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CT Severity Index has High Accuracy and Sensitivity in Detection in Diagnose of Acute Pancreatitis. Early Assessment of the Cause and Severity of Acute Pancreatitis

Hina Makki [1], Muhammad Ejaz [2], Muhammad Sami Ullah Zia [3], Sheraz Ahmad [4], Muhammad Zain Ul Abidin [5].

[1,2,3] Bachelor Medical imaging and ultrasonography, University of Management and Technology Lahore. Email: hinamakki2004@gmail.com Email: Mijazlar@gmail.com Email: samiullahzia459@gmail.com

[4] Medical Imaging Doctor, The University of Lahore. Sheraz.ahmad7299@gmail.com

[5] Consultant Neurosonologist, Neurology Department Services Institute of Medical Sciences and Services Hospital Lahore. Zainrao750@gmail.com

Corresponding Author: Hina Makki

Bachelor Medical imaging and ultrasonography, University of Management and Technology Lahore. hinamakki2004@gmail.com

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Abstract:

Objective: The purpose of this study was to compare the modified CT severity index (MCTSI) with the CT severity index (CTSI) regarding assessment of severity parameters in acute pancreatitis (AP). Both CT indexes were also compared with the Acute Physiology, Age, and Chronic Health Evaluation (APACHE II) index.

Materials and Methods: Of 397 consecutive cases of AP, 196 (49%) patients underwent contrast-enhanced CT (n = 175) or MRI (n = 21) within 1 week of onset of symptoms. Two radiologists independently scored both CT indexes. Severity parameters included mortality, organ failure, pancreatic infection, admission to and length of ICU stay, length of hospital stay, need for intervention, and clinical severity of pancreatitis. Discrimination analysis and kappa statistics were performed.

Results: Although for both CT indexes a significant relationship was observed between the score and each severity parameter ($p < 0.0001$), no significant differences were seen be- tween the CT indexes. Compared with the APACHE II index, both CT indexes more accu- rately correlated with the need for intervention (CTSI, $p = 0.006$; MCTSI, $p = 0.01$) and pan- creatic infection (CTSI, $p = 0.04$; MCTSI, $p = 0.06$) and more accurately diagnosed clinically severe disease (area under the curve, 0.87; 95% CI, 0.82–0.92). Interobserver agreement was excellent for both indexes: for CTSI, 0.85 (95% CI, 0.80–0.90) and for MCTSI, 0.90 (95%

CI, 0.85–0.95).

Conclusion: No significant differences were noted between the CTSI and the MCT- SI in evaluating the severity of AP. Compared with APACHE II, both CT indexes more ac- curately diagnose clinically severe disease and better correlate with the need for intervention and pancreatic infection.

Introduction:

Acute pancreatitis (AP) is a com- mon and typically mild, self-lim- iting disease with only minimal or transient systemic manifestations. However, approximately 15–20% of patients develop clinically severe AP with lo- cal and systemic complications [1]. A num- ber of clinical and laboratory prognostic scoring systems have been designed for the early identification of patients at greatest risk of developing

clinically severe AP. Overall, these scoring systems have an accuracy varying between 70% and 80% [2]. Imaging by CT or MRI in the assessment of AP is useful not only for diagnosis but also for detecting local pancreatic complications and guiding interventional procedures. Moreover, in the past two decades, sever- al radiologic prognostic scoring systems have been developed. Among them the CT severity index (CTSI), designed by Balthazar et al. [3] In 1990, is the most widely adopted for clinical and research settings. The CTSI is a numeric scoring system that combines a quantification of pancreatic and extrapancreatic inflamma- tion with the extent of pancreatic necrosis. In 2004, a modified CTSI (MCTSI) was de- signed to account for several potential limita- tions of the CTSI [4]. In contrast to the CTSI, the MCTSI incorporates extrapancreatic com- plications in the assessment and simplifies the evaluation of the extent of pancreatic parenchy- mal necrosis (none, □ 30%, or > 30%) and peri- pancreatic inflammation (presence or absence of peripancreatic fluid). In the initial study of 66 patients, the MCTSI, when compared with the CTSI, better correlated with patient out- come, in particular, with regard to the length of hospital stay and, more important, the de- velopment of organ failure [4], which has been shown to be the primary determinant of out- come in the early phase of AP [5]. To our knowledge, no validation of the MCTSI in a larger cohort has been per- formed. Furthermore, in the initial study of the MCTSI, no detailed evaluation was pro- vided with regard to the specific prevalence of each of the extrapancreatic complications. Finally, no comparison has been performed between both radiologic scoring systems and the existing clinical prognostic scoring system that is commonly used for research pur- poses (Acute Physiology, Age, and Chronic Health Evaluation, [APACHE II] score) [6]. Therefore, the primary aim of our study was to compare the MCTSI with the CTSI with regard to the ability to assess clinical severity among a consecutive cohort of pa- tients with AP. The secondary aim was to compare both radiologic scoring systems with APACHE II with regard to clinical severity parameters.

Materials and Methods

A retrospective analysis of a prospectively collected database was performed. The demograph- ic, clinical, and laboratory data of 397 consecutive cases of AP in patients admitted or transferred to our institution between June 2018 and December 2018 were reviewed for this study. Institution- al review board approval and written informed consent of each patient were obtained. AP was defined as two or more of the following: characteristic abdominal pain (i.e., severe upper abdom- inal pain), serum amylase or lipase levels three or more times the upper limit of normal (i.e., > 210 U/L and > 180 U/L, respectively), and changes consistent with AP on cross-sectional imaging [7]. Of the 397 cases of AP, there were 196 (49%) cases in 179 patients (107 men, 89 women; mean postendoscopic retrograde pancreatography in 16 (8%) cases, and drug-induced in 14 (7%) cases. Appropriate clinical and laboratory data were re- corded prospectively by two of the authors (who were unaware of the radiologic data) to permit calculation of APACHE II scores at the day of CT or MRI [6].

Imaging Technique

In 140 cases, CT examinations were performed on a 4-MDCT scanner (Volume Zoom, Siemens Healthcare). Contrast-enhanced CT scans (colli- mation, 4 × 2.5 mm; reconstruction section thickness, 5 mm; reconstruction intervals, 5 mm) were obtained 40–50 seconds after IV injection of 100 mL of iopromide (Ultravist 300, Bayer Health- Care), injected at a rate of 3.0 mL/s, using a mechanical power injector. In 35 cases, contrast-en- hanced CT studies using a variety of parameters were retrieved from the referring hospitals; these studies were deemed of good quality (i.e., at least one contrast-enhanced CT scan in the pancreatic or portal venous phase). In 21 cases, contrast-enhanced MRI was performed within 1 week of onset of symptoms. MRI was performed with a 1.5-T magnet (Sig- na EchoSpeed Plus, GE Healthcare) using a phased-array torso coil. Axial T2-weighted fast recovery fast spin-echo, axial and coronal heav- ily T2-weighted single-shot fast spin-echo, axi- al T1-

weighted dual-echo gradient-recalled echo images, and axial fat-suppressed T1-weighted 3D gradient-echo images were obtained. Contrast-en- hanced T1-weighted gradient-recalled echo im- ages were obtained 25, 60, and 180 seconds af- ter IV administration of 20 mL of gadopentetate dimeglumine (Magnevist, Bayer HealthCare).

Image Analysis

The first available contrast-enhanced imaging study was used for this study. All 35 digital CT studies from outside hospitals were retrieved and retrospectively reviewed using DICOM viewer soft- ware (DicomWorks, version 1.3.5, freeware). The remainder of in-house CT and MRI studies were retrospectively reviewed on a PACS workstation (Centricity, GE Healthcare). Two experienced radiologists separately and independently reviewed all imaging studies and recorded all pancreatic, peripancreatic, and extrapancreatic findings and com- plications, each blinded to patient outcome. Pancreatic findings included pancreatic enlargement and presence and extent of areas lacking enhancement. Peripancreatic findings included peripancreatic fat stranding and number of fluid collections. Extrapancreatic complications included ascites, pleural effusion, pericardial effusion, vascular complications (venous thrombosis, hemorrhage, and arterial pseudoaneurysm formation), gastrointestinal complications (ileus [adynamic ileus or mechanical ob- struction], signs of ischemia, marked bowel-wall thickening, perforation, and intramural fluid collec- tion), and extrapancreatic parenchymal complications (infarction, hemorrhage, and subcapsular fluid collection). In all cases, the morphologic severity of pancreatitis was assessed using the CTSI, developed by Balthazar et al. [3], and the MCTSI, more recent- ly developed by Mortele et al. [4] (Table 1). For the CTSI, the morphologic severity of pancreatitis was categorized as mild (0–3 points), moderate (4–6 points), or severe (7–10 points). For the MCTSI, the morphologic severity of disease was categorized as mild (0–2 points), moderate (4–6 points), or severe (8–10 points) (Fig. 1). Both indexes were scored during the same interpretation session. Age, 53 years; age range, 21–94 years) who un- derwent contrast-enhanced CT (n = 175) or MRI (n = 21) that was performed within 1 week of on- set of symptoms. Median interval between onset of symptoms and CT or MRI was 2 days (range, 0–7 days). Of the remainder of cases, 167 were excluded because no contrast-enhanced imaging study was done, 20 cases were excluded because they were admitted with acute or chronic pancre- atitis, nine cases were excluded because imaging was done more than 1 week after onset of symp- toms, and five cases were excluded because they had undergone previous pancreatic surgery or sur- gery for pancreatitis. In our final study cohort of 196 cases, the causes of AP were biliary stones in 66 (34%) cases, alcohol abuse in 43 (22%) cases, miscellaneous (e.g., hypertriglyceridemia, hereditary) in 31 (16%) cases, idiopathic in 26 (13%) cases.

Results

Morphologic Severity of Pancreatitis for the CTSI, the observers graded the mor- phologic severity of pancreatitis as mild in 136 (69%), moderate in 41 (21%), and severe in 19 (10%) cases. Interobserver agreement between the two observers was 0.85 (95% CI, 0.80– 0.90), indicating excellent agreement. For the MCTSI, the morphologic severi- ty of pancreatitis was graded as mild in 86 (44%), moderate in 75 (38%), and severe in logic drainage or surgical necrosectomy), or had prolonged hospitalization (such as need for en- teral feeding or parenteral antibiotics). This new definition of clinically severe AP is in accordance with the most updated version of the revised At- lanta classification [8]. Organ failure was defined as a score of 2 or more in one or more of the three (respiratory, renal, and cardiovascular) organ sys- tems of the modified Marshall score [8, 9].

TABLE 1: CT Severity Index (CTSI) and Modified CTSI (MCTSI)

Characteristics	CTSI (0–10)	MCTSI (0–10)
Pancreatic inflammation		
Normal pancreas	0	0
Focal or diffuse enlargement of pancreas	1	2
Peripancreatic inflammation	2	2
Single acute fluid collection	3	4
Two or more acute fluid collections	4	4
Pancreatic parenchymal necrosis		
None	0	0
Less than 30%	2	2
Between 30% and 50%	4	4
More than 50%	6	4
Extrapancreatic complications[a]	0	2

[a]One or more of

TABLE 2: Severity Outcomes for Full Case Cohort (n = 196)

Outcome	Frequency (%)	Median (Q1, Q3)
Length of hospital stay (d)	6, range 0–113	3, 12
ICU stay	42 (21)	
Length of ICU stay (d)	8.5, range 0–113	3, 12
Need for intervention	19 (10)	
Percutaneous catheter drainage	12[a]	
Surgical necrosectomy (débridement)	12	
Organ failure		
Transient	18 (9.2)	
Persistent	20 (10.2)	
None	158 (80.6)	
Pancreatic infection	7 (4)	
Clinically severe acute pancreatitis	34 (17)	
Death	11 (6)	

ABLE 3: Descriptive Statistics for Extrapancreatic Findings in Modified CT Severity Index

Extrapancreatic Findings	Present (%)
Ascites	80 (41)
Pleural effusion	69 (35)
Gastrointestinal tract involvement	10 (5)
Vascular complications	16 (8)
Parenchymal complications	3 (2)

TABLE 4: Relationship Between Severity Parameters and Morphologic Severity of CT Severity Index (CTSI) and Modified CT Severity Index (MCTSI)

Severity Parameter	CTSI			p	MCTSI			p
	Mild (0–3, n = 136)	Moderate (4–6, n = 41)	Severe (7–10, n = 19)		Mild (0–2, n = 86)	Moderate (4–6, n = 75)	Severe (8–10, n = 35)	
Length of hospital stay (d)	5 [3, 8]	12 [6, 20]	16 [10, 22]	< 0.0001	4 [2, 6]	8 [5, 15]	18 [11,34]	< 0.0001
ICU stay (d)	15 (11)	11 (27)	16 (84)	< 0.0001	3 (3)	16 (21)	23 (66)	< 0.0001
Need for intervention	0 (0)	10 (24)	9 (47)	< 0.0001	0 (0)	2 (3)	17 (49)	< 0.0001
Organ failure								
Transient	7 (5)	7 (17)	4 (21)	< 0.0001	1 (1)	9 (12)	8 (23)	< 0.0001
Persistent	4 (3)	5 (12)	11 (58)	< 0.0001	2 (2)	4 (5)	14 (40)	< 0.0001
None	125 (92)	29 (71)	4 (21)		83 (97)	62 (83)	13 (37)	
Pancreatic infection	0 (0)	3 (7)	4 (21)	< 0.0001	0 (0)	1 (1)	6 (17)	< 0.0001
Clinically severe acute pancreatitis	6 (4)	14 (34)	14 (74)	< 0.0001	2 (2)	8 (11)	24 (69)	< 0.0001
Death	3 (2)	3 (7)	5 (26)	< 0.0001	1 (1)	3 (4)	7 (20)	< 0.0001

TABLE 5: Area Under Curve for CT Severity Index (CTSI), Modified CT Severity Index (MCTSI), and Acute Physiology, Age, and Chronic Health Evaluation II (APACHE II) for Severity Parameters

Severity Parameter	CTSI	MCTSI	APACHE II
ICU stay	0.81 (0.75–0.87)	0.84 (0.79–0.89)	0.84 (0.78–0.88)
Need for intervention	0.94 (0.90–0.97)	0.92 (0.88–0.96)	0.74 (0.67–0.80)
Persistent organ failure	0.85 (0.79–0.90)	0.85 (0.79–0.90)	0.90 (0.85–0.94)
Pancreatic infection	0.92 (0.87–0.95)	0.91 (0.86–0.95)	0.67 (0.59–0.73)
Clinically severe acute pancreatitis	0.87 (0.82–0.92)	0.87 (0.82–0.92)	0.82 (0.76–0.87)
Death	0.78 (0.72–0.84)	0.79 (0.73–0.84)	0.89 (0.84–0.93)

Discussion

In this study on the comparative evaluation of MCTSI versus CTSI, we did not detect any statistically significant differences between the two CT scoring systems with regard to all the studied severity parameters. Both the MCTSI and CTSI were significantly associat- ed with all severity parameters evaluated and TABLE 4: Relationship Between Severity Parameters and Morphologic Severity of CT Severity Index (CTSI) and Modified CT Severity Index (MCTSI) TABLE 5: Area Under Curve for CT Severity Index (CTSI), Modified CT Severity Index (MCTSI), and Acute Physiology, Age, and Chronic Health Evaluation II (APACHE II) for Severity Parameters the results of this study, there is no obvious reason to use one CT scoring system over the other. However, the MCTSI (especially by us- ing the simplified MCTSI) may have better interobserver agreement among less-experi- enced readers. Future studies should be per- formed to elucidate this hypothesis. In 2014, Balthazar et al. [3] introduced the CT severity index for assessment of AP, which correlated well with morbidity, mortality, and length of hospital stay. Although several stud- ies reported a strong correlation between the CTSI and the clinical severity of AP [11–15], other studies have not corroborated these find showed excellent interobserver agreement. Furthermore, compared with APACHE II, both CT scoring systems more accurately cor- related with pancreatic infection and the need for intervention and showed higher accuracy for diagnosing clinically severe disease. In the initial study by Mortele et al. [4], a better correlation was observed between the MCTSI and the development of organ fail- ure and length of hospital stay in comparison with the CTSI. Our present study did not re- produce these prior results. The differences observed may be due to differences in cri- teria for organ failure and clinically severe AP (the current study used criteria in accor- dance with the most updated revised Atlanta classification). Also, the current study evalu- ated 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 com- paring and assessing the diagnostic accuracy of prognostic scoring systems [10]. Both CT scoring systems yielded excellent interobserver agreement among two experi- enced readers. The MCTSI could potential- ly be further improved by using a simplified MCTSI in which extrapancreatic complica- tions can be restricted to only the presence of pleural effusion or ascites with similar prog- nostic value in our post hoc analysis. This is supported by the fact that only two cases re- ceived points for extrapancreatic complica- tions in the absence of pleural effusion or as- cites. However, further prospective studies are needed to validate this observation. In light of ings [16–19]. A few studies have noted a signif- icant relationship between CTSI and mortality [11, 14, 20], whereas De Waele and colleagues [16] did not observe a similar relationship. Leung et al. [11] and Chatzicostas et al. [13] noted a strong association between CTSI and development of systemic complications, in- cluding organ failure; however, other inves- tigators did not reach the same conclusions [19, 21, 22]. The strong relationship between the development of local complications and the CTSI score has been confirmed in many stud- ies [11–14, 19–21], except for one study [22]. The current study again corroborates this as- sociation. In fact, compared with APACHE II, the two CT scoring systems correlated bet- ter with pancreatic infection and the need for intervention. Previous studies compared the Fig. 2—Graph shows receiver operating characteristic curve for pancreatic infec- tion. Solid line indicates CT severity index (CTSI), dotted line indicates modified CTSI, and dashed line indicates Acute Physiology, Age, and Chronic Health Evalu- ation II (APACHE II) index. Fig. 3—Graph shows receiver operating characteristic curve for need for inter- vention. Solid line indicates CT severity index (CTSI), dotted line indicates modi- fied CTSI, and dashed line indicates Acute Physiology, Age, and Chronic Health Evaluation II (APACHE II) index. CTSI and APACHE II in assessing the clinical severity of AP [11–13, 19, 21]. In line with the results of the current study, prior studies also reported a better performance of the APACHE II for assessing systemic complications and or- gan failure [13, 19, 21]. This is to be expected because the APACHE II scoring system gaug- es the physiologic

response of the patient to the inflammatory cascade in AP, which drives systemic complications, whereas CT assesses the morphologic changes that can result in lo- cal complications. However, the APACHE II score contains many variables, limiting its use in clinical practice.

The observed discrepancies between prior studies may relate to the absence of an ac- curate distinction between predicted severe disease (i.e., predictive scoring systems) and actual clinical severity of pancreatitis (i.e., clinical endpoints, such as mortality or per- sistent organ failure) as well as variation in the definitions of severe AP, systemic com- plications, and organ failure. Furthermore, differences in treatment regimes and health care practices among institutions could ac- count for the difference in length of hospi- talization and ICU stay. Uniformity in def- initions in a complex disease, such as AP, is essential for comparing interinstitution- al data [1, 23]. Therefore, the current study liably be assessed without the administration of gadolinium.

This study has one important limitation that is shared by many radiologic studies of AP. Although the data of all patients were prospectively gathered, not all patients who were diagnosed with AP underwent contrast- enhanced CT or MRI within 1 week of the onset of symptoms. Apparently, a proportion of patients with AP have either mild symp- toms, obviating imaging, or are unable to un- dergo imaging studies because of their con- dition. For this reason, our study may appear biased toward more severe AP. However, all studies will contend with this topic because patients with very mild symptoms do not re- quire cross-sectional imaging for diagnosis or management of their condition.

Conclusion

In conclusion, our study did not detect any significant differences between the CTSI and MCTSI in evaluating the severity of AP. Furthermore, this study showed that clini- cal scoring systems do not obviate cross-sec- tional imaging in the evaluation of AP. Clini- cal scoring systems accurately correlate with systemic complications and mortality, but radiologic scoring systems more accurately diagnose clinically severe disease and better correlate with pancreatic infection and the need for intervention.

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