Management of Pancreaticoduodenal Injuries

Atul K. Sharma

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Abstract The nature of the pancreatic or duodenal injury itself influences mortality, and is co-dependent on the presence of multiple other injuries, which account for most of the early mortality. Intra-abdominal sepsis leading to multiple organ failure accounts for most of the late deaths, indicating the importance of early haemodynamic stabilization, adequate debridement of devitalized tissue and wide drainage. Most duodenal injuries can be adequately managed with primary repair or resection and anastomosis. The presence of a pancreatic injury certainly increases the likelihood of an anastomotic leak from a duodenal repair. With a significant associated pancreatic injury a more conservative initial approach to the duodenal injury may be more appropriate. Pancreatic injuries should be treated by debridement and simple drainage unless there is clinically obvious duct involvement. For distal injuries with duct involvement, a distal pancreatectomy is indicated. In injuries to the pancreatic head with clinical duct involvement, complex procedures such as pancreaticoduodenectomy should not be performed in the unstable patient with multiple injuries. Debridement and wide external drainage may be implemented and the resulting fistula dealt with at a later operation, if necessary. Large, complex, combined pancreaticoduodenal injuries may require temporary duodenal ligation or a pancreaticoduodenectomy and subsequent reconstruction.

Keywords Pancreatic injuries · Duodenal injuries · pancreaticoduodenal injuries

Introduction

Pancreaticoduodenal injuries, although relatively rare, have a significant morbidity (36–60%) and mortality (18–23%)

[1–4]. The outcome depends on early diagnosis, which is essentially based on a high index of suspicion. Being retroperitoneal in location, the signs and symptoms are subtle and both pre and intraoperative detection can be difficult. Most of the patients have multiple associated injuries and are haemodynamically unstable, which is the cause of the high early mortality in these patients. As a result a number of temporizing techniques have been used, resulting in a number management options. The aim of this review is to discuss the available options for the benefit of young surgeons working in India and other developing countries.

Determinants of Outcome

The severity of the injury and subsequent outcome is related to the mechanism of injury, associated injuries, time to diagnosis/treatment and pancreatic duct disruption.

Mechanism of Injury There is enough evidence in the literature that penetrating trauma carries worse outcomes when compared with blunt trauma. Furthermore, patients who have suffered a gunshot wound to pancreas or duodenum fare worse than those with stab wounds. In countries with a high incidence of civilian violence, majority of pancreaticoduodenal injuries are due to penetrating trauma, 70–80% being due to gunshot wounds [1]. Such injuries are rarely isolated, and major vessels, stomach and liver are commonly associated [4]. Blunt trauma to the epigastrium due to stomping, boxing/karate, steering wheel/handlebar, not uncommonly leads to a combined pancreaticoduodenal injury, as the organs get crushed against the dorsolumbar spine. Such injuries may also be associated with the flexion/distraction fracture of L1–L2 vertebra (the “Chance” fracture) [5]. Deceleration may produce a tear at the junction of the mobile and fixed parts of the duodenum.

A. K. Sharma (✉)
Armed Forces Medical College,
Pune 411040, India
e-mail: akms@vsnl.com

Associated Injuries Majority of early deaths after pancreaticoduodenal trauma are caused by haemorrhage, the main areas of concern being vascular injuries (75%), liver (46, 8%) and spleen (28%) [6, 7]. Late deaths are almost always related to septic complications mainly related to fistula formation and abscesses.

Time to Treatment In the cases where diagnosis and treatment are delayed >24 h, mortality increases to 40% as compared with 11% for those diagnosed <24 h. Two-thirds of the patients who survive more than 48 hours end up with complications, and 37% of deaths are late [6, 7] and are related to complications such as fistula, abscess, anastomotic breakdown, pancreatitis, pseudocysts and pneumonia.

Pancreatic Duct Involvement Pancreatic duct injury occurs in about 15% of the patients [7], mostly from penetrating trauma; unrecognised duct disruption is almost always fatal due to sepsis.

Grading of Pancreatic and Duodenal Injury

Pancreatic and duodenal injuries have been graded according to the Organ Injury Scaling (OIS) Committee of the American Association of the Surgery of Trauma (Tables 1 and 2) [8]. Pancreatic injuries are defined as proximal for those to the right of the mesenteric vessels and distal for those to the left.

Clinical Features and Diagnostic Imaging

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

In the rest of the patients, plain abdominal X-rays can identify retroperitoneal air, free intraperitoneal air or air in

Table 2 Duodenal organ injury scale by the American Association of the Surgery of Trauma

Grade	Type	Description
I	Haematoma	Involving single portion of duodenum
	Laceration	Partial thickness, no perforation
II	Haematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference
III	Laceration	Disruption 50–75% of D2
		Disruption 50–100% of D1, D3, D4
IV	Laceration	Disruption >75% of D2 Involving ampulla or common bile duct
V	Laceration	Massive disruption of duodenopancreatic complex
	Vascular	Devascularization of duodenum

the biliary tree. Other signs such as obliteration of the psoas muscle shadow and scoliosis of the lumbar vertebrae should trigger suspicion of duodenal trauma. A focused abdominal ultrasound for trauma is useful in detecting intraperitoneal fluid, especially if performed rapidly in unstable patients with multiple injuries to identify a major haemoperitoneum requiring early surgical intervention.

Computed tomography 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, its sensitivity is not very good, and the extent of the pancreatic injury is not often evident on an initial computed tomography scan [9].

Endoscopic retrograde cholangiopancreatography is very useful in identifying injuries to the main pancreatic duct, but it is seldom available in the acute setting. Magnetic resonance imaging pancreatography can detect pancreatic injuries, but its reliability has not yet been established.

Operative Management

Intraoperative Assessment

All upper central retroperitoneal haematoma needs to be explored by opening the gastrocolic/gastrosplenic omentum. However, in the absence of such a haematoma, it is important to look for subtle signs, and special attention must be directed to look for bile staining of the retroperitoneum, small bubbles of entrapped air in the periduodenal tissues and small periduodenal haematomas. These may be the earliest clues suggestive of a lacerated duodenum which necessitate a full Kocherization, so as to be able to inspect the first, second and a portion of the third parts of the organ. The Cattell and Braasch manoeuvre consists of mobilization of the hepatic flexure of the colon, sharp dissection of the

Table 1 Pancreas organ injury scale by the American Association of the Surgery of Trauma

Grade	Type	Description
I	Haematoma	Minor contusion without duct injury
	Laceration	Superficial laceration without duct injury
II	Haematoma	Major contusion without duct injury or tissue loss
	Laceration	Major tissue laceration without duct injury
III	Laceration	Distal transection or parenchymal injury
IV	Laceration	Proximal transection or parenchymal injury
V	Laceration	Massive disruption of pancreatic head

small bowel attachment from the ligament of Treitz to the right lower quadrant and cephalad displacement of the small bowel. This brings the third portion of the duodenum into view and also facilitates an assessment of the integrity of the pancreas. The fourth portion of the duodenum may be evaluated by mobilizing the ligament of Treitz. Optimal management of duodenal injuries requires a complete assessment for an associated injury to the pancreas as well as the bile duct and the ampulla.

Damage Control Surgery

The high prevalence of vascular and solid organ injury associated with pancreatic and duodenal trauma dictates damage control techniques, and planned reoperations are frequently required. Arrest of active haemorrhage must be the primary concern for these patients, to prevent the development of the downward spiral of acidosis, hypothermia and progressive coagulopathy. Adjuncts to this are the limitation of contamination and protection of abdominal contents. Avoiding lengthy, complex procedures during the initial operation is most important. A staged approach to high-grade pancreaticoduodenal injuries also seems to preserve parenchyma and allows more frequent use of non-resectional alternatives [10]. For those with duodenal injury requiring a damage control procedure, the damaged duodenum is debrided, the ends sutured or tied off with surgical tape and dealt with at a planned reoperation. A feeding jejunostomy should be placed as early as possible to provide enteral nutrition.

Duodenal Injuries

Most authors when dealing with duodenal injuries now prefer to avoid complex reconstructive procedures and are advocating necessary debridement and adequate drainage. Primary repair or resection and primary anastomosis in a single layer is performed where possible. More complex procedures such as duodenal diverticulization or pyloric exclusion have also been considered for severe duodenal injuries. The main purpose of such procedures is to exclude the duodenal repair from gastric secretions and allow time for adequate healing of the duodenal repair.

Duodenal diverticulization was first described by Berne et al. [11] in 1968 for the treatment of combined extensive injury to the duodenum and pancreas or severe injury of the duodenum alone. The operation consists of suture closure of the duodenal injury, gastric antrectomy with end-to-side gastrojejunostomy, tube duodenostomy and generous drainage in the region of the duodenal repair. Truncal vagotomy and biliary drainage could be added. The same authors later describing their experience with this procedure in 50 patients [12] reported 7 (14%) patients developing duodenal

fistulas, with an overall mortality of 16%. However, in a subsequent report from the same institution, duodenal diverticulization was used in only 12 of 105 patients [13]. Two of these patients developed duodenal fistulas and subsequently succumbed to septic complications, leading to a mortality of 17%. The drawback of duodenal diverticulization is that it is a time-consuming operation, ill advised in a haemodynamically unstable patient with multiple injuries, and requires the resection of an uninjured antrum, which is perhaps the reason it has largely been given up.

A supposedly superior variant of excluding the duodenal suture line and diverting gastric contents is 'pyloric exclusion', in which the pyloric ring is identified and grasped from inside a gastrotomy. The pyloric ring is closed from within with a running suture of a non-absorbable material such as polypropylene. A gastrojejunostomy is performed at the gastrotomy site. Alternatively, a staple line may be placed just distal to the pylorus. The first large series describing this procedure was reported by Vaughan et al. [14] from Ben Taub Hospital. In 1983, a 12-year experience with pyloric exclusion was reported from the same institution. One hundred and twenty-eight of 313 (41%) patients with duodenal injuries underwent the procedure, with a duodenal fistula rate of 5.5% [15]. Jansen et al. [16] from South Africa have reported the outcome of a liberal use of pyloric exclusion procedure without vagotomy in all patients with complex duodenal injuries. Resort to pyloric exclusion in this study is correlated broadly with the 'severity' or more advanced American Association for the Surgery of Trauma (AAST) grades of injury, although more subjective observations as to the degree of oedema, contusion or friability of the injured duodenum require judgment calls which can only be made on an individualized basis. The authors argue that pyloric exclusion can be rapidly and simply performed and that the potential for long-term sequelae can be readily addressed by take-down of the gastrojejunostomy. On the basis of this prospective audit, they have concluded that duodenal injuries is repaired primarily, when technically feasible and safe, and pyloric exclusion is employed liberally if any doubt as to the security of repair is entertained. Recently, however, two large retrospective reviews have shown a trend towards a greater complication rate and length of hospital stay in the pyloric exclusion group and have concluded that the use of pyloric exclusion in patients with severe duodenal injuries confers no survival or outcome benefit [17, 18].

Duodenostomy has been advocated [19] to decompress the distal duodenum after a primary repair, although its use has been brought into question by two separate studies, which found consistently higher morbidity and mortality rates in those treated with decompression [20, 21]. Small bowel serosal patching of duodenal defects or variations on the theme, in the form of gastric or jejunal pedicled mucosal

grafts, have little appeal and do not appear to have achieved wide application [22]. However, duodenojejunostomy with a Roux-en-Y reconstruction appears to be the safest option for defects defying primary suture or anastomosis [23].

Pancreatic Injuries

There has been a significant change in the approach to the management of these injuries from complex procedures and towards simple drainage [24]. Drainage with the subsequent formation of a controlled pancreatic fistula carries a low mortality, has an acceptable morbidity and is preferred over complex procedures [25]. Although some workers advocate the use of intraoperative cholangiography and pancreatography to determine the status of the pancreatic duct and ampulla [26, 27], its routine use has not become popular.

The treatment of distal pancreatic injuries has moved away from complex enteropancreatic anastomoses to simple drainage or distal pancreatectomy. This decision is based on the presence of a pancreatic duct injury; however, results show an increase in the risk of complications, especially fistula formation with distal pancreatectomy even when organ injury scale (OIS) grade is accounted for. Patton et al. [28] have previously reported the increased incidence of fistula and abscess formation with distal pancreatectomy, although they collected data on duct integrity rather than grade of injury, and concluded that this was due to severity of injury and not the performance of a distal pancreatectomy. The question of whether distal pancreatectomy is inferior to closed suction drainage or other procedures on the duct and distal stump for OIS III injuries ideally should be addressed by a prospective, randomized study, but the number of patients required for an adequately powered study would be large [29].

Combined Pancreaticoduodenal Injuries

The surgical management of combined pancreaticoduodenal injuries is complex, and options vary from repair and external drainage to pancreaticoduodenectomy [30, 31] described initially in 1969 by Foley et al. [32] for massive and unreconstructable injuries to the head of the pancreas, duodenum, distal common bile duct or any combination of these structures. More recent reports suggest that Whipple's procedure is only occasionally appropriate for combined AAST OIS grade V injuries of both the pancreas and the duodenum [33–35]. Pancreaticoduodenectomy is now essentially a debridement procedure to salvage these critically ill patients with uncontrollable bleeding from the pancreatic head, proximal pancreatic duct or ampullary injuries which preclude reconstruction, and extensive devitalization of the duodenum and pancreatic head as leaving behind devitalized

tissue results in postoperative bleeding and infections. Controlled external drainage of the bile and pancreatic ducts facilitates postoperative care and prevents ongoing contamination of the peritoneal cavity. The technique of external drainage as an alternative to pancreaticoenteric anastomosis is safe and simple to perform, and no complications of the external drainage of the pancreatic duct have been reported [3, 36]. Occasionally in a relatively stable patient, pancreaticoduodenectomy with or without reconstruction may be a valid option, but the mortality rate in an emergency situation is high and may exceeded 30% [37, 38]. The main factors responsible for such high morbidity and mortality rates are the associated pancreatitis, a soft and friable pancreas and an undilated normal sized pancreatic duct [3, 39, 40].

Summary

The characteristics of the pancreatic or duodenal injuries themselves influence mortality, which appears to be dependent on the presence of multiple injuries, which is borne out by the low mortality in patients with a stab injury who usually have isolated injuries, compared with the poor outcome in a gunshot injury with associated vascular and hepatic trauma, and blunt trauma which is mainly associated with head injuries.

Intra-abdominal sepsis is by far the most common complication, leading to multiple organ failure, which accounts for most of the late deaths, indicating the importance of adequate debridement of devitalized tissue, wide drainage and early haemodynamic stabilization. Data suggest that a higher grade of pancreatic injury may be associated with an increased incidence of abdominal sepsis. Most duodenal injuries can be adequately managed with primary repair or resection and anastomosis. The presence of a pancreatic injury certainly increases the likelihood of an anastomotic leak from a duodenal repair. With a significant associated pancreatic injury, a conservative initial approach to the duodenal injury may be more appropriate.

Pancreatic injuries should be treated by debridement and simple drainage unless there is clinically obvious duct involvement. For distal injuries with duct involvement, a distal pancreatectomy is indicated. In injuries to the pancreatic head with clinical duct involvement, complex procedures such as pancreaticoduodenectomy should not be performed in the unstable patient with multiple injuries. Debridement and wide external drainage may be implemented, and the resulting fistula dealt with at a later operation, if necessary. Large, complex, combined pancreaticoduodenal injuries may require temporary duodenal ligation or a pancreaticoduodenectomy and subsequent reconstruction.

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