

# Magnitude, Severity, and Outcome of Traumatic Pancreatic Injury at a Level I Trauma Center in India

Amit Gupta<sup>1</sup> · Subodh Kumar<sup>1</sup> · Sanjay Kumar Yadav<sup>1</sup> · Biplab Mishra<sup>1</sup> ·  
Maneesh Singhal<sup>1</sup> · Atin Kumar<sup>2</sup> · Pramod Garg<sup>3</sup>

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**Abstract** Pancreatic injury is an uncommon and frequently missed injury in abdominal trauma patients. However, missed pancreatic injury is associated with significant morbidity and mortality. This study was conducted to know the burden of pancreatic injury and its outcome in our setup. A retrospective analysis of 53 patients with pancreatic injury from January 2008 through March 2012 at the Jai Prakash Narayan Apex Trauma Center (JPNATC), All India Institute of Medical Sciences (AIIMS), New Delhi. Pancreatic injuries were present in 1.18 % of all trauma admissions. Blunt trauma to the abdomen ( $n = 49$ , 92.45 %) due to road traffic injury ( $n = 38$ , 71.70 %) was the most common mechanism of injury. Isolated pancreatic injury was present in eight (15.09 %) patients. Grade III pancreatic injury ( $n = 25$ , 47 %) was the most common. Of these patients, 18.86 % were managed nonoperatively and 81.13 % were managed operatively. Among the operatively managed patients ( $n = 43$ ), 74.4 % were operated due to pancreatic injury and 25.5 % were operated due to associated injuries. Distal pancreatectomy with or without spleen preservation ( $n = 25$ ) was the most common operative procedure done. Three out of five patients of Whipple operation for pancreatic injury died. Pancreatic injury was associated with complications in 43.40 % and death in 20 % ( $n = 11$ ). Pancreatic injury is rare, but delay in diagnosis of pancreatic injury has been associated with higher morbidity and

mortality. Low-grade pancreatic injury with intact main pancreatic duct (MPD) could be successfully managed nonoperatively, whereas in high-grade pancreatic injury, an operative intervention is invariably necessary. Distal pancreatectomy with spleen preservation is a desirable goal whenever possible for distal transection of the pancreas. Whipple resection should be reserved only for hemodynamically stable patients with complex pancreaticoduodenal injury and is associated with high mortality.

**Keywords** Abdominal trauma · Pancreatic injury · Distal pancreatectomy · Nonoperative management

## Introduction

Although pancreatic injury is uncommon, it is usually associated with other visceral injuries and causes significant morbidity and mortality [1]. The management of pancreatic injury depends on the status of main pancreatic duct (MPD) and associated injuries. However, it can be missed in the early phase of evaluation of trauma patients by contrast-enhanced computed tomography (CECT) scan if the index of suspicion of pancreatic trauma is not kept high in abdominal trauma patients. All these issues prompted us to review our institution's experience with pancreatic injuries in abdominal trauma and to discuss various challenges in its management in our setup.

## Materials and Methods

### Study Design

It is a retrospective analysis of prospectively maintained database of all patients with pancreatic injuries from January 2008 through April 2012 at the Jai Prakash Narayan Apex Trauma

✉ Subodh Kumar  
Subodh6@gmail.com

<sup>1</sup> Department of Surgery, JPN Apex Trauma Center, All India Institute of Medical Sciences (AIIMS), New Delhi 110029, India

<sup>2</sup> Department of Radiology, All India Institute of Medical Sciences (AIIMS), New Delhi 110029, India

<sup>3</sup> Department of Gastroenterology, All India Institute of Medical Sciences (AIIMS), New Delhi 110029, India

Center (JPNATC), All India Institute of Medical Sciences (AIIMS), New Delhi.

## Methodology

The charts of all the patients with traumatic pancreatic injuries were reviewed from trauma registry, and the following data were collected: demographics, mechanism of injury, admission hemodynamics, pancreatic injury grade, associated injuries, indications for operative interventions, complications, lengths of stay in the intensive care unit (ICU) and/or in ward, and death.

All patients with blunt abdominal trauma were initially reviewed in the emergency department by the emergency physicians and trauma surgeons and resuscitated as per advanced trauma life support (ALTS) guidelines. Patients who were hemodynamically stable and had no other indications for immediate abdominal surgery were evaluated by CECT scan, magnetic resonance cholangiopancreatography (MRCP), etc. MRCP was done only in case of suspected pancreatic injury where CECT was inconclusive for the status of MPD. All hemodynamically unstable patients with abdominal trauma were directly shifted to operation theater for exploratory laparotomy.

Low-grade pancreatic injuries (grades I and II) with intact MPD were managed nonoperatively or drainage, whereas high-grade pancreatic injuries (grades III, IV, and V) were managed operatively with either distal pancreatectomy or Whipple procedure or damage control surgery (DCS).

## Statistical Method

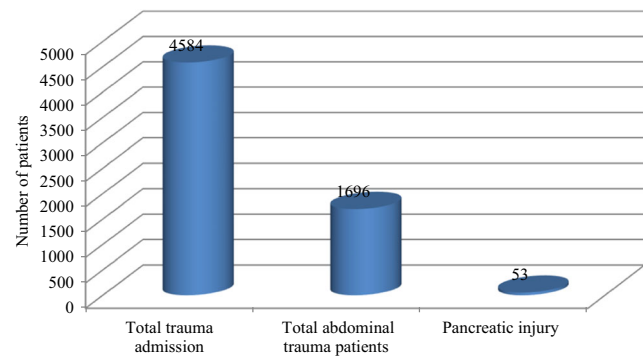
Median, range, and frequencies were reported as descriptive statistics.

## Results

There were 53 patients with pancreatic injury during the study period, and out of which, 48 (90.57 %) were male (Fig. 1). The age of the patients ranged from 3 to 55 years with a median age of 24 years. Out of 53, 43 (81.13 %) patients were hemodynamically stable on presentation and 10 (18.87 %) patients were hemodynamically unstable. Out of 10 hemodynamically unstable patients, eight patients became hemodynamically stable after initial resuscitation. There was one transient responder and one nonresponder to resuscitative measures that included crystalloid and blood.

Those patients who became hemodynamically stable after resuscitation were further investigated for other associated injuries and assessment of the integrity of MPD. Those patients who were transient responder or nonresponder were directly shifted to operation theater for exploratory laparotomy.

## Incidence of Pancreatic Injury



**Fig. 1** Incidence of pancreatic injury

The average systolic blood pressure of patients at presentation was 130.96 mmHg with median BP of 120 mmHg (range 70 to 150 mmHg). The median HR was 70 per min (70 to 160/min).

All cases of blunt abdominal trauma were diagnosed to have pancreatic injury either by CECT scan or MRCP in hemodynamically stable patients or intraoperatively in hemodynamically unstable patients. The pancreatic injury was diagnosed intraoperatively in 10 (18.87 %) patients who were operated either because of hemodynamic instability or because of associated injuries. In 32 (60.38 %) patients, CECT scan was able to diagnose pancreatic injury and determined the status of MPD. In the remaining 11 (20.75 %) patients, although CECT scan was able to show pancreatic parenchymal injury, it was inconclusive for the status of MPD. In all such cases, MRCP was done to delineate the status of MPD.

There was a delay in the diagnosis of pancreatic injuries by more than 24 h in five (9.43 %) patients, and out of which, four cases of pancreatic injuries were missed outside and referred to our center because of complications. In the remaining one case, the diagnosis was missed at initial evaluation by CECT scan at our center. Sixteen (30.19 %) patients were brought directly to the JPNATC, whereas 37 (69.18 %) patients were referred from other hospitals after some primary treatment or when patients developed some complications that required a higher level of care. Serum amylase measured within 24 h of injury was elevated in only 35 (66.04 %) patients with pancreatic injuries.

Pancreatic injury was graded according to the American Association for the Surgery of Trauma (AAST) pancreas Organ Injury Scale (OIS) [2]. Grade III pancreatic injury was the most common. There were 10 grade I (18.87 %), 10 grade II (18.87 %), 25 grade III (47.17 %), 6 grade IV (11.32 %), and 2 grade V (3.77 %) injuries.

The body of pancreas was the most common site ( $n = 22$ , 41.50 %) of injury. The head of pancreas was involved in 16 (30.18 %), neck in 10 (18.86 %), and tail in 19 (35.84 %) patients. More than one part of the pancreas was involved in 15 (28.30 %) patients. Isolated pancreatic injury was present

in eight (15.09 %) patients. Pancreatic injury was associated with one other organ injury in 25 (53.33 %), two other organ injuries in 11 (24.44 %), and three or more than three organ injuries in 3 (22.22 %) patients. Among the associated injury patients ( $n = 45$ ), the most common injured organ was the spleen in 21 (46.66 %). Liver injury was associated in 20 (44.44 %), chest injury in 17 (37.77 %), kidney in 15 (33.33 %), hollow viscus in 9 (20 %), extremity bone fracture in 8 (17.77 %), and vascular in 3 (6.66 %) patients.

## Management

Ten (18.86 %) patients were managed nonoperatively, and 43 (81.13 %) patients were managed operatively. Among the 43 patients who were managed operatively, 32 (74.42 %) patients were operated due to pancreatic injuries and 11 (25.58 %) were operated because of associated injuries.

Two patients with grade I pancreatic injury were managed operatively because of associated injuries. Nine patients with grade II pancreatic injuries were managed operatively, and out of which, six patients underwent tube drainage while undergoing exploratory laparotomy for associated injuries; pancreatic injury was the incidental finding intraoperatively. However, in three remaining cases, grade II pancreatic injury was diagnosed preoperatively and operated due to associated injuries and no drainage of pancreatic bed was done as the injuries were confirmed preoperatively. All cases of grade III, IV, and V pancreatic injuries except one in grade IV pancreatic injuries were managed operatively. One case in grade IV pancreatic injury was managed conservatively outside and later on referred to our center with complications (pseudocyst and abdominal collections) (Table 1, Fig. 2).

The most common operative procedure was distal pancreatectomy (58.13 %) with or without spleen preservation, and it was done in all cases of grade III pancreatic injuries. Distal pancreatectomy with splenectomy was done in 14 (32.55 %) patients, and distal pancreatectomy with spleen preservation was done in 11 (25.58 %) patients. A one-stage Whipple procedure was performed in five (11.62 %) patients with pancreatic head injury.

## Complications

Pancreatic injury was associated with complications in 23 (43.40 %) patients. The most common complication was intra-abdominal collections followed by post-traumatic pancreatitis and chest-related complications. Intra-abdominal collections and sepsis was present in nine, post-traumatic pancreatitis in eight, pleural effusion in four, and pseudocyst of the pancreas and pancreatic fistula in one patient each. All cases of delayed diagnosis by more than 24 h and missed pancreatic injuries were associated with complications.

**Table 1** Management and outcome of patients by grade of pancreatic injury

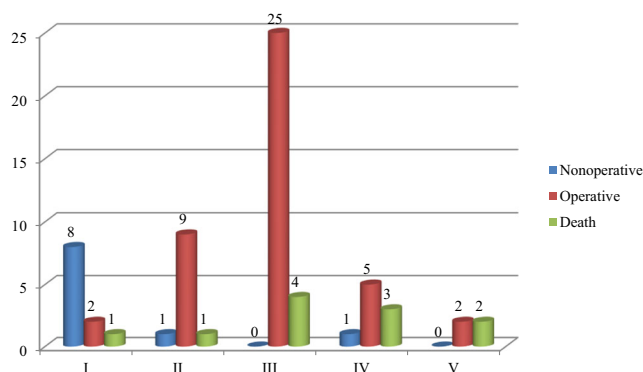
Grade	Nonoperative	Operative	Operated due to pancreatic injury	Death
I	8	2	0	1
II	1	9	0	1
III	0	25	25	4
IV	1	5	5	3
V	0	2	2	2

All values are in number

## Mortality ( $n = 11$ )

The overall mortality for pancreatic injuries was 11 (20.75 %). Nine (81.81 %) deaths were directly related to pancreatic injuries and occurred in patients who underwent operative management. Two patients died due to associated injuries. One patient who was operatively managed (due to associated injury) and had grade II pancreatic injuries died due to persistent ongoing bleed. One patient of nonoperative management (NOM) and grade I pancreatic injury died due to contrast-induced nephropathy. The causes of pancreatic injury-related mortality were sepsis, multi-organ dysfunction syndrome (MODS), and disseminated intravascular coagulation (DIC). Three patients of Whipple procedure (60 %) and four patients of distal pancreatectomy with splenectomy (16 %) died.

As the grade of pancreatic injury increased, the probability of death also increased. All patients with grade V pancreatic injury died. There were 10 % death in grades I and II, 16 % in grade III, and 50 % in grade IV. Four (7.55 %) patients died within 24 h of admission, and seven (13.21 %) died after 72 h of admission to our hospital. The cause of death in the immediate group was DIC, coagulopathy, and ongoing bleed. The patients who died later were due to septic shock. The median ICU stay was 3 days (range 1 to 23 days). The median general ward stay was 8 days (range 0 to 20 days).



**Fig. 2** Management and outcome of patients by grade of pancreatic injury

## Discussion

In our study, pancreatic injury occurred in 1.18 % of all trauma admissions. It constituted 3.12 % of all abdominal traumas. The reported incidence of pancreatic injury varies from 0.4 % by Akhrass et al [3] to 6 % by Feliciano et al [4]. The difference in incidence of pancreatic injury is due to different mechanisms and pattern of abdominal trauma in different series.

The most common mechanism of injury was road traffic injury due to motorcycle accidents (42 %). In a study by Duchesne et al [5], the most common mechanism of injury was motor vehicle collision with steering wheel deformity in 33 (94.2 %) patients. Similarly, Sutherland et al [6] had shown motor vehicle accident as the most important cause of pancreatic trauma in adults while bicycle handlebar injuries were most common among pediatric age groups.

In our study, the incidence of isolated pancreatic injury was 15.09 % (eight patients). The reported incidence of isolated pancreatic injury varies widely in the literature. Akhrass et al [3] had reported 2 % incidence of isolated pancreatic injury, whereas Bradley et al [7] had reported 41.5 % incidence of isolated pancreatic injuries.

In the present study, the most common associated injury was spleen injury (46 %). In a study by Duchesne et al [5], the most common other solid organ injury was liver injury in eight (66 %) patients, followed by spleen in six (50 %). In a study of abdominal penetrating trauma due to gunshot injuries by Feliciano et al [4], the most common associated injury was hollow viscus injuries.

Most of our patients (70 %) were transferred from other hospitals, and these referral decisions were made either because of missed pancreatic injury or complications following pancreatic injury. This highlights the lack of standard protocol-based decisions on the part of treating surgical team to refer patients to tertiary center early when patients needed a higher level of care.

Most of our patients (81 %) were hemodynamically stable at presentation to trauma center. One patient who did not respond to resuscitative measures had to be shifted to operation theater for exploratory laparotomy. Intraoperatively, there was grade V liver injury and packing was done but patient succumbed subsequently due to coagulopathy. This patient had grade II pancreatic injury as detected intraoperatively.

Clinical presentation for pancreatic trauma, especially for the blunt trauma, is often subtle because of the retroperitoneal location of the pancreas, frequently resulting in delayed diagnosis and surgical treatment. Therefore, prompt and accurate diagnosis, especially with respect to major duct status, and proper management are essential to reduce morbidity and mortality.

In the current study, pancreatic injury was diagnosed intraoperatively in 18 % of patients. Although CECT scan was able to diagnose pancreatic injury in 60 % patients, it was

inconclusive in 20 % of patients. In all these cases of missed pancreatic injury by CECT scan of the abdomen, MRCP was able to delineate the status of MPD.

There are several reports in the literature showing that CECT scan can miss the traumatic pancreatic injuries. Udekwe et al [8] found that the overall accuracy of dynamic CECT scanning for diagnosis of pancreatic trauma was lowest among all abdominal organs. Similarly, Wong et al [9] have suggested that when there is laceration of more than half of the parenchymal tissue as determined from abdominal CECT imaging, major duct injury should be suspected and operation should be scheduled.

Although endoscopic retrograde cholangiopancreatography (ERCP) allows visualization of ductal structure and facilitates assessment of ductal integrity [10, 11], it is often not available during emergency hours and may not be suitable for patients with severe associated injuries. As MRCP is noninvasive and can be performed at night, it may be more appropriate than ERCP in pancreatic trauma cases. MRCP was performed in 20 % of our patients where there was a suspicion of pancreatic ductal injury not confirmed by CECT scan. In all those cases, MRCP was able to delineate the MPD.

Major duct injury is the principal determinant of outcome in cases of pancreatic trauma, and a high morbidity and mortality can be expected where there is major duct involvement [7, 12]. Smego et al [12] and Bradley et al [7] had shown that ductal status is an important predictor of outcome in pancreatic trauma and is essential for establishing the basis for treatment decision. Wisner et al [13] and Leppaniemi et al [14] have independently shown that a delay in diagnosis of pancreatic injury has been associated with increased pancreas-related morbidity and mortality.

Serum amylase measured within 24 h of injury was elevated in only 66 % of the patients with documented pancreatic injuries. In 33 % of pancreatic injury, serum amylase was normal. Several studies have demonstrated that elevation of amylase was neither sensitive nor specific in the diagnosis of pancreatic injury. Bradley et al [7] had reported that serum amylase levels were elevated among 82 % of people with documented pancreatic injuries. However, Takishima et al [15] had found that hyperamylasemia after blunt pancreatic trauma is time dependent and elevated in all their cases when the samples were collected more than 3 h following injury. Therefore, serum amylase is nonspecific for diagnosis of pancreatic injury. However, if the serum amylase is raised in blunt trauma abdomen patients, they should be investigated for pancreatic injury by appropriate investigations.

Low-grade pancreatic injuries occurred in 37.7 % of our study populations. The indications of laparotomy in all low-grade pancreatic injuries were associated injuries. So, most of the patients with low-grade pancreatic injury with intact MPD (confirmed by MRCP and where there is no indication of



laparotomy due to associated injuries) can be managed nonoperatively like in other solid organ injuries.

The current evidences in the literature also support the non-operative management of low-grade blunt pancreatic injury. Akhrass et al [3] have shown that patients with low-grade blunt pancreatic injury (LGBPI), confirmed by laparotomy, had a higher morbidity with external drainage compared with exploration without drainage. Similarly, Duchesne et al [5] has shown that NOM of LGBPI diagnosed by CECT was successful in the majority of hemodynamically stable patients, with low morbidity and mortality. However, the authors have emphasized the role for early ductal injury detection with either ERCP or MRCP and select patient without ductal injury for NOM for better outcome.

Six patients with low-grade pancreatic injury were managed with exploratory laparotomy and tube drainage. These patients were operated for associated injuries, and intraoperatively, pancreatic injury was also found so external drainage was done. All the cases of high-grade pancreatic injury were operated. Distal pancreatectomy with or without spleen preservation was the most common operative procedure in our study. Spleen preservation was done in 11 out of 25 cases of distal pancreatectomy whenever possible.

There are several reports in the literature which suggest spleen preservation should be done whenever possible [16–18]. In a study of six trauma patients by Yadav et al [19], the authors have advocated that distal pancreatectomy with spleen preservation can be done safely in hemodynamically stable patients. In all four cases of distal pancreatectomy with splenectomy, death occurred because of septic shock. The cause of sepsis was pancreatic injury-related abdominal collection and chest infection which might have been aggravated by post-splenectomy status. Therefore, we also favor spleen preservation during distal pancreatectomy whenever possible.

The reported incidence of mortality for Whipple procedure is as high as 30 to 40 % in trauma setting [20]. In a study by Thompson et al [21], 12 patients underwent damage control surgery and staged reconstruction and 3 patients underwent complete Whipple procedure as initial surgery and in-hospital mortality was only 13 % (2 patients). In all such cases of complex pancreaticoduodenal injuries, initial damage control surgery and staged reconstruction is recommended. However, mortality rate was 60 % for pancreaticoduodenal resection in the present study. Therefore, pancreaticoduodenal resection should be reserved for only complex pancreaticoduodenal injuries in hemodynamically stable patients and should be done as staged reconstruction.

Bradley et al [7] and Oláh et al [22] has shown that pancreatic injury has high rates of morbidity and mortality, with overall complication rates up to 62 %, reaching 80 % when diagnosis is made 24 h after injury. In our study, the morbidity of pancreatic injury was present in 43 %. In all five cases of delayed diagnosis and missed pancreatic injury, the pancreas-related complications

occurred, indicating that high index of suspicion should be kept for pancreatic injury and patients should be thoroughly investigated to rule out pancreatic injury. The most common complication in our series was post-traumatic pancreatitis and intra-abdominal collections. There was only one case of pancreatic fistula and pseudocyst that occurred in grade IV pancreatic injury patients in whom the pancreatic injury was missed and delayed referral was considered.

Twenty percent mortality was directly related to pancreatic injury, and additional 20 % deaths occurred due to associated injuries. Several studies have shown that the pancreatic injury is associated with a mortality rate of up to 30 % and a morbidity rate of up to 45 % [3, 7, 14].

Death of two patients in low-grade pancreatic injury was due to associated injuries in the present study. Death of one patient of NOM grade I pancreatic injury was due to contrast-induced nephropathy. Another patient died due to persistent bleeding because of grade V liver injury. The deaths of high-grade pancreatic injury were attributable to pancreatic injury itself and were due to late sepsis.

As the grade of pancreatic injury increased, the probability of death also increased. Death occurred in all patients with grade V, 16 % patients with grade III, and 50 % patients with grade IV pancreatic injuries. Many deaths occurred late because of septic complications due to pancreatic injury.

## Conclusion

Pancreatic injury is rare, but a delay in diagnosis of pancreatic injury has been associated with significantly higher morbidity and mortality. Low-grade pancreatic injury with intact MPD could be successfully managed nonoperatively, whereas in high-grade pancreatic injury, operative intervention is invariably necessary. Distal pancreatectomy with spleen preservation is a desirable goal whenever possible for distal transaction of the pancreas. Whipple resection should be reserved only for hemodynamically stable patients with complex pancreaticoduodenal injury and is associated with high mortality.

## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no competing interests.

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