Chapter 8

Traumatic Bile Duct Injuries

Michele Molinari

Additional information is available at the end of the chapter

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Abstract

The vast majority of bile duct injuries is iatrogenic and occurs during abdominal surgeries or other interventions such as endoscopic or percutaneous cannulation of the biliary tree. Accidental traumas are responsible only for 1–5% of the total number of biliary injuries. The diagnosis of non-iatrogenic traumatic bile duct injuries is challenging as current cross-sectional imaging tests are not very specific. Therefore, most of the patients are diagnosed when they undergo early explorative laparotomy or when they develop late complications. Among all patients who experience traumatic bile duct injuries, 80–90% are victims of penetrating traumas from stab or gunshot wounds. On the other hand, bile duct lesions due to blunt traumas are predominantly caused by traffic accidents (compression by safety belt or airbag), falls, kicks, or work accidents. Iatrogenic bile duct injuries have been extensively covered in many other papers. In this chapter, we will focus our attention only on traumatic bile duct injuries.

Keywords: bile duct injuries, penetrating trauma, blunt trauma, endoscopic retrograde cholangiography, cholecystectomy, cholecystorrhaphy, biliary-enteric anastomosis, biloma, hemobilia

1. Introduction

Most of the bile duct injuries from traumas are associated with damage to the liver and present with a spectrum of conditions ranging from full transections or partial lacerations, to simple contusions and wall hematomas [1–12]. Eighty-five percent of patients diagnosed with extrahepatic biliary traumas suffer injuries of the gallbladder, whereas involvement of the main bile duct alone occurs only in 15% of the cases. In patients with injuries of the extrahepatic bile duct, the most frequent location is in the proximity of the hepatic hilum or within the head of the pancreas. Theories to explain this phenomenon are several. The most convinc-

ing is that blunt forces to the abdomen push the liver upward stretching the hepatoduodenal ligament to the point of disruption at the bile duct bifurcation. Moreover, in the proximity to the sphincter of Oddi there is already a physiologic elevation of the intraluminal pressure that is suddenly increased by the traumatic event causing disruption of the bile duct wall in this area. In patients affected by blunt trauma, the portal vein and hepatic artery are not usually injured because these structures are longer and more elastic than the main bile duct. Also, when patients suffer damage to vascular structures of the hepatoduodenal ligament, most of the times they do not survive the accident and are pronounced dead before arrival to the emergency department [1, 13–24].

2. Clinical presentation

The clinical presentation of patients with traumatic bile duct injuries has changed over the last few decades due to the different management of patients with blunt abdominal traumas. Currently, patients with a blunt trauma and who are hemodynamically stable or without signs of peritonitis are managed nonoperatively regardless of the severity and mechanism of their liver injuries [25, 26]. On the other hand, hemodynamically unstable patients or patients with peritoneal signs require an exploratory laparotomy. The primary goal during trauma laparotomies is to stop the hemorrhage and to prevent uncontrolled contamination of the peritoneal cavity by repairing defects of hollow viscera. Trauma laparotomies in these settings are referred as "damage controlled surgeries" (DCS) where the main goal is to control life-threatening conditions while more definitive treatments are necessary after patients are adequately resuscitated [27, 28].

3. Diagnosis of bile duct injuries

Injuries to the extrahepatic bile ducts are particularly rare and make up no more than 30% of biliary injuries, the vast majority being due to penetrating trauma [29–31]. There are three main diagnostic patterns of traumatic bile duct injuries. The first one is immediate identification during DCS. Patients with immediate diagnosis represent a challenging group as they require complex surgical interventions because they often have multiple other injuries.

The second one is diagnosis within the first week and includes 50% of patients with blunt traumas who present with hemodynamic stability and absence of peritoneal signs at the time of presentation in the emergency room. In these cases, cross-sectional imaging studies often show the presence of free intra-abdominal fluid. Radiologically, it is quite difficult to distinguish between blood and other types of fluids. Therefore, when indicated percutaneous drainage or peritoneal lavage is helpful to characterize the nature of the abdominal free fluid. The presence of elevated concentrations of amylase and bilirubin in the aspirate confirms the occurrence of a bile duct injury or intestinal perforation that will require surgical intervention. Other diagnostic modalities that can help in the differential diagnosis are hydroxy iminodi-

acetic acid (HIDA) scan, magnetic resonance cholangiography (MRCP), and endoscopic retrograde cholangiography (ERCP). Finally, a relatively small proportion of patients presents with late complications, often several months or years after their original trauma. These patients usually develop biliary strictures conditioning dilation of the proximal biliary tree with recurrent episodes of cholangitis or obstructive jaundice. In recent years, because of the growing adoption of nonsurgical approaches to the initial treatment of abdominal traumas, this group of patients has increased significantly.

4. Clinical definition of minor or major bile duct injuries

Minor bile duct leaks are defined as drainage of less than 400 ml of bile per day for a period shorter than 14 days. On the other hand, a major bile duct leak occurs when there is more than 400 ml of bilious drainage per day or more than 50 ml of bilious drainage each day for more than 14 days [32].

5. Anatomical classification and severity of bile duct injuries

Traumatic bile duct injuries can be classified in intrahepatic and extrahepatic. This classification not only identifies the anatomical location of the injuries, but also helps directing diagnostic modalities and treatment interventions.

5.1. Intrahepatic injuries

Intrahepatic biliary duct injuries are subcategorized into two groups according to where the injury occurs in the biliary tree. The first group includes central biliary injuries and the second group includes peripheral bile duct injuries. Central intrahepatic biliary injuries are those where the injury falls within 5 cm from the hepatic duct bifurcation. Peripheral biliary injuries

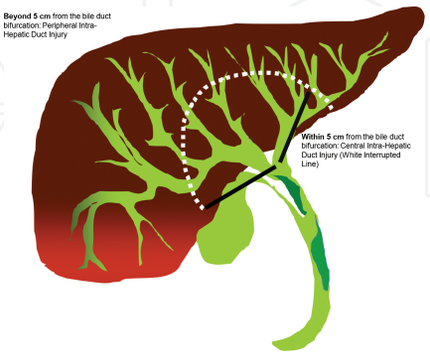

Figure 1. Schematic representation of the anatomical classification of intrahepatic biliary duct injuries. Central intrahepatic biliary duct injuries occur when the trauma affects biliary ducts within 5 cm from the biliary duct bifurcation. Peripheral intrahepatic bile duct injuries occur when the trauma affects hepatic parenchyma that is more than 5 cm distant from the bile duct bifurcation.

are those within the hepatic parenchyma affecting bile ducts that is more than 5 cm distant from the hepatic duct confluence (**Figure 1**) [33]. Since most of the intrahepatic bile duct injuries are associated with hepatic parenchyma damage, classification of this type of biliary injuries is often based on the liver injury scale as proposed by Moore et al. [34, 35] and summarized in **Table 1**.

Grade	Injury	ICD
I. Hematoma	Nonexpanding, subcapsular hematoma occupying less than 10% of surface area	846.01
I. Laceration	Nonbleeding, less than 1 cm deep capsular tear	864.11
II. Hematoma	Nonexpanding, subcapsular hematoma occupying 10–50% of surface area	864.01
	Nonexpanding intraparenchymal hematoma less than 2 cm in diameter	864.11
II. Laceration	Active bleeding, 1–3 cm deep capsular tear measuring less than 10 in length	864.03
III. Hematoma	Subcapsular hematoma more than 50% of surface area or expanding	864.04
	Ruptured subcapsular hematoma with active bleeding	
	Intraparenchymal hematoma larger than 2 cm or expanding	
III. Laceration	Deeper than 3 cm	864.04
IV. Hematoma	Ruptured intraparenchymal hematoma with active bleeding	
IV. Laceration	Parenchymal disruption involving 25–50% of hepatic lobe	864.04
V. Laceration	Parenchymal disruption of more than 50% of hepatic lobe	864.14
V. Laceration vascular	Juxtahepatic venous injuries: i.e., retrohepatic vena cava/major hepatic veins	864.14
VI. Vascular	Hepatic avulsion	864.14

Modified with permission from Moore et al. [34, 35].

Table 1. Liver injury scale

Grade	Injury	ICD
I	Contusion or hematoma of the gallbladder	868.02
	Contusion of the portal triad	
II	Partial gallbladder avulsion from liver bed with intact cystic duct	868.02
	Laceration or perforation of the gallbladder	868.12
III	Complete gallbladder avulsion from liver bed	868.02
	Cystic duct laceration	868.12
IV	Partial or complete right hepatic duct laceration	868.12
	Partial or complete left hepatic duct laceration	
	Partial common hepatic duct laceration (<50%)	
	Partial common bile duct laceration (<50%)	
V	Laceration of common hepatic duct (>50%)	868.12
	Laceration of common bile duct (>50%)	
	Combined right and left hepatic duct injuries	
	Intraduodenal or intrahepatic bile duct injuries	

Modified with permission from Moore et al. [34, 35].

Table 2. Extrahepatic biliary tree injury scale.

5.2. Extrahepatic injuries

Extrahepatic bile duct injuries can affect the biliary bifurcation, the hepatic duct, the cystic duct, or the common hepatic duct as summarized in **Table 2**.

6. Management of patients with intrahepatic bile duct injuries

During DCS or subsequent surgeries, ligation or oversewing of the leaking duct is often the only intervention needed. This is usually a relatively straightforward procedure. For patients who are managed conservatively, the natural history of these injuries is spontaneous resolution with scarring of the liver parenchyma and sealing of the bile duct providing that there is no distal bile duct obstruction [36, 37]. However, in a small percentage of patients, bile duct and hepatic parenchyma injuries can cause hemobilia or formation of bilomas.

6.1. Hemobilia

Hemobilia is extravasation of blood in the biliary tree due to the presence of a communication the presence of a communication between a blood vessel and the bile ducts. The majority of symptomatic hemobilias are caused by arterial bleed while hemobilias from venous injuries are quite rare [38]. The frequency of hemobilia after trauma ranges between 3 and 7% [39] with the majority of patients experiencing clinically insignificant and self-limiting blood loss into the biliary tree and in the upper gastrointestinal tract [39]. In these circumstances, arterial blood seeps into the biliary tree and, due to the fibrinolytic activity of the bile, clots rapidly dissolve and often go unnoticed [39]. In a very small proportion of patients, clots might not dissolve and form biliary plugs that can cause biliary obstruction causing jaundice and colic pain [38, 39]. The majority of symptomatic patients with hemobilia present with melena (90%), abdominal pain (70%), and obstructive jaundice (60%) [40, 41]. In trauma, hemobilia should always be suspected when patients present with upper gastrointestinal bleeding since this condition can occur as a late complication [38]. Diagnosis of hemobilia can be confirmed by arterial phase computerized tomography (CT) or selective hepatic artery arteriography. Selective arteriogram by percutaneous approach has become the leading modality to treat hemobilia with microembolization of the arterial branches communicating with the biliary tree with success rates in 84–95% of patients [38, 42]. In the last decade, diagnosis of hemobilia by upper endoscopy has become less frequent as the majority of patients, particularly those with blunt traumas, undergo CT scans that are very sensitive and specific in identifying evidence of active or recent bleeding into the biliary tree and gallbladder by pooling of contrast in the biliary system and presence of intraluminal clots or biliary dilatation [43, 44].

6.2. Bilomas

The rate of liver-related complications in hemodynamically stable patients with blunt traumas is low (0–7%) [45–49]. On the other hand, liver-related complications in high-grade liver injuries are common (11–13%) [49–51]. Ischemic necrosis of the liver and gallbladder, forma-

tion of hepatic abscesses, and bile leaks are the most frequent complications of blunt hepatic traumas [52]. Based on clinical signs and symptoms of liver-related complications such as right upper quadrant pain, jaundice, fever, or melena, the optimal time to repeat imaging studies for patients with high-grade liver injuries is usually within 7–10 days [53]. The presence of bilomas is suggested by the progressive growth of a well-circumscribed, low attenuation intraparenchymal or perihepatic fluid collections on cross-sectional imaging studies [54]. The majority of patients with suspected bilomas are currently treated by the placement of percutaneous drainages under radiological guidance while ERCP with the insertion of biliary stenting is indicated for those patients with expanding or persistent bilomas that failed resolution after external drainage [53, 55].

7. Extrahepatic bile duct trauma

7.1. Gallbladder injuries

The gallbladder is relatively protected from blunt traumas due to its anatomic position within the liver parenchyma and behind the ribcage. Similarly, isolated injuries to the gallbladder are uncommon, and mortality is related to other injuries [31, 56, 57]. One of the predisposing factors for both blunt and penetrating trauma to the gallbladder is intraluminal distension. This occurs when secretin and gastrin are released, often after consumption of alcoholic beverages, causing an increasing production of bile and the tone of the sphincter of Oddi. The result is a distended gallbladder and an increased pressure in the biliary tree. When the gallbladder is distended, it becomes less protected by the ribcage and by the liver, and it is more at risk of perforating injuries or blunt forces compressing the gallbladder or decelerations responsible for avulsions.

Traditionally, cholecystectomy has been the recommended treatment for gallbladder injuries with significant contusion or tissue injury [58, 59]. In the past, cholecystorrhaphy was regarded as a risk factor for stone formation and subsequent cholecystitis [60, 61]. However, there is little evidence to support these recommendations, and recently, simple suture repair has been considered acceptable for some patients with minor injuries.

The role of cholecystostomy tubes is very limited and should be avoided due to the increased risk of developing biliary fistulas. However, the placement of a cholecystostomy tube can be useful in the unstable, critically injured patient and might provide access to the biliary tract where there is an associated intrahepatic or distal common bile duct injury [57].

7.2. Common and hepatic duct injuries

The biliary tree is relatively fixed proximally and distally and it does appear that disruption is more prone to occur either at the hilum of the liver or at the junction with the pancreas [21, 61]. When the lesion involves at least 50% of the main bile duct circumference, the majority can be treated by choledochorrhaphy and insertion of a Kehr tube through a different orifice where the biliary duct tissue is healthy. This is a rapid and efficacious technique for trauma

patients who, typically, do not present with dilatation of the bile duct that could facilitate other form of repair. Other techniques using patches to close the defect have been used with variable outcomes. When there is a complete transaction of the bile duct, hepaticojejunostomy is the approach of choice if the patient is hemodynamically stable and there is no frank intra-abdominal contamination. For a selected group of patients who are hemodynamically stable and with scant symptoms, endoscopic sphincterotomy and insertion of biliary prosthesis can be used in addition to percutaneous drainage of concomitant bilomas. The morbidity associated with main bile duct lesions affects approximately 10% of patients who might develop biliary fistulas, hemobilia, bilomas, intrahepatic abscesses, stenosis, and ascending cholangitis. For the majority of patients who die, often the cause of death is unrelated to complications caused by their biliary lesions.

8. Endoscopic management of bile duct injuries

ERCP has become a very attractive diagnostic and treatment modality for patients with extrahepatic biliary trauma. During the ERCP, patients undergo sphincterotomy of the papilla of Vater and cannulation of the common bile duct with placement of a biliary stent to reduce the pressure gradient between the bile duct and the duodenum by eliminating the physiologic role of the sphincter of Oddi. In this way, bile drains preferentially Bile drains preferentially into the duodenum, allowing the disrupted duct to heal spontaneously. The timing of ERCP has been open to debate with some authors suggesting that this should be done as soon as the bile leak is diagnosed. This, however, does not take into consideration the natural history of a bile leak that usually heals, irrespective of the mechanism, provided there is adequate drainage.

9. Natural history of bile duct injuries

Regardless of the type of injury, the natural history of traumas to the biliary tree is spontaneous closure within 3 weeks if the biliary drainage is maintained. Conservative management of bile leaks is safe provided that the patients are adequately drained and remain afebrile.

10. Management of posttraumatic bile duct strictures

Posttraumatic biliary strictures are most likely caused by inflammation and scarring of the involved bile ducts. Traumas induce inflammation that eventually leads to fibrosis and occlusion of the lumen of the involved bile ducts. In addition, the formation of intramural hematomas or direct damage to the arterial supply of the bile duct results in ischemic fibrosis and stricture of the biliary tree. There are very few reports of the incidence and management of posttraumatic bile duct strictures. Previous studies have reported that traumatic bile duct

strictures could be managed with percutaneous drainage and/or endoscopic stenting. However, there are no reports on the optimal time for surgical intervention for the repair of late biliary stricture after trauma. Treatment of the bile duct injuries depends on the position and the type of lesions. For an incomplete transection of the common hepatic duct or common bile duct, simple repair over a T-tube or stent is quite appropriate. However, a complete transection where the blood supply of the biliary tract has been disrupted an end-to-end anastomosis should not be performed [62]. In 20 collected cases of traumatic complete transection of the biliary tract repaired by end-to-end anastomosis, the stricture rate requiring reoperation was 55% [61].

11. Conclusions

Noniatrogenic trauma to the extrahepatic biliary tract is uncommon. A high index of suspicion is required for early diagnosis. Most gallbladder injuries are managed by cholecystectomy, with cholecystorrhaphy being reserved only for minor isolated lacerations. Common bile duct injuries are managed by simple repair or biliary-enteric anastomosis depending on whether there is a tangential perforation or a complete transection. Minor bile duct injuries, if symptomatic, can be managed by endoscopic techniques or by interventional radiology modalities. Optimally, these injuries should be managed in specialized hepatobiliary surgery units [57].

Author details

Michele Molinari

Address all correspondence to: michele.molinari@nshealth.ca

1 Dalhousie University, Halifax, Nova Scotia, Canada

2 Department of Surgery Hepatobiliary and Pancreatic Surgery and Transplantation, Dalhousie University, Halifax, Nova Scotia, Canada

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