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Management of pancreatic and duodenal injuries

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Pancreatic and duodenal injuries are rare and, excluding patients with devastating injuries to the pancreaticoduodenal complex and adjacent vascular injuries, can be managed successfully with adequate and determinate exposure during explorative laparotomy, simple surgical procedures, and sound surgical judgment adapted to the demands of the circumstances and the skills of the operating surgeon. Nevertheless, more complex repair techniques, such as distal pancreaticojejunostomy or pyloric exclusion, may be needed for optimal results in more demanding injuries. Although mortality specifically related to the pancreatic or duodenal injury itself is relatively low, postoperative complications are frequent and often associated with delayed diagnosis and treatment.

Key words: abdominal trauma, pancreas, duodenum, pancreaticoduodenal injuries

Introduction

Pancreatic and duodenal injuries are not common and their detection can be challenging both preoperatively and during explorative laparotomy. Their protected location in the retroperitoneum can give subtle symptoms and signs in isolated injuries leading to delayed diagnosis and management. The purpose of this review is to outline the main characteristics of treating these injuries with emphasis on the operative decision making strategies.

Trauma mechanism

In larger series, especially from the United States, about 70–80% of pancreatic and duodenal injuries are caused by penetrating trauma [1]. In Europe, blunt trauma is a more common cause of pancreatic injury [2]. The mechanism of injury in penetrating trauma is direct violation of the pancreatic gland or duodenal wall by the wounding agent. Pancreas is a fixed organ in the retroperitoneum that lies against a rigid vertebral column and is therefore prone to crush injuries following blunt trauma. Disruption of the duodenum by blunt trauma can occur by crushing following a direct blow to the abdomen, shearing associated with sudden deceleration, or bursting energy associated with sudden abdominal compression [3]. Intramural duodenal hematoma is a rare injury usually following blunt abdominal trauma most commonly presenting with signs of progressive high intestinal obstruction (Fig. 1).

Fig. 1. CT of an intramural duodenal hematoma

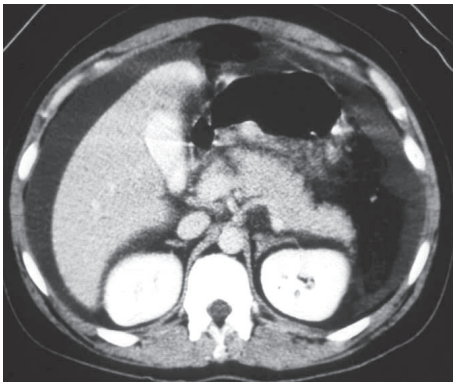

Fig. 2. CT of a proximal pancreatic injury with ductal involvement

Diagnosis and indications for operation

Depending on the institutional practice guidelines on managing penetrating and blunt abdominal injuries the indications for operative exploration vary. However, inspection of the penetrating wounds with assessment of the knife or bullet tract, and evaluation of localized or generalized abdominal tenderness are mandatory for all hemodynamically stable patients with injuries potentially involving abdominal organs. Surgical exploration of the wound under local anesthesia may reveal peritoneal penetration. Diagnostic peritoneal lavage with visual and laboratory assessment of the lavage fluid may reveal components of intraperitoneal blood, bile or intestinal contents, but its use has greatly diminished in recent years. Serum or urine amylase levels are not reliable in detecting or excluding a pancreatic injury.

Plain abdominal x-rays can identify extraluminal air in the intra- or retroperitoneal areas indicative of gastrointestinal perforation, as well as assess the level of mechanical intestinal obstruction and follow up of the resolution (enhanced with oral contrast medium) in patients with suspected intramural duodenal hematomas. Contrast studies with water-soluble contrast medium to reveal upper gastrointestinal perforations are useful when positive, but are not reliable in excluding a perforation. Ultrasound examination is useful in detecting intraperitoneal fluid especially, if performed rapidly in unstable patients with multiple injury sites identifying a major hemoperitoneum requiring early surgical intervention.

Findings strongly suggesting gastrointestinal perforation, such as generalized peritonitis on physical examination, bowel content seen in the wound, upper gastrointestinal hemorrhage, or DPL positive for bile or gross intestinal content warrant early exploratory laparotomy.

Computed tomography (CT) is the most reliable method to detect subtle retroperitoneal perforations of the duodenum and it can be enhanced with oral contrast medium. In blunt pancreatic injuries, especially at the initial stage, its sensitivity is not very good, but remains the primary diagnostic tool (Fig. 2). Endoscopic retrograde cholangiopancreatography (ERCP) is very useful in identifying injuries to the main pancreatic duct, but it is seldom available in the acute setting. Magnetic Resonance Imaging pancreatography (MRP) can detect pancreatic injuries but its reliability has not yet been established.

Grading of organ injuries

The American Association for the Surgery of Trauma has published the most commonly used scales for grading individual organ injuries. The injuries are graded from I to V with increasing severity. Although useful in determining the management strategy for pancreatic injuries, its role in managing duodenal injuries is less important.

Nonoperative management

Pancreatic contusions and minor lacerations can be treated nonoperatively provided that no other inju-

ries requiring surgical repair are present, and that an injury to the major pancreatic duct has been excluded. Occasionally, a minor leak or a side-fistula of the pancreatic duct can be managed with an endoscopically placed stent.

In the absence of associated injuries requiring surgery, the treatment of an intramural duodenal hematoma is nonoperative consisting of nasogastric suction and parenteral fluid administration. Prolonged obstruction may require parenteral nutrition and even operative treatment if the obstruction persists for more than 2 weeks.

Operative management of pancreatic injuries

Visualization of the entire pancreas requires several maneuvers including transection of the gastrocolic ligament to allow inspection of the anterior surface and inferior border of the gland, and the Kocher maneuver to allow for the exposure of the head and uncinate process of the pancreas. Additional exposure of the superior border of the head and body of the pancreas can be achieved by transection of the gastrohepatic ligament. Finally, lateral mobilization of the spleen and splenic flexure of the colon, and the dissection of the retroperitoneal attachments of the inferior border of the pancreas allows the visualization and bimanual palpation of the posterior surface of the tail and body of the gland [4].

Fig. 3. Transected pancreas at operation. The divided pancreatic tissue edges are pointed with forceps and a pediatric feeding tube has been placed in the pancreatic duct of the proximal stump

After adequate exposure of the pancreas, the most important step in assessing the severity of the pancreatic injury is the determination whether the main pancreatic duct is intact. Complete transection (Fig. 3) which sometimes can be sealed with a hematoma under the pancreatic capsule, central perforation, large vertical laceration, and severe contusion especially in the distal part of the gland are indicative of disruption of the main pancreatic duct. Attempts at verifying the ductal injury with radiological means or injecting dye are often cumbersome and unreliable.

Injuries with intact main pancreatic duct can be managed with simple hemostatic sutures and peripancreatic drainage. Injuries with ductal disruption at or to the left of the superior mesenteric vein are best treated with distal pancreatectomy. Splenic preserving distal pancreatectomy can be performed under favourable conditions. To avoid endocrine insufficiency, distal resections involving more than 80% of the gland should be avoided, except in unstable patients with major associated injuries.

Injuries involving the main pancreatic duct at the head of the gland are challenging injuries, and in most cases the best option in multiply injured patients is just to ensure adequate peripancreatic drainage with 1–3 well-placed drains.

Under favorable conditions, proximal injuries can be treated with duodenum-preserving resection of the pancreatic head (avoiding the intrapancreatic portion of the common bile duct), closure of the proximal stump, and draining the distal pancreas into a Roux-en-Y limb of jejunum with a distal pancreaticojejunostomy. The other alternative is to perform a distal pancreatectomy accepting the risk of the development of diabetes.

All pancreatic injuries, even peripheral ones, require adequate placement of peripancreatic drains. In patients with major pancreatic injuries, nasogastric suction to reduce pancreatic stimulation and secretion is useful.

Operative management of duodenal injuries

Even the most minimal positive intraoperative finding should prompt a thorough exploration and visualization of all four portions of the duodenum. A

Kocher maneuver is performed by incising the lateral peritoneal attachments of the duodenum, and sweeping both the second and third portions medially using a sharp and blunt dissection. The fourth portion of the duodenum can be visualized by transecting the ligament of Treitz while identifying and preserving the inferior mesenteric vein and rotating the duodenum laterally from left to right. Thereafter, the third portion or transverse portion of the duodenum can most often be adequately visualized anteriorly and digitally palpated posteriorly. In severe injuries of the right side of the transverse duodenum, the exposure can be dramatically improved by mobilizing the right hemicolon and hepatic flexure medially and incising the retroperitoneal attachments of the small bowel from the right lower quadrant upwards enabling the complete reflection of the small bowel out of the abdominal cavity (Cattell and Braasch maneuver) [4].

Small perforations encountered early after injury heal well after debridement and transverse closure in two layers without tension. A through-and-through perforation with a narrow duodenal strip in between can be formed into one defect and closed as a simple laceration. Injuries facing the head of the pancreas can be sutured from inside through the anterolateral defect. In injuries close to the ampulla of Vater, careful placement of the sutures is important to avoid accidental closure of the distal common bile duct. The intact bile duct system can be confirmed by placement of a soft, small-caliber feeding tube through a separate choledochotomy incision in the hepatoduodenal ligament down through the ampulla before duodenal closure.

More extensive lacerations not amenable to suture closure without significant narrowing can be treated with segmental duodenal resection and end-to-end anastomosis, especially in the first, third and fourth portions. Roux-en-Y duodenojejunostomy with or without resection can be used in distal duodenal injuries. The serosal patch technique to close extensive duodenal defects has very limited value in clinical practice.

In patients with large or multiple duodenal perforations associated with extensive loss of duodenal tissue, especially after high velocity missile wounds, and in patients seen after more than a few hours after injury with generalized peritonitis, duodenal wall edema and maceration of surrounding tissues, duodenal repair is associated with a high risk of duodenal leak and subsequent mortality and morbidity. The main purpose of duodenal exclusion procedures is to exclude the duodenal repair from gastric secretions and allow time for adequate healing of the duodenal repair.

Following duodenal repair, the pyloric exclusion procedure consists of closure of the pyloric ring from inside through a gastrotomy incision at the greater curvature of the antrum with a running polypropylene suture and a gastrojejunostomy placed at the gastrotomy site.

A more complete exclusion is achieved with a duodenal diverticulization procedure that consists of suture repair of the duodenal injury, antrectomy and gastrojejunostomy, tube duodenostomy and periduodenal drainage. Truncal vagotomy and biliary drainage are useful additions.

Pancreaticoduodenectomy or the Whipple procedure requires extensive experience and considerable time to complete and is seldom indicated.

Even a simple duodenal repair should be accompanied with a nasogastric tube for decompression which can also be equipped with extra side holes and placed so that it decompresses both the stomach and the proximal part of the duodenum. A more extensive decompression can be achieved with a lateral tube duodenostomy or retrograde tube jejunostomy. Biliary decompression with a T tube placed in the common bile duct is useful in delayed presentation of duodenal injuries, and is commonly used in association with the duodenal diverticulization procedure.

External drainage of the periduodenal space is useful in all duodenal injuries and can sometimes be used to treat a small duodenal leak.

All complex or delayed duodenal injuries are associated with a high risk of duodenal leak warranting the placement of a feeding tube jejunostomy at the primary operation.

Combined pancreaticoduodenal injuries

Minor co-existing injuries of duodenum and pancreas can be treated separately with duodenal repair and

peripancreatic drainage, respectively. More extensive duodenal injuries combined with minor pancreatic head injuries are best treated with duodenal repair combined with pyloric exclusion and drainage.

Major lacerations in the head of the pancreas with ductal involvement, devascularizing lesions of the duodenum, or duodenal lacerations with destruction of the ampulla and distal common duct may require pancreaticoduodenectomy as a debridement procedure. It can be performed in a one-stage or two-stage procedure [3].

One alternative to the Whipple procedure which could be used under difficult conditions in managing major pancreaticoduodenal injuries consists of duodenal repair (with or without pyloric exclusion), intraluminal tube decompression (gastrostomy, duodenostomy, retrograde jejunostomy), extensive peripancreatic and periduodenal drainage and a feeding jejunostomy. In destructive injuries of the ampulla of Vater, complete biliary diversion with ligation of the common bile duct near the pancreas and cholecystojejunostomy (or a T tube) should be added.

Postoperative complications

Postoperative pancreatitis, pseudocyst formation and pancreatic fistulas can be difficult to identify and in most cases can be initially managed nonoperatively. Definitive treatment of these complications require usually advanced radiological and endoscopic techniques. Dehiscence of a pancreaticojejunal anastomosis after a Roux-en-Y pancreaticojejunostomy is a severe complication requiring early reoperation. In most cases total removal of the distal pancreas is the only viable option.

Worsening general condition, fever and tachycardia, increasing abdominal pain, decreasing urinary output and increasing respiratory distress few days after initially good recovery from duodenal repair may point towards suture line or anastomotic dehiscence. Bile-stained secretion from the drains or wound confirm the diagnosis. Positive finding in a upper gastrointestinal contrast study confirms the diagnosis but the absence of contrast leak or extraluminal air in the abdomen do not exclude anastomotic dehiscence.

A controlled duodenal leak into a drain with good general condition of the patient can be managed expectantly, whereas progressive sepsis and uncontrolled leakage of the duodenal content outside the confined area of drainage require a reoperation, diversion of the duodenal content, luminal decompression and insertion of a feeding jejunostomy, if not placed at the primary operation. In all cases reoperated for anastomotic leakage, the peritoneal cavity must be irrigated with large amounts of warm normal saline to dilute the toxic effects of the intestinal content and prevent formation of retention abscesses.

Preoperative shock with aggressive fluid resuscitation, prolonged operation, extensive handling of the intestines and many other factors can contribute to the postoperative swelling of the abdominal viscera leading to intra-abdominal hypertension which if severe, can lead to progressive compromise of the respiratory, renal and other organ system functions, and eventually death. Measurement of the intra-abdominal pressure is essential to detect abdominal compartment syndrome. Decompressive laparotomy should be considered, if the intra-abdominal pressure exceeds 25 mmHg and should be performed without delay with a pressure over 35 mmHg.

Outcome

In penetrating pancreatic injuries, the mortality rate is about 15–20% and most commonly caused by hemorrhage from associated vascular injuries or devastating injuries from close range shotgun wounds [5–7]. In a series of 432 patients with pancreatic injuries surviving 48 hours, the late mortality rate was 8%, and only in one third of these did the pancreatic injury contribute to death [5]. The pancreatic fistula rate following penetrating pancreatic injury is about 10% and seldom contribute to death [5, 7]. In contrast, postoperative hemorrhagic pancreatitis, albeit rare, is associated with a mortality rate as high as 80% [5].

In a study of 57 patients with civilian gunshot wounds of the distal pancreas, of which 84% were treated with distal pancreatectomy and splenectomy, the fistula and mortality rates after this procedure were 14% and 2%, respectively [8]. Among 48 patients with civilian gunshot wounds to the head of the pancreas, there were 16 patients (33%) with pancreatic

fistulas with an overall pancreatic-related mortality rate of 10% [9].

The mortality rate after blunt pancreatic injury is less than 10%, but the morbidity remains high. In a series of 48 patients with blunt major (grade III–V) pancreatic injuries, the complication rate was significant (62%), especially when treatment was delayed more than 24 hours [10].

The mortality rate after penetrating duodenal trauma is about 15–20%, and in the majority of cases caused by early uncontrollable hemorrhage from associated vascular and hepatic injuries. The duodenum-related mortality rate is 1–2% and associated with duodenal repair dehiscence. The duodenal fistula rate in patients surviving the first 24 hours is about 5%, and associated with both duodenorrhaphy and pyloric exclusion or duodenal diverticulization procedures although pyloric exclusion seems to be more often related to spontaneous resolution of the fistula [11, 12].

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