

Management of Blunt Major Pancreatic Injury

Being-Chuan Lin, MD, Ray-Jade Chen, MD, Jen-Feng Fang, MD, Yu-Pao Hsu, MD, Yi-Chin Kao, MD, and Jung-Liang Kao, MD

Background: Major duct injury is the principal determinant of outcome for patients with pancreatic trauma, and there are a number of therapeutic choices available specific to the location of the insult. We report a series of blunt major pancreatic injury cases, with a review of the different procedures used and a discussion of the results.

Methods: A total of 48 cases of blunt major pancreatic injury treated during a 10-year period at one trauma center were reviewed retrospectively. Diagnosis and assessment of injury severity were based on imaging studies and proved by surgical findings. Charts were reviewed to establish the mechanism of injury, surgical indications and imaging studies, management strategy, and outcome.

Results: Of the 32 grade III patients, 19 underwent distal pancreatectomy with splenectomy, 8 had pancreatectomy with preservation of the spleen, and 2 received a pancreatic duct stent, with the remain-

ing 3 individuals undergoing nonsurgical treatment, pancreaticojejunostomy, and drainage alone, respectively. The grade III complication rate was 60.6%. Of the 14 grade IV patients, 4 underwent drainage alone because of the severity of the associated injuries, 4 underwent pancreaticojejunostomy, 3 had distal pancreatectomy with splenectomy, and 1 underwent distal pancreatectomy. The two remaining patients received a pancreatic duct stent. The grade IV complication rate was 53.8%. The Whipple procedure was performed for two grade V patients; one died subsequently. For all 48 patients, intra-abdominal abscess was the most common morbidity (n = 11) followed, in order of prevalence, by major duct stricture (n = 4), pancreatitis (n = 2), pseudocyst (n = 2), pancreatic fistula (n = 1), and biliary fistula (n = 1). All stented cases developed complications, with one dying and three experiencing major duct stricture.

Conclusion: The complication rate for our cases of blunt major pancreatic injury was high (62.2%), especially when treatment was delayed more than 24 hours; the same result was also noted for cases transferred from other institutions. Distal pancreatectomy with spleen preservation had a lower complication rate (22.2%) compared with other procedures and is suggested for grade III and grade IV injuries. Magnetic resonance pancreatography was unreliable early after injury but was effective in the chronic stage. Although pancreatic duct stenting can be used to treat posttraumatic pancreatic fistula and pseudocyst, the major duct stricture in the chronic stage of recovery and the risk of sepsis in the acute stage must be overcome.

Key Words: Major pancreatic duct, Pancreatic duct stent, Magnetic resonance pancreatography.

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In comparison to analogous injury to other visceral organs, blunt trauma of the pancreas is less common because of the organ's retroperitoneal location. In addition, clinical presentation is often subtle, frequently resulting in delayed treatment. Furthermore, trauma to the pancreatic duct can induce autodigestion of the adjacent tissue from exocrine secretion, leading to the associated risk of erosion of adjacent vascular and visceral structures when treatment has been delayed.^{1,2} Major duct injury is the principal determinant of outcome for cases of pancreatic trauma. Thus, this report describes the diagnostic approach and treatment of blunt pancreatic injury with special focus on the diagnostic utility

of magnetic resonance pancreatography and endoscopic retrograde pancreatography and the efficacy of pancreatic duct stenting.

MATERIALS AND METHODS

From July 1991 through June 2001, the case records were reviewed for 48 patients (40 men and 8 women) treated for blunt major pancreatic injuries at one institution, as diagnosed from computed tomographic (CT) scanning, endoscopic retrograde pancreatography (ERP), magnetic resonance pancreatography (MRP), and/or surgical findings. Eight of them were transferred from another hospital after operation. During this 10-year study period, there were 3,739 blunt abdominal trauma admission cases and, of these, 201 involved pancreatic trauma (5.37%). The incidence of major pancreatic injury was 1.28%. Information with respect to age, gender, injury mechanism, surgical indications, imaging studies, type of surgical management, complications, and outcome were collated from patient charts. Age range was 18 to 71 years (mean, 37 years). The most frequent causes of pancreatic duct injuries were impact with the steering wheel (approximately 71%), motorcycle crash (15%), and compression injury (8.3%). The Injury Severity Score ranged from 9

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From the Division of Trauma and Emergency, Department of Surgery, Chang Gung Memorial Hospital, Chang Gung University, Kweishan, Taoyuan, Taiwan.

Address for reprints: Being-Chuan Lin, MD, Division of Trauma and Emergency Surgery, Department of Surgery, Chang Gung Memorial Hospital, Chang Gung University, 5 Fu-shing Street, Kweishan, Taoyuan, Taiwan; email: ml2158@cgmh.org.tw.

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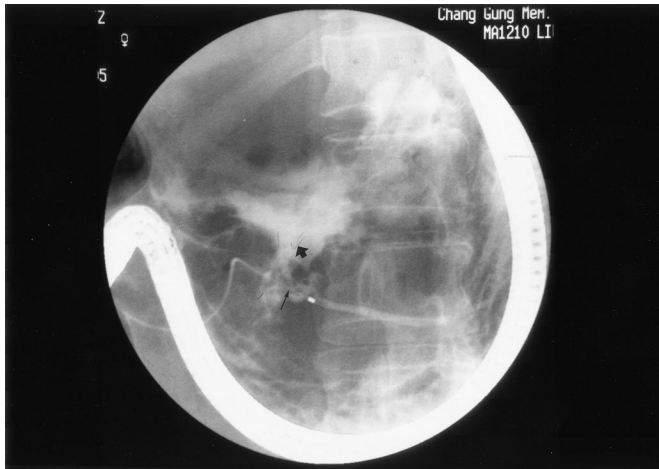


Fig. 1. Endoscopic retrograde pancreatography (ERP) of a 61-year-old woman performed 28 hours after trauma shows complete disruption of the major duct over the pancreatic body (arrow) with extravasation of the contrast media (arrowhead).

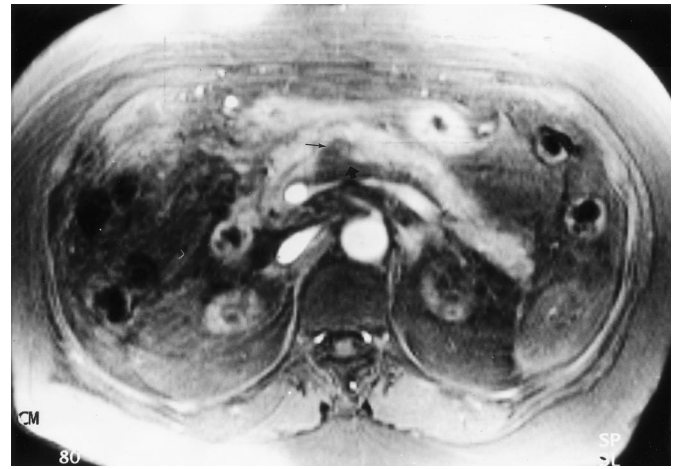


Fig. 2. Axial contrast fat-suppressed T1-weighted magnetic resonance imaging scan of the same 61-year-old woman revealing contusion injury over the body of the pancreas (arrow) and fluid collection between the pancreas and splenic vein (arrowhead).

to 50 (mean, 20.6). A pancreatic fistula was defined as the leakage of pancreatic fluid over 2 weeks in duration. Where a major duct stricture was associated with a fistula, the ductal stricture was defined as a major complication. The pancreatic stents (Wilson-Cook Medical, Inc., Winston-Salem, NC) were made of Teflon, with multiple side holes for drainage. Pancreatic injuries were graded according to the pancreatic organ injury scale of the American Association for the Surgery of Trauma.³ This report restricted the analysis to grades III, IV, and V complications only.

RESULTS

Surgical Indications and Imaging Studies

Abdominal CT scanning was the most commonly used diagnostic tool, with 30 patients undergoing this form of study. Laparotomy was conducted because of unstable hemodynamic status with fluid accumulation as detected by sonography in 10 patients; operation was performed for peritonitis, without any other study, in 3 patients. Two hemodynamically unstable patients with positive diagnostic peritoneal lavage went directly to surgery for control of hemoperitoneum. ERP was performed for seven patients, four after CT imaging resulted in suspicion of pancreatic duct injury, and three postlaparotomy. Extravasation of contrast media was noted for all seven patients. MRP was performed for two patients; major duct stricture with a dilated distal duct was seen late after injury in one case, whereas an intact duct was reported in the other patient, soon after injury, despite complete transection of the body of the pancreas as evidenced from ERP imaging (Fig. 1).

The first of these MRP-assessed cases was a 22-year-old man who had suffered steering wheel impact, with liver and pancreatic injury revealed from abdominal CT scanning. Laparotomy with hepatorrhaphy was performed, but exploration

of the pancreas was not performed because it was felt to be unnecessary because the pancreatic capsule was intact. Postoperative ERP was arranged for the next day, but the patient was unable to tolerate the procedure because of left acromioclavicular joint dislocation. The ERP was cancelled and the duct injury was missed, producing the subsequent complication of repeated pancreatitis after discharge. Six months later, MRP revealed a stricture in the middle part of the major pancreatic duct with a dilated distal segment. This patient underwent distal pancreatectomy with pancreaticojejunostomy and recovered without sequelae. The second MRP-assessed case was a 61-year-old woman with chronic renal failure, who was injured by a steering wheel impact and was diagnosed from abdominal CT scanning. One day after injury, magnetic resonance imaging revealed stage 1 parenchyma injury (Fig. 2), with a normal major pancreatic duct. Four hours later, however, ERP revealed complete disruption of the major duct over the body of the pancreas with extravasation of the contrast media.

Management of Blunt Major Pancreatic Injury

Treatment modalities were selected according to the grade of pancreatic injury severity of the associated injuries and the hemodynamic status when surgery was performed (Table 1). Nonsurgical treatment was chosen for one grade III patient, who has no subsequent complications. Five patients underwent only drainage because of the severity of the associated injuries and unstable hemodynamic status; all subsequently died. Distal pancreatectomy was performed for 31 patients; the spleen was preserved for 9, and 22 underwent splenectomy. One grade III and four grade IV patients underwent pancreaticojejunostomy (end-to-end for four, end-to-side for one). These five patients were in stable hemodynamic status, all without associated injuries, and underwent opera-

Table 1 Management of Blunt Major Pancreatic Injury and Complication Rate (July 1991–June 2001)

Grade	Nonsurgical	Stent	Drainage (No.)	Distal Pancreatectomy	Distal Pancreatectomy plus Splenectomy	Pancreaticojejunostomy	Whipple Procedure	Total
III	1	2	1	8	19	1		32
IV		2	4	1	3	4		14
V							2	2
Total (mortality)	1	4 (1)	5 (5)*	9 (1)	22 (1)	5 (1)	2 (1)	48
Complication rate (%)		100	100	22.2	72.7	60	50	62.2

Drainage added to all operative procedures.

* Death caused by vascular and liver injury (n = 3) and sepsis (n = 2).

tion within 24 hours. Only two of our cases underwent pancreaticoduodenectomy; one was performed without anastomosis as part of damage control for severe associated visceral injury. A pancreatic duct stent was inserted at 28 hours postinjury in one case and postoperatively in another three patients on days 8, 19, and 20, respectively. Case 1 was a 37-year-old woman who had suffered pancreatic head injury and had undergone laparotomy with drainage. Postoperative ERP revealed major duct disruption in the head area, and a stent was inserted 20 days after laparotomy. Follow-up at 11 months revealed ductal stricture (Fig. 3), with dislodgement of the stent into the distal duct at 15 months, where it could not be removed endoscopically. Operation was suggested, but she refused and was lost to follow-up. Case 2 was a 35-year-old man who had been transferred to our emergency room 12 days postlaparotomy at another hospital. ERP was arranged 7 days later because of persistent leakage of pancreatic fluid from the drain tube. Because the ERP revealed contrast leakage at the pancreatic head, a stent was inserted. Pancreatic duct stricture was subsequently detected and the stent was exchanged every 2 months during follow-up to ensure dilatation. The stent was eventually removed 1 year later and follow-up ERP still showed mild ductal stricture. Case 3 was

a 61-year-old woman with chronic renal failure who suffered an injury to the pancreatic body. Complete disruption of the major duct was demonstrated from ERP, 28 hours after injury when a stent was inserted. Although the abdominal pain subsided, septic shock developed the next day, and an emergency operation with distal pancreatectomy and splenectomy was performed. However, the patient died 3 days later because of the effects of sepsis and multiple organ failure. Case 4 was a 36-year-old man who underwent laparotomy with drainage of a pancreatic neck hematoma. Eight days later, ERP revealed two leaks in the area of the pancreatic body, and a stent was inserted. Severe ductal stricture was noted at the 15-month follow-up and the stent was removed finally because it was believed there would be no more benefit from stenting.

Complications

Three patients sustained severe injuries, which caused shock and eventual death from superior mesenteric vein, superior mesenteric artery, or liver injury. The overall complication rate for the remaining 45 patients was 62.2%. Intra-abdominal abscess was the leading cause of morbidity (n = 11) followed, in order of prevalence, by major duct stricture (n = 4), pancreatitis (n = 2), pseudocyst (n = 2), pancreatic fistula (n = 1), and biliary fistula (n = 1) (Table 2). The complications were analyzed and the patients divided into three groups according to the length of time from injury to surgery. Of the 32 grade III patients, 12 were treated within



Fig. 3. Endoscopic retrograde pancreatography of a 37-year-old woman performed 11 months after pancreatic duct stenting shows irregular dilatation of the pancreatic duct over the body and tail (arrow), with stricture over the pancreatic head region (arrowhead).

Table 2 Intra-abdominal Complication of Blunt Major Pancreatic Injury

Intra-abdominal abscess	11
Sepsis with multiple organ failure	6*
Pancreatic duct stricture	4#
Pseudocyst	2
Pancreatitis	2
Biliary fistula	1
Pancreatic fistula	1
Pancreaticojejunostomy leakage with sepsis	1*
Total	28

Morbidity rate, 21 of 45 (46.7%); average hospital day, 50 days; mortality rate, 7 of 45 (15.5%).

Two with pancreatic fistula, one with pseudocyst.

* Mortality.

12 hours and had 7 complications (58.3%), 4 were treated between 12 and 24 hours after injury and had 1 complication (25%), and 15 were operated on more than 24 hours after injury and had 12 complications (80%). The five grade III deaths had all been treated more than 24 hours after injury. Of the 14 grade IV cases, three died from superior mesenteric vein, superior mesenteric artery, or liver injury and were excluded, and 3 of the remaining 11 patients were treated within 12 hours and 2 had complications (66.6%). Two of these patients were treated between 12 and 24 hours after injury with one complication (50%), and six were treated more than after 24 hours with five complications (83.3%). Two grade V cases were treated within 12 hours; one died as a result of the associated injuries. Treatment delays of more than 24 hours were associated with higher complication rates. In 4 of the 11 intra-abdominal abscess cases, the abscess was drained using CT guidance, with 3 requiring a second operation and 4 relying on long-term drainage through a preexisting tube. In total, seven patients died as a result of sepsis, giving an overall mortality rate of 15.5%. Average overall length of hospitalization was 50 days in these complication patients.

DISCUSSION

Blunt pancreatic trauma is infrequent. When it does occur, however, the morbidity rate is often high (8–45%), with an average mortality rate of 5%.^{2,4–7} Because major duct injury is the principal determinant of outcome in cases of pancreatic trauma, higher morbidity and mortality can be expected where there is major duct involvement. Clinical presentation for pancreatic trauma, especially for the blunt variant, is often subtle because of the retroperitoneal location of the pancreas, frequently resulting in delayed treatment. Given this likelihood,^{1,2,8} prompt and accurate diagnosis, especially with respect to major duct status, and proper management are needed to decrease morbidity and mortality.

Udekwi et al. found that, of all the abdominal organs, the overall accuracy of dynamic CT scanning for diagnosis of pancreatic trauma was lowest.⁹ Where there is laceration of more than half of the parenchymal tissue as determined from abdominal CT imaging, major duct injury should be suspected and operation should be scheduled.¹⁰ Although ERP allows visualization of ductal structure and facilitates assessment of ductal integrity,^{11–14} it is often not available after hours and may not be suitable for patients with severe associated injuries. As MRP can be performed at night, it may be more available than ERP in pancreatic trauma cases.

The effectiveness of MRP was poor in the one patient studied early after injury, possibly because of the blood and fluid around the pancreas and the fact that the pancreatic duct, though injured, was not dilated. In contrast, MRP performed in the chronic stage when ductal dilation from stricture is present appears to be helpful, although further evaluation is needed.¹⁵

All seven patients undergoing ERP, whether performed early or late (at postlaparotomy days 8, 19, and 20) after injury had extravasation of the contrast media from complete ductal disruption in three patients and partial ductal disruption in four patients. One patient with incomplete ductal disruption and limited leak of contrast media was successfully treated without operation, as has been reported by Takishima et al.¹⁶

Successful insertion of pancreatic duct stents has been reported for management of major pancreatic duct disruption; however, late complications are mentioned less frequently.^{17,18} Four of our recent patients (two grade III, two grade IV) received a pancreatic duct stent to treat ductal disruption revealed by the ERP study. Three patients underwent ERP after laparotomy, persistent fever, abdominal pain, and persistent leakage of pancreatic fluid from the drain tube. All three had pancreatic ductal stenting for confirmed ductal extravasation. Each patient recovered, but later ERP study showed ductal stricture in all three patients. The stent could be successfully removed in only two patients after 1 year and 15 months, respectively. One patient experienced dislodgment of the stent into the distal duct, detected at the 15-month follow-up. The fourth patient underwent ERP and stenting 28 hours after injury; however, sepsis developed and she subsequently died despite emergency distal pancreatectomy and splenectomy. Thus, a pancreatic duct stent appears useful for a pancreatic fistula but may be complicated by a long-term stricture, whereas ductal stenting in the acute phase is potentially dangerous in that it may lead to delay in necessary laparotomy and definitive repair of the pancreatic injury.

Nine patients underwent distal pancreatectomy without splenectomy, whereas splenectomy was performed with pancreatectomy in the other 22 patients. The reasons for splenectomy were associated visceral injury ($n = 8$); associated spleen injury ($n = 6$); delayed treatment with severe abdominal inflammation ($n = 6$); and priority given to damage control, followed by staged operation ($n = 2$). These factors may account for the higher complication rate for the group of patients undergoing distal pancreatectomy with splenectomy (72.7%) in comparison with their study counterparts with spleen preservation (22.2%).

Eight patients were transferred to our center after surgery at another hospital. All developed complications and two died. Four underwent laparotomy without exploration of the pancreas, three had distal pancreatic resection, and one received peripancreatic drainage only. The complications and deaths in these patients reflected delayed diagnosis and delayed treatment, missed injury, and inadequate treatment because of undergrading of injury severity. The high complication rate (60%) after pancreaticojejunostomy in four grade IV patients and one grade III patient and the one death caused by anastomotic leakage suggest that distal pancreatectomy is a superior operative treatment for grade III and grade IV injuries.

Our current management guidelines include abdominal CT scanning for visualization of the pancreas and evaluation of injury severity where pancreatic trauma is suspected. If transection of the pancreas parenchyma is complete or laceration exceeds 50% from CT scanning, major duct injury should be suspected and surgery scheduled immediately. When this deep laceration is less than 50%, ERP may be arranged in suitable cases. Pancreatic resection should be performed for distal duct disruption (grade III). For proximal duct injury (grade IV), multiple procedures such as closed suction drainage and distal resection can be selected, depending on clinical condition. Pancreatic duct stenting may be an alternative or adjunctive treatment for proximal duct disruption. For grade V injury, pyloric exclusion or duodenal diverticulization with distal pancreatic resection, pancreaticojejunostomy, or drainage alone should be attempted first; the Whipple procedure should be reserved until other alternatives have been attempted.

CONCLUSION

In our patients, blunt major pancreatic injury was associated with a high complication rate (62.2%), especially when treatment was delayed by more than 24 hours. Complications developed in all of the transferred cases. Distal pancreatectomy with spleen preservation had a lower complication rate (22.2%) compared with the other procedures, and is suggested for grade III and grade IV injuries. MRP is a new diagnostic tool that is also effective in the chronic stage; additional evaluation is required to prove the efficacy of this technique during the acute stage. The pancreatic duct stent can be used to treat posttraumatic pancreatic fistula, but the later problem with ductal stricture in the chronic stage must be addressed. Pancreatic stenting, acutely, may delay operative intervention and definitive repair of life-threatening injury.

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