

Case Report

## Complete Transection of the Common Bile Duct Caused by Blunt Abdominal Trauma: A Rare Case Report

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Common bile duct (CBD) injury after blunt abdominal trauma is rare and difficult to diagnose. Delayed recognition leads to severe morbidity. A 70-year-old Japanese man was admitted after sustaining blunt abdominal trauma. Ultrasonography revealed intra-abdominal fluid, suggesting bleeding. Contrast-enhanced computed tomography revealed pancreatic head injury, intra-abdominal bleeding, and pseudoaneurysm of the anterior superior pancreaticoduodenal artery (ASPD). Bile duct injury was not evident. The application of transarterial embolization (TAE) controlled the bleeding. Canulation into the pancreatic or biliary duct was not possible during endoscopic retrograde cholangiopancreatography. An emergency laparotomy revealed severe pancreatic head and extrahepatic bile duct injuries. Pancreaticoduodenectomy/Child reconstruction was performed. Complete CBD transection was confirmed. The patient was ultimately discharged without complications. Early recognition, timely surgical management, and intensive care are essential for favorable outcomes in patients who have sustained abdominal trauma.

**Key words:** blunt abdominal trauma, intensive care, emergency laparotomy, pancreaticoduodenectomy

Extrahepatic bile duct traumatic injuries are rare, with an estimated incidence of 2-5% in cases of abdominal trauma; in addition, the reported instances of extrahepatic biliary trauma affected primarily the gallbladder [1]. Most lesions of the extrahepatic bile ducts are caused by penetrating trauma [1]. Reports of gallbladder injury due to blunt abdominal trauma in which the common bile duct (CBD) is preserved are extremely rare. The preoperative diagnosis of such cases by fluorescence imaging is challenging, and the extreme rarity of these cases compounds the challenge. We present a very rare case of CBD transection that was due to blunt abdominal trauma. Our diagnostic and therapeutic experience in this patient's case provides

valuable insights for surgeons facing similar challenging situations.

### Case Presentation

A 70-year-old Japanese man was admitted to our emergency department after sustaining abdominal trauma in a traffic accident in which he crashed into a utility pole while driving a compact car. He was not wearing a seatbelt, and the car was not equipped with an airbag system. He had undergone a laparoscopy-assisted distal gastrectomy and Billroth-I reconstruction for early gastric cancer 4 years prior to this admission.

On admission, the patient complained of abdominal pain. His vital signs were as follows: blood pressure

Received September 25, 2025; accepted December 23, 2025.

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Conflict of Interest Disclosures: No potential conflict of interest relevant to this article was reported.

112/84 mmHg; heart rate 85 beats/min; respiratory rate 24 breaths/min; oxygen saturation 100% on a non-rebreathing oxygen mask, 10 l/min; and Glasgow Coma Score (GCS) 15/15 (E4 V5 M6). The patient's vital signs were stable, but ultrasonography revealed intra-abdominal fluid. The laboratory examination showed elevated liver enzymes (Table 1).

Contrast-enhanced computed tomography (CT) scans revealed high-density intra-abdominal fluid, low density in the area of the pancreatic head, a 6.5-mm-dia. pseudoaneurysm of the anterior superior pancreaticoduodenal artery (ASPDA), extravasation of the contrast agent behind the duodenum, and a high-density area in the gallbladder. The pancreatic head appeared to be shattered into fragments, as indicated by patchy enhancement of the pancreatic parenchyma (Fig. 1). Based on these findings, we diagnosed a traumatic pancreatic injury and intra-abdominal bleeding due to rupture of the ASPDA, which subsequently led to the formation of a pseudoaneurysm.

We first conducted transarterial embolization (TAE) to manage the patient's intra-abdominal bleeding, since his vital signs were stable. Angiography of the celiac artery confirmed a pseudoaneurysm in the ASPDA; however, no extravasation was noted. The proximal and distal sides of the ASPDA pseudoaneurysm were embolized, thereby isolating the pseudoaneurysm. A

small pseudoaneurysm in the posterior superior pancreaticoduodenal artery (PSPDA) was also identified; however, this artery could not be selectively catheterized, and embolization was therefore not performed (Fig. 2A-D). Endoscopic retrograde cholangiopancreatography (ERCP) was then conducted for pancreatic and biliary duct stenting. However, because of persistent bleeding the cannulation into the pancreatic and biliary ducts was not possible (Fig. 2E, F).

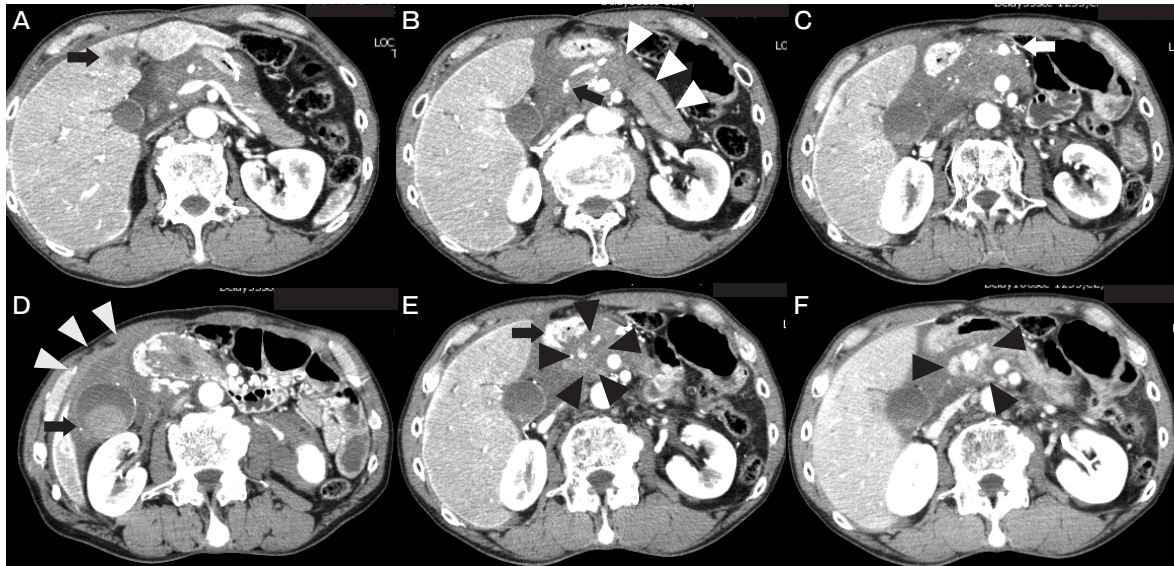
Only patchy enhancement of the pancreatic parenchyma in the head was noted, accompanied by a broad low-attenuation area suggestive of massive disruption of the pancreatic head. An assessment of the patency of the main pancreatic duct (MPD) as well as internal drainage of the MPD were not feasible, and a small pseudoaneurysm persisted in the PSPDA. Surgical intervention was therefore deemed necessary after the multidisciplinary team discussed the findings.

An emergent pancreaticoduodenectomy (PD) was planned at 8 h after the injury. Laparotomy revealed bloody ascites. In addition, the liver was adhered to the right diaphragm and elevated cranially. Severe adhesions were observed around the remnant stomach tissue. A massive subserosal hematoma was noted around the pancreatic head and duodenum, but active bleeding was not detected. No obvious injury of the duodenum was identified; however, the pancreatic head was

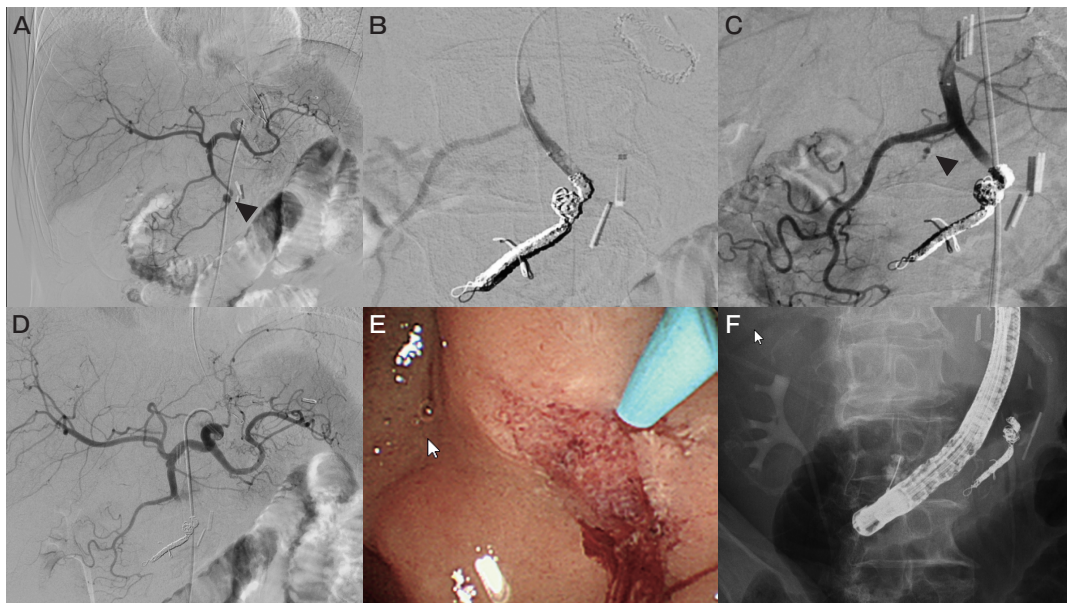
**Table 1** Laboratory examination at admission

Hematology		Biochemistry			
White blood cell	7,070 / $\mu$ l	Total protein	6.4 g/dl	Amylase	78 U/l
Hemoglobin	13.5 g/dl	Albumin	3.6 g/dl	Creatinine kinase	293 U/l
Hematocrit	40.5%	AST	165 U/ml	Blood urea nitrogen	12.4 mg/dl
Platelet counts	186,000 / $\mu$ l	ALT	104 U/ml	Creatinine	0.93 mg/dl
Coagulation		LDH	516 U/ml	Sodium	142 mEq/l
PT	81.1%	ALP	95 U/ml	Potassium	3.8 mEq/l
APTT	23.1 sec	$\gamma$ -GTP	247 U/ml	C-reactive protein	0.03 mg/dl
Fibrinogen	178 mg/dl	Total bilirubin	1.1 mg/dl	Blood sugar	184 mg/dl
FDP	4.2 $\mu$ g/ml	Blood gas analysis (O2 10L)			
D-dimer	2.6 $\mu$ g/ml	pH	7.447	HCO <sup>3</sup>	22.3 mmol/l
		pCO <sup>2</sup>	32.4 mmHg	Lactate	3.7 mmol/l
		pO <sup>2</sup>	309.0 mmHg		

PT, prothrombin time; APTT, activated partial thromboplastin time; FDP, fibrin degradation product; AST, aspartate aminotransferase; ALT, alanine aminotransferase; LDH, lactate dehydrogenase;  $\gamma$ -GTP,  $\gamma$ -glutamyl transpeptidase.



**Fig. 1** Contrast CT imaging of the patient, a 70-year-old male. **A**, Liver injury was suspected in the low-density area of liver segment 4 (*arrow*); **B**, The pancreatic head was indiscernible with surrounding diffuse low-density attenuation, but the pancreatic body and tail were intact (*arrowhead*). Contrast agent extravasation was suspected (*arrow*); **C**, The anterior superior pancreaticoduodenal artery was dilated (diameter 6.5 mm) (*arrow*), suggesting a pseudoaneurysm after arterial rupture; **D**, High density was noted in the gallbladder area, indicating possible hemobilia (*arrow*). High-density ascites indicated intraabdominal bleeding (*arrowhead*); **E**, Early-phase contrast CT image showing strong enhancement of the duodenum (*arrow*); however, the pancreatic head was not clearly enhanced; **F**, Portal-phase contrast CT image showing patchy enhancement of the pancreatic parenchyma (*arrowhead*).



**Fig. 2** **A**, Angiography of the celiac artery demonstrated a pseudoaneurysm of the anterior superior pancreaticoduodenal artery (ASPDA) (*arrowhead*); no extravasation was observed; **B**, The proximal and distal sides of the pseudoaneurysm were embolized, and the aneurysm was thereby completely isolated; **C**, A small pseudoaneurysm of the posterior superior pancreaticoduodenal artery (PSPDA) (*arrowhead*) was identified; **D**, The pseudoaneurysm of the PSPDA was not isolated, because the artery could not be selectively catheterized; **E**, Continuous bleeding was observed from the ampulla of Vater; **F**, Endoscopic retrograde cholangiopancreatography did not show the biliary and pancreatic ducts.

severely crushed. The markedly damaged pancreatic head, surrounded by the hematoma, made it impossible to assess the patency of the MPD. The bile leakage from the hepatoduodenal ligament indicated a biliary tract injury (Fig. 3A).

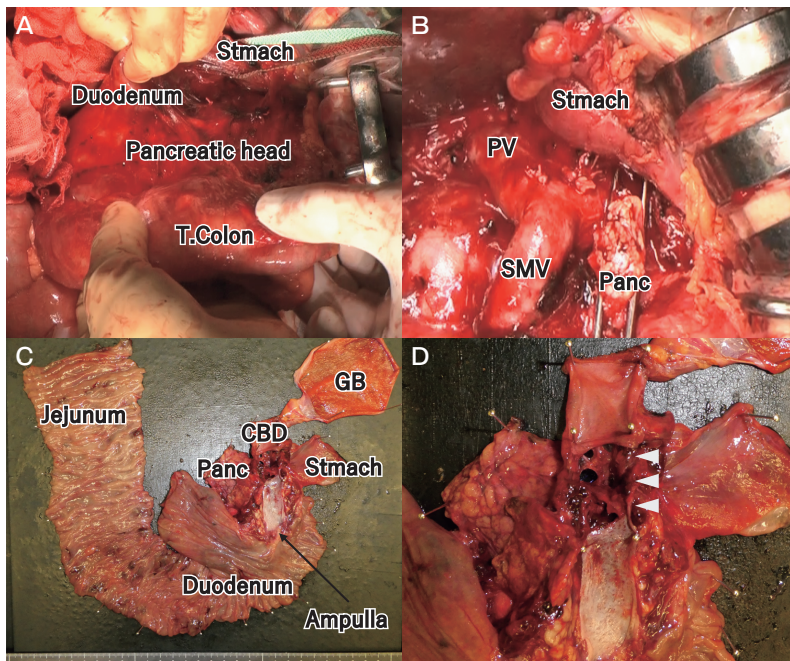
The emergent PD was performed using the Child reconstruction method. Although adhesions were present around the remnant stomach, adhesiolysis was required to adequately inspect the pancreatic head. Because the patient's previous gastrectomy had been reconstructed using the Billroth I method, the remnant stomach could be transected, allowing a standard pancreatoduodenectomy to be subsequently performed. Dissection around the pancreatic head enabled pancreatic transection at an intact, non-injured portion of the gland (Fig. 3B). No saponification was observed around the pancreas, and the pancreatojejunostomy was thus performed as a primary reconstruction. The operative time was 3 h 36 min, and the estimated blood loss was 1,610 ml. Twelve units of fresh frozen plasma were transfused preoperatively, and six units of red blood cell concentrate, eight units of fresh frozen plasma, and 10 units of platelet concentrate were transfused intraoperatively.

The gross examination of the resected specimen confirmed complete transection of the CBD (Fig. 3B, C).

Postoperatively, the patient was admitted to the intensive care unit (ICU), intubated, and placed on a ventilator. On postoperative day (POD) 1, his respiratory and circulatory status improved, enabling extubation. On POD 2, the patient was transferred from the ICU to a surgical ward. The postoperative course was relatively uneventful except for a surgical site infection. He was discharged from the hospital on POD 27. At a follow-up visit 2 months post-injury, the patient had resumed his normal daily activities.

## Discussion

The three areas of relative fixation of the biliary tract in which a CBD injury has been most frequently described are: (1) the origin of the left hepatic duct, (2) bifurcation of the hepatic ducts, and (3) the pancreatoduodenal junction [2]. Although the precise mechanisms that underlie injury to a bile duct after blunt trauma have not been established, the following factors have been identified: (1) "shearing force" producing avulsion of the common duct at its fixed part at the junction with the pancreas or liver, (2) a sudden increase of intraluminal pressure in the gallbladder with a short and permeable cystic duct subsequent to intraluminal pressure resulting from the bile duct injury, and



**Fig. 3** A, B: Intraoperative photographs. A, The pancreatic head was covered with hematoma. T. colon: transverse colon; B, The pancreas was transected at an intact, non-injured portion of the gland. PV, portal vein; SMV, superior mesenteric vein; Panc, pancreas; C, D, Resected specimens showing complete transection of the common bile duct (CBD). GB, gallbladder; Panc, pancreas.

(3) compression of the ductal system against the vertebral column [1,3]. In our patient's case, the extrahepatic bile ducts at the upper edge of the pancreas were completely transected. He had not used his car's seat-belt, and the airbag did not activate. The abdominal trauma can thus be presumed to be due to a steering wheel injury.

The patient had previously undergone a laparoscopy-assisted gastrectomy, and severe adhesions were observed between the right diaphragm and liver during the present laparotomy. The pancreatic head was covered with a large amount of hematoma. Although the patient's CBD was completely transected in the car accident, the hepatoduodenal ligament was relatively smooth. We suspect that the pancreatic head was subject to high-energy force trauma, and we speculate that (i) the shearing force as the pancreatic head moved dorsocaudally due to the trauma was the major mechanism of injury and (ii) the fixation of the liver from existing adhesions may have contributed to this mechanism.

The clinical presentation of biliary tract injuries varies according to the extent of bile duct damage [1]. A major ductal injury typically causes signs of peritoneal irritation and subsequent hypovolemic or distributive shock, making the diagnosis and the indications for laparotomy relatively straightforward [1]. In contrast, an individual with a minor bile duct injury may initially present with only mild abdominal pain or tenderness in the right upper quadrant that subsides within a few days; however, jaundice and abdominal distension due to bilious peritonitis may gradually develop around 5 days after injury [4].

Detecting CBD injuries with ultrasonography or CT is often difficult [1]. Drip infusion cholangiography-CT and ERCP have been reported as useful diagnostic modalities for CBD injuries [4,5]. Because extrahepatic bile duct injuries are rare and complex, they are frequently overlooked in cases of blunt abdominal trauma and are often diagnosed only during an exploratory laparotomy [6]. These injuries are also commonly associated with trauma to adjacent organs such as the liver, duodenum, and pancreas, and they may be missed unless a meticulous intraoperative search is conducted [7]. The presence of bile in the hepatoduodenal ligament, retroperitoneum, and/or abdominal cavity should raise suspicion of a bile duct injury and prompt a careful exploration of the biliary structures. In our patient's

case, a traumatic pancreatic injury with suspected pancreatic duct transection and intra-abdominal bleeding was initially considered preoperatively, but the bilious ascites identified during the laparotomy led to the diagnosis of biliary injury.

Pancreatic trauma is life-threatening. The estimates of the morbidity rate have ranged from 26% to 86%, and the reported rate of mortality related to pancreatic injury is 20% [8,9]. Mortality in these cases is depends primarily on the involvement of other organs, the mechanism, the site, the degree of pancreatic injury, and the delay in diagnosis [8]. Treatment strategies are determined based on the location of the pancreatic injury and the presence of an injury to the MPD. Closed drainage is the first-choice treatment if the MPD is preserved. When MPD damage is suspected, a pancreatectomy is performed [10]. However, confirming/ruling out MPD injury is sometimes difficult with the existing preoperative imaging modalities.

A pancreatoduodenectomy may be necessary in patients with duodenal or pancreatic injuries in whom repair is not feasible. However, this procedure is associated with significant morbidity and mortality and should be restricted to carefully selected cases [10,11]. We applied TAE to sustain the present patient's hemodynamic stability because he was stable with volume resuscitation and intra-abdominal bleeding via the ASPDA was suspected. After the TAE to address the ASPDA pseudoaneurysm, ERCP was planned in order to investigate the MPD injury. Cannulation of the pancreatic duct was unsuccessful, and surgical management was indicated. The patient's CBD injury and severe damage to the pancreatic head were identified intraoperatively. MPD injury could not be ruled out either preoperatively or intraoperatively, and a small untreated PSPDA aneurysm was also identified. A pancreatoduodenectomy was thus ultimately performed. If a pancreatic duct stent had been successfully inserted and the MPD injury had not been confirmed, a Roux-en-Y choledochojunostomy with adequate external drainage could have been considered as an alternative approach.

The concepts of damage control surgery [DCS] and staged management are well established [9]. DCS is usually considered during the initial operation for severe pancreatic injuries involving massive disruption of the duodeno-pancreatic complex [9]. However, we ultimately elected to perform synchronous reconstruction in our patient's case, for the following reasons. (1)

The patient remained hemodynamically stable after admission to our hospital. (2) No saponification was observed around the remnant pancreas, and a normal, intact portion of the pancreas could be transected and used for reconstruction; therefore, the risk of anastomosis-related complications was not presumed to be higher than that of a standard procedure. (3) Because the operative time was relatively short, the patient's condition allowed us to proceed safely with the anastomotic procedures.

Predictive factors of mortality in patients with abdominal trauma include age  $\geq 54$  years, GCS  $\leq 14$ , an Injury Severity Score (ISS)  $\geq 24$ , shock index  $\geq 1.08$ , and the presence of gastric or small intestinal injury [12]. Although our patient was older (aged 70 years), his consciousness was not impaired and his hemodynamic status was stable (shock index = 0.76); the prognosis was thus considered relatively favorable. However, emergency pancreaticoduodenectomy for trauma has been associated with mortality rates of 16-33% and morbidity rates of 51-84% [11, 13]. Although no small bowel or gastric injury was identified in our patient's case, his condition required a pancreaticoduodenectomy, which can be regarded as a poor prognostic factor. Intensive postoperative care was therefore essential.

Early postoperative ICU admission contributes to improved outcomes and the avoidance of complications, particularly by facilitating smoother weaning from mechanical ventilation [14]. Our patient's respiratory condition remained stable postoperatively, allowing for early extubation. Surgeons may occasionally be compelled to conduct major procedures, such as a PD, in the setting of abdominal trauma. A careful selection of surgical techniques and attentive postoperative management may contribute to improved patient outcomes in similar cases.

### Conclusion

An injury to the common bile duct due to blunt abdominal trauma is a rare phenomenon. Surgeons should consider this rare and severe injury in patients who have sustained high-energy trauma to the right quadrant of the abdomen.

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