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Associated organ injuries in pancreatic injuries, morbidity, and mortality

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Aim: Pancreatic injuries are rarely seen due to the retroperitoneal location of the organ. Associated organ and vascular structures usually accompany injury. In this study, the effect of ductal injury and associated organ injuries on morbidity and mortality was investigated.

Materials and methods: Between January 2004 and October 2010, 26 patients with abdominal trauma who developed pancreatic injury and underwent surgery at the Dicle University General Surgery Department were evaluated retrospectively.

Results: Of the 26 patients, 20 were males (76.9%) and 6 (23.1%) were females. The mean age of the patients was 24.96 ± 9.4 (14-56) years. Of the injuries, 21 (80.8%) were related to penetrating trauma and 5 (19.2%) were related to blunt trauma. Of the patients, 6 (23.1%) were stage I, 12 (46.2%) were stage II, 5 (19.2%) were stage III, and 3 (11.5%) were stage IV The most commonly injured associated organs were the stomach (50%) and vascular structures. Eighteen patients underwent primary suturing, 5 underwent distal pancreatectomy, 3 underwent Roux-en-Y pancreaticojejunostomy., Common postoperative complications included intraabdominal abscess and pancreatic fistula. Mortality occurred in 3 (11.5%) patients, 2 of them due to hemorrhagic shock resulting from vascular injury and 1 of them as a result of fistula-induced sepsis and multi-organ failure.

Conclusion: A good exploration should be done in all abdominal traumas, remembering that pancreatic injury could occur. Mortality may increase during the early period in patients who have vascular injuries. Morbidity and late mortality may increase in patients with ductal injuries.

Key words: Pancreatic ductal injury, associated organ injury, morbidity, mortality

Pankreas yaralanmalarında yandaş organ yaralanmaları, morbidite ve mortalite

Amaç: Pankreasta duktal yaralanma ve yandaş organ yaralanmalarının morbidite ve mortaliteye etkisini araştırmak.

Yöntem ve gereç: Ocak 2004-Ekim 2010 tarihleri arasında Dicle Üniversitesi Tıp Fakültesi Genel Cerrahi Anabilim Dalında karın travmalarına bağlı pankreas yaralanması gelişen ve cerrahi uygulanan 26 olgu retrospektif olarak değerlendirildi.

Bulgular: Yaralanmaların 21'i (% 80,8) penetran, 5'i (% 19,2) künt travmaya bağlı idi. Hastaların 6'sı (% 23,1) evre I, 12'si (% 46,2) evre II, 5'i (% 19,2) evre III ve 3'ü (% 11,5) evre IV`den oluşuyordu. En sık yaralanan yandaş organ 13 olgu (% 50) ile mide ve vasküler yapılardı. Dört olgu izole idi. Onsekiz olguya primer sütur, hemostaz ve drenaj, 5'ine distal pankreatektomi, 3'üne Roux-en-Y pankreatikojejunostomi uygulandı. Postoperatif en sık intraabdominal apse ve pankreatik fistül gelişti. Bu çalışmada 2 hasta vasküler yaralanmaya bağlı hemorajik şoktan, bir hasta da pankreatik fistüle bağlı sepsis ve çoklu organ yetmezliğinden olmak üzere toplam 3 (% 11,5) hastada mortalite gelişti.

Sonuç: Karın yaralanmalarında nadir de olsa pankreas hasarı olabileceği akılda tutularak iyi bir eksplorasyon yapılmalıdır. Vasküler yaralanmaların eşlik ettiği yaralanmalarda erken dönemde mortalite artabilir. Duktal yaralanmaların olduğu hasta grubunda ise morbidite ve geç dönemde mortalite artabilir.

Anahtar sözcükler: Pankreas duktal yaralanma, yandaş organ yaralanması, morbidite, mortalite

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Introduction

Pancreatic injury is infrequent following blunt or penetrating abdominal trauma (1). The rate of pancreatic injury in abdominal trauma is 3%-12% (2). Nearly two-thirds of the injuries are the penetrating type (3). The rates of morbidity and mortality in pancreatic injuries are high because it is an area with major vascular structures (aorta abdominalis, vena porta, vena cava inferior, vena splenica, and left renal artery) frequently associated organ injuries, and the retroperitoneal location of the organ (4-6). Whether the injury involves pancreatic ducts or not is an important factor for complications (7). The diagnosis of a penetrating pancreatic injury is usually made intraoperatively (1). In this study, we aimed to study the effect of ductal injury and associated organ injuries on mortality and morbidity in pancreatic injury patients who underwent surgery in our clinic.

Materials and methods

Of 1187 patients who presented to the Dicle University Medical Faculty, Department of General Surgery due to abdominal trauma, between January 2004 and October 2010, 744 had penetrating injuries and 443 had blunt injuries. The records of 26 patients who presented with penetrating and blunt pancreatic injuries and received surgical treatment were analyzed retrospectively. While penetrating injuries of the pancreas occur due to gunshot and stab wounds, blunt traumas occur due to traffic accidents, falls, and blows to the abdomen. Staging of the pancreatic injuries was done based on the pancreatic organ injury scale of the American Association for the Surgery of Trauma (Table 1) (8). Age, gender, injury type, hospital admission times, interval between injury and operation, preoperative diagnostic methods, severity of injury, associated organ injuries, injury severity score (ISS), applied surgical method, morbidity, and mortality were investigated. All of the patients who presented with gunshot wounds and stab wounds were operated on under emergent conditions. Hemogram, biochemistry, and serum amylase levels were studied and a posteroanterior (PA) chest X-ray was obtained for the patients who were admitted with blunt abdominal trauma. Additionally, ultrasonography (US) and computed tomography (CT) were performed. Subjects whose systolic blood pressure was below 90 mmHg on admission and who did not respond to an infusion of 2 L of crystalloid solution and a blood transfusion of more than 2 L within 2 h, were regarded as hemodynamically unstable (6). The US and CT were repeated within the first 48 h in patients who were suspected of having an isolated pancreatic injury, clinically or radiologically. The decision to operate was made based on peritonitis and/or CT results. One patient underwent primary suturing and drainage due to an isolated pancreatic injury in another medical center and he was operated on after a follow-up. All of the patients were given adequate fluid replacement, total parenteral nutrition, and somatostatin during the postoperative period. The serum amylase activity was examined for more than 10 days following the operation with drainage of more than 50 mL of fluid in 24 h and an amylase content of more than 3 times the serum amylase activity (9).

Table 1. Pancreatic organ injury scale of the American Association for the Surgery of Trauma (8).

Stage	Description
I	Hematoma minor contusion without duct injury Laceration superficial laceration without the duct injury
II	Hematoma major contusion without duct injury or tissue loss Laceration major laceration without the duct injury or tissue loss
III	Laceration distal transaction or parenchymal injury with duct injury
IV	Laceration proximal (to the right of the superior mesenteric vein) transaction or parenchymal injury
V	Laceration massive disruption of pancreatic head

Statistical analysis

SPSS 15.0 for Windows was used for statistical analysis. Student's t-test and chi-square test were used, as well as descriptive statistical methods (mean, standard deviation), for assessment of the data. $P < 0.05$ was considered statistically significant.

Results

Patient characteristics

Of the 26 patients, 20 (76.9%) were males and 6 (23.1%) were females. The mean age of the patients was 24.9 ± 9.4 (14-56) years. Sixteen (61.5%) patients were admitted to the emergency room with gunshot wounds, 5 (19.2%) with stab wounds, and 5 (19.2%) with blunt abdominal trauma (3 traffic accidents, 1 fall, and 1 beating). Of the patients admitted with blunt abdominal trauma, 4 were isolated. According to the pancreatic organ injury scale, 6 (23.1%) patients were stage I, 12 (46.2%) were stage II, 5 (19.2%) were stage III, and 3 (11.5%) were stage IV. The mean ISS value of the patients was 23.6 ± 9.8 (9-50).

Associated organ injuries

Associated organ injury was detected in 22 patients (84.6%). The mean number of associated organ injuries was 2.7 (0-7). The most commonly seen associated intraabdominal organ injuries were stomach, vascular structures (aorta abdominalis, left renal artery), and liver (Table 2). Extraabdominal injuries were detected in a total of 9 patients (6 thorax injuries, 2 upper extremity injuries, and 1 cardiac injury). No statistically significant relationship was detected between the number of injured organs and morbidity and mortality ($P > 0.05$).

Table 2. Associated intraabdominal organ injuries.

Organ	Number	%
Gastric	13	50
Vascular	13	50
Liver	10	38.5
Duodenal	8	30.8
Bowel	5	19.2
Spleen	5	19.2
Kidney	5	19.2
Small intestine	3	11.5
Diaphragmatic	3	11.5
Common bile duct	3	11.5
Gallbladder	2	7.7

Admission times and clinical view

The mean hospital admission time was 1.6 ± 4.6 (0.5-24) h. Twenty-one patients with penetrating injury were operated on immediately after admission because of hemodynamic instability. One patient with blunt injury was operated on after 3 h of follow-up because of hemodynamic instability. The remaining 4 patients with blunt injury were hemodynamically stable and had isolated pancreatic injuries. These patients were operated on 6, 36, 24, and 24 h after admission, respectively, because of peritonitis and/or CT results. The relationship between admission time and morbidity and mortality was not statistically significant ($P > 0.05$).

Serum amylase level

Serum amylase levels could not be studied preoperatively in 22 patients, as they were operated on within a very short time of admission, because of hemodynamic instability. It was measured in 4 out of 5 patients with blunt trauma. The amylase levels were initially normal in 2 patients. The first patient was operated on at 6 h based on physical examination and CT results. Gradual elevation of the amylase level was detected in the follow-up of the second patient. The amylase level was detected as high when the remaining 2 patients arrived at 24 h.

Imaging methods

Twenty-one patients underwent urgent laparotomy without imaging methods because of gunshot wounds and/or stab wounds, related hemodynamic instability, and/or associated organ injuries. US and CT were performed in 5 patients with blunt abdominal trauma. Free fluid and associated organ injury were detected in the US and CT in 1 patient. He was operated on after 3 h because of peritonitis and hemodynamic instability. Only intraabdominal free fluid was detected in the US in the other 4 patients and ductal injury was detected in the CT in all of the patients. In these 4 patients, the decision to operate was given based on peritonitis and CT results.

Surgical treatment

The mean interval between admission and operation of the patients was 4.6 ± 8.9 (0.5-36) h. Diagnosis of pancreatic injury was made intraoperatively, as laparotomy was performed in 22 patients because of hemodynamic instability and associated organ injury. In this study, primary suturing, hemostasis, and drainage were performed in 18 patients, 5 patients underwent distal pancreatectomy, and 3 patients underwent Roux-en-Y pancreaticojejunostomy (Table 3).

Postoperative period

The mean duration of hospital stay was 13.3 ± 9.4 (1-44) days. The duration of hospital stay was 9.8 ± 4.6 days in patients who did not develop complications, while it was 19.8 ± 12.7 days in patients who did develop complications. The relationship between duration of hospital stay and complications was statistically significant ($P < 0.05$). Total morbidity was 34.6%. Complications developed in 3 of 18 patients (16.7%) in stages I-II, and 6 of 8 patients (75%) in stages III-IV. This was statistically significant ($P < 0.05$) (Table 4). Mortality occurred in 3 (11.5%) patients because of vascular structure (aorta abdominalis and left renal artery) injury-related hemorrhagic shock, and 1 patient died because of pancreatic fistula-related sepsis and multiorgan failure (Table 5). Exocrine and endocrine insufficiencies were not seen at the 1- and 3-month check-ups of 8 patients who underwent resection.

Table 3. Number of patients, stage, and surgical procedures.

Stage	Number	%	Surgical procedures
I	6	23.1	Primary suture + hemostasis + drainage
II	12	46.2	Primary suture + hemostasis + drainage
III	5	19.2	Distal pancreatectomy
IV	3	11.5	Roux-en-Y pancreaticojejunostomy
V	None	None	None

Table 4. Complication, stage, and associated organ injury.

Abscess 3 (11.5%)	Stage	Associated organ injury
patient 1	III	Vascular, liver, small intestine
patient 2	III	Isolated
patient 3	IV	Vascular, liver, duodenal, small intestine, kidney
Pancreatic fistula 2 (7.7%)		
patient 1	III	Isolated
patient 2*	IV	Isolated
Pulmonary 2 (7.7%)		
patient 1	IV	Gastric, vascular, colon
patient 2	I	Gastric, vascular
Wound infection 2 (7.7%)		
patient 1	II	Gastric, liver, colon
patient 2	II	Gastric, liver, duodenal, colon, small intestine

*Ileus developed in this patient.

Table 5. Demographic and clinical characteristics of patient mortality.

Patient	Age	Sex	Mechanism of trauma	Time to surgery (h)	Associated injuries	Stage	Causes of mortality	Duration of mortality improvement (day)
1	18	Female	Gunshot	0.5	Aorta, liver, duodenal, gastric	II	Hemorrhagic shock	1
2	16	Male	Stab wound	0.5	Aorta, adrenal artery, renal artery, gastric	II	Hemorrhagic shock	1
3	28	Male	Blunt	24	Isolated	III	Fistula and sepsis	44

Discussion

Penetrating injuries of the pancreas may occur due to gunshot and stab wounds. Blunt traumas occur due to traffic accidents, a blow to the abdomen, or falls. While pancreatic injuries are related to penetrating injuries at a rate of 39%-79% in North America and 78%-85% in South Africa, they are related to blunt traumas in Europe at a rate of 81.8% (10). Pancreatic injuries are more commonly reported in young adults due to a thinner layer of protective fatty tissue, which forms a protective cushion in the retroperitoneal area (11,12). In this study, the mean age of the patients was 24.9 years and 80.8% of the patients had penetrating injuries. The high frequency of cases in young and middle-aged people may be related to the popularity of carrying guns in this region of the country. Pancreatic injury was seen at a rate of 1.1% and 0.2% in penetrating and blunt traumas, respectively. Isolated pancreatic injuries are rarely seen and were reported to constitute 3%-10% of pancreatic injuries (13). In this study, the rates of penetrating and blunt traumas to all of the abdominal traumas were 2.8% and 1.1%, respectively. This rate of 15.4% for isolated pancreatic injuries was striking.

Pancreatic injuries are seen with associated organ injury at a rate of 50%-98% and hemodynamic and clinical findings related with this may suppress the clinical view of pancreatic injury. The stomach and liver were the organs most commonly injured. Thus, pancreatic injuries may be missed (14,15). Of the patients in this study, 84.6% were operated on because of unstable hemodynamics and/or clinical findings. Pancreatic injury could only be detected intraoperatively**.** The most common associated organ injuries were stomach and vascular structures (50%).

US is the first choice diagnostic method in abdominal traumas. Being able to perform it bedside and giving information about the presence of intraabdominal free fluid and associated organ injuries are important advantages. However, US is not very useful for diagnosis because of the retroperitoneal location of the organ (16). CT may evaluate the pancreas well, as well as the solid organs in hemodynamically stable patients, and is valuable when making the decision to operate. CT is reported to visualize ductal injuries at a rate of 68%-100% (16-18). Detection of fluid in the bursa omentalis, extraperitoneal fluid accumulation, edema or hematoma in the pancreas, thinning in the anterior renal fascia or fluid in the anterior pararenal space, and fluid accumulation in the tissues between the splenic vein and pancreas parenchyma are findings suggestive of pancreatic injury on CT (6). The success rate of CT repeated after 24 h is reported to be higher due to fluid accumulation and edema development around the pancreas (19). Ductal injury should be suspected if parenchymal laceration is more than 50% on CT; nevertheless, ductal injury may be observed even in minor injuries. Thus, CT should be repeated in suspected cases and the cases with continuing symptoms (20). Preoperative US and CT could not be performed in 21 patients who were operated on under emergent conditions because of penetrating injuries. US and CT were performed in 5 stable patients. One patient was operated on because of associated organ injury, peritonitis findings, and

unstable hemodynamics. The remaining 4 patients had isolated pancreatic injury. Isolated pancreatic injury may not exhibit signs in the early period (21). It was reported that serum amylase levels were not diagnostic within the first 3 h following trauma and were more significant after 3 h (22-24). Additionally, a correlation was not found between pancreatic ductal injury and serum amylase levels (16). Serum amylase levels were normal in 2 patients initially; however, CT showed a diagnosis of isolated pancreatic injury in 4 patients. It was decided to perform a laparotomy based on isolated pancreatic injuries, peritonitis findings, and/or CT findings.

The primary treatment strategy for pancreatic injury is bleeding control and prevention of contamination. The strategy of pancreas surgery is determined according to parenchymal injury, ductal injury, and location (25,26). Treatment is primary suturing and drainage if the injury does not involve ductal injury (stages I-II) and distal pancreatectomy is recommended if the ductal injury is on the left side of the vena mesenterica superior (VMS) (stage III). The spleen was preserved in 44% of the patients. Pancreaticojejunostomy is performed in order to prevent exocrine and endocrine insufficiency if the injury is on the right side of the VMS (stage IV) and more than 90% resection is required; if the general condition and performance of the patient is good, pancreaticoduodenectomy is performed for injuries localized in the head of the pancreas; if the patient is considered not to tolerate the operation, damage control surgery is performed (27-29). In the present study, primary suturing and drainage were applied to a total of 18 patients in stages I-II, 5 patients in stage III underwent distal pancreatectomy, and 3 patients in stage IV underwent pancreaticojejunostomy.

In retrospective studies, somatostatin and its analogue octreotide were reported to reduce the flow-rate of pancreatic fistula (30). In this study, 18 patients in stages I-II were not given somatostatin. A total of 8 patients in stages III-IV were administered intravenous somatostatin infusion for 7 days postoperatively. Fistula development was prevented in 6 patients. We think that the number of patients was too small to be able to make a comment about somatostatin treatment, in spite of the high rate (75%) of success in our clinic.

Pancreatic injury-related morbidity varies between 34% and 45% (6). Complications like fistula, abscess, pancreatitis, pseudocyst, and endocrine and exocrine insufficiency may be seen in pancreatic injuries (25,31,32). Pancreatic fistula is the most common complication and usually emerges in injuries close to the head of the pancreas. It closes spontaneously after between 2 weeks and 2 months (33). Morbidity was found in 34.6% of the patients. Ultrasound-guided drainage was performed for abscess formations in 3 of the patients. One of the fistulas closed spontaneously 3 weeks later. The other patient died because of sepsis. In pancreatic injury-related pancreatitis, endogenous septicemia may develop secondary to bacterial translocation (34). We consider that this mechanism was effective in the patient that developed sepsis-related mortality as well. Athelectasis and pneumonia developed in 2 patients and was resolved with medical treatment. A cure was obtained with medical treatment in 2 patients with wound infections and in 1 patient with ileus. Exocrine and endocrine insufficiencies were not seen in patients that underwent pancreas resection.

Mortality is between 16% and 24% in pancreatic injuries (6). Vascular injuries cause 67%-92% of deaths in the first 24-48 h, while the most important cause of mortality in the late period is incomplete control of ductal injuries and related sepsis, and multiorgan insufficiency (25,35). The mortality rate was 11.5% in our series. Of the 3 patients with gunshot wound-related aorta and renal artery bleeding, 2 developed shock and hemodynamic instability. One of the patients died intraoperatively and another died at 12 h postoperatively, while the other patient had undergone primary suturing, as the ductal injury had not been recognized at another medical center. Pancreatic fistula and abscess developed in this patient during the follow-up. Resection could not be performed because of abscess formation and, in the second operation, drainage was performed. However, redrainage was performed because of abscess formation. The patient died on the 44th day due to sepsis and multiorgan failure.

In conclusion, pancreatic injury is rare and usually accompanies other organ injuries and

vascular injuries. Thus, a good exploration should be done in all laparotomies, remembering that a pancreatic injury may have occurred. Mortality may increase in the early period in patients with vascular injuries such as aorta abdominalis and the left renal artery. On the other hand, morbidity and mortality in the late period may increase in patients with ductal injuries.

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