Original Article

How to deploy a uniform and simplified acute-phase management strategy for traumatic pancreatic injury in any situation

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Aim: Management of traumatic pancreatic injury is challenging, and mortality and morbidity remain high. Because pancreatic injury is uncommon and strong recommendations for pancreatic injury management are lacking, management is primarily based on institutional practices. We propose our strategy of pancreatic injury management.

Methods: We retrospectively reviewed patients with pancreatic injury and evaluated our strategy and outcomes.

Results: From January 2013 to December 2019, 18 patients were included with traumatic pancreatic injury. The median Injury Severity Score was 22 (25–75% interquartile range, 17–34) and probability of survival was 0.87 (25–75% interquartile range, 0.78–0.93). Patients were grouped according to the American Association for the Surgery of Trauma injury grades: grade I, *n* = 3 (16.7%); II, *n* = 6 (33.3%); III, *n* = 7 (38.9%); and IV, *n* = 2 (11.1%). All patients underwent endoscopic pancreatic ductal evaluation within 1–2 days after admission. Abbreviated surgery because of hemodynamic instability and subsequent open abdominal management were undertaken in one patient with pancreas head injury and two patients with pancreas body/tail injury. Management was by laparotomy for closed suction drain insertion with main ductal endoscopic drainage in six patients, endoscopic ductal drainage only in six patients, and distal pancreatectomy with closed suction drainage and endoscopic drainage in five patients. One patient with grade I injury underwent observation only. Median length of closed suction drainage was 12 days and that of hospital stay was 36 days. The observed mortality during the study period was 0%. Late formation of pseudo-pancreatic cyst was observed in two patients (11.1%).

Conclusion: Our uniform, simplified strategy offers good outcomes for any pancreatic injury site and any concomitant injuries, even in hemodynamically unstable patients.

Key words: Closed suction drainage, damage control surgery, open abdominal management, pancreatectomy, traumatic pancreatic injury

INTRODUCTION

PANCREATIC TRAUMA TENDS to result in high rates of mortality and morbidity.[1-4] In Japan, 90% of pancreatic injury is caused by blunt trauma, in contrast to that in the majority of patients in the USA and South Africa, which is caused by penetrating injury.[5-7] Total mortality from pancreatic injury is reported to be approximately 10–30%, and morbidity increases especially when hemodynamic instability or other injuries are present.[4,8] This high mortality is mainly because it is so rare; for each surgeon, and even each institution, the management strategy generally depends on individual experience.[9,10]

The most important evaluation in the management of pancreatic injury is to determine whether the pancreatic main duct is injured,[11,12] and the Eastern Association for the Surgery of Trauma guideline also recommends early evaluation to decide how best to manage the injury with minimal interventions.[13]

However, when and how to evaluate the duct is still not strongly established even in the guidelines and completely depends on the patient's hemodynamic state and the availability of an endoscopist or other perioperative procedures. Thus, establishment of an accurate and safe strategy for evaluating ductal injury in any circumstance is warranted. From 2013, in the era of common use of open abdominal

strategy, we introduced a simplified multiadaptable strategy for all kinds of pancreatic injury. The objective of this study is to assess the accuracy and safety of our strategy for pancreatic injury patients.

METHODS

THIS IS SINGLE-CENTER retrospective review in which we assessed the patients admitted to the Trauma and Critical Care Center of Osaka City University Hospital (Osaka, Japan). Our institution is comprised of 11 staff members including five attending surgeons. Approximately 150–200 multiple trauma patients with an Injury Severity Score of 16 or higher are admitted annually. The records of all the patients admitted with pancreatic injury were reviewed and included 18 patients who were evaluated for outcomes with complications (Fig. 1).

Our strategy for pancreatic injury

Resuscitation strategy for abdominal trauma

In the trauma patients treated in our institution who have clinical findings or are suspected of having abdominal trauma, if the focused assessment of sonography for trauma

(FAST) is positive and their hemodynamics are unstable for transfer to the computed tomography (CT) room or operating room, we immediately undertake resuscitative surgery in the resuscitation unit without carrying out a pan-scan CT. If the FAST is positive and circulation is stable or controlled, or findings of FAST are negative, a contrast-enhanced CT scan is carried out to assess their injuries at the time of admission.

Evaluation of ductal injury

In addition to the fact that ductal evaluation by using endoscopic retrograde cholangiopancreatography (ERCP) is reported to be the most accurate in terms of sensitivity and specificity, ERCP is frequently and routinely carried out by endoscopists as a basic evaluation of ductal disease. However, we never undertake an ERCP during surgery, even if an endoscopist is available, because the limited supine position of the patient makes it difficult for the endoscopist to cannulate the pancreatic duct, which can be time-consuming. To avoid complications occurring by unnecessary incisions, we also do not use other intraoperative evaluations, such as incising the duodenum and injecting the main duct with indocyanine green or injecting indocyanine green from the tail of the
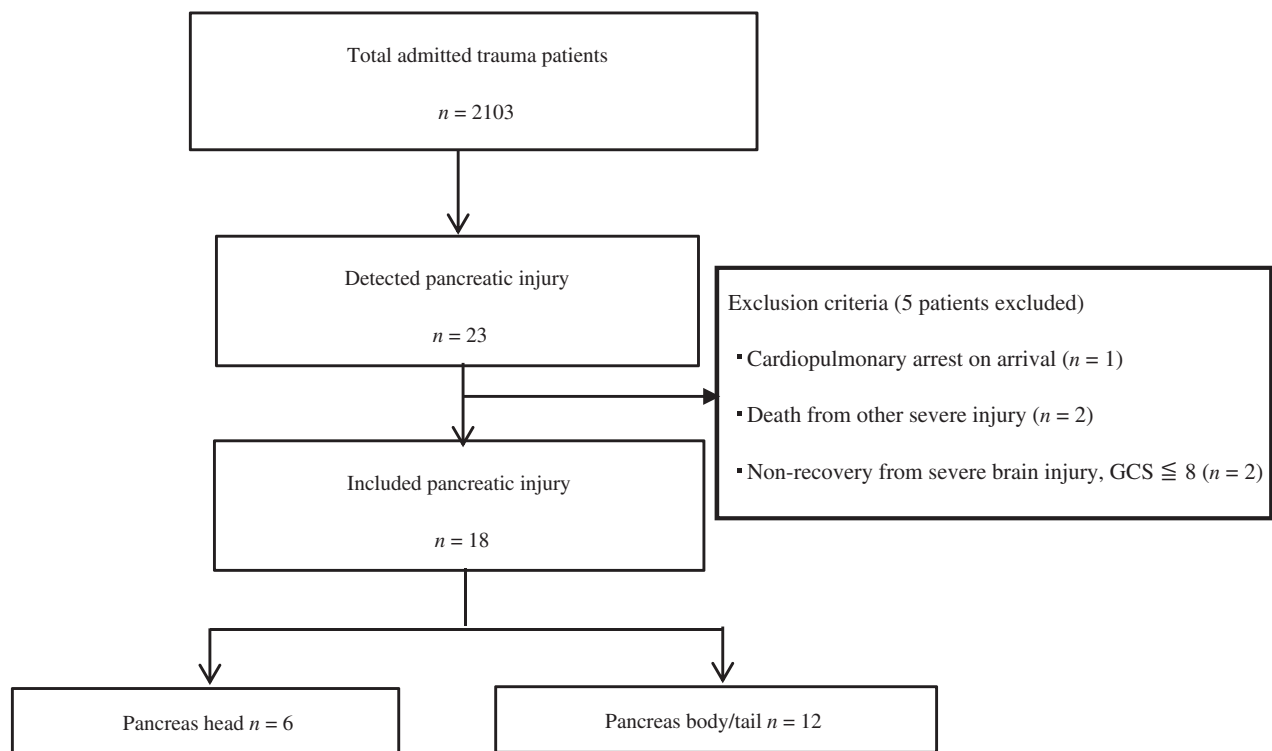

Fig. 1. Selection flowchart for patients with traumatic pancreatic injury included in this study. GCS, Glasgow Coma Scale.

pancreas because of its difficulty, invasiveness, and limited reliability.

Pancreatic injury with unstable hemodynamics

Our strategy for hemodynamically unstable patients with pancreatic injury is shown in Figure 2. Patients with unstable hemodynamics should be immediately operated without CT scan. If we find pancreatic body or tail injury present to the left of the superior mesenteric vein during the procedure, we either carry out distal pancreatectomy or just place a drain tube, depending on the severity of the injury. However, if unstable patients are being resuscitated, we sometimes just place the drain and leave the injured pancreas until it is assessed in a second-look operation. If the site of injury is located at the pancreas head, we place drains to prevent the pancreatic fluid from massively expanding into the peritoneum and leave the abdomen opened with negative pressure wound therapy (NPWT). The pancreatic duct is evaluated by ERCP within 1–2 days after initial abbreviated surgery, and then we decide whether to continue with
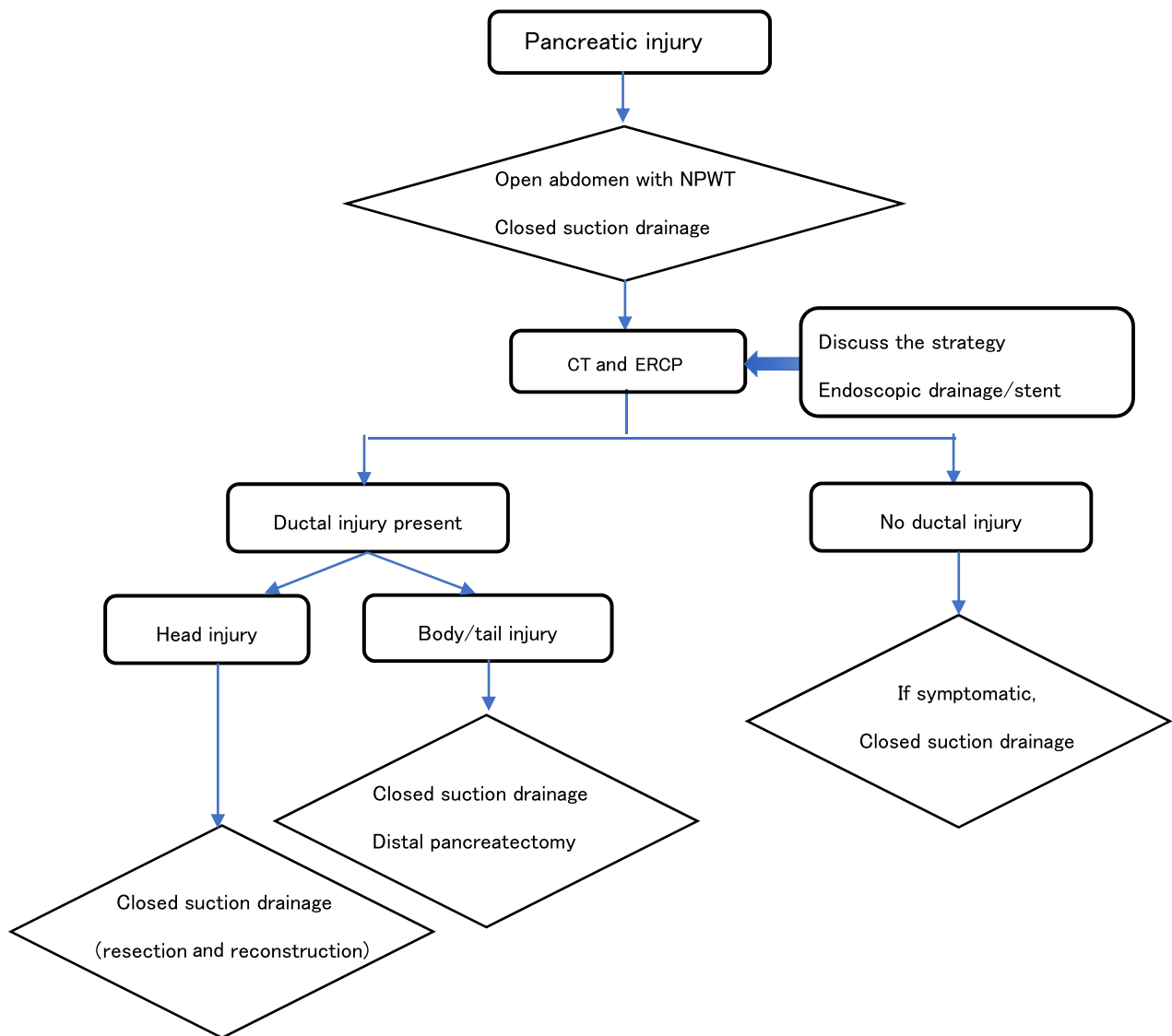

Fig. 2. Our strategy for hemodynamically unstable patients with pancreatic injury. CT, computed tomography; ERCP, endoscopic retrograde cholangiopancreatography; NPWT, negative pressure wound therapy.

drainage management only or to add other procedures, such as resection and reconstruction of the pancreas head.

After resuscitation is accomplished, if the main duct is successfully cannulated without detecting total resection of the pancreas or major injury to the main duct, in addition to placing a closed suction drain around the pancreas, we insert an endoscopic nasopancreatic drainage (ENPD) tube to decrease ductal flow.

Pancreatic injury with stable hemodynamics

Our strategy for hemodynamically stable patients with pancreatic injury is shown in Figure 3. If the patient is stable for transfer to contrast-enhanced CT and there are findings of pancreatic injury, our strategy basically depends on the patient's symptoms and the availability of an endoscopist. Our endoscopy team specializing in ERCP is usually not immediately available, especially during the night shift and sometimes on the weekends as well. Thus, we sometimes have to determine management without endoscopic evaluation of ductal injury. We carefully observe the patient's symptoms, and if the patient complains of significant abdominal pain, such as would be caused by peritonitis, we open the abdomen and determine whether to place a drain or add distal pancreatectomy if the body/tail are totally resected clinically. The abdomen is left open with NPWT, and we wait for the evaluation by ERCP to decide on additional procedures. Here, too, an ENPD tube is inserted if the main duct is successfully cannulated to decrease ductal flow. With this simple management protocol, even young surgeons seldom waver in their decision-making. After the initial abbreviated surgery, we can take time to discuss the results of ERCP to determine how best to treat the injury definitively during open abdominal management.

Statistical methods

Because this was a pilot study with a small sample size and the data were not normally distributed, data of the continuous variables are presented as the median (25–75% interquartile range), and the categorical variables are presented as number (%). Data were analyzed using IBM SPSS Statistics, version 22 (SPSS, Chicago, IL, USA).

RESULTS

FROM JANUARY 2013 to December 2019, 18 patients were diagnosed as having pancreatic injury (Fig. 1). Four patients (22.2%) suffered penetrating injuries including gunshot wounds, and two patients (11.1%) were assaulted. The severity and characteristics of the patients are described in Table 1. Paramedics transported 10 patients directly to our hospital, and the other 8 patients were transferred from different hospitals because pancreatic injury was detected. The median Injury Severity Score was 22 (17–34), and probability of survival was 0.87 (0.78–0.93).

The concomitant injuries observed in the patients are listed in Table 2. Table 3 shows the detailed management of the patients and the outcomes. Endoscopic pancreatic ductal evaluation was carried out in all patients within 1–2 days after admission. Because of unstable hemodynamics on patient arrival, abbreviated surgery and subsequent open abdominal management were undertaken in two patients with pancreas head injury and one patient with pancreas body injury. Six patients were managed by laparotomy for placement of a closed suction drain with main ductal endoscopic drainage, six patients were managed only by endoscopic ductal drainage, and five patients underwent distal pancreatectomy with closed suction drainage and the addition of endoscopic drainage. One patient with grade I injury was managed non-operatively with careful observation only. Evaluation by ERCP was made prior to surgery in five hemodynamically stable patients. The other 13 patients were operated on emergently or were initially managed conservatively according to the CT findings or their clinical symptoms. The main duct could not be cannulated endoscopically in two patients with pancreas head main ductal injury, and these patients were managed with closed suction drainage only. Endoscopic pancreatic main ductal drainage was basically undertaken by ENPD tube, or if the injury was branchial lesion and pancreatic leakage seemed to be mild to moderate, stenting, lost stent, or an internal drainage tube was inserted. The median number of days of ENPD was 10 (6–24), and three patients with pancreatic head injury were converted to an internal drainage tube for observation in the outpatient clinic.

The observed mortality during this study period was 0%, and late formation of a pseudopancreatic cyst was observed in two patients (11.1%). No other complications, such as pancreatitis peritonitis or expansive intraperitoneal abscess formation, were observed during the study period. The survival rate of these patients during the study period was 100%.

DISCUSSION

ALTHOUGH THE INCIDENCE of traumatic pancreatic injury is rare,[14-16] its mortality and morbidity are still high, especially in patients with an AAST severity level of more than grade III injury.[17] Currently, the mortality from pancreatic injury is reported to range from 2% to 17%, and the morbidity rate approaches as high as approximately
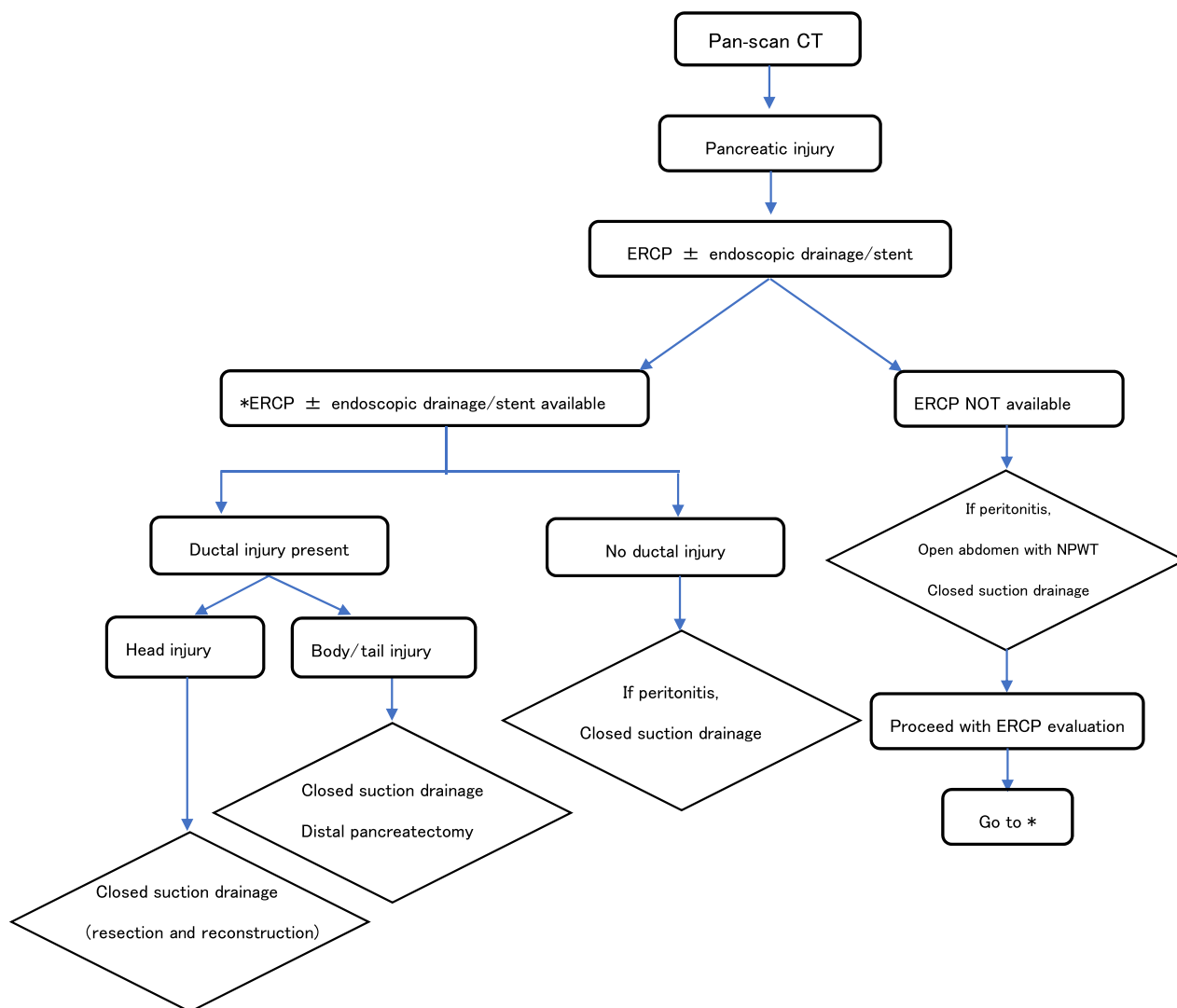
Fig. 3. Our strategy for hemodynamically stable patients with pancreatic injury. ERCP, endoscopic retrograde cholangiopancreatography; NPWT, negative pressure wound therapy.

45%.[18-20] Furthermore, if diagnosis or treatment was delayed, some studies found that the morbidity rate increased to approximately 60%.[21,22]

It is already clear that appropriate evaluation of the pancreatic main duct is mandatory to decrease the rates of mortality and morbidity.[13] But even for those who work in a tertiary emergency center or trauma center, it is difficult to access an endoscopist 24 h a day, 7 days a week. To solve this dilemma, we aggressively undertake abbreviated surgery with NPWT to earn time for evaluation and discussion of the treatment strategy. The most valuable point of this approach is that it is applicable for surgery in both hemodynamically unstable patients without a CT scan and hemodynamically stable patients with CT findings.

When operating on an unstable patient and there are findings of pancreatic injury during surgery, the only thing we have to determine is whether to place a drain around the pancreas to avoid the spread of pancreatic fluid into the peritoneum or to carry out distal pancreatectomy if the injured site exists to the left of the superior mesenteric vein. After placing the drain and closing temporarily with NPWT, ERCP can be organized within a couple of days by the time the second-look operation is planned.

When operating on stable patients with findings of pancreatic injury on CT scan, the determination of what procedure should be undertaken temporarily is the same as with unstable patients unless ERCP evaluation is available. The important indication for surgery is the symptoms of the patient.

Table 1. Characteristics of patients with traumatic pancreatic injury (*n* = 18)

	n = 18
Sex, male/female	17/1 (male, 99.4%)
Age, years	48 (32–68)
Mechanism of injury	
Penetrating	4 (22.2%)
Gunshot wound	1
Stab wound	3
Blunt	14 (77.8%)
Assaulted	2
Fall from height	4
Pedestrian hit by car	8
AAST injury grade (head/body or tail)	
I	3 (1/2)
II	6 (0/6)
III	7 (3/4)
IV	2 (2/0)
V	0
Hemodynamically unstable (head/body or tail)	3 (1/2)
Probability of survival	0.87 (0.78–0.93)

AAST, American Association for the Surgery of Trauma.

Table 2. Concomitant injuries in patients with traumatic pancreatic injury (*n* = 18)

Intracranial hemorrhage	2 → 1: observed with ICP monitoring; 1: only observation
Hemothorax/ pneumothorax	7 → 6: TT[†]
Liver injury	4 → 2: PHP[‡] + TAE[‡]
Kidney injury	2 → 1: TAE[†]
Pelvic fracture	3 → 1: TAE[†] + EF[‡]
Extremities fracture	4 → 3: traction[‡]

EF, external fixation; ICP, intracranial pressure; PHP, perihepatic packing; TAE, transcatheter arterial embolization; TT, tube thoracostomy.
[†]Carried out prior to operation.
[‡]Carried out concurrently or after operation for pancreatic management.

Table 3. Management results in patients with traumatic pancreatic injury (*n* = 18)

Time from admission to first operation (days)	1 (0–2)
Operation time (min)	148 (62–216)
Patients undergoing ERCP	18 (100%)
Patients undergoing ERCP prior to surgery	5 (27.8%)
Time from admission to first ERCP (days)	1 (1–2)
Maneuver performed for pancreas	
Temporary OAM	5
Laparotomy with CS and ES drainage	6
Distal pancreatectomy with CS and ES drainage	5
ES drainage only	6
Observation with evaluation of ERCP	1
Duration of ES drainage (days)	10 (6–24)
Duration of CS drainage (days)	12 (8–36)
Duration of OAM (days)	2 (1–4)
Length of ICU stay (days)	6 (4–12)
Length of hospital stay (days)	28 (21–68)
Survival	100%
Complications	
Formation of pseudopancreatic cyst	2 (11.1%)
Sepsis	0
Intestinal perforation/fistula	0

CS, closed suction; ERCP, endoscopic retrograde cholangiopancreatography; ES, endoscopic; ICU, intensive care unit; OAM, open abdominal management.

maneuver, because these procedures for severe pancreatic trauma have already been discussed globally with dismal outcomes, and the number of case reports reporting success is still limited.[5,23,24] To decrease and control fluid volume and pressure in the pancreatic main duct, we basically insert an ENPD tube or endoscopic retrograde pancreatic drainage tube if the duct is successfully cannulated at the time of the initial ERCP.

Usually when the abbreviated surgery finishes with NPWT, additional suction drains are not needed. However, we place an additional closed suction drain around the pancreas only when managing pancreatic trauma.

Some reports describe the use of intraoperative endoscopy and evaluation,[5] but this can be time-consuming, especially in hemodynamically unstable patients, and furthermore, the limited supine position of the patient during surgery makes ERCP difficult to accomplish. We also rarely use magnetic resonance cholangiopancreatography because its evaluation is difficult, and it is

If the ductal injury was detected in the pancreas head during the surgery or ERCP evaluation, we usually do not aggressively perform pancreatoduodenectomy or any other reconstructive procedures, such as the Letton and Wilson

not adaptable to hemodynamically unstable patients receiving many continuous drugs or with attached electronic devices.[25] We also do not infuse indocyanine green during surgery because of its reliability and sometimes difficult evaluation.

With the use of these simple systematic strategies, our treatment outcomes are satisfactory from the viewpoints of mortality and morbidity. Additionally, logically we think our management strategies described here are completely adoptable for pediatric pancreatic injury precisely because pediatric pancreatic duct is tremendously more difficult to anastomose than adults.

Limitations

This single-center study is a small preliminary report, and further multi-institutional evaluation and trials will be planned on the basis of this study.

CONCLUSION

WE CONCLUDE THAT our simple and systematic institutional strategy for managing traumatic pancreatic injury is acceptable, and no unexpected complications or critical delays in treatment were observed in these patients.

DISCLOSURE

Approval of the research protocol: As this was a retrospective study, the institutional review board of Osaka City University waived the need for informed consent.
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.
Informed consent: All participants gave their written informed consent.
Conflict of interest: None.

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