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Master of Medicine in Surgery

Research Report

**The role of endoscopic retrograde pancreatography in  
the management of pancreatic trauma**

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Submitted to

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## DECLARATION

I, David Alexander Thomson, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree at this or any other university.

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24/02/2012

## DEDICATION

To my grandfather Dr Horace Thomson who's questioning mind inspired and still inspires his grandson.

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## ABBREVIATIONS AND DEFINITIONS

ERP – endoscopic retrograde pancreatography

ERC – endoscopic retrograde cholangiography

ERCP – endoscopic retrograde cholangiopancreatography

MRCP – magnetic resonance cholangiopancreatography

MRI – magnetic resonance imaging

CT – computed tomography

US – ultrasound

FAST – focused abdominal sonography in trauma

MPD – main pancreatic duct

AAST – American Association for the Surgery of Trauma

TPN – total parental nutrition

IU/l – international units/litre

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## ABSTRACT

### Background:

Endoscopic retrograde pancreatography (ERP) has various applications in the diagnosis and management of pancreatic trauma. The utility of ERP in pancreatic trauma presenting to a level 1 equivalent trauma centre was analysed.

### Methods:

Patients who sustained pancreatic trauma and underwent ERP were identified. Patient demographics, mechanism of injury, time to presentation, diagnostic modalities, associated injuries, clinical management, endoscopic interventions and their timing, surgical treatment and patient outcomes were recorded.

### Results:

Forty-eight patients with pancreatic trauma were referred for ERP after blunt (26), gunshot (15), or stab (7) injury. The average time from injury to ERP was 38 days (range 2 – 365). An ERP visualized the duct in 47 patients. Twenty-four patients had a pancreatic fistula, 12 patients had a main pancreatic duct stricture or cut-off and 10 patients had a pseudocyst. Endoscopic interventions were pancreatic duct sphincterotomy (15), pancreatic duct stent (7) or pseudocyst drainage (6). Ten patients demonstrated minor injuries and no interventions were performed. One patient had a normal pancreatogram. Ten patients required pancreatic surgery following ERP (distal pancreatectomy n=6, pancreaticojejunostomy n=3 and cystjejunostomy n=1). One patient unable to tolerate ERP had a distal pancreatectomy.

### Conclusion:

The majority of ERPs were performed post surgery or after a delayed presentation. Diagnostic success was high and in conjunction with therapeutic interventions 77% of patients avoided surgery for their pancreatic complications. ERP is an effective tool in the delayed management of the local complications of pancreatic trauma.

## INTRODUCTION

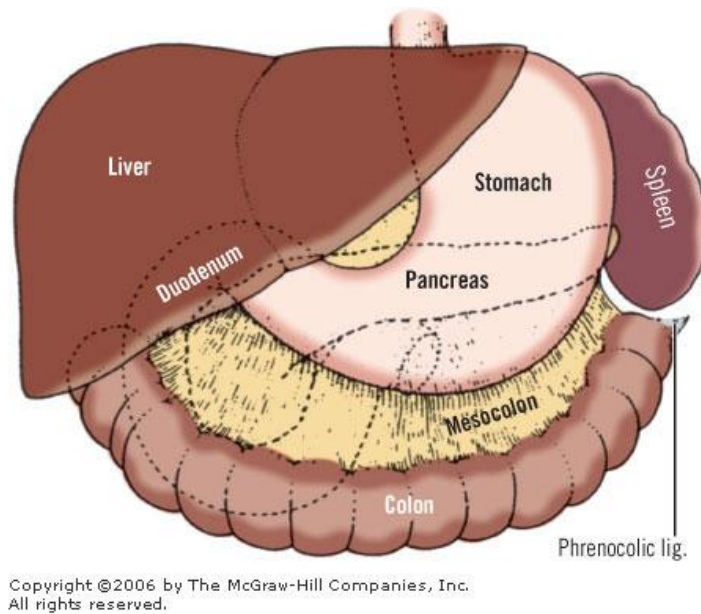
The incidence of pancreatic trauma is reported to be between 2-3% in patients with severe abdominal injury.<sup>1</sup> This incidence is increasing due to a rise in high speed automobile accidents and an escalation in interpersonal violence involving dangerous weapons.<sup>2</sup> In Western Europe, England and Australia the predominant cause of pancreatic injury is due to automobile accidents while in North American cities and South Africa penetrating injuries from gunshots are the most common.<sup>3-5</sup> The likelihood of a pancreatic injury occurring is dependent on the mechanism of trauma. Approximately 5% of patients with blunt abdominal trauma have a pancreatic injury<sup>6</sup>, while 6% of patients with penetrating gunshot wounds<sup>7</sup>, and 2% of patients with penetrating abdominal stab wounds have a pancreatic injury.<sup>8</sup> The pancreatic injury can occur as an isolated injury or as a component of an injury complex.

Because of its rarity and subtle signs pancreatic injury may present diagnostic and therapeutic challenges to the surgeon.<sup>9</sup> Pancreatic injury has a high morbidity of approximately 30%<sup>10</sup> but this increases to 60% if diagnosis is delayed.<sup>6</sup> The integrity of the pancreatic duct is the most important determinant of prognosis.<sup>9, 11-15</sup>

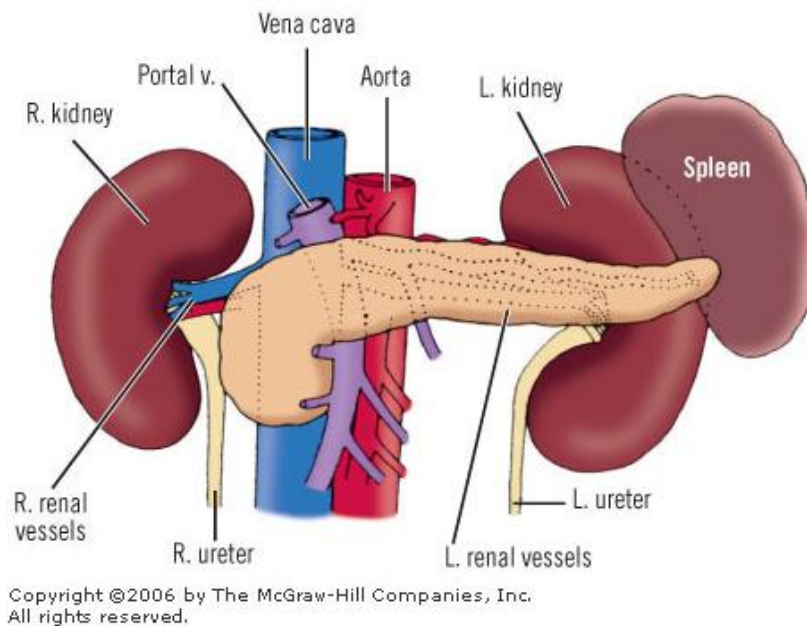
Endoscopic retrograde pancreatography was first used in the management of patients with pancreatic injuries in 1976.<sup>16</sup> Its use has evolved from a purely diagnostic procedure into a mainly therapeutic tool. This evolution has taken place during a period where cross-sectional imaging has become an integral part of the management of the trauma patient. Pancreatic complications are varied and the natural history is not well documented. The timing and role of ERP in pancreatic trauma is not clearly defined and treatment is done on an individual basis. There is consensus that the integrity of the main pancreatic duct is the key to assessing these injuries and the likelihood that they may complicate. ERP offers the "gold standard" of ductal assessment and in some cases can offer a definitive therapeutic intervention.

## RELEVANT PANCREATIC ANATOMICAL CONSIDERATIONS

The pancreas is a centrally placed retroperitoneal organ with numerous vital structures in close proximity. These are depicted schematically in figures 1 & 2. A pancreatic injury can be life threatening because of associated injuries to the liver, spleen, major blood vessels or hollow organs.

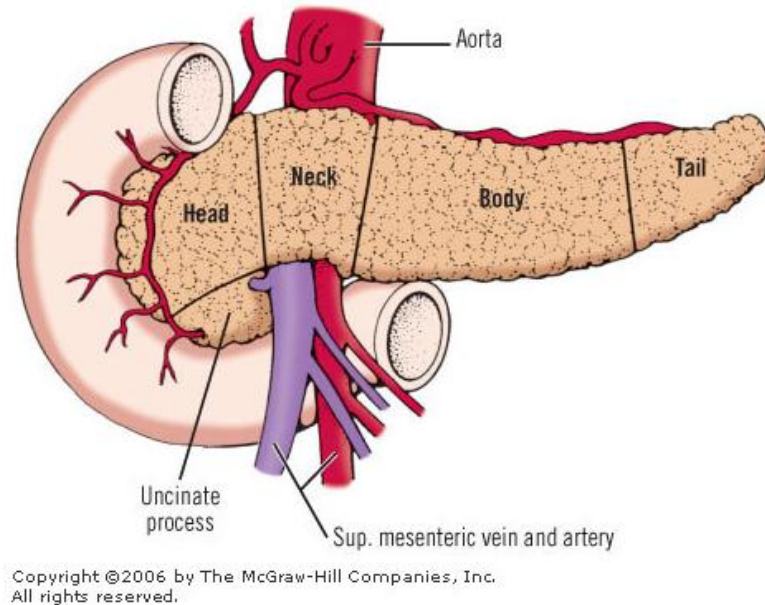


**Figure 1:** Anterior relations of the pancreas<sup>17</sup>



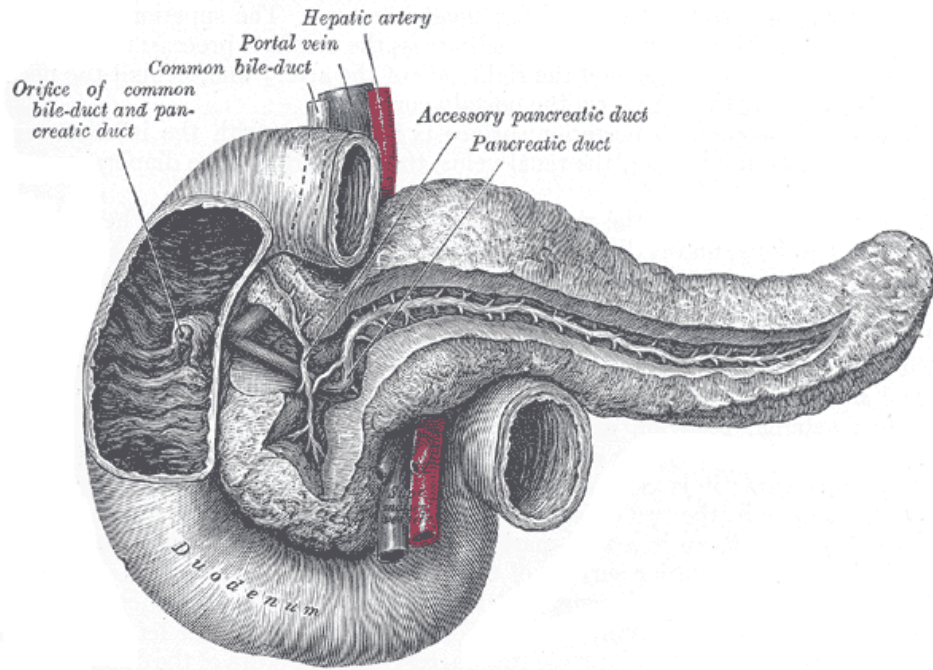
**Figure 2:** Posterior relations of the pancreas<sup>17</sup>

The pancreas is divided into 4 discrete areas (Figure 3). Contained within the C loop of the duodenum is the head and uncinete process of the pancreas.



**Figure 3:** Anatomical subdivisions of the pancreas. Line dividing body and tail is arbitrary. <sup>17</sup>

The ductal system of the pancreas comprises the main and accessory pancreatic ducts which lie anterior to the pancreatic blood vessels. The main duct of Wirsung arises in the tail and continues through the body at a level midway between the superior and inferior margins. Approximately 15 to 20 side branches enter the duct from the body and tail. Within the head of the pancreas the duct courses inferiorly and posteriorly before entering the wall of the duodenum between the second and third part with the common bile duct entering superiorly, at the level of the second lumbar vertebra. The accessory pancreatic duct of Santorini has a variable drainage: either into the duodenum at the minor papilla or into the main pancreatic duct. This duct drains the anterior superior portion of the pancreatic head (Figure 4).



**Figure 4:** Ductal system of the pancreas<sup>18</sup>

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## ASSOCIATED INJURIES

Isolated injuries to the pancreas are uncommon.<sup>1</sup> Due to the proximity of the pancreas to adjacent important structures most patients sustain multiple other significant injuries compounding the morbidity and mortality rate. In the 11 year single institution study by Vasquez et al. the associated injury rate in penetrating injury was 98%.<sup>8</sup> Penetrating injuries are also more likely to be associated with multiple associated injuries than blunt injuries. An average of 2.6<sup>19</sup> to 3.6<sup>8</sup> associated injuries per patient have been reported. In penetrating trauma the most frequently injured organs are the liver (55%), stomach (51%), colon (24%) and duodenum (23%) compared to blunt trauma in which the liver (32%), spleen (28%) and duodenum (6%) are most likely to be injured.<sup>20</sup> Blunt abdominal trauma can cause isolated pancreatic injury and presentation in these cases is often delayed.<sup>21</sup>

## GRADING OF PANCREATIC INJURIES

Operative management of pancreatic injuries is based on the haemodynamic stability of the patient, associated injuries and grade of injury. Several grading systems exist and have been applied in the management of pancreatic trauma.

The first of these was described in 1977 by Lucas<sup>22</sup> in his paper on pancreaticoduodenal injuries. The modified Lucas classification system is shown in Table 1.

**Table 1:** Modified Lucas Classification of Pancreatic Injury<sup>22, 23</sup>

| <b>Class</b> | <b>Description</b>   |
|--------------|--|
| I            | Simple superficial contusion or laceration with minimal parenchymal damage. Any portion of the pancreas can be affected but the main pancreatic duct is normal |
| II           | Deep laceration, perforation or transection of the neck, body or tail with or without pancreatic duct injury   |
| III          | Severe crush, perforation or transection of the head of the pancreas with or without ductal injury   |
| IV           | Combined pancreaticoduodenal injuries, subdivided into:<br>(a) minor pancreatic injury<br>(b) severe pancreatic injury and duct disruption                     |

In 1990 the Organ Injury Scaling (O.I.S.) Committee of the American Association for the Surgery of Trauma (A.A.S.T.) published their grading system in the Journal of Trauma placing a greater emphasis on ductal integrity (Table 2).

**Table 2:** Pancreas Organ Injury Scale of the American Association for the Surgery of Trauma (A.A.S.T.)<sup>24</sup>

| <b>Grade</b> | <b>Injury</b> | <b>Description</b>  |
|--------------|---------------|---|
| I            | Haematoma     | Minor contusion without ductal injury                                       |
|              | Laceration    | Superficial laceration without ductal injury                                |
| II           | Haematoma     | Major contusion without ductal injury or tissue loss                        |
|              | Laceration    | Major laceration without ductal injury or tissue loss                       |
| III          | Laceration    | Distal transection or pancreatic parenchymal injury with ductal injury      |
| IV           | Laceration    | Proximal transection or pancreatic parenchymal injury involving the ampulla |
| V            | Laceration    | Massive disruption of the pancreatic head                                   |

In this classification minor injuries (Grade I and II) have by definition an intact main pancreatic duct. These can be managed at operation by simple techniques (repair and drainage) while Grade III injuries and higher often require pancreatic resection.<sup>9</sup>

Such is the importance of ductal integrity that in 2000 Takishima et al.<sup>25</sup> proposed a classification of pancreatic injuries based on findings at endoscopic retrograde cholangiopancreatography and proposed a management algorithm based on these findings.

**Table 3:** Classification of pancreatic injuries by endoscopic retrograde cholangiopancreatography<sup>25</sup>

| Grade | Description   |
|-------|---|
| I     | Normal main pancreatic duct on ERCP   |
| IIa   | Injury to branches of main pancreatic duct on ERCP with contrast extravasation inside the parenchyma              |
| IIb   | Injury to the branches of main pancreatic duct on ERCP with contrast extravasation into the retroperitoneal space |
| IIIa  | Injury to the main pancreatic duct on ERCP at the body or tail of pancreas  |
| IIIb  | Injury to the main pancreatic duct on ERCP at the head of the pancreas  |

The A.A.S.T. Pancreas Organ Injury Scale is the most widely used in the literature and not dependent on an ERP to grade the injury. This scale places emphasis on the ductal integrity of the pancreas whereas the Lucas classification does not emphasize this important factor. The majority of pancreatic injuries are minor and can be treated conservatively without the need for endoscopic grading thus the utility of Takashima's grading system is limited.

## DIFFICULTIES IN DIAGNOSIS

The retroperitoneal location of the pancreas may mask presenting signs and symptoms. Isolated pancreatic injuries may present with few abnormal clinical findings and consequently early diagnosis may be difficult.<sup>21</sup> In penetrating trauma associated injuries may mask an injury to the pancreas and even during laparotomy the pancreatic injury can be missed while focus is placed on major vascular injuries or intestinal spillage.<sup>11</sup>

In all patients with abdominal trauma a high index of suspicion (starting with the mechanism of injury) is necessary to make a prompt diagnosis. This is of particular importance in blunt trauma where the modern trend in management is towards non-operative treatment. Clinical suspicion can be combined with laboratory and radiological investigations to help ascertain the presence or absence of a pancreatic injury.

An increased serum amylase is neither sensitive nor specific for pancreatic injury and is also time (relative to injury) dependent. The reported incidence of hyperamylasaemia in proven blunt pancreatic trauma ranges from 3% to 75%.<sup>1</sup> Buccimazza et al.<sup>21</sup> reported on 16 cases of isolated main pancreatic duct injury and found the amylase level to be raised in all patients. In those patients who presented acutely levels were >1000IU/L while those with delayed presentation had a range from 200 to 490 IU/L.<sup>21</sup> Other authors however have reported that even with complete transection of the main pancreatic duct 38% of patients will have a normal serum amylase.<sup>20</sup> However a retrospective study by Takishima et al. evaluated amylase levels in 73 cases of blunt pancreatic trauma and reported a raised level in 83%. All false negatives were in the group which presented within 3 hours of injury.<sup>26</sup> Therefore a delayed (>3 hours) or rising amylase level in conjunction with clinical signs of abdominal pain and tenderness is considered highly suspicious of pancreatic injury and further investigation with contrast enhanced CT scan, ERP or MRCP is warranted.<sup>1, 9</sup>

## IMAGING

Plain abdominal radiographs may show subtle signs which are suspicious of a pancreatic injury. If a duodenal injury is present there may be gas bubbles in the retroperitoneum or free intraperitoneal air. Fractures of the transverse processes are collateral evidence of a high energy injury and possible retroperitoneal trauma. Displacement of the transverse colon or stomach bubble and an overall "ground glass appearance" may also suggest pancreatic injury. A review article on the management of blunt abdominal trauma suggested that there was no role for routine plain abdominal films in patient assessment.<sup>27</sup> In penetrating trauma however an erect chest radiograph is a useful investigation to identify free air under the diaphragm and to assess concomitant chest injuries.

Ultrasound is now widely used in trauma units. The emphasis of FAST (Focused Abdominal Sonography in Trauma) is on detecting free fluid in the abdomen and has a sensitivity of 79 – 100% and a specificity of 95 – 100% in prospective observational studies. Directed examination of the pancreas is however often difficult due to overlying gas, associated abdominal injuries, obesity or subcutaneous emphysema. There is recent evidence in a Cochrane review and subsequent rebuttal study which both conclude that ultrasound directed management algorithms make no difference to patient outcome.<sup>28, 29</sup> In patients with a delayed presentation and an abdominal mass ultrasound is a good investigation to confirm the presence of a possible pseudocyst.

Computed tomography scan (CT) should intuitively be a more sensitive and specific test for pancreatic trauma. CT however tends to underestimate the grade of injury and when done in the acute setting may miss the pancreatic injury. In a multi-institutional review aimed at providing guidelines for the management of blunt pancreatic trauma CT had a sensitivity of only 71% in detecting unspecified pancreatic trauma and a sensitivity of only 43% in predicting a ductal injury.<sup>30</sup> Although peripancreatic fluid, focal or diffuse pancreatic enlargement, and areas of low attenuation in the pancreatic parenchyma may raise the possibility of pancreatic duct injury CT does not offer good visualization of

the pancreatic duct and may result in false positive and false negative diagnoses of main pancreatic duct disruption. This is despite newer CT technology which have reduced scanning times and improved resolution of 2D and 3D images. CT scans are more reliable in patients presenting late and with established pancreatic complications.

Of the commonly available tests (amylase, lipase, ultrasound and CT) none is especially sensitive or specific for pancreatic ductal injury. However in combination an educated assessment can be made of the risk of pancreatic injury and the need to progress to further investigations.

Magnetic resonance cholangiopancreatography (MRCP) is an accurate, quick (5 minutes) and non-invasive means of assessing the pancreatic duct. Fulcher et al.<sup>31</sup> reported a series of 10 patients with suspected traumatic pancreatic injury where MRCP was used to guide clinical management. However the numbers were small and only 4 patients had evidence of a ductal injury.<sup>31</sup> The expense of MRCP and a lack of widespread availability has limited its application. Logistically its use in the acute setting and in the multiply injured patient is difficult, although MRI compatible ventilators and equipment have been developed.<sup>32</sup>

Dynamic secretin-enhanced MRCP is a newer modality available for identifying pancreatic duct injury. This technique takes more time (20 min) than a standard MRCP and is similarly expensive and not widely available. It is very sensitive and specific and an excellent non-invasive test for determining pancreatic duct integrity. In the largest series utilizing this method the study population of 17 patients included 8 who had blunt abdominal trauma. The seven patients who had an intact pancreatic duct on MRCP did well on conservative treatment however three patients who had “minor” ductal disruption treated conservatively all developed persistent complications.<sup>33</sup> MRCP can be used to screen for an intact duct but its role in assessing the severity of ductal injuries needs further clarification. Houben et al. reported 4 patients who had both MRCP and ERP for pancreatic trauma. In 3 patients the findings correlated however in one case the MRCP did not accurately grade the injury.<sup>34</sup>

Currently ERP is the diagnostic tool of choice as it demonstrates contrast filling of the pancreatic ducts and extravasation in realtime.<sup>35</sup> The place of MRCP in the diagnostic algorithm for pancreatic trauma is to assess pancreatic ductal integrity prior to an ERP, as the demonstration of an intact ductal system would reduce the number of non-therapeutic ERPs, which is an invasive procedure with its own inherent complications. In a recent review article on “ERP in pancreatic trauma: Need to break the mental barrier” MRCP was recommended for all patients with evidence of pancreatic injury on CT scan.<sup>11</sup>

**Table 4:** Investigations used in the diagnosis of an injury to the pancreatic duct in patients with abdominal trauma<sup>11</sup>

| <b>Investigation</b>                               | <b>Role in pancreatic trauma</b>   |
|--|--|
| Serum lipase or amylase                            | Low sensitivity and specificity. Elevated levels warrant further investigation   |
| Ultrasound abdomen                                 | Low sensitivity and specificity. Can provide supportive evidence by demonstrating free fluid.  |
| Diagnostic peritoneal lavage                       | Not useful   |
| Contrast enhanced computed tomography              | Initial non-invasive investigation of choice. Indirect findings may suggest ductal injury. Excludes other solid organ injury reliably. |
| Endoscopic retrograde pancreatography              | Most accurate method for detecting ductal injuries. Invasive and associated with complications. Therapeutic procedures possible.       |
| Magnetic resonance cholangiopancreatography (MRCP) | Limited but encouraging experience. Non-invasive. Therapeutic procedures not possible.   |
| Dynamic secretin-enhanced MRCP                     | Limited data suggest highly accurate in demonstrating pancreatic injuries. Non-invasive. Therapeutic procedures not possible.          |

## OPERATIVE MANAGEMENT

Pancreatic trauma can present in three forms.

- 1) A patient with an acute indication for emergency surgery
- 2) A stable patient with symptoms warranting further investigation
- 3) Delayed presentation with epigastric pain and/or a palpable mass

In the acute setting focus is initially on the control of bleeding and contamination and on quantifying the associated injuries. Once these have been dealt with an adequate assessment needs to be made of the pancreas. Indicators of possible pancreatic trauma are a lesser sac fluid collection, haematoma over the pancreas, fat necrosis of the omentum or retroperitoneum and retroperitoneal bile staining.<sup>15</sup>

Adequate mobilization of the pancreas is essential to make an accurate assessment of the injury. In the tail and body of the pancreas this may entail mobilizing the spleen to the midline to allow close inspection of the anterior and posterior portions of the pancreas. For injuries of the pancreatic head a full Kocherisation of the duodenum up to the third part allows adequate assessment.

When inspecting the pancreas it is the integrity of the main pancreatic duct which is of paramount importance. Duct injury can either be seen directly within the injured pancreas or can be inferred from a major pancreatic laceration, penetrating central perforation or severely macerated pancreatic tissue.<sup>10, 15, 36, 37</sup>

The initial management at laparotomy is determined by the grade of injury as assessed at operation. The American Association for the Surgery of Trauma guidelines (Table 5) are widely quoted but there are different approaches between institutions and individual surgeons. The Groote Schuur management policy is more conservative in terms of surgical undertaking when compared to the American Association for the Surgery of Trauma guidelines.<sup>38</sup> This is also reflected in the Johannesburg practice.<sup>15</sup>

**Table 5:** Pancreatic trauma management options based on American Association for the Surgery of Trauma guidelines.

| Grade | Treatment Options   |
|-------|---|
| I     | Fix associated injuries<br>Observation, drainage if needed (operative or percutaneous)  |
| II    | Fix associated injuries, ERP or MRP<br>Observation, drainage if needed (operative or percutaneous)  |
| III   | Fix associated injuries<br>Consider middle segment pancreatectomy, spleen preserving distal pancreatectomy, distal pancreatectomy<br>Drainage suggested, consider pancreatic sphincterotomy   |
| IV    | Fix associated injuries<br>Consider middle segment pancreatectomy, Roux-en-Y to disrupted region, pyloric exclusion, duodenal diverticulization<br>Extensive drainage suggested, consider pancreatic sphincterotomy                                 |
| V     | Fix associated injuries<br>Consider middle segment pancreatectomy, Roux-en-Y to disrupted region, pyloric exclusion, duodenal diverticulization, rarely pancreaticoduodenectomy<br>Extensive drainage suggested, consider pancreatic sphincterotomy |

Grade I and II injuries should be treated with haemostasis and drainage. Primary repair was initially thought to reduce the complication rate<sup>3</sup> however other studies have refuted this and these injuries can be treated conservatively.<sup>10, 39, 40</sup>

Grade III injuries should be treated by distal pancreatectomy and splenectomy. In the haemodynamically stable patient a splenic preserving distal pancreatectomy may be considered. Some authors advocate saving more pancreatic tissue by constructing a pancreaticogastrostomy or a pancreaticojejunostomy.<sup>41</sup>

Grade IV injuries should be treated by external drainage and monitored closely for development of complications. Complicated procedures such as anastomosing a Roux-en-Y loop over the injury carry a risk of anastomotic breakdown and a leak rate which is

probably higher than the natural risk of a pancreatic fistula. Adequate drainage is the preferred surgical treatment of these injuries.<sup>42</sup>

Grade V injuries are by definition “a massive disruption of pancreatic head and duodenum.” Good outcomes with these injuries also follow the tenets of other pancreatic injuries: the simpler the better. Primary duodenal repair and adequate external drainage is the optimum strategy. Some authors recommend pyloric exclusion (gastrojejunostomy and pyloric closure from within with a slowly absorbable suture) to reduce the complication rate. Using this technique Feliciano et al. reported a pancreatic fistula rate of 26% and a duodenal fistula rate of 6.5%.<sup>43</sup> Despite this high complication rate many authors still recommend this treatment for combined pancreaticoduodenal injuries.<sup>9,43</sup>

Only when simpler measures are not at all possible should a Whipple’s resection be contemplated. In the trauma setting this is usually done as a two stage procedure: the first being a damage control laparotomy and within 48 hours the definitive operation.<sup>44</sup>

In stable patients with a possible isolated pancreatic injury there is no role for surgery acutely. Further steps to define a possible ductal disruption need to be taken based on symptoms and investigations.

## PANCREATIC COMPLICATIONS - OVERVIEW

The propensity for pancreatic injuries complicate is well known. Inappropriate initial management of pancreatic injury leads to a higher rate of pancreatic morbidity and mortality.<sup>6</sup> Increasing non-operative management strategies for abdominal trauma mean that the clinician must be aware of the possibility of an occult pancreatic injury in order to avoid complications. These complications can occur following delay in treatment, after conservative non-operative management or after operative intervention. They are related to leakage of pancreatic ductal secretions, infection and stricture formation. The major complications are traumatic pancreatitis, pancreatic fistula,

pseudocyst, stricture, abscess, and ascites. Pancreatic complications may evolve from one into another and may occur in combination.

The terminology to describe common pancreatic complications is largely derived from the Atlanta classification. In 1992 this consensus meeting defined pancreatitis and more clearly defined the terminology relating to the local complications of pancreatitis.<sup>30</sup> The focus was on pancreatitis due to gallstones or alcohol and not traumatic pancreatic injury however its definitions are widely accepted.

The local pancreatic complications defined are:

- (i) Acute fluid collections occur early in the course of acute pancreatitis, are located in or near the pancreas, and always lack a wall of granulation or fibrous tissue.
- (ii) A pseudocyst is a collection of pancreatic juice enclosed by a wall of fibrous or granulation tissue (>4 weeks old).
- (iii) A pancreatic abscess is a circumscribed intra-abdominal collection of pus, containing little or no pancreatic necrosis.
- (iv) Pancreatic necrosis is a diffuse or focal area of non-viable pancreatic parenchyma.

Despite the publication of the Atlanta classification there are still marked variations in terminology between studies. In a review article containing 12 guidelines and 82 review articles, altered definitions of predicted severity of acute pancreatitis, actual severity, and organ failure were used in over half of the studies. The authors noted a large variation in the interpretation of the Atlanta definitions of local complications, especially relating to the content of peripancreatic collections.<sup>45</sup> The Atlanta classification does not define pancreatic fistulae (see later section on pancreatic fistulae) or pancreatic ascites.

While the natural history of traumatic pancreatic complications is not described as a separate entity in the literature, using recognized terms from the pancreatitis literature allows comparison and facilitates discussion.

## INCIDENCE OF PANCREATIC COMPLICATIONS

The complication rate following pancreatic trauma is notoriously high.

**Table 6:** Comparison of pancreatic complication and mortality rates in pancreatic trauma<sup>10</sup>

| <b>Study</b>                 | <b>No. Patients</b> | <b>No. Pancreas related complications (%)</b> | <b>Pancreas specific mortality (%)</b> |
|------------------------------|---------------------|---|--|
| Cogbill, 1982 <sup>46</sup>  | 38                  | 34  | 5                                      |
| Jones, 1985 <sup>47</sup>    | 450                 | 8   | 3                                      |
| Smego, 1985 <sup>39</sup>    | 57                  | 19  | 3                                      |
| Mansour, 1989 <sup>48*</sup> | 79                  | 35  | 17                                     |
| Wisner, 1990 <sup>49</sup>   | 85                  | 25  | 0                                      |
| Ivatury, 1990 <sup>50</sup>  | 76                  | 29  | 8                                      |
| Cogbill, 1991 <sup>51</sup>  | 75                  | 45  | 3                                      |
| Akhrass, 1997 <sup>13</sup>  | 72                  | 29  | 0                                      |
| Patton, 1997 <sup>10</sup>   | 123                 | 31  | 2                                      |

\*The mortality rate is much higher in combined pancreaticoduodenal injuries as reported by Mansour et al., the obvious outlier in the above table, who reported a 17% mortality in their series of purely combined injuries.

## AVOIDANCE OF COMPLICATIONS

The principles of management of pancreatic trauma focus on the need for early diagnosis and accurate definition of site and grade of the injury in order to facilitate optimal intervention. Delays can result in serious complications.

### SPECIFIC COMPLICATIONS - PANCREATIC FISTULA

There are a variety of definitions of pancreatic fistulae based on the fistula volume, duration, amylase content, and route. This has resulted in marked variations in the reported incidence of pancreatic fistulae in the literature. An international study group paper defined a pancreaticocutaneous fistula as a drain output of any measureable volume after post-operative day 3 with an amylase content greater than three times the serum amylase level.<sup>52</sup> This communication between the disrupted pancreatic duct and the skin causes significant morbidity due to malnutrition, skin excoriation and infection.

The majority of literature dealing with pancreatic fistulae relates to elective surgery or pancreatitis, and not primarily to traumatic injury of the pancreas. In a review article by Alexakis et al. the incidence of pancreaticocutaneous fistulae is reported at 12 – 13%.<sup>53</sup> Fistula rates are however similar whether the pancreatic trauma is accidental or by design (Table 7).

**Table 7:** Incidence of pancreatic fistulae following pancreaticoduodenectomy, distal pancreatectomy and pancreatic trauma.<sup>53</sup>

| <b>Cause</b>            | <b>Total No. of patients</b> | <b>No. of fistulae</b> | <b>Fistula rate (%)</b> |
|-------------------------|------------------------------|------------------------|-------------------------|
| Pancreaticoduodenectomy | 3268                         | 422                    | 12.9                    |
| Distal pancreatectomy   | 617                          | 80                     | 13                      |
| Pancreatic trauma       | 243                          | 29                     | 12                      |

Various other types of pancreatic fistulae can occur. Internal fistulae can occur between the pancreatic duct and the bowel, the peritoneum, or the pleural cavity.

Pancreaticobronchial, pancreaticomediastinal and pancreaticopericardial fistulae have also been described but are extremely rare and are more commonly associated with chronic pancreatitis.<sup>54</sup>

Imaging of fistulae can be done by fistulography, CT scan, magnetic resonance cholangiopancreatography (MRCP), and endoscopic retrograde pancreatography (ERP). CT scan or MRI may give valuable information on associated injuries and degree of parenchymal damage which may influence management. ERP is the gold standard in delineating pancreatic fistulae. ERP demonstrates filling of the pancreatic ducts and extravasation of contrast in real time. Fluid collections can be shown to fill from the pancreatic duct. The degree of disruption of the pancreatic duct can be assessed as a side branch extravasation, a minor main duct leak (with continuity of the main duct distally), or a major main duct leak (with complete disruption/cut-off). ERP also offers therapeutic options at the same procedure.

There is no universally accepted prevention strategy to reduce the incidence of pancreatic fistulae. Somatostatin and its analogues (octreotide) have not been shown to have an effect following pancreatic surgery in a large meta-analysis.<sup>55</sup> The benefit of fibrin glue at surgery is also not proven.<sup>56, 57</sup>

Treatment options for pancreatic fistulae are conservative, endoscopic or surgical. An initial conservative approach to pancreatic fistulae is justified in that 80% of fistulae will close with appropriate nutrition, control of sepsis, correction of fluid and electrolytes, and adequate skin care. However the duration of hospital stay is often prolonged and currently there is no method to determine which patients will benefit from early endoscopic intervention to facilitate earlier resolution of their fistula.<sup>58</sup>

Miller et al. and Prinz et al. used a classification scheme based on the pancreatic duct status: an end fistula is when the pancreatic duct is completely disrupted and a side

fistula being is when the main pancreatic duct opacifies beyond the leak site.<sup>59, 60</sup> In a recent series discussing the contemporary treatment strategies for pancreatic fistulae following surgery none of the patients with “end fistulae” healed with conservative treatment.<sup>61</sup> Thus assessment of the pancreatic duct integrity can help to select those patients who are unlikely to respond to conservative treatment. In centres with the necessary expertise there is a trend towards earlier endoscopic assessment and intervention for pancreatic fistulae secondary to pancreatitis (acute or chronic) instead of a long-term conservative approach.<sup>62</sup>

Opacifying the pancreatic duct is not without risk and a high injection pressure is a known risk factor for post ERCP pancreatitis. Even with adequate contrast up to 10% of fistulae may not be evident on ERP (although this was a study of pancreatitis patients.)<sup>63</sup> In these patients with a fistula confirmed by other means a trial of pancreatic sphincterotomy (and possibly stent placement) is still warranted to favour physiological drainage and hasten fistula closure.

The aim of endoscopic therapy is to reduce the pancreatic duct pressure by pancreatic sphincterotomy, stent placement or nasopancreatic drain. Stenting beyond the defect also results in increased resolution of fistulae. Up to 90% of patients with pancreatic fistulae can be successfully treated endoscopically.<sup>62</sup> The optimum length of stenting is not known and the stent itself may lead to ductal epithelial damage and subsequent stricturing. In previous healthy pancreatic ducts these strictures are rarely clinically significant and often disappear on follow-up.<sup>62, 63</sup> Canty et al.<sup>64</sup> removed two patients' stents under weeks after placement and still noted some clinically insignificant ductal changes in one patient. Stents are often left in for up to 2 months in endoscopic treatment of post-surgical pancreatic fistulae and even longer in chronic pancreatitis patients. Halttunen et al.<sup>62</sup> advised that stents be removed as soon as feasible.

The final treatment option for pancreatic fistulae is surgery. However a trial of endoscopic treatment is warranted in most patients given the morbidity and mortality associated with resectional pancreatic surgery. This is especially true in fistulae

occurring in the head of the pancreas where pancreaticoduodenectomy has significant morbidity and mortality and endoscopic access is relatively good. Resectional surgery of the tail of the pancreas is less technically demanding and endoscopic access quite challenging in terms of stenting. Thus while a trial of endoscopic therapy is warranted in most patients the location of the defect will influence persistence with such therapy before proceeding to surgery. Pancreatic tail resection has been the preferred treatment option for trauma patients.<sup>62</sup>

#### SPECIFIC COMPLICATIONS - PANCREATIC PSEUDOCYST

A pancreatic pseudocyst is defined as a pancreatic fluid collection more than 4 weeks old and surrounded by a wall of fibrous or granulation tissue. Pseudocysts may vary markedly in their symptomatology, size, wall thickness, location, content and whether they are single or multiple.

Methods of classifying pseudocysts have been proposed by D'Egido and Bornman in separate papers.<sup>65, 66</sup> Three distinct types of pseudocysts were identified in chronic pancreatitis patients, with the message extrapolated to pancreatic trauma being that management differs based on the status of the main pancreatic duct. Pseudocysts may occur following minor duct disruption or parenchymal injury and have normal major pancreatic duct anatomy with no demonstrable communication between the pancreatic duct and the cyst. Alternatively there may be a main pancreatic duct disruption and hence a significant incidence of duct-pseudocyst communication.

Initial treatment of uncomplicated pseudocysts with minimal symptoms is “watchful waiting” as 40% will resolve without intervention.<sup>67</sup> Of those pseudocysts persisting for longer than 6 weeks the need for intervention was based on the fact that these rarely resolved and had a 50% complication rate.<sup>68</sup> However in more recent studies conservative treatment showed a more indolent course with the authors advocating a less interventional approach – although neither of these studies looked at endoscopic treatment options.<sup>69, 70</sup>

In evaluating a pseudocyst it is important to consider alternative diagnoses such as a cystic pancreatic neoplasm. In the trauma setting this is unlikely and if there are no concerning features such as septations or associated inflammatory changes on CT scanning it is safe to treat these patients as traumatic pseudocysts. CT scanning also allows the content of the pseudocyst to be evaluated. The amount of necrotic pancreatic debris may necessitate repeat interventions for effective drainage. Incomplete drainage can lead to recurrent sepsis and incomplete symptom resolution.

For endoscopic transmural drainage the wall of the pseudocyst should be well formed and this typically occurs after 4 – 6 weeks. The wall should be in close apposition to the stomach or duodenum. This is assessed on CT scan and by the presence of a bulge at endoscopy. EUS offers further assistance in assessing apposition when there is no bulge and can help avoid blood vessels in the potential drainage site. Clear benefit of one method over the other has not been demonstrated and local expertise and the individual patient presentation should determine treatment.<sup>71</sup>

A pseudocyst complicate with a pseudoaneurysm and this represents a contraindication to endoscopic treatment, unless prior embolization has been successful.

Gastrointestinal bleeding, sudden pseudocyst expansion and an unexplained drop in haematocrit are suggestive of a pseudoaneurysm. The presence of pseudoaneurysm can be assessed on the arterial phase of a CT scan.

Optimal treatment is achieved by effective drainage of the pseudocyst.<sup>72</sup> Some authors take the view that simple drainage of the pseudocyst is sufficient and the inherent status of the duct need not be known. However the risk of recurrent pseudocyst, pancreatic fistula or downstream chronic pancreatitis from a stricture, remains if there is not a permanent drainage route for residual pancreatic parenchyma.<sup>73</sup>

Treatment options are percutaneous, endoscopic or surgical. These need to be individualized to the patient and depend on the availability of the various options.

Percutaneous techniques are easily available, are safe in sick, multiply injured patients and offer effective drainage with the option of repeated flushing of the drain if there is a concern of sepsis. This treatment can be definitive in patients where the pancreatic duct does not communicate with the pseudocyst. However in patients with persistent communication and possible downstream stricturing there is a high rate of recurrence or formation of a pancreatic fistula. In the paediatric literature a paper reported on two children who had non-operative management of traumatic pancreatic pseudocysts with associated pancreatic duct injury. After percutaneous drainage the pancreatic complications only resolved after 45 days to 2 months, with the use of TPN and octreotide infusion in one patient.<sup>74</sup> It must be noted however that these “pseudocysts” would be defined as acute fluid collections by the Atlanta classification.

Endoscopic drainage offers successful drainage in 82-89% of pseudocysts, has a complication rate (of bleeding) requiring surgical intervention in 5% and has a recurrence rate of 6 – 18% with up to 4 years follow-up.<sup>75</sup> In a series of 37 patients looking specifically at endoscopic efficacy the procedure was technically possible in 92% of patients. The reported morbidity was 16%, with no deaths and endoscopic drainage was a definitive treatment in 65%.<sup>76</sup> The majority of the literature deals with pseudocysts as a complication of pancreatitis with few reports dealing with pseudocyst drainage following abdominal trauma.

Lin et al.<sup>77</sup> reported on 9 patients with a pseudocyst following blunt trauma. They concluded that percutaneous drainage should be considered the primary therapy when there is no major pancreatic duct injury and the injury is distal. Only if there is no resolution do they advise an ERP to prove a proximal duct injury. If ERP demonstrates a disrupted but not obstructed duct then pancreatic stenting may avert surgical resection. However if there was obstruction/complete cut-off then the authors felt surgical resection was required. Two of their patients had ERP and pancreatic duct stenting in the acute setting. Despite successful stenting these patients went on to develop “pseudocysts” noted on days 7 to 20 following the injury. By the Atlanta classification some of these “pseudocysts” would be termed acute fluid collections. This

would explain why, in this study published in 2006, there were no endoscopic cystenterostomies of the “pseudocysts”. The wall of granulation tissue would not have been sufficiently formed to allow safe endoscopic drainage.

Buccimaza et al.<sup>21</sup> reported six patients in their series of isolated main pancreatic duct injuries who presented (after a delay from their injury) with an epigastric mass defined as a pancreatic pseudocyst on subsequent CT scan. ERP was able to accurately locate the ductal injury by cut-off or extravasation in all patients. Various endoscopic techniques were used with some success (Table 8).

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**Table 8:** Traumatic pancreatic pseudocyst: endoscopic technique and result. <sup>21</sup>

| <b>Endoscopic technique</b>  | <b>Treatment</b>                           |
|--|--|
| Percutaneous transgastric endoscopically assisted gastro-pancreatic cyst stent decompression.            | Successful                                 |
| ERP needle knife pancreatico-cyst gastrostomy with subsequent endoscopic tract dilatation 2 weeks later. | Successful                                 |
| ERP gastro-pancreatic cyst stent decompression with cyst resolution and subsequent stent removal.        | Successful                                 |
| ERP gastro-pancreatic cyst stent decompression with stent migration                                      | Failed – subsequent distal pancreatectomy  |
| ERP gastro-pancreatic cyst stent decompression with stent migration                                      | Failed – subsequent pancreaticojejunostomy |
| ERP gastro-pancreatic cyst stent decompression.  | Successful                                 |

Open surgery is considered the gold standard of pseudocyst treatment due to a low recurrence rate of 5%. However surgery does carry a significant morbidity and mortality.<sup>78</sup> Surgical procedures aim to drain the pseudocyst via cystgastrostomy or cystenterostomy. These procedures have also been described laparoscopically.<sup>79</sup> The use of surgery has been tempered by the widespread increase in the use of endoscopic techniques. Endoscopic drainage has a low complication rate, is very effective and should be attempted in all patients in whom it is feasible with surgery reserved for those patients in whom endoscopic drainage fails.

#### SPECIFIC COMPLICATIONS - PANCREATIC STRICTURE

Pancreatic trauma can cause various degrees of duct disruption and subsequent healing can result in stricture formation. The injury can vary from a slight narrowing of the duct to complete duct cut-off with no visualization of the pancreatic duct beyond the injury.

Various management algorithms have been proposed for ductal disruptions. In all cases the clinical situation must be adequately assessed. Minor disruptions may heal with conservative treatment. Decompression of the pancreatic ductal system to promote normal flow and drainage of pancreatic juices into the duodenum can be done by a pancreatic sphincterotomy. Dilatation and stenting of strictures further aids this process.

The technique of endoscopic stenting varies between centres and must be adapted to the locations and severity of the pancreatic injury. When possible a stent placed across a defect is preferable however this may be technically impossible particularly if the injury is complete or distal. When unable to bridge the defect the stent can be left into the collection or up to the defect. Failing this a short trans-sphincteric stent or sphincterotomy alone can be used in an attempt to decompress the pancreatic ductal system.

The success rate of such endoscopic therapy is not known as there are no large studies. Rather patients proceed directly to surgery based on the degree of duct disruption at ERP and endoscopic intervention is not attempted or reattempted.

#### COMPLICATIONS OF ENDOSCOPIC RETROGRADE PANCREATOGRAPHY

ERP is not a benign procedure. It is invasive, requires sedation and is prone to various complications. The major complications associated with ERP are pancreatitis, bleeding, perforation and sepsis. Other events are rare but may be equally life threatening and include cardiopulmonary and sedation-related complications, contrast allergy and distal embolism, systemically or into the portal system.

It should be noted that all the major review articles do not distinguish between endoscopic biliary interventions and endoscopic pancreatic interventions. It is however noted that an endoscopic retrograde cholangiogram (ERC) in a blocked biliary system is more likely to result in post ERC sepsis and that imaging the pancreatic system with ERP is more likely to provoke pancreatitis.

Post ERP pancreatitis is the most common complication of ERCP. A transient increase in serum amylase post ERCP is found in up to 75% of patients. Acute clinical pancreatitis - hyperamylasaemia combined with abdominal pain requiring hospitalization is uncommon. The overall incidence is reported at 3% in most studies.

Post ERP bleeding is a relatively uncommon complication and is most commonly observed after sphincterotomy. Patients with a bleeding diathesis and those with unfavourable anatomy are most at risk and require periprocedural optimisation. The incidence in a large review article of 21 studies found a bleeding rate of 1.3%, 226 of 16,855 patients, with eight deaths (0.05%) related to bleeding.<sup>80</sup> The length of sphincterotomy is accepted as a risk factor for bleeding and should never be longer than necessary. The experience of the endoscopist and his or her case volume is a risk factor as is the use of a needle-knife sphincterotomy or a rapid "zipper cut". Bleeding can typically be dealt with by injection sclerotherapy, followed by electrocautery or clipping of visible vessels. Refractory bleeding may need angiographic embolization or even surgery. Catastrophic bleeding can occur when draining a pseudocyst. A pseudoaneurysm should be embolised prior to drainage. EUS guidance is advised for patients with evidence of segmental portal hypertension to reduce the risk of hitting significant vessels at the time of pseudocyst drainage.

## ANALYSIS OF PREVIOUS STUDIES LOOKING AT PANCREATIC TRAUMA AND ENDOSCOPIC RETROGRADE PANCREATOGRAPHY

### **Endoscopic retrograde cholangiopancreatography in pancreatic trauma<sup>81</sup>**

In 1988 Barkin et al. opened their article with the statement: "Pancreatic ductal rupture can be an elusive diagnosis." Early studies of ERP in pancreatic trauma focused entirely on the diagnostic utility of ERP with no interventions being performed. The authors reported on 14 consecutive patients with abdominal pain and a suspected pancreatic injury secondary to trauma who underwent ERP. ERP was 100% sensitive and specific for pancreatic ductal rupture while no combination of serum amylase, CT scan and peritoneal lavage was as effective.

### **Blunt Pancreatic Trauma: Prospective Evaluation of Early Endoscopic Retrograde Pancreatography<sup>82</sup>**

In this study from the University of Miami, Whittwell et al. reported on nine patients with suspected pancreatic injury who underwent ERP. Eight were technically successful. Two patients with major ductal injury were treated operatively while 6 patients with normal ducts were treated conservatively. The authors concluded that ERP was safe and accurate in assessing the pancreatic ductal system and in guiding management.

### **Contribution of endoscopic retrograde pancreatography in the management of complications following distal pancreatic trauma<sup>83</sup>**

This study by Wind et al. demonstrates the natural history of pancreatic complications following trauma. Thirty-eight patients with distal pancreatic trauma developed complications, 16 fistulae and 12 pseudocysts. In 16 patients ERCP was used to determine management. Two patients with a side duct disruption had pancreatic fistulae which settled after 17 and 21 days respectively. One patient with a pseudocyst and an intact pancreatic duct settled with external drainage alone. Eleven patients had a

pancreatic resection based on the finding of complete ductal disruption at ERCP. Two patients with indications for acute laparotomy had ERCP assessment prior to surgery. One patient demonstrated ductal disruption and had an uncomplicated splenic preserving distal pancreatectomy. The other, with an intact pancreatic duct on ERP, had a drain placed to the pancreas at laparotomy and recovered uneventfully. The delay to ERCP (excluding two preoperative ERCPs) was 14 days to 4 years post injury. Nineteen patients had a main pancreatic duct (MPD) injury treated without initial resection. Fourteen patients developed fistulae with 4 healing spontaneously and 10 requiring surgery (7 for persistent fistulae, 2 for subsequent pseudocyst development and 1 for chronic pain). The remaining five patients with MPD injury developed pseudocysts ultimately requiring surgery.

This study shows that the integrity of the pancreatic duct is integral to the development of pancreatic complications. When demonstrated to be intact or with only a minor side leak non-operative management was successful – both for fistulae and pseudocysts. Persistent pancreatic complications generally had major ductal disruption at ERCP and required surgery.

### **The role of endoscopic retrograde pancreatography in the treatment of traumatic pancreatic duct injury<sup>84</sup>**

In 2001 Kim et al. reported on 23 patients undergoing ERP, with 14 patients having pancreatic duct injuries demonstrated. CT scan was used in 11 patients with main pancreatic duct (MPD) injury being successfully predicted in 6 patients. In 3 patients pancreatic injury was suspected but not accurately graded. In two patients a MPD injury was falsely predicted. At ERP 3 of the pancreatic duct injuries were side branch leaks into pancreatic parenchyma which settled on conservative treatment. Of the 11 MPD injuries 8 showed leakage into the peritoneum and were explored surgically. Five patients had distal pancreatic resection, one had a pancreaticoduodenectomy and the remaining two had simple surgical drainage due to severe adhesions (both had a significant delay to surgery). Three patients with main pancreatic duct injury and

extravasation limited to pancreatic parenchyma were successfully treated by endoscopic stent insertion. The stents were left in situ for 3 months and in 2 patients asymptomatic stricturing was noted.

The authors analysed their data based on delay to ERP and its relationship to pancreatic complications. The 9 patients who had early ERP were compared to the 5 who had an ERP after 72 hours. There was a 100% complication in the late group compared to 22% in the early group. The authors concluded that early ERP reduced the complication rate. It must be noted that numbers were small and despite these complications the length of hospital stay between the two groups was not statistically significant.

An ERP in the acute setting was feasible and useful in guiding treatment. The authors also concluded that the AAST grading of pancreatic injuries be refined to include the degree of pancreatic duct disruption.

#### **Treatment of pancreatic duct disruption in children by an endoscopically placed stent<sup>64</sup>**

Also in 2001 Canty and Weinman from San Diego treated two children with traumatic pancreatic duct disruption endoscopically. In one patient the stent was passed across the site of injury while in the other this was unsuccessful and a simple transampullary stent was left in place. The stents were removed very early at 11 and 12 days respectively. In one patient a stricture was noted at the injury site on follow-up ERP. This was dilated and although an incidental pseudocyst was noted on follow-up CT scan (which subsequently resolved) no further treatment was necessary.

These patients had intense follow-up and if one looks hard enough minor pancreatic abnormalities may be evident however the clinical significance is debateable. The two children had AAST Grade II and III injuries with a “side hole” injury in an otherwise intact main duct. Endoscopic treatment can be a successful method of treating minor duct

disruptions however the natural history of these minor disruptions is good even when left alone.

### **The value of endoscopic diagnosis and the treatment of pancreas injuries following blunt abdominal trauma<sup>85</sup>**

Wolf et al. from Germany reported on 5 patients with suspected pancreatic injury undergoing ERP. Only 2 patients had ductal disruption at ERP. One was after a laparotomy and pancreatic resection while the other was initially treated non-operatively. Both leaks were successfully treated by endoscopic stenting. Stents were removed after 16 days in one patient and 3 months in the other.

The rarity of the injury is illustrated as the study was carried out over 5 years. If no ductal disruption was found patients did not develop pancreatic complications.

### **Long-term results of endoscopic stent in the management of blunt major pancreatic duct injury<sup>86</sup>**

In 2006 Lin et al. reported on the long-term follow-up of patients treated with stenting of major pancreatic duct disruption and showed less favourable results than other studies. One patient died 3 days post stent insertion due to multi-organ failure. The remaining five patients all had stent related complications with multiple reinterventions.

One patient underwent 15 ERPs related to stent changes with the average patient having eight ERPs. The average duration of treatment was 25 months. The authors concluded that stenting could avoid surgery but given the “inevitability of stricturing” surgery should remain the treatment of choice for injuries involving the body and tail of the pancreas.

Treating main pancreatic duct injuries with stenting is not a single intervention and multiple reinterventions are common. Protracted endoscopic therapy may not be preferable to surgery for some patients.

### **Isolated main pancreatic duct injuries spectrum and management<sup>21</sup>**

From Durban, South Africa this retrospective review by Buccimazza et al. in 2006 of 16 patients (14 blunt and 2 penetrating) divided patients into acute and chronic presentations. The acute patients all proceeded to surgery based on an acute abdomen in three and CT evidence of pancreatic injury in six. The operations performed were six splenic-preserving distal pancreatectomies, one suture repair and drainage, one pancreaticogastrostomy and one pancreaticojejunostomy. None of these patients underwent ERP. In the delayed presentation group (from 2 weeks to 6 months post injury) six patients presented with an epigastric mass shown to be a pseudocyst and one patient presented with sepsis. The patient with sepsis died after three days following an attempted necrosectomy. ERP was used in 6 patients with delayed presentation and endoscopic intervention successful in 4.

### **Traumatic pancreatic duct injury in children: minimally invasive approach to management.<sup>34</sup>**

Houben et al. from Kings College Hospital, London reviewed a minimally invasive management approach in 15 children admitted with pancreatic trauma. A significant delay was noted in 13 due to minimal presenting symptoms.

Eleven children had a CT scan and an ERP. CT was reported to accurately identify the pancreatic injury in 10 patients although the authors do not report whether it was able to accurately grade the pancreatic ductal injury. In one case with a normal CT subsequent ERP demonstrated a Grade IV injury. The higher pick-up rate of pancreatic injury compared to other studies was attributed to the delay in presentation. CT features of pancreatic injury being harder to detect in the acute setting. MRCP was performed in 7

children with 4 going on to have an ERP. Of the three who were treated conservatively following MRCP two had minor ductal injuries demonstrated, but due to minor clinical symptoms ERP was withheld. These two patients and the other patient had no ductal disruption demonstrated all did well with no further intervention.

In patients with both an MRCP and an ERP the non-invasive test was 100% sensitive. By using an MRCP in patients with a clinical suspicion of pancreatic duct injury (based on CT or clinical suspicion) three patients were spared unnecessary ERPs. The reason that MRCP wasn't more widely used during this study was that it only became available during the latter years of the study.

Of the twelve children undergoing ERP nine had endoscopic stent placement: three across the ductal defect and six into the fluid collection at the site of ductal disruption. There were two technical failures to place a stent: due to a tortuous duct in one and a pancreatic divisum in another.

Three stents were exchanged for larger stents (5-7 French) to allow better drainage of residual collections and in one patient a blocked stent was replaced after 4 months. All stents were removed at a median of 127 days (range 56 – 193 days). Two patients had mild self-limiting pancreatitis following stent insertion.

Two patients had endoscopic cyst-gastrostomy drainage of pseudocysts (on days 38 and 41 respectively). One of these proceeded to surgery when the pseudocyst recurred 8 weeks after removal of the internal drain. Eleven of the children were treated with parenteral nutrition for a median of 28 days (range 11 – 50) and the total hospital stay was for a median of 41 days. (range 15 – 67) Despite successful endoscopic treatment the patients were in hospital for a protracted period of time due to this cautious approach to oral feeding. The authors did not report any pancreatic strictures in their series following removal of the stents despite a relatively long duration of stenting.

## **Blunt pancreatic trauma and pseudocyst: Management of major pancreatic duct injury<sup>77</sup>**

Lin et al. reported the long term outcome of children with endoscopic drainage of their pseudocysts as very good in 2007. There were no recurrences in nine patients (8 due to trauma). In two patients with assessment of their pancreatic duct there was complete cut-off with no communication into the pseudocyst.

## **Endoscopic retrograde cholangiopancreatography in patients with pancreatic trauma<sup>87</sup>**

In 2010 Rogers et al. from San Francisco published the largest series in the literature consisting of twenty-six patients accumulated over 13 years. Nine injuries were penetrating 16 blunt with 1 being a complication following a total colectomy. Over half (54%) underwent emergency laparotomy on admission. Forty-six percent were initially treated non-operatively and had further diagnostic work-up. The entire study group underwent ERP at some stage during their admission. The indication for ERP was if serum amylase, lipase, CT scan or laparotomy findings suggested a pancreatic injury. Five were carried out on the day of injury, 2 prior to laparotomy, 1 during laparotomy and 2 after abdominal closure.

Eight patients (31%) had a negative ERP with one patient being diagnosed with an unsuspected gallbladder rupture. A total of eighteen patients (69%) were found to have pancreatic duct injury. Endoscopic interventions included five sphincterotomies, one had a nasopancreatic drain, and six had pancreatic duct stent placements (7 – French). All stents were removed 4-8 weeks after placement and all patients demonstrated a healed MPD. Strictureing was not reported. Nine patients were discharged without further surgical treatment following endoscopic intervention. Follow-up at 6 – 24 months showed these patients to be well.

Three patients, including one patient with a stent placed, were taken to theatre for a distal pancreatectomy and splenectomy based on the ERP findings. Six patients had minor injuries not requiring intervention. One of these patients went on to develop a pseudocyst which was treated operatively with a pancreatic cystgastrostomy. Fifteen of the patients with proven ductal injury received an octreotide infusion for an unspecified amount of time.

This series shows that endoscopic intervention can be successful in guiding operative management, and as a therapeutic modality can potentially reduce the need for further surgery. The negative ERP rate of 31% shows a low threshold for this investigation and the role of MRCP to reduce this rate needs to be explored. The number of patients spared an ERP would be even higher if MRCP could successfully assess the minor injuries picked up on ERP which were treated conservatively. The duration of follow-up of these patients was variable as is typical for trauma patients.

### **Operative vs. nonoperative management of blunt pancreatic trauma<sup>88</sup>**

Also in 2010 Wood et al. from Colorado, USA noted a lack of management protocols for pancreatic trauma in children with debate being between operative and non-operative management strategies. Their study took 11 years to accrue 43 patients. Fifteen patients underwent ERP 12 of which were technically successful.

All patients with positive ERP findings had evidence of pancreatic injury on CT scan however it wasn't mentioned whether this was under or over-assessed except that 3 patients with Grade I injuries were found to have no injury, 2 at laparotomy and 1 at ERP.

The major conclusion was that non-operative management of pancreatic injuries carries a significantly higher risk of complications than operative intervention (73% vs. 21%,  $p=0.02$ ). This did not however translate into increased hospital stay or readmission rates. Of the patients undergoing successful ERP there were 11 Grade III and 1 Grade

IV injury. Six patients with major main duct disruption were managed operatively while 6 patients were managed non-operatively: Four main duct injuries without complete transection and 2 with side branch injuries.

Despite an ERP assessment the authors noted an increased pancreatic complication rate in the non-operatively treated patients. (86% vs. 29%,  $p=0.02$ ) They did not specify the location of the MPD injury or the details of the complications. Of 6 patients treated conservatively post ERP only one had a successful stent placement. It was not reported whether a sphincterotomy was performed at ERP in the other 5 patients. Whether routine sphincterotomy offers a benefit in reducing complications in these patients is debateable. This study highlights the technical difficulties of endoscopic treatment and the importance of reporting specific details regarding the nature of the injury and the form of the complications in order to adequately assess treatment.

### **Summary of previous studies looking at pancreatic trauma and endoscopic retrograde pancreatography**

There is an evolution in the role of ERP in the literature with time. ERP was initially used in a purely diagnostic role with the status of the main pancreatic duct used to decide on whether surgery was required.<sup>81-83</sup> With the availability of endoscopic stenting various authors attempted stenting of the pancreatic duct in an effort to prevent or treat complications.<sup>34,64,72,84-88</sup>

The success of endoscopic interventions depends on various factors and can be difficult to assess. Various authors have reported the success of endoscopic stenting. However the injuries are sometimes minor, and with the natural history of pancreatic injuries being poorly documented assessing these interventions is difficult. The timing of the endoscopic intervention is a further consideration. However ERP is rarely performed prior to surgery in the acute setting with only isolated cases reported within various series.

Technical success rates of ERP depend on the intention to treat. When limited to purely diagnostic imaging there have been 4 reported failures in visualising the pancreatic duct.<sup>64,77,88</sup> The technical success rate of stenting is difficult to assess however when the surrogate marker of success is the avoidance of surgery there are still 31 patients across 6 studies who ultimately required surgery even in the era of interventional ERP.<sup>34,64,84-88</sup>

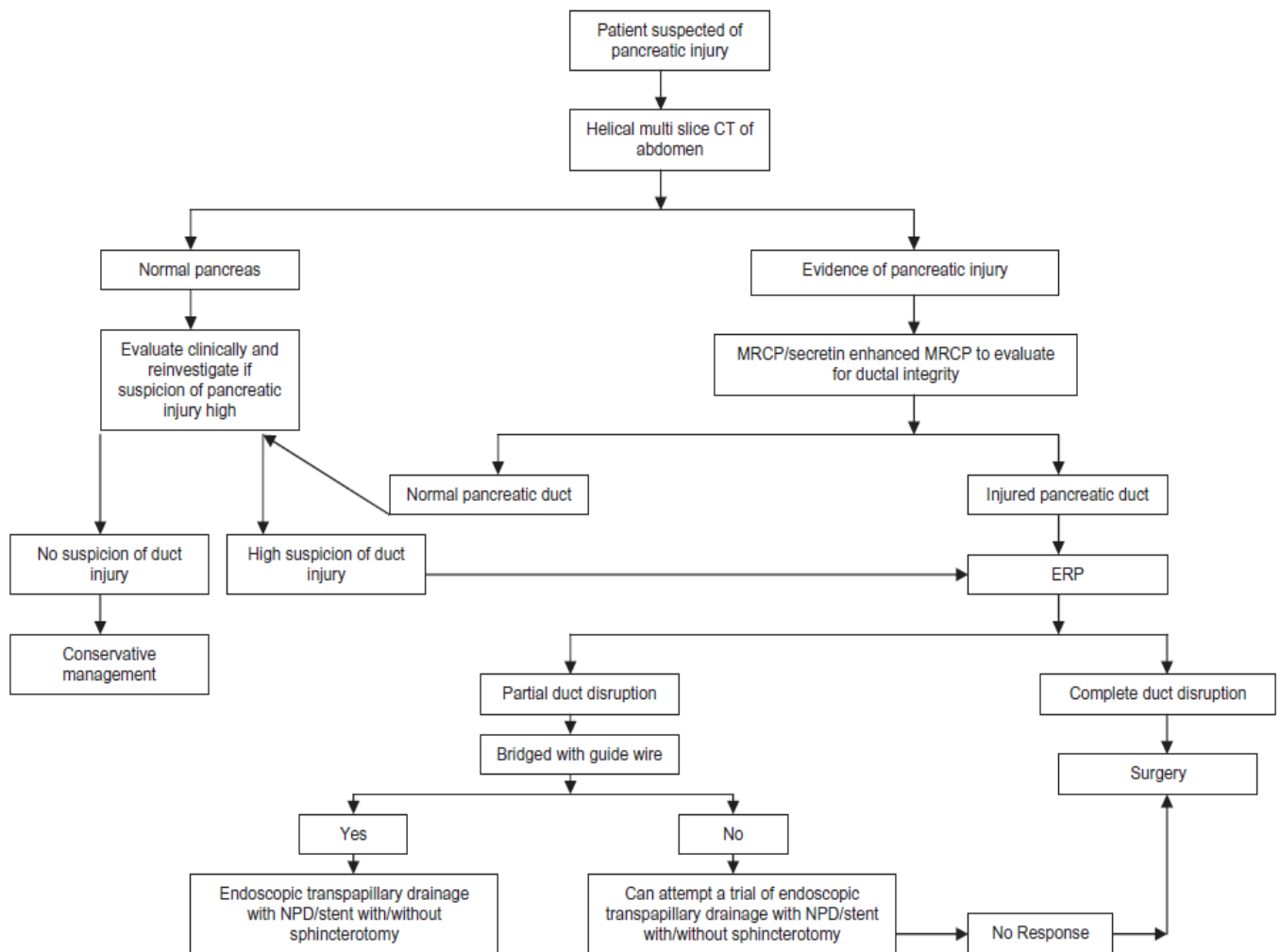
The complication of stricturing after pancreatic duct stenting is mentioned in various studies however it is reported as asymptomatic in most series.<sup>34,64,85,87</sup> Even Lin et al.<sup>86</sup> who cited it as a major concern had no patients requiring surgery after endoscopic intervention. The optimum duration of stenting is not known however it seems that prolonged stenting increases the incidence of strictures.

The utility of ERP in the management of pseudocysts is well put forward by Buccimazza et al.<sup>21</sup> and Lin et al.<sup>77</sup> in their respective papers. In the clinical scenario of pseudocysts the effectiveness of ERP is easily quantifiable.

More recent studies have focused on the utility of ERP in patients with established pancreatic complications.<sup>87</sup>

**Endoscopic retrograde pancreatography in pancreatic trauma: Need to break the mental barrier<sup>11</sup>**

Bhasin et al. from Chandigarh, India analysed seven studies looking at endotherapy for pancreatic trauma. The authors discuss ERP in its various contexts: diagnostic ERP, early therapeutic ERP and delayed therapeutic ERP in dealing with the complications of pancreatic trauma. The authors proposed an algorithm detailing the role of ERP in pancreatic trauma (Figure 5).



**Figure 5:** Role of ERP in stable patients in early phase of traumatic pancreatic injury.<sup>11</sup>

The authors noted that published experience is in the form of case reports, retrospective case series and 2 studies published in abstract form only. The studies were comprised of small numbers. They felt that there is mental barrier to performing ERP in the early phase of polytrauma and that this needs to be overcome in order to assess the role of pancreatic stenting in pancreatic trauma. The utility of ERP in dealing with delayed complications was acknowledged.

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## SUMMARY OF INTRODUCTION

Pancreatic trauma is a complex and challenging problem. The pancreas is difficult to treat and even in optimum circumstances the complication rate is significant. These complications relate to disruption of the main pancreatic duct. ERP serves to confirm the diagnosis and to offer different therapeutic options. The long duration of patient accrual, differences in classification of injuries and complications as well as the timing and method of endoscopic intervention make comparing these studies difficult. The recent addition of MRCP in assessing pancreatic ductal integrity adds another dimension to the interpretation of the data. The role for ERP in managing pancreatic trauma is evolving and varies between institutions. This introduction summarizes all the available data on the role of ERP in pancreatic trauma providing a framework with which to analyse the experience at our institution.

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## HYPOTHESIS

Endoscopic retrograde pancreatography can define the extent of the main pancreatic duct injury and facilitate the treatment of the local complications of pancreatic trauma.

## AIMS

The aim of this study was to describe the experience at our institution of complicated traumatic pancreatic injuries which required ductal assessment and possible intervention with ERP. Our data was analysed and our results compared to those in the international literature to define the role of ERP in treating the local complications of pancreatic trauma.

## METHODOLOGY

### Patients:

We prospectively collected a database which included all patients who sustained a pancreatic injury and were treated at Groote Schuur Hospital (Level 1 equivalent trauma centre) from January 1983 to January 2010. All patients who underwent endoscopic retrograde pancreatography (ERP) were reviewed. Folders, radiological and laboratory investigations, operative and ERP notes were studied. Data was entered into a specifically formulated relational database.

Variables documented included demographics, mechanism and date of injury, clinical presentation and delay in presentation, associated injuries, grade of pancreatic injury, amylase levels, surgical findings and management, complications and their management, ERP findings and management, duration of ICU stay, length of hospital stay, morbidity and mortality.



\*In the rare case of a devitalizing, destructive injury a pancreaticoduodenectomy may be required. These cases would be excluded from subsequent ERP management due to the nature of the operative resection.

Injuries were graded as per the Pancreas Organ Injury Scale of the American Association for the Surgery of Trauma.<sup>24</sup>

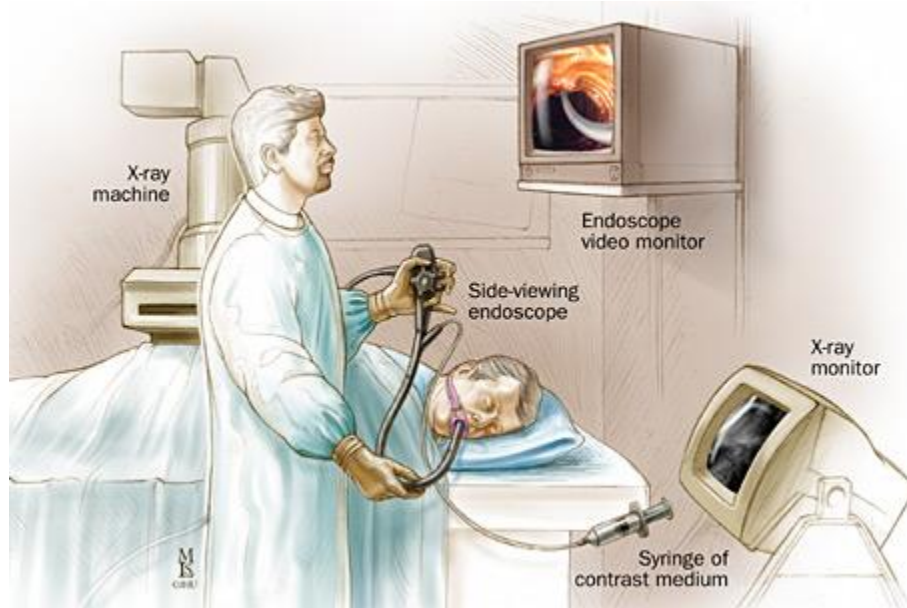
### *ERP management*

An ERP was performed in any patient with a high suspicion of a pancreatic duct injury either clinically or radiologically and included patients with established pancreatic complications. This was carried out by an experienced interventional endoscopist in a dedicated ERP suite. The aim at ERP was selective pancreatic cannulation to define the injury site and nature of pathology, or to visualize endoscopic evidence of a pseudocyst.

If a fistula was demonstrated an assessment was made as to the severity of leak. Minor leaks from peripheral ducts or the distal pancreas were treated conservatively. Major leaks were managed by sphincterotomy with stenting where feasible.

Pseudocysts with an obvious bulge into duodenum or stomach underwent endoscopic drainage with cyst enteric stenting. If cystenteric drainage was not possible transpapillary drainage was attempted when technically feasible. Endoscopic ultrasound was not used during the study period.

If a significant stricture or duct cut-off was demonstrated an attempt was made to pass a guidewire, stent the injury and await clinical resolution. If this failed and symptoms were minimal an expectant approach was undertaken. If endoscopic treatment failed to resolve symptoms then surgery was performed.



**Image 1:** Schematic representation of ERP procedure<sup>89</sup>

If there was technical failure and it was thought that there could be a successful endoscopic intervention in the future ERP was repeated.

#### *Delayed surgical management*

If the decision to operate was made after ERP the operation was at the discretion of the surgeon doing the procedure guided by the ERP findings and other investigations. Options were distal pancreatectomy (+/- splenic preserving), cystgastrostomy, cystjejenostomy or pancreaticojejenostomy.

#### Database and Statistical analysis:

Data was entered into a password protected Microsoft Access 2007 database and analysed within Microsoft Access and Microsoft Excel.

## RESULTS

### Demographics:

Forty-eight patients (42 men, 6 women; median age 29 years, range 15-68) underwent ERP for pancreatic trauma from a database of 417 traumatic pancreatic injuries.

### Mechanism of injury:

Twenty-six patients had sustained blunt injury due to assault (n=19), motor vehicle accidents (n=5), and one each from a fall from a height and a rugby tackle. Twenty-two penetrating injuries were due to gunshots (n=15) and stabs (n=7). Twenty-nine patients had associated injuries. The majority of blunt pancreatic injuries, were isolated injuries (n=19).

### Delay to presentation:

Thirty patients presented within 24 hours of their injury, a further 8 in the following week and the remaining 10 with a complication of their injury up to a year later.

### Clinical presentation:

Thirteen of the 48 patients were treated non-operatively. Thirty-five underwent an initial laparotomy. Of the 31 pancreatic injuries identified intra-operatively simple drainage was performed in 23, while 7 patients had a distal pancreatectomy and one had a cyst-gastrostomy.

Of the 23 patients treated with initial drainage of their pancreatic injury 3 went on to have further pancreatic surgery. Two of these patients required surgery for pancreatic fistulae originating from the body of the pancreas while the other required surgery for a stricture in the head of the pancreas. The first two patients could have undergone

pancreatic resection at their initial operation. Drainage was the only appropriate management option for the remaining patient who had an injury to the head of the pancreas and underwent 2 damage control operations in the acute setting.

There were 4 missed pancreatic injuries all in patients with penetrating trauma. One of these had two damage control laparotomies and the pancreatic injury presented 4 months later as chronic pancreatitis secondary to a pancreatic stricture. One patient had a nephrectomy done at a peripheral hospital complicated by a large pancreatic fluid collection which was drained at relook laparotomy. One patient had a small bowel repair at a peripheral hospital and returned 3 weeks later with a symptomatic pseudocyst. One patient had a diagnostic laparoscopy following a stab wound which found only blood and presented with a gastric outlet obstruction 16 days later.

Of the 13 patients who were initially managed conservatively 6 presented to hospital acutely of who 3 had a pancreatic injury recognized on admission. In the other 3 acutely hospitalized patients the pancreatic injury was missed initially. The remaining 7 patients treated conservatively had a delay of more than a week from the time of injury to their initial medical assessment.

#### Amylase levels:

Serum amylase was done in 22 patients who had an average level of 1558u/l (range 94-4200u/l) and was suspicious of pancreatic injury in 19 of the 22. A further 17 patients had fluid (fistula fluid or aspiration of intra-abdominal collection) sent for amylase determination and this ranged from 10000 to 291300u/l (average 89000u/l) all deemed indicative of a pancreatic injury.

Pancreatic injury:

Injuries were graded using the Pancreas Organ Injury Scale of the American Association for the Surgery of Trauma<sup>24</sup> based on the operative and radiological findings (Table 9).

**Table 9:** AAST grading of pancreatic injury

| <b>AAST</b> | <b>Number of patients</b> | <b>Acute</b> | <b>Delayed</b> |
|-------------|---------------------------|--------------|----------------|
| Grade I     | 2                         | 2            | 0              |
| Grade II    | 4                         | 3            | 1              |
| Grade III   | 30                        | 24           | 6              |
| Grade IV    | 11                        | 8            | 3              |
| Grade V     | 1                         | 1            | 0              |

The majority of injuries were Grade 3 (n=30) or more (Grade 4: n=11; Grade 5: n=1). Only 6 patients had minor injuries Grade 1 (n=2) or Grade 2 (n=4). The site of pancreatic injury was head (n=16), neck (n=6), body (n=16) and tail (n=9). In one patient with a fistula the site of pancreatic leak was never demonstrated.

### Associated injuries:

More than half (n=29) of patients had associated injuries (Table 10). The likelihood of associated injuries correlated with the mechanism of injury. All penetrating trauma patients had 1 or more associated injuries. One patient with an abdominal stab had omentum reduced at initial presentation, was treated conservatively but represented later with a gastric outlet obstruction secondary to pancreatic pseudocyst.

**Table 10:** Associated injuries related to mechanism of injury

| <b>Organ Injured</b> | <b>Total</b> | <b>Penetrating</b> | <b>Blunt</b> |
|----------------------|--------------|--------------------|--------------|
| Liver                | 12           | 11                 | 1            |
| Stomach              | 10           | 10                 | 0            |
| Colon                | 10           | 8                  | 2            |
| Kidney               | 8            | 5                  | 3            |
| Small bowel          | 5            | 4                  | 1            |
| Duodenum             | 5            | 5                  | 0            |
| IVC                  | 5            | 5                  | 0            |
| Chest                | 5            | 5                  | 0            |
| Spleen               | 5            | 4                  | 1            |
| Diaphragm            | 4            | 4                  | 0            |
| Limbs                | 3            | 3                  | 0            |
| Spine                | 3            | 3                  | 0            |
| Head                 | 1            | 0                  | 1            |

The mean number of associated injuries in the penetrating trauma group was three (range 0 -7). In the blunt trauma group the number of associated injuries ranged from 0 to 3.

### Isolated injuries:

There were 19 isolated pancreatic injuries. These only occurred in blunt trauma patients. Twelve presented acutely and 7 had a delayed presentation. Their average hospital stay was 25 days (range 1 - 65) similar to the rest of the patients in this study. Within this group were the only eight patients who did not have an operation at any stage of their management.

### Nutritional support:

Fourteen patients received total parenteral nutrition during the course of their management. Enteral nutritional support was not recorded.

### Complications:

There were a total of 106 complications at an average of 2.2 per patient (range 1 - 5).

Of the pancreatic complications fistulae were the most common (n=30) followed by pseudocyst (n=10), acute pancreatic fluid collections (n=8) and pancreatitis (n=7). Some pancreatic complications diagnosed clinically and radiologically resolved prior to the use of ERP. The most common extra-pancreatic complications were abdominal sepsis (n=12), respiratory (n=8), coagulopathy (n=4) and wound infections (n=4). Table 11 lists all the complications.

**Table 11:** Number of complications

| <b>Complication</b>               | <b>Number</b> |
|-----------------------------------|---------------|
| <b>Pancreatic</b>                 |               |
| Pancreatic fistula                | 30            |
| Pseudocyst                        | 10            |
| Acute pancreatic fluid collection | 8             |
| Pancreatitis                      | 7             |
| <b>Non-pancreatic</b>             |               |
| Abdominal sepsis                  | 12            |
| Respiratory                       | 8             |
| DIC                               | 4             |
| Wound infection                   | 4             |
| Gastric outlet obstruction        | 2             |
| Pleural effusion                  | 2             |
| Adhesive obstruction              | 1             |
| Urinary tract infection           | 1             |
| Abdominal compartment syndrome    | 1             |
| Enterocutaneous fistula           | 1             |
| Biliary fistula                   | 1             |
| DVT                               | 1             |
| Anastomotic failure               | 1             |

Percutaneous radiological interventions:

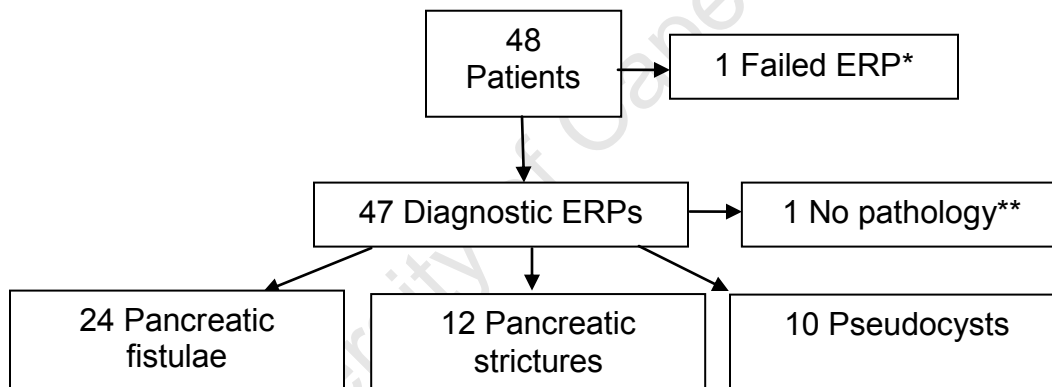
Twelve patients had percutaneous drains placed. One was a definitive procedure after an ERP demonstrated an intact main pancreatic duct. Eleven drainage procedures were performed for acute fluid collections.

## ERP Results:

A total of 74 ERPs were attempted on 48 patients (Figure 7). In 12 cases there was initial failure to cannulate the pancreatic duct due to adverse conditions (swollen papilla, distorted anatomy) however a subsequent attempt was successful in 11. One patient who did not have a diagnostic ERP went on to have a distal pancreatectomy. Additional ERPs were for changing of stents in 4 patients, stent removal in 6, checking for a leak in 4 and for a new pancreatic complication in 1.

Figure 7 shows the pathology demonstrated at ERP and Table 12 shows the management specific to the ERP diagnosis.

**Figure 7:** Pathology demonstrated at ERP



\* Patient had a distal pancreatectomy.

\*\* Patient clinically had a pancreatic fistula however no leak was demonstrated. A sphincterotomy was performed and the fistula resolved.

The pathology listed is the primary pathology demonstrated at ERP as some crossover between the groups was possible. One patient who had dual pathology (a fistula followed later by a pseudocyst) is placed only in the fistula group and is discussed under complications.

**Table 12:** Pathology demonstrated at ERP and subsequent management.

| <b>Intervention</b>       | <b>Pancreatic Fistula</b> | <b>Pancreatic strictures</b> | <b>Pseudocysts</b> |
|---------------------------|---------------------------|------------------------------|--------------------|
|                           |                           |                              |                    |
| <b>Minimally invasive</b> |                           |                              |                    |
| Conservatively treated    | 5                         | 3                            | 2                  |
| Sphincterotomy            | 12*                       | 1                            | 0                  |
| Stenting                  | 6                         | 1                            | 0                  |
| Endoscopic drainage       | 0                         | 0                            | 6                  |
| Percutaneous drainage     | 0                         | 0                            | 1                  |
| <b>Total</b>              | <b>23</b>                 | <b>5</b>                     | <b>9</b>           |
|                           |                           |                              |                    |
| <b>Surgery</b>            |                           |                              |                    |
| Distal pancreatectomy     | 2                         | 4                            | 0                  |
| Pancreaticojejunostomy    | 0                         | 3                            | 0                  |
| Cystjejunostomy           | 0                         | 0                            | 1                  |
| <b>Total operations</b>   | <b>2</b>                  | <b>7</b>                     | <b>1</b>           |
|                           |                           |                              |                    |

\*One patient had a clinical fistula (fluid amylase = 291300u/L) but no demonstrable leak at ERP. This patient had a pancreatic sphincterotomy and the fistula did resolve.

ERP provided information which was used to determine management in 47 patients. Ten patients were treated conservatively following ERP. Nine of these had uncomplicated resolution of their pancreatic complication. One patient with a pancreatic fistula re-presented with a pseudocyst. This was successfully managed with transmural endoscopic drainage.

When stenting was attempted this was technically successful in only 1 of 9 patients with strictures/duct cut-off and in 6 of the 19 fistula patients. In 6 patients with successful stent placement surgery was avoided. The 7 patients stented had an average delay

from injury to stent placement of 27 days. In the 21 failures of stent placement there was a longer average delay from injury to ERP of 48 days.

Endoscopic assessment of a pseudocyst led to cystenteric drainage in 6 patients. One pseudocyst recurred and required repeat endoscopic drainage. Two patients with no visible bulge endoscopically and an intact pancreatic duct were treated successfully conservatively. One patient with severe symptoms, a disrupted duct and no visible endoscopic bulge proceeded to surgery and had a cyst-jejunostomy.

The decision to operate based on the ERP findings was carried out in 8 of 10 patients earmarked for surgery after ERP. One patient with a fistula was scheduled for a distal pancreatectomy, however in the three month wait for his operation the fistula had resolved. He had had a sphincterotomy at initial ERP. In another patient surgery was performed but abandoned due to dense adhesions. He had had an initial stent placed, later exchanged for a larger one, which was felt to be unsatisfactory. His fistula resolved 28 days after his abandoned operation.

#### Complications of ERP:

There were two episodes of self-limiting pancreatitis following ERP. One patient had a bleeding sphincterotomy which was successfully managed by injection sclerotherapy. One patient was lost to follow up with a stent in situ. Of the patients undergoing surgery after ERP there were 4 complications, none of which were pancreatic.

#### Time to ERP:

There was a significant delay from time of injury to ERP in most patients, performed on average 38 days after the initial injury (range 2 - 365 days). ERP was carried out on average 22 days after hospital admission (range 0 - 68 days).

Hospital stay and follow-up:

Average length of hospital stay was 29 days (range 1 - 86 days). Time from ERP to hospital discharge was on average 9 days (range 0 - 54 days). Long term follow-up was not conducted beyond the resolution of pancreatic pathology. There were no deaths in the study group.

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## DISCUSSION

Pancreatic trauma is an uncommon injury and this study took 27 years to accrue 48 patients who underwent ERP. All published series of more than 15 patients took over 10 years to accumulate pancreatic trauma patients undergoing ERP.

Table 13 shows our results in the context of previously published studies. Thirteen studies were analysed with a total of 147 patients undergoing ERP. Fifty-one patients proceeded to surgery after their ERP. However it must be noted that the studies performed prior to 2000 were of a purely diagnostic nature and surgery offered the only form of treatment for major pancreatic disruption at this time. Excluding these studies shows that from 2001 onwards ERP was performed in 101 patients and was followed by an operation in 31 patients (28%). Our own rate of operation after ERP was 20% and can possibly be explained by a high perseverance rate with endoscopic intervention with 26 repeat ERPs being performed. This is only surpassed by Kim et al.<sup>84</sup> who carried out 32 procedures in 6 patients for stenting of pancreatic duct disruption and reported 4 severe strictures upon stent removal. The duration of stenting should be reduced to prevent this complication.

Endoscopic interventions across these 10 studies included 47 patients who had stents placed, 14 patients where endoscopic drainage of a pseudocyst was performed and 7 patients who had a pancreatic sphincterotomy. In our study we placed 7 stents, 6 patients had pseudocysts drained endoscopically and 14 patients had a sphincterotomy alone. The inability to pass pancreatic stents could be attributed to the marked delay between injury and ERP, a mean of 38 days in our study. ERP being performed a mean of 22 days after hospital admission. In pancreatic trauma there can be an insidious onset before the pancreatic injury becomes manifest and it is important for the primary treating physician to maintain a high index of suspicion.

In our study ERP was used in patients with established pancreatic complications and not as an initial diagnostic tool. Thirty-nine patients (81%) had main pancreatic

Table 13: Studies evaluating the role of ERP in Pancreatic Trauma

| Author                        | Year | Period    | Patients   | ERPs Done      | Normal duct | PS       | PD Stent  | Cyst drainage | Repeat ERPs   | Pancreatic surgery after ERP | Early vs Late | Mechanism Blunt/ Penetrating | Grade of Injury           |
|-------------------------------|------|-----------|------------|----------------|-------------|----------|-----------|---------------|---------------|------------------------------|---------------|------------------------------|---------------------------|
| <b>Barkin<sup>81</sup></b>    | 1988 | NS        | 14         | 14             | 9           | 0        | 0         | 0             | 0             | 5                            | 14/0          | 12/2                         | MPD 5                     |
| <b>Whittwell<sup>82</sup></b> | 1989 | NS        | 9          | 9              | 6           | 0        | 0         | 0             | 0             | 2                            | 9/0           | 9/0                          | MPD 3                     |
| <b>Wind<sup>83</sup></b>      | 1999 | 10        | 38         | 16             | 2           | 0        | 0         | 0             | 0             | 13                           | 2/14          | 34/4                         | MPD 14                    |
| <b>Kim<sup>84</sup></b>       | 2001 | 5         | 23         | 14             | 0           | 0        | 10        | 0             | 12            | 8                            | 9/5           | 23/0                         | I-2 II-3 III-16           |
| <b>Canty<sup>64</sup></b>     | 2001 | NS        | 9          | 9(1F)          | 0           | 0        | 2         | 0             | 0             | 3                            | 9/0           | 2/0                          | III-2                     |
| <b>Wolf<sup>85</sup></b>      | 2005 | 5         | 5          | 5              | 2           | 0        | 2         | 0             | 2             | 0                            | 1/1           | 5/0                          | MPD 2                     |
| <b>Buccimaza<sup>21</sup></b> | 2006 | 5         | 16         | 6              | 0           | 0        | 0         | 6(2F)         | 3             | 2                            | 0/5           | 14/2                         | III-16                    |
| <b>Lin<sup>86</sup></b>       | 2006 | 6         | 6          | 6              | 0           | 0        | 6         | 0             | >12           | 0                            | 3/3           | 6/0                          | III-6                     |
| <b>Lin<sup>77</sup></b>       | 2007 | 9         | 9          | 5 (1F)         | 1           | 0        | 3         | 0             | 3             | 2                            | 2/3           | 9/0                          | MPD 9                     |
| <b>Houben<sup>34</sup></b>    | 2007 | 5         | 15         | 15             | 2           | 0        | 10        | 1(1F)         | 3             | 4                            | 4/11          | 15/0                         | II-2III-4                 |
| <b>Sharma<sup>72</sup></b>    | 2008 | 10        | 7          | 7              | 0           | 0        | 0         | 7             | 0             | 0                            | 0/7           | NS                           | MPD-9                     |
| <b>Rogers<sup>87</sup></b>    | 2009 | 13        | 26         | 26             | 7           | 7        | 12        | 0             | 8             | 6                            | 9/17          | 20/6                         | I-6 II-11 III-8 IV - 1    |
| <b>Wood<sup>88</sup></b>      | 2010 | 9         | 43         | 15(2F)         | 1           | 0        | 2         | 0             | 1             | 6                            | 15/0          | 15/0                         | I-18 II-6 III-17 IV 2     |
| <b>TOTAL</b>                  | -    | <b>32</b> | <b>220</b> | <b>147(4F)</b> | <b>30</b>   | <b>7</b> | <b>47</b> | <b>14(3F)</b> | <b>&gt;44</b> | <b>51</b>                    | <b>77/66</b>  | <b>164/14</b>                | -                         |
| <b>This series</b>            | 2012 | 27        | 48         | 48(1F)         | 1           | 14       | 7         | 6(2F)         | 26            | 10                           | 0/48          | 26/22                        | I-2 II-4 III-30 IV-11 V-1 |

F- technical failure; PS – pancreatic sphincterotomy; PD – pancreatic duct; MPD – main pancreatic duct injury; Grading – AAST Grade I - V

duct injury compared to 60 - 69% in the two largest studies in the literature.<sup>84, 87</sup> The majority of pancreatic injuries were detected operatively within 24 hours due to the need for emergency laparotomy. A delay in diagnosis of pancreatic injury is associated with increased morbidity and mortality with Kim et al.<sup>84</sup> reporting that a delay in ERP assessment of the duct resulted in an increased pancreatic complication rate. The frequent occurrence of associated injuries complicates the assessment of pancreatic morbidity and mortality. In our series 19 patients with isolated pancreatic injuries had a hospital stay of 25 days compared to 29 days in the patients with associated injuries. This seems may suggest that it is the morbidity of the pancreatic complications which prolongs the hospital stay.

The timing of ERP in pancreatic trauma has evolved over time. Initially an early ERP was used to help assess the integrity of the pancreatic duct and guide the need for surgery.<sup>84</sup> Since the advent of therapeutic ERP the number of patients having an endoscopic intervention in the acute setting is small with less than 30 patients across 7 studies.<sup>34, 64, 84-88</sup> More recent studies report a greater proportion of patients undergoing delayed ERP with established pancreatic complications.<sup>34, 87</sup> The average length of hospital stay in our series was 29 days and this compares to Kim et al. who reported an average of 20 days in their early ERP group and 43 days in their delayed ERP group although this was not statistically significant.<sup>84</sup> Effectiveness of ERP assessments and interventions is hard to judge as the natural history of pancreatic fistulae is poorly defined. This is illustrated by 2 of our patients who had main pancreatic duct injuries which were assessed as not amenable to endoscopic treatment. Both patients had complete resolution of their pancreatic fistulae after a month of conservative therapy despite the planned surgery not being performed.

Minor pancreatic injuries (Grade I and II) do well with conservative treatment<sup>15</sup> so the need for endoscopic treatment of these injuries is questionable. Canty and Weinman<sup>64</sup> reported on endoscopic stenting in two children with this type of injury who ultimately did well. However these authors did also report duct stricturing and this remains a concern when stenting otherwise normal ducts.<sup>84</sup> A conservative approach to minor ductal and

parenchymal injuries is therefore prudent. For more severe injuries treated by stenting there is a marked variation in the length and calibre of stents used as well as the duration of stenting which further complicates the assessment of this intervention.<sup>11</sup>

Although only one ERP was ultimately unsuccessful in contributing any information to patient management eleven patients had to undergo a second procedure to delineate the pancreatic duct. This attests to the difficulty of selective pancreatic cannulation in this group of patients. Historically patients who had an ERP showing an intact pancreatic duct were spared surgery and this was reported as an ERP success. In the modern era with increasing access to MRCP this should no longer be valid. In early studies by Barkin et al.<sup>81</sup> and Whittwell et al.<sup>82</sup> 15 of 23 patients had completely normal ducts and were exposed to the potential complications of ERP.<sup>80</sup>

MRCP was not used in our series but could possibly have made a difference in eleven patients, one with no ductal disruption on ERP and ten with conservatively treated injuries. When available MRCP is a valuable adjunct in assessing the pancreatic duct injury and is complication free. There is limited published data on MRCP related to pancreatic trauma. Houben et al. had seven children of whom three were successfully spared further intervention on the basis of the MRCP findings.<sup>34</sup> Gillam et al. reported on eight trauma patients with four spared further intervention.<sup>33</sup> MRCP is placed before ERP in a recently published algorithm dealing with pancreatic trauma in patients with a high suspicion of ductal injury.<sup>11</sup> In patients with a demonstrated minor ductal disruption its accuracy in stratifying patients into conservative or interventional management still needs to be assessed. Patients with an intact pancreatic duct on MRCP can however be safely observed without ERP and its use is justified in order to avoid the potential complications of ERP in these patients.

ERP may reduce the need for surgery if endoscopic therapy is successful. In our series pancreatic fistulae and pseudocysts were most likely to be resolved by this minimally invasive approach (19 of 24 fistulae and 6 of 10 pseudocysts). These are the most well defined pancreatic complications both clinically and in the literature. In pancreatic

fistulae and pseudocysts the patient's response to the injury has localized the inflammatory process. If the pancreatic ductal disruption can be dealt with, or a new communication made, endoscopic results are good. In these pathologies ERP should be a therapeutic option before surgery.

It is the heterogeneous group of patients with strictures or complete duct cut-off who are difficult to manage. They present with acute fluid collections, pancreatic ascites or later with chronic pancreatitis. In our series surgery was required in the majority of these patients due to the unsatisfactory nature of their endoscopic intervention. There was only one successful stent placement in this group with 7 of 12 patients proceeding to surgery.

In our series the overall success rate of therapeutic ERP was 28 of 38 (73%) when the 10 patients treated conservatively based on ERP findings were excluded. This compares to 12 of 19 (63%) by Rogers et al.<sup>87</sup>

We did not note a significant pancreatic stricture rate from ERP as reported by Lin et al.<sup>86</sup> One patient returned with a symptomatic pseudocyst following pancreatic fistula resolution and one patient with a pseudocyst had a recurrence following endoscopic drainage. Both were managed by endoscopic drainage. Follow-up was limited and one patient was lost to follow-up with a pancreatic duct stent still in situ.

The lack of mortality in the study group can be attributed to the delayed use of ERP, a mean of 22 days after admission. This allowed complications to be established rather than attempting to pre-empt them in the acutely ill patients. The complication rate is linked to the delay from time of injury to detection of main pancreatic duct disruption. It is these MPD injuries which need to be definitively dealt with or they will invariably complicate. The patients in our series stayed in hospital a mean of 9 days after ERP. The earlier use of ERP could potentially result in a reduction in hospital stay and the timing of needs to be studied as an end-point in future studies. The delay noted from hospital admission to ERP may be due to a limited availability of a highly specialized

service as well as a lack of awareness regarding the utility of ERP in treating pancreatic complications amongst treating physicians.

The distinction between a pseudocyst and an acute fluid collection is often not made in the literature and this has implications for management strategy. Without an established wall the treatment options are expectant, percutaneous or endoscopic . We have not analysed the implications of ERP in the context of acute fluid collections due to the significant delay to undergoing ERP. In order for future studies to accurately assess the utility of ERP in the acute setting these collections need to be accurately defined.

We did not analyse the role of CT scanning to diagnose pancreatic injuries in the acute setting as it was not consistently performed throughout the study period. Houben et al.<sup>34</sup> compared CT scan findings to ERP findings and found it suggestive of pancreatic injury in 10 of 11 patients. However its accuracy in assessing the grade of injury was not reported and there was one false positive which was erroneously labelled as a grade IV injury. Kim et al.<sup>84</sup> reported a 55% success rate of CT scan in predicting a main pancreatic duct injury. They also reported two false positives and three cases where the injury was inaccurately graded. CT detection of pancreatic injuries is not very sensitive or specific and it is relatively unreliable in grading the pancreatic injury although this has improved in more recent studies.<sup>90</sup> CT is the investigation of choice for certain other abdominal organ injuries and as such should feature in a management algorithm dealing with pancreatic trauma despite its limitations in assessing the pancreas.<sup>11</sup>

Our operative success in detecting a pancreatic injury was 31 of 35 (89%). This was similar to that previously reported in international literature of 84%<sup>10</sup> to 100%<sup>21</sup>. The majority (73%) of injuries in our series warranted operative therapy on presentation due to a high proportion of penetrating injuries and their increased rate of emergency laparotomy. Rogers et al.<sup>87</sup> reported a 54% emergency laparotomy rate in their series of predominantly blunt injuries.

Accurate assessment of pancreatic injuries intra-operatively with appropriate surgical management reduces the risk of pancreatic complications.<sup>28</sup> In our series the initial surgical management of the acute pancreatic injury was by simple drainage of the pancreas in 23 patients while 7 patients had a distal pancreatectomy. Two patients with initial pancreatic drainage who ultimately underwent distal pancreatectomy could potentially have had a pancreatic resection at their initial operation, a possible error in surgical judgement. In one patient, who later required a pancreaticojejunostomy to resolve a pancreatic stricture, the initial surgical option of drainage was appropriate given the location of the injury in the pancreatic head and the clinical situation of 2 damage control operations and a protracted course in intensive care. It should be noted however that pancreatic resection in the trauma setting has a recognized pancreatic complication rate of 12%.<sup>53</sup>

Injuries were distributed throughout the 4 parts of the pancreas and were mostly Grade III and IV injuries which again emphasizes that it is the integrity of the pancreatic duct which is linked to the development of pancreatic complications. Minor injuries do well with conservative treatment and one has to question the benefit of immediate ERP in patients with minor ductal disruptions which may heal spontaneously. Some authors present favourable outcomes with endoscopic intervention in patients with essentially minor injuries.<sup>64</sup> The natural history of minor duct injury is not known and prolonged duct stenting has been reported to lead to stricturing.<sup>86</sup> We feel that the extent of intervention in the setting of a minor injury should be limited to a pancreatic sphincterotomy.

In our study intravenous nutritional support was seldom required and we feel its use should be limited to patients with intestinal failure and not used as a treatment of pancreatic complications. Its routine use in fistula management is not an international standard and necessitates prolonged hospital stay which may not alter outcome. In the series by Houben et al.<sup>34</sup> it was used in 11 of 15 patients for a mean of 28 days with the authors citing their cautious approach to oral nutrition as a reason for the prolonged hospital stay. Madiba et al.<sup>58</sup> reported on 20 patients with pancreatic fistulae

predominantly due to penetrating trauma who all settled on conservative treatment, with enteral nutritional support used in 15 and intravenous nutritional support in only 5.

## CONCLUSION

Some of the limitations of this study are inherent due to of the long duration required to accrue patients with a rare injury. Technology and practices have evolved during the study period. Specifically MRCP and the additional utility of endoscopic ultrasound were not assessed. Early therapeutic ERP, which was not done due to significant delays in referral and diagnosis, is an aspect which we were unable to study. In keeping with all trauma related studies there was limited long-term follow-up.

The use of ERP for pancreatic trauma is evolving. Its diagnostic and therapeutic utility is proven. The diagnostic role will change with the increasing availability and use of MRCP. However the interventions offered at ERP provide an effective means of dealing with various pancreatic complications. This is especially true with pancreatic fistulae and pseudocysts but less so with pancreatic strictures or duct cut-off. The use of ERP in the setting of delayed complications of pancreatic trauma is both prudent and practical. ERP helps guide management and in many cases offers a minimally invasive solution with good results.

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## APPENDIX 1 – RESEARCH PROTOCOL SUBMISSION

DEPARTMENT OF SURGERY RESEARCH COMMITTEE PROTOCOL SUBMISSION  
– April 2010

FOR MMED IN SURGERY(UCT)

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General Surgery Registrar  
Groote Schuur Hospital  
Observatory  
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Cape Town  
South Africa  
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### TITLE

**The role of endoscopic retrograde pancreatography in the management of pancreatic trauma**

Principle investigator: Dr DA Thomson

Supervisor: Prof JEJ Krige, Prof PC Bornman

### INTRODUCTION

The integrity of the main pancreatic duct is the most significant factor in predicting pancreatic morbidity in traumatic injury of the pancreas. (Subramanian, Dente & Feliciano, 2007, Krige and others, 2005) Endoscopic retrograde pancreatography (ERP) is recognized as the most accurate method of determining the status of the pancreatic

duct.(Bhasin,Rana & Rawal, 2009) It is however an invasive procedure carrying its own significant morbidity and mortality.(Bilbao and others, 1976) It does however also offer a therapeutic management option in the management of pancreatic injury and its complications.

There are only seven studies in the world literature examining the role of ERP in pancreatic trauma, all with relatively small numbers.

| <b>Author</b>      | <b>Year</b> | <b>Journal</b>                | <b>No. of patients</b> |
|--------------------|-------------|-------------------------------|------------------------|
| Davila et al.      | 1997        | Gastrointestinal Endoscopy    | 9                      |
| Canty & Weinman    | 2001        | Journal of Paediatric Surgery | 2                      |
| Delcenserie et al. | 2001        | Gastrointestinal Endoscopy    | 13                     |
| Wolf et al.        | 2005        | Surgical Endoscopy            | 2                      |
| Lin et al.         | 2006        | Surgical Endoscopy            | 6                      |
| Houben et al.      | 2007        | Journal of Paediatric Surgery | 11                     |
| Rogers et al.      | 2009        | Journal of Trauma             | 26                     |

Table 1: Papers examining the role of ERP in pancreatic trauma. (Davila,Rogers & Cello, 1997)(Delcenserie,Barthet & Yzet, 2001, Wolf and others, 2005, Lin and others, 2006, Houben and others, 2007, Rogers,Cello & Schecter, 2009)

Since 1983 Groote Schuur Hospital has kept a database on all patients with pancreatic trauma. In the same year the first ERP was done at Groote Schuur hospital. In the Western Cape our position as a Level 1 trauma centre with a high trauma burden and as the tertiary centre for ERP leaves us well positioned to evaluate our use of ERP in pancreatic trauma.

#### AIM

We aim to define the role of ERP in the management of traumatic injury to the pancreas.

#### PATIENTS AND METHODS

This is a retrospective audit of a prospectively collected database of all patients who sustained a traumatic injury to the pancreas and who underwent ERP from January 1983 to January 2010.

Exclusion criteria:

Patients who underwent ERP for bile duct or liver injury are excluded from analysis.

Study design:

Data collected will be: Demographics, mechanism and date of injury, clinical presentation and delay in presentation, revised trauma score, associated injuries, amylase levels and radiological investigations, initial management, associated complications and their management, ERP findings and subsequent treatment, outcome of endoscopic therapy, number of repeat endoscopic procedures, grade of pancreatic injury, duration of ICU stay, length of hospital stay, morbidity and mortality.

Upon analysis we wish to review the demographics of pancreatic trauma patients undergoing ERP, review their mechanism of injury and associated injuries and their mode of presentation and clinical management. Diagnostic tools, surgical management and complications will be analysed with particular focus on the utility of ERP. Patient outcomes will then be looked at and our practices compared with those in the international literature.

## ETHICS

Each patient will be given a unique identifier and data stored in a password protected database. This study will be conducted in accordance with the Declaration of Helsinki - 2008. (Williams, 2008)

## REFERENCES:

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## APPENDIX 2 - ETHICS APPROVAL



UNIVERSITY OF CAPE TOWN

Health Sciences Faculty  
Research Ethics Committee  
Room E53-24 Groote Schuur Hospital Old Main Building  
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e-mail: ransyth.eric@uct.ac.za

10 June 2010

**HREC REF: 279/2010**

**Dr D Thonnon**  
Surgery

Dear Dr Thonnon

**PROJECT TITLE: THE ROLE OF ENDOSCOPIC RETROGRADE PANCREATOGRAPHY IN THE MANAGEMENT OF THE LOCAL COMPLICATION OF PANCREATIC TRAUMA**

Thank you for entrusting your study to the Health Sciences Faculty Research Ethics Committee for review.

It is a pleasure to inform you that the Ethics Committee has **formally approved** the above mentioned study.

Approval is granted for one year till the 28<sup>th</sup> June 2011.

Please submit a progress form using the standardized Annual Report form (PHS016), if the study continues beyond the approved period. Please submit a Standard Closure form (PHS010) if the study is completed within the approved period.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC REF in all your correspondence.

Yours sincerely

**PROFESSOR M BLOEMAN**  
**CHAIRPERSON, HSE HUMAN ETHICS**

Federal Wide Assurance Number FWA00001687  
Institutional Review Board (IRB) number IRB00001938

cc:Ethics

This serves to confirm that the University of Cape Town Research Ethics Committee conforms to the Helsinki Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SD), Food and Drug Administration (FDA USA), International Conference on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines for Good Clinical Practice (GCP/ICH/135/95) and FDA Code of Federal Regulation Part 31, 312 and 312.

University of Cape Town

UCT/12/01/001

APPENDIX 3 - MS ACCESS DATA SHEET EXAMPLE

|   |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
|---|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| FNO   | SURNAME                  | NME                      | AGE                      | RC-SX                    | INJ DATE                            | MECH INJ                            |                          |                                     |                          |                          |                          |                          |
| 24162067  |                          |                          | 19                       | BM                       | 2007/06/03                          | BLT ASS                             |                          |                                     |                          |                          |                          |                          |
| ADM DATE  | DISCH DATE               | H_DAYS                   | ICU DAYS                 | SCHOCK                   | ABDPAIN                             | ABDDIS                              | ABDRIG                   | ABDGUARD                            |                          |                          |                          |                          |
| 2007/07/10  | 2007/07/19               | 9                        | 0                        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> |                          |                          |                          |                          |
| DELAY1  | DELAY2                   | RTS                      | INJ SITE                 | LUCAS                    | AAST                                | OTHER INJs                          | COLON                    | KIDN                                | STOMACH                  | SPLEEN                   |                          |                          |
| 840   | 0                        | 12                       | NECK                     | 2                        | 3                                   | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> |                          |                          |
| DUOD  | LIVER                    | GALLB                    | JEJUN                    | IVC                      | AORTA                               | ILEUM                               | PORT VEIN                | CHEST                               | LIMBS                    | NECK                     | SPINE                    | HEAD                     |
| <input type="checkbox"/>  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| OTHER   |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
|   |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| PREOP INVEST1   | PREOP INVEST2            | PREOP INVEST3            | PREOP INVEST4            | DIAG MADE                |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| US  | CT                       |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| MANAGEMENT1   | MANAGEMENT2              | MANAGEMENT3              |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| NO SURGERY  |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| PANC MANAGEMENT1  | PANC MANAGEMENT2         | PANC MANAGEMENT3         |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| ERCP  |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| AMYLASE   | BLDTRANSF24HRS           | TOTAL TRANSF             | DRAIN                    | NUTRITION 1              | NUTRITION 2                         |                                     |                          |                                     |                          |                          |                          |                          |
| 2035  | 0                        | 3                        | NONE                     | NORMAL                   |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| COMP1   | COMP2                    | COMP3                    | MISSED INJURY            |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| PSEUDOCYST  |                          |                          | <input type="checkbox"/> |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| COMP4   | COMP5                    | COMP6                    | TOTAL COMP               |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
|   |                          |                          | 1                        |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| MANAGE COMP   | MANAGE COMP1             | RELOOK LAP               | TOTAL OP                 |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| ERCP  |                          | 0                        | 0                        |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| OUTCOME   |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| DISCHARGED  |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| NOTES   |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |
| REFERRAL FROM GFJ, PRESENTING WITH PANCREATIC PSEUDOCYST, FOLLOWING AN ASSAULT 5 WEEKS EARLIER BY THE POLICE. ON 18/07 PSEUDOCYST WAS DRAINED ENDOSCOPICALLY AND A 7CM FR STENT INSERTED. READMITTED WITH RECURRENCE ON 15/08 - 20/08. REPEAT ERCP ON 16/08, PSEUDOCYST DRAINED AND STENT PLACED. WELL, DISCHARGED. |                          |                          |                          |                          |                                     |                                     |                          |                                     |                          |                          |                          |                          |

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