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REVIEW

Management of pancreatic trauma

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Summary

Background: Pancreatic injury can pose a formidable challenge to the surgeon, and failure to manage it correctly may have devastating consequences for the patient. Management options for pancreatic trauma are reviewed and technical issues highlighted.
Method: The English-language literature on pancreatic trauma from 1970 to 2006 was reviewed.
Results and conclusions: Most pancreatic injuries are minor and can be treated by external drainage. Injuries involving the body, neck and tail of the pancreas, and with suspicion or direct evidence of pancreatic duct disruption, require distal pancreatectomy. Similar injuries affecting the head of the pancreas are best managed by simple external drainage, even if there is suspected pancreatic duct injury. Pancreaticoduodenectomy should be reserved for extensive injuries to the head of the pancreas, and should be practised as part of damage control. Most complications should initially be treated by a combination of nutrition, percutaneous drainage and endoscopic stenting.

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Introduction

Pancreatic injury can pose a formidable challenge to the surgeon and failure to manage it correctly may have devastating consequences for the patient. Detailed knowledge and correct application of the available operative choices is important. The purpose of this review is to discuss extensively such management options, as well as to highlight technical issues and potential pitfalls, in the hope of assisting surgeons unfamiliar with these injuries.

Mechanism of injury

Penetrating trauma caused by stab and gunshot wounds is common in certain parts of the world and is almost always associated with other injuries.[22,39] Blunt trauma to the pancreas occurs in motor vehicle, bicycle and pedestrian accidents and with direct blows to the epigastrium during assaults, in which case the pancreas is crushed against the spine. The part of the pancreas usually injured overlies (or is situated to the left of) the portal vein and superior mesenteric vessels. Associated injuries of the liver or proximal small bowel are common in these cases.[14]

Diagnosis

It is worth noting that 95% of pancreatic injuries can be diagnosed by careful inspection following adequate exposure. The remaining 5% of injuries may require more elaborate investigative techniques to diagnose ductal injury.[35] Intraoperative ultrasound and intraoperative endoscopic studies have been suggested as possible means of identifying major ductal injuries. The applicability and accuracy of these approaches have not been validated to date.[35]

Plain abdominal radiographs are not helpful in directly demonstrating pancreatic injury. However, it is important to note that if abdominal radiographs demonstrate fractures of the lower thoracic and/or upper lumbar vertebrae, the possibility of associated pancreatic or duodenal injuries should be considered. Further investigations for detection of pancreatic injury are required if plain abdominal radiographs show retroperitoneal air bubbles along the right psoas muscle or along the right kidney (as in duodenal injury), or if they demonstrate displacement of the stomach and transverse colon or a generalised ground-glass appearance.[35] The same applies in the detection of duodenal injury following gastrografin swallow, with the patient in the right lateral position.

Ultrasound can show the presence of free abdominal fluid and, as such, provide collateral evidence in cases of suspected pancreatic injury. The assessment of the pancreas *per se* is difficult because of its retroperitoneal position and the presence of overlying transverse colonic gas.[47]

Patients with penetrating trauma to the pancreas usually undergo surgical exploration; they are physiologically unstable and may have clinical signs of peritonitis due to concomitant organ injuries. In these cases the diagnosis of pancreatic injury will be made by intraoperative pancreatic examination. In blunt trauma the detection of isolated pancreatic injury can be more difficult. This is due to the fact that the retroperitoneal site of the pancreas can mask significant clinical findings, even in the presence of pancreatic duct disruption, as pancreatic enzymes can remain inactive following an isolated injury.[34] Confirmation or exclusion of this injury requires extensive diagnostic work-up.

Diagnostic peritoneal lavage has not proved useful in the diagnosis of significant injuries to the pancreas. Several cases of complete transection have been described with normal lavage findings.[32,65] Failure of lavage to indicate pancreatic injury has been attributed to the retroperitoneal location of the gland and limited access of lavage fluid to the lesser sac.

Serum amylase was initially considered a reliable indicator of pancreatic trauma. Further studies demonstrated that elevation of amylase in neither serum nor peritoneal lavage fluid was sensitive or specific in the diagnosis of pancreatic injury.[54] The introduction of amylase isoenzyme determination (to distinguish pancreatic from salivary amylase) did not improve sensitivity or specificity. Bradley et al.,[12] in a review of the literature including more than 400 cases of blunt pancreatic injury, found that

serum amylase levels were elevated among 82% of people with documented pancreatic injuries. Takishima et al.[60] observed that the presence of hyperamylasaemia after blunt pancreatic trauma is time dependent; elevated serum amylase was present in all their cases when the samples were collected more than 3 h following injury. The latter investigators concluded that serum amylase levels, determined before this time period, were not diagnostic. It has also been demonstrated that there is no relation between the degree of pancreatic trauma and the level of hyperamylasaemia. Jones[32] and Wisner et al.[65] reported that one third of patients with injuries as severe as complete pancreatic transection had serum amylase concentrations within the normal range. It is important to mention that raised serum amylase is not a reliable indicator of pancreatic injury in cases of brain injury; a significant percentage of these patients have hyperamylasaemia in the absence of abdominal trauma, suggesting that a central nervous system pathway is involved in the regulation of serum amylase levels.[45]

However, elevated amylase in serum or peritoneal lavage fluid in the setting of blunt abdominal trauma does mandate further investigation. People with a reliable history, lack of significant clinical signs and elevated serum amylase should be observed and undergo repeated amylase measurements. Persistent elevation or appearance of abdominal signs necessitate further evaluation by other methods such as abdominal CT, endoscopic retrograde cholangio-pancreatography (ERCP) or surgical exploration.[34]

Helical multi-slice CT represents the best non-invasive diagnostic method for the detection of pancreatic injury, with sensitivity and specificity as high as 80%. CT findings associated with pancreatic trauma include: extraperitoneal fluid; fluid in the lesser sac, the arterial pararenal space or between the splenic vein and the pancreatic parenchymal space; pancreatic oedema; haematoma; and fracture and thickening of the anterior renal fascia.[51,55] However, particularly in the initial phase, CT may miss or underestimate the severity of the damage; normal initial findings do not exclude appreciable pancreatic injury, and repeated CT in the light of continuing symptoms may improve its diagnostic efficiency.[34]

Morbidity and mortality rates for isolated pancreatic trauma are directly related to the presence of damage to the pancreatic duct. It has also been demonstrated that delayed detection of pancreatic duct disruption is related to increased incidence of morbidity and mortality. ERCP has been until recently the most accurate method for detecting pancreatic duct trauma in the physiologically stable patient, by demonstrating extravasation of contrast medium from the pancreatic duct system.[36,63] Patients with hyperamylasaemia, persistent abdominal pain and questionable abdominal CT findings, who are being considered for non-operative management, should have the integrity of the duct system demonstrated. However, if ERCP is to be carried out in lieu of operative exploration, it must be performed urgently within 12—24 h of injury, as further delays will jeopardise subsequent care. ERCP may be of value in cases with delayed presentation or injuries missed by CT. It is also valuable in defining the nature and extent of damage to the duct, and in planning appropriate surgical correction (open surgery, internal transpancreatic duct stenting, transductal drainage) for those patients who develop post-injury complications, such as pseudocysts or distal chronic pancreatitis.[34]

Magnetic retrograde cholangio-pancreatography (MRCP) has recently been added to the armamentarium of pancreatic duct delineation techniques and could, in the future, replace ERCP as a first-line investigation, particularly with the development of rapid MRI imaging techniques.[10,25,52] MRCP is particularly useful for patients with pancreatic injuries managed by drainage, who have subsequently developed a persistent pancreatic fistula, as well as for patients with pancreatic fistula who have undergone pyloric exclusion.

Grading

There are three main classification systems for pancreatic injuries (Tables 1—3). All three address the key issues of treatment of parenchymal disruption and major pancreatic duct status in the more severe injuries by focusing on anatomical location. The latest system was proposed by the American Association for the Surgery of Trauma Committee on Organ Injury Scaling (Table 3).[48] There are similarities between these three systems, but undoubtedly their multiplicity creates problems when comparing the outcomes of studies using differing systems.

Table 1 Classification of pancreatic injury[58]

Grade	Criteria
I	Contusion/haematoma, intact capsule, no parenchymal injury
II	Parenchymal injury without major duct injury
III	Parenchymal disruption, presumed major ductal injury
IV	Massive parenchymal disruption

Table 2 Modified LUCAS classification of pancreatic injury[46]

Class	Criteria
I	Simple superficial contusion or peripheral laceration with minimal parenchymal damage, any portion of the pancreas can be affected, but intact main pancreatic duct
II	Deep laceration, perforation or transection of the neck, body or tail of the pancreas, with or without pancreatic duct injury
III	Severe crush, perforation or transection of the head of the pancreas, with or without pancreatic duct injury
IV	Combined pancreaticoduodenal injuries: (a) minor pancreatic injury, (b) severe pancreatic and also duct injury

Operative technique in pancreatic trauma

Patients undergoing laparotomy for penetrating or blunt injuries, other than isolated pancreatic injuries, generally do so without the luxury of an extensive preoperative work-up. Laparotomy is usually required because of evidence of major intraperitoneal bleeding or peritonitis. A long midline incision provides optimal exposure. The first priority is control of bleeding and of ongoing contamination. Once these goals are achieved and the patient is stable, a thorough examination must take place for evidence of pancreatic injury. Clues suggesting the presence of pancreatic trauma include lesser sac fluid collection, retroperitoneal bile staining, haematoma overlying the pancreas and fat necrosis of the omentum or retroperitoneum.[53] In penetrating trauma, missile tracks should be followed in their entirety. If parenchymal injury is noted, duct integrity should be determined. Observation is accepted by the great majority of surgeons as the only method of determining ductal damage, using the intraoperative criteria of main pancreatic duct injury introduced by Heitsch et al.[30] These comprise direct visualisation of ductal violation, complete transection of the pancreas, laceration of more than half the diameter of the pancreas, central perforation and severe maceration. In order to assess fully the injury and manage it appropriately, full mobilisation of the injured area is of paramount importance.

Table 3 The Organ Injury Scaling Committee of the American Association for the Surgery of Trauma, for pancreatic trauma[48]

Grade	Criteria
I	Simple contusion of the pancreas
II	Major contusion or laceration without tissue loss or involvement of the main pancreatic duct
III	Complete transection of the pancreas or a parenchymal injury with involvement of the major duct to the left of the superior mesenteric vein
IV	Ductal transection or a major parenchymal injury to the right of the superior mesenteric vein
V	Massive disruption of the head of the pancreas

Intraoperative evaluation of the head of the pancreas includes determining the integrity of the main pancreatic duct, the presence of a devitalised pancreatic head or duodenum, the extent of duodenal injury, the integrity of the ampulla and bile duct and whether a concomitant vascular injury is present.[3,11] Thus complete visualisation of the head of the pancreas is necessary, involving an extended Kocher's manoeuvre following initial mobilisation of the hepatic flexure and the proximal third of the transverse colon. Gentle traction of the duodenal loop can help with the performance of this manoeuvre. The peritoneal attachment along the lateral portion of the second part of the duodenum is divided, and the left index finger should be inserted behind the lateral duodenal ligament which attaches the second part of the duodenum to the fascia of Gerota. Following division of this ligament over the index finger, this line of dissection should be continued towards the third portion of the duodenum, as far as the point where the superior mesenteric vein crosses the transverse duodenum. This should be performed with care, as excessive upward traction of the duodenum and pancreas may tear the superior mesenteric vein. The duodenum is mobilised superiorly as far as the foramen of Winslow. The surgeon should then be able to palpate the aorta posterior to the pancreas and fully visualise the anterior and posterior aspects of the second and third part of the duodenum, as well as the head and uncinate process of the pancreas.

The distal pancreas can initially be seen by opening the greater omentum. If there is anything suggesting injury, the whole lesser sac should be opened by detaching the greater omentum from the transverse colon along the bloodless line, to display the full width of the lesser sac. If there is suspicion that the injury may involve the distal tail of the pancreas near the hilum of the spleen, incision of the lienosplenic, splenocolic and splenorenal ligaments should be undertaken and the spleen mobilised, medially rotated and lifted towards the incision. This allows inspection of the anterior as well as the posterior aspects of the tail of the pancreas. Proper visualisation of an injury suspected

at the body and tail of the pancreas can be achieved by incising the avascular peritoneal attachment of the transverse mesocolon to the pancreas and exposing its inferior border. Subsequently the pancreas is lifted upwards by blunt dissection with the fingers in the retropancreatic space the upper border of the pancreas is reached (the peritoneum superficial to the fingers should also be incised along the upper border of the pancreas). A cephalad rotation of the pancreas will allow inspection of the posterior surface and bimanual palpation. This manoeuvre can be performed safely as long as the initial sharp dissection is properly completed. A few retropancreatic vessels may bleed, but this can easily be controlled by local pressure.

If after mobilisation of the pancreas the injury is judged to require distal pancreatectomy, the splenic artery and vein are ligated 1—2 cm proximal to the injury site, to decrease bleeding from the splenic parenchyma. Mobilisation of the pancreas should then be continued for 1—2 cm proximal to the site of the proposed resection. A soft-bowel clamp is applied and the parenchyma is divided by sharp dissection or electrocautery. Gradual release of the soft-bowel clamp helps to identify the two pancreaticoduodenal arteries and to overrun them with a 5.0 vascular stitch. Our experience is that in many cases it is possible to identify the minute pancreatic duct, in which case it is also advisable to occlude it with a 5.0 vascular stitch.[19] Closure of the pancreatic stump is performed by overlapping interrupted mattress stitches of polypropylene or silk. This technique of mattress sutures can by itself achieve parenchymal closure as well as adequate haemostasis and occlusion of the pancreatic duct, although we prefer to occlude the arteries and the duct separately if possible, and then continue with the mattress sutures. Resection of the body of the pancreas can also be achieved with a linear stapler. Initially we used both hand-sewing and stapling techniques, without significant difference in outcome for 70 people who underwent distal pancreatectomy for gunshot injury to the distal pancreas.[19] However, over the last 10 years we have observed that the stapling technique has been unsatisfactory in a significant percentage of cases, the stapled line having to be reinforced with sutures. This observation (which, to our knowledge, has not been reported by other authors) has prompted us to use only the hand-sewing technique. A structured review of our results, as well as further reports of extensive studies, are required to justify our caution in avoiding stapling in cases where constraints do not prohibit the use of the hand-sewing technique.

Distal pancreatectomy with preservation of the spleen has been advocated for physiologically stable cases. This is an elaborate exercise suitable mostly in an elective setting. In any case, saving the spleen has not proved beneficial for adults, as opposed to children. We do not recommend or use it in trauma cases.[17,19]

Intraoperative deaths after gunshot injuries to the pancreas are often due to uncontrollable haemorrhage from neighbouring vessels or the liver. However, the major determinant of morbidity and mortality related to pancreatic trauma *per se* is injury to the main pancreatic duct.[15,20,43] Several radiological methods of intraoperative evaluation of the biliary and pancreatic ducts have been recommended. The easiest approach is to perform a conventional operative cholangiogram through the cystic duct following removal of the gall bladder or, alternatively, to insert a 25-gauge butterfly needle into the common bile duct and inject 10 ml of full-strength iodinated contrast medium under fluoroscopic control. The images obtained may be useful in assessing the intrapancreatic portion of the bile duct, the integrity of the ampulla and the continuity of the pancreatic duct, if there is incidental reflux of contrast medium into the pancreatic duct.[11] Intraoperative pancreatography can be carried out by cannulation of the duct via a transduodenal approach, by cannulation of the duct through the tail of the pancreas, or by concomitant ERCP.[5,6,9,29,64]. In a series of pancreatic injuries of mixed aetiology, a threefold reduction in mortality was attributed to the introduction of transduodenal pancreatography, without any added morbidity from the procedure itself.[9] This technique involves intubation of the ampulla of Vater either through an open duodenotomy or through an amputated tail of the pancreas. The duct is then cannulated with a 5-Fr paediatric feeding tube, and 2—5 ml of radiographic contrast material instilled to visualise the pancreatic duct. We are very cautious in recommending these techniques as they can lead to serious complications. Opening the second part of the duodenum, aiming to intubate the ampulla of Vater, can result in a duodenal leak. The identification of the ampulla and the pancreatic duct (at the amputated tail of the pancreas) may be difficult.

It is worth mentioning that in the great majority of cases of pancreatic trauma the gland is normal, and as such is related to a duct of minute diameter (particularly at the periphery of the pancreas), making detection or cannulation literally impossible. Objections of a different nature are levelled at the use of intraoperative ERCP; the procedure is time consuming, logistically demanding and often unavailable at night. Its role is limited to the investigation of stable cases where other visceral injuries have been ruled out with certainty,[65] a most unlikely

situation in the setting of abdominal gunshot trauma.[19,20] We do not practise intraoperative radiological evaluation of the pancreatic duct, although we probably could use the conventional operative cholangiogram described above in selected, physiologically stable cases. Generally, if we suspect injury to the duct we perform distal pancreatectomy even without definitive proof of duct injury. If there is a low suspicion of ductal injury or the patient is physiologically unstable, we simply insert a drain for external drainage of possible fistula and perform ERCP in the postoperative period if the patient's clinical picture and condition necessitate it.

All pancreatic injuries should be drained regardless of severity. Reports evaluating types of drainage are scanty.[2] In a retrospective study comparing Penrose drains with sump drainage, Anderson et al.[2] concluded that passive Penrose drains are ineffective. In another retrospective study, however, Wisner et al.[65] noticed no difference between these two methods, but found dependency of the drain to be of crucial importance; multiple Penrose drains placed through a single drain site in the posterior flank were found to be effective. In a prospective randomised trial,[21] sump drainage was compared with closed suction drainage and was found to incur a higher sepsis rate. We use soft closed suction drains routinely;[19,20] further trials are needed to confirm their superiority.

If the amylase concentration in the drain is less than that of serum, the drain should be removed after 24—48 h. If the amylase concentration persists above that of the serum, the drain should be left in place until there is no evidence of pancreatic leak.

Surgical decisions in the presence of pancreatic trauma

Contusions and lacerations without duct injury

Contusions and lacerations constitute the majority of pancreatic injuries, and should be treated with haemostasis and drainage. It has been advocated that if a capsular laceration is identified, it should be repaired. This proposal is based on early studies that have shown incidences of pancreatic fistula of 35% and 40% in cases treated by drainage only, as opposed to 23% and 28% when suture repair of the capsule was carried out.[27] This surprisingly high incidence of pancreatic fistulae has not been confirmed by more recent studies. No attempt should be made to repair capsule lacerations, as closure may result in a pancreatic pseudocyst, whereas a controlled pancreatic fistula is usually self-limiting.

Distal injury with duct disruption

Injury to the neck, body or tail of the pancreas with major lacerations or transections and associated duct injury is best treated by distal pancreatectomy and splenectomy.[55,56] It has been suggested that the resection margin should be anastomosed to a Roux-en-Y loop, to prevent the development of a pancreatic fistula. This procedure is time consuming and therefore inappropriate for patients with multiple injuries. Even if the patient is physiologically stable, an anastomosis between a normal soft pancreatic remnant and a Roux-en-Y loop of bowel is unsafe and is likely to leak.

Proximal injury with probable duct disruption

Injuries of the pancreatic head are challenging to the surgeon. The safest option is to manage them by external drainage, if there is no devitalisation of the pancreatic head or duodenum and the ampulla is intact.[20,56] In cases where a fistula is formed, there is a good chance that it will seal by itself, if the nutritional status of the patient is adequate and infection is controlled. Any Roux-en-Y anastomosis to incorporate the injured area in the head of the pancreas at the time of injury is ill advised because of the high risk of anastomotic breakdown.[55,62]

Combined pancreaticoduodenal injuries

Minor pancreaticoduodenal injuries can be managed with primary duodenal repair and pancreatic drainage. There is consensus that in more severe pancreaticoduodenal injuries duodenal decompression is beneficial, in order to ensure an intact duodenal suture line. There is controversy regarding the method of achieving this, with three-tube decompression (gastrostomy with twin jejunostomies), gastrostomy and duodenostomy, and duodenal diverticulisation falling out of favour.[18,23,24,64] The creation of a further breach in an injured duodenum and a more extensive operation with resection of normal gastric tissue (antrum), as in diverticulisation, are considered disadvantageous.[23] There has been growing support in the last decade for pyloric exclusion as a means of duodenal decompression in more severe pancreaticoduodenal injuries.[18,64]

Pancreaticoduodenectomy

The role of pancreaticoduodenectomy in trauma was best summarised by Walt[61]: "Finally, to Whipple or not to Whipple, that is the question. In the massively destructive lesions involving the pancreas,

duodenum and common bile duct, the decision to do a pancreaticoduodenectomy is unavoidable; and, in fact, much of the dissection may have been done by the wounding force. In a few patients, when the call is of necessity close, the overall physiological status of the patient and the extent of damage become the determining factors in the decision. Though few in gross numbers, more patients are eventually salvaged by drainage, total parenteral nutrition and meticulous overall care than by a desperate pancreaticoduodenectomy in a marginal patient''.

Pancreaticoduodenectomy should be performed as a two-stage procedure.[4,37,38,40,41] After the initial damage control operation and achievement of haemostasis, the stomach, jejunum and pancreatic stump are stapled off. The common bile duct is ligated or drained. The anastomoses are completed at reoperation within the next 48 h, when the patient is stable.[31] There are two main differences between performing a pancreaticoduodenectomy in the clinical setting of trauma and that of cancer. First, in trauma surgery it is not necessary to remove the uncinate process. This simplifies the procedure, as the surgeon can operate away from the superior mesenteric vein. Second, the gall bladder is not removed in a trauma case as it can be used for biliary-enteric reconstruction in the presence of a delicate common bile duct.[31] There is controversy regarding the management of the pancreatic stump after pancreaticoduodenectomy. A soft, normal pancreas with a normal main duct is found in the great majority of trauma cases. This generates technical difficulties with ensuing complications. In an attempt to tackle this problem, the pancreatic stump has been managed in various ways, including ligation of the pancreatic duct and pancreatico-enteric or gastric anastomosis. Although ligation of the pancreatic duct in the non-trauma situation has been associated with a significantly higher fistula rate when compared with anastomosis, the mortality rate is not significantly different.[57] The experience in trauma is limited, and pancreatic duct ligation has been advocated as a technique available when faced with an unstable patient unable to tolerate further operations.[26] The long-term risks of beta cell function insufficiency among young trauma patients are disputed.[26] Pancreatico-gastric and pancreatico-enteric anastomosis have been reviewed, with the former advocated as an exceptionally safe procedure.[50] On the other hand, its superior safety compared with other conventional techniques has yet to be proved, particularly with the declining trend in the incidence of pancreatic fistula and related mortality following pancreatico-jejunostomy.[57] Total pancreatectomy has been advocated to obviate the consequences of a leaking stump, but this creates an endocrine cripple with a brittle endocrine status.

Role of octreotide

Octreotide is routinely used to control post-traumatic pancreatic fistulisation. In a multi-centre prospective randomised study in 1992, Buchler et al.[13] reported that the perioperative administration of octreotide reduced typical postoperative complications after pancreatic resection, particularly in the presence of tumours. In a subsequent, prospective, non-randomised study of trauma cases with equivalent abdominal trauma index, injury severity score and pancreatic grade injuries, Amirata et al.[1] reported that the prophylactic use of octreotide was associated with no pancreatic complications and no negative sequelae. In contrast, there was a 21% complication rate among the group of patients who did not receive prophylactic octreotide treatment. The greatest limitations of this study were the small number of patients, particularly in the treated group, the fact that the patients were prophylactically treated with octreotide at the discretion of the attending surgeon, and the fact that guidelines dictating specific indications for treatment were not established.[1] We only use octreotide in the presence of an established pancreatic fistula; further prospective studies are required.

Complications

Among cases treated surgically for pancreatic trauma, 20—40% will present complications. The complication rate is particularly high in combined pancreaticoduodenal injuries,[35,42,56] but most are self limiting or treatable. Sepsis and multiple organ failure[34] cause 30% of deaths after pancreatic trauma.

The most common complication after surgical treatment for pancreatic trauma is the formation of a pancreatic fistula.[44] Most fistulae resolve spontaneously within 1 or 2 weeks after injury, provided adequate external drainage and nutritional support have been established. Fistulae secondary to major disruption of the pancreatic duct can generally be sealed by endoscopic stenting. If this fails, a distal pancreatectomy is recommended for fistulae of the neck, body and tail, and a Roux-en-Y loop to the head of the pancreas for fistulae of the head.

The incidence of abscess formation after pancreatic trauma ranges from 10% to 25%, depending on the number and type of associated injuries.[34]

Operative or percutaneous drainage is necessary as early as possible. The majority of these abscesses are peripancreatic; abscesses within the parenchyma are rare and require operative intervention.[16,56] Subhepatic and subphrenic fluid collections can be dealt with by percutaneous drainage with ultrasound or CT assessment and guidance.

Secondary haemorrhage can originate from the pancreatic bed or the surrounding vessels as a result of an infected retroperitoneal autodigestion. The first line of management is angiographic embolisation. If this fails, laparotomy is necessary for overrunning the bleeding vessels or, if this not possible, packing with abdominal swabs.[40]

Pseudocyst formation resulting from pancreatic trauma can present weeks or months after the original injury.[11] The major determinant of outcome and indicator of preferred treatment is the status of the pancreatic duct. If the pancreatic duct is intact, as shown by ERCP or MRCP, percutaneous aspiration or pigtail drainage is sufficient in the majority of cases.[33,43,44] If investigations show disruption of the duct, the above methods can lead to a chronic external fistula. Therefore endoscopic drainage, endoscopic stenting, internal surgical drainage or, in selected cases, distal pancreatectomy is selected.[7,8]

Mild pancreatitis presenting with transient abdominal pain and raised serum amylase may be anticipated among up to 18% of people who have undergone surgery for pancreatic trauma.[16,49,59] This resolves spontaneously with conservative management. Very rarely there is postoperative development of haemorrhagic pancreatitis, which presents initially with a drop in the serum haemoglobin or with haemorrhagic fluid from the drain site. It is associated with an 80% mortality rate.[28,33]

Endocrine and exocrine insufficiencies are very unusual after resection for pancreatic trauma.[19] The remaining pancreatic tissue is generally sufficient, as in the great majority of cases the injured pancreas is healthy.

Conclusion

Most pancreatic injuries are minor and can be treated by external drainage. Trauma to the body, neck and tail of the pancreas, with suspicion or evidence of duct disruption, should undergo distal pancreatectomy. Similar injuries affecting the head of the pancreas are best managed by simple external drainage even if there is suspected damage to the duct. Pancreaticoduodenectomies should be reserved for cases where the pancreatic head tissue has been extensively devitalised and should always be practised as only part of damage control. Most post-injury or postoperative complications should initially be treated by a combination of total parenteral nutrition and endoscopic stenting or percutaneous drainage.

Conflict of interest

None.

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