Abdominal Radiology (2019) 44:2459–2465
https://doi.org/10.1007/s00261-019-01979-4

PANCREAS

Interobserver agreement of computed tomography reporting standards for chronic pancreatitis

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Published online: 6 April 2019

Abstract

Aim To assess the interobserver agreement of computed tomography (CT) reporting standards for chronic pancreatitis (CP).

Subjects and methods Retrospective analysis of CT of 47 patients (33 males and 11 females, age range 36 to 56 years) with CP who presented with abdominal pain ($n=41$), steatorrhea ($n=37$), and glucose intolerance ($n=31$). The patients underwent CT study using a 16-multidetector CT scanner with a pancreatic protocol including a nonenhanced scan followed by pancreatic phase at 35 s and portal venous phase at 65 s after intravenous injection of nonionic contrast medium. Image analysis was performed by two radiologists according to reporting standards for CP.

Results There was excellent interobserver agreement (84.8 %) between the two reviewers in CT reporting standards for CP ($K=0.80$, 95 % CI 0.75–0.85, $P=0.001$). There was good interobserver agreement for pancreatic duct (PD) caliber ($K=0.71$, 95 % CI 0.56–0.87, $P=0.001$), PD contour ($K=0.76$, 95 % CI 0.61–0.91, $P=0.001$), PD stricture ($K=0.070$, 95 % CI 0.53–0.88, $P=0.001$), and distribution of findings ($K=0.69$, 95 % CI 0.51–0.86, $P=0.001$). There was excellent interobserver agreement for intraductal calculi ($K=0.84$, 95 % CI 0.68–0.98, $P=0.001$), pancreatic calcifications ($K=0.86$, 95 % CI 0.84–0.98, $P=0.001$), and pancreatic diameter ($K=0.87$, 95 % CI 0.75–0.99, $P=0.001$).

Conclusion CT reporting standards for CP is a reliable method for diagnosis of patients with CP.

Keywords Pancreatitis · Inflammation · Pancreatic duct · Radiology

Abbreviations

CP Chronic pancreatitis
PD Pancreatic duct

Introduction

Chronic pancreatitis (CP) is an irreversible fibroinflammatory disease of the pancreas leading to permanent damage of the gland that presents with a triad of abdominal pain, steatorrhea, and diabetes [1–3]. Early and accurate diagnosis of patients with CP is necessary as this disorder is associated with pain, exocrine and endocrine insufficiency, and pancreatic cancer with mortality rates of 28–35 % and higher death rate 3.6 times normal. Diagnosis is done based on a combination of clinical symptoms, pancreatic function tests, and morphological abnormalities seen on imaging [2–4]. Management of CP is challenging, involving medical treatment for pain, endoscopic and surgical intervention, and use of pancreatic enzyme replacement therapy [3–7]. Different imaging modalities are used for assessment of CP [8–12]. Abdominal ultrasound has low accuracy due to gases and operator dependence [13]. Endoscopic ultrasound is used to diagnose CP, but findings are nonspecific [14]. Ultrasound elastography and contrast ultrasound have a limited role in diagnosis of CP [15, 16]. Magnetic resonance imaging (MRI) and magnetic resonance cholangiopancreatography (MRCP) are used for detection of ductal changes of CP, but pancreatic calcifications and calculi cannot be identified [17–20]. Diffusion-weighted MR imaging and MR elastography do not give more information than routine MR [21, 22]. Biopsy of the pancreas is not usually performed due to the risk of biopsy-related pancreatitis [2–5].

CT plays a significant role in diagnosis of CP, as it provides comprehensive information about pancreatic duct (PD) caliber, contour, stricture, and intraductal stones as well as

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pancreatic composition, volume, and calcifications [8–12]. Different classification systems that include imaging and/or clinical features are used for diagnosis of CP [23–26]. However, there is no standardized reporting system for cross-sectional imaging of CP. Recently, reporting standards for CP were presented, incorporating parenchymal and ductal abnormalities using several features such as calcifications, parenchymal T1 signal changes, focal or diffuse gland atrophy, or irregular contour of the gland [27, 28]. This system is used for diagnosis and to detect disease severity, but this new unique reporting standard system requires validation to determine its reliability and ability.

The aim of this work is to assess the interobserver agreement of CT reporting standards for CP.

Materials and methods

Patients

This study was approved by the institutional review board; informed consent from the patients was waived because of its retrospective nature. The inclusion criteria were patients with proved CP diagnosed on the basis of clinical and imaging tests, according to American Pancreatic Association practice guidelines in chronic pancreatitis [29]. The patient cohort was obtained from patients presenting at inpatient and outpatient clinics of Ahmadi Hospital in the period from January 2011 till July 2018 who underwent contrast-enhanced CT of the pancreas. We excluded one patient from the study due to image quality degradation. Finally, 47 patients (33 male and 11 female) with age range of 36–56 years were included. Patients presented with abdominal pain ($n=41$) steatorrhea ($n=37$), and glucose intolerance ($n=31$). The cause of CP was idiopathic ($n=25$), obstructive ($n=19$), and alcoholic ($n=3$). Patients with advanced ($n=34$) and early ($n=13$) CP were included in the study group.

CT technique

CT was carried out using a multidetector 16-slice LightSpeed helical scanner (General Electric Healthcare, Milwaukee, WI) with a pancreatic protocol including a nonenhanced scan followed by two phases, pancreatic phase at 35 s and portal venous phase at 65 s, after intravenous injection of 80–100 ml nonionic contrast (iopromide, Ultravist 370) at dose of 1.5 ml/kg with rate of 3 ml/s using an automatic injector followed by saline chase of 20 ml normal saline. Scanning extended from the hepatic dome to the iliac crest in the precontrast and pancreatic phases and to the symphysis pubis in the portal venous phase. Automated dose modulation was applied to reduce the dose with Kv (80–120 ms) and mAs (variable according to the patient), the collimation was 16×1.25 mm^2, the beam pitch was 0.9, and the section thickness/reconstruction interval was 3 mm/3 mm.

Image analysis

CT image analysis was performed by two expert radiologists (A.R. and E.E.) with 25 and 20 years of experience in abdominal imaging, respectively, blinded to clinical presentation. Image analysis was done according to the reporting standards of CP [27]. PD diameter was classified into less than 3.5 m, from 3.5 to 7 mm, and more than 7 mm; PD contour was classified into smooth, mild irregular, and moderately irregular; PD stricture was classified into none or present in the tail, body, and head and neck location; ductal calculi were classified into not present, present, or unclear; pancreatic calcifications were classified into fewer than 7 punctate, 7–49 punctate/fewer than 7 coarse foci, or innumerable (50 or more punctate/7 or more coarse foci); the diameter of the pancreatic body was classified into 21 mm or more, less than 21 mm and more than 14 mm, between 14 and 7 mm, and less than 7 mm; the distribution of findings was classified as 30 % or less, between 30 and 70 %, or 70 % or more.

Statistical analysis

Statistical analysis of data was carried out using the Statistical Package for Social Sciences (SPSS) program version 20. The weighted kappa statistic (K) including the 95 % confidence interval (CI) with percentage agreement was used to estimate the proportion of agreement between the two reviewers. The K values were interpreted as follows: good for 0.61–0.80, and excellent for 0.81–1.00. P-value less than 0.05 indicated statistically significant difference. Overall agreement was dependent on a positive finding by both reviewers in each parameter, after coding as one variable for the first observer and another variable for the second observer.

Results

Table 1 presents the interobserver agreement of the CT reporting standards of CP, revealing excellent interobserver agreement (84.8 %) between the two reviewers ($K=0.80$, $P=0.001$). There was good interobserver agreement for PD caliber (Fig. 1) ($K=0.71$, $P=0.001$), PD contour (Fig. 2) ($K=0.76$, $P=0.001$), and PD stricture (Fig. 3) ($K=0.070$, $P=0.001$). There was excellent interobserver agreement for intraductal calculi (Fig. 4) ($K=0.84$, $P=0.001$), pancreatic calcifications (Fig. 5) ($K=0.86$, $P=0.001$), and pancreatic diameter (Fig. 6) ($K=0.87$, $P=0.001$). There was good

Table 1 Interobserver agreement between two observers for CT reporting standards for CP

	Observer 1	Observer 2	*K*	95 % CI	*P* value	Agreement (%)
PD caliber						
Cannot assess	11	9	0.71	0.56–0.87	0.001	78.7
Less than 3.5 mm	12	13				
From 3.5 to 7 mm	15	15				
More than 7 mm	9	10				
PD contour						
Cannot assess	10	10	0.76	0.61–0.91	0.001	82.9
Smooth	18	16				
Mild irregular	14	16				
Moderate/marked irregular	5	5				
PD stricture						
None	26	24	0.70	0.53–0.88	0.001	80.8
Tail	5	4				
Body	6	10				
Head and neck	10	9				
Intraductal calculi						
Absent	28	26	0.84	0.68–0.98	0.001	91.5
Present	18	18				
Unclear	1	3				
Pancreatic calcification						
< 7 punctate	24	22	0.86	0.84–0.98	0.001	89.4
7–49 punctate/< 7 coarse foci	14	16				
≥ 50 punctate/≥ 7 coarse foci	9	9				
Pancreatic diameter (mm)						
7–14	19	19	0.87	0.75–0.99	0.001	91.5
> 14–21	13	13				
> 21	15	15				
Distribution						
Normal	4	3	0.69	0.51–0.86	0.001	78.7
≤ 30 %	9	8				
30–70 %	14	15				
≥ 70 %	20	21				
Overall			0.80	0.75–0.85	0.001	84.8

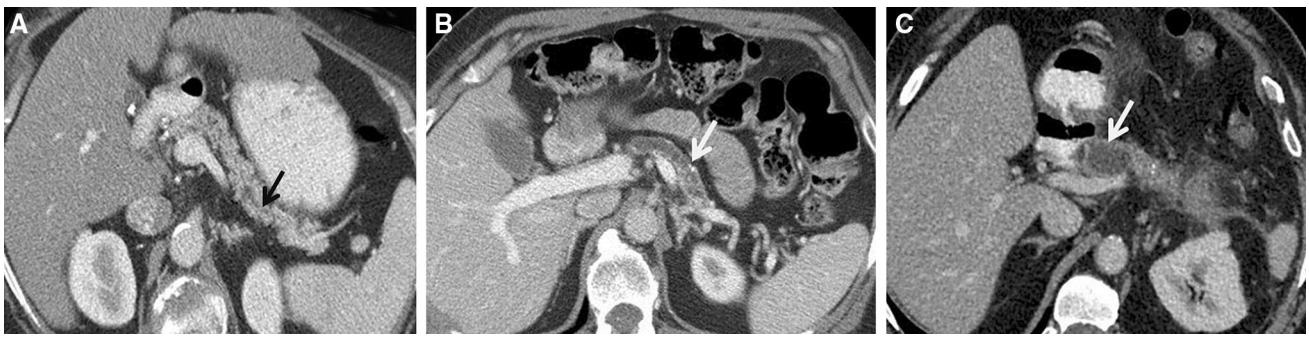

Fig. 1 Pancreatic duct caliber: axial CT scan showing PD caliber (arrow) less than 3.5 mm (**a**), from 3.5 to 7 mm (**b**), and more than 7 mm (**c**)

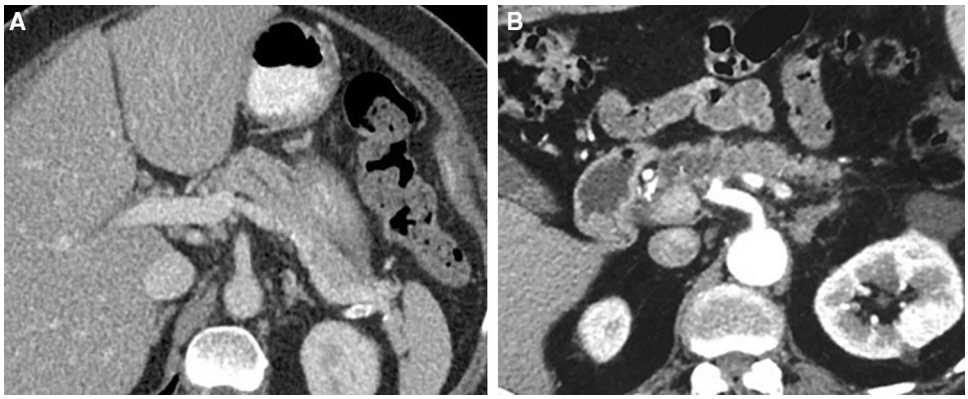

Fig. 2 Pancreatic duct contour: axial and coronal CT scan showing pancreas with smooth contour (**a**) and moderately irregular contour (**b**)

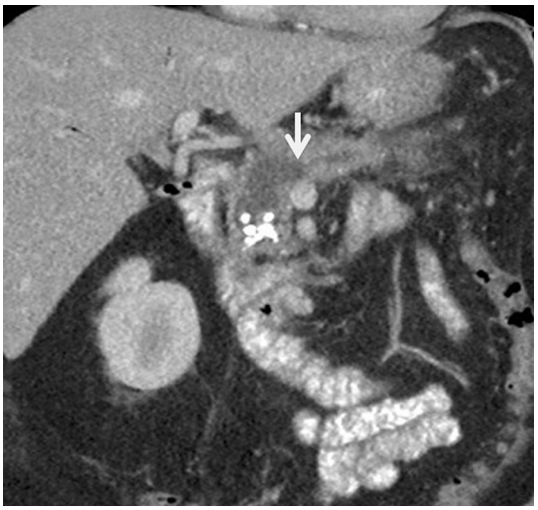

Fig. 3 Pancreatic duct stricture: axial CT scan showing stricture (arrow) in body of pancreas

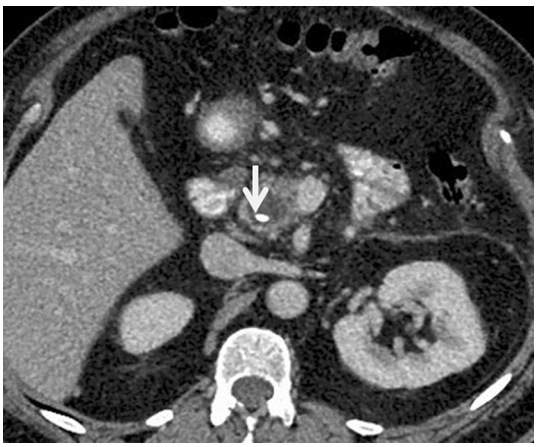

Fig. 4 Intraductal calculi: axial CT scan showing intraductal calculus (arrow)

interobserver agreement of distribution of findings (Fig. 7) ($K = 0.69$, $P = 0.001$).

Discussion

Overall, excellent interobserver agreement between the two reviewers was found for evaluation of CT reporting standards for CP. There was good interobserver agreement for PD caliber, PD contour, PD stricture, and distribution, and excellent interobserver agreement for intraductal calculi, pancreatic calcifications, and pancreatic diameter.

In this study, there was good interobserver agreement for PD caliber. Narrowing of the PD can be due to stricture or calculus in the absence of malignancy. If multiple foci of PD narrowing are present, the most downstream one, closest to ampulla, should be documented. Dilatation of PD is commonly seen in patients with CP. The dilation may be smooth, beaded, or irregular with no particular pattern predominating, and there is good correlation between PD caliber at CT and endoscopic retrograde cholangiopancreatography [26, 27].

The change in the PD contour is an important finding at CT in patients with CP. The PD contour may show mild, moderate, or advanced irregularity. PD contour irregularity is a cardinal sign of CP denoting the presence of periductal fibrosis and is associated with stasis within the PD, leading to stone and obstruction, further atrophy, and fibrosis [23–27]. In this study, there was good interobserver agreement for PD contour.

Pancreatic ductal changes are also more prominent and range from obstruction to overt dilatation and/or distortion. Obstruction of the main pancreatic duct or its branches results in distal ductal dilatation and distortion [25–27]. In this study, there was good interobserver agreement for PD stricture.

In this study, there was excellent interobserver agreement for intraductal calculi. Intraductal calculi are the main cause of abdominal pain in patients with CP, and can lead to parenchymal or functional damage to the pancreas. Calculi are

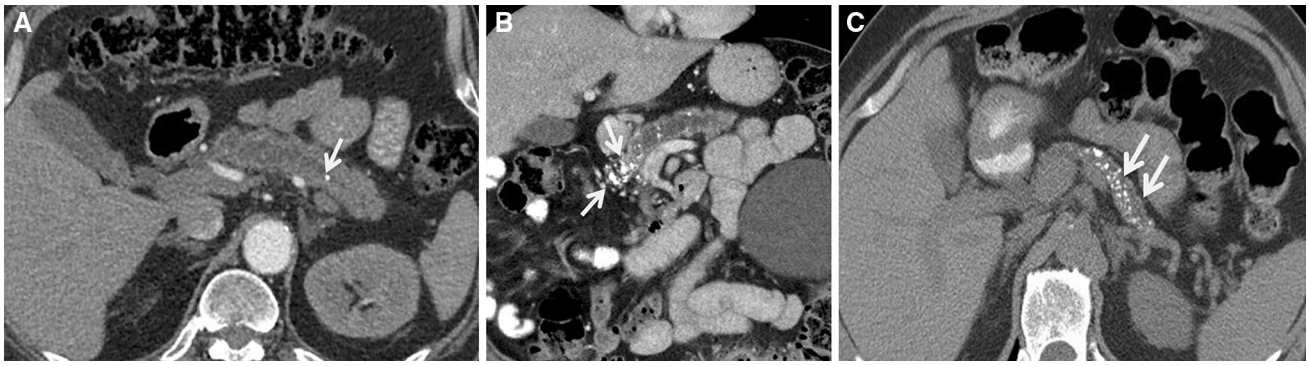

Fig. 5 Pancreatic calcifications: axial and coronal CT scan showing < 7 punctate (**a**), 7–49 punctate calcifications (**b**), and more than 50 punctate (**c**)

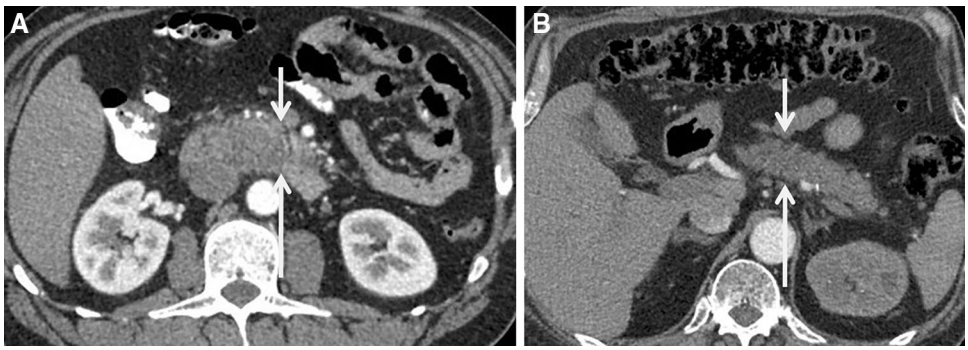

Fig. 6 Pancreatic diameter: axial CT scan showing pancreatic diameter more than 21 mm (**a**) and 14–21 mm (**b**)

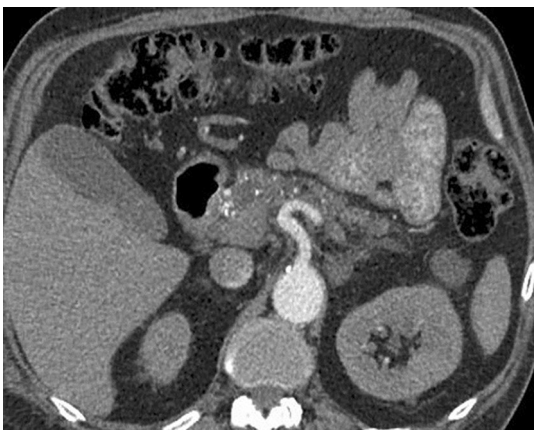

Fig. 7 Distribution of findings: axial CT scan showing distribution of findings more than 70 % of pancreas

commonly seen within the main PD and side branches that vary from 1 mm to 1 cm [30–32].

In this study, there was excellent interobserver agreement for pancreatic calcification. The merit of CT compared with MR imaging is detection of calcifications. Calcifications are more commonly seen in patients with CP due to alcohol and smoking, and may be seen in hereditary CP. Calcifications vary in size (tiny, stippled to large, coarse) and distribution (localized to diffuse), appearing late in the disease and in patients with severe disease. The size and number of pancreatic calcifications correlate with the disease course. Coarse calcification is a sure sign of CP, whereas fine calcifications in peripheral ducts may not always imply CP. Innumerable (more than 50) punctate calcifications indicate an advanced disease course [27, 33].

In this study, there was excellent interobserver agreement for pancreatic diameter. One study reported that parenchymal atrophy is seen in 54 % of patients with CP, and pancreatic enlargement in 30 % [27]. Parenchymal changes due to CP occur late in the disease process. There is poor correlation between pancreatic morphology and exocrine and endocrine deficiency in patients with CP. Patients with CP show a shrunken pancreas of reduced size due to parenchymal atrophy and fibrosis [8–11, 27].

Previous studies reported that features of CP can be seen as a diffuse or localized process. The extent of involvement should be graded because pancreatic insufficiency varies in relation to the disease distribution. The localized form of the disease is usually restricted to part of the pancreas distal to PD obstruction, associated with reduced size and irregular contours due to parenchymal atrophy [9, 11, 27].

In this study, there was good interobserver agreement for the distribution of findings.

The CT reporting standards for CP offer many advantages. First, they provide a common language between radiologists, clinicians, and surgeons for better patient management and care. Second, CT reporting standards are simple and reliable to apply in clinical practice. Third, they may give an idea about the severity and prognosis of patients with CP. Fourth, they may help in treatment selection for patients with CP, who may require medical, endoscopic, or surgical treatment. A multidisciplinary approach is recommended for management of patients with CP. Endoscopic therapy is recommended for patients with dilated PD of more than 5 mm with stone or stricture, or surgery for more advanced disease.

This study has a few limitations. First, this was a retrospective study on a small number of patients. Further prospective multicenter studies on larger numbers of patients are recommended. Second, this study applied CT for standards reporting of CP. Further studies are recommended on MR imaging and its comparison with CT for reporting standards of patients with CP. Third, this study used CT reporting standards of CP for diagnosis. Further studies are recommended to assess the severity and course of CP using reporting standards.

Conclusion

CT reporting standards for CP are a reliable method for diagnosis of patients of CP.

Funding No funding of this research.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was waived because of the retrospective nature of this study.

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