EAST GUIDELINES

FOR THE

DIAGNOSIS AND MANAGEMENT OF PANCREATIC TRAUMA.

Eastern Association for the Surgery of Trauma

Practice Management Guidelines Committee

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STATEMENT OF THE PROBLEM

Pancreatic injury is rare. Pancreatic injury is accompanied by high acute vascular mortality due to the location of the pancreas near the aorta, the superior mesenteric artery and the vena cava. In addition, missed pancreatic injury results in significant morbidity and mortality.

The timely diagnosis of pancreatic injury has been challenging, particularly in blunt trauma patients. In penetrating abdominal trauma patients, pancreatic injury is more rapidly diagnosed. However, the precarious location of the pancreas can also cause increased mortality due to concomitant injury to the nearby vascular structures. While the immediate mortality of blunt pancreatic trauma might not be as great as with penetrating injury, diagnosis and management can present a challenge.

The pancreas is a retroperitoneal organ, and thus physical examination findings of abdominal pain or peritonitis are not reliable. This can be particularly challenging in multisystem trauma patients with altered levels of consciousness or distracting injuries. This situation is more commonplace in the new era of non-operative management. Hyperamylasemia, CT findings and leukocytosis have not been as reliable in acute injury as they have been in pancreatitis of non-traumatic origin. Diagnosis has relied on CT scans, amylase levels, MRI and ultrasound, with varied levels of success.

The optimal management of pancreatic injury once a diagnosis has been made is also not well established. Non-operative management, suture and repair, non-drainage or drainage of injury with or without sumps have all been utilized with varying degrees of success. Complications of the aforementioned methods have included abscesses, fistulae, pancreatitis and pseudocysts. The literature is filled with small series describing the experiences of surgeons who have had to contend with the rarity of the disease process. Improving technology and processes have rendered many previous conclusions invalid.

I. PROCESS

a. IDENTIFICATION OF REFERENCES

The MEDLINE database in the National Library of Medicine and the National Institute of Health was searched using Entrez PubMed (www.pubmed.gov). The MeSH headings used were ‘Pancreas’ AND ‘Wounds and Injuries’. The articles were limited to the English language, Humans, Clinical trials, Randomized controlled trials, Practice Guidelines, Meta-analyses and reviews. Case reports and small case series were excluded. The committee chair and members then reviewed the articles for relevance and excluded any reviews and tangential articles. Fifty (49 class three and one class one) articles were reviewed and used to create the recommendations.

b. REFERENCE QUALITY

Class I evidence:

Prospective Randomized Controlled Trials.

Class II evidence:

Clinical studies in which data were collected prospectively and retrospective analyses based on clearly reliable data.

Class III evidence:

Studies based on retrospectively collected data such as clinical series, data bases or registries.

II. RECOMMENDATIONS

a. Level I

There is insufficient data to support a Level I recommendation.

b. Level II

There is insufficient data to support a Level II recommendation

c. Level III

1. Delay in the recognition of main pancreatic duct injury causes increased morbidity.
2. CT scan is suggestive but not diagnostic of pancreatic injury
3. Amylase/Lipase levels are suggestive but not diagnostic of pancreatic injury
4. Grade I and II injuries can be managed by drainage alone.
5. Grade III injuries should be managed with resection, and drainage.
6. Closed suction is preferred to sump suction.

III. SCIENTIFIC FOUNDATIONS

Timing of Diagnosis of Pancreatic Injury

Injury to the main pancreatic duct appears to increase the pancreatic-specific morbidity and mortality[1]. This is especially true if the diagnosis of pancreatic duct injury is delayed. It is not clear what time period constitutes a 'delay' in diagnosis but a 6-12 hour interval seems to increase morbidity and mortality.

Bach first proposed that injury to the main pancreatic duct can increase pancreas-specific mortality and morbidity[2]. **Tybusrski et al** and **Voeller et al** also showed that pancreatic injuries are accompanied by a higher mortality and more nosocomial infections[3,4]. **Bradley et al** conducted a retrospective chart review from 6 institutions[1]. They found that there was an increased pancreas-specific morbidity and mortality for patients who had a main pancreatic duct injury. In contrast, parenchymal pancreatic injuries not involving the ductal system rarely resulted in pancreas-specific morbidity or death. There were 51 Grade I, 18 Grade II, 30 Grade III, and 2 grade IV injuries. Sixty eight percent (69/101 pts) had contusions and pancreatic lacerations not involving the main duct, while 32% (32/101 pts) had main pancreatic duct injury. The overall mortality was 18% (18/101 pts) but the pancreas-specific mortality was approximately 6%. There was an increased pancreas-specific morbidity and mortality when the pancreatic duct was injured which occurred primarily due to a lack of timely diagnosis. There was a significant correlation between injury to the main pancreatic duct and pancreatic-specific complication (p=0.04), with peri-pancreatic abscesses being the main cause of pancreas-specific mortality. There was a trend toward higher pancreatic-specific mortality in patients who had a delay in operation when compared to those who were immediately operated upon (p=0.074), as well as a trend toward an increase in mortality when compared to observation patients (p=0.062). Both the immediate and delayed operation patients had a significantly higher rate of main pancreatic duct injury when compared to the observation patients.

Lin et al confirmed Bradley et al's finding that complication rates increase with delay in treatment after blunt pancreatic injury[5]. They reviewed 48 cases (32 grade III, 14 grade IV, 2 grade V) of blunt pancreatic injury, of which 3 were managed non-operatively. The complication rate was 62% (28 complications/45 surviving pts), with the most common complication being intra-abdominal abscess (11/48 pts and 11/21 of all complications). Twelve of 32 grade III patients were treated within 12 hours and had a complication rate of 58%, while the 15 patients operated on 24 hours after injury had a complication rate of 80%. All 5 deaths in the grade III group occurred in the greater than 24 hour subgroup. Of 11 surviving grade IV patients, three were treated within 12 hours and had a 67% complication rate while six were treated more than 24 hours later and had an 83% complication rate. In all, 7 patients died of sepsis for a mortality rate of 16%. **Wisner et al** reviewed 91 pancreatic injury patients (80% blunt) with injuries confirmed at laparatomy[6]. Patients operated on 6 hrs or more after admission had a complication rate of 45%, compared to 18% for those operated on sooner.

Other investigators have provided further evidence of the importance of not missing major pancreatic ductal injury. **Berni et al** looked at the role of intraoperative pancreatography in penetrating and blunt trauma patients (divided approximately equally) in a retrospective review of data from 1971-1981[7]. In the first 5 yrs, 10 of 18 patients had a suspected main pancreatic duct injury based on intra-operative exam. The criteria included direct visualization of the ductal injury, transection of the pancreas, greater than 50% parenchymal laceration, central gland perforation, or severe contusion. Intraoperative pancreatography identified 33 patients (58%) with major duct injury in the last 5 yrs of the study. Complication rates dropped from 55% to 15%, with the majority of the complications being pancreatic fistulae. These findings were in the face of similar patient profiles, including a similar time from injury to operative treatment (all the patients were treated within 12 hours of injury). While it should be mentioned that pancreatojejunostomy was not used in the last 5 yrs when distal pancretectomy was done, drainage procedures alone showed a dramatic reduction in complication rates, presumably as a result of discovering and not missing major ductal injuries.

Method of Diagnosis of Pancreatic Injuries: CT Scan

While many studies have stressed the importance of a timely diagnosis of pancreatic duct injury, this is an elusive goal. It is unclear if CT scan is as accurate as some have suggested. **Akhrass et a**l looked at 17 pts who underwent abdominal CT at the time of presentation[8]. The CT scan was normal in 9 pts, of whom 8 were explored for other reasons (most commonly due to splenic injury). They found 3 grade I, 2 grade II and 3 grade III injuries. The CT was abnormal in 8 pts, of whom 3 were explored while 5 had pancreatitis which was managed non-operatively. Therefore, a total of 11 pts were explored of whom 10 had sustained blunt trauma. CT scan was accurate in 2/11 cases and missed or undergraded injuries in 9/11 pts. The mean grade of injury on CT vs surgical findings was 0.45 vs 2.0 (p<0.001). Hence, CT scan often missed or undergraded pancreatic injuries that needed operative intervention implying that a normal CT scan cannot be relied upon. It must be mentioned that this study was performed from 1984-1994 and it is unknown if the unreliability of CT scan extends to the modern spiral and multi-channel scanners.

Bradley et al reviewed the sensitivity of CT scan in blunt pancreatic trauma patients[1]. ICD-9 codes were used to look at the records of 99 surviving patients from 1988-1996. CT was done in 54 pts, with pancreatic injury being verified in 37 of these patients by laparotomy or autopsy. True positives were found in 25/37, 10 were false negatives and 2 were false positives. The presence of an unspecified injury was predicted by CT in only 71% of cases. Moreover, the grade of injury was predicted accurately by CT in only 16/25 of the true positive patients. Six were undergraded and 3 were overgraded. It should also be noted that in 32 cases with operatively proven ductal injuries, CT predicted main duct injury in only 9 pts for a sensitivity of 43%.

Patton et al retrospectively looked at records of patients with blunt pancreatic injury from 1990 to 1995[9]. Fifteen of 19 pts (79%) with blunt trauma had a high suspicion CT for pancreatic injuries which were confirmed at laparotomy. At an average of 3 days later the remaining 21% showed pancreatic injury as well. **Canty et al** showed the unreliability of CT in the pediatric blunt trauma population[10]. CT scan was performed in 16 pts and was deemed suggestive of pancreatic injury in 11 pts. In the other 5 pts the CT missed a ductal injury, yielding a sensitivity of 70%. Finally, **Ilahi et al** found that CT was only moderately sensitive in detecting the severity of pancreatic injury while both missing and underestimating injuries[11].

Method of Diagnosis of Pancreatic Injuries: Amylase/Lipase Levels

Some investigators have tried to use amylase levels to diagnose clinically significant pancreatic injury. **Adamson et al** retrospectively reviewed 1,821 pediatric trauma patients[12]. Eight pancreatic injuries were identified and 5 of these pts underwent surgery for pancreatic ductal injury. Six of 8 pts with proven pancreatic injury underwent amylase/lipase testing, with 5 being found to have elevated levels. Severity of injury did not correlate with level of elevation of the enzymes. Forty eight percent of patients with elevated amylase/lipase levels had no evidence of pancreatic injury. The sensitivity of screening was 84% but the PPV was only 4%. Thus, while elevated enzymes may suggest pancreatic injury, this screening test could result in a large number of expensive tests such as CT scans in patients without abdominal injuries. **Takishima et al** retrospectively looked at 73 pts with blunt injury to the pancreas over a 16 yr period (1980-1996)[13]. The mean time from injury to admission was 6 hrs. Amylase levels were elevated in all patients admitted 3 hrs after trauma. Comparisons between elevated amylase levels (n=61 pts) and normal levels (n=12 pts) showed that the only factor that was significant was the time from admission (7 +/- 1.5 hrs vs 1.3 +/- 0.2 hrs, p<0.001). However, the investigators did not look at patients without pancreatic injuries who might have had subsequent elevated amylase levels. This fact does not allow a reasonable conclusion to be made about the utility of amylase in diagnosing pancreatic injury. **Sruissadaporn et al** also found no correlation between amylase on presentation and the presence of pancreatic injury[14].

Babb et al looked at pancreatic trauma patients with surgically proven pancreatic injuries[15]. Amylase was elevated in 14/18 blunt pancreatic injury patients. Once again the data did not evaluate amylase elevation in non-pancreatic injury patients. **Mayer et al** reviewed blunt pancreatic trauma patients and found that an increase in amylase/lipase levels were the most common reason for delayed laparotomy[16]. Of these blunt trauma pts, 6/11 had their pancreatic injury diagnosed within 48 hours of injury. They concluded that enzyme levels are useful. However, neither the sensitivity nor specificity of this test can be established based on the data provided.

Jobst et al looked at pediatric blunt pancreatic trauma patients in a retrospective fashion[17]. Pancreatic injury was diagnosed by CT, U/S, ERCP, intra-operative or post-mortem findings in 56 pts. Forty pts (71%) had increased admission amylase levels, but these did not correlate with the severity of pancreatic injury. The mean initial amylase level for minor pancreatic injuries was 209 IU/dL and that of ductal injuries was 631 IU/dL. However, the initial amylase level was not useful since several patients with major duct injuries had normal initial levels and several patients with extremely elevated admission amylase levels had only minor pancreatic injuries. Mean peak levels were significantly higher in major versus minor pancreatic injuries, however (1020 vs 473 IU/dL, $p<0.009$). Within 48 hrs, 47/51 pts (92%) who had amylase determinations performed showed elevated levels (36/51 immediately, 11/51 by 48 hrs). Of note, 4/15 pts with minor pancreatic injuries never showed amylase elevations. Again, no patients without pancreatic injury were utilized as controls.

Repeated amylase determinations for 48 hours might therefore be helpful in diagnosing major duct injuries. The implications of delayed intervention in a pancreatic duct injury must be weighed against the morbidity of a non-therapeutic laparotomy as well.

Management Strategies

In general, higher grade pancreatic injuries result more frequently in operative interventions. Their management once diagnosed, however, has been controversial. **Balasegaram et al** reviewed 91 pancreatic injuries (47 blunt, 44 penetrating) and concluded that all the mortality and the majority of the morbidity was limited to injuries grade 3 and higher[18]. Of 17 grade I and 15 grade II injuries who received drainage alone (penrose or sump) or suture repair, no deaths were noted. Partial pancreatectomy had a mortality of 1/35 patients. Most of the post-operative complications appeared in patients who had a pancreatoduodenectomy or primary repair of ductal injury. They concluded that suturing ducts should be abandoned in favor of resection.

Stone et al looked at 283 pancreatic trauma patients (227 penetrating) and their management over 30 years[19]. Diagnosis was made by laparotomy in all patients. Pancreatic wound locations were 91 head, 109 body and 83 tail. Eighty seven percent of the patients were managed by drainage alone, and 11% with resection including splenectomy and some form of drainage. Resection was performed only when injury had performed the majority of the resection itself. Penrose drainage was used in 41 patients, while sump drainage was utilized in 198 pts. Pancreatic morbidity decreased from 46% to 2% with the change to sump drainage. The majority of the complications were pancreatic fistulae and abscesses. Internal drainage of pancreatic secretions was done in 7 patients by pancreticojejunostomy with a subsequent 38% mortality. They concluded that drainage without debridement is adequate for minor injuries and that sump drains should be used. While it is unclear what the grades of injuries were in this investigation, the clear implication is that they are referring to grades I/II of injuries.

Lappaniemi et al examined 43 patients with acute blunt pancreatic injury[20]. There were 21 AAST grade I/II injuries and the remainder were AAST grades III or higher. When pancreatic duct injuries were not resected but were merely sump-drained, the fistula rate was 80% vs 18%. Drainage or drainage and suture were used in 19/21 grade I patients with a lower complication rate. Thus pancreatic injuries of grades III or higher should undergo more than drainage alone. **Akhrass et al** looked at 72 patients with pancreatic injury of whom 27 were blunt and 46 were penetrating[8]. Of these injuries, 18 were grade I, 32 were grade II, 16 were Grade III, and 5 were Grade IV. Among the grade I and II injuries, 5/13 pts (38.5%) who underwent exploration and drainage had complications, as opposed to 2/19 (10.5%) who underwent exploration and no drainage. It should be noted, however, that the two populations were not equivalent and surgeon bias was acknowledged by the authors themselves.

Young et al retrospectively reviewed 62 survivors of penetrating abdominal trauma[21]. There were 7 grade I, 30 grade II, 19 grade III, 4 grade IV and 2 grade V patients. Twenty nine of 37 grade I and II patients were treated with drainage alone, 4 had no surgical treatment and 2 had distal resections. No difference in complication rates was seen between these groups. The authors concluded that drainage should continue to be used in non-ductal injuries and that resection is not essential in these cases. For grade III patients, fistulae formed in 2/15 (13%) of the patients with resection; a fistula also occurred in the only patient who had drainage alone for a Grade III injury.

Patton et al retrospectively examined 123 adult patients with pancreatic injuries (81% penetrating) identified at laparotomy or after CT scan[9]. Distal injuries were treated with closed drains if deemed less severe, and a consequent complication rate of 21% was noted. Resection and drainage were performed if the duct was involved, and a complication rate of 42% was noted in this group. Fifty four patients had an indeterminate duct status. High-probability duct injuries were treated with resection (24/54 pts). Low-probability duct injuries were drained (30/54 pts). The morbidity rates were similar (33% vs 27%) as complications developed in 31% of the patients. Nineteen patients developed fistulae, all of which resolved with drainage at a median of 43 days. Seventeen pts developed abscesses, of which 11 were managed with CT drainage and 6 with reoperation. There were no deaths. Major duct injury and colonic injury were found to be associated with abscess formation, and duct injury was associated with fistula. However, multivariate analysis showed severity of injury to be related to fistula formation and not pancreatic resection per se. The authors concluded that duct injuries can be managed with acceptable morbidity by resecting the distal pancreas and draining the stump.

Takishima et al examined pancreatic duct injuries and their management[13]. They proposed nonoperative management for grade I and II injuries, asserting that grades III-V needed operative management. These conclusions were echoed by **Vasquez et al**[22] and **Rickard et al**[23] as well. **Wilkinson et al** suggested that drainage alone could be used for contusions of the pancreas and that moderate wounds should be sutured or resected[24]. However, no grading of the injuries occurred in this paper.

Wind et al examined 38 patients with pancreatic trauma to the left of the portal vein[25]. Eighty nine percent (34 pts) were blunt trauma pts, and two-thirds of the pts underwent laparotomy within 24 hrs. Patients who had a main pancreatic duct injury treated without resection all had complications (19/19 pts: 14 fistulae and 5 pseudocysts) and 14 ultimately required pancreatic resection. For the 12 patients who had no duct injury and no resection, 10 had complications of which 9 required surgery. Under-treatment of pancreatic duct injury thus appeared to be an important contributor to morbidity in this series. **Young et al** reviewed the courses of 52 pts, 19 with pancreatic duct injury and 33 with parenchymal injuries[21]. Of the non-duct injury pts, 6.9% developed a pancreatic fistula, while the only duct injury patient who did not undergo a resection developed a fistula. Two out of 15 grade III injury pts (13%) who underwent resection also developed a fistula. **Hendel et al** also reported an increased morbidity with mere drainage of all grades of pancreatic injuries[26], while **Keller et al** also urged operative management for grade III or higher injuries[27]. **Heitsch et al** urged resection for distal injuries as they felt that mortality due to sepsis was increased with injury to the duct[28].

Nowak et al examined 42 patients with distal pancreatic injury, of which 93% were due to a penetrating mechanism[29]. Patients with debridement and drainage had a lower complication rate than those with distal pancreatectomy. (12 pts with a 33% complication rate vs 5 pts with a 66% complication rate). There are questions, however, about equivalency between these groups.

Degiannis et al recommended distal pancreatectomy for severe grade II and all grade III, IV and V injuries[30]. There were no fistulae for low grade II injuries managed with debidement or suture, while 14% of the severe grade II and higher injuries managed with pancreatectomy developed fistulae. Unfortunately, this study did not have a comparison group for morbidity. It is also not clear how the fistula rate of 14% for pancreatectomy was distributed between the 'severe' grade II injuries and the other higher grades. **Sturim et al** found lower complication rates with resection versus repair but the grades of injuries were not well described[31]. **Sukul et al** do not convincingly support their preference for debridement and drainage in the absence of duct injury, distal pancreatectomy for injuries to the left of the SMV and whipple for those to the right of the SMV[32]. No controls were described.

The management of grade IV and V injuries is very controversial with poor data in the literature. **Nowak et al** favor debridement and drainage over pancreatoduodenectomy but there was only one patient in the latter group[29]. **Asensio et al** performed a Whipple for 17 patients with grade V injuries, and demonstrated a survival of 67%[33]. The series is small, but is one of the largest reported and suffers from lack of any lesser procedures as controls. In addition, only 5 patients had damage control procedures. Hence, it is difficult to make any data based recommendations for grade IV and V injuries.

Another discussion that is common in the management of pancreatic injury is the issue of splenic preservation. While this approach might make intuitive sense, the data supporting this approach in traumatic pancreatic injury is not adequate. **Pachter et al** looked at splenic preservation with distal pancreatectomy in 9 patients and showed that it could be done in 51 minutes with minimal complications[34]. The power of this study is low and cannot be used to make general recommendations regarding this aspect of management.

Thus it appears that drainage alone suffices for grade I/II injuries, while grade III and higher injuries should undergo a resectional procedure and drainage in order to reduce morbidity.

Management of Pediatric Pancreatic Injuries

Management of pancreatic injuries in pediatric patients seems to follow many of the same principles as those for adults, albeit with key exceptions in the potential role for nonoperative management. While **Bass et al** recommended nonoperative management of all pancreatic injuries in children, they did not describe the grades of injury in their population[35]. **Shylansky** agreed with this guideline, but showed a high rate of pseudocysts (5/11 pts) in patients with grade III or higher injuries[36]. **Nadler et al** reviewed the records of 51 pediatric patients who sustained pancreatic trauma[37]. A total of 32 patients underwent laparotomy. The patients were divided into those with minor pancreatic injury (29 pts) or pancreatic duct/major pancreatic injury (22 pts). The criteria for minor injury were enzyme elevation, and CT or intraoperative findings. Patients with pancreatic transection or major injury were divided into 2 further groups based on whether they received an operation within or after 48 hours from the time of injury. These groups were noted to have similar ISS scores. The patients with pancreatic transection had significantly higher initial and peak amylase/lipase levels. The median amylase levels in transection were >200 and the lipase levels were >1800 ($p<0.05$) compared to contusions. The amylase and lipase median values were 106 and 636, respectively, for pancreatic contusions. The six patients with major pancreatic injuries who underwent operative intervention more than 48 hours post-injury had a longer length of stay (23.5 days vs 10 days, $p<0.05$) and had more complications than the 16 patients explored in less than 48 hours. The complications were primarily due to infected pseudocysts. Thus, early operative intervention resulted in shorter LOS and fewer complications.

Drainage

The type of drains to be used has been debated in the literature. **Stone et al** reported a decrease in complication rates from 46% to 2% when sump rather than penrose drains were used[31]. Sixteen of 41 pts with penrose drains had complications with 5 attributable deaths. With sump drains, 4/198 (2%) pts experienced complications and there were no pancreatic-injury related deaths. This advantage for sump drainage was demonstrated by **Anderson** et al[38] as well. **Fabian et al** showed in a randomized, prospective trial that closed suction drainage reduced septic complications compared to sump drainage (from 5/24 (21%) to 1/35 (3%)[39]. Sixty five pts with penetrating injuries were randomized to closed or sump drainage. The groups were not significantly different, and 12 pts in each group needed resection and drainage for grade III injuries. Closed suction drains proved better than sump drains by demonstrating a lower morbidity (3% abscess rate compared to a 20% abscess rate for sump drains).

Octreotide

The usage of Octreotide in pancreatic injury was studied by **Nwariaku et al**[40]. Seventy six patients (85% penetrating) with intraoperatively diagnosed pancreatic injury constituted the study population. The frequency and severity of complications (abscess, pseudocyst, and fistula) were not decreased by using octreotide, but it should be noted that both grades I and II had a higher incidence of fistula than would be expected (46% fistula rate in the octreotide vs 35% in the non-octreotide treated patients). Grade III, IV and V injuries had fistula rates of 50% when treated with octreotide, and 56% without. This difference was not statistically significant. **Amirata et al** also looked at the use of octreotide in pancreatic injuries with dissimilar results as pancreatic complications were decreased when octreotide was used[41]. The sample size, however, was very small. The conflicting results in the two aforementioned studies do not allow any reasonable conclusions to be drawn regarding the use of octreotide in pancreatic injury.

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