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Predictors of successful non-operative management of grade III & IV blunt pancreatic trauma

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HIGHLIGHTS

- Non-operative measures should be attempted in a select group of high grade (grade III/IV) pancreatic trauma.
- Controlled leak walled off as a pseudocyst, absent necrosis&organ injuries predict high success rate for NOM.
- Dedicated nutritional, gastrointestinal and interventional radiological support are the key components of care.

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ABSTRACT

Introduction: Although surgery is the preferred treatment for grade III&IV pancreatic trauma, there is a growing movement for non-operative management. in blunt pancreatic trauma. Very few studies compare operative versus non-operative management in adult patients.

Methods: Retrospective analysis of a prospectively maintained database was performed from 2004 to 2013 in the department of gastrointestinal surgery, NIMS, Hyderabad. Comparative analysis was performed between patients who failed versus those who were successfully managed with non-operative management.

Results: 34 patients had grade III/IV trauma out of which 8 were operated early with the remaining 26 initially under a NOM strategy, 10 of them could be successfully managed without any operation. Post-traumatic pancreatitis, Necrotizing pancreatitis, Ileus, contusion on CT, surrounding organ injuries are independently associated with failure of NOM on a univariate analysis. On multivariate logistic regression presence of necrosis& associated organ injury are factors that predict failure of NOM independently. Development of a pseudocyst is the only significant factor that is associated with a success of NOM.

Conclusions: Non-operative measures should be attempted in a select group of grade III&IV blunt pancreatic trauma. In hemodynamically stable patients with a controlled leak walled off as a pseudocyst without associated organ injuries and pancreatic necrosis, NOM has a higher success rate.

1. Introduction

Among the solid organ injuries in the abdomen, pancreatic injuries are rare as compared to liver and spleen [1,2]. Morbidity and mortality rates of pancreatic trauma are comparatively high and stems from associated vascular and surrounding organ injury, delays in diagnosis, ductal breach (Grade III and higher) [3–6]. Contemporary management of grade III and grade IV injuries is an operative intervention. Operative management of grade III and grade IV injuries however is associated with higher morbidity and mortality [7,8]. In a series of 42 patients who had pancreatic resection at the time of initial damage control surgery mortality rates for pancreatic resection were as high as 55% [8]. One third of patients who underwent pancreatic resection and 20% of those who did not undergo resection developed pancreatic related complications [8]. In a consecutive series of 107 patients who underwent

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distal pancreatectomy for grade III injuries the rates of overall complications is 75%, rates of pancreas specific complications are 50**%** [7]. There is a growing movement for non-operative management (NOM) of solid organ injury in blunt abdominal trauma [9]. Nationwide trends have shown that rates of NOM of pancreatic trauma has increased and that is associated with decreased mortality [9]. NOM has been embraced as an essential part of care in the management of blunt trauma of spleen and liver in hemodynamically stable patients [10,11]. In pediatric population non-operative management has become the standard of care in management of grade II and grade III pancreatic injuries [12]. However very few studies exist that compare operative to NOM of higher grade (Grade III/IV) pancreatic trauma in adults.

1.1. Aim of the study

To analyze patients who presented with blunt pancreatic trauma at the department of gastrointestinal surgery, Nizam's institute of medical sciences, Hyderabad from 2004 to 2013. To assess NOM in a select group of hemodynamically stable patients of grade III and grade IV pancreatic trauma. To determine the factors that predict success of non −operative management in such patients.

2. Material and methods

All patients with blunt pancreatic trauma who were treated between Januarys 2004–2013 at the department of gastrointestinal surgery, Nizam's institute of medical sciences, Hyderabad were included. Among 72 patients 34 patients were identified to have grade III/IV pancreatic trauma in whom non-operative management strategy was attempted. Patient's demographic data including age, sex, comorbid illness, mode of injury, time of presentation, imaging modalities used and interventions were entered into a prospective database.

2.1. Diagnosis

Pancreatic injuries were diagnosed using a combination of dedicated 64 slice CT scanner, MRI with MRCP in majority of the patients. Injuries identified during intra-operative exploration were graded according to the extent of injury determined intra-operatively. ERCP solely as a diagnostic modality is not used in any of these patients. Serum amylase and lipase was obtained in all patients and in all grades of trauma.

2.2. Definitions

Pancreatic fistula, hemorrhage and other pancreatic specific complications are defined according to the standard ISGPF criteria [13,14].

2.3. Management of pancreatic trauma

Grading of pancreatic injuries was done according to the AAST grading system. CT scan was obtained on all patients who are hemodynamically stable and had intra-abdominal fluid on FAST exam as per the ATLS protocol of blunt abdominal trauma. Patients who are hemodynamically unstable had an early operation. Early operation is defined as surgery within first 24 h of presentation. In these patients no attempt at NOM was made. Non-operative strategy was considered in hemodynamically stable patients with grade III and IV trauma. Such strategy included excellent analgesia, Incentive spirometry, IV fluids, and enteral nutritional support if needed with help of a naso-jejunal tube no later than 48 h of injury. Patients who had progressive abdominal pain, hemodynamic instability, abdominal distension with inability to tolerate enteral feeds, need for blood transfusions, persistent leukocytosis (>11), sepsis or organ failure were considered failure of NOM. Organ failure that responded to initial resuscitation was not considered a failure of NOM. All patients with pancreatic trauma with duct disruption received octreotide 50 mcg TID. For patients who were operated octreotide was continued through the post-operative period for one week. Radiological or endoscopic guided drainage of fluid collections, necrosis or abscess externally or internally is not considered a failure of non-operative management.

2.4. Statistical analysis

Comparative analysis was performed between patients who failed versus those who were successfully managed with non-operative management in grade III and grade IV injuries. Descriptive statistics were used to identify differences in the clinical variables between the two groups. Continuous variables were described using mean. Categorical variables were compared between the two groups using non-parametric tests (X2/fisher's exact, Man Whitney *U* test). A p-value of <0.05 is considered significant. Univariable (unadjusted) logistic regressions were used to test the significance of individual variables (Presence of pseudocyst, Blood transfusions, pancreatic necrosis etc.) in predicting success of NOM. Multivariate logistic regression was used to determine predictors of success of NOM while controlling for other significant covariates identified on univariable analyses. All tests used a type I error set at α 0.05. Statistical analyses were carried out using SPSS (Version 18).

3. Results

During the study period 92 patients had pancreatic trauma overall. Of the 92 patients 20 patients with penetrating trauma were excluded from analysis. Among the 72 patients with blunt pancreatic trauma 34 patients were identified to have grade III or grade IV injury and were included for analysis. (Ref Table 1). There were five mortalities overall (6.9%). Two patients had grade V injuries both of them died with multiorgan failure from sepsis (Average of 12 days post trauma). One patient with grade IV died from necrotizing pancreatitis. One patient of grade III injury died on day 18 with respiratory failure from hospital acquired pneumonia. Both deaths in grade III and grade IV injuries are in patients in whom NOM was not attempted.

3.1. Operative versus non-operative management

Overall 34 patients (34/72, 47.2%) had grade III/IV trauma (Ref Table 1). Of these 24 patients eventually had surgery (8 early and 16 failed NOM). Five patients of grade 1 & 2 injuries (5/33) underwent operative exploration for other abdominal injuries. All patients (5/5) with grade 5 injuries underwent operative exploration. Among grade III and grade IV injuries 10 out of 34 were managed without any operation.

Table 1
Summary of all blunt pancreatic trauma patients according to different grades.

	Total	Operated
Grade 1	16	2/16
Grade2	17	3/17
Grade 3	20	14/20
Grade 4	14	10/14
Grade 5	5	5/5

3.2. Operative management

3.2.1. Grade I and II injuries

Overall 33 patients had grade I/II pancreatic injuries. Only five of them underwent operative exploration. None of the five patients had a pancreatic directed operative procedure performed aside thorough assessment of pancreatic injury. Three patients had splenectomy for grade III/IV splenic trauma. one patient had grade II duodenal laceration that was repaired primarily. One patient underwent segmental colectomy and end to end anastomosis for colonic perforation.

3.2.2. Grade III and grade IV trauma

Of patients with grade III trauma 14 underwent operative exploration (2 early and 12 late). Nine patients had pancreatic necrosectomy, 5 patients had a distal pancreatectomy with splenectomy. Ten patients with grade IV underwent operative exploration (6 early and 4 late). Seven patients had associated duodenal injuries (one patient had intramural hematoma only). All the seven patients had resectional debridement of the devitalized pancreas and closed external drainage along with damage control procedure for a duodenal injury if present. G. I restitution after duodenal injury is via a duodeno-jejunostomy in a second stage operation. Two patients with isolated grade IV injuries had resectional debridement, hemostasis and closed suction external drainage. One patient had a necrotizing pancreatitis-with colonic perforation who was operated on day 19 after admission (Fig. 1).

3.2.3. Grade V injuries

All five patients with grade V injuries underwent operative exploration. Pancreatico-duodenectomy was performed in all 5 patients on an emergency basis. Three patients had massive disruption of the Pancreatico-duodenal head region and Whipple procedure was necessary for control of bleeding and enteric spillage. Two patients had uncontrolled hemorrhage failed with non-operative measures underwent Whipple procedure for hemostasis from the Pancreatico-duodenal groove region.

3.3. Non –operative management

Of the 34 patients with grade III/IV pancreatic trauma eight patients had an early operation (<24 h). For these patients there was no attempt made at non-operative management. All of the remaining 26 patients were initially placed on a non-operative management strategy. Of all the 26 patients initially placed on NOM protocol only 3 patients had a delayed diagnosis with a mean delay of 2.6 days (2–3 days), 16 patients eventually had a laparotomy for failed non-operative strategy. All of the 16 patients who had surgery had an operation at an average of 29 days (19–53). Ten patients were successfully managed with non-operative strategy. Six patients with Grade III were managed conservatively. Five patients had endoscopic cysto-enterostomy, one patient had an IR guided pigtail placement with external drainage for 28 days that was subsequently removed with no sequale. Four patients with grade IV were managed without abdominal exploration. Two patients had endoscopic cystogastrostomy. Two others had endoscopic drainage of pancreatic necrosis and cyst-enterostomy.

3.4. Failure of NOM

Failure of NOM occurred because of complications that warranted surgical intervention like hemorrhage that failed IR embolization (3 pt), enteric fistulae (3 pt), Failure to thrive with persistent necrotizing pancreatitis (4 pt), infected necrosis (9 pt).

3.5. NOM – complications

There was no mortality in any of the patients managed non-operatively. However NOM is associated with high rate of complications. The overall complication rate in our series is 8/10 (Ref Table 2). Pancreatic fistula, abscess, pancreatic necrosis and intra-abdominal hemorrhage and formation of pseudocyst constituted most of the complications. Three patients (3/10) had pancreatic fistulae. All the three closed with conservative treatment with octreotide, pancreatic duct sphincterotomy and stenting and dedicated drain care. Mean duration of octreotide use is 3.75 months (1 patient - 3 months, 1 patient-4.5 months). If the fistulae persisted beyond three weeks Endoscopic pancreatic sphincterotomy ± pancreatic duct stenting was performed to facilitate healing of the fistula. Abscess formation occurred in six patients (6/10). All the abscess are managed non-operatively with IR guided pigtail placement and antibiotics. Pancreatic necrosis and hemorrhage are next most common (3/10 and 2/10 respectively). IR guided coil embolization was used to control hemorrhage successfully in both the patients. Image guided percutaneous drainage of the necrosum and endoscopic necrosectomy was used successfully in the three patients with pancreatic necrosis.

3.6. Regression analysis

On a univariate analysis (Ref Table 3) patients who had post-traumatic pancreatitis [2.24 (1.78–2.83), p = 0.0001], presence of necrosis, [1.66 (1.37–2.00) P = 0.0001], intestinal Ileus [1.54 (1.15–2.06) p = 0.003], contusion on CT [1.62 (1.36–1.95),P = 0.013] and surrounding organ injuries [1.58 (1.39–1.80),P = 0.00011, had higher odds of failure of NOM. However on multivariate analysis

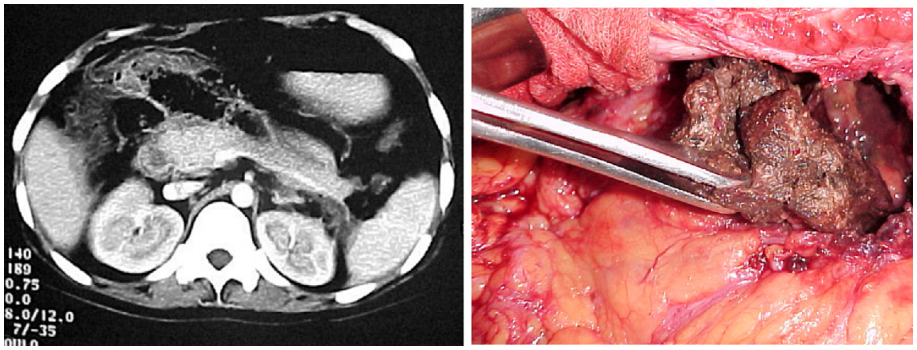

Fig. 1. CT scan of a patient with grade IV pancreatic trauma complicated by necrotizing pancreatitis with colonic perforation. Patient had open necrosectomy on day 19 following trauma, closed external drainage along with temporary colostomy which was reversed after three months.

Table 2
Clinical characteristics of operative and non-operative groups.

	Operative MX (16)	Non-operative (10)	P value[a]
Age (mean)	43 (19–61)	39 (20–72)	0.095
Sex (M/F)	11/5	9/1	0.086
ASA class III and above	2	2	0.103
Mean blood transfusions	6.8 (3–12)	2.2 (1–8)	0.048
Associated injury			0.0031
Liver	2	1	
Spleen	7	2	
Duodenal	2	1	
Colonic	1	0	
Other (MSK)	6	4	
Grade III	12	6	0.083
Grade IV	4	4	
Organ failure			0.001
Respiratory	12	3	
Renal	4	1	
Cardio-vascular	10	0	
Pancreatitis	8	2	0.078
No of days of octreotide use	96 (54–116)	102 (84–186)	0.068
Complications (overall)	**(3/16)**	**(8/10)**	0.001
Abdominal abscess	3/16	6/10	
Hemorrhage	1/16	2/10	
Pancreatic fistula	1/16	3/10	
Necrosis	2/16	3/10	
Pseudocyst	2/16	8/10	0.003

[a] Nonparametric test; X^2/Fischer's exact, Mann Whitney *U* test, p value of <0.05 is significant which is indicated in bold.

Table 3
Regression analysis of factors predicting successful NOM of grade III/IV pancreatic trauma.

	Univariate analysis		Multivariate analysis	
	0R (95% CI)	P value	OR (95% CI)	P value
Age	0.92 (0.77–1.11)	0.360	1.10 (0.71–1.71)	0.688
Sex	0.95 (0.77–1.16)	0.592	1.22 (0.66–2.25)	0.532
ASA class > III	1.09 (0.80–1.49)	0.578	1.04 (0.84–1.29)	0.710
Pancreatitis	2.24 (1.78–2.83)	0.0001	0.87 (0.32–2.36)	0.781
Presence of ileus	1.54 (1.15–2.06)	0.003	1.48 (0.20–11.09)	0.701
Presence of necrosis	1.66 (1.37–2.00)	0.0001	1.04 (1.01–1.08)	0.018
Pseudocyst	0.45 (0.32–0.64)	0.005	0.57 (0.35–0.94)	0.026
Blood transfusion	1.19 (0.93–1.53)	0.161	1.09 (0.80–1.49)	0.572
Other organ injury	1.95 (1.28–2.97)	0.002	1.63 (1.16–2.30)	0.005
Octreotide use	1.43 (0.82–2.49)	0.214	1.22 (0.66–2.25)	0.536
Contusion on CT	1.62 (1.36–1.95)	0.013	1.04 (0.84–1.29)	0.710
Organ Failure	1.58 (1.39–1.80)	0.00011	1.02 (0.99–1.04)	0.153

NOM (Non-operative management).

adjusting for other factors that were statistically different between the two groups, only presence of necrosis and associated organ injury are factors that predict failure of NOM independently. Development of a pseudocyst is the only significant factor that is associated with a success in NOM on both univariate [0.45 (0.32–0.64) p = 0.005] and multivariate analysis [0.57 (0.35–0.94) p = 0.026].

4. Discussion

Pancreatic injury is seen in 2–5% of all blunt abdominal trauma patients [1,2,6,7]. Surrounding organ injuries are noted in greater than 50% of the patients [1–6]. The topography of pancreas in the retroperitoneal pocket surrounded by stomach, duodenum, spleen, and colon predisposes to the high incidence of associated injuries [15–18]. In our series pancreatic injuries complicated 6.9% of all blunt abdominal trauma (72/634) with 61% having associated organ injuries. Pancreatic trauma occurred more commonly in males and in a younger age group with mean age group 35–45 years [19–22]. Blunt abdominal trauma accounted for most of the pancreatic trauma which is contrary to the experience in the US where penetrating injuries account for a greater percentage [16,20,23,24].

Grade I and II pancreatic injuries preserve the ductal integrity. Most of the grade I and grade II injuries can be managed non-operatively or simple drainage. If pancreatic injury is detected intra-operatively debridement of devitalized tissue along with closed drainage offers the best possible management strategy [24,25]. None of the 33 patients with grade I and grade II trauma in the current series needed a pancreatic resection. Contrary views exist on whether to drain routinely in grade I, II injuries [16,26–28]. A randomized trial comparing closed suction drainage to sump drainage in this regard demonstrated that closed suction drainage resulted in fewer intra-abdominal abscesses (2.6%) compared to sump drainage (20.8%) [29]. We have not encountered any major complications with drain use and recommend routine use of closed suction drainage externally.

Pancreatic injuries with ductal disruption are of special significance. These injuries are associated with higher morbidity and mortality, greater incidence of associated organ injuries, delayed diagnosis [30–33]. Also these are unique when compared to other major abdominal solid visceral trauma (liver and spleen). Apart from the hemodynamic instability and the metabolism involved in recuperation from major trauma pancreatic ductal disruption adds an additional insult. The leak of enzyme rich pancreatic juice into

and surrounding the pancreas incites a vigorous inflammatory cascade with its sequale. Associated pancreatitis with necrosis, hemorrhage, abscess, pseudocysts, enteric fistulae and organ failures limit the physiological reserve and deserve special aspects of care [30–34].

Contemporary management of grade III/IV trauma recommend operative interventions. Western trauma association recommend distal pancreatectomy for ductal disruption to the left of SMV [35]. However for proximal ductal injuries (grade IV) there is no clear consensus. Recommendations have ranged from simple drainage alone to complex procedures such as pancreaticoduodenectomy [36]. There is substantial evidence at present that recommend controlled external drainage and obviating any pancreatic directed resections for proximal ductal injuries [25,37].

Non-operative management of pancreatic trauma is on the rise. A nationwide analysis of trends in pancreatic trauma from 1998 to 2009 revealed that proportion of patients managed non-operatively increased from 56.7 to 59.1 ($p = 0.01$). The overall rate of any operation 43.3 to 40.9% ($p = 0.01$) as well as pancreas specific surgery decreased from 21.7 to 19.8% ($p = 0.0004$). On a regression analysis model having any type of surgery is an independent predictor of mortality. 43.3 to 40.9% [9].

Non-operative management of high grade pancreatic trauma is less commonly described in adult population. In the largest review of English literature by Alireza et al. 51 cases of pancreatic trauma with MPDT were studied. Thirty nine patients in the surgical group were compared with 12 patients in the non-operated group. The rates of general and pancreas related complications were no different between the groups [$p = 0.42$ and 0.65 respectively [38]. Pancreatic fistula formation was not different between the groups. However the length of stay was significantly higher in the NOM ($P = 0.04$). Both operative and Non-operative management were successful with similar complication rates [38].

We describe the largest cohort of high grade (III/IV) pancreatic trauma managed non-operatively from a tertiary level I trauma center. Thirty four patients had grade III/IV trauma out of which 8 were operated early with the remaining 26 initially under a NOM strategy, 10 of them could be successfully managed without any operation. Adjusted multivariate analysis demonstrates that only presence of necrosis and associated organ injury are factors that predict failure of NOM independently. Development of a pseudocyst is the only significant factor that is associated with a success in NOM on both univariate [0.45 (0.32–0.64) $p = 0.005$] and multivariate analysis [0.57 (0.35–0.94) $p = 0.026$].

The current series describe a select group of patients who had ductal disruption that self-triaged themselves into a stable group, with controlled leak managed conservatively without an operation. With advancements in interventional endoscopy and radiology, sequale of ductal leak were managed successfully in the NOM group. Success of NOM depends on the degree of ductal disruption and the extent of dissemination of the inflammatory cascade from pancreatic enzymatic leak. If patient had well defined walled off pancreatic necrosis or pseudocyst formation, it may well be amenable for endoscopic or percutaneous drainage without the need for an additional surgical intervention [39–42]. Presence of extensive necrosis and associated organ injuries should signal a higher failure rate of such strategy. It seems logical that the ongoing insults from necrotizing pancreatitis along with associated organ injuries push the limits of physiological reserve of the individual to an extreme that warrant operative intervention.

The complication rate arising from conservative management of pancreatic ductal leak in trauma setting is high [38]. However majority of the complications can be managed non-operatively. **Giacamao et al** report a series of six adult patients with grade III pancreatic trauma managed conservatively. Three out of six treated non-operatively had complications (abscess, fistula, pancreatitis) related to pancreatic trauma and all of them could be managed successfully without an operation [43].

Endoscopic and percutaneous techniques for pseudocysts and pancreatic necrosis have a fairly high success rate [39–42] and can at times obviate the need for open or laparoscopic necrosectomy. The management of pancreatic fistula is fairly standardized in our unit and is consistent with the current standard of care [44,45]. All patients will be on octreotide injections 50 mcg TID, low fat diet with either a total or partial parenteral nutritional support. If the patients had persistent leak beyond three weeks ERCP ± stenting was performed in all patients. The use of octreotide and the beneficial role in the management of pancreatitis, pancreatic leak and fistulae is still debated [46,47]. The mean duration of octreotide administration was three months and did not differ between the groups (Ref Table 1). At the minimum we noticed that it helps in reducing the quantity of pancreatic secretions and aid in a better control of pancreatic leak or fistula.

One of the major caveats of non-operative strategy is the selection of patients for NOM. Should every patient with grade III/IV have a trial of NOM?If not which of these patients should be selected for NOM? These are questions that demand strong evidence based explanations. In view of the rarity of these injuries, it is highly unlikely that a randomized trial would ever be performed to compare NOM over surgical intervention. The retrospective nature of the current study limit us from deriving at strong selection criteria for NOM. It is very difficult at the onset of trauma to discern which of the patients will have a contained host response (resulting in the formation of pseudocyst or walled off pancreatic necrosis) and which one of these will have a more severe insult warranting an operation. Furthermore continuous monitoring of the patient with liberal imaging policy is essential to further determine the course of injury and appropriate directed intervention. Hence at present we recommend that the selection of patients for NOM be individualized. In patients who are hemodynamically stable, have no or limited additional organ injuries, have a well delineated pseudocyst, walled off necrosis and have expertise available in endoscopic and IR guided interventional procedures, consideration should be given for NOM in grade III/IV trauma.

5. Conclusion

Non-operative strategy is successful in a select group of high grade (grade III/IV) pancreatic trauma. In hemodynamically stable patients, a controlled leak walled off as a pseudocyst, absent associated organ injuries and absent pancreatic necrosis predict a higher success rate for non-operative strategy. Dedicated multidisciplinary involvement with excellent nutritional support, Octreotide injections, Endoscopic (sphincterotomy, stenting, necrosectomy, and internal drainage of pseudocyst) and Interventional radiological procedures (Percutaneous image guided drainage) are essential components of care in patients selected for such an approach.

Ethical approval

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Author contribution

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Conflicts of interest

None.

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