete cholangiography, surgical repair technique, and repair performed by a biliary specialist (Fig. 24.2) [15, 37, 38] Success rates among 307 BDI patients undergoing initial BDI repair by biliary specialist were 91 % vs. 13 % in those

undergoing repair by the primary surgeon [12]. Patients with BDI injury repaired by the primary surgeon show higher postoperative rates of biliary stricture, cholangitis, need for subsequent intervention, as well as overall morbidity and mortality measures [5, 31]. Repair of BDI by biliary specialist has been shown to be more cost effective and associated with decreased length of patient symptoms. [10, 15]

Early referral of patients diagnosed with BDI to biliary specialist not only delivers specialized clinical expertise but also gives emotional detachment from the primary surgeon and may decrease potential litigation by avoiding association with further complications [25]. Despite these implications, review of Medicare beneficiaries from 1992 to 1999 found that 75 % of BDI repairs were performed by the primary surgeon [5]. Survey of surgeons in British Columbia in 2002 found that only 40 % sought HPB referral after a patient was diagnosed with BDI [39]. While surgeons may feel obligated to deal with the complications their patients experience, the obligation to provide the best possible outcome requires early HPB referral. The expertise of HPB specialist is now highlighted by an accredited fellowship. The correct time to arrange for transfer to biliary specialist is as soon as BDI diagnosis is made [40]. Further diagnostic or therapeutic interventions at the referring hospital should be limited to those necessary to minimize complications while awaiting transfer [18].

Early Versus Late Repair

Evidence regarding the appropriate timing for operative repair of BDI has produced controversial results. Proponents of delaying repair of BDI up to or beyond 6 weeks from the index injury procedure state that this time period is necessary for inflammation and infection to regress and is crucial for durable BDI repair. Inflammation may blur ischemic limits or impair dissection in the hilar plate necessary for high bile duct anastomosis. Delaying BDI repair may also allow for biliary dilation to make for a technically easier anastomosis and also allow for evolution of any hepatic ischemia secondary to hepatic artery injuries [13, 31]. Advocates for early repair of BDI state that that this will minimize the morbidity that patients experience while awaiting repair as well as eliminate their potential to develop new complications. Importantly, they argue that the inflammatory response around the hepatic hilum will be low enough within 72 h of the index procedure that a repair can be successfully completed with good long-term results [13].

Variations in time intervals to BDI repair across studies have explained some of the differences observed. While three studies have shown that time to BDI repair did not make a difference, one study of 151 patients with BDI found that repair undergone less than 6 weeks from injury was associated with higher major complications rates [11, 12, 16, 21]. These complications included higher rates of long-term anastomotic stricture [21]. The authors hypothesized that the complications were driven by persistent perihepatic inflammation or infection and that repairs undergone in the period within 72 h of biliary injury should be further examined. Smaller follow-up

studies confirmed that repair within 72 h post-injury was associated with improved outcomes including biliary stricture rate, extended ICU stay and intra-abdominal abscesses compared to longer delays from injury to repair [13, 18].

One important source of bias in the analysis of time to BDI repair is the delay that occurs when patients are transferred to a biliary specialist. A significant difference between biliary surgeons and primary surgeons in BDI reconstruction is that repair by biliary surgeons is associated with a longer delay from BDI diagnosis to operative repair in patients who present with severe symptoms such as cholangitis, abscess, peritonitis, or shock. This can be indicative of appropriate preoperative diagnostic and therapeutic interventions including fluid collection drainage as well as complete cholangiography, which are strongly associated with successful BDI repair. When multivariate analysis was applied, time to repair of BDI was not associated with success rates in initial BDI repair [12]. Contrarily, study of 112 BDI patients who only underwent biliary reconstruction performed by a biliary specialist found that repairs greater than 21 days from injury were associated with increased reoperations and overall morbidity [31].

Given these findings together, the timing of BDI repair must be individualized for each patient [41]. When patients are diagnosed with BDI, referral arrangements to an HPB specialist should be made immediately. The patient should be evaluated for intra-abdominal fluid collections and complete cholangiography should be performed. If fluid collections or bilious ascites are present, the patient should undergo the appropriate drainage procedures. Following drainage procedures, BDI repair should be delayed up to or beyond 6 weeks to allow inflammation and infection to regress. If the patient does not illustrate intra-abdominal fluids collections, has minimal metabolic disarrangements, and possesses the appropriate physiologic reserve, immediate repair may be undertaken by a HPB specialist.

UAB Experience

BDI referrals to the UAB HPB service come mostly from statewide community hospital settings. Referral is made largely in the postoperative period after cholecystectomy when fluid collections are found, but occasional intraoperative consults from primary surgeons do occur. Upon arrival to our institution, patients undergo laboratory work-up for metabolic abnormalities, hepatic and biliary function, as well as nutrition and infectious markers. Immediate imaging consists of triple-phase CT to identify intra-abdominal fluid collections, hepatic arterial patency, and any evidence of hepatic ischemia. Our next goal is to define biliary anatomy. Cholangiography is first performed through consultation with gastrointestinal medicine colleagues for ERCP diagnostic and potential therapeutic capabilities. For Strasberg level E injuries, where proximal biliary anatomy is incomplete, interventional radiology is consulted for PTC and drains are left in place. When drainage from bilateral hepatic ducts is unclear, bilateral PTC drains are pursued. If intra-abdominal collections are present, percutaneous drainage is performed and

antibiotics therapy initiated as appropriate. Cases that present within 72 h of injury with no need for drainage procedures and minimal complications will be considered for early biliary reconstruction. Arterial reconstruction is considered on a case by case basis. Otherwise biliary repair is delayed for 6 weeks with focus on nutritional support and antibiotic therapy during the intervening time as indicated.

Conclusions

Patients with BDI often present with only vague symptoms of nausea and abdominal discomfort in the first 48 h following injury. High clinical suspicion is necessary for early identification of injuries. Laboratory workup should assess for metabolic abnormalities, hepatic function, nutritional parameters, and signs of infection. Imaging should include evaluation for intra-abdominal fluid collections, complete cholangiography, and arteriography for select cases. All intra-abdominal biloma or abscesses should be drained to alleviate infection and inflammation prior to BDI repair. Patients should be transferred to HPB specialist as soon as BDI has been diagnosed. Immediate biliary reconstruction may be pursued if no drainage procedure is required and the patient is physiologically fit. When drainage procedures are required, infection is present, or inflammation is excessive, BDI repair should be delayed up to or beyond 6 weeks.

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