SEVERITY ASSESSMENT OF ACUTE PANCREATITIS USING SEVERITY INDICES, REVISED ATLANTA CLASSIFICATION AND CORRELATING WITH CLINICAL OUTCOMES

Radiodiagnosis

Dr. Krishna Naik* Geetanjali Medical College and Hospital, Udaipur. *Corresponding Author

Dr. Ashish Choudhary Geetanjali Medical College and Hospital, Udaipur.

Dr. S. C. Baser Professor and Head Geetanjali Medical College and Hospital, Udaipur.

ABSTRACT

To determine the prognostic efficacy of CT severity index, Modified CT severity index and Revised Atlanta Classification in acute pancreatitis. **Materials and method:** This prospective study was carried out from February 2019 to June 2020 on 42 patients who were referred to the Dept. of Radiodiagnosis, GMCH with acute pancreatitis and underwent the contrast enhanced CT after 72 hours of onset of symptoms. The severity of pancreatitis was assessed and scored using CTSI, MCTSI and RAC. Clinical outcome parameters included duration of hospital stay and ICU, presence of persistent organ failure (OF), evidence of infection, need for intervention, and mortality. **Results:** Out of 42 cases, 33 were males, age group 20-85 years (mean 47.69 ± 16.32). As per CTSI 61.9% had mild, 35.7% moderate and 2.4% severe pancreatitis. Based on MCTSI grading, 21.4% had mild, 59.6% moderate and 19% severe pancreatitis. Based on RAC grading, 31% had mild, 52.4% moderate and 16.6% severe pancreatitis. Area under the curve were generated using ROC analysis. Duration of stay of the patients, presence of organ failure and the evidence of infection was significantly associated with CTSI, MCTSI and RAC ($P < 0.001$). Need for intervention was significantly associated with only MCTSI. **Conclusion:** ROC analysis of the three scoring systems for the prediction of various patient outcomes in our study revealed that the AUCs overlap, showing all the three scoring systems performed well. Duration of stay of the patients, presence of organ failure and the evidence of infection was significantly associated with CTSI, MCTSI and RAC ($P < 0.001$). Need for intervention was significantly associated with only MCTSI.

KEYWORDS

INTRODUCTION:

Acute pancreatitis is defined as a multifactorial acute inflammatory condition of the pancreas which also involves the peripancreatic tissues and organs. Patients with acute pancreatitis may present with a mild, self-limiting disease without complications or with a complex clinical course and severe disease, which results in local or systemic complications and associated significant morbidity and mortality.^(1,2) Majority of the patients with the mild form of the disease recover almost completely without any complications. Approximately 15-20% of the patients develop severe form of the disease with associated local as well as systemic complications.^(6,7)

According to the Revised Atlanta classification, 2012, the severity of the acute pancreatitis was classified as mild, moderate and severe along with new definition for the peripancreatic collections. The RAC defined acute pancreatitis as clinical disorder consisting of a) abdominal pain b) serum amylase and lipase levels raised by more than three times and c) imaging findings suggestive of pancreatitis. Clinical course of the disease was divided into a) early phase (<1 week) and b) late phase (>1 week).⁹ During the early phase of the disease, role of imaging findings is limited as the morphological changes take time and therefore the criteria advises the radiological investigation after 72 hours of onset of clinical symptoms.⁸ On the basis of imaging AP was classified as a) interstitial edematous pancreatitis b) acute necrotizing pancreatitis.

Wide range of studies have been undertaken proving the role of CECT in diagnosis of acute pancreatitis. RAC and many other studies show the role of CECT in detection of pancreatic necrosis thus helping in the better management of the patient.^{2,10} Currently, CECT plays a crucial role in the evaluation of the extent and evolution of the disease and its complications.³ It helps in early detection, evaluation of the parenchymal necrosis, presence and extent of peripancreatic fluid collection and presence of infection.

In 1994, Balthazar et al developed the CTSI to grade AP into mild, moderate and severe on the scale of 10. It consisted of pancreatic inflammation, peripancreatic fluid collections and necrosis.^{13,14} In 2004, Modified CT severity index (MCTSI) was introduced by Mortelet et al.¹⁵ MCTSI shows better differentiation of mild, moderate and severe along with better evaluation of pancreatic necrosis, peripancreatic collection and complications secondary to pancreatitis.

Many studies have been performed which show the role of CTSI and MCTSI along with other scoring systems in the severity assessment of

acute pancreatitis. However, the most commonly used systems have been CTSI and MCTSI.^{11,14} There is still lack of studies between the severity assessment scoring system and grading according to the RAC. In this study, the aim is to assess the severity of AP using CTSI, MCTSI and RAC and correlate the findings with clinical outcome of the patients.

AIM & OBJECTIVE:

1. To determine CTSI, MCTSI and RAC in acute pancreatitis.
2. To correlate the CTSI, MCTSI and RAC with clinical outcomes.

MATERIALS AND METHOD:

Study design and patient selection

All the 42 patients were referred to the department of Radiodiagnosis, GMCH with acute pancreatitis and underwent CECT abdomen between February 2019 to June 2020. Institutional Human Research Ethics committee and Ethical clearance certificate for this study was obtained (GU/HREC/EC/2019/1560). A detailed history and consent were taken from every patient including their laboratory reports and renal function test for the creatinine levels.

Imaging

All scans were performed on 64 slice multidetector row CT scanner SOMATON Sensation (SEIMENS). A single bolus injection of contrast was administered containing 100 ml of 350mg/ml non-ionic iodinated contrast (IOHEXOL) was injected using pressure injector at the rate of 3-4ml/sec. Threshold set at 150 Hounsfield units (HU) for arterial phase. The venous phase was acquired after a delay of 60 seconds from the time of contrast injection. Images were retro reconstructed with 1.25mm slice thickness and reformatted in coronal and sagittal images from the domes of the diaphragm to the pubic symphysis for the analysis.

Image analysis:

The severity of pancreatitis was scored using CTSI, MCTSI and RAC and classified into three categories (mild, moderate and severe). CTSI and MCTSI are 10 points scoring system derived by assessing the degree of pancreatic inflammation (0 to 4 points) pancreatic necrosis (0 to 4 points) and extrapancreatic complications (0 or 2 points). According to RAC the patients were classified into EIP and NP along with the surrounding peripancreatic fluid collections and organ failure. Clinical outcome parameters were evaluated.

Definitions:

Transient organ failure lasts for less than 24 hours and persistent

organ failure lasts more than 48 hours, regardless of intervention. The modified Marshall scoring system incorporates measurements from the respiratory, cardiovascular, and renal systems, with a score of 2 or higher for any system indicating organ failure.¹⁶

According to RAC, patients with mild pancreatitis have no complications, moderate with complications or transient organ failure (<24 hours) and severe will have persistent organ failure (48 hours). In the revised classification system, new definitions were created to clearly stratify acute pancreatitis into two subcategories based on imaging findings: IEP and necrotizing pancreatitis.¹⁷

Pancreatic necrosis is the non-enhancing pancreatic parenchyma. Peri pancreatic necrosis is extrapancreatic non enhancing areas. The peripancreatic fluid collections are classified as acute peripancreatic fluid collection (APFC) and acute necrotic collection (ANC). In APFC, there is homogeneous fluid-attenuation collection lacking a wall and confirming to the retroperitoneal spaces and seen most commonly associated with EIP. ANC are poorly organized non enhancing necrotic collections occurring only in necrotizing pancreatitis. ANCs can be distinguished from APFCs by the presence of non-liquefied debris, such as solid components or fat globules within the fluid.^{18,19}

• Clinical outcome parameters:

The clinical outcome parameters included duration of hospital or ICU stay, occurrence of persistent organ failure, evidence of infection, need for intervention, and mortality. These parameters were compared with the grading systems.

• Statistical analysis:

Statistical analysis of quantitative parameters were expressed as means and standard deviation or medians. Median duration of hospital stay was compared between the patients according to the three scoring systems using Kruskal Wallis test. Cross tables were generated and chi square test was used for testing of associations. ROC curves were drawn to compare the predictive value of the three scoring systems and AUC was calculated. P-value < 0.05 is considered statistically significant.

RESULTS AND OBSERVATION:

Table 1: Distribution of patients according to their age

Age group	Frequency	Percent
21 to 30	6	14.3
31 to 40	10	23.8
41 to 50	9	21.4
51 to 60	9	21.4
61 to 70	5	11.9
71 to 80	2	4.8
More than 80	1	2.4
Total	42	100

In this study, 42 patients were included. Mean age of the patients was 47.69 ± 16.32 years, ranging from 20 to 85 years.

Table 2: Distribution of patients according to their gender

Sex	Frequency	Percent
Female	9	21.4
Male	33	78.6
Total	42	100

In this study, 21.4% of the patients were females (n=9) and rest being males (78.6%, n=33).

Table 3: Distribution of patients according to their clinical presentation

Clinical presentation	Frequency	Percent
Presenting complaint		
Abdominal pain	41	97.6
Vomiting	30	71.4
Jaundice	21	50
Fever	6	14.3
Pancreatic enzymes		
Raised serum amylase	42	100
Raised serum lipase	42	100

Type of pancreatitis	Frequency	Percent
Interstitial edematous pancreatitis	18	42.9
Interstitial edematous pancreatitis with APFC	13	31
Necrotizing pancreatitis	11	27.1
Necrotizing pancreatitis (n=11)		
Pancreatic necrosis	3	7.1
Peripancreatic necrosis	0	0
Pancreatic with peripancreatic necrosis	8	19
Total	42	100

The most common presenting complaint was abdominal pain (97.6%). Vomiting 71.4%, jaundice by 50% and fever by 14.3%. Pancreatic serum amylase and lipase were raised in all the patients.

42.9% of the patients had Interstitial edematous pancreatitis (EIP), 31% had Interstitial edematous pancreatitis with APFC and the rest 27.1% had necrotizing pancreatitis. Among 11 cases with necrotizing pancreatitis, three cases had pancreatic necrosis alone and rest of the 8 cases had pancreatic with peripancreatic necrosis. None had peripancreatic necrosis alone.

Table 4: Distribution of patients according to their complications

Complications	Frequency	Percent
Ascites		
Not present	18	42.8
Mild	23	54.8
Gross	1	2.4
Pleural effusion		
Not present	23	54.8
Minimal	4	9.5
Mild	14	33.3
Moderate	1	2.4
Vascular complications		
Yes	4	9.5
No	38	90.5
Total	42	100

Ascites was present in 57.2% (n=24patients), of which 23 had mild ascites and one case had gross ascites. Pleural effusion was present in 19 (n=45.2%) patients, of which 4 cases had minimal pleural effusion, 14 had mild and one case had moderate effusion. Vascular complications were present in 9.5% of the patients.

Table 5: Distribution of patients according to their severity of acute pancreatitis

	CTSI grade		MCTSI grade		RAC grade	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Mild	26	61.9	9	21.4	13	31
Moderate	15	35.7	25	59.6	22	52.4
Severe	1	2.4	8	19	7	16.6
Total	42	100	42	100	42	100

Using CTSI grading, 61.9% had mild, 35.7% had moderate and 2.4% had severe pancreatitis. Based on MCTSI grading, 21.4% had mild, 59.6% had moderate and 19% had severe pancreatitis. Based on RAC grading, 31% had mild, 52.4% had moderate and 16.6% had severe pancreatitis.

Table 6: Comparing median duration of stay with the severity of pancreatitis

	Median DOS (days)	p value*
CTSI		
Mild	4	< 0.01
Moderate	7	
Severe	7	
MCTSI		
Mild	4	< 0.001
Moderate	5	
Severe	7	
RAC		
Mild	4	< 0.001
Moderate	5.5	
Severe	8	

*analysed using Kruskal Wallis test

Median duration of stay was found to be significantly associated with the severity of pancreatitis. Median DOS according was 4, 7 and 7 days in patients with mild, moderate and severe pancreatitis based on CTSI (p value < 0.01), 4, 5 and 7 days (p value < 0.001) and 4, 5.5 and 8 (p value < 0.01) days in patients with mild, moderate and severe pancreatitis based on MCTSI and RAC respectively.

Area under ROC curves (AUROC) for CTSI, MCTSI and RAC for prediction of severity parameters

Severity parameters	CTSI	MCTSI	RAC
Any OF	0.80 (0.66-0.94)	0.81 (0.63-0.94)	0.86 (0.75-0.97)
Evidence of infection	0.81 (0.65-0.96)	0.65 (0.47-0.82)	0.67 (0.51-0.83)
Need for intervention	0.56 (0.37-0.74)	0.53 (0.32-0.73)	0.53 (0.34-0.72)

AUC calculated by ROC analysis

AUROC for predicting any organ failure was 0.80, 0.81 and 0.86 for CTSI, MCTSI and RAC respectively. For predicting evidence of infection, AUROC was 0.81, 0.65 and 0.67 for CTSI, MCTSI and RAC respectively. For predicting the need for intervention, AUROC was 0.56, 0.53 and 0.53 for CTSI, MCTSI and RAC respectively.

DISCUSSION:

This prospective observational study was conducted to determine the role of CTSI, MCTSI and RAC in prognostication of patients with acute pancreatitis. During the study period, 42 patients with diagnosis of acute pancreatitis underwent severity grading using CTSI, MCTSI and RAC in the Department of Radiodiagnosis, GMCH, Udaipur. The observations are as follows.

Demography

Mean age of our patients was 47.69 ± 16.32 years, from 20 to 85 years and 78.6% of the patients were males.

Clinical presentation

The most common presenting complaint was abdominal pain (97.6%) followed by vomiting 71.4%, jaundice 50% and fever 14.3%. Pancreatic enzymes like serum amylase and lipase were raised in all the patients. In study by Sahu et al, the most common clinical presentation was epigastric pain in 78.3%, followed by vomiting 76.7%.⁶⁹ Raghuwansi et al found the triad of epigastric pain, nausea and vomiting was present in 75% of patients⁵.

Types of pancreatitis

We observed that 42.9% of the patients had IEP, 31% had Interstitial edematous pancreatitis with APFC and the rest 27.1% had NP. Among the 11 cases with necrotizing pancreatitis, three had only pancreatic necrosis and the rest of the 8 cases had pancreatic with peripancreatic necrosis. None had peripancreatic necrosis alone.

In a similar study, Sahu et al reported IEP in 46.7% (28/60) and NP in 50% (30/60).⁷ Thus, Sahu reported a higher proportion of patients with NP as compared to our study. The study site and level of care provided at the hospital can determine the composition of the study population with respect to their severity.

Complications

Modified CTSI differs from CTSI in two important aspects. It includes points for extra-pancreatic complications such as pleural effusion, ascites, vascular, or GI complications. Moreover, MCTSI has a simpler quantification of amount of necrosis (as <30% or >30% only), which is easier to apply. In the present study, ascites was present in 57.2% patients, pleural effusion in 45.2% patients, and vascular complications in 9.5% of the patients. Left sided pleural effusion was more common than right side. In vascular complications venous thrombosis was most common. In a similar study, Kondekar et al reported pleural effusion as the most common extra-pancreatic complication, 30 patients (47.6%). Left pleural effusion was more common than the right followed by ascites, 16 patients (25.3%). Among vascular complications, venous thrombosis was the most common (2 in portal vein and 1 in splenic vein). One case of pseudoaneurysm of splenic artery was noted.

Severity grading

Using CTSI grading, we observed that 61.9% had mild, 35.7% had moderate and 2.4% had severe pancreatitis. Based on MCTSI grading, 21.4% had mild, 59.6% had moderate and 19% had severe pancreatitis. Based on RAC grading, 31% had mild, 52.4% had moderate and 16.6% had severe pancreatitis.

In a similar study, Sahu et al reported that as per the RAC, 26 (43.3%) patients had mild AP, 12 (20%) had moderately severe disease, and 22 (36.7%) had severe AP. According to CTSI, 45% were mild, 31.7% were moderate and 23.3% were severe AP. According to MCTSI 40%, 16.7% and 43.3% had mild, moderate and severe AP respectively.

Kondekar and colleagues classified 41.2%, 26.9% and 31.7% of the patients as mild, moderate and severe AP using CTSI, while according to MCTSI, 20.6%, 36.5% and 42.8% of the patients had mild, moderate and severe AP respectively.

Duration of hospital stay

In the present study, the median duration of stay was 5 days (IQR = 3). It was observed that 97.6% of the patients had a duration of stay up to 10 days, and only one case had stay >10 days. Median duration of stay was found to be significantly associated with the severity of pancreatitis. Sahu and colleagues reported the median duration of hospital stay to be 8 days (range, 3–71 days), and 43.3% cases had a hospital stay of more than 10 days.⁷ In their study, median duration of study was significantly associated with the severity on CTSI and MCTSI.

Kondekar et al reported that mean duration of hospital stay was 13 days, 21 days and 21 days for patients with mild, moderate and severe AP according to CTSI.³ Similarly, mean duration of hospital stay was 7 days, 17 days and 27 days for patients with mild, moderate and severe AP according to MCTSI. They found that the mean duration of hospital stay was significantly associated with the severity grading. In the study

by Raghuvansi et al, length of hospital stay was significantly more in cases with moderate grade AP according to CTSI and severe AP according to MCTSI.⁵ Mortelet et al observed a better correlation between the MCTSI and length of hospital stay in comparison with the CTSI.⁴

Organ failure

Half of all patients in the present study had organ failure (n=21). 14 cases had transient organ failure, among which 13 had single and one had both renal and CVS failure. 7 cases had persistent organ failure, among which 4 had single and 3 had both renal and CVS failure. Overall, 17 patients had single and 4 had multiple organ failures. Renal system was most commonly involved followed by cardiovascular and respiratory systems. 5/7 patients with persistent organ failure were classified as severe on MCTSI while on CTSI only 1/7 patients were classified as severe. However, all three grading systems were significantly associated with the presence of any type of organ failure. Persistent organ failure was better assessed by MCTSI. AUROC for predicting any organ failure was 0.80, 0.81 and 0.86 for CTSI, MCTSI and RAC respectively.

Study by Sahu et al, OF was noted in 25 (41.7%) cases, of which 21 (35%) had persistent OF.⁷ Renal system was the most common system involved followed by cardiovascular and respiratory systems. All patients who developed persistent OF (21/21 i.e., 100%) were correctly categorized as "severe" pancreatitis by MCTSI scoring. On the other hand, while using CTSI scoring system, only 12/21 (57.1%) of these cases were labelled as "severe," while as many as 9/21 (42.9%) were categorized as "moderate" pancreatitis.

The differences observed may be due to differences in criteria for organ failure and clinically severe AP (the current study used criteria in accordance with the most updated revised Atlanta classification). Also, the current study evaluated a larger number of patients, including a larger proportion of patients with clinically severe AP, and used discrimination analysis, which is regarded as more accurate for comparing and assessing the diagnostic accuracy of prognostic scoring systems.

Evidence of infection

Infections were present in 76.2% of our patients. All three grading systems were significantly associated with the presence of infection. For infection, AUROC was 0.81, 0.65 and 0.67 for CTSI, MCTSI and RAC respectively. Sahu et al reported that seventeen (40.0%) patients had clinical evidence of infection, whereas only 3 out of these 17 showed radiological evidence of infection.⁷ Bollen et al reported that infection of pancreatic or extrapancreatic necrosis occurred in seven (4%) cases.⁷ Presence of infection was significantly associated with the severity grading on both CTSI and MCTSI, however, CTSI had a higher AUC for predicting infection.

Need for intervention

Need for intervention was present in 4.8%. We observed that it was significantly associated with the severity of pancreatitis based on MCTSI and not on CTSI or RAC grading. It is possible that because there were only two cases who had a need for intervention, that we could not detect a significant association with CTSI and RAC. For predicting the need for intervention, AUROC was 0.56, 0.53 and 0.53 for CTSI, MCTSI and RAC respectively.

In the study by Sahu et al, 15 patients needed intervention and 100% of them who needed intervention were categorized as severe on MCTSI.⁷ However, 4/15 (26.7%) cases who required intervention were categorized as "moderate" pancreatitis on CTSI. In the study by Bollen et al, nineteen patients (10%) needed intervention for local complications and were significantly associated with the severity grading as per CTSI and MCTSI.⁶ AUROC for CTSI was higher as compared to MCTSI for predicting need for intervention. In the study by Raghuvansi et al, the need for intervention was significantly more common in cases with moderate grade AP (46.6%) according to CTSI and severe AP according to MCTSI. (53.3%).⁵

CONCLUSION:

ROC analysis of the three scoring systems for the prediction of various patient outcomes in our study revealed that the AUCs overlap, showing all the three scoring systems performed well. Duration of stay of the patients, presence of organ failure and the evidence of infection was significantly associated with CTSI, MCTSI and RAC ($P < 0.001$).

Need for intervention was significantly associated with only MCTSI.

REFERENCES:

- Balthazar EJ. Acute pancreatitis: assessment of severity with clinical and CT evaluation. *Radiology*. 2002 Jun;223(3):603-13.
- Bradley EL 3rd. A clinically based classification system for acute pancreatitis: summary of the International Symposium on Acute Pancreatitis, Atlanta, Ga, September 11-13, 1992. *Arch Surg* 1993;128(5):586-90.
- Kondekar S, Minne I. Assessment of acute pancreatitis using CT severity index and modified CT severity index: A tertiary care hospital based observational study. *International Journal of Radiology and Diagnostic Imaging* 2020; 3(1): 118-22.
- Mortelet KJ, Wiesner W, Intriore L, Shankar S, Zou KH, Kalantari BN, Perez A, VanSonnenberg E, Ros PR, Banks PA, Silverman SG. A modified CT severity index for evaluating acute pancreatitis: improved correlation with patient outcome. *American Journal of Roentgenology*. 2004 Nov;183(5):1261-5.
- Raghuvansi S, Gupta R, Vyas MM, Sharma R. CT evaluation of acute pancreatitis and its prognostic correlation with CT severity index. *Journal of clinical and diagnostic research*: JCDR. 2016 Jun;10(6):TC06.
- Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Critical care medicine*. 1985 Oct 1;13(10):818-29.
- Sahu B, Abbey P, Anand R, Kumar A, Tomer S, Malik E. Severity assessment of acute pancreatitis using CT severity index and modified CT severity index: Correlation with clinical outcomes and severity grading as per the Revised Atlanta Classification. *The Indian journal of radiology & imaging*. 2017 Apr;27(2):152.
- Bollen TL, Singh VK, Maurer R, Repas K, van Es HW, Banks PA, et al. Comparative evaluation of the modified CT severity index and CT severity index in assessing severity of acute pancreatitis. *Am J Roentgenol*. 2011;197:386-92.
- Mutunga M, Rosenbluth A, Tenner SM, Odze RR, Sica GT, Banks PA. Does mortality occur early or late in acute pancreatitis? *Int J Pancreatol* 2000;28(2):91-95.
- McMahon MJ, Playforth MJ, Pickford IR. A comparative study of methods for the prediction of severity of attacks of acute pancreatitis. *British journal of surgery*. 1980 Jan;67(1):22-5.
- Knaus WA, Draper EA, Wagner DP, et al: APACHE II: A severity of disease classification system. *Crit Care Med* 1985; 13:18.
- Balthazar EJ, Robinson DL, Megibow AJ, Ranson JHC. 'Acute pancreatitis: value of CT in establishing prognosis'. *Radiology* 1990; 174:331-36.
- Balthazar EJ, Freeny PC, VanSonnenberg E. Imaging and Intervention in acute pancreatitis. *Radiology* 1994; 193:297-6.
- Koenraad J. Mortelet, Walter Wiesner, Lisa Intriore et al, 'A Modified CT Severity Index for Evaluating Acute Pancreatitis: Improved Correlation with Patient Outcome', *AJR* 2004;183:1261-65.
- Lenhart DK, Balthazar EJ. MDCT of acute mild (non-necrotizing) pancreatitis: abdominal complications and fate of fluid collections. *American Journal of Roentgenology*. 2008 Mar;190(3):643-9.
- Tenner S, Sica GR, Hughes MI, Noordhoek EL, Feng SA, Zinner MI, Banks PA. Relationship of necrosis to organ failure in severe acute pancreatitis. *Gastroenterology*. 1997 Sep 1;113(3):899-903.
- Marshall JC, Cook DJ, Christou NV, et al: Multiple organ dysfunction score: A reliable descriptor of a complex clinical outcome. *Crit Care Med* 1995; 23:1638-52.
- Siegelman SS, Copeland BE, Saba GP, et al. 'CT of fluid collections associated with pancreatitis' *AJR Am J Roentgenol*, 1980; 134(6):1121-32.
- Clemente CD. *Gray's Anatomy of the Human Body*, 30th ed. Philadelphia: Lea & Febiger; 1985.