

**Comparative Study of Balthazar CT Severity Index and Modified CT Severity Index in Predicting the Outcome of Acute Pancreatitis**Sekhar Reddy Jilakapally<sup>1</sup>, Amit Kumar Routh<sup>2</sup>, Anusha Mulka<sup>3</sup><sup>1</sup>Associate Professor, TRR Institute of Medical Sciences, Pathancheru, Sangareddy, Telangana<sup>2</sup>Associate Professor, Department of Radiodiagnosis, MNR Medical College and Hospital, Fasalwadi, Sangareddy, Telangana<sup>3</sup>Assistant Professor, Mahavir Medical College and Research Institute, Vikarabad, Telangana

Received: 30-03-2023 / Revised: 30-04-2023 / Accepted: 02-05-2023

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Conflict of interest: Nil

**Abstract:****Introduction:** Acute pancreatitis is generally classified into mild and severe forms: mild pancreatitis is associated with minimal organ failure and an uneventful recovery. Severe pancreatitis, also, is associated with organ failure or local complications.**Aims and Objectives:** To compare the Balthazar CT Severity Index and Modified CT Severity Index in predicting the outcome of acute pancreatitis.**Materials and Methods:** 50 cases of acute pancreatitis underwent CECT. The scans were reviewed and scored using both CT indices. Severity parameters included the length of hospital stay, occurrence of organ failure, need for intervention, evidence of infection, and mortality. Descriptive statistics were used for baseline characteristics. Chi-square or Fisher's exact tests were used to compare the two indices.**Results:** The age of the patients in the study group was in the range of 21 to 80 years. Maximum patients were in the age group 40-50 years (44%). The mean age was 42.32 years. Out of 50 cases, 45 (90%) were male and 05 (10%) were females with a male to female ratio of 2:1. Majority of patients were of severe pancreatitis (44%) category. 38% patients were grouped into moderate pancreatitis and 20% were categorized in mild pancreatitis. The outcome parameters in terms of length of hospital stay, need of intervention, development of infection, and development of organ failure were more in patients with higher modified CT severity index.**Conclusion:** Contrast-Enhanced Computed Tomography (CECT) is considered an excellent imaging modality for diagnosis, detecting the extent of disease process and in grading its severity. The Modified CT Severity Index is a simpler scoring tool and more accurate than the Balthazar CT Severity Index. In the present study, significant statistical correlation is found with the clinical outcome in terms of the length of hospital stay, development of infection, occurrence of organ failure and overall mortality. It may help in predicting the need for interventional procedures.**Keywords:** Acute pancreatitis, Balthazar CT Severity Index, Modified CT Severity Index.

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**Introduction**

Acute pancreatitis (AP) is a diffuse inflammatory disease process of the pancreas, which is triggered by several factors such as alcoholism and choledocholithiasis are most common. [1] Diseases of the pancreas have variable presentation and different modalities of imaging play an important role in diagnosis and aid in management. Imaging is performed to evaluate the presence of inflammatory extension of pancreatic fluid, pancreatic necrosis and associated complications.[2]

Different Modalities of imaging includes plain abdomen x-ray, Ultrasonography (USG), endoscopic ultrasound, Endoscopic Retrograde Cholangiopancreatography (ERCP), Contrast

Enhanced Computed Tomography (CECT), Magnetic Resonance Imaging (MRI), Magnetic Resonance Cholangiopancreatography (MRCP).

Generally acute pancreatitis is classified into mild and severe pancreatitis. Mild pancreatitis is also known as oedematous or interstitial pancreatitis, resulting in mild organ failure in majority of patients and uneventful recovery. Severe pancreatitis also called as necrotizing pancreatitis is associated with organ failure and other complications, including necrosis, infection and pseudo cyst formation.[3] In general, physical examination and laboratory findings help to diagnose acute pancreatitis. However, severity of disease is more difficult. For this purpose, several

clinical and radiological scoring systems have been developed, Ranson's criteria [4], Imrie score [5] the acute physiology and chronic health evaluation (APACHE II) scoring system [6], Simplified Acute Physiology score (SAP score) [7] and the CT severity index.[8,9]

Several radiologic prognostic scoring systems have been created and among them CT severity index (CTSI) designed by Balthazar in 1990[10], is the most widely accepted for clinical and research settings. The CT severity index is a numeric scoring system that combines with the presence of pancreatic and extrapancreatic inflammation with the extent of pancreatic necrosis.[9] It has better prognostic factors than the earlier score but it also has some limitations. First, the score obtained with the severity index did not correlate with occurrence of organ failure [11] extrapancreatic parenchymal complications[12,13] or peripancreatic vascular complications [14] and their correlation with the final outcome. Secondly, as observed in some researches, inter-observer agreement for scoring the computed tomography scans using the CTSI was only moderate, with a reported agreement of approximately 75%.[12,15] The source of this variability may relate to the subjective and multiple categorization of the extent of pancreatic necrosis and inflammation.

To overcome those limitations, in 2004, a modified CTSI (MCTSI) was designed by Moretele et al to account for several potential limitations of CTSI. [16] MCTSI is easy to calculate and correlates more closely with the patient outcome like occurrence of infection, organ failure and death than Balthazar CT Severity Index. Few other studies have evaluated the patient outcome of MCTSI in acute pancreatitis. The present study is an attempt to correlate the Balthazar CT severity index and Modified CT severity index with outcome of acute pancreatitis patients to determine their strengths and limitations.

### Aims and Objectives

1. The aim of this study is to determine whether modified CT severity index is effective in assessing the severity of acute pancreatitis and predicting outcome.
2. To compare and correlate the Balthazar computed tomography severity index with modified computed tomography severity index in predicting the outcome of acute pancreatitis.

### Materials and Methods

This was a hospital based prospective correlative study done in a teaching hospital of South India on patients of all age groups referred to the department of Radiodiagnosis, from the various indoor and outdoor departments of the hospital, with clinical/laboratory/ultrasonography findings

suggestive of acute pancreatitis. Fifty cases of acute pancreatitis who presented to the emergency department as acute abdomen were included in the study. Informed and written consent was taken from all the participants

### Diagnostic criteria

#### Presence of at least two of the following:

1. Acute abdominal pain and tenderness suggestive of pancreatitis.
2. Serum amylase/lipase  $\geq 3$  times the normal.
3. Imaging findings (USG and/or CT) suggestive of acute pancreatitis.

### Inclusion Criteria

- Patients diagnosed as AP by clinical/laboratory/USG, who were willing to undergo Contrast enhanced computed tomography.
- All age groups.
- Both Male and Female.

### Exclusion Criteria

- Patients not willing to undergo Contrast study.
- Patients with known history of allergy to iodinated contrast agents.
- Patients with deranged renal function test (serum creatinine  $>1.5$  mg/dl after rehydration).
- Pregnant women.

### Procedure:

The clinical details of patients were recorded e.g. demographic data, detailed clinical history with presenting symptoms like pain abdomen, nausea, vomiting, and fever with duration, physical examination (local and systemic) including pulse rate, blood pressure, respiratory rate, temperature and icterus and any history suggestive of possible aetiology such as gallstone disease, alcohol abuse, trauma to abdomen, drug intake, metabolic disorder or any recent surgical intervention or procedure. The purpose of study and brief procedure were explained to all the patients. Informed and written consent was taken from the patient in writing both in English and local language. Imaging was done by GE Medical Systems with OPTIMA 660 128 slice spiral CT scan with 120 KVp and 150-350mAs. Plain and post-contrast series of the abdomen and pelvis were taken.

It consisted of acquisition of contiguous axial sections, of thickness 5mm, interval of 5mm and large FOV in cranio-caudal direction from the level of the xiphisternum to pubic symphysis before and after administration of oral (10-20ml water soluble contrast in 500-1000ml normal saline) and intravenous non-ionic iodinated contrast of 1.5-2ml/kg dose @ 3-4ml/s. All images were viewed in a range of soft tissue window settings. Images were

reformatted in sagittal and coronal planes for analysis.

severity index (Table-1, 2) and classified into mild, moderate and severe categories.

**Image analysis:** The severity of pancreatitis was scored using CT severity index & Modified CT

**Table 1: CTSI developed by Balthazar**  
**CT severity index developed by Balthazar**

Prognostic Indicator	
Pancreatic inflammation Normal pancreas	0
Focal or diffuse enlargement of the pancreas	1
Intrinsic pancreatic abnormalities with inflammatory changes in peripancreatic fat	2
Single, ill-defined fluid collection or phlegmon	3
Two or more poorly defined collections or presence of gas in or adjacent to the pancreas	4
Pancreatic necrosis	
None	0
≤ 30%	2
> 30–50%	4
> 50%	6

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

**Table 2: Mortelet Modified CTSI**

Prognostic indicator		
Pancreatic Inflammation	Normal pancreas	0
	Intrinsic pancreatic abnormalities with or without inflammatory changes in peripancreatic fat.	2
	Pancreatic or peripancreatic fluid collection or peripancreatic fat necrosis	4
Pancreatic Necrosis	none	0
	<30%	2
	>30%	4
Extra Pancreatic Complications	One or more of following: Pleural Effusion, ascites, vascular complications, parenchymal complications, or gastrointestinal tract involvement	2

The modified CTSI was calculated by summing these values and acute pancreatitis 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

#### Clinical Outcome Parameters

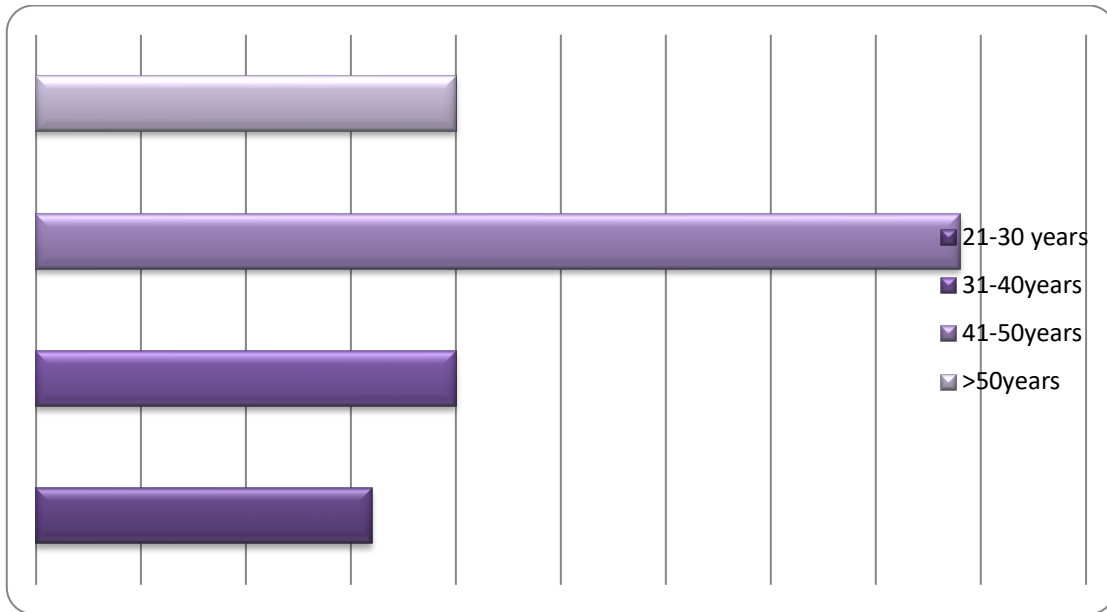
Clinical outcome parameters for correlation collected from respective referral departments included, the length of hospital stay (in days), need for surgical intervention, need for percutaneous intervention (aspiration and drainage), evidence of infection in any organ system (combination of a fever > 100°F and elevated WBC >15,000/ mm<sup>3</sup>), evidence of organ failure (PaO<sub>2</sub> < 60 mm Hg or need of ventilation, systolic BP of < 90 mm Hg, serum creatinine of >300µmoles / L or urine output of < 500 ml / 24 h) and death.

#### Statistical Analysis:

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Pearson correlation of CT score and MRI score is performed to find the correlation, Student t test has been used to find the significance of correlation. Simple statistical methods such as Pie diagram and Bar charts were used for descriptive purpose. Chi-Square test was used to determine significance between parameters observed in this study with the similar study of other authors.

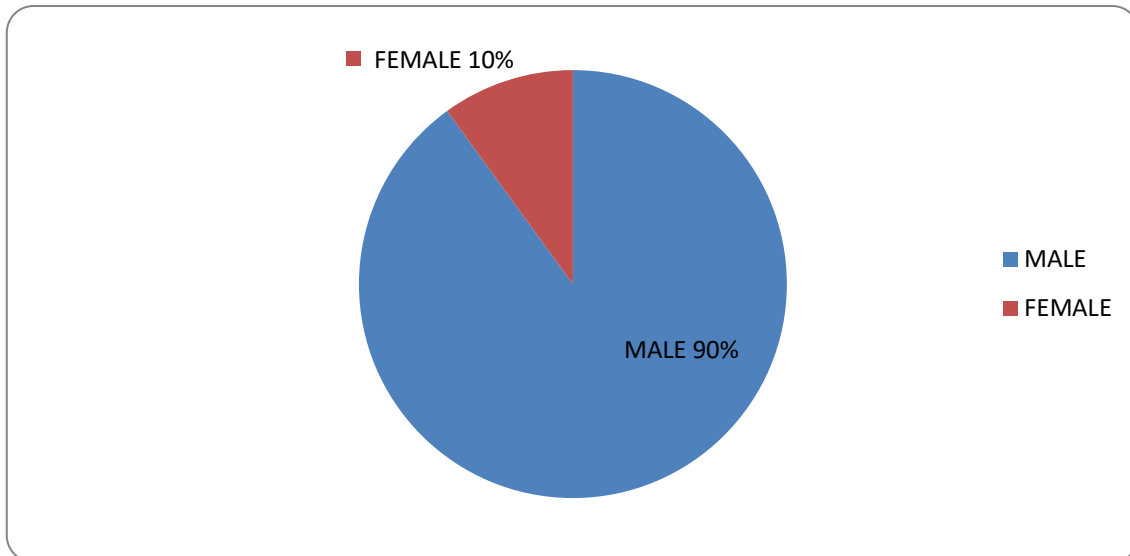
#### Result

The occurrence of acute pancreatitis was more (44%) in the age group of 40-50 years. The mean age was 42.32 years.



**Figure 1: Age distribution of patients**

Out of 50 cases, 45(90%) were males and 05(10%) were females with male to female ratio of 2:1.



**Figure 2: Gender distribution of acute pancreatitis**

**Table 3: Distribution of MCTSI scored in subjects**

MCTSI score	No. of cases	Percentage
0	2	4
2	8	16
4	7	14
6	12	24
8	10	20
10	11	22
Total	50	100

Majority of patients were categorized as severe pancreatitis (42%), 38% patients were grouped into moderate pancreatitis and 20% were categorized in mild pancreatitis.

**Table 4: Grading of Acute pancreatitis**

Grading	No. of cases according to CTSI	No. of cases according to MCTSI
Mild	21	10
Moderate	11	19
Severe	18	21
Total	50	50

Majority of patients had mild pancreatitis according to CT Severity Index. However, according to Modified CT Severity Index, majority were categorized as severe pancreatitis. The Spearman rank correlation between CT Severity Index and Modified CT Severity Index was +0.815 with significance value of 0.01.

**Table 5: Modified CT Severity Index (MCTSI) and patients' outcome**

Patients' outcomes using Modified CT severity index			
Outcome factor	CT Severity Index		
	Mild (0-3 points)	Moderate (4-6 points)	Severe (7-10points)
No. of patients	10	19	21
Length of hospital stay(days)	1.5	6.9	14.2
Intervention or surgery	0	2	8
Infection	0	1	9
Organ failure	0	1	7
Death	0	0	2

When the Modified CT Severity Index was applied, the average duration of hospital stay in patients categorized as mild pancreatitis was 1.5 days, in moderate pancreatitis 6.9 days and in severe pancreatitis 14.2 days. None of the patients categorized as mild pancreatitis had an adverse or fatal outcome. The majority (80%) of patients

requiring interventional procedure fell in the severe pancreatitis group.

Likewise, 9 out of 10 patients who developed infection and 7 out of 8 patients who developed organ failure belonged to this group.

Mortality was also only reported in this group.

**Table 6: Comparison of Average length of hospital stay with Balthazar and MCTSI**

Grading	Average length of hospital stay in days	
	CTSI	MCTSI
Mild	4.8	1.5
Moderate	7.3	6.9
Severe	13.5	14.2

The length of the hospital stay significantly correlated with both Balthazar CT Severity Index and Modified CT Severity Index. However, the Modified CT Severity Index ( $p = 0.000$ ) outperformed the Balthazar CT Severity Index ( $p = 0.011$ ).

**Table 7: Comparison of need for intervention with Balthazar and MCTSI**

Grading	Need for intervention	
	CTSI	MCTSI
Mild	2	0
Moderate	3	2
Severe	5	8

Need for intervention showed no statistically significant differences ( $p > 0.05$ ) between the two CT scoring systems.

**Table 8: Comparison of development of infection with Balthazar and MCTSI**

Grading	Development of infection	
	CTSI	MCTSI
Mild	1	0
Moderate	2	1
Severe	7	9

Development of infection showed no significant correlation ( $p > 0.05$ ) between the two CT scoring systems.

**Table 9: Development of organ failure comparison with Balthazar and MCTSI**

Grading	Development of organ failure	
	CTSI	MCTSI
Mild	1	0
Moderate	1	1
Severe	6	7

Significant correlation between the severity of pancreatitis and the development of organ failure was seen only using the MCTSI ( $p = 0.0024$ ), not the CTSI ( $p = 0.0513$ ). Our study resulted in almost similar findings.

**Table 10: Comparison of mortality with Balthazar and MCTSI**

Grading	Mortality	
	CTSI	MCTSI
Mild	0	0
Moderate	1	0
Severe	1	2

Mortality showed no significant correlation ( $p > 0.05$ ) between the two CT scoring systems.

### Discussion

The present study was undertaken to evaluate the acute pancreatitis on CT and the patient outcome correlated on the basis of CTSI (including Balthazar's Computed Tomography Severity Index and the Modified Computed Tomography Severity Index). Fifty cases were studied over a period of three years consisted of 45 males (90%) and 5 females (10%) with male predominance. Also study conducted by Jain S et al (2014) [17] showed the similar male predominance.

In the present study when Balthazar CT severity index was applied, acute pancreatitis was graded as mild in 42% (21/ 50), moderate in 22% (11/50) and severe in 36% (18/50) patients. Study conducted by Banday et al [18] showed the similar CT grading of pancreatitis

In contrast, when using the Modified CT Severity Index, a much larger number, viz. 21/50 (42%) patients were placed in the severe pancreatitis group. Mild pancreatitis was present in 20% (10/50) and moderate pancreatitis in 38% (19/50) patients. Study conducted by Banday et al [18] and Sameer Raghuvanshi et al [19] showed the similar MDCT grading of pancreatitis.

According to Balthazar CT severity index grading 18(36%) patients were placed into severe group while the MDCT index 21(42%) patients were in the severe group. The increase in number patients due to the extra pancreatic complication they upgraded in to severe group under the MDCTSI, and 1 patient downgraded from severe group in Balthazar CT Severity index to the moderate group under Modified CT Severity Index.

In the present study according to Balthazar CTSI 21(42%) patients graded into mild group, with average duration of hospital stay was 4.8 days, study conducted by Jain S et al showed the fairly

same average hospital stay. 2(4%) patients required intervention, 1(2%) developed infection and no organ failure and mortality noted in this group.

In contrast 9 patients fall under mild pancreatitis with MDCT, with average duration of hospital stay was 1.5 days, with no patients developed infection, organ failure and no mortality noted. Study conducted by Banday et al [18] showed the similar patient outcome according to Balthazar CTSI and MDCTSI.

According to Balthazar CT Severity Index 11(22%) patients graded under moderate pancreatitis, with average duration of hospital stay was 7.3 days, 3(27%) patients required intervention, 2(18%) developed infection and 1 (9%) patient developed organ failure and 1(9%) death noted in this group. Moderate pancreatitis patients were 19(38%) with average length of hospital stay 6.9 days, 1(5%) patients developed infection, 2(11%) patients required intervention and 1(5%) patient had organ failure while no mortality was noted in this group.

Study conducted by Koenraad J. Mortelet, Walter Wiesner et al [20] showed the same patient outcome according to Balthazar CTSI and MCTSI. In the 18 (36%) patients graded as severe pancreatitis with Balthazar CT Severity Index, the average duration of hospital stay was 13.5 days, 5 (29.4%) patients required intervention, 7(41%) developed infection, 6 (35.2%) had organ failure and 1 (5%) patients succumbed due to the disease process.

In contrast in the 21 (40%) patients graded as severe pancreatitis with the Modified CT Severity Index, the average duration of hospital stay was 14.2 days, 8 (36.6%) patients needed intervention, 9 (40.9%) patients had infection, and 7(32%) developed organ failure. 2(9%) patients died from this group. Present study showed a strong correlation of grades of pancreatitis based on both CT Severity Index and Modified CT Severity Index. However, Modified CT Severity Index was more closely associated with patient outcome than CTSI in present study.

Results of the present study are consistent with the study conducted by Shivanand Melkundi et al [21], which proved a significant correlation of grades of severity of acute pancreatitis based on Modified CT Severity Index with patient outcome variables than grades of severity of acute pancreatitis based on CT severity index. There are other studies reported significant correlation between clinical severity and CT evaluation of acute pancreatitis. [11,22,23] other studies not showing significant correlation of this findings. [23,24] This difference in statistical significance between CT severity index and modified CT severity index in the current study may be due to the inclusion of extrapancreatic complications in the modified CT severity index system.

The strong relationship between the Modified CT severity index and the patient outcome in this study corroborates with the findings of Mortelet et al. [25] 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 et al. [25] in their study. This also correlated with the study by Banday et al [18], which concluded that Modified CT Severity Index is a simpler scoring tool and more accurate than the Balthazar CT Severity Index. The differences observed may be due to differences in criteria for organ failure and clinically severe AP (the present study used criteria in accordance with the Marshall criteria of end organ failure).

#### Limitations:

1. Patient with acute pancreatitis treated conservatively without doing Contrast CT.
2. Patient with acute pancreatitis who has discharged earlier.
3. Patient with abnormal renal parameters.
4. It was a nonrandomized prospective study with a medium-sized sample.
5. Consecutive patient cohort diagnosed with acute pancreatitis in our institution, we analyzed only the subgroup of patients who underwent contrast-enhanced CT.

#### Conclusion

Contrast-Enhanced Computed Tomography (CECT) is considered an excellent imaging modality for diagnosis, detecting the extent of disease process and in grading its severity. The Modified CT Severity Index is a simpler scoring tool and more accurate than the Balthazar CT Severity Index. In the present study, significant statistical correlation is found with the clinical outcome in terms of the length of hospital stay, development of infection, occurrence of organ failure and overall mortality. It may help in predicting the need for interventional procedures.

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