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VALIDATION OF THE PANCREATIC INJURY MORTALITY SCORE (PIMS) IN PREDICTING OUTCOMES OF TRAUMATIC PANCREATIC INJURY: A PROSPECTIVE TERTIARY CARE CENTRE STUDY

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ABSTRACT

Background: Traumatic pancreatic injury poses significant diagnostic and therapeutic challenges. Unlike hepatic or renal trauma pancreatic injuries often evade early detection due to vague clinical and biochemical manifestations. Delayed diagnosis increases the risk of complications such as pseudocyst formation, abscesses and endocrine insufficiency. This study evaluated the role of Pancreatic Injury Mortality Score (PIMS) in Predicting Outcomes of Traumatic Pancreatic Injury.

Materials and Methods: This prospective observational study was conducted over 18 months at a tertiary care institute in South India. It included 44 patients with radiologically confirmed pancreatic trauma. Inclusion criteria were patients >18 years with abdominal trauma (blunt or penetrating) and confirmed pancreatic injury. Patients with pre-existing pancreatic disease or those who did not consent were excluded. All patients being haemodynamically stable underwent conservative management. Radiological grading was based on the AAST-OIS classification and risk stratification was done using the PIMS. Clinical outcomes, including complications, ICU requirements, and mortality, were analyzed using SPSS version 23.0. A p-value <0.05 was considered statistically significant.

Results: Among 44 patients, 86.4% were male, with the highest incidence in the 41–50-year age group. PIMS classified 40.9% as moderate risk, 34.1% as low risk, and 25% as high risk. Overall mortality was 20.5%. Mortality was found to be significantly associated with higher PIMS scores (mean 11.8 vs. 5.5 in survivors; p = 0.0005). Vessel involvement and presence of shock were strongly correlated with mortality (p < 0.01). ROC analysis of PIMS showed an AUC of 0.990, with 100% sensitivity and 94.3% specificity at a cutoff score of 9.5. AAST grade alone did not show statistically significant correlation with mortality.

Conclusion: Pancreatic trauma outcomes are influenced more by physiological compromise and associated injuries than by AAST grade alone. The PIMS is a highly sensitive and specific tool for mortality prediction and may be used as a guide for timely and appropriate management. Non-operative management remains effective for low to moderate-grade injuries in hemodynamically stable patients.

Keywords: Pancreatic trauma, Abdominal injury, PIMS score, AAST grading, Mortality prediction.

INTRODUCTION

Trauma to the pancreas may be a rare but possibly fatal injury that can also be exceedingly challenging to identify.[1] Conventional imaging methods don't pick up on minute indications connected to pancreatic injury, unlike the liver, kidney, or spleen. After the first event, post-traumatic pancreatitis may take several hours to change the blood or induce edema. Magnetic resonance cholangiopancreatography (MRCP) or endoscopic retrograde cholangiopancreatography (ERCP), which may not be available at all centres, may be necessary for diagnostic testing.[2] Complications such as infection, pseudocysts, abscess, duct stricture, peritonitis, and endocrine/exocrine insufficiency that are linked to significant morbidity and mortality result from a delay in diagnosis. An incorrect classification prevents effective management and intervention. Effective diagnosis, classification, and management of traumatic pancreatic necrosis require a high degree of suspicion and thorough understanding.[3]

Prompt, early, and accurate diagnosis depend on understanding of the mechanisms underlying pancreatic injury, the presence of coexisting injuries, the delay to diagnosis, the presence or absence of significant ductal injury, and the involvement of various imaging modalities. Since the main cause of delayed problems like pseudopancreatic cyst, disruption of the main pancreatic duct must be detected as soon as possible. Junction of body and tail of pancreas is where acute pancreatic injury most frequently occurs.[4]

Only about 2% of individuals with trauma injuries and 10% of those with other intra-abdominal injuries have pancreatic damage because of their protected retroperitoneal location. Although penetrating trauma occurs more commonly on an individual case-by-case basis and may more frequently include the pancreatic tail, most occurrences of pancreatic injury are secondary to blunt trauma. Kuza et al conducted a retrospective analysis and discovered that pancreatic trauma occurs 0.3% of the time with 61% of cases being caused by blunt trauma and 39% by penetrating injury. The main pancreatic duct (MPD) status and the time between the pancreatic injury and the definitive diagnosis are the two most significant factors affecting the outcome.[5]

Imaging plays a crucial role in the clinical diagnosis of pancreatic injuries because it can be difficult to diagnose them, especially in situations of multiorgan trauma. CT is the diagnostic imaging modality of choice for examining the pancreas after abdominal trauma, notwithstanding the possibility of different trauma imaging procedures. The ideal approach is intravenous contrast-enhanced CT, which frequently includes arterial and portal venous phase imaging. Due to their increased vulnerability to blunt trauma because of the lack of a cushioning effect and the difficulty in detecting post-traumatic peripancreatic alterations, people with relatively low body fat composition provide a special challenge in the context of pancreatic trauma. The clinical and biochemical signs of pancreatic injury can be vague and subtle; they frequently become more obvious later in the post-injury course after the best window for treatment has gone, which reduces their value in early care. For the detection of MPD injuries CT has suboptimal sensitivity and specificity.[6]

The consequences of primary pancreatic injury depend upon the severity of the trauma. Patients with high-grade damage are more likely to experience complications such as pancreatic fistulas, intra-abdominal abscesses, wound infections, and formation of pancreatic pseudocysts. Vascular problems, like the development of a pseudoaneurysm in the splenic artery, can have catastrophic consequences and in many cases it may even prove fatal. Concomitant organ injuries are frequent with pancreatic trauma and raise morbidity and mortality. The complications such as sepsis and multiorgan failure account for up to 30% of deaths after pancreatic trauma. Hepatic, gastric, major vascular, splenic, renal, and duodenal injuries are among the organ injuries frequently linked to pancreatic damage.[7]

Imaging plays an important role in the diagnosis of traumatic pancreatic injuries. Early diagnosis and prompt treatment are associated with better outcomes in pancreatic trauma cases. The initiation of surgical care within 24 hours can minimise mortality. It may be required to identify modest radiological findings and use multimodal imaging. Mortality rates are much greater if the diagnosis is delayed.[8]

In order to predict mortality following traumatic pancreatic injury, the Pancreatic Injury Mortality Score (PIMS) was developed.[9] Age (more than 55), Shock at admission, Vascular injury, Total number of concomitant injuries and the American Association for the Surgery of Trauma (AAST) Organ Injury Scale for the pancreas are the five factors that make up the Pancreatic Injury Mortality Score (PIMS). The related mortality is roughly less than 1%, 15%, and 50%, respectively, according to PIMS, which categorises risk as low risk (0 to 5), medium risk (5 to 9), and high risk (9 to 20). We undertook this study to correlate AAST-OIS grading of pancreatic injuries and the validity of the PIMS in patients with pancreatic trauma.

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary care medical institute in South India. The duration of study was 1 year and 6 months extending from April 2021 to October 2022. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before their enrolment in the study. Patients were informed regarding the nature of their condition, study objectives and the possible treatment modalities. The study aimed to assess the clinical features and outcomes of patients with pancreatic trauma secondary to abdominal injury.

The sample size was calculated based on data from a reference study conducted by Krige et al which reported a mortality rate of 64.7% among patients with pancreatic trauma classified under AAST grades III to V. Using the formula $n = Z^2pq/d^2$ (where $Z = 1.96$ for 95% confidence interval, $p = 64.7\%$, $q =$

35.3%, and d = 16% (absolute precision of approximately 10.5) the required sample size was determined to be 68 after adjusting for a 10% non-response rate. Although a predicted sample size of 70 was targeted, the constraints imposed by the COVID-19 pandemic limited enrolment to 47 cases which constituted the final study cohort.

The study included patients admitted with a primary diagnosis of abdominal trauma either blunt or penetrating and subsequently diagnosed with pancreatic injury. After hemodynamic stabilization these patients underwent conservative management on the basis of their clinical condition. Relevant investigations such as complete blood count, liver function tests, renal parameters, and serum amylase were done with radiological assessments such as ultrasonography and contrast-enhanced computed tomography (CECT). Imaging was done with an aim to identify pancreatic injury and grade its severity. The American Association for the Surgery of Trauma (AAST) pancreatic injury scale was used for classification. Outcomes assessed included the stage of haemorrhagic shock, the presence of major vascular injury, involvement of the pancreatic ductal system and the degree of tissue loss. Surgical findings were documented and correlated with preoperative imaging.

All patients were monitored during their hospital stay for complications, requirement for intensive care and eventual outcomes. Morbidity and mortality were recorded, and correlations with the grade of pancreatic injury and presence of associated injuries were analyzed.

Statistical analysis was done using SPSS software version 23.0. Descriptive statistics such as mean, median and standard deviation were used for continuous variables. Categorical variables were expressed as frequencies and percentages. Chi-square test was used for comparison of categorical variables. A p-value of <0.05 was considered statistically significant.

Inclusion Criteria

- Patients with acute abdominal trauma (blunt or penetrating) with pancreatic involvement
- Age of the patients above 18 years

Exclusion Criteria

- Age below 18 years
- Patients with known pre-existing pancreatic disease

RESULTS

The analysis of the gender distribution of the studied cases showed that the majority were male (86.4%), while females accounted for only 6 cases (13.6%). The most common age group affected was 41–50 years (22.7%) followed by 31–40 years (20.5%) and 21–30 (15.9%). Assessment of Pancreatic Injury Mortality Score (PIMS) showed that 18 patients (40.9%) were classified as moderate risk, 15 (34.1%) as low risk and 11 (25.0%) as high risk. This was all about assessment of these gradings [Table 1].

Table 1: Age, Gender and Risk Distribution in studied cases.

		Frequency	Percent
Gender Distribution	Female	6	13.6
	Male	38	86.4
	Total	44	100.0
Age Distribution	Upto 20 yrs	3	6.8
	21 - 30 yrs	7	15.9
	31 - 40 yrs	9	20.5
	41 - 50 yrs	10	22.7
	51 - 60 yrs	7	15.9
	61 - 70 yrs	5	11.4
	Above 70 yrs	3	6.8
	Total	44	100.0
Risk Distribution	Low	15	34.1
	Moderate	18	40.9
	High	11	25.0
	Total	44	100.0

The analysis of the mortality distribution of the studied cases showed that the majority of patients survived. Out of 44 studied cases 9 patients (20.5%) with pancreatic trauma succumbed to injuries [Figure 1].

The analysis of the comparison between PIMS score and mortality showed that patients who expired had a significantly higher mean PIMS score of 11.8 (SD = 1.5), whereas those who survived had a much lower mean score of 5.5 (SD = 2.9). The independent sample t-test yielded a t-value of 8.940 and a p-value of 0.0005, which is highly statistically significant ($p < 0.01$) [Table 2].

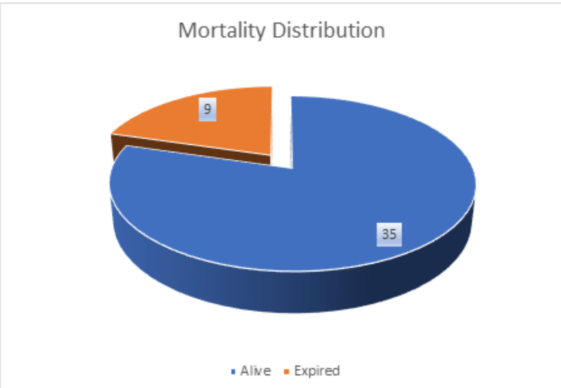

Figure 1: Mortality in cases of pancreatic injuries.

Table 2: Comparison of PIMS Score with Mortality by Independent sample t-test

Variable	Mortality	N	Mean	SD	t-value	p-value
PIMS Score	Dead	9	11.8	1.5	8.940	0.0005 **
	Alive	35	5.5	2.9		
** Highly Statistical Significance at $p < 0.01$ level						

The analysis of the correlation between age and PIMS score showed a weak positive correlation with an r-value of 0.231 based on a sample size of 44. However, the p-value was 0.131, indicating that the correlation was not statistically significant [Table 3].

Table 3: Correlations of Age and PIMS Score

Correlations		
		PIMS Score
Age	r-value	0.231
	p-value	0.131
	N	44
$p > 0.05$ level		

The analysis of the comparison between PIMS score and gender showed that male patients had a mean PIMS score of 6.6 +/- 3.7, while female patients had a higher mean score of 8.5 +/- 3.1. The difference was not statistically significant [Table 4].

Table 4: Comparison of PIMS Score with Gender by Independent sample t-test

Variable	Gender	N	Mean	SD	t-value	p-value
PIMS Score	Male	38	6.6	3.7	1.209	0.234
	Female	6	8.5	3.1		
$p > 0.05$ level						

The analysis of the comparison between the presence of shock and mortality showed that among the 25 patients without shock, all survived (71.4%), and none died (0.0%), whereas among the 19 patients who presented with shock, 10 (28.6%) survived and 9 (100.0%) died. The chi-square test yielded a χ^2 value of 14.887 with a p-value of 0.0001. The difference was statistically highly significant [Table 5].

Table 5: Comparison of Shock with Mortality by Fisher's exact test

			Mortality		Total	χ 2 - value	p-value
			Alive	Dead			
Shock	No	Count	25	0	25	14.887	0.0001 **
		%	71.4%	0.0%	56.8%		
	Yes	Count	10	9	19		
		%	28.6%	100.0%	43.2%		
Total		Count	35	9	44		
		%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at $p < 0.01$ level							

Comparison of Vessel Involvement with Mortality by Fisher's exact test were $\chi 2=13.294$, $p=0.002<0.01$ which showed highly statistical significance with Vessel Involvement and Mortality [Table 6].

Table 6: Comparison of Associated Organ Injury with Mortality by Pearson's Chi-Square test

			Mortality		Total	χ 2 - value	p-value
			Alive	Dead			
Vessel Involvement	No	Count	33	4	37	13.294	0.002 **
		%	94.3%	44.4%	84.1%		
	Yes	Count	2	5	7		
		%	5.7%	55.6%	15.9%		
Total		Count	35	9	44		
		%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at $p < 0.01$ level							

The analysis of the comparison between associated organ injury and mortality showed that among the 5 patients without any associated organ injury, all survived (14.3%), while among those with one associated injury, 19 (54.3%) were alive and 1 (11.1%) had died. In patients with two associated injuries, 5 (14.3%) survived and 5 (55.6%) died, and among those with three associated injuries, 6 (17.1%) were alive and 3 (33.3%) had died. The Pearson's Chi-Square test yielded a χ^2 value of 10.504 with a p-value of 0.015. The difference was statistically significant [Table 7].

Table 7: Comparison of Associated Organ Injury with Mortality by Pearson's Chi-Square test

			Mortality		Total	χ 2 - value	p-value
			Alive	Dead			
Associated Organ Injury	None	Count	5	0	5	10.504	0.015 *
		%	14.3%	0.0%	11.4%		
	One	Count	19	1	20		
		%	54.3%	11.1%	45.5%		
	Two	Count	5	5	10		
		%	14.3%	55.6%	22.7%		
	Three	Count	6	3	9		
		%	17.1%	33.3%	20.5%		
Total		Count	35	9	44		
		%	100.0%	100.0%	100.0%		
* Statistical Significance at p < 0.05 level							

The analysis of the comparison between AAST pancreatic injury grade and mortality showed that among patients with Grade I injury, 29 (82.9%) were alive and 5 (55.6%) had died; for Grade II, 5 (14.3%) were alive and 2 (22.2%) had died; in Grade III, 1 patient (2.9%) survived and 1 (11.1%) died; and for Grade IV, there were no survivors while 1 patient (11.1%) had died. The Pearson's Chi-Square test yielded a χ^2 value of 5.936 with a p-value of 0.115. The difference was not statistically significant [Table 8].

Table 8: Comparison of AAST Pancreatic Grade with Mortality by Pearson's Chi-Square test

			Mortality		Total	χ 2 - value	p-value
			Alive	Dead			
AAST Pancreatic Grade	Grade I	Count	29	5	34	5.936	0.115 #
		%	82.9%	55.6%	77.3%		
	Grade II	Count	5	2	7		
		%	14.3%	22.2%	15.9%		
	Grade III	Count	1	1	2		
		%	2.9%	11.1%	4.5%		
	Grade IV	Count	0	1	1		
		%	0.0%	11.1%	2.3%		
Total		Count	35	9	44		
		%	100.0%	100.0%	100.0%		
# No Statistical Significance at p > 0.05 level							

The analysis of the comparison between age and mortality showed that among patients younger than 55 years, 25 (71.4%) were alive and 6 (66.7%) had died, while among those older than 55 years, 10 (28.6%) survived and 3 (33.3%) died. The Fisher's exact test yielded a χ^2 value of 0.078 with a p-value of 1.000. The difference was not statistically significant [Table 9].

Table 9: Comparison of Age with Mortality by Fisher's exact test

			Mortality		Total	χ 2 - value	p-value
			Alive	Dead			
Age	< 55 yrs	Count	25	6	31	0.078	1.000 #
		%	71.4%	66.7%	70.5%		
	> 55 yrs	Count	10	3	13		
		%	28.6%	33.3%	29.5%		
Total		Count	35	9	44		
		%	100.0%	100.0%	100.0%		
# No Statistical Significance at p > 0.05 level							

The above table shows the comparison of PIMS Score with Mortality using Receiver Operating Characteristic curve (RoC), which shows the area of the curve is 0.990, p- value= 0.0001<0.01 with 95% C.I-0.970 to 1.000, which is highly statistical significance with the Cut off is 9.50, Sensitivity is 100.0%,Specificity 94.3%, PPV 81.8%, NPV 100.0% and accuracy is 95.5% [Table 10,11].

Table 10: Comparison of PIMS Score with Mortality using Receiver Operating Characteristic curve (RoC)

Area Under the Curve				
Area	Std. Errora	p-value	95% C.I	
			LB	UB
.990	.011	0.0001 **	.970	1.000
** Highly Significant at p < 0.01				

Table 11: Sensitivity, specificity, positive predictive value and negative predictive value of PIMS Score with mortality.

		Mortality		Total	Sensitivity	100.0
		Dead	Alive		Specificity	94.3
PIMS Score	>= 10	9	2	11	PPV	81.8
	< 10	0	33	33	NPV	100.0
Total		9	35	44	Accuracy	95.5

DISCUSSION

In the present study 44 patients with abdominal trauma and radiologically confirmed pancreatic injury were managed conservatively with no surgical intervention required. The demographic profile showed a male predominance (86.4%). Similar male predominance was observed by Siboni et al who evaluated blunt abdominal trauma in a large multicentric retrospective cohort and found 81% of their patients were male.[10] This male preponderance indicates a continued trend of higher trauma incidence among men likely to be secondary to occupational and behavioural factors. Moreover, our cases showed the highest incidence in the 30–50-year age group. These findings were similar by Shibahashi et al who identified the third and fourth decades of life as the peak age range for pancreatic trauma in their population-based review of trauma registries.[11] This likely reflects the increased exposure to vehicular and occupational hazards among the working-age men. In our study also road traffic collisions and falls were the most common causes of injuries.

The majority (comprising nearly 90% of cases) of pancreatic injuries in our study were low-grade (AAST I or II). There was no associated mortality among those classified as moderate risk. This is consistent with the findings by Gupta et al who reported 40–50% of cases as low-grade, and observed improved outcomes with conservative management in such cases.[12] Our results were similar to those of Siboni et al who observed 83% of pancreatic injuries to be low-grade and were managed conservatively.[10] This finding reflected an increasing trend toward nonoperative management (NOM) in hemodynamically stable patients. However, Krige et al reported an even distribution of low- and high-grade pancreatic injuries.[13] This study reported the variable presentation based on injury mechanisms and referral patterns to trauma centers. Interestingly, although the correlation between higher-grade injuries and complications was evident in our study we did not find a statistically significant association between injury grade and mortality. This finding suggests that associated injuries and physiological status at presentation may play a significant role in outcome determination than injury grade alone.

Our data highlighted the critical influence of associated injuries and physiological compromise such as hypotension and head trauma on mortality. In our cohort, 43% of patients had concurrent cranial injuries and over 25% were in shock on admission. These findings were similar to findings of Hwang et al who found that a Glasgow Coma Scale (GCS) ≤13 and systolic blood pressure <90 mm of Hg were both significant predictors of mortality in patients with pancreatic trauma.[14] Similarly, Krige et al emphasized that the presence of vascular injury and shock significantly increased in-hospital mortality and complications.[13] Our study further validated the Pancreatic Injury Mortality Score (PIMS) demonstrating high sensitivity and specificity (area under the ROC curve: 0.970–1.000). Comparable predictive utility of injury scoring systems in trauma was also reported by Moore et al who emphasized the relevance of composite scores in outcome prediction following complex abdominal trauma.[15]

In contrast to many earlier studies that emphasized the diagnostic ambiguity of early pancreatic enzyme elevation, our results revealed that lipase was a more reliable marker than amylase in indicating pancreatic injury. Previous work by Bradley et al suggested that up to 40% of patients with pancreatic trauma may present with normal serum amylase levels, particularly within the first 6 hours of injury.[16] Our findings are similar to Bhasin et al who emphasized the diagnostic superiority of serum lipase over amylase for early screening.[17] In terms of imaging, our study supported the current consensus that contrast-enhanced CT (especially multidetector CT) is highly sensitive and specific for detecting pancreatic injuries such as ductal disruptions. Becker et al demonstrated the sensitivity and specificity of multidetector CT to be over 90% and up to 100%, respectively for ductal injuries.[18] However, both our findings and those of Somasekar R reinforce the importance of serial imaging when initial scans are performed too early post-trauma as the pancreas may appear deceptively normal within the initial 12-hour window.[19]

Finally, our study's nonoperative management (NOM) strategy aligns with contemporary guidelines and observational studies advocating for selective NOM in low- and even selected intermediate-grade pancreatic injuries. All 44 patients in our series were managed conservatively, with favorable outcomes in the vast majority. This is similar to outcome of study by Al-Ahmadi et al who supported NOM in hemodynamically stable patients.[20] Our findings are further supported by the World Society of Emergency Surgery (WSES) guidelines which recommend NOM for grade I and II injuries and in selected cases of grade III injuries. However surgical procedures such as distal pancreatectomy and pancreaticoduodenectomy may be necessary in some cases of pancreatic trauma. The low complication rate in moderate-risk patients in this study confirms the safety and efficacy of NOM when appropriately applied.

CONCLUSION

Blunt pancreatic trauma is often underdiagnosed due to nonspecific clinical picture and subtle imaging findings. In many cases multiorgan injuries are responsible for underdiagnosis. CT remains the first-line modality for diagnosis and determination of severity. The AAST-OIS grade, vascular injury and hemodynamic status are important from the point of view of management. Most of the lower-grade injuries can be treated conservatively and higher grades often requiring surgery. The proposed Pancreatic Injury Mortality Score (PIMS) incorporating clinical and radiological parameters shows high sensitivity and specificity in stratifying risk and guiding intervention.

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