

# CT Evaluation of Acute Pancreatitis and its Prognostic Correlation with CT Severity Index

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## ABSTRACT

**Introduction:** Pancreatitis is one of most complex and clinically challenging of all abdominal disorders. USG and abdominal CT are the most commonly used diagnostic imaging modalities for the evaluation of pancreas. Computed Tomography (CT) is highly accurate and sensitive than USG in both diagnosing as well as demonstrating the extent. Early assessment of the cause and severity of acute pancreatitis is of utmost importance for prompt treatment and close monitoring of patient with severe disease. CT is the imaging method of choice for assessing the extent of acute pancreatitis and for evaluating complications.

**Aim:** To assess prognostic correlation and clinical outcome of acute pancreatitis on the basis of CT severity index.

**Materials and Methods:** A prospective study of 50 cases was carried out in the Department of Radio Diagnosis, with complaint suggestive of acute pancreatitis on the basis of clinical/laboratory/ultrasonography findings were evaluated in Siemens somatom 40 slice CT. The severity of pancreatitis was scored using CT severity index, modified severity index and revised Atlanta classification and classified into mild, moderate, severe categories. Clinical follow-up of the patients was done in terms of the following parameters: Length of hospital stay, Need for surgery or percutaneous intervention, Evidence of infection in any organ system, Occurrence of organ failure- respiratory,

cardiovascular, renal, hepatic and haematological system, death. The clinical outcome was compared with the currently accepted Balthazar's CTSI and Modified Mortelet's CTSI and revised Atlanta classification in all the cases.

**Results:** Gall stone disease was most common aetiological factor seen in 40% cases, it was more common in females than males. Alcohol was second most common aetiological factor seen in 38% cases and was noted only in males. Pleural effusion was the most common extra-pancreatic complication seen in 46% cases. Balthazar grade C was the most common (40%) followed by grade D and E (25% each). Acute peri-pancreatic collection was the most common findings seen in 72% cases. Majority of the cases (42%) were categorized as mild pancreatitis according Balthazar CTSI score. Majority of the cases (44%) were categorized as severe pancreatitis according modified CTSI. Majority of the cases were categorized as mild pancreatitis according revised Atlanta classification. Organ system failure, death were more seen in severe grade in modified CTSI and revised Atlanta classification.

**Conclusion:** Modified CT severity index makes the score easier to calculate and reduces the inter-observer variation. Scores obtained with the modified Mortelet index, show a stronger statistical correlation for all clinical outcome parameters in all the patients better than the Balthazar index.

**Keywords:** Abdominal computed tomography, Complications, Pancreatic diseases

## INTRODUCTION

Diseases of pancreas have a very variable presentation and imaging plays an important role in the diagnosis and management of pancreatic diseases. Modalities for imaging pancreas range from plain x-ray to Ultrasonography (USG), endoscopic ultrasound, Endoscopic Retrograde Cholangiopancreatography (ERCP), Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Magnetic Resonance Cholangiopancreatography (MRCP). Computed Tomography (CT) is highly accurate, and sensitive than USG in both diagnosing as well as demonstrating the extent [1]. CT is a key diagnostic tool in understanding the cause of endocrine and exocrine pancreatic insufficiency in most patients. Pancreatitis is one of most complex and clinically challenging of all abdominal disorders [2].

As early treatment of patients with severe acute pancreatitis can reduce morbidity and mortality. Balthazar in 1990, created the CT Severity Index (CTSI) by combining the original grading system with the presence and extent of pancreatic necrosis. The combined score of CTSI proved to have a better prognostic accuracy than the Balthazar score but it, too, had some drawbacks. The score obtained with the index did not significantly correlate with the subsequent development of organ failure, extra pancreatic parenchymal complications or peripancreatic vascular complications [3,4]. In view of these limitations, a modified and

simplified CT scoring system was hypothesized in 2004 by Mortelet and colleagues so as to determine if the scores obtained with this could be used to predict the clinical outcome more accurately. The modified Mortelet CTSI was easier to calculate and was found to correlate more closely with patient outcome measures like the length of the hospital stay, the need for surgery/intervention, and the occurrences of infection, organ failure and death than the currently accepted Balthazar CT severity index, with similar inter observer variability [5]. The revised Atlanta classification system, introduced in 2012, better defined the clinical diagnosis, Computed Tomographic (CT) manifestations and disease course of acute pancreatitis into two morphologic subtypes [6]: Interstitial oedematous pancreatitis and Necrotizing pancreatitis

## AIM

To assess the prognostic correlation of patient outcome with currently accepted Balthazar and the Modified Mortelet Computed Tomography severity indices in acute pancreatitis.

## MATERIALS AND METHODS

It was a prospective study, conducted from November 2013 to November 2015, in the Department of Radio Diagnosis, People's Hospital associated to People's College of Medical Sciences and Research Centre, Bhanpur, Bhopal, India.

A total of 50 patients referred from the Department of Emergency Medicine and Department of Surgery, People's Hospital associated with People's College of Medical Sciences and Research Centre presented with the chief complaint of epigastric pain, nausea and vomiting and CECT abdomen were suggestive of acute pancreatitis were included in this study.

### Assessment of Severity

Assessment of severity of acute pancreatitis was done in all cases by Balthazar CTSI scoring [3] and Mortelet Modified [7] CTSI scoring.

Each case was assigned a CT grade from A to E and awarded points from 0-4 as in [Table/Fig-1].

Grade A:	Normal pancreas	0 Point
Grade B:	Focal or diffuse enlargement of the pancreas (including contour irregularities, non-homogenous attenuation of the gland, dilation of the pancreatic duct and foci of small fluid collections within the gland, as long as there was no evidence of peri-pancreatic disease.	1 Point
Grade C:	Intrinsic pancreatic abnormalities associated with hazy streaky densities representing inflammatory changes in the peri-pancreatic fat.	2 Point
Grade D:	Single ill defined fluid collection (phlegmon).	3 Point
Grade E:	Two or multiple, poorly defined fluid collections or presence of gas in or adjacent to the pancreas.	4 Point

[Table/Fig-1]: Balthazar CTSI-Scoring.

The presence and extent of necrosis in each case was classified into four categories and awarded points from 0-6 as follows:

Necrosis absent	0 Points
< 30% necrosis	2 Points
30-50%	4 Points
> 50% necrosis	6 Points

The Balthazar CTSI was calculated by adding the above points in each case and the total score was then categorized as:

Mild pancreatitis	CTSI score 0-3
Moderate pancreatitis	CTSI score 4-6
Severe pancreatitis	CTSI score 7-10

### Mortelet Modified CTSI Scoring

Normal pancreas	0 Point
Intrinsic pancreatic abnormalities with or without inflammatory changes in peripancreatic fat	2 Points
Pancreatic or peripancreatic fluid collection or peripancreatic fat necrosis	4 point

The presence and extent of necrosis in each case was scored from 0-4 as follows:

Necrosis absent	0 Points
< 30% necrosis	2 Points
> 30% necrosis	4 points

To the above score, 2 points were added for the presence of extra-pancreatic findings.

The Modified CTSI was calculated by summing these values and the total score was then categorized as:

Mild pancreatitis	Modified CTSI score 0-2
Moderate pancreatitis	Modified CTSI score 4-6
Severe pancreatitis	Modified CTSI score 8-10

The severity is classified into three categories based on clinical and morphologic findings according to revised Atlanta classification [8]

1. *Mild* – No organ failure and no local or systemic complications.
2. *Moderate* – Presence of transient organ failure less than 48h and/or presence of local complications.
3. *Severe* – Persistent organ failure > 48 hour.

### Outcome Parameters

Clinical follow-up of the patients was done in terms of the following parameters:

- Length of hospital stay.
- Need for surgery or percutaneous intervention.
- Evidence of infection in any organ system.
- Occurrence of organ failure- respiratory, cardiovascular, renal, hepatic and haematological system.
- Discharged/death.

The clinical outcome was compared with the currently accepted Balthazar's CTSI and Modified Mortelet's CTSI in all the cases.

Method of data collection clinical diagnosis was based on the symptoms like upper abdominal pain, nausea, vomiting, fever and/or elevation of serum amylase three times the upper limit of normal (normal serum amylase 20-110 U/L).

### Inclusion Criteria

Clinically suspected case of acute pancreatitis of all ages.

### Exclusion Criteria

1. Patients with chronic pancreatitis suggested by intraductal calculi, ductal stricture and parenchymal calcification.
2. Other pancreatic pathology like pancreatic malignancy, cyst.
3. Any previous pancreatic surgery.
4. Contraindicated cases for contrast study.
5. Postoperative cases.
6. Pregnant females.

Equipments used in the study – Siemens Somatom Sensation mdct 40 slice and Mederton Inkjeterton CT2 (pressure injector).

### STATISTICAL ANALYSIS

Data analysis was done using SPSS version 16.0 Data transformation by recoding, counting and cross tabulation was performed and obtained information was processed using Pearson chi-square and Fisher's-exact test.

### RESULTS

**Symptoms and signs in patients of acute pancreatitis:** Triad of epigastric pain, nausea and vomiting was present in 75% of patients.

**Findings in patients of acute pancreatitis:** Most common CT findings were peri-pancreatic inflammatory changes in mesentery, greater omentum and transverse mesocolon (88%). Second most common CT finding was pancreatic contour irregularity (80%). Twenty five patients (50%) had necrosis of the pancreas with 14 of them having > 50% necrosis.

Causes	Total		Male		Female	
	No. of cases	%	No. of cases	%	No. of cases	%
Gall stones	20	40	8	38	12	62
Alcohol	19	38	19	100	0	0
Trauma	1	2	0	00	1	100
Drug induced	1	2	0	0	1	100
Idiopathic	11	24	8	75	3	25

[Table/Fig-2]: Aetiology of acute pancreatitis.

Gall stone disease was most common aetiological factor seen; it was more common in females than males. Alcohol was second most common aetiological factor and was noted only in males [Table/Fig-2].

Findings	No. of Cases	%
Extra pancreatic complications	34	68
Pleural fluid	23	46
• Left pleural effusion	13	26
• B/L pleural effusion	10	20
Ascites	17	34
Solid organ abnormality	5	10
• Infarction	0	0
• Haemorrhage	0	0
• Subcapsular fluid collection	5	10
Vascular complications	4	8
• Venous thrombosis	4	8
• Arterial haemorrhage	0	0
• Pseudoaneurysm formation	0	0
Inflammation of GIT	12	24
• Thickening of wall	12	24
• Intramural fluid collection	0	0

**[Table/Fig-3]:** Extra pancreatic complications in patient of acute pancreatitis.

Pleural effusion was the most common extra-pancreatic complication with left pleural effusion being the more common. Isolated right pleural effusion was not seen [Table/Fig-3].

**Balthazar grading in patients with acute pancreatitis:** Balthazar grade C was the most common (40%) followed by grade D and E (25% each).

**Correlation of Balthazar grade with Degree of necrosis:** Of the 25 (50%) patients, 6 had < 30%, 5 had 30-50% and 14 had > 50% pancreatic necrosis. No necrosis was noted in patients with grade B pancreatitis. Of the 20 patients with Grade C pancreatitis, 9 (45%) patients had gland necrosis with 6 patients having > 50% necrosis. Of the 13 patients with grade D pancreatitis, 7(54%) patients had parenchymal necrosis. Of the 13 patients with Grade E pancreatitis, 9(69%) patients had evidence of necrosis.

Acute peripancreatic collection	Acute necrotic collection	Pseudocyst	Walled off necrosis
36	24	0	0

**[Table/Fig-4]:** The morphological classification according to Revised Atlanta classification.

Acute peri pancreatic collection was the most common findings [Table/Fig-4].

Severity	Score	No. of patients	%
Mild	0-3	21	42
Moderate	4-6	12	24
Severe	7-10	17	34
Total		50	100

**[Table/Fig-5]:** Grading severity of acute pancreatitis using Balthazar CTSI score.

Majority of the cases were categorized as mild pancreatitis according Balthazar CTSI score [Table/Fig-5].

Severity	Score	No. of Cases	%
Mild	0-2	9	18
Moderate	4-6	19	38
Severe	8-10	22	44
Total		50	100

**[Table/Fig-6]:** Grading severity of acute pancreatitis using modified mortelete CTSI.

Majority of the cases were categorized as severe pancreatitis using the Modified Mortelete CTS score [Table/Fig-6].

Severity	Total no. of cases	Organ failure	No. of death
Mild	42	0	0
Moderate	0	0	0
Severe	8	8	7

**[Table/Fig-7]:** Severity of acute pancreatitis according to revised Atlanta classification.

According to revised Atlanta classification majority of the cases were categorized as mild pancreatitis [Table/Fig-7].

Outcome Parameter/ No. of patients	Total (n=50)		Mild (n=21)		Moderate (n=12)		Severe (n=17)	
	No.	%	No.	%	No.	%	No.	%
Average duration of hospital stay (in days)			17		25		23	
Intervention/ drainage	15	30	3	20	7	46.6	5	33.33
Surgical debridement	2	4	0	0	0	0	2	100
Infection	8	16	1	12.5	0	0	7	87.5
Organ system failure	8	16	1	12.5	1	12.5	6	75
Death	0	12	0	0	1	16.6	6	83.3

**[Table/Fig-8]:** Patient outcome using currently accepted Balthazar CTSI.

Intervention and length of stay was significantly more (p-value = 0.02 and 0.01 respectively) associated with moderate grade. Infection, organ system failure and death were significantly associated with severe grade [Table/Fig-8].

Outcome Parameter/ No. of patients	Total (n=50)		Mild (n=8)		Moderate (n=20)		Severe (n=22)	
	No.	%	No.	%	No.	%	No.	%
Average duration of hospital stay (in days)			9		22		29	
Intervention/ drainage	15	30	0	0	7	46.6	8	53.33
Surgical debridement	2	4	0	0	0	0	2	100
Infection	8	16	0	0	1	12.5	7	87.5
Organ system failure	8	16	0	0	1	12.5	7	87.5
Death	7	12	0	0	1	14.2	6	85

**[Table/Fig-9]:** Patient outcome using modified Mortelete CTSI.

Average duration of hospital stay was significant more (p-value = 0.02) with severe grade. Infection, organ system failure and death were also significantly associated with severe grade [Table/Fig-9].

Grading System	Severity	Organ Failure	No of death
Balthazar CTSI	Mild	1	
	Moderate	1	1
	Severe	6	6
Modified Mortelete CTSI	Mild	0	0
	Moderate	1	1
	Severe	7	6
Revised Atlanta Classification	Mild	0	0
	Moderate	0	0
	Severe	8	7

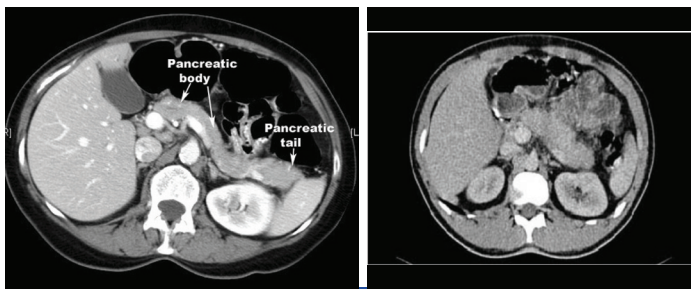
**[Table/Fig-10]:** Comparison of outcome according to the currently accepted balthazar ctsi and mortelete modified ctsi and revised atlanta classification (N=50).

Organ failure, death seen in only severe category in revised Atlanta classification, moderate and severe category in modified Mortelete CTSI, mild, moderate, severe category in Balthazar CTSI [Table/Fig-10]. Few illustrations of cases have been provided in [Table/Fig-11-18].

## DISCUSSION

The present study was undertaken to evaluate the acute pancreatitis on CT and the patient was prognostically correlated on the basis of CTSI (including Balthazar's Computed Tomography Severity Index and the Modified Computed Tomography Severity Index). The study group consisted of 35 male and 15 female patients with a male: female sex ratio of 2:1 In a prospective study by Block et al., consisted of 61 (65.6%) males and 32 (34.4%)



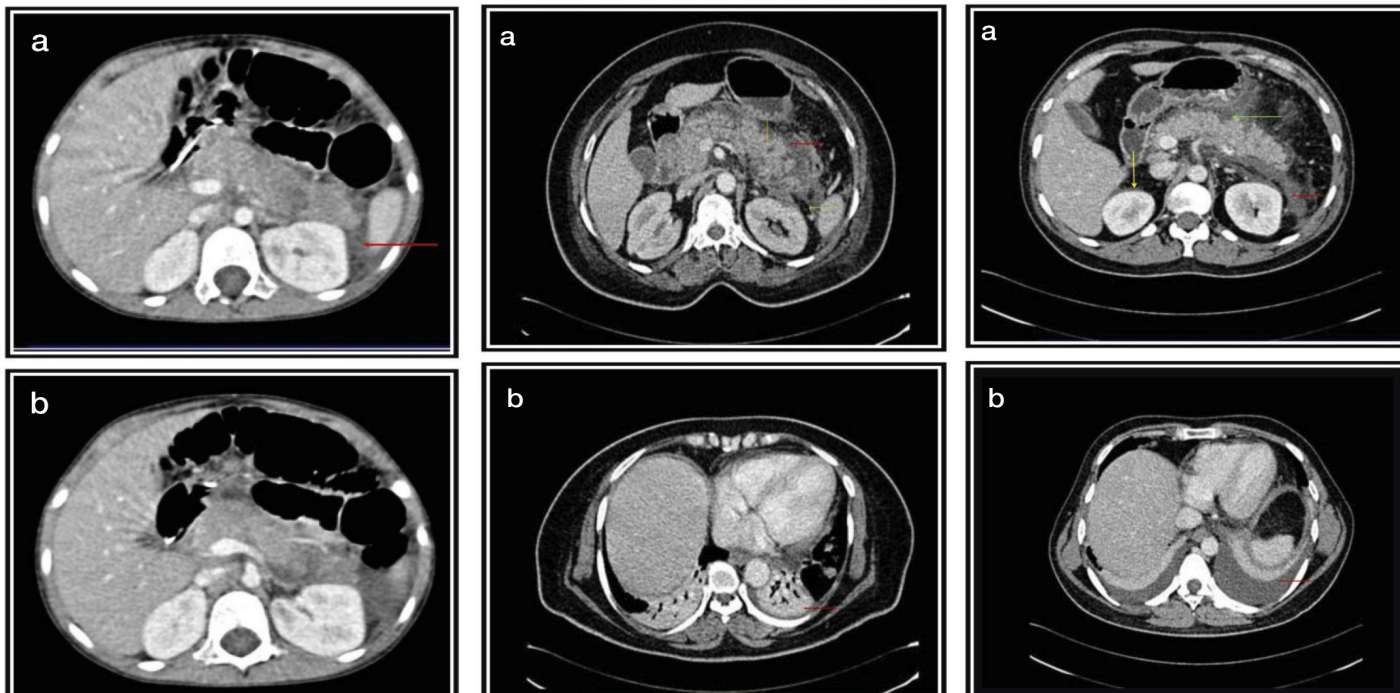


**[Table/Fig-11]:** Axial CT image of abdomen reveals normal anatomy of Pancreas (arrows). **[Table/Fig-12]:** Bulky pancreas both Balthazar CTSI 1 and modified CTSI score 2 suggestive of mild pancreatitis.

than 30%, 5 (20%) patients had 30-50% necrosis and majority 14 (56%) of them had more than 50% pancreatic gland necrosis. Consequently 76% of the cases had more than 30% pancreatic necrosis.

Balthazar et al., found that on the basis of initial assessment, pancreatic necrosis was detected in 22% of the patients of which 28% patients had less than 30% necrosis, 22% had 30-50% and 50% patients had more than 50% necrosis which is similar to the present study [14]. Extra-pancreatic and systemic complications occurred in 34(68%) of the patients in our study.

The most common complication was pleural effusion seen in 46% of the cases with left pleural effusion being commoner. Balthazar



**[Table/Fig-13]:** (a) Bulky pancreas with heterogeneous enhancement; (b) Bulky pancreas with mild ascites (Red Arrow) both Balthazar and modified CTSI score 4 suggestive of moderate pancreatitis.

**[Table/Fig-14]:** (a) Bulky, heterogeneous pancreas with peri pancreatic fat stranding (red arrow) & few necrotic areas seen within pancreas (<30%), (yellow arrow) and thickened Gerota's fascia (green arrow). (b) Minimal bilateral pleural collection and basal subsegmental atelectasis (red arrow) Balthazar CTSI score 6 and modified CTSI scores 8 suggestive of intermediate and severe pancreatitis respectively.

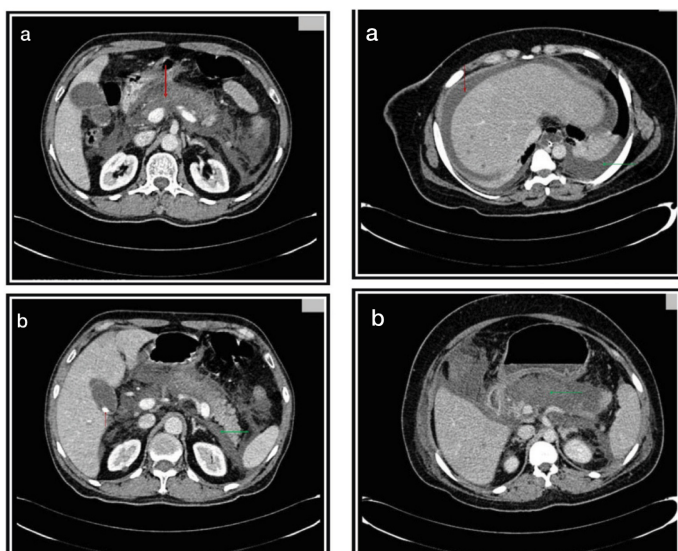
**[Table/Fig-15]:** (a) Diffusely edematous pancreas with peripancreatic fat stranding (green arrow), fluid collection (yellow arrow) and perinephric fascial thickening (red arrow). (b) Bilateral pleural effusion and basal sub segmental atelectasis (red arrow) Balthazar CTSI score 5 and modified CTSI score 6 suggestive of intermediate and moderate pancreatitis respectively.

females with a male to female ratio of 2:1 [9]. Silverstein et al., in his prospective study of 102 patients, also had a male to female ratio of 2:1 [10].

In our study, most common aetiological factors were cholelithiasis (42%) and alcoholism (38%) followed by idiopathic (24%), trauma (2%) and drug induced (2%). Casas et al., in their study of 148 patients, found the cause of acute pancreatitis as gall stones in 57%, alcohol over indulgence in 21% and to both in 5% which is in concordance with the present study [11]. According to Steinberg et al., biliary calculi and alcohol together constituted about 80-90% of causes of acute pancreatitis, the frequency varied in different populations. Peripancreatic inflammatory changes were the most common CT findings seen in 88% of the cases of acute pancreatitis. Mendez et al., found that out of 32 patients, 28 (87.5%) exhibited extrapancreatic spread of the inflammatory process. In the present study, the pancreatic gland was enlarged in 60% cases [12]. Silverstein et al., found enlargement of the pancreas in 68% of the cases as in this study [10]. And also, similar findings concluded in a study by Irshad Ahmad Banday et al., [13]. Infected necrosis occurred in 4 cases (8%) in this study Silverstein et al., and Mendez et al., have also reported an incidence of infected necrosis in 10.5% and 3% respectively [5,9]. Twenty-five patients (50%) had necrosis of the pancreas. Six (24%) patients had less

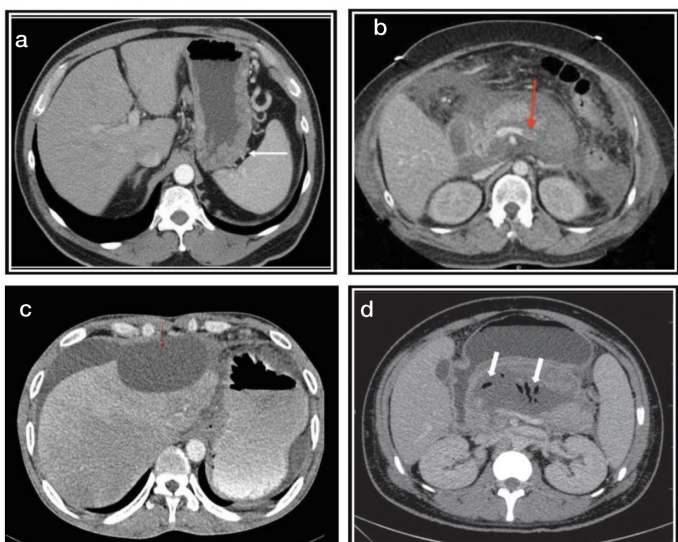
et al., also found left pleural effusion to be the most common abnormality (43% of the cases) which is similar to the present study [14]. Ascites was found to be present in 17 patients (34%) in our study. Venous thrombosis were seen in 4 patients (8%). Irshad Ahmad Banday et al., in their study found ascites to be the second most common complication and was seen in 18 patients (36%) [13]. Among vascular complications, venous thrombosis was the most common (3 in portal vein and 1 in splenic vein). A fairly common finding in the present study was inflammation of gastrointestinal tract seen in 12(24%). A recent study by Irshad Ahmad Banday et al., stated that GI involvement was found in 13 patients that is (26%) [13]. Balthazar et al., have also reported similar incidence [14]. There was a proportionally increasing trend of gland necrosis with increasing severity of Balthazar grade; 45% patients in grade C, 54% patients in grade D and 69% patients in grade E had gland necrosis in grade E pancreatitis (28%) as in our study with the most common type being grade C pancreatitis.

Balthazar et al., found that necrosis was present in 7% patients with grade B, 1% with grade C, 17% with grade D and 52% with grade E pancreatitis [14]. Their findings were on the lower side as compared to this study. The possible explanation for this is the large number of patients having mild pancreatitis in their study group. Using the currently accepted Balthazar CTSI, the severity



**[Table/Fig-16]:** (a) Acute necrotizing pancreatitis affecting >50% pancreas (red arrow). (b) Acute necrotizing pancreatitis with peripancreatic fluid collection (green arrow) perinephric fascial thickening and ascites with cholelithiasis (red arrow) both Balthazar & modified CTSI score 10 suggestive of severe pancreatitis.

**[Table/Fig-17]:** (a) Acute necrotizing pancreatitis with ascites (red arrow) and pleural effusion (green arrow). (b) Acute necrotizing pancreatitis (>50%) (green arrow) both Balthazar and modified CTSI score 10 suggestive severe pancreatitis.



**[Table/Fig-18]:** (a) Acute pancreatitis associated with thickened stomach wall. (b) Acute necrotizing pancreatitis complicated by splenic vein thrombosis. (c) Acute pancreatitis complicated by subcapsular collection. (d) Acute gangrenous pancreatitis.

of acute pancreatitis was graded as mild (score of 0-3) in 21 (42%) cases, moderate (score of 4-6) in 12 (24%) and severe (score of 7-10) in 17 (34%) patients. Using the modified CTSI scoring, maximum number 22 (44%) of the patients had severe (score of 8-10) pancreatitis. Mild (score of 0-2) and moderate (score of 4-6) pancreatitis were categorized in 9(18%) and 19 (38%) patients respectively. This was fairly similar to the study conducted by Irshad Ahmad Banday et al., where in when Balthazar CT Severity Index was employed, acute pancreatitis was graded as mild in 22/50 (44%), moderate in 11/50 (22%) and severe in 17/50 (34%) patients [13]. In contrast, when using the Modified CT Severity Index, a much larger number, viz. 22/50 (44%) patients were placed in the severe pancreatitis group and 9/50 (18%), 19/50 (38%) patients as mild and moderate pancreatitis.

According to Balthazar CT severity index, amongst the patients with mild pancreatitis (n=21), average duration of hospital stay was 17 days). In the moderate group pancreatitis group (n=12), average duration of hospital stay was 25 days. In the severe group (n=17), average duration of hospital stay was 23 days.

Modified CT scoring system correctly predicted the outcome in all the patients who had a shift in their severity grades than Balthazar CTSI. The change in severity scoring was seen mainly due to the presence of extrapancreatic complication.

The strong relationship between the Modified CT severity index and the patient outcome in this study corroborates with the findings of Mortelet et al., [7]. Similar trends in duration of hospital stay, intervention or surgery, evidence of infection, organ failure, and mortality in patients with variable grades of severity of pancreatitis were observed in our study as that seen by Mortelet in their study. This also correlated with the study by Irshad Ahmad Banday et al., which concluded that Modified CT Severity Index is a simpler scoring tool and more accurate than the Balthazar CT Severity Index [13].

Results of our study were also found similar to a study conducted by Shivanand Melkundi et al., which showed a significant correlation of grades of severity of acute pancreatitis based on MCTSI with patient outcome parameters than grades of severity of acute pancreatitis based on CTSI [15].

Patient outcome using currently accepted Balthazar CTSI (N=50) showed intervention and length of stay was more significantly (p-value=0.02 and 0.01 respectively) associated with moderate grade. Infection, organ system failure and death were significantly associated with severe grade. Whereas with Modified Mortelet CTSI (N=50) the average duration of hospital stay was significant more (p-value=0.02) with severe grade.

Patient outcome in terms of organ failure and death is more accurately assessed by revised Atlanta classification in comparison with Balthazar and modified ct severity index. The revised classification seems to be a good predictor for clinical outcome of AP Shyu JY et al., [16].

## LIMITATIONS

In patients of derange renal function and pregnant patients contrast CT is contraindicated. Repeated follow-up study was not possible due to cost and radiation exposure. Different treatments were given to patients which changed the patient outcome. Sample size was small which may have affected the result. As per the revised Atlanta classification, CECT is useful after first week. However, in first week only clinical parameters are useful.

## CONCLUSION

Contrast enhanced Computed Tomography is excellent diagnostic modality to stage the severity of inflammatory process, detect the pancreatic necrosis and depict local complications and grading of severity of acute pancreatitis. The scores obtained with the modified Mortelet index, showed a stronger correlation for all outcome parameters in all the patients better than the Balthazar index. Revised Atlanta classification is more accurate than modified Mortelet index and Balthazar severity index for assessing patient mortality and organ failure.

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