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Original Article

An analysis of 77 cases of pancreatic injuries at a level one trauma center: Outcomes of conservative and surgical treatments

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Backgrounds/Aims: Traumatic pancreatic injury (TPI) is rare as an isolated injury. There is a trend to perform conservative treatment even in patients with complete duct dissection and successful treatment. This study reviewed our 20 years of experience in the management of TPI and assessed patient outcomes according to age group and treatment strategy.
Methods: A retrospective analysis of patients diagnosed and treated with TPI at a level-I trauma center from 2000–2019. Patients were divided into two groups: adults and pediatrics. Conservative treatment cases were subjected to subgroup analysis. Level of evidence: IV.
Results: Of a total of 77 patients, the mean age was 24.89 ± 15.88 years. Fifty-six (72.7%) patients had blunt trauma with motor vehicle accident. Blunt trauma was the predominant mechanism in 42 (54.5%) patients. Overall, 38 (49.4%) cases had grade I or II injury, 24 (31.2%) had grade III injury, and 15 (19.5%) had grade IV injury. A total of 30 cases had non-operative management (NOM). Successful NOM was observed in 16 (20.8%) cases, including eight (32.0%) pediatric cases and eight (15.4%) adult cases. Higher American association for the surgery of trauma (AAST) grade of injury was associated with NOM failure (16.7% for grade I/II, 100% for grade III, and 66.7% for grade IV injury; p = 0.001). An independent factor for NOM failure was female sex (69.2% in females vs. 29.4% in males; p = 0.03).
Conclusions: High AAST grade TPI is associated with a high rate of NOM failure in both pediatric and adults.

Key Words: Trauma; Pancreas; Conservative management; Adult; Pediatric

INTRODUCTION

Pancreatic injuries constitute 0.2%–0.3% of all injuries [1]. Traumatic pancreatic injury (TPI) is rare, particularly as an isolated injury. Only 3.1% to 12% of patients with other abdominal injuries have additional TPI [2-4]. The prevalence of TPI according to each grade of the American Association for the Surgery of Trauma (AAST) scale has been reported to be 1.9% for grade II, 0.6% for grade III, 0.3% for grade IV, and 0.2% for grade V injuries [2,5]. The mechanism of injury mainly involves sudden and direct compression of the pancreas against the lumbar vertebra, especially in patients with thin retroperitoneal fat like children and thin adults [6]. Isolated injuries are difficult to diagnose due to the lack of clinical signs in the first hours after admission, leading to an increase in late phase mortality [4]. Measurement of amylase and lipase levels along with computer tomography usually could help establish its diagnosis [4,7,8]. The mortality of TPI ranges from 3% to 34%. Only 4% to 5% of deaths are directly related to pancreatic injury itself. More than 70% of pancreatic trauma deaths occur within the first 24 hours because of associated injuries [2,6,9,10].

The key predictor of morbidity and treatment decisions in conservative versus operative management of TPI is the integrity of the main pancreatic duct [6,9,11]. The AAST classifica-

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tion helps in treatment decision by grading the injury according to injury location and duct status [5]. Most TPI cases are grade I or II with conservative treatment including hemostasis and drainage [3,7]. Historically, surgical treatment is chosen for high-grade TPI, especially in patients with other abdominal injuries. Recently, there has been a clear paradigm and shift to conservative treatment in patients with complete duct dissection, leading to improved outcomes [2,12-15]. However, it has been suggested that nonstable patients should also be treated surgically regardless of nonsurgical treatment options [2,3,6,9]. An adjunct to conservative treatment is endoscopic retrograde cholangiography (ERCP) with stent insertion in selected cases to reduce endoscopic management failure [5,16]. Some studies have reported similar outcomes of conservative and operative treatments of TPI in pediatric patients [14,17].

The aim of this study was to review our experience over the past 20 years in the management of TPI in pediatric and adult groups and to assess patient outcomes according to age group and treatment strategy for each TPI grade.

PATIENTS AND METHODS

This study was approved by the Ethics Committee of Hadassah Medical Center. The Institutional Review Board approved this study and waived the need for informed consent of patients (no. 0314-19-HMO). This was a retrospective analysis of patient records used to diagnose and treat TPI at a level I trauma center of our university teaching hospital between 2000 and 2019. Data retrieval used electronically medical records and international classification of disease coding. We double checked that no cases were missed via manual searches. Cases without a documented pancreatic injury were excluded. The following data were reviewed: demographics, mechanism and area of pancreatic injury, injury severity scale (ISS), Glasgow Coma Scale (GCS), type and time-to-surgery, length of hospital stay (LOHS), length of intensive care unit stay (ICU stay), imaging performed (including ERCP), injury to other organs, diastase level (maximal during hospitalization), procedures performed, and complications. Patients were divided into adults and pediatric groups in order to investigate if there were any differences in the feasibility of conservative management. Additionally, all patients were divided into non-operative management (NOM) and operative treated groups. Analysis of those who had NOM failure was done. Failed NOM was defined as surgically treating patients after a trial of conservative management due to either hemodynamic instability, clinical or laboratory deterioration; peritonitis, fever, or increases of inflammatory markers. We also noted if feeding jejunostomy or total parenteral nutrition was used. The grade of pancreatic injury was defined according to grading of AAST scale ranging from minor (grade I) to devastating (grade V).

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Mean and standard deviation (SD) are provided for continuous variables. Absolute frequencies and percentages are provided for categorical variables. Patients were divided into adult and pediatric groups and compared. Group means of categorical variables were compared using Pearson chi-squared test and Mantel–Haenszel tests as appropriate. p-values < 0.05 were considered statistically significant. A subgroup analysis of cases that received conservative management were analyzed. We performed logistic regression analysis of preoperative risk factors for operative management.

RESULTS

A total of 77 patients were identified and included in this study. There were 52 (67.54%) in the adult group (≥ 18 years) and 25 (32.46%) in the pediatric group (< 18 years). The mean age ± SD of all patients was 24.89 ± 15.88 years. There were 54 (70.1%) male. A total of 56 (72.7%) patients had blunt injury. Motor-vehicle accident (MVA) was the predominant injury mechanism (54.5%, n = 42). Of the total cohort, 38 (49.4%), 24 (31.2%), and 15 (19.5%) had AAST grade I/II, III, and IV/V injuries, respectively. Diastase levels were elevated two-fold in 26 (41.3%) patients and three-fold in 24 (38.1%) patients. The most common injured area of the pancreas was the pancreatic tail (31.2%, n = 24). Most (n = 44, 57.1%) patients had an ISS of more than 25.

Table 1 shows baseline characteristic of patients. Most (n = 70, 90.9%) patients had concomitant injury to other organs. Of these organs, the most common injury was to the liver (n = 42, 54.5%) and the spleen (n = 40, 51.9%). Table 2 shows details of concomitant injuries. Thirty (39.0%) patients had conservative management. Forty-seven (61.0%) patients were operated directly. Fourteen out of 30 patients (18.2%) with conservative management underwent an operation during hospitalization. The mean time from admission to operation was 13.8 ± 31.09 hours. The mean LOHS and ICU stay were 25.4 ± 25.43 and 10.72 ± 16.62 days, respectively. Eight (10.4%) patients died. All of them had an operative management.

Table 3 shows patient outcomes for all patients as well as for age subgroups (adults and pediatric groups). Eight patients died (all were adults), including four who had penetrating trauma and four who had a blunt mechanism of injury. Of these eight patients, five had AAST grade IV injury, two had an AAST grade III injury, and one had a grade I injury. One patient with AAST grade I TPI died from associated kidney and spleen injury. Of three patients who died due to gunshot wounds (GSW) and AAST grade III/IV TPI, one died due to associated injury to the superior mesenteric artery and bowel ischemia. Four other patients died due to injury to other vessels and associated organs.

Table 1. Characteristics of patients with traumatic pancreatic injuries

Characteristic	Total	Adult group (≥ 18 yr)	Pediatric group (< 18 yr)	*p*-value
Frequency	77 (100)	52 (67.54)	25 (32.46)	
Age (yr)	24.89 ± 15.88	31.4 ± 14.90	10.67 ± 4.94	
Sex				
Male	54 (70.1)	39 (75.0)	15 (60.0)	0.178
Female	23 (29.9)	13 (25.0)	10 (40.0)	
Mechanism of Injury				
Penetrating	21 (27.3)	17 (32.7)	4 (16.0)	0.124
Blunt	56 (72.7)	35 (67.3)	21 (84.0)	
Mechanism of injury				
Gunshot wound	17 (22.1)	14 (26.9)	3 (12.0)	
Stab wound	2 (2.6)	2 (3.8)	0 (0)	
Others	3 (3.9)	2 (3.8)	1 (4.0)	0.240
Blust	2 (2.6)	1 (1.9)	1 (4.0)	
MVA	42 (54.5)	28 (53.8)	14 (56.0)	
Fall	11 (14.3)	5 (9.6)	6 (24.0)	
Imaging				
CT	59 (76.6)	39 (75.0)	20 (80.0)	0.627
US	51 (66.2)	32 (61.5)	19 (76.0)	0.209
ERCP	12 (15.6)	7 (13.5)	5 (20.0)	0.459
GCS				
13–15	50 (64.9)	32 (61.5)	18 (72.0)	
9–12	5 (6.5)	5 (9.6)	0 (0)	0.606
3–8	22 (28.6)	15 (28.8)	7 (28.0)	
ISS				
1–15	13 (16.9)	6 (11.5)	7 (28.0)	
16–24	20 (26.0)	12 (23.1)	8 (32.0)	0.025
≥ 25	44 (57.1)	34 (65.4)	10 (40.0)	
Diastase				
30–118	13 (20.6)	8 (19.5)	5 (22.7)	0.956
119–354	26 (41.3)	18 (43.9)	8 (36.4)	
≥ 355 (NL^3)	24 (38.1)	15 (36.6)	9 (40.9)	
AAST injury grade				
I or II	38 (49.4)	24 (46.2)	14 (56.0)	
III	24 (31.2)	16 (30.8)	8 (32.0)	0.496
IV or V	15 (19.5)	12 (23.1)	3 (12.0)	
Injured area of pancreas				
Head	18 (23.4)	14 (26.9)	4 (16.0)	0.471
Neck	2 (2.6)	1 (1.9)	1 (4.0)	
Body	20 (26.0)	12 (23.1)	8 (32.0)	
Tail	24 (31.2)	17 (32.7)	7 (28.0)	
Head and neck and body or tail	6 (7.8)	5 (9.6)	1 (4.0)	
Not specified	7 (9.1)	3 (5.8)	4 (16.0)	
Injury to other organs				
Yes	70 (90.9)	49 (94.2)	21 (84.0)	0.144
No	7 (9.1)	3 (5.8)	4 (16.0)	

Values are presented as number (%) or mean ± standard deviation.
MVA, Motor Vehicle Accident; CT, computed tomography; US, ultrasonography; ERCP, endoscopic retrograde cholangiography; GCS, Glasgow Coma Scale; ISS, injury severity score; NL, normal liter; AAST, American Association for the Surgery of Trauma.

Table 2. Concomitant injuries

Concomitant injury	Total (n = 77)	Adult group (≥ 18 yr; n = 52)	Pediatric group (< 18 yr; n = 25)	*p*-value[a)]
Abdominal				
Liver	42 (54.5)	34 (65.4)	8 (32.0)	0.006
Spleen	40 (51.9)	28 (53.8)	12 (48.0)	0.631
Small bowel	6 (7.8)	5 (9.6)	1 (4.0)	0.389
Duodenum	14 (18.2)	9 (17.3)	5 (20.0)	0.774
Stomach	13 (16.9)	10 (19.2)	3 (12.0)	0.428
Colon	13 (16.9)	12 (23.1)	1 (4.0)	0.036
Omentum	4 (5.2)	4 (7.7)	0 (0)	0.154
Diaphragma	9 (11.7)	7 (13.5)	2 (8.0)	0.485
Urologic				
Bladder	1 (1.3)	1 (1.9)	0 (0)	0.485
kidney	21 (27.3)	17 (32.7)	4 (16.0)	0.124
Orthopedic				
Fracture of pelvis	12 (15.6)	9 (17.3)	3 (12.0)	0.548
Extremities	13 (16.9)	10 (19.2)	3 (12.0)	0.428
Fracture of ribs	14 (18.2)	10 (19.2)	4 (16.0)	0.731
Fracture of vertebra	18 (23.4)	14 (26.9)	4 (16.0)	0.289
Fracture of skull	13 (16.9)	10 (19.2)	3 (12.0)	0.428
Head and spinal cord				
Head (ICH)	8 (10.4)	6 (11.5)	2 (8.0)	0.634
Spinal cord Injury	4 (5.2)	2 (3.8)	2 (8.0)	0.442
Thoracic				
Pneumothorax or Hemothorax	23 (29.9)	19 (36.5)	4 (16.0)	0.065
Hearth	2 (2.6)	2 (3.8)	0 (0)	0.320
Others				
Others retroperitoneal	19 (24.7)	14 (26.9)	5 (20.0)	0.509
Vascular injury	14 (18.2)	10 (19.2)	4 (16.0)	0.731

Values are presented as number (%).
ICH, intracranial hemorrhage.
[a)]Pearson chi-squared test comparison to absent of injury in the same organ.

As shown in Table 4, 59 (76.6%) patients underwent laparotomy. Of them, 12 underwent the operation mainly because of other injuries or reasons. However, during the surgery, an exploration of the pancreas and lesser sac was performed with drainage mainly. No resection was performed. The remaining 47 patients had an operative intervention on the pancreas.

Adult and pediatric groups

Adult group

In the adult group, 39 (75.0%) were males. The mean age of the adult group was 31.4 ± 14.9 years. Seventeen (32.7%) patients had penetrating trauma, of which GSW was the most common reason (n = 14). Thirty-five (67.3%) patients had blunt trauma, with MVA (n = 28) accounting for the most. As shown in Table 3, 17 (32.7%) patients were initially treated with NOM. Of them, nine (17.3%) underwent laparotomy during index hospitalization. A total of 43 (82.7%) adult patients underwent laparotomy. Table 4 shows details of procedures performed for these patients. All NOM patients were admitted to the ICU except for one patient who was admitted to the general surgery ward. The mean time to laparotomy was 14.13 ± 33.84 hours for all adults. Of note, seven (13.5%) patients who underwent laparotomy at another hospital were transferred to our center after the surgery. Thus, their time from presentation to surgery was unavailable. The average length of ICU was 15.2 ± 19.8 days (15.5 ± 24.4 days for the initial NOM). The mean LOH and ICU stay were 29.05 ± 29.17 days and 12.9 ± 19 days, respectively. Concomitant injury to the liver was seen in 34 (65.4%) of adult cases. Other parameters are summarized in Table 2 and 3.

Pediatric group

Twenty-five patients were under 18 years of age with a male predominance (n = 15, 60.0%). As in the adult group, the predominant mechanism of injury was blunt trauma (n = 21;

Table 3. Patient's outcome according to group

Clinical outcome and management	Total (n = 77)	Adult group (≥ 18 yr; n = 52)	Pediatric group (< 18 yr; n = 25)	*p*-value
Received somatostatin				0.613
Yes	13 (16.9)	8 (15.4)	5 (20.0)	
No	64 (83.1)	44 (84.6)	20 (80.0)	
Management				0.104
Operative	47 (61.0)	35 (67.3)	12 (48.0)	
Conservative	30 (39.0)	17 (32.7)	13 (52.0)	
Management				0.07
Successful conservative	16 (20.8)	8 (15.4)	8 (32.0)	
Failed conservative	14 (18.2)	9 (17.3)	5 (20.0)	
Operative management	47 (61.0)	35 (67.3)	12 (48.0)	
Time from admission to operation (h)				0.899
Mean ± SD	13.8 ± 31.09	14.13 ± 33.84	12.93 ± 22.89	
Preoperative ERCP				0.459
Yes	12 (15.6)	7 (13.5)	5 (20.0)	
No	65 (84.4)	45 (86.5)	20 (80.0)	
Intervention on the Pancreas				
Distal pancreatectomy	24 (31.2)	16 (30.8)	8 (32.0)	0.913
Whiple	2 (2.6)	2 (3.8)	0 (0)	0.320
Hemostasis[a)]	22 (28.6)	19 (36.5)	3 (12.0)	0.026
Operation in another abdominal organ				0.530
Yes	47 (61)	33 (63.5)	14 (56.0)	
No	30 (39.0)	19 (36.5)	11 (44.0)	
Blood transfusion				0.018
Yes	30 (39.0)	25 (48.1)	5 (20.0)	
No	47 (61.0)	27 (51.9)	20 (80.0)	
Length of hospital stay (day)				0.069
Mean ± SD	25.4 ± 25.43	29.05 ± 29.17	17.8 ± 12.22	
Range	1–161	1–161	2–42	
Length of ICU stay (day)				0.098
Mean ± SD	10.72 ± 16.62	12.9 ± 19	6.2 ± 8.66	
Range	0–83	0–83	0–38	
Outcome				0.203
Death	8 (10.4)	7 (13.5)	1 (4.0)	
Survive	69 (89.6)	45 (86.5)	24 (96.0)	
Complication				
Abscess	8 (10.4)	6 (11.5)	2 (8.0)	0.634
VAP	4 (5.2)	2 (3.8)	2 (8.0)	0.442
Renal failure	6 (7.8)	5 (9.6)	1 (4.0)	0.389
Liver failure	2 (2.6)	1 (1.9)	1 (4.0)	0.592
Seizure	1 (1.3)	0 (0)	1 (4.0)	0.147
Fever	26 (3.8)	22 (42.3)	4 (16.0)	0.022

Values are presented as number (%).
SD, standard deviation; ERCP, endoscopic retrograde cholangiography; ICU, intensive care unit.
[a)]One case had angiographic embolization only.

84.0%), with MVA accounting for 56.0% (n = 14). AAST grades I/II, III, and IV/V had 14 (56.0%), 8 (32.0%), and 3 (12.0%) cases, respectively (Table 1). The most commonly injured organ in the pediatric group was the spleen in 12 (48.0%) cases. The second-most common injured organ was the liver (n = 8, 32.0%) (Table 2).

Table 4. Concomitant operation on other organs

Intervention	Total (n = 77)	Adult group (≥ 18 yr; n = 52)	Pediatric group (< 18 yr; n = 25)	*p*-value
Laparotomy	59 (76.6)	43 (82.7)	16 (64.0)	0.07
Emergency thoracotomy	4 (5.2)	4 (7.7)	0 (0)	0.154
Splenectomy	26 (33.8)	19 (36.5)	7 (28.0)	0.458
Nephrectomy	9 (11.7)	8 (15.4)	1 (4.0)	0.145
Hemicolectomy	8 (10.4)	6 (11.5)	2 (8.0)	0.634
Small bowel resection	2 (2.6)	2 (3.8)	0 (0)	0.320
Suture of liver	11 (14.3)	9 (17.3)	2 (8.0)	0.274
Ligation of spleen	1 (1.3)	1 (1.9)	0 (0)	0.485
Repair of stomach	9 (11.7)	7 (13.5)	2 (8.0)	0.485
Repair of vessel	8 (10.4)	4 (7.7)	4 (16.0)	0.263
Repair of duodenum	1 (1.3)	0 (0)	1 (4.0)	0.147
Repair of kidney	1 (1.3)	0 (0)	1 (4.0)	0.147
Resection of stomach	3 (3.9)	3 (5.8)	0 (0)	0.221
Repair of small bowel	5 (6.5)	3 (5.8)	2 (8.0)	0.710
Repair of ureter	1 (1.3)	1 (1.9)	0 (0)	0.485
Repair of colon	3 (3.9)	2 (3.8)	1 (4.0)	0.974
Ileocolic resection	2 (2.6)	2 (3.8)	0 (0)	0.320
Repair of diaphragm	7 (9.1)	5 (9.6)	2 (8.0)	0.817
Ileostomy	2 (2.6)	2 (3.8)	0 (0)	0.320

Values are presented as number (%).

Comparison between adult and pediatric groups

Sex distribution was similar between adult and pediatric groups. There was a male predominance in both groups. There was no significant difference in the mechanism of injury or the blunt mechanism between the two groups. MVA was the most common injury mechanism in both groups. However, the mean ISS was significantly different between adult and pediatric groups. Most adults (n = 34; 65.4%) had ISS over 25 whereas only ten (40.0%) had ISS over 25 in the pediatric group (p = 0.025). Other parameters were not significantly different between the two groups (Table 1).

As shown in Table 2, the most common concomitantly injured organ in adults was the liver (n = 34; 65.4%), followed by the spleen (n = 28; 53.8%). In the pediatric group, injury to the liver and spleen occurred in 8 (32.0%) and 12 (48.0%) patients, respectively. The difference in incidence of liver injury was significant (p = 0.006) between adult and pediatric groups. Concomitant injury to the colon occurred more often in the adult group (n = 12; 23.1%) than in the pediatric group (n = 1; 4.0%) (p = 0.036).

Successful NOM was seen in 8 of 25 pediatric patients (32.0%) and 8 of 52 adult patients (15.4%) (p = 0.07). Adults were more likely to receive blood transfusion than pediatric patients: 25 of 52 adults (48.1%) vs. 5 of 25 pediatric patients (20.0%) (p = 0.018; Table 3). Most adults (43 of 52; 82.7%) underwent laparotomy as did pediatric patients (16 of 25; 64%) (p = 0.07). The distribution of remaining surgical tasks was not significantly different between adult and pediatric groups (Table 4).

Subgroup analysis of NOM cases

Of 30 cases with NOM, successful NOM was observed more commonly in males than in females (12 of 17 males [70.6%] vs. 4 of 13 females [30.85%], p = 0.03). NOM was successful in 8 of 13 pediatric patients (61.5%) and 8 of 17 adult patients (47.1%) (p = 0.431). An independent predictor factor for a failed NOM was AAST score III or IV. Failed NOM was seen in all 9 (100%) cases with AAST grade III injuries, 2 of 3 cases (66.7%) with AAST grade IV injuries, and 3 of 18 cases (16.7%) with grade I/II injuries (p = 0.001). Importantly, 85.7% (6 of 7) of patients with ISS of 1–15 had successful NOM versus 46.2% (6 of 13) or 40.0% (4 of 10) of those with ISS of 16–24 or ≥ 25, respectively (p = 0.083). All other factors were not significantly different between the two groups (Table 5). All patients with NOM either failed or were successfully discharged without death.

DISCUSSION

TPI is an elusive diagnosis that can be easily overlooked. Nevertheless, it is a diagnosis that harbors a bad prognosis for the patient. Therefore, immediate and appropriate management is the key [6]. The current study investigated outcomes of various management options and compared conservative and operative management outcomes.

In accordance with other studies, this study showed that the leading mechanism of pancreatic injuries was blunt injury, with MVA being the most common. The pancreas is crushed

Table 5. Subgroup analysis of 30 cases that received conservative management

Characteristic	Factors	Frequency (n)	Successful NOM	Failed NOM	*p*-value
Age (yr)	< 18	13	8 (61.5)	5 (38.5)	0.431
	≥ 18	17	8 (47.1)	9 (52.9)	
Sex	Male	17	12 (70.6)	5 (29.4)	0.03
	Female	13	4 (30.8)	9 (69.2)	
AAST Grade of injury	I or II	18	15 (83.3)	3 (16.7)	0.001
	III	9	0 (0)	9 (100)	
	IV	3	1 (33.3)	2 (66.7)	
Injured area	Head or neck	6	5 (83.3)	1 (16.7)	0.188
	Body or tail	19	8 (42.1)	11 (57.9)	
	All the pancreas	3	2 (66.7)	1 (33.3)	
	Not detected	2	1 (50.0)	1 (50.0)	
Blood transfusion	No	22	12 (54.5)	10 (45.5)	0.825
	Yes	8	4 (50.0)	4 (50.0)	
Diastase	30–118	6	6 (100)	0 (0)	
	119–354	8	1 (12.5)	7 (87.5)	0.221
	≥ 355 (NL^3)	15	8 (53.3)	7 (46.7)	
Mechanism of injury	Penetrating	1	0 (0)	1 (100)	0.277
	Blunt	29	16 (55.2)	13 (44.8)	
GCS	13–15	25	14 (56.0)	11 (44.0)	0.513
	3–8	5	2 (40.0)	3 (60.0)	
ISS	1–15	7	6 (85.7)	1 (14.3)	
	16–24	13	6 (46.2)	7 (53.8)	0.083
	≥ 25	10	4 (40.0)	6 (60.0)	
Injury to other organs	No	6	4 (66.7)	2 (33.3)	0.464
	Yes	24	12 (50.0)	12 (50.0)	
ERCP	Didn't	21	13 (61.9)	8 (38.1)	0.151
	Did	9	3 (33.3)	6 (66.7)	
Discharged to	Home	25	14 (56.0)	11 (44.0)	
	Other's hospital	1	1 (100)	0 (0)	0.348
	Rehabilitation	4	1 (25.0)	3 (75.0)	
Survival	Survive	30	16 (53.3)	14 (46.7)	
	Death	0	0 (0)	0 (0)	

Values are presented as number (%).
NOM, non-operative management; AAST, American Association for the Surgery of Trauma; NL, normal liter; GCS, Glasgow Coma Scale; ISS, injury severity score; ERCP, endoscopic retrograde cholangiography.

between the steering wheel and the first and second vertebra [6,18].

Our study detailed conservative versus operative treatment. Our data showed that conservative management was relatively successful, especially in grade I and II pancreatic injuries. However, operative management was consequently needed in 14 of 30 patients. Such cases were mainly defined as grades III and IV. In addition, no deaths were reported in the conservative group. However, previous studies showed higher rates of mortality following conservative treatment [19]. This might be due to a relatively small study population analyzed in the current study. These findings might be misguiding since the vast majority of pancreatic injuries are concomitant with other organ injuries. Only 9.1% of cases have isolated pancreatic injuries, making it especially challenging to isolate the effect of pancreatic injuries on patients' outcomes per se. However, our study showed that conservative treatment was especially successful in low grade ASST and in pediatric patients. In addition, pediatric patients were less likely to have laparotomy than adult patients. This might be related to the fact that adult patients were more likely to be involved in penetrating trauma such as gunshot and stab wound.

Operative treatment included distal pancreatectomy, the Whipple procedure, and hemostasis and drainage. Distal pancreatectomy was the most frequent operation. In general, operative management showed higher mortality rates in our study along with a number of previous studies that similarly found higher mortality rates, especially in patients who had higher grades of injuries [19]. This might be explained by the fact that higher ASST score usually implies more concomitant organ injuries, higher ISS, and subsequently worse outcomes regardless whether the injury is directly related to the pancreas or not. This shows the importance of a multidisciplinary team in making decisions.

As addressed in recent reports, there is a huge controversy on whether to manage pancreatic trauma surgically or conservatively [12-14]. Thus, prompt and reasonable decision-making is still at the top of the list because no rigorous guidelines have been published on this issue.

Early clinical imaging of pancreatic injury may be subtle. Thus, the history and mechanism of injury should be strictly obtained. The current study found that amylase levels were normal in 20.6% of cases and minimally elevated (two-fold) in 41.3% of cases. Thus, we could conclude that amylase was not sensitive enough to detect pancreatic injury or its severity. This is because amylase levels are not usually sufficiently elevated within the first six hours of injury if at all. This finding is consistent with previous studies [8].

Several diagnostic modalities have been used to assess the severity of pancreatic injuries. In the present study, CT was used when pancreatic injuries were suspected along with other abdominal injuries. However, the accuracy of this modality depends on findings themselves. Peripancreatic fluid is highly sensitive but not specific for pancreatic injury. Pancreatic lacerations and hemorrhage in CT are less sensitive but more specific finding for TPI [20].

ERCP was also used in special cases when other diagnostic modalities had failed to assess the pancreatic duct status. Thus, it has a therapeutic role where a stent can be inserted. In our study, 15.6% of patients underwent an ERCP [21].

Finally, our study found higher failure rates of NOM in those with a female sex, those aged less than 18 years, those with AAST scores III and IV, and those with a high ISS. However, the pediatric subgroup showed significantly a higher success rate following conservative treatment than the adult group. This finding is consistent with a study by Mora et al. [14]. The higher rate of failure of NOM in female patients found in this study should be very carefully interpreted because of the small number of female patients used in this study.

Limitation of study

This was a retrospective study with a relatively small number of patients. It included all trauma patients with a pancreatic injury regardless of the mechanism of injury or concomitant injuries. Obviously, the more severe the mechanism of injury, the more the risk of having concomitant injuries, the more chance of needing a surgery, and the higher the mortality. Thus, it was difficult to determine the exact effect of pancreatic injury on a patient's outcome taking into consideration the design of our study and the diversity of the type of pancreatic injuries in this study. Another limitation of the current study was the low number of high-grade injuries.

In conclusion, TPI is a diagnosis that needs a high index of suspicion. It should be considered in any traumatic abdominal injuries. This study has one of the largest pediatric and adult cases of TPI presented in the literature. Results of this study suggest that conservative treatment of high AAST grade TPI is associated with a high rate of failure regardless of the age group. These findings might be misguiding since the vast majority of pancreatic injuries are concomitant with other organ injuries while only 9.1% of cases have isolated pancreatic injuries. This makes it especially challenging to isolate the effect of a pancreatic injury on a patient's outcome per se.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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