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Bile Leaks

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INTRODUCTION

Bile duct leaks (BDL) are characterized by a mural defect in the intrahepatic and or extrahepatic biliary tree leading to leakage of bilious fluid into the abdominal cavity.[1] Post-surgical causes of bile leak after laparoscopic cholecystectomy and orthotopic liver transplant (OLT) occur in 1% and 26% of cases, respectively.[2]

Other non-surgical procedures that potentially lead to iatrogenic bile leak include liver biopsy, trans-jugular intrahepatic portosystemic shunting (TIPS) procedures, and hepatic tumor ablation therapies.[2] Most non-iatrogenic bile leaks are due to trauma. These include penetrating injuries, such as gunshot or knife wounds, or blunt trauma, such as falls or motor vehicle accidents.[3]

The clinical presentation of bile leaks ranges from asymptomatic bile drainage to life-threatening conditions such as biliary peritonitis. Typical presentation symptoms include abdominal pain, fever, ascites, and jaundice.[4] Regardless of the etiology and clinical presentation, bile leaks can cause significant morbidity and, rarely, mortality in afflicted patients.[5] Early diagnosis is critical, with various diagnostic imaging modalities that have been described. Ultrasound and Computed Tomography (CT scan) can detect intra-abdominal collections or biliary dilation, suggesting common bile duct (CBD) obstruction.[6] Hepatobiliary iminodiacetic acid (HIDA) scan can be useful in detecting biliary leaks, particularly when ultrasound and CT scan are equivocal; however, they cannot anatomically localize the site of leak.[7] Magnetic resonance cholangiopancreatography (MRCP) can also detect a bile leak if transabdominal ultrasound is nondiagnostic. However, its use is limited by its inability to offer therapeutic interventions.[8]

Endoscopic retrograde cholangiopancreatography (ERCP) provides a minimally invasive technique that replaces surgery as the preferred treatment in most patients with biliary leaks. The benefits of ERCP include identifying the leak site in real time coupled with the ability to perform direct therapeutic interventions to treat the patient and heal the leak directly.

ERCP-based approaches to patients with bile leaks include performing a biliary sphincterotomy, with or without placement of a trans papillary biliary stent. Endoscopic therapy aims to eliminate the trans-papillary pressure gradient, which promotes

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trans-papillary bile flow and potentially bridges or covers the leak, promoting healing.[2] I.e., in a normal patient, the only route for bile to exit the biliary tree is the Sphincter of Oddi/Ampulla of Vater. In the setting of a bile leak, the leak site itself becomes the path of least resistance for bile to flow. Endoscopic therapy aims to make the path of least resistance for bile flow to be towards the duodenum. Once this situation is established, bile flow through the site of the leak itself will diminish greatly and the leak will heal.

ERCP is highly effective for treating bile leaks; however, in the presence of a perihepatic bile collection, percutaneous drainage is an adjunctive therapy that should be considered to achieve symptom relief and to reduce the risks of abscess formation and bile peritonitis. Surgical management of bile leaks is performed very rarely in modern practice and is reserved for therapeutic failures or bile leaks from high-grade injuries, or for patients who cannot undergo ERCP due to anatomic constraints i.e. postsurgical anatomy.[2] This article focuses on the different etiologies of bile leaks, clinical presentation and diagnosis, and the role of ERCP in the management of bile leaks.

Classification of Bile Leak

There are several classification systems for bile duct injury post-cholecystectomy, including the Bismuth classification, The Strasberg classification, and the Amsterdam classification.[10,11] Of these, the Amsterdam classification is the most straightforward. It characterizes bile duct injuries and leaks into four types: A: cystic duct or aberrant hepatic duct leak, B: major bile duct leak with or without concomitant stricture, C: bile duct stricture without leakage, D: complete transection of the duct. Among patients with Amsterdam type A leaks, the most common type of bile duct injury encountered after cholecystectomy, success rates for ERCP-based techniques approach 100%, whereas Amsterdam type D leaks generally require surgery.[12]

Sandha et al. proposed a two-category system of grading bile leak severity.[13] They sub-categorized bile leaks into two major categories:

- Low-grade (LG, i.e., a leak identified only after opacification of the intrahepatic biliary duct)
- High-grade (HG, i.e., a leak observed fluoroscopically before intrahepatic opacification.)

This classification aimed to provide a practical endoscopic classification system for bile leak after cholecystectomy for optimal endoscopic management.

Role of ERCP in the Management of Bile Leaks

ERCP has emerged as a preferred minimal invasive approach for biliary leaks' primary treatment.

Binmoeller et al., in 1991, first reported a case series on the endoscopic management of postoperative biliary leaks. In their study, endoscopic treatment was technically successful in 95% of cases and resulted in healing of the leak itself in 82% of cases.[14] Modern rates of technical and clinical success have only improved over time.

Despite favorable outcomes of ERCP, there is still an ongoing debate on the principles of endotherapy regarding the optimal time to intervene, and which technique to use (sphincterotomy with or without placement of stents), the size of stents, and the type of stent (metal versus plastic).[15]

I. Timing of ERCP

There is no consensus on the appropriate timing of ERCP for biliary leaks, with variability in the timing of ERCP between different centers. In general, most patients with bile leaks can be treated electively, especially if a biliary fluid collection (i.e. biloma) has been percutaneously drained already.

A retrospective multicenter study of patients with bile leaks showed that there was no statistically significant difference in BDL healing among patients who underwent ERCPs performed within 1 day compared with those performed on day 2 or 3 or after 3 days of bile duct injury (91.2%, 90%, and 88.5%, respectively; P = .77). Overall, adverse event (AE) rates were similar among the 3 groups (21.1%, 22.9%, and 24.6%, respectively; P = .81). However, the 90-day mortality rate was lower in the group who underwent ERCP on day 2 or 3 than in those admitted for ERCP within 1 day or after 3 days, but this difference was not statistically significant.[16] The findings of this study demonstrated that the overall success rates and AEs after ERCP were not dependent on the timing of

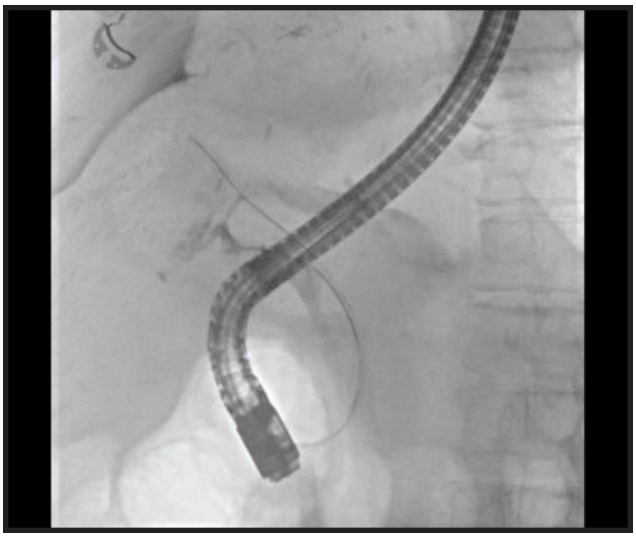

Figure 1a. Right Living Donor Transplant with two separate anastomoses:
- **Right anterior to recipient CHD and right posterior to recipient cystic duct.**
- **Leak from cystic duct.**

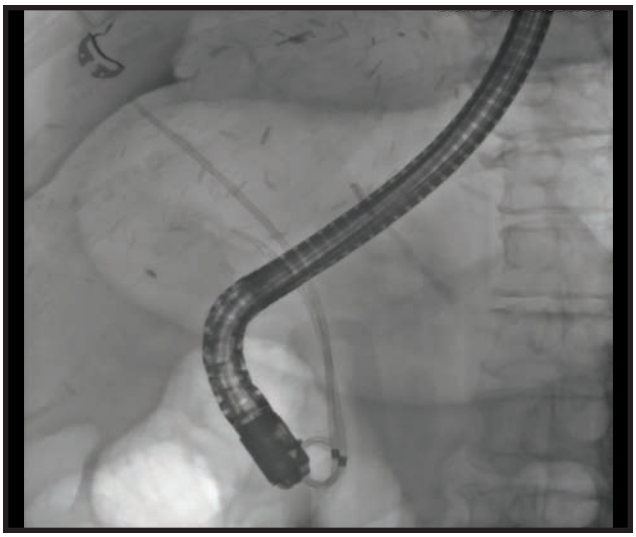

Figure 1b. 7 Fr plastic stent placed in the cystic duct and right anterior duct.

the procedure on the discovery of the bile leak. This study has also been used to demonstrate that most bile leaks do not warrant emergent ERCP. It is important to note that the relationship between the ERCP's timing and outcomes in patients with an undrained or infected biloma were not evaluated in this study.[16]

Similarly, Abbas et al. performed a retrospective, nationwide, inpatient analysis of 1,028 patients who underwent ERCP for a bile leak. ERCP was classified as emergent, urgent, and expectant if it was performed within 1 day, after 2 or 3 days, or after 3 days after the biliary leak occurred, respectively. Their results showed that post-ERCP AEs were similar (11%, 10%, and 9% for emergent, urgent, and expectant ERCP, respectively ($P = .577$). This study further promoted the notion that most bile leaks do not need to be treated emergently via ERCP. However, in-hospital mortality showed a U-shape trend of 5%, 0%, and 2% for emergent, urgent, and expectant ERCP, respectively ($P < .001$).[17] The authors suggested the apparent high mortality in patients who underwent an emergent ERCP was likely to a selection bias; patients with initial clinical severity were more likely to undergo emergent ERCP.

Nevertheless, while consensus guidance on the timing for endoscopic therapy for BDL is lacking, limited data from the above studies demonstrate that the timing of ERCP is not a significant predictor of post-ERCP outcomes. It is conceivable that ERCP should not be delayed for more than 3 days, particularly if evidence of a persisting bile leak. More large prospective studies are warranted to determine the timing of ERCP in patients with bile duct leaks.

II. Sphincterotomy versus stent placement without sphincterotomy and combination therapy

Currently, there is no consensus on the optimal endoscopic intervention for the management of bile leaks regarding sphincterotomy (EST) versus bile stent placement (BS) without sphincterotomy or combination therapy (EST+BS). Any or all of these approaches should decompress the biliary tree and promote drainage to the duodenum with subsequent bile leak healing. Multiple studies have compared the efficacy of sphincterotomy versus biliary stenting with sphincterotomy with conflicting results.

In a prospective study of patients with post-cholecystectomy bile leaks undergoing EST+10 Fr BS placement versus a 7 Fr BS without EST, resolution occurred in100% of patients in both

Figure 1c. Leak is resolved after 6 weeks of stent dwell time.

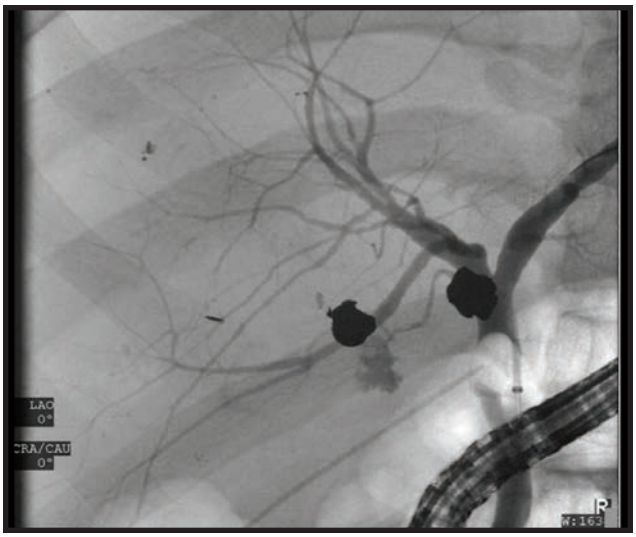

Figure 2. Bile leak from a branch of the right hepatic ductal system after gun shot wound.

groups, arguing against the need for EST at all in this setting. The authors concluded that endoscopic therapy with small diameter biliary stents without endoscopic sphincterotomy is effective and safe as endoscopic sphincterotomy followed by insertion of large-diameter stents in treating biliary leaks after laparoscopic cholecystectomy.[18]

In contrast, Abbas et al., in a nationwide analysis database, demonstrated that combination therapy of EST+BS or BS monotherapy had lower failure rates of 3% and 4%, respectively, compared with EST monotherapy which had a failure rate of 11% ($P < .001$). On multivariate analysis, both combination (EST+BS) and BS monotherapy were less likely to fail than sphincterotomy monotherapy.[17] It should be noted that EST monotherapy may be suitable in patients who are felt to be at risk for poor follow-up, as it does not involve stent placement and subsequent ERCP for removal.

More recently, Vlaemynck et al. conducted a network meta-analysis comprising 11 studies to compare EST vs. BS vs. combination (EST+BS) treatment in treating bile leaks. Stenting was further stratified into leak-bridging and short stenting (i.e. stenting only across the ampulla and not the leak site itself).[19] Compared with EST monotherapy, the combination therapy with leak-bridging stenting had a significantly higher success rate.[19] Interestingly, there was no significant difference between biliary stent monotherapy (either leak-bridging or short stents) and EST monotherapy.[19] It is worth noting that a leak-bridging stent was inserted, when possible, whereas, in patients with leaks that were located too peripherally within the biliary tree, a short stent was used.

In general, it is not necessary to bridge the leak site, although it could be considered technically feasible. Some endoscopists prefer to place the proximal end of the stent into the affected system in hepatic, intrahepatic, and sub vesical bile duct (duct of Luschka) leaks. There is often a perception that bridging the leak site will promote healing more rapidly, but data to support this notion is lacking.

In the absence of consensus guidelines focusing on endoscopic management of biliary leaks, limited data suggest stenting with or without sphincterotomy has better outcomes than sphincterotomy alone. It is conceivable that the selection of endoscopic intervention (e.g., sphincterotomy alone, stenting alone, combination therapy) should be based on multiple factors, including the presence of a retained CBD stone, severity of the bile leak, and patient's risk for complications of sphincterotomy (e.g., bleeding, perforation).

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III. Large diameter stents versus small diameter stents

The optimal size of the stent introduced during ERCP is still debatable. In general, 10 F plastic biliary compared to 7 Fr stents have potentially more durable patency and are likely to improve downstream flow; however, limited data suggests so. 8.5 Fr stents are also widely available and can be placed without the need to perform a biliary sphincterotomy and may be a good option for many patients as they offer patency rates comparable to that of 10 Fr stents.

In a randomized trial of 7 Fr vs. 10 Fr stents for post-cholecystectomy bile leaks, there was no difference in success rates between the two groups.[20] The stent size also did not affect the outcome of the endoscopic intervention in their cohort of patients. It is important to note that most patients included in this study had minor biliary leaks. Therefore, generalizability to the treatment of more significant biliary leaks cannot be confirmed.

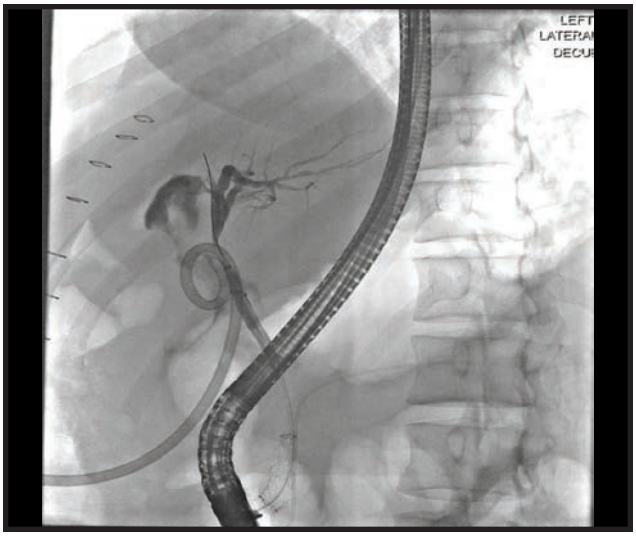

Figure 3a. Metastatic ovarian tumor debulking with cholecystectomy complicated by right intrahepatic injury. A short fully covered metal stent was placed due to post-sphincterotomy bleeding. A 7 Fr stent was placed through the metal into the right duct (not shown).

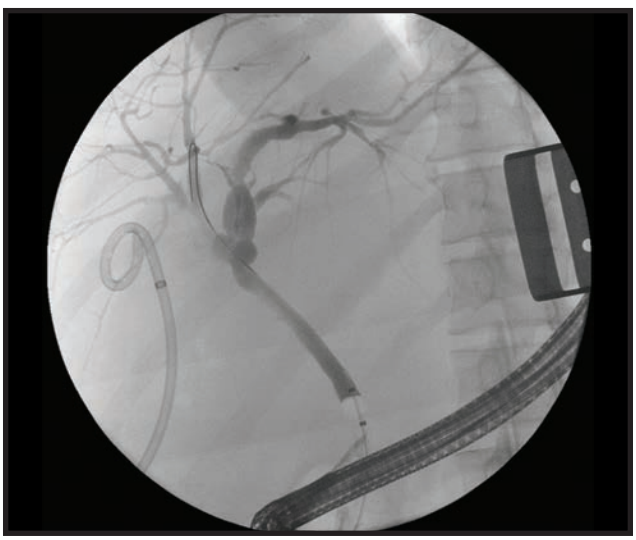

Figure 3b. Resolution of bile leak after 4 weeks of stent placement.

Types of Bile Duct Leaks and Treatment

Post-Cholecystectomy Bile Leaks

Bile leaks are reported in up to 1.1% of patients undergoing cholecystectomy and are usually associated with complex operations, technical problems, or conversion to open cholecystectomy.[21-23] Post-cholecystectomy bile leaks make up more than 80% of all post-surgical bile leaks.[16] Leaks can occur from the cystic duct remnant ("stump") in up 77% of cases.[21] Cystic duct remnant leaks may occur due to failure of clip ligation or iatrogenic injury during surgery. Cystic duct remnant leaks can also occur in the absence of any surgical error.

Patients usually present with increased bilious output from the surgical drain within days of the procedure, but delayed presentations up to 30 days postoperative can also occur.[24] Drain fluid bilirubin greater than three times the serum bilirubin is commonly used to support the diagnosis of a bile leak, but in practice this is rarely checked. If the drain output is obviously bilious, a leak is likely present.

In patients with severe bile leaks, abdominal pain, fevers, distension, and jaundice may also occur. Additional workup may include abdominal ultrasound to assess for fluid collection or biliary tree caliber. MRCP with a biliary contrast agent such as Eovist or Cholescintigraphy using 99mTC-hepatic iminodiactic acid (HIDA scan) can be used to confirm the presence and location of post-cholecystectomy bile leaks and assess

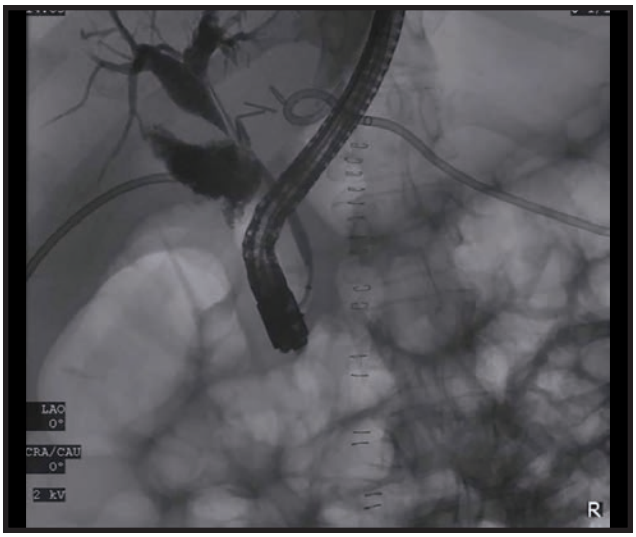

Figure 4. Anastomotic bile leak in a patient with history of decompensated NASH cirrhosis who underwent liver transplant.

Figure 5a. Cholangiogram revealed a leak from the right intra-hepatic ducts after a Grade IV liver laceration from a motor vehicle accident.

for concomitant choledocholithiasis prior to any interventions being performed, but is not required in most cases as once the presence of a leak is established ERCP is performed.

ERCP is the mainstay of therapy for post-cholecystectomy bile leaks. Endoscopically placed biliary stents are typically left in situ for 4-6 weeks. Percutaneous drains, if present, should be removed once drain output has resolved or is less than 10cc per day. In most patients with bile duct leaks, drains are typically removed by the time of the follow-up ERCP. At follow-up ERCP, an occlusion cholangiogram is generally performed to confirm that the site of the leak has healed. If the leak persists, a new stent can be placed and the patient can be scheduled for a follow up ERCP in another 4-6 weeks. ERCP is highly successful in treating post-cholecystectomy leaks, with success rates ranging from 90-95% of cases.[25,26]

In patients with biloma collections, percutaneous drainage is usually required in addition to ERCP. However, if the patient is not symptomatic from the biloma, a reasonable strategy is to perform endoscopic therapy of the leak and allow spontaneous reabsorption of the biloma. If the biloma persists despite endoscopic therapy, then percutaneous drainage can always be performed at a later date.

In up to 10% of bile leak cases following cholecystectomy the leak may persist despite endoscopic therapy.[27] In these cases, one must consider the possibility of transection of an aberrant right hepatic duct, which can cause leakage from both the proximal and distal aspects of the transection. An MRCP with or without Eovist or a HIDA scan can be performed if suspicion remains high prior to performing ERCP.

In patients with refractory bile leaks, fully covered self-expanding metal stents (FCSEMS) or multiple plastic stents are attractive options. In a prospective series of patients who failed conventional ERCP with plastic stents, FCSEMs resulted in the resolution of the bile leaks in 94% of patients.[28] In a retrospective study of patients with post-cholecystectomy bile leaks that were unsuccessfully treated with a combination of biliary sphincterotomy and the placement of a 10F trans-papillary biliary stent, the subsequent placement of a FCSEM led to much higher success rates than multiple plastic stents (100% vs. 65% respectively, $p<.004$).[29]

It is plausible that the large metallic stent diameter diverts more flow away from the leak site, causing a significant decrease in the pressure gradient at the papilla. Additionally, the FCSEMS directly covers the leak site and exerts expansile pressure along the bile duct wall, increasing the potential for sealing/occluding the leak leading to

Figure 5b. Colangiogram showing resolution of bile leak after 6 weeks of stent placement.

the healing of the bile leak. FCSEMS placement for bile leaks is fully within the standard of care at this time.

Bile Leak Post-Liver Transplant

The incidence of bile leak after liver transplantation (LT) ranges from 2% to 25% and usually occurs within 1 to 3 months post-transplantation.[30] Bile leaks are the second most common biliary adverse event following liver transplant and are a cause of significant morbidity for liver transplant recipients.[31] Moreover, bile leaks are considered an independent risk factor for developing early or late anastomotic biliary strictures, highlighting the importance of timely diagnosis and management.[32] Bile leaks post liver transplant are classified as being anastomotic or non-anastomotic.[31]

Anastomotic bile duct leaks occur due to technical challenges in reconstruction, such as excessive dissection of periductal tissue at the anastomosis or ischemic necrosis at the bile duct anastomosis, or may simply be due to impaired healing following surgery.[30] Non-anastomotic bile leaks originate from either failed ligation of the cystic duct remnant, elective or inadvertent T-tube removal, the cut surface of a partial liver in recipients of living donor allografts, or deceased donor split-liver transplants.[33]

Post-transplant bile leaks can be classified as early when they occur within 4 weeks of liver transplant and late when they occur beyond 4 weeks. Early bile leaks usually arise from the anastomosis and may be related to insufficient blood flow from the hepatic artery to the anastomosis.[34] Late bile leaks tend to be rare and occur due to recurrence or persistence of early complications, delayed removal of T-tubes or biliary stent migration and perforation, and hepatic artery thrombosis.[30]

The clinical presentation of a bile leak post liver transplant varies with the extent of the leak. A bile leak should be suspected in any patient who develops abdominal pain, fever, or any sign of peritonitis following liver transplant, especially after T-tube removal. Some patients, especially those on corticosteroids, may be asymptomatic, with no symptoms of pain or fever. In asymptomatic patients, bile leak should be suspected if there are unexplained elevations in serum bilirubin, fluctuation in cyclosporine levels, or bilious ascites.[35]

The role of transabdominal ultrasound (US) is limited to early detection of biliary leaks, as it lacks sufficient sensitivity to detect small but clinically significant ductal changes and more delayed leaks.[36] MRCP has also been studied to detect biliary complications after OLT but has not been effective in identifying the location of the site of the leak itself unless hepatobiliary contrast is used.[37] Small anastomotic leaks can be diagnosed with a T-tube cholangiogram in recipients with a T-tube, although the use of a T-tube following liver transplant is becoming uncommon.

ERCP remains the gold standard for the diagnosis and therapy of bile leaks following liver transplant.[34] Individualized endoscopic management of bile leaks is determined by the type of biliary anastomosis and the severity of the bile leak. In a retrospective study of patients with bile leak after liver transplant, BS+/-EST had a much higher resolution rate than EST monotherapy (94% vs. 58%, $p<.001$). This study demonstrated that ERCP with plastic stent placement is highly successful and more effective than sphincterotomy alone for post-LT bile leak treatment.[31]

Simple biliary defects including the T-tube exit site, the cystic duct remnant, or small anastomotic leaks typically heal within 2 to 6 weeks; hepatic surface leaks that may take up to 8 weeks to

resolve.[38] However, stents can be left in place for as long as needed clinically as some patients may experience delayed healing due to the use of immunosuppression.[39] Small anastomotic leaks can be managed in recipients with a T-tube by leaving the tube open to drainage without further intervention.[39] If symptoms persist, ERCP (with or without sphincterotomy) with biliary stent placement may be indicated.[39]

There is limited data on the safety and the formal efficacy of partially or, more commonly, fully covered self-expanding metal stents for the treatment of post-liver transplant bile leaks that have not been established, although in practice the use of FCSEMS in this context is widespread. In a retrospective series of 31 patients with post-liver transplant bile leaks, endoscopic therapy was performed with the placement of SEMS (3 partially CSEMS, 18 FCSEMS with fins, and 10 FCSEMS with flare ends). Clinical success was achieved in 100%, 77.8%, and 70%, respectively. Postplacement complications included cholangitis (1) and proximal migration (1), both of which occurred among patients treated with FCSEMS with fins. Large studies with long-term follow-up data regarding the safety, efficacy, and cost-effectiveness of CSEMS are needed.[40]

Anastomotic leaks are less common among liver transplant patients with Roux-en-Y hepaticojejunostomy anastomosed. However, for such patients with a bile leak, ERCP is technically challenging and may often not be feasible due to anatomic difficulties in reaching the biliary anastomosis. Management of these patients usually involves percutaneous biliary drainage and decompression, often with an internal/external catheter.[41] Surgery or a percutaneous transhepatic approach is reserved for patients in whom ERCP is unsuccessful or, more commonly, not technically feasible, particularly when biliary extravasation is major, or the anastomosis is significantly disrupted.[41] Large or infected bilomas should be drained percutaneously by placing an indwelling catheter and administering intravenous antibiotics.[41]

Post-traumatic bile leaks

Bile leaks can result from penetrating injuries, such as gunshot (GSW) or knife wounds, or from blunt trauma, such as bicycle, motor vehicle (MVA) or motorcycle accidents (MCA).[3] The incidence of bile leaks following hepatobiliary trauma ranges from 0.5 to 21%, depending on the criteria and methods used to diagnose the bile leak itself.[3] The clinical presentation of traumatic bile duct injury is often nonspecific and can include right upper quadrant pain, fever, nausea with vomiting, and/or jaundice. Traumatic biliary leaks can lead to organized collections or unorganized intra-abdominal bile spillage with subsequent bile peritonitis. The presence of bilious output from a surgically placed percutaneous drains or at the surgical incision site should be considered evidence of a bile leak.

There is limited data on the endoscopic management and outcomes of biliary injury after blunt or penetrating abdominal trauma due to a low frequency of presentation of traumatic bile duct injuries. Endoscopic management of traumatic biliary leaks is extrapolated from data on iatrogenic leaks after cholecystectomy. The treatment is often based on the injury's extent and the mechanism of the injury itself, associated organ injuries, and local expertise.

ERCP is a valuable tool for diagnosing and treating post-traumatic bile leaks, mainly when repeat surgery is deemed a substantial risk and control of post-traumatic BL is incomplete.

In a retrospective series of 10 patients with traumatic bile leaks over a three-year period, ERCP resulted in resolution in 90% of patients. The majority of patients in this study had a penetrating injury from a GSW (5 patients), blunt injuries from a MVA (4 patients), and injury secondary to a fall in 1 patient. There were no ERCP-related adverse events.[42] In a retrospective series of 14 patients who underwent ERCP for traumatic bile leaks over a 5-year period, the success rate of endoscopic therapy was 100%. The etiologies included blunt trauma from MVA in 8 patients, motorcycle accident in 3 patients, and penetrating injury from a GSW in 3 patients. The mean duration of follow-up was 85.6 days (range 54-175 days). There were no ERCP-related adverse events.[43]

The aforementioned studies highlight the role of ERCP in managing traumatic bile duct leaks. If an extrahepatic biliary fluid collection is present, percutaneous drainage of intra-abdominal fluid

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is an adjunctive treatment modality of choice to decrease the high risk of infection.

Bile leaks after liver resection

Bile leakage post liver resection (LR) is associated with an increased rate of sepsis, liver failure, and higher postoperative mortality.[44] The frequency of bile leaks after hepatectomy ranges from 3.6 to 10%.[45] Bile leaks following LR can be classified as central bile leaks if they occur from the hilum or common hepatic duct or peripheral bile leaks if they arise from the resection surface.[46] Central bile leaks after LR tend to manifest as larger volumes of bile spillage into the peritoneum and have been associated with a worse prognosis than peripheral leaks.[46] Risk factors for bile leaks after LR are related to technical aspects of the surgery, including longer operative time, left hemi-hepatectomy, segment IV resection, and advanced age.[47]

Options for managing post-LR leaks include surgical repair, percutaneous drainage, and endoscopic therapy. The majority of post-LR can be managed with ERCP with stent placement with or without biliary sphincterotomy. Compared to peripheral leaks, placement of stents spanning the area of the leak in central leaks is preferred. ERCP is typically repeated after 2–6 weeks, and the stents are removed if the leak has healed and replaced if additional treatment is indicated.

Dechene et al. evaluated the efficacy of ERCP in treating bile leaks after liver resections in a series of 60 patients. In 46 patients (77%), endoscopic therapy successfully resolved the bile leak without further surgical interventions. The logistic regression model identified only endoscopic sphincterotomy without stent insertion (P =.002) as highly significant for the failure of endoscopic therapy.[48]

Refractory bile leaks

ERCP effectively resolves 70%–100% of post-cholecystectomy bile leaks and up to 84% of bile leaks after cadaveric liver transplant.[49,50] Despite the safety and efficacy of endo-therapy for bile leaks, refractory bile leaks do occur, leading to multiple endoscopic interventions and, rarely, surgery.[51] The optimal approach for refractory/complex leaks has not been clearly defined but is approached similarly to post-cholecystectomy leaks with FCSEMS or simultaneous placement of multiple plastic stents, depending on the clinical scenario.

Other innovative endoscopic treatments of refractory biliary leakage include n-butyl-2 cyanoacrylate glue occlusion during ERCP and endoscopic coil placement. Currently, the safety and success of these techniques are based on limited case reports. Large cases series are currently warranted to determine the role of these therapies.[52,53]

CONCLUSION

Bile leaks are a common and well-described complication of hepatobiliary and gallbladder surgery, and with early and prompt recognition treatment usually results in excellent outcomes. Post-cholecystectomy bile leaks are the most common post-surgical leaks. Bile leaks also occur after liver transplant, liver resection, traumatic injury, and iatrogenic bile duct injury during an unrelated intraabdominal surgery, a liver biopsy, or other interventions. With the advent of endoscopic therapy, the surgical treatment of bile leaks is no longer commonplace and reserved for rare refractory leaks. Endoscopic therapy is generally performed using the combination of endoscopic biliary sphincterotomy and biliary stent placement. Although endoscopic biliary sphincterotomy monotherapy has been advocated in the past, the preponderance of the literature seems to favor the addition of a biliary stent for improved outcomes. The data also suggest that the stent should bridge the leak if feasible, but this is not mandatory. Among patients with refractory leaks, fully covered metal stents and multiple plastic stents represent an attractive option that has been shown to improve resolution rates. Further large and randomized studies are needed to study topics such as the timing of ERCP and management of refractory leaks. ■

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Answers to this month's crossword puzzle:

1 D	I	2 V	E	3 R	T	4 I	5 C	6 U	L	I	T	7 I	S	
U		I		E		8 D	A	S				N		
9 M	E	L	E	N	A		10 B	E	L	11 C	H	I	N	12 G
P		L		N			L			O		T		A
13 I	C	U		14 I	N	15 G	E	16 S	T	A		17 I	18 P	S
N		19 S	U	N		R		I		20 T	R	A	C	E
21 G	22 I				23 R	A	N	G	E			T		O
	24 I	25 N		26 G		M		N		27 G		28 E	29 D	U
30 H	I	A	T	A	L		31 P	S		L			32 O	S
E		U		T			R		33 M	U	34 C	35 U	S	
36 R	E	S	E	C	T	37 I	O	38 N		39 C	U	R	E	40 S
N		E		H		N		I		A		41 I	S	T
42 I	R	O	N		43 C	O	L	L	44 A	G	45 E	N		A
A		U		46 A		S			47 B	O	W	E	L	S
		48 S	P	L	E	E	N		49 O	N	E			H