

Surgical Management of Traumatic Transection of the Pancreas:

Review of Nine Cases and Literature Review

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PANCREATIC injuries from external trauma occur relatively infrequently (1 to 2 per cent of abdominal wounds²¹). Complete transection of the pancreas, either as an isolated injury or associated with other intraabdominal injuries, is rare. It poses difficulties in surgical management, however, because access of the organ is limited and associated injuries are frequent.

This report presents nine patients treated in St. Louis, Missouri, in a 15-year period for complete transection of the pancreas.

Historic Review

Forty-seven cases of traumatic transection of the pancreas have been collected from the literature and are summarized in Table 1.

The earliest recorded case of pancreatic injury was reported by Travers⁴² in 1827. A woman struck down by the wheel of a stage coach had a hepatic laceration and a completely divided pancreas at postmortem examination. The first instance of complete rupture as an isolated lesion was reported by Jaun²⁴ in 1856. Until 1900 the treatment of abdominal injuries was "expectant" and of nine reported cases of pancreatic transections only two patients underwent exploratory operations. All nine patients failed to survive.

In 1905, Garré¹⁶ reported the first successful treatment of a patient with a totally transected pancreas. The torn edges of the organ were sutured with fine silk and a gauze pack placed. The patient developed

a fistula which closed spontaneously 6 weeks postoperatively. In following years pancreatic fistulas usually followed operative manipulation but patient survival increased.

Newton³² initiated an era of more definitive treatment in 1929 by attempting a direct end-to-end anastomosis of the divided pancreatic duct and capsule. A pseudocyst subsequently developed, requiring treatment by marsupialization. Pellegrini and Stein³³ reported the primary successful repair of the duct of Wirsung in 1961. Their patient developed pancreatitis 6 weeks after operation but remained asymptomatic after it subsided.

Walton⁴⁷ (1930) recommended the complete removal of the separated body and tail and careful suture of the divided stump of the neck. This method has been used successfully by Hannon and Sprafka,¹⁷ Blandy,³ Fogelman,¹⁵ Sturim⁴¹ and Weitzman.⁴⁷

Pancreatic-enteric anastomosis has been suggested by several authors. A pancreatogastrostomy was used in a single case by Bracey⁴; Letton and Wilson²⁰ reported two cases of complete transection of the pancreas treated with an enteric Roux-Y anastomosis to the distal fragment. Jones and Shires²⁵ sutured both ends of the transected pancreas into the jejunum by a Roux-en-Y anastomosis. These technics allow preservation of pancreatic tissue while providing internal drainage of pancreatic secretions.

Doubilet and Mulholland⁸ recommend intubation of the pancreatic duct and concurrent sphincterotomy as an adjunct to other methods of treatment to overcome the

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TABLE 1. Reported Cases of Complete Traumatic Transection of the Pancreas

Case	Author	Date	Sex	Age	Injury	Operation	Complications	Results
1	Travers ²²	1827	F	—	Struck by coach	—	—	Died 2-3 hours
2	Jaun ²⁴	1856	M	50	Assaulted, kicked	—	—	Died after 18 hours
3	Wilks & Moxon ⁴⁸	1875	M	16	Crushed	—	—	Died
4	Wagstaff ⁴⁶	1895	M	—	Fell off cart	—	—	Died after 4 days
5	Villiere ⁴⁴	1895	M	20	Struck by wheel of machine	Laparotomy	—	Died 24 hours
6	Mayo-Robson ³⁰	1897	M	37	Crushed between 2 vans	—	—	Died 3 days post injury
7	Stern ³⁹	1899	M	37	Crushed	Laparotomy	—	Died 5th postop. day
8	Kolaczek ²⁷	1899	M	37	Run over	—	—	Died
9	Simmonds ³⁷	1902	M	51	Run over	—	—	Died 5th day
10	V. Schneider ³⁵	1904	M	18	Struck by wagon pole	Tapon after 64 hours	—	Died 5th day
11	Garró ¹⁶	1905	M	24	Crushed between cars	Sutured	Fistula	Recovered
12	Heinecke ¹⁸	1907	M	34	Crushed	Sutured with catgut 4 hours post trauma and packed	Fistula	Recovered
13	Heinecke ¹⁸	1907	M	36	Crushed	Laparotomy 36 hours post trauma	—	Died
14	Hohmeier ¹⁹	1907	F	35	Struck by wagon pole	Sutured with catgut 1½ hours post trauma	—	Recovered
15	Newton ³²	1929	M	30	Crushed	End-to-end anastomosis and drained	Pseudocyst	Recovered
16	Fast ¹²	1930	F	20	Auto accident, pseudocyst 8th day	Laparotomy 8th day	Fistula	Recovered
17	Brown & Barlow ⁵	1932	M	44	Run over	Pancreas reapproximated with sutures	Fistula	Recovered
18	Ransom ³⁴	1932	M	28	Fight	Suture, packs drainage	Shock	Died 24 hours postop.

TABLE 1. (Continued)

Case	Author	Date	Sex	Age	Injury	Operation	Complications	Results
19	Venable ⁶	1932	M	56	Crushed	Unsuccessful attempt to suture gland	Shock	Expired 38 hours postop.
20	Curr ⁷	1945	M	44	Crushed	Suture closure of the divided ends, packed	Fistula	Recovered
21	Flavell ¹⁴	1947	M	28	Fall	Suture & drainage	Fistula & cyst	Recovered
22	Smith ³⁸	1948	M	25	Crushed	Suture of capsule, reapproximation of gland	Pseudocyst	Recovered
23	Becker ²	1954	M	36	Auto accident	Sutured, drained	Fistula	Recovered
24	Burnett ⁶	1955	M	20	Football injury	Laparotomy 30th hour, drainage	Fistula	Recovered
25	Kinnaird ²⁶	1956	M	21	Crushed	Distal pancreatectomy, splenectomy	Massive hemorrhage on 8th postop. day following use of anticoagulants	Died 8th day
26	Hannon & Sprafka ¹⁷	1957	M	3	Auto accident	Body and tail of pancreas excised, splenectomy	—	Recovered
27	Hannon & Sprafka ¹⁷	1957	M	9	Fall	Caudal pancreatectomy, splenectomy	—	Recovered
28	Hannon & Sprafka ¹⁷	1957	F	32	Beaten up	Distal pancreatectomy, splenectomy	—	Recovered
29	Blandy ³	1959	M	22	Kicked in abdomen	Pancreas reapproximated with sutures and drained	Fistula	Recovered
30	Letton & Wilson ²⁹	1959	F	20	Auto accident	Roux-en-Y pancreaticojejunostomy	—	Recovered
31	Letton & Wilson ²⁹	1959	F	10	Fall	Roux-en-Y pancreaticojejunostomy	—	Recovered
32	Doublet ⁸	1959	M	21	Stab wound	Transudodenal sphincterotomy, cannulation of pancreatic duct distal segment	—	Recovered
33	Wolley ³⁹	1960	M	9	Fell on stick	Distal pancreatectomy	—	Recovered
34	Bracey ⁴	1961	F	21	Auto accident	Pancreaticogastrostomy	—	Recovered

TABLE 1. (Continued)

Case	Author	Date	Sex	Age	Injury	Operaiton	Complications	Results
35	Fogelman ¹⁵	1961	M	68	Stab wound	Distal pancreatectomy & splenectomy	—	Recovered
36	Pellegrini ³⁸	1961	F	37	Auto accident	Primary repair of duct of Wirsung	Fistula	Recovered
37	Doubilet ⁸	1963	M	39	Fall from bicycle	20 hours after the injury, distal pancreatectomy, transduodenal sphincterotomy	—	Recovered
38	Doubilet ⁸	1963	F	26	Auto accident	Originally distal cut duct ligated. At reoperation 4 days later Roux-en-Y pancreatojejunostomy (distal fragment)	Fistula	Recovered
39	Doubilet ⁸	1963	F	40	Auto accident	Transduodenal sphincterotomy, cannulation of pancreatic duct distal segment, suture of capsule	—	Recovered
40	Baker ¹	1963	—	—	Nonpenetrating trauma	Roux-en-Y pancreatojejunostomy	—	Recovered
41	Weitzman ¹⁷	1965	M	22 (mo.)	Fall	Distal pancreatectomy, splenectomy	—	Recovered
42	Jones & Shires ²⁵	1965	M	40	Auto accident	Debridement, subtotal gastrectomy, drainage	Subarachnoid hemorrhage	Expired 24 hours
43	Jones & Shires ²⁵	1965	F	19	Tornado (blunt)	Repair of vena cava, partial rt. hepatectomy	Hemorrhage	Expired on operating table
44	Jones & Shires ²⁵	1965	M	16	Multiple gunshot	Sump, Penrose drains, suture of pancreas	Fistula & pseudocyst (distal pancreatectomy performed 9 months)	Recovered
45	Jones & Shires ²⁵	1965	M	16	Shotgun	Exploration	Hemorrhage	Expired on operating table
46	Jones & Shires ²⁵	1965	M	13	Auto accident	Exploration	Head injury	Expired on operating table
47	Jones & Shires ²⁵	1965	F	33	Auto accident	Roux-en-Y pancreatojejunostomy, drainage	—	Recovered

resistance to the flow of pancreatic juice into the duodenum. They suggest that this would prevent fistulas and pseudocyst formation.

Clinical Material

Nine patients sustaining complete traumatic transection of the pancreas were operated upon at Barnes, Children's, Veteran Administration, St. Louis City and St. Louis County Hospitals in St. Louis, Missouri, between 1950 and 1965 (Table 2).

Seven pancreatic transections followed blunt trauma; two patients suffered transection of the pancreas from gunshot wounds. One occurred in a 2½ year old boy, the other in a 30-year-old man who bled to death from a lacerated inferior vena cava because of failure to control the hemorrhage, and despite the use of 13.5 L. of whole blood. This was the only death in this series.

Injuries to the colon, spleen, liver or kidney were present in all but two patients (Table 2). Associated injury to major vessels required attention before care of the pancreatic lesion in eight of nine patients. All patients were operated upon within 24 hours of their injury because of generalized abdominal pain, symptoms of intra-abdominal hemorrhage or peritonitis. An elevated preoperative serum amylase level was present in the five patients from whom a blood sample was obtained; however, the diagnosis of a pancreatic injury was not made preoperatively.

Operative management of the pancreatic wound reflected the personal preference of the individual surgeon. Four patients were treated with *suture and drainage* and five with caudal *pancreatectomy* (Table 2).

Pancreatic fistulas followed treatment in two patients—one treated with suture and drainage (Case 1) and one by caudal pancreatectomy (Case 6). Pseudocyst and abscess formation were not seen. No patient exhibited signs of pancreatic exocrine or endocrine insufficiency postoperatively.

Case Report

An epileptic man, age 40 years, was involved in an auto accident September 7, 1964. When admitted to the hospital 8 hours after injury he complained of abdominal and left shoulder pain and was in shock. His abdomen, although soft, was diffusely tender, particularly in the upper quadrants; no masses were felt. The patient was given intravenous saline solutions until whole blood could be obtained and was then operated upon with a preoperative diagnosis of a lacerated spleen. About one liter of blood was found in the peritoneal cavity. The spleen and liver were intact. The lesser omental sac was filled with blood. Branches of the superior mesenteric vein were torn and required ligation. The pancreas was completely transected in the region of the superior mesenteric artery and vein (Fig. 1). A distal pancreatectomy and splenectomy were performed, the end of the pancreatic remnant was oversewn with chronic catgut and the pancreatic bed was drained.

On the eighth postoperative day he again complained of abdominal pain and had a fever. An exploratory operation showed only fat necrosis in the right lower quadrant and an appendectomy was performed. The patient had an uneventful postoperative course and was discharged 1 month following the accident although the right upper quadrant stab wound was drained for several weeks following his discharge.

The patient has been observed for 6 months following his operation without evidence of pancreatic endocrine or exocrine insufficiency.

Discussion

The most frequent single cause of pancreatic injuries in our society are *automobile accidents*. Because the duodenum, spleen and colon are often injured together with the pancreas, the problem of the surgeon is augmented. The proximity of major vascular trunks and the abundant blood supply to the pancreas accounts for extensive hemorrhage accompanying injuries to this area.^{11, 35} The problems attending pancreatic injury cannot be dissociated from those of the contiguous vascular trunks and organs. *Hemorrhage* is the most frequent cause of death soon after injury. Several authors have shown a direct relationship between the mortality rates and the number of associated visceral and vascular injuries.^{15, 21, 40, 41}

TABLE 2. Cases of Complete Traumatic Transection of the Pancreas from St. Louis, Missouri (1950-1965)

Case No.	Age Sex	Injury	Time from Injury to Surgery	Preop. Amylase (Somogyi units)	Operation	Concomitant Injuries	Complications	Length of Stay in Hospital	Drainage
1	31 M	Auto accident	12 hours	800	Suture and drainage	Colon lacerated midcolic vein torn	Fistula	53 days	Penrose
2	2½ M	Bullet	6 hours	—	Suture and drainage, lt. nephrectomy	Left kidney lacerated, liver	Pneumonia	17 days	Sump & Penrose
3	25 F	Auto accident	14 hours	457	Suture and drainage	None		13 days	Sump
4	49 F	Auto accident	8 hours	1,600	Caudal pancreatectomy, splenectomy	Spleen torn, fracture of patella	Gastrocolic fistula, pneumonia	49 days	Penrose drains
5	27 M	Auto accident	6 hours	—	Caudal pancreatectomy, suture of liver laceration, splenectomy & resection of omentum at 2nd operation	Liver & colon lacerated, greater omentum torn	Infarcted omentum, pulmonary infarct	60 days	Penrose
6	40 M	Auto accident	10 hours	—	Caudal pancreatectomy, splenectomy	Mesentery torn	Fistula 6 weeks	28 days	Penrose
7	17 M	Auto accident	8 hours	444	Caudal pancreatectomy, splenectomy	Spleen torn		9 days	Penrose
8	4 M	Fall	24 hours	800	Cadual pancreatectomy, splenectomy	Spleen torn		9 days	Sump & Penrose
9	30 M	Gunshot	1 hour	—	Suture, drainage, colon exteriorized	Inf. vena cava torn, sup. mesenteric vein torn, colon torn		died 2 hours postop.	Penrose

Diagnosis of traumatic injury to the pancreas in patients sustaining a nonpenetrating injury requires a high index of suspicion. Symptoms are vague, shock often exists, and the intensity of pain may vary. When the trauma has not been severe, signs of serious abdominal injury may not appear for weeks or months; a pseudocyst or abscess of the pancreas then develops. In more severe injuries peritonitis and intra-abdominal hemorrhage may require immediate surgical intervention.

Diagnostic paracentesis is unreliable. The serum amylase level may be markedly elevated and contribute to the diagnosis of traumatic pancreatitis^{10, 20, 23, 31}; however, elevated amylase levels have been recorded in intra-abdominal illnesses not affecting the pancreas, such as closed loop obstruction, acute cholecystitis and perforated duodenal ulcer.²³

Penetrating wounds dictate early surgical exploration. Even so, injuries to the pancreas, including complete transections, may be overlooked at operation because of associated major vascular injury and hemorrhage. Once hemostasis is accomplished and obvious injuries to other organs identified, the lesser sac must be opened for adequate visualization and recognition of pancreatic wounds. Exposure of the body and tail of the pancreas is easily accomplished by entering the lesser sac through the gastrocolic omentum, gastrohepatic omentum or transverse mesocolon. The *gastrocolic approach* provides the widest access to the body and tail of the pancreas. This approach also permits partial pancreatectomy when this procedure is indicated. Mobilization of the head of the pancreas and duodenum by the technic described by Kocher²⁸ is a valuable maneuver for evaluation of the head of the pancreas; however, it is not often necessary unless associated duodenal, common duct or vena cava injury is suspected.

Operative management of the transected pancreas has included: drainage alone,⁶

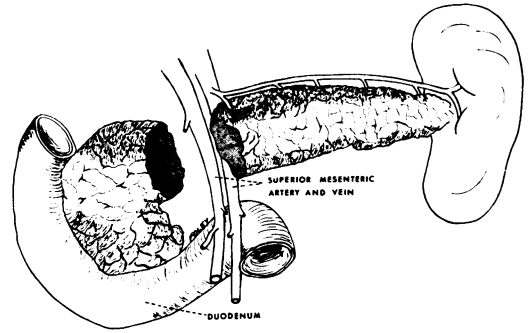


FIG. 1. Illustration of the transected pancreas in Case 6. Mesenteric vessels are exposed because of the separation of the pancreatic fragments.

suture and drainage,² distal pancreatectomy,^{17, 41, 47} sphincterotomy,⁸ primary reconstruction of the ducts,³³ and internal drainage of the distal pancreatic segment by a Roux-Y-loop^{25, 29} or pancreatogastrostomy⁴ (Table 1). The method does not seem to effect the survival rate, but will effect the frequency of complications such as pseudocyst, abscess and fistula formation.

If the patient's condition is critical and multiple intra-abdominal injuries present, suture of the cut ends of the pancreas for hemostasis and the use of multiple drains are most efficacious. A pancreatic fistula often will form, but the patient will survive (Table 2, Case 1).

Primary reconstruction of the pancreatic ducts is not often practical; sphincterotomy with the necessary duodenotomy presents an additional hazard to an already seriously ill patient.

Fear of producing pancreatic insufficiency has led to elaborate technics to reintroduce exocrine secretions into the gastrointestinal tract.^{4, 25, 29} Roux-en-Y pancreatojejunostomy and pancreatogastrostomy are two such operations. The time required to fashion the several anastomoses in a severely traumatized patient and the possibility of contamination from small intestinal contents with both enterokinase and virulent organisms important objections to these procedures.

The necessity of preserving the gland distal to the transection is also questioned. In 1943 Dragstedt⁹ showed that removal of 80 to 90 per cent of the pancreas in dogs causes no defect in carbohydrate and fat metabolism or in digestion and absorption of foodstuffs—provided the pancreatic remnant remains in continuity with the duct and its secretion has free access to the upper intestines.⁹

None of 14 patients treated by partial pancreatectomy have developed symptoms of pancreatic insufficiency (Tables 1, 2). A temporary pancreatic fistula was seen in only one patient. None of the patients treated with subtotal pancreatectomy developed a pseudocyst or abscess. The operation was successful in all cases except one in which the patient recovered initially but then died from hemorrhage following anticoagulant therapy.²⁶ *Distal resection* appears to be a useful way of decreasing pancreatic complications while providing effective control of hemorrhage from damaged splenic and pancreatic vessels.

While the mortality attending pancreatic injuries is due to extensive hemorrhage and concomitant organ injury, the morbidity is more related to complications such as pancreatic fistula, abscess, pseudocyst and pancreatitis. In cases of completely transected pancreas reviewed from the literature, fistula formation was the most frequent pancreatic complication observed (Table 1). Most pancreatic fistulas close spontaneously and are only a temporary problem. Infrequently, a definitive surgical procedure is required to establish continuity between the fistula and the gastrointestinal tract.

Pseudocysts of the pancreas usually require surgical therapy in order to relieve symptoms and to avoid rupture which is associated with a high mortality. They rarely undergo spontaneous resolution. While acceptance of surgical treatment is widespread, there is lack of agreement concerning the type of operation. External drainage by marsupialization and internal

drainage utilizing either a cystogastrostomy or Roux-en-Y cystojejunostomy are accepted methods of management.

Despite the many methods of operative management reviewed, exocrine or endocrine pancreatic insufficiency have not been a problem. The type of operative management of the transected pancreas should depend upon the condition of the patient and the anatomic location of the pancreatic wound. If the condition of the patient is precarious, the least amount of operative surgery consistent with survival is indicated. If the patient's condition is stable and the hemorrhage controlled, a more definitive operative procedure may be chosen which will prevent the development of pancreatic complications and attendant morbidity.

Regardless of the operative method selected, drainage of the pancreas should be provided to permit egress of fluid collections. Penrose drains have proved effective; however, soft sump suction is more efficient.

Summary

Forty-seven cases of traumatic transection of the pancreas collected from the literature and nine from St. Louis, Missouri are presented.

Control of hemorrhage, care of associated organ injuries and provision of drainage to the transected pancreas are the most important points in surgical management.

The conservative approach necessary in critical patients is often followed by serious pancreatic complications such as fistula, pseudocyst and abscess formation. Distal pancreatectomy reduces the incidence of pancreatic complications, preserves adequate pancreatic function and appears indicated when the patient's condition permits.

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