Diagnosis and Management of High-Grade Pancreatic Trauma: Report of 14 Cases

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Abstract The aim of this study was to review the diagnosis and operative management of cases of high-grade pancreatic trauma. A retrospective analysis was performed on 14 patients treated for high-grade pancreatic trauma at our institution between December 2008 and November 2013. The patients were treated for injuries resulting from blunt abdominal trauma. The main clinical data of the patients was analyzed, including time to diagnosis, initial serum amylase level, ultrasonography and abdominal computed tomography (CT) findings, pancreatic injury severity as scored according to the American Association for the Surgery of Trauma Organ Injury Scale, injury to other organs, operative treatment method, postoperative complications, and patient outcome. All 14 patients were diagnosed with severe ($\geq$ grade III) pancreatic trauma. Diagnosis was confirmed in all seven hemodynamically stable patients that underwent CT and in 9/13 patients receiving ultrasound examination. All patients underwent surgical operations, including emergency pancreaticoduodenectomy ($n=8$), splenectomy with distal pancreatectomy ($n=3$), spleen-preserving distal pancreatectomy ($n=1$), medial pancreatectomy with Roux-en-Y pancreaticojejunostomy ($n=1$), and peripancreatic debridement and drainage ($n=1$). Diagnosis was delayed beyond 24 h in two patients, both of whom underwent reoperative peripancreatic debridement and drainage, with one death. The complications included pancreatic fistula ($n=8$), peripancreatic abscess ($n=2$), hepatic artery hemorrhage ($n=1$), gastrointestinal bleeding ($n=1$), and intra-abdominal abscess ($n=1$). CT is the most reliable method for diagnosing high-grade pancreatic trauma. Aggressive surgical

therapy including pancreaticoduodenectomy is acceptable in hemodynamically stable patients.

Keywords High-grade pancreatic trauma · Early diagnosis · Operative management · Therapeutic strategies

Introduction

Traumatic injury to the pancreas after blunt abdominal trauma is rare due to its retroperitoneal location, with rates of 1–5 % [1–3]. In addition, there are no specific physical signs or indicators [4], and therefore, diagnosis is delayed. Timely diagnosis and treatment is crucial, as the mortality associated with this condition is 7.1–12.4 % due to the difficulty in management [5–7]. There are several factors that contribute to a poor prognosis, such as the presence of coexisting injury to other abdominal organs [8], and the high risk for postoperative complications, including traumatic pancreatitis, pancreatic and duodenal fistulas, diffuse peritonitis, bile leakage, abdominal abscesses, and pancreatic pseudocysts [9–11]. To evaluate the diagnosis and management of high-grade pancreatic trauma in more detail, we retrospectively analyzed 14 cases that were treated in our facility.

Patients and Methods

Fourteen consecutive patients with high-grade pancreatic trauma treated at our institution between December 2008 and November 2013 were included in this study. The following patient data was collected: age, gender, mechanism of injury, time to diagnosis, initial serum amylase level, ultrasonography and contrast-enhanced computed tomography (CT) findings,

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injury classification according to the American Association for the Surgery of Trauma Organ Injury Scale [12], presence of injury to other organs, operative management, postoperative complications, and patient outcome.

Results

Ten of the 14 patients were male with a median age of 30.5 years (range, 18–65 years), and the four female patients had a median age of 28.5 years (range, 18–55 years). All patients included in this study had blunt abdominal trauma. The causes were injury by steering wheel ($n=7$), bicycle handlebars ($n=3$), sudden localized compression to the upper abdomen ($n=2$), or a collapsed wall ($n=2$). A diagnosis was made within 24 h in 85.7 % (12/14) of the cases. Eight patients had hemodynamic instability in the emergency department. The associated injuries are reported in Table 1.

Thirteen patients received ultrasound examinations, and 69.2 % (9/13) of these provided positive diagnosis. Seven patients underwent CT, which revealed pancreatic trauma in all cases. Only 25.0 % (2/8) of the patients in whom serum amylase was examined showed a positive diagnostic sign of >500 U. Final pancreatic injury classifications are presented in Table 2. All 14 cases in this study received operative management. A majority of the patients (8/14) underwent pancreaticoduodenectomy (Table 3). The two patients diagnosed beyond 24 h underwent peripancreatic debridement and drainage again on the 25–28th postoperative day because of peripancreatic abscesses, and one patient died in the postoperative period due to an intestinal fistula. The remaining 13 patients were discharged successfully. Seven of the 13 patients that underwent pancreatectomy had postoperative pancreatic fistulas, which were managed conservatively in six cases, and with peripancreatic debridement and drainage in one case. One patient had an intra-abdominal abscess, which was managed by percutaneous drainage under the guidance of

Table 2 Pancreatic trauma classifications

Grade	Injury description	Number (%)
I Hematoma/laceration	Minor/superficial without ductal injury	0 (0.0)
II Hematoma/laceration	Major without ductal injury or tissue loss	0 (0.0)
III Laceration	Distal transection or pancreatic parenchymal injury with ductal injury	8 (57.1)
IV Laceration	Proximal transection or pancreatic parenchymal injury involving the ampulla	3 (21.4)
V Laceration	Massive disruption of the pancreatic head	3 (21.4)

Grading was based on the American Association for the Surgery of Trauma Organ Injury Scale [12]

ultrasound. An interventional angiography-embolization was performed in the patient with a delayed hepatic artery hemorrhage. Digital subtraction angiography revealed that the gastrointestinal hemorrhage in one patient was due to a small artery bleeding in the pancreatic stump, which was managed by embolotherapy.

Discussion

Diagnosis of Pancreatic Injuries

Early diagnosis and treatment are crucial factors affecting the occurrence of complications and mortality of traumatic pancreatic injury. It was reported by Kao et al. that a diagnosis delayed beyond 24 h is associated with a longer treatment time in the intensive care unit and a higher mortality [6]. Indeed, both patients with delayed diagnoses in the present study developed pancreatic fistulas and peripancreatic abscesses, which resulted in death in one case.

To expedite pancreatic injury diagnosis, the patient's history, clinical signs, auxiliary examination, and intraoperative exploration should be carefully evaluated. Patients with blunt pancreatic trauma often have nonspecific abdominal symptoms and most complain of severe abdominal pain. Tenderness with rebound tenderness was observed in the epigastric area in all 14 of our patients. This may be due to disruption of the main pancreatic duct that results in collection of pancreatic juice in the lesser peritoneal sac, which then infiltrates into the abdominal cavity.

Serum amylase was initially considered a reliable indicator of pancreatic trauma, but further studies indicate it is neither sufficiently sensitive nor specific to be used alone for the diagnosis of pancreatic injury [13]. In a report by Takashima et al., 83 % of patients with pancreatic injury showed elevated serum amylase levels at least 3 h after the initial trauma; however, the levels did not correlate with injury severity [14]. In the present study, serum amylase levels were examined in

Table 1 Associated injuries in cases of blunt abdominal trauma ($n=14$)

Injury type	Number (%)
Splenic injury	8 (57.1)
Liver rupture	2 (14.3)
Intrahepatic hematoma	1 (7.1)
Duodenal injury	2 (14.3)
Small bowel injury	1 (7.1)
Retroperitoneal hematoma	1 (7.1)
Gallbladder injury	1 (7.1)
Limb fracture	1 (7.1)
Cerebral trauma	1 (7.1)
Chest trauma	1 (7.1)

Table 3 Surgical procedures and complications

Case	Pancreatic injury	Surgical procedures	Complications
1	Transection of pancreatic neck	Distal pancreatectomy, splenectomy, partial hepatectomy	Delayed hemorrhage
2	Transection of pancreatic head	Pancreaticoduodenectomy Reoperation: peripancreatic debridement and drainage	Pancreatic fistula, intestinal fistula, peripancreatic abscess
3	Transection of pancreatic head	Pancreaticoduodenectomy	Pancreatic fistula
4	Transection of pancreatic head	Pancreaticoduodenectomy	Pancreatic fistula
5	Transection of pancreatic head	Pancreaticoduodenectomy, live repair	Pancreatic fistula
6	Transection of pancreatic neck	Central pancreatectomy, Roux-en-Y pancreaticojejunostomy	None
7	Transection of pancreatic body	Peripancreatic debridement and drainage Reoperation: peripancreatic debridement and drainage	Pancreatic fistula, peripancreatic abscess
8	Transection of pancreatic neck	Distal pancreatectomy, splenectomy	None
9	Transection of pancreatic head	Pancreaticoduodenectomy	None
10	Transection of pancreatic body	Distal pancreatectomy, splenectomy	Pancreatic fistula
11	Transection of pancreatic body	Spleen-preserving distal pancreatectomy	No
12	Transection of pancreatic head	Pancreaticoduodenectomy	Pancreatic fistula
13	Transection of pancreatic head	Pancreaticoduodenectomy	None
14	Transection of pancreatic head	Pancreaticoduodenectomy	Pancreatic fistula, abdominal abscess, gastrointestinal hemorrhage

Fig. 1 Abdominal computed tomography. **a** Scan showing transection of the neck of the pancreas with hematoma; **b** Scan showing pancreaticoduodenal injury

eight patients, of which only two showed elevated levels. However, another two cases showed progressively increasing levels.

Abdominal CT plays an important role for hemodynamically stable patients with abdominal trauma as it provides the most comprehensive information for the diagnosis of pancreatic injury. Signs of injury include intrapancreatic split, complete transection, or an enhanced pancreas with an unenhanced hematoma [15] (Fig. 1). Many of the patients in our study were hemodynamically unstable; however, signs of pancreatic fracture were observable in the seven patients who underwent preoperative CT. Therefore, abdominal CT is the most definitive diagnostic indicator for pancreatic injury in patients that are hemodynamically stable and should be performed as soon as possible.

Although ultrasound is easy to perform and cost-effective, its use in the diagnosis of pancreatic injury is limited due to the presence of gastrointestinal gas. In this study, only 9 of the 13 cases that underwent ultrasound examination had suspected pancreatic injury. Real-time contrast-enhanced ultrasound is an effective technique in emergency imaging but should not be considered as a replacement for CT [16]. However, ultrasound is valuable in the follow-up of complications.

Therapeutic Strategies

In patients with low-grade (I–II) blunt pancreatic injuries without disruption of the main pancreatic duct, conservative management or simple peripancreatic drainage is usually sufficient [1–3]. Although there are reports of successful treatment of pediatric pancreas fracture with conservative management [17, 18], operative management is recommended for patients with high-grade (III–IV) blunt pancreatic injuries with involvement of the main pancreatic duct [1–3].

Patients with grade III injuries are typically treated by distal pancreatectomy with or without splenectomy, depending on the hemodynamic condition. Preservation of the spleen is recommended for patients that are hemodynamically stable. However, the inclusion of a splenectomy can reduce the surgical trauma in unstable patients with multiple injuries [1–3]. Although an overwhelming post-splenectomy infection is a possible complication, the risk in adults is quite low. Moreover, elaborate maneuvers to preserve the spleen are not advocated in a trauma setting. In this study, the spleen was preserved in only one of the four patients that underwent distal pancreatectomy.

In patients with grade IV injury, the transection of the pancreas is on the right side of the mesenteric vein. Central pancreatectomy is therefore recommended due to the risk for diabetes mellitus from the reduced volume of the remaining pancreas [1–3]. However, distal pancreatectomy should be considered for hemodynamically unstable patients. One patient with a pancreas neck transection in our study had a 20-year history of diabetes. Because of this, a central pancreatectomy with Roux-en-Y pancreaticojejunostomy was performed to salvage pancreatic function.

Patients with significant pancreatic head injury and ductal disruption (grade V) often have associated duodenal and vascular injuries, with a reported mortality of 18–23 % [19–22]. In patients with unstable hemodynamics, a two-stage procedure can be performed to control the bleeding and close the stomach, jejunum, and pancreatic stump and provide adequate drainage of the bile duct and stomach. For stable patients, a pancreaticoduodenectomy (Whipple procedure) should be performed as soon as possible, and within 48 h, to reduce the risk of traumatic pancreatitis [1–3, 15, 17]. Although there is a high risk of morbidity and mortality with an emergency pancreaticoduodenectomy, resection and reconstruction can more easily be performed before traumatic pancreatitis or abdominal cavity infection develops. In this study, the mortality of emergency pancreaticoduodenectomy is 12.5 %.

Complications

Complications of pancreatic trauma can range from minor pancreatitis to death. Traumatic pancreatitis, peripancreatic abscesses, and pseudocysts are more common in patients

who are diagnosed late or treated conservatively. Surgical treatment is more likely to be complicated by pancreatic fistulas, celiac infection, and postoperative hemorrhage [5–7]. In this study, eight patients had pancreatic fistulas, which are the most frequent complication. Five of these were the patients who underwent emergency pancreaticoduodenectomy and recovered successfully with conservative management within 2 months after the operation.

Postoperative hemorrhage is a serious complication of pancreatic trauma. Although the mechanism remains unknown, it is thought to be associated with pancreatic fistulas, intraperitoneal abscesses, and autodigestion [22–27]. A delayed hemorrhage can be managed by interventional angiography-embolization in hemodynamically stable patients or by laparotomy in unstable cases [22, 25]. In the present study, there was one case with a delayed hemorrhage that was identified on the 33rd postoperative day. Angiography of the celiac and superior mesenteric arteries indicated that contrast agent had leaked from common hepatic artery, and the patient recovered after a common hepatic artery embolization was performed.

Intra-abdominal infections and peripancreatic abscesses are serious complications related to delayed diagnosis of pancreatic injury. In our study, both patients with diagnoses delayed beyond 24 h required additional peripancreatic debridement and drainage because of peripancreatic abscesses. One of these patients represented the only death in our study, which was due to an intestinal fistula and fungal infection.

Conclusion

High-grade pancreatic trauma can result in serious complications or death. Therefore, it is crucial to obtain an early diagnosis. Abdominal CT provides the most reliable method for detecting pancreatic injury. Once detected, aggressive surgical therapy including pancreaticoduodenectomy is acceptable in hemodynamically stable patients.

Conflict of Interest The authors declare that they have no competing interests. Authors of the article either have or do not have commercial associations (e.g., consultancies, stock ownership, equity interests, patent-licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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