

# Endoscopic management of biliary injuries and leaks

T. S. Chandrasekar, Hameed Hussain, M. Muruges

Department of Medical Gastroenterology, MedIndia Institute of Medical Specialities, Chennai, MedIndia Hospitals, Coimbatore, India

## Abstract

Bile duct injuries and subsequent leaks can occur following laparoscopic and open cholecystectomies and also during other hepatobiliary surgeries. Various patient related and technical factors are implicated in the causation of biliary injuries. Over a period of twenty five years managing such patients of biliary injuries our team has found a practical approach to assess the cause of biliary injuries based on the symptoms, clinical examination and imaging. Bismuth classification is helpful in most of the cases. Immediate referral to a centre experienced in the management of bile duct injury and timely intervention is associated with improved outcomes. Resuscitation, correcting dyselektrolytemia, aspiration of undrained biloma and antibiotics take the priority in the management. The goal is to restore the bile conduit, and to prevent short and longterm complications such as biliary fistula, intra-abdominal abscess, biliary stricture, recurrent cholangitis and secondary biliary cirrhosis. Endoscopic therapy by reducing the transpapillary pressure gradient helps in reducing the leak. Endoscopic therapy with biliary sphincterotomy alone or with additional placement of a biliary stent/ nasobiliary drainage is advocated. In our tertiary care referral unit, we found endoscopic interventions are useful in situations where there is leak with associated CBD calculus or a foreign body, peripheral bile duct injury, cystic duct stump leak and partial bile duct injury with leak/ narrowing of the lumen. Endotherapy is not useful in case of complete transection (total cut off) and complete stricture involving common hepatic or common bile ducts. In conclusion, endoscopic treatment can be considered a highly effective therapy and should be the first-line therapy in such patients. Though less successful, an endoscopic attempt is warranted in patients suffering from central bile duct leakages failing which surgical management is recommended.

## Key words

Bile duct injuries, Bile leaks, Endotherapy

## Introduction

Currently laparoscopic cholecystectomy is the gold standard treatment for symptomatic cholelithiasis, but it is associated with a higher incidence of bile duct injury than open cholecystectomy. Various reports have demonstrated that the incidence of bile duct injuries has risen from 0.1-0.2%

to 0.4-0.7% from the era of open cholecystectomy to the era of laparoscopic cholecystectomy.<sup>[1-3]</sup> Bile duct injury can also occur during other operative procedures. Management depends on the timing of recognition of injury, the extent of bile duct injury, the patient's condition and the availability of expertise in dealing the biliary injuries. Immediate detection and timely interventions are associated with an improved outcome, and the minimum standard of care after recognition of a bile duct injury is immediate referral to a centre experienced in the management of bile duct injury. The goal of timely interventions of the injured biliary tract is the restoration of a durable bile conduit, and the prevention of short- and long-term complications such as biliary fistula, intra-abdominal abscess, biliary stricture, recurrent cholangitis and secondary biliary cirrhosis.

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### Address for correspondence:

Dr. TS. Chandrasekar, Chairman and Chief Gastroenterologist, Department of Medical Gastroenterology, MedIndia Institute of Medical Specialities, Chennai, India.  
E-mail: medindiacon@gmail.com

The constellation of symptoms in the appropriate setting should heighten clinical suspicion for bile leak and prompt noninvasive imaging. When the volume of bile leak is large, the diagnosis is apparent and prompt endoscopic interventions (ERCP) is indicated. When bile leak is suspected, we suggest early ERCP to determine the nature of the injury and to facilitate treatment, either endoscopically for bile leak or surgically for major ductal injury. Early biliary endoscopic interventions may reduce duration of hospital stay.

### Biliary injury assessment in our center

We found following practical approach is useful to assess the cause of biliary injury [Table 1].

### Causes of biliary injury

- Failure to properly occlude cystic duct.
- Injury to ducts in the liver bed is caused by entering a plane deep to the fascial plane on which the gall bladder rests.
- Misuse of cautery may cause serious bile duct injuries with loss of ductal tissue due to thermal necrosis.
- Pulling forcefully up on the gall bladder when clipping the cystic duct causing a tenting injury in which the junction of the common bile duct and hepatic duct is occluded.

### Biliary injuries during cholecystectomy

Misidentification injuries: Two main types.

1. Common duct is mistaken for cystic duct and is clipped and divided.
2. The segment of an aberrant right hepatic duct, between entry of the cystic duct and junction of the common hepatic, is mistaken to be the cystic duct.

### Diagnostic test

The principle of treatment is entirely dependent on the site and nature of the bile duct injury. This can be identified by various noninvasive imaging modalities like MRCP, nuclear Scanning, etc [Table 2].

### Classification of bile duct injury

Various types of biliary injuries have been grouped and classified by several authors. The fact that many classifications are available in the literature means no one classification is ideal.

**Table 1: Practical approach to assess the cause of biliary injury**

Abdomen pain+Amylase elevation	Retained CBD stone
Severe abdominal pain	Retained CBD stone
Progressive jaundice/no ascites/ LFT- Grossly deranged	ligation/occlusion/clipping
Normal LFT/ascites	Proximal transaction+biliary leak
Mildly deranged LFT/ascites	a. Bilioma compressing biliary tree b. Partial transaction [lateral injury] of biliary tree

Historically Bismuth classification has been quoted. However, it is ideal for treatment of biliary malignancies.

### Bismuth's classification (1982)<sup>[4]</sup>

1. Low CHD stricture, with a length of the common hepatic duct stump of >2 cm
2. Proximal CHD stricture-hepatic duct stump <2 cm
3. Hilar stricture, no residual CHD, but the hepatic ductal confluence is preserved
4. Hilar stricture, with involvement of confluence and loss of communication between right and left hepatic duct
5. Involvement of aberrant right sectorial hepatic duct alone or with concomitant stricture of the CHD

The Bismuth classification is based on the complications arising from open surgery and in relation with the most distal level at which healthy biliary mucosa at the proximal site of the injury/stricture is available for anastomosis. The classification is intended to help the surgeon choose the appropriate surgical technique for the repair of the biliary injuries [Figure 1].

This classification has a good correlation with the final outcome after surgical repair.<sup>[5]</sup> Type 1 strictures can be repaired without opening the left duct and without lowering the hilar plate. Type 2 strictures require opening the left duct for a satisfactory anastomosis. Lowering the hilar plate is not always necessary but may improve the exposure. Type 3 lesions, in which only the ceiling of the biliary confluence is intact, require lowering the hilar plate and anastomosis on the left ductal system. There is no need to open the right duct if the communication between the ducts is wide. With type 4 lesions the biliary confluence is interrupted and requires either reconstruction or two or more anastomosis. Type 5 lesions are strictures of the CHD associated with a stricture on an aberrant right sectorial duct, and the sectorial duct must be included in the repair. However, the Bismuth classification does not cover the whole spectrum of biliary injuries.

Other classifications which are useful for surgeons and endoscopist with respect to management are:

1. Strasburg's Classification (1995)<sup>[6]</sup> [Figure 2]

Type	Criteria
A	Cystic duct leaks or leaks from small ducts in the liver bed
B	Occlusion of a part of the biliary tree, almost invariably the aberrant right hepatic ducts
C	Transection without ligation of the aberrant right hepatic ducts
D	Lateral injuries to major bile ducts
E	Subdivided as per Bismuth's classification into E1 to E5

2. Neuhaus Classification (2000)<sup>[7]</sup>

Type	Criteria
A	Peripheral bile leak (in communication with the CBD)
A1	Cystic duct leak
A2	Bile leak from the liver bed
B	Occlusion of the CBD (or right respectively left hepatic duct, i.e., clip, ligation)
B1	Incomplete

- B2 Complete
- C Lateral injury of the CBD
- C1 Small lesion (<5 mm)
- C2 Extended lesion (>5 mm)
- D Transection of the CBD (or right hepatic duct not in communication with the CBD)
- D1 Without structural defect
- D2 With structural defect
- E Stenosis of the CBD
- E1 CBD with short stenosis (<5 mm)
- E2 CBD with long stenosis (>5 mm)
- E3 Confluence
- E4 Right hepatic duct or segmental duct

### Management of biliary injury

The following is the algorithm for the management of biliary injury:

1. Resuscitate
2. Fluid electrolyte care
3. Higher antibiotics
4. Aspiration of bilioma/ascitic fluid
5. Investigation: Hemogram/LFT/urea/creatinine/blood culture, etc.
6. Imaging to assess the site and type of injury
7. Interventional radiology/endoscopy/laparoscopy/laparotomy

### Treatment options

The primary goal of endoscopic therapy is to reduce the transpapillary pressure gradient. Consequently, transpapillary flow is improved, and the extravasation out of the bile duct leakage is reduced. In addition to decompressing the biliary system, stent implantation closes the defect and works as a bridge at the site of extravasation. Endoscopic therapy consists of biliary sphincterotomy alone, placement of a biliary stent, or nasobiliary drainage, as well as a combination of these approaches.<sup>[8,9]</sup>

- Early surgical repair – Possibly permanent in nature.
- Early endoscopic intervention – Possibly permanent in nature.
- Early endoscopic intervention to manage crisis followed by surgery to offer permanent treatment.

In our tertiary care referral unit for biliary injuries, we found endoscopic interventions are useful in the following situation:

- Biliary leak with retained CBD stone.
- Biliary leak with foreign body in the CBD, e.g., blood clot, suture material migrated metallic clips, etc.
- Leak from peripheral bile duct.
- Leak from cystic duct stump.
- Partial central bile duct injury with bile duct and narrowing of the lumen.
- Bile leak with biloma (endoscopic intervention shows more successful result). If endoscopic intervention is attempted after bilioma aspiration.

Endotherapy is not useful hence not preferred in the following situation:

- Complete transaction (total cut off)
- Complete CBD/CHD stricture.

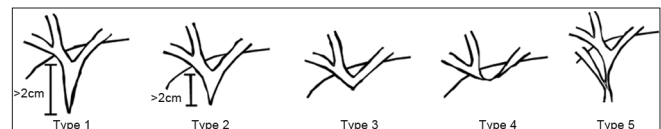
### Review of literature

A large body of data supports the early use of ERCP to exclude significant bile-duct injury and to effect closure of the leak by various endoscopic means [Figure 3].<sup>[10-20]</sup> There is no consensus as to the optimal endoscopic intervention.

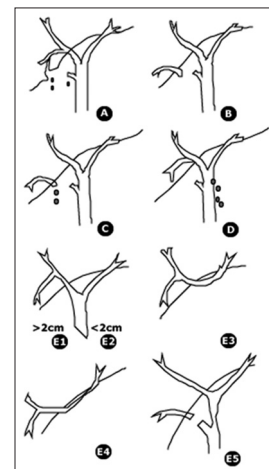
Strategies for stent insertion include “crossing” the leak site with the stent vs. elimination of the transpapillary pressure

**Table 2: Comparison of diagnostic techniques for investigating biliary injuries**

Test	Major functions	Characteristics
Hepatobiliary scintigraphy	Detect bile leak	Poor localization of site of leakage. Good screening test
Ultrasound	Detect biloma, detect dilated bile ducts	Localizes bile collections well. Good screening test. Combined with percutaneous aspiration
Fistulagram	Detect site of leak and presence of biloma	Very useful when established external fistula exists.
CT Scan	Detect biloma, detect dilated bile ducts	Can be combined with percutaneous aspiration
ERCP	Detect exact site of leak or obstruction	Drainage to treat Type A, E and D injuries. Important planning step for many operative procedures
Percutaneous transhepatic cholangiography	Detect exact site of leak and obstruction. Demonstrates intrahepatic biliary anatomy	Decompresses ducts, can be used for some Type A and D injuries and E injuries with strictures



**Figure 1: Diagram illustrating of Bismuth's classification**



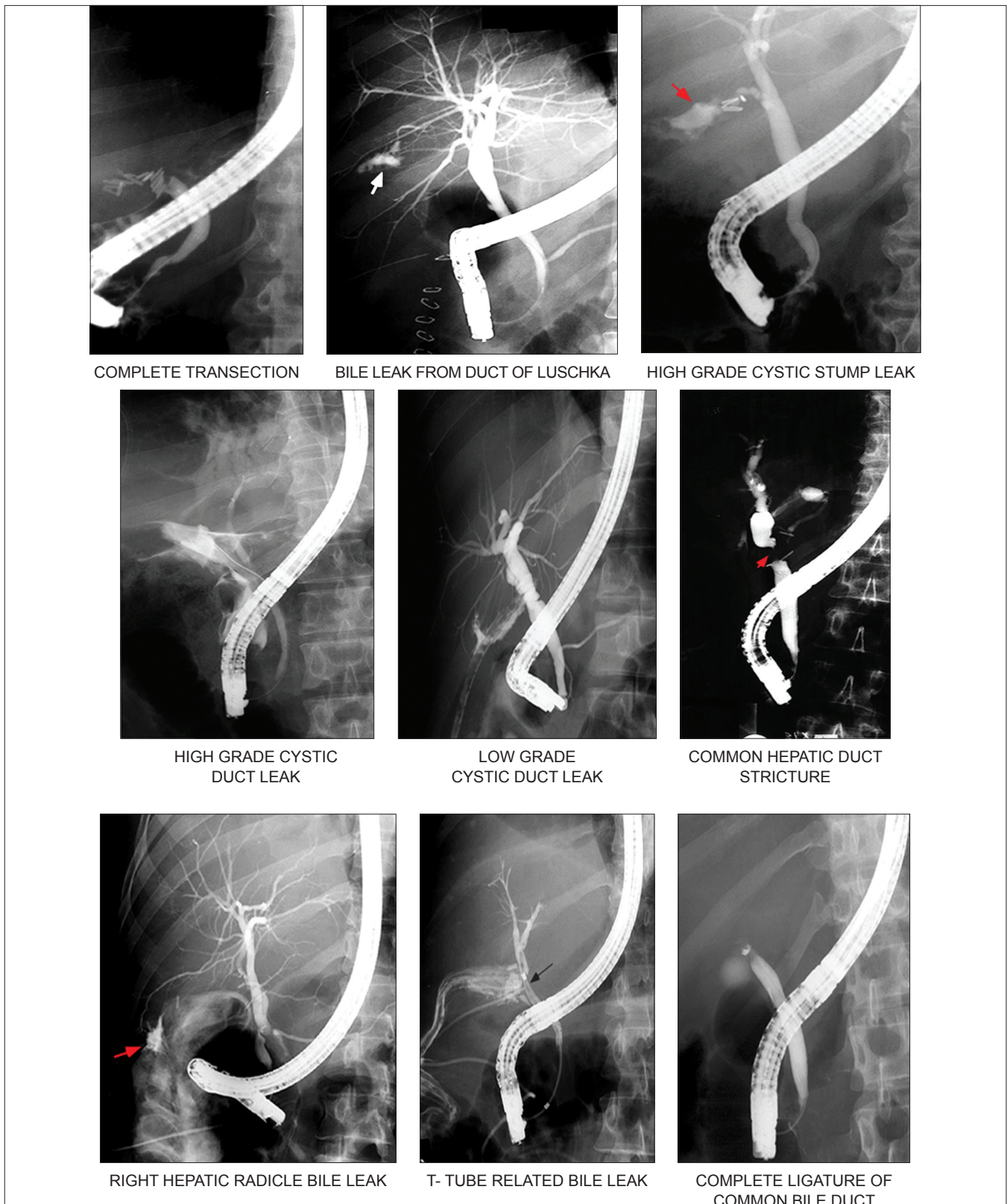
**Figure 2: Strasberg's classification**



gradient without crossing the leak. The latter two approaches have not been thoroughly evaluated, but, in general, the diameter of the biliary tree proximal to the leak site (e.g., cystic duct) exceeds the diameter of the stent, and it seems unlikely

that crossing the leak provides any additional therapeutic benefit, such as occlusion of the defect.<sup>[9]</sup>

Flow rates are better *in vitro* through straight compared with



**Figure 3:** ERCP showing various type of biliary injuries

pigtail stents, and fistula closure is more rapid in dogs with stent alone compared with sphincterotomy alone.<sup>[21,22]</sup>

Kaffees *et al.* reported that based on the current series, the optimal endoscopic treatment for a simple bile-duct leak is insertion of a straight plastic stent at least 7F in diameter.<sup>[9]</sup> The stent should be removed after 4 weeks, and, in the majority of cases, follow-up cholangiography will not be required, particularly for uncomplicated cystic-duct stump or peripheral duct of Luschka leaks. However, cholangiography should be obtained if there is known or probable stricture formation, for example, if the leak had arisen directly from the bile duct or the right hepatic duct. Study by Kaffees *et al.* found that stent insertion alone for postcholecystectomy bile leak is superior to sphincterotomy alone, because fewer patients required additional intervention (particularly surgery) to control the leak.<sup>[9]</sup>

In a study by Marks *et al.*, dogs underwent cholecystectomy without closure of the cystic duct stump.<sup>[21]</sup> The study design consisted of one group that was treated by sphincterotomy alone, and another group that was treated by placement of a transpapillary stent. The animals that underwent stent placement had a more rapid resolution of the leakage (2.6 days) as compared to the animals that underwent sphincterotomy alone (6.75 days). In another animal study with dogs, pressures between the common bile duct and the duodenum was measured after the insertion of endobiliary stents or sphincterotomy alone concluded that endobiliary stenting is more effective in lowering the bile duct pressure compared to sphincterotomy alone.<sup>[23]</sup> Stent length and diameter had no significant variables. These results are comparable with the results reported by Kaffees *et al.* who suggest that stent insertion is better than sphincterotomy alone.<sup>[9]</sup> Ryan *et al.* also reported in his study that the stent diameter does not influence the outcome biliary leak.<sup>[18]</sup>

The study by Chow *et al.*, 16 patients with postcholecystectomy bile leaks using endoscopic sphincterotomy and placement of a nasobiliary drainage.<sup>[24]</sup> They reported that nasobiliary drainage was used for a mean of 3.9 days (range 1–12 days). Fourteen of 16 patients had radiographical evidence of leak closure, and only one patient with chronic fistula required additional surgical therapy. The authors concluded that endoscopic management with nasobiliary drainage and sphincterotomy is effective for acute, uncomplicated bile leaks, but may not be adequate for chronic fistulas.

In a study Weber *et al.* found that, 34 of 35 patients (97%) with peripheral bile duct leakages, endoscopic therapy was successful.<sup>[25]</sup> In patients with central bile duct leakages, the success rate after median 90 days of endoscopic therapy was 66.7% (6/9 patients). Eleven of 12 patients (91.6%) with bile duct strictures had successfully completed stent therapy. The author concluded that endoscopic treatment of bile

duct lesions after cholecystectomy is effective, particularly in patients with peripheral bile duct leakages and bile duct strictures.

Other treatment options, other than the conventional forms of intervention at ERCP, are aimed at decreasing basal sphincter of Oddi pressure. A case has been described in which topically applied nitroglycerine (which relaxes the sphincter of Oddi) was used to heal a postcholecystectomy bile leak.<sup>[26]</sup> Also, botulinum toxin has been shown in an animal model to heal bile leaks with similar efficacy to stent insertion.<sup>[27]</sup> At present, these strategies are experimental, and data from clinical trials are needed before that can be considered for clinical practice.

Finally, we recommend from our experience 10 golden rules to be followed while managing post cholecystectomy biliary injury;

1. Do not panic
2. Immediate resuscitation
3. Get the help from senior and experienced colleagues
4. Do not jump for relaparoscopy/laparotomy
5. Assess the type of injury and site of injury
6. Ascitic tapping/Biloma aspiration
7. Interventional radiology/endoscopy/laparoscopy/laparotomy as per the availabilities of expertise and type of injury
8. Elective intervention - surgery/endoscopy after stabilizing the patient
9. Long follow-up – look for early derangement of LFT/stricture/stenosis and relieve obstruction before biliary cirrhosis sets in
10. All measures to be taken prevent biliary injuries.

In conclusion, endoscopic treatment can be considered a highly effective therapy in patients with peripheral bile duct leakages after cholecystectomy. Therefore, endoscopic treatment should be the first-line therapy used in these patients. Although endoscopic management is less successful in patients suffering from central bile duct leakages, an endoscopic attempt is warranted. Only in patients with a structural deficit of the hepatic duct or common bile duct we do recommend surgical management.

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