Acute pancreatitis in children: efficacy of computed tomography severity index in the assessment, management, and prediction of complications

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Aim The aim of the study was to describe the assessment and management aspects and the role of computed tomography severity index (CTSI) in children with acute pancreatitis.

Materials and methods All the children ($\leq$ 14 years) admitted to the pediatric surgery unit of our institution with acute pancreatitis from 2003 to 2014 were included. This retrospective analysis studied the demographic, clinical, diagnostic, and treatment aspects and the role of CTSI.

Results The male-to-female ratio out of a total of 45 patients studied was 4 : 1. The differences in mean leukocyte count, mean serum amylase, and mean serum lipase were not significant in children with different CTSI scores. The children with higher CTSI scores are more likely to have both early and late complications, need for intensive care, and overall longer hospital stay.

Conclusion CTSI plays an important role in early determination of the clinical severity, guiding the need for intensive care and in predicting the occurrence of early and late complications in children with acute pancreatitis. *Ann Pediatr Surg* 14:203–207 © 2018 Annals of Pediatric Surgery.

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Introduction

Acute pancreatitis in children is a sporadic emergency condition where the disease process has a variable course [1]. It can range from simple aseptic inflammation of the gland to necrosis with secondary infection. Management of acute pancreatitis in children is challenging and is often marked by unsatisfactory results and development of severe complications and/or chronic pancreatitis (CP) [2]. The exact incidence of the disease is unknown. However, various authors have reported it to range from 1.0 to 2.5% [3,4]. Contrary to adults, where the main etiological factors for acute pancreatitis are gallstone disease and alcohol, the causes of acute pancreatitis in children are diverse and in many cases remain unclear. In children, diseases of the biliary tract and idiopathic causes predominate. Other causes include trauma, drugs, infections and systemic diseases [5]. In this study, we aimed to determine the clinical presentation, demographic profile, assessment, and management of children who were diagnosed with acute pancreatitis and the role of computed tomography severity index (CTSI). We tried to determine any association between CTSI and elevated pancreatic enzymes which can predict the severity of the disease. We also analyzed the role of CTSI in predicting early and late complications.

Materials and methods

A retrospective analysis of medical records of children with acute pancreatitis and admitted in pediatric surgery unit from July 2003 to June 2014 was performed. A total of 45 patients were treated for acute pancreatitis during the period. Clinical and demographic profiles of the patients were recorded. All the patients underwent estimation of serum amylase, serum lipase complete blood count, renal function, and chest radiography at the time of admission. Emergency ultrasound was done at the time of reporting. The patients then underwent computed tomography (CT) scan after stabilization, that is, 48 h or more after the onset of symptoms. Acute pancreatitis was graded using the CT severity index, that is, adding the score of Balthazar scoring (Table 1) and the score of degree of necrosis (Table 2). The occurrence of local and systemic complications, and their management and role of CTSI in predicting the complications were studied. All the results were statistically analyzed using SPSS 20 (IBM, Armonk, New York, USA). Descriptive statistics such as frequency, percentages, mean, and SD were computed. χ^2-Test was used to test the association between qualitative and categorical variables. One-way analysis of variance was used to test the association for quantitative and continuous outcome variables. Post-hoc Tukey's honestly significant difference was used for testing pairwise association between each of the two groups following one-way analysis of variance.

Results

There were 36 boys and nine girls. The age of the patients ranged from 6 to 14 years; however, the most common age was between 7 and 9 years as 28 patients were in these age groups. Abdominal pain was the most common presenting complaint which was present in all the patients while vomiting was present in 37 patients. Twelve patients had fever at the time of presentation. Epigastric tenderness was present in 35 patients, while epigastric tenderness with generalized tenderness was present in six patients (Table 1). Four patients had minimal epigastric tenderness only. In biochemical analysis, there was marked leukocytosis which ranged from 18×10^9 to 36×10^9/l with a

Table 1 Patient profile

Age [median (range)]	9 (5–14)
Sex [n (%)]	
Female	9 (20)
Male	36 (80)
Socioeconomic status [n (%)]	
Lower middle/upper lower	41 (91)
Upper middle	4 (9)
Presenting complaint [n (%)]	
Abdominal pain	45 (100)
Vomiting	37 (82)
Fever	12 (26)

Table 2 Calculation of the computed tomography severity index score
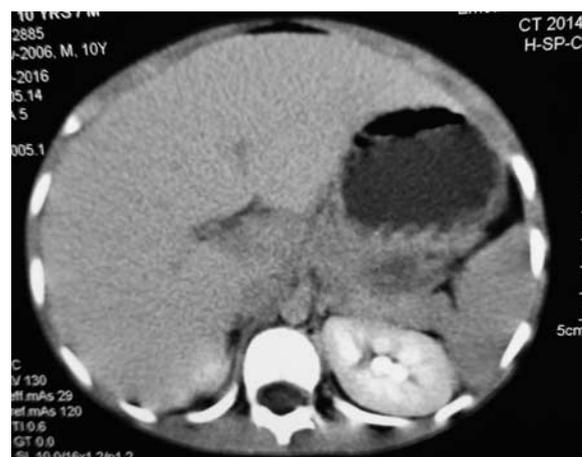
Pancreatic inflammation (Balthazar scoring) score 1	
Normal findings	0
Focal or diffuse enlargement of the pancreas	1
Distorted pancreatic fat planes and peripancreatic inflammation	2
Fluid collection in a single location	3
Two or more collections, gas bubbles in or adjacent to the pancreas, or both	4
Pancreatic necrosis score 2	
No necrosis	0
> 30% necrosis	2
30–50% necrosis	4
> 50% necrosis	6

Computed tomography severity index (i.e. score 1 + score 2): 0–3 points, minor; 4–6 points, moderate; 7–10 points, severe.

Table 3 Comparison of leukocytosis, serum amylase, and serum lipase with computed tomography severity index

Parameters	Computed tomography severity index [mean (SD)]			P-value
	0–3 (group A) (n = 14)	4–6 (group B) (n = 22)	7–10 (group C) (n = 9)	
Leukocytosis	1.65×10^{10} (2.14×10^9)	1.76×10^{10} (1.64×10^9)	1.82×10^{10} (1.32×10^9)	0.071
Serum amylase (U/l)	382.64 (154.5)	476.73 (162.03)	605.89 (417.01)	0.090
Serum lipase (U/l)	351.71 (102.50)	317.86 (113.96)	416.33 (108.05)	0.086

Contrast enhanced computerised tomography image showing mildly swollen pancreas with normal enhancement. Mild pancreatitis computed tomography severity index-2.

Contrast enhanced computerised tomography image showing laceration of the liver and grossly damaged pancreas showing normal parenchyma only in the head and neck region. Body and tail completely lacerated with fluid pockets seen in the region.

Contrast enhanced computerised tomography image showing grossly swollen pancreas with necrotic areas and fluid collection pockets (computed tomography severity index-6).

predominance of neutrophils (Table 3). The serum amylase was raised (i.e. > 3 times normal) in 32 patients and ranged from 72 to 1108 U/l, while serum lipase was raised (i.e. > 3 times) in 39 patients and ranged from 110 to 882 U/l. The most common findings on emergency ultrasonography were diffusely enlarged pancreas, poorly defined borders, and peripancreatic fluid collection. Ten patients showed biliary sludge. CT scan was done after stabilization. CT severity index was calculated by adding the score of pancreatic inflammation (Balthazar scoring) and pancreatic necrosis score (Table 2). In patients with CTSI 0–3 (Figs 1 and 2), the mean leukocyte count was 1.65×10^{10} (2.14×10^9), whereas in patients with CTSI 4–6 it was 1.76×10^{10} (1.64×10^9) and in patients with CTSI 7–10 (Fig. 3) it was 1.82×10^{10} (1.32×10^9). The difference in mean leukocyte count between these groups was not significantly different. In patients with CTSI 0–3, the mean serum amylase level was 382.64 (154.5) U/l, while in patients with CTSI 4–6 it was 476.73 (162.03) U/l and in patients with CTSI 7–10 it was 605.89 (417.01).

Table 4 Shows children who needed surgical intervention at initial admission

Patients	Age/sex	Cause	Presentation	Reason for exploration	Procedure	Outcome
1	7 years/female	Idiopathic	> 3 days of onset of pain	Fever, Toxemia	Necrosectomy + lavage + drainage	Improved
2	8 years/male	Idiopathic	> 2 days of onset of pain	Fever, toxemia	Necrosectomy + lavage + drainage	Expired
3	8 years/male	Traumatic	Immediate	Fever, abdominal distension	Drainage + lavage	Improved

The difference in mean serum amylase level between these groups was not significantly different. In patients with CTSI 0–3, the mean serum lipase level was 351.71 (102.50) U/l, while in patients with CTSI 4–6 it was 317.86 (113.96) U/l and in patients with CTSI 7–10 it was 416.33 (108.05). The difference in mean serum lipase level between these groups was not significantly different. This table shows that although the serum markers are showing increasing trend with increased CTSI value, they are not found to be statistically significant. The reason for this may be the small number of patients in all the groups. All the patients except three were managed conservatively on initial admission (Table 4). There were three patients that needed operation on initial admission. Patient 1 was a 7-year-old female who presented with features of pancreatitis for the past 3 days. The patient needed exploration due to persistent fever and toxic symptoms (white blood cell on the third day of admission was 34×10^9). On laparotomy, there was necrosis present at the body region which was excised. Thorough lavage and adequate drainage was done. Patient 2 was an 8-year-old boy presented with idiopathic pancreatitis and was operated due to persistent fever. On laparotomy, there was extensive necrosis involving part of the head, neck, and the body region. Necrosectomy, lavage, and drainage were done. In the postoperative period, the patient developed pancreatic fistula and florid sepsis. The patient was put on octreotide and TPN and was planned, but the patient expired on postoperative day 5. Patient 3 was an 8-year-old male child who had a history of trauma to the epigastric region. The patient developed features of pancreatitis on day 4 of admission and initially was managed conservatively. But the patient started to develop abdominal distension with fever spikes. The patient was operated and about 200 ml of fibrinopurulent fluid was drained. The pancreas was bulky and edematous. Thorough lavage and drainage was done. There were six more patients who developed acute complications who were managed conservatively (Table 5). A total of eight patients were diagnosed with some form of late complications. Patients with higher CTSI were more likely to develop both early and late complications ($P = 0.003$) (Table 6). Out of these, there were five patients diagnosed as cases of pseudopancreatic cyst and were treated by open cystogastrostomy. There were three patients of CP in the follow-up. Two patients underwent balloon dilatation of the main pancreatic duct and one patient underwent stent insertion for CP at the other center.

The difference in mean hospital stay and the need for intensive care was significant in children with higher CTSI score. Table 6 shows that the difference in ICU admission and overall hospital stay was statistically significant in children with higher CTSI score ($P = 0.001$ and 0.005, respectively).

Table 5 Complications following pancreatitis

Early complications (< 4 weeks of onset of pain)	n	Late complications (>4 weeks of onset of pain)	n
Pleural effusion	3	Pseudocyst	4
Ascites	3	Pseudocysts with ascites	1
Infected ascites	1	Chronic pancreatitis	3
Pancreatic fistula	1		

Table 6 Comparison of complications of ICU admission and hospital stay with computed tomography severity index

	Computed tomography severity index			
Parameters	0–3 (n = 14)	4–6 (n = 22)	7–10 (n = 9)	P-value
Complications (n)				
Early	0	3	5	0.003
Late	0	4	4	
ICU admission	1	3	6	0.001
Hospital stay [mean (SD)] (days)	9 (2.18)	11 (2.44)	15 (2.91)	0.005

Discussion

Acute pancreatitis causes significant morbidity in children [1]. In recent years, there has been an increased incidence of acute pancreatitis in children. This increase can be due to the definite rise in the disease itself or its risk factors like rising obesity in children, increased incidence of systemic illnesses which lead to pancreatitis or due to increased knowledge and increased testing of biochemical markers of acute pancreatitis in children who present with epigastric pain [3,4,6]. Unlike adults where the etiology is mainly two pronged, the causes in children are varied and often multifactorial [7]. The main causes of acute pancreatitis in children are idiopathic, biliary tract diseases, systemic diseases, medications, and trauma in decreasing order of frequency. Other causes include metabolic (hypercalcemia, hypertriglyceridemia, hyperlipidemia, and antitrypsin deficiency), hereditary, and genetic mutations [8–10]. Diseases of the biliary tree (biliary sludge or gallstones) and congenital anomalies of the pancreas and pancreatic ducts (pancreatic divisum, anomalous pancreaticobiliary duct junction) are the predominant causes of acute pancreatitis in children making up to 10–30% of all the causes [11,12]. About 10–20% of cases of acute pancreatitis in children are associated with systemic illnesses [13,14]. Among the drugs, the most commonly involved are L-asparaginase, valproic acid, and immunosuppressive agents (glucocorticoids and azathioprine) [15]. Trauma as the cause of pancreatitis is seen in up to 36% of the cases [16–18]. Infectious agents implicated are Coxsackie B, Epstein Barr virus, herpes simplex virus, and cytomegalovirus [19,20]. Among the genetic diseases, cystic fibrosis is the most widely studied cause of hereditary pancreatitis [21,22]. In our study, the most

common cause was found to be idiopathic and/or infectious. This conclusion was reached mainly after ruling out other causes and there was a history of preceding viral illnesses in about 15 patients. Trauma was the next most common cause. Ten patients had biliary sludge. None of the patients had any systemic illnesses or exposure to drugs.

Like adults, the diagnosis of acute pancreatitis in children is based on revised Atlanta classification. It is defined as inflammation of the pancreas when two of the following three criteria are present: clinical symptoms associated with acute pancreatitis (abdominal pain, nausea and vomiting, back pain), an increase of serum amylase and/or serum lipase levels of three times upper limit of normal and imaging findings typical of acute pancreatitis [23,24]. The main presenting complaint in acute pancreatitis is abdominal pain. This was typically located in epigastrium in 77% of our patients, while it was generalized in 15% of the patients. Only three (6%) patients gave a definite history of pain radiating to the back. This is associated with vomiting in 80% of the patients while fever in 25% of the patients. The increase in enzyme levels should be substantial because increased levels are also observed in other conditions. The sensitivity of serum amylase in our study was 74.5%, while that of serum lipase was 91%. Various authors have reported these values to range from 50 to 80% for serum amylase and up to 100% for serum lipase, respectively. The patients with increasing CTSI show increased serum markers but as shown in Table 3 these values are not statistically significant. The reason for this discrepancy could be the small number of patients in each group. Perhaps a study with a larger number of patients may answer this question more clearly. Normal values of these enzymes do not rule out acute pancreatitis [24]. This applies to leukocytosis as well. Some investigators have reported other biochemical markers of the disease and these include interleukin-6, C-reactive protein, and procalcitonin [24]. Imaging is another very important criterion in the Atlanta classification. Its role is to confirm the clinical findings and the degree of involvement and if feasible to investigate the cause of pancreatitis. At our center, we performed emergency ultrasonography followed by CT scan. The main findings detected on emergency ultrasonography were diffusely enlarged pancreas, poorly defined borders, and peripancreatic fluid collection [25]. CT findings include an increase in pancreatic size with ill-defined borders and peripancreatic fluid. Necrosis is suggested by areas of low enhancement or no enhancement on contrast CT scan. CT scan is considered the investigation of choice because it establishes the diagnosis accurately, can stage the disease, can detect pleural effusion and ascites, quicker thereby decreasing the need or dose for sedation in children, and higher sensitivity [26,27]. We performed the CT scan after 48 h or more of symptom onset because an early CT may undervalue ultimate morphologic severity of the disease, as the necrosis may not be visible on CT within 24–48 h of symptom onset [26]. Pancreatic inflammation is classified into five groups (Balthazar scoring) [28]. CTSI is calculated by the addition of Balthazar and necrosis

score (Table 2). By assessing necrosis and local complications, CTSI allows assessment of the severity of the inflammatory process and helps categorize patients for the treatment options including ICU admission. CTSI effectively predicts morbidity and mortality in children with pancreatitis. We can clearly see in our patients that patients with higher CTSI have high rate of complications, both early and late (Table 6). In their study Balthazar et al. [28] found an excellent correlation between necrosis, the length of hospitalization, development of complications, and mortality: patients with a CTSI up to 3 showed a morbidity rate of 8% and a mortality rate of 3%. However, in patients with CTSI at least 7 a higher rate of both local and systemic complications was observed, higher rate of ICU admission, and the rate of morbidity and mortality was 92 and 17%, respectively. In our study also we found that children with higher CTSI had a longer hospital stay and they required intensive care during that stay as well. In our study, one (11%) patient had died out of nine patients with CTSI of 7–10 (severe). We found that the patients with higher CTSI scores had a more complicated course in the form of local complications, need for surgical intervention, and longer hospital stay (Tables 4 and 6). In 2000, Simchuk et al. [27] in their study on adults found that there was a correlation of CTSI with mortality rate, hospital stay, and need for necrosectomy.

The outcome in acute pancreatitis is related to the development of complications secondary to necrosis which therefore entail surgical intervention, need for ICU admission, and increased hospital stay. Therefore, for better outcome, detection of necrosis and staging of the severity of the disease must be early and objective. For this, the detection system should have high sensitivity and a positive predictive value. It should be able to detect necrosis early in the course of the disease. CT is 80–90% accurate in the detection of pancreatic necrosis. Various scoring and imaging systems have been used to achieve this in children with acute pancreatitis. Hashimoto et al. [29] reported that pediatric acute pancreatitis severity scoring system is best in the pediatric age group. But they have admitted that CTSI could not be done in all the patients.

Thus, we recommend CTSI in children of acute pancreatitis for earlier and better recognition of its severity and therefore better outcome as compared with other scoring systems.

Treatment of acute pancreatitis is mainly conservative. Restoring hemodynamics, rehydration, correction of disorders of acid–base balance together with pain control is the initial goal. The complications observed in children with pancreatitis can be immediate or late. Immediate complications may include shock and multiorgan failure. The occurrence of acute systemic complications is associated with already present comorbid conditions [24,25]. Since there are fewer comorbid conditions in children as compared with adults, the incidence of acute complication following acute pancreatitis is less as was observed in our study also. In our study, the main reasons for surgical intervention during initial admission were

fever, toxemia, and increasing abdominal distension. These features indicate the development of necrosis and/or infected ascites. The most common late complication to affect children following pancreatitis is the formation of pseudocysts. The incidence of pseudopancreatic cyst is higher in children who develop traumatic pancreatitis. Small asymptomatic pseudocysts with no evidence of complication is managed conservatively [25]. Larger, mature, and symptomatic pseudocysts are managed by surgical drainage (open, laparoscopic, or endoscopic). Acute recurrent pancreatitis is reported to occur in 15–35% of the patients with acute pancreatitis [30]. The incidence of CP is even lesser. But the morbidity associated with acute recurrent pancreatitis and CP is significant. The mainstay of treatment in CP is pain control which may require opioids. The other drugs given are pancreatic enzymes and antioxidants. Endoscopic or surgical intervention may be needed in nonresponsive patients [31]. Six percent of our patients developed CP. All of them were managed by endoscopic intervention (two of them required balloon dilatation of the main pancreatic duct while one required stent insertion).

Conflicts of interest

There are no conflicts of interest.

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