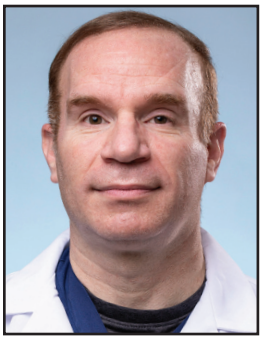
Douglas G. Adler MD, FACG, AGAF, FASGE, Series Editor

The Role of ERCP in Patients with Hepatobiliary and Pancreatic Trauma

Caleb Hanson



Douglas G. Adler

INTRODUCTION

Abdominal trauma affects a wide range of demographics and is considered a significant cause of patient mortality. Abdominal trauma can be difficult to diagnose due to the broad presentation of patients. Many patients with abdominal trauma suffer hepatobiliary and/or pancreatic injury. ERCP is an effective diagnostic tool and treatment modality for patients that have experienced these types of injuries. This manuscript will review the endoscopic interventions of patients that present with hepatic and pancreatic trauma, with a focus on ERCP.

Hepatic Trauma

Blunt trauma is the most common cause of non-iatrogenic injury to the biliary system. [1] Biliary disruptions that develop secondary to trauma are a rare adverse event with an incidence rate of 4-23% among patients with hepatobiliary trauma.[1,2,3] Blunt trauma to the abdomen is most commonly seen following motor vehicles accidents (MVA), but also arise from motorcycle or all-terrain vehicle (ATV) accidents, bicycle accidents, and traumatic falls. Penetrating trauma can also cause biliary duct disruptions.[1,3] Penetrating traumas include gunshot wounds (GSW), explosion shrapnel penetration, and stabbing wounds with a sharp object.[4] (Figure 1)

Hepatic trauma affecting the biliary tree can be classified in a variety of ways, but the most widely accepted is the grading scale set by the American Association for the Surgery of Trauma (AAST).[4] Generally, higher grades are associated with increased rates of mortality.[3,5] The location of the hepatic trauma can also alter the risk factor for bile leaks and may alter the success of the treatment.[6] The main bile ducts are located more centrally and are larger than the peripheral bile ducts. Centrally located hepatic traumas were associated with an increased risk of bile leaks and more difficulty recovering compared to peripherally located trauma.[1] (Figure 2)

Caleb Hanson[1] Douglas G. Adler MD, FACG, AGAF, FASGE[2] [1]Rocky Vista University School of Medicine, Parker, CO [2]Center for Advanced Therapeutic Endoscopy (CATE) Porter Adventist Hospital, Centura Health PEAK Gastroenterology Denver, CO

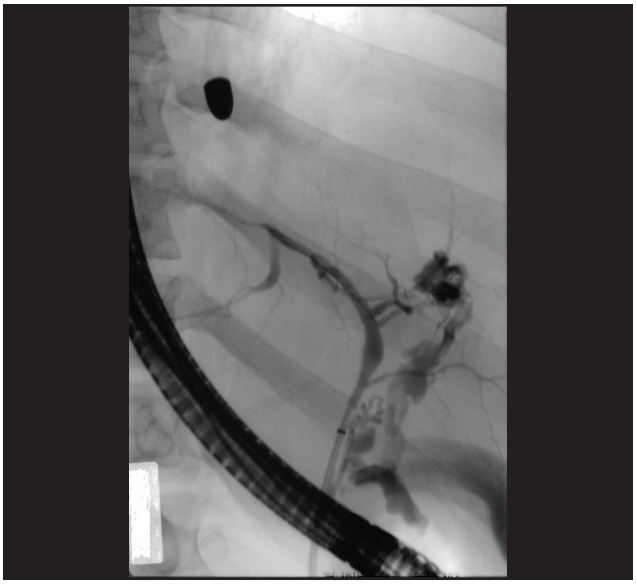


Figure 1. Bile extravasation in a patient with a hepatic gunshot wound. Note bullet in image.

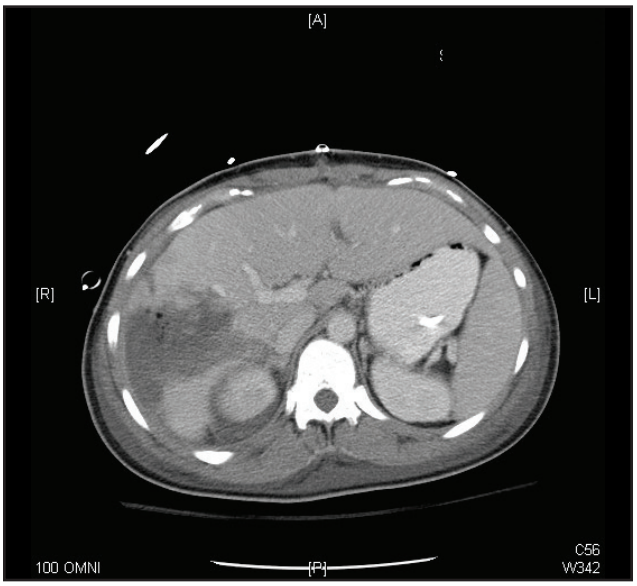


Figure 2. CT scan of a high-grade liver laceration following a motorcycle accident. The patient developed a bile duct injury as well.

Manifestations of Hepatobiliary Trauma

Hepatobiliary trauma can manifest in a variety of ways depending on severity of the liver damage. Manifestations include bile leaks, hemobilia, abdominal abscesses, and bile peritonitis.[2] The incidence of major bile leaks and bilomas is 4.9-16% among patients presenting with hepatic trauma.[3] Bile leaks were characterized as either a type I or type II in this study. Type I bile leaks are confined to the liver, while type II bile leaks expand out of the liver due to liver capsule disruptions. Type II bile leaks are associated with an increase in hospital length of stay (LOS) as well as increased total bilirubin levels.[7] Traumatic extrahepatic biliary injuries can be difficult to diagnose due to the involvement of multiple organ injuries and the deceptive presentation of trauma patients. Many times, incomplete biliary injuries present days to weeks after the initial injury and present with nausea, vomiting, jaundice, and abdominal pain. All of which are nonspecific for bile duct injuries.[8,9] This combined with suboptimal imaging and rarity of traumatic bile leaks can present difficulties in diagnosing bile duct leaks.[9]

In a study by Yuan et al., serum total bilirubin level greater than 2.55 mg/dL had a sensitivity of 100% and a specificity of 85.1% for predicting bile duct injury.[1] Hemobilia is a less common presentation of abdominal trauma, with an incidence rate below 5%. Hemobilia presents clinically as abdominal pain, the presence of bleeding in the upper gastrointestinal tract, and jaundice, although, all three clinical presentations are only seen in 20% of patients with hemobilia.[10] Abscesses are a rare adverse event and were only seen in 1/22 patients with liver related adverse events following a high grade (III-V) liver injury in one study.[3]

Management of Hepatobiliary Trauma

It has been well established that nonoperative management is indicated in hemodynamically stable patients following blunt trauma resulting in bile leaks. Laparotomy is generally performed in patients that are unstable or have experienced penetrating wounds that require exploration.[11] Nonoperative treatment has been shown to decrease the need for blood transfusions and injury severity score in the nonoperative treatment group with major liver injury grades (II-V).[1,12] Nonoperative treatment of blunt hepatic trauma has demonstrated a success rate between 85 and 100%.[13] Nonoperative management has also been shown to significantly decrease liver related adverse events when compared to those who underwent surgical hemostasis.[3,10]

Endoscopic retrograde cholangiopancreatography (ERCP) has been a well-established treatment modality for the diagnosis and management of iatrogenic biliary leaks (which are almost always secondary to surgical interventions) with a success rate of 90-100%.[14] There are currently no guidelines on the treatment non-iatrogenic causes of biliary leaks, but ERCP has been widely applied in this setting as well. The timing of intervention has not been well established. In a study by Desai et al., they investigated the rates of adverse events (AEs) on the timing of ERCP. AEs that were included were pancreatitis, duodenal perforation, duodenal hemorrhage, and cholangitis. Patients that had ERCP performed emergently (1 day after bile duct leak) or urgently (2-3 days after the bile leak) had a significantly higher rate of AEs than those who had ERCP done expectantly (3 or more days) after diagnosis of the bile leak.[15] The authors did discuss a possible "severity bias" that describes a situation of less stable patients requiring a quicker intervention and thus are at increased risk of developing AEs. Expectant timing has also been shown to have a lower 90-day mortality rate than urgent and emergent groups.[16] These findings could also have been affected by the "severity bias" phenomenon. Regardless these studies as well as previously mentioned studies on delayed bile leak presentation support a delayed intervention approach to hemodynamically stable patients presenting with nonspecific symptoms.

ERCP techniques commonly used to treat bile duct leaks include biliary sphincterotomy, bile duct stent placement, or a combination of the two. (Figure 3) Combination therapy has been shown to have a lower rate of ERCP failure when compared to biliary stenting alone, although in practice many simply place stents as it is simple to perform and avoids the (admittedly low) risks of sphincterotomy, most notably bleeding and perforation.[14] The mechanism for bile leak resolution following stent placement and/or sphincterotomy is by lowering the transpapillary pressure, making the transpapillary route of biliary drainage the path of least resistance, which leads to a decrease in resistance and reduces bile flow out of the leak itself, so that the site of the leak can then heal (as healing cannot occur while bile is flowing out of the leak site).[17,16] In the study by Flumignan et al., it was determined that there was no difference in clinical success between sphincterotomy combined with biliary stenting and sphincterotomy alone.[18] Some believe that high-grade leaks require stenting, whereas smaller leaks can be managed by sphincterotomy alone, but in practice this is left to the operator and most treatment is individualized.[19,20]

Figure 3a. ERCP image showing a traumatic bile leak.

It is not uncommon for patients to undergo exploratory laparotomy following trauma to the abdomen if severe, potentially repairable injury is suspected. This is especially true in patients that are hemodynamically unstable. One study found that 29% of patients that presented to a level 1 trauma center required an immediate operation and of those patients that required immediate operation, only 15% required emergency operation due to severe liver bleeding.[21] Bala et al. found that among patients presenting with high grade liver injuries, 37.5% died in the first 24 hours. Among those who died, 75% died due to hemorrhagic shock. It is important to note that grade V injuries showed a 69% mortality rate when compared to grade III and IV.[3] ERCP with sphincterotomy and stent placement is an effective treatment for patients

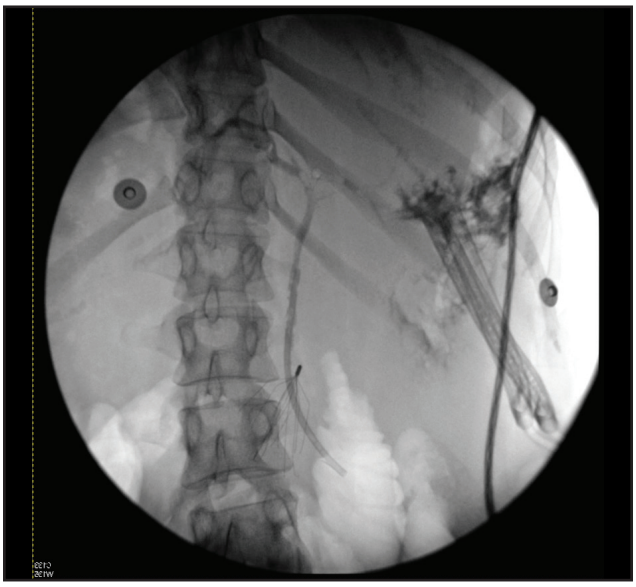


Figure 3b. Same patient, following biliary stent placement.

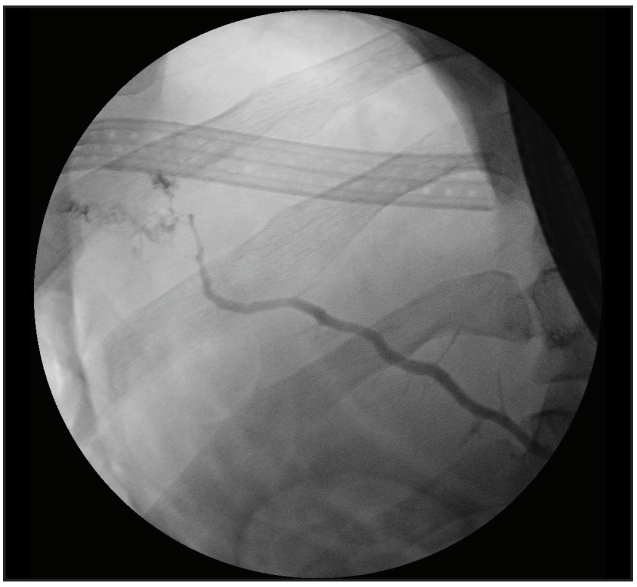


Figure 4. Traumatic injury to pancreatic tail resulting in a leak seen on pancreatogram during ERCP. The patient was treated via a pancreatic duct stent to good effect.

with bile duct damage after hepatic trauma and resolves bile leaks in 90-100% of patients.[2,11,14,20,21] In addition to a high success rate in diagnosing and treating bile leaks, ERCP can decrease the risk of developing strictures and cholangitis after abdominal trauma.[20]

Pancreatic Trauma

Pancreatic trauma is reported to occur in as low as 0.2%-3% of all traumas.[22] Blunt trauma to the pancreas is rare due to the retroperitoneal location of the pancreas. Blunt trauma represents 37% of those reports, while penetrating trauma, such as GSW and stab wounds, make up the remaining 63%. Mortality rates for pancreatic injury range from 9-34% but have been reported as high as 64% in a site with a level 1 trauma center.[22,23,28] In a study by Buitendag et al., overall mortality was 13%. A majority of the fatalities were seen in the operative group. The reasons for mortality in these patients included multiple organ injuries, sepsis, hypovolemic shock, and traumatic brain injury.[24] Integrity of the main pancreatic duct is the most important factor in the mortality of patients with pancreatic injury.[31,37,39] There are few studies that compare the adverse events that can occur following blunt and penetrating trauma to the pancreas. Coelho et al. found that patients with penetrating trauma were more likely to have recurrence of pancreatic pseudocysts and increased risk of developing an infection when compared to those with blunt trauma.[43]

Pancreatic injuries are classified by the American Association of Surgery and Trauma on a scale of I-V on CT.[25] Grades I and II include minor contusions with superficial lacerations for grade I laceration without duct injury for grade II. Grade III is a distal transection or parenchymal injury with duct injury. Grade IV is a proximal transection or parenchymal injury involving the ampulla. Grade V is "massive disruption" of the pancreatic head.[25] Grade I and II injuries are generally managed without surgery, but grade III and higher are usually managed surgically.[26] Grade I and II injuries are the most common pancreatic injuries and represent 80-87% of all pancreatic trauma.[26,28] Takishima et al. were able to classify traumatic pancreatic injuries via ERCP. Grade I is a normal appearing pancreatic duct. Grade IIa is injury to branches of the main pancreatic duct with contrast extravasation into the parenchyma, whereas grade IIb is contrast extravasation into the retroperitoneal space. Grade IIIa is injury to the main pancreatic duct at the body or tail of the

pancreas, and grade IIIb involves the head of the pancreas.[27]

Manifestations of Pancreatic Trauma

Most patients with pancreatic injury present with polytraumatic injuries due to the retroperitoneal location of the pancreas. The most common concomitant injuries included the liver and the spleen at 34% and 38%, respectively.[28] Traumatic injury to the pancreas can present with non-specific abdominal pain or without pain.[26] Pancreatic trauma can present with elevated serum amylase and lipase and peripancreatic hematoma.[29] Serum lipase and amylase levels were also shown to increase proportionately to the grade of pancreatic injury.[27] Serum lipase and amylase have shown a 100% specificity and 85% sensitivity for the prediction of traumatic pancreatic injury.[30] Although other studies have failed to show this same correlation, elevated serum amylase and lipase should raise the clinical suspicion of pancreatic injury.[30] Other less common adverse events of pancreatic trauma include hemorrhagic pancreatitis, pancreatic ascites, abscesses, and fistula formation.[26]

Delays in the diagnosis of traumatic pancreatic duct leaks greater than 24 hours have been shown to increase pancreas-specific morbidity and mortality rates, especially in patients with pancreatic duct disruption.[31] Diagnosis of a pancreatic duct leak can be confirmed via ERCP if indicated, based on findings from abdominal CT or observations made during laparotomy if the patient is not hemodynamically stable and warrants surgical exploration.[32] ERCP has been shown to be a more sensitive diagnostic tool for pancreatic duct leaks when compared to CT or laparotomy and has a lower rate of adverse events.[31] A study by Barkin et al. found that ERCP had a sensitivity and specificity of 100% in the diagnosis of pancreatic duct disruption.[33] Another study found that CT scans alone underestimated the grade of pancreatic injury in 13% of patients, as well as missed important findings such as pancreatic head ductal disruptions due to the high fat content surrounding the head of the pancreas.[29] Abdominal CT has been shown to miss the diagnosis of major pancreatic duct injury in up to 40% of patients.[34] As such, ERCP is considered the gold standard for diagnosis of pancreatic duct leaks. ERCP allows for better visualization of pancreatic injury and can be a platform for simultaneous enactment of therapy to treat a wide range of pancreatic ductal injuries.[27]

Management of Pancreatic Duct Injury

Management of pancreatic trauma is dependent on whether the patient is hemodynamically stable or not.[28] Patients that have abdominal trauma with comorbid hemorrhagic shock have been shown to be at increased risk of mortality.[28] Conservative management of a pancreatic duct disruption consist of stenting to correct any improper drainage of pancreatic enzymes and bicarbonate, decreasing systemic inflammation, optimal nutritional support, and decreasing the exocrine secretions of the pancreas.[35] This can be achieved with the use of parenteral nutrition in combination with medications like octreotide and somatostatin.

Disconnected duct syndrome is a serious adverse event due to trauma to the abdomen that results in a transection of the pancreatic duct causing an accumulation of pancreatic enzymes and bicarbonate to leak into the abdominal cavity. Endoscopic transpapillary drainage has a clinical success rate of 87% of patients with disconnected pancreatic duct syndrome, but the endoscopist must be able to bridge the disruption fully with a stent for this approach to be successful.[36] It is believed that this success rate is so high because this method utilizes the patient's normal anatomy to route the drainage appropriately. Bhasin et al. have developed a proposed algorithm to evaluate patients with pancreatic duct injury. If there is suspicion of pancreatic duct leak or it is visualized on CT, then ERCP should be performed to evaluate the severity of the leak. Complete disruptions should be surgically repaired, but partial leaks can be treated with endoscopic transpapillary drainage via stenting with or without pancreatic sphincterotomy. If that treatment is unsuccessful, then the patient should be referred to surgery.[37]

Recent studies have shown that ERCP can allow as many as three fourths of patients with blunt and penetrating pancreatic trauma to avoid surgery altogether.[38] (Figure 4) Patients who receive ERCP greater than 72 hours after the trauma have a significantly increased rate of pancreas-related adverse events and increased hospital LOS.[34] ERCP

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is especially effective at treating patients with fistulae and pancreatic fluid collections following trauma.[39] Transpapillary drainage via ERCP is an effective treatment as long as the pancreatic duct disruption is partial and can be bridged.[39] If the disruption is complete, placement of a bridging transpapillary stent via ERCP is still possible, but has a lower success rate overall. A common adverse event in patients with pancreatic trauma is the formation of a pancreatic duct stricture, generally at the site of ductal injury itself (even if the ERCP is successful) and was seen in 4 out of the 6 patients in a study conducted by Lin et al. They also reported one fatality 3 days following the stent placement as a result of sepsis, although the death was likely due to the inciting trauma itself and not the ERCP *per se*.[40] Kim et al. also noted that 2 patients in their series developed mild stenosis of the main pancreatic duct at a 3-month follow-up, but both were asymptomatic 1 year later.[34]

Pseudocyst formation is a reported adverse events following blunt trauma to the abdomen and generally occurs weeks to months after the event itself.[43] Lin et al. demonstrated the success of ERCP stenting following a distal pancreatectomy complicated by a pancreatic pseudocyst.[41] Coelho et al. demonstrated a success rate of 94% for patients treated with ERCP for post-traumatic pancreatic pseudocysts.[42] Rates of early adverse events were similar between blunt and penetrating trauma, but stent occlusion was only found in those patients that received ERCP after a penetrating trauma (5.8%).

CONCLUSION

Endoscopy is a well-established diagnostic tool that can be utilized in both biliary and pancreatic injury secondary to abdominal trauma. ERCP should be considered as a first-line treatment of hemodynamically stable patients that have suffered abdominal trauma. ERCP has a high success rate for treating biliary and pancreatic injuries. ERCP has shown a low rate of adverse events when used to treat patients with traumatic abdominal injuries. While ERCP is still considered an invasive procedure, the multifunctionality of visualizing the biliary and pancreatic duct and treating the patient outweigh the risk associated with the procedure. ERCP may be utilized in an acute and delayed setting for the treatment of biliary and pancreatic leaks. Biliary injuries specifically show a decrease in adverse events when delayed. Conversely, delays in the diagnosis of pancreatic duct injuries have shown an increase in both mortality and morbidity among trauma patients. Thus, using ERCP is an effective and efficient modality to diagnose and treat patients with traumatic pancreatic and biliary injuries. ■

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