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Computed tomography and magnetic resonance cholangiopancreatography in the assessment of acute pancreatitis

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ABSTRACT

BACKGROUND

Acute pancreatitis (AP) is a disease associated with sudden onset of abdominal and back pain in a band-like pattern, nausea, and vomiting. In patients with AP, the gold standard, i.e., the initial imaging modality to be used is ultrasonography (US). However, in cases where evaluation is insufficient, computed tomography (CT) and magnetic resonance cholangiopancreatography (MRCP) are other modalities to be applied. In this study, we aimed to demonstrate the diagnostic accuracy of CT and MRCP in patients with acute pancreatitis.

METHODS

Seventy-five patients diagnosed with acute pancreatitis were evaluated using CT and, as well as patients who underwent contrast-enhanced MRCP within 48 hours. CT and MRCP were examined in terms of the biliary tract and pancreatic duct structure, gallbladder, common bile duct stones and complications. Chi-square test and the Mann-Whitney U test were used to analyze the data at significance level of $p<0.05$.

RESULTS

Of all the included patients, 44 were male (58.7%), and the mean age was 59.27 ± 17.37 years. In CT findings, the percentage of AP complication findings such as pancreatic necrosis, extrapancreatic complications, the pancreatic or peripancreatic fluid collection was significantly higher than the MRCP group ($p<0.05$). MRCP showed biliary tract findings such as cholelithiasis, gallstone, common bile duct dilatation, intrahepatic bile duct dilatation, choledochal stone and pancreatic duct dilatation at a higher percentage than CT.

CONCLUSION

MRCP was superior to CT in gallbladder and choledochal stone and biliary tract dilatation but not in AP complications. Therefore, non-invasive and radiation-free MRCP can be used more widely in AP patients, especially in emergency departments.

Keywords: Acute pancreatitis, computed tomography, magnetic resonance cholangiopancreatography

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INTRODUCTION

Acute pancreatitis (AP) is a reversible acute inflammatory condition, accompanied by sudden-onset of abdominal and back pain in a band-like pattern, nausea, and vomiting, where local tissue or organ systems may also be affected.[1] The annual incidence of AP is about 5–80/100,000 people, and the most common etiological causes are alcohol and gallstones.[2] Amylase and lipase are the most commonly used biochemical parameters. Trypsin, phospholipase-A, carboxypeptidase-A, serum elastase-1 and lipase isoforms are also used for diagnosis.[3]

Radiological examinations are used in AP to determine both the etiology of the disease and local complications occurring in the treatment and follow-up processes of the disease.[4] The gold standard in patients with AP, i.e., the initial imaging modality to be used, is ultrasonography (US).[5] Computed tomography (CT) examination with intravenous contrast agent is the initial imaging modality applied in emergency departments, especially in cases where US is not sufficient for evaluation. Computed tomography is a more useful method than US both for diagnosis and demonstration of AP complications, but CT often fails to evaluate the biliary tract and gallbladder and is currently replaced by other imaging modalities due to exposure to high radiation and contrast agent.[6] On the other hand, with the advances in technology, the biliary tract can be easily monitored by rapid magnetic resonance imaging and thus, can serve as a guide for diagnosis and treatment. Therefore, non-invasive and radiation-free magnetic resonance cholangiopancreatography (MRCP) has been increasingly used in examinations of the biliary tract and pancreatic duct.[7]

Magnetic resonance cholangiopancreatography has the unique capability of providing non-invasive images of the pancreatic ducts and can demonstrate possible communication of a pancreatic pseudocyst with pancreatic ducts.[8] In order to recognize the cause and complications of AP, especially in emergency departments, it is important to exclude alternative causes of abdominal pain and to evaluate the degree of acute pancreatitis as well as CT imaging for preoperative planning.[9,10] Although both imaging methods have advantages and disadvantages to each other, the use of MRCP in patients with AP is highly limited in emergency departments. Thus, in this study, we aimed to evaluate the diagnostic performance and superiority of MRCP and CT, compared to each other, in the AP evaluation.

METHODS

Research design

A retrospective study was conducted in Health Science University, Antalya Training and Research Hospital, Antalya, Turkey between January 2016 and December 2018.

Research subjects

During the study period a total of 274 patients suffering from AP, who applied to our emergency department were assessed for eligible into the study. Patients who are younger than 18 years, pregnant, have acute, chronic pancreatitis exacerbation, have AP-related malignancy or are transferred to another hospital, those who have not performed CTs in the emergency room or MRCP in 48 hours in the hospital or those with incomplete data were excluded from the study. A total of 199 patients were excluded from the study after exclusion criteria. Consequently seventy-five patients complying with these criteria were selected for this study. All subjects underwent contrast-enhanced abdominal tomography (CT), as well as patients who underwent contrast enhanced MRCP within 48 hours of hospitalization for the diagnosis of AP. All images were evaluated separately by the radiologist. Abdominal tomography and MRCP were performed in all patients included in the study.

Clinical variables

Demographic characteristics, prognosis, length of hospital stay, RANSON scores at admission, laboratory parameters {white blood

cell, amylase, lipase, alanine transaminase (ALT) and aspartate transaminase (AST)} of the patients were recorded. Balthazar scores were calculated from A to E according to the necrosis and fluid collection in the pancreas. Mild pancreatitis grouped as Balthazar score (A, B, C); severe pancreatitis grouped as Balthazar score (D, E).

Contrast-enhanced abdominal computed tomography

Abdominal tomography of the cases included in the study was performed with ECLOS 16 slice CT scanner (Hitachi Medical Systems, Tokyo, Japan). The scanning area was the area located between the diaphragm and the iliac crest and the images were taken with a collimation section thickness of 0.5 mm at kVp 120, 150-200 mAs, reconstruction interval of 0.3 mm, FOV width (30 cm), pitch value 1-1.5, Window Width 350 (200-600) and Window Level: 50 (30-60). All patients received the contrast agent at a rate of 3ml/sec from the antecubital vein, and images were taken within a single breath-hold period of 65 seconds. None of the patients developed allergic reactions during the administration of the contrast agent. Intra-extrahepatic biliary tract, pancreatic parenchyma, pancreatic duct, surrounding fat planes and other possible pathological findings of the patients were examined (Figure 1-2). In the pancreas, parenchymal lesion, pancreatic duct enlargement, peripancreatic adipose tissue contamination, and fluid presence were examined and the diameter (width) of pancreatic duct was measured at its widest point. Abdominal tomography and MRCP imaging findings of the patients were compared.

Magnetic resonance cholangio-pancreatography

MRCP was performed on all patients on Days 0-2 following hospitalization with 1.5 Tesla Philips Achieva MR device (Best, The Netherlands). HD 8 Channel Body Array Coil was used. Images were first obtained with a breath-hold axial 2D FIESTA sequence, and then, data were obtained from breath-triggered, coronal oblique 3D T2-weighted fast spin-echo (FRFSE – XL) sequence, followed by thick-slab, breath-hold T2 SSFSE (HASTE) sequence. Besides, breath-hold SSFSE (HASTE) thin-section coronal oblique images were obtained.

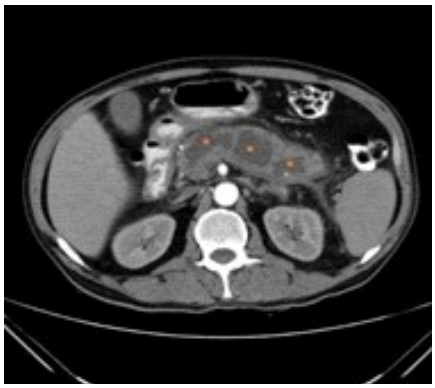

Figure 1: Axial enhanced CT shows that multipl acute necrotic collection in pancreatic bed (Asterisks)

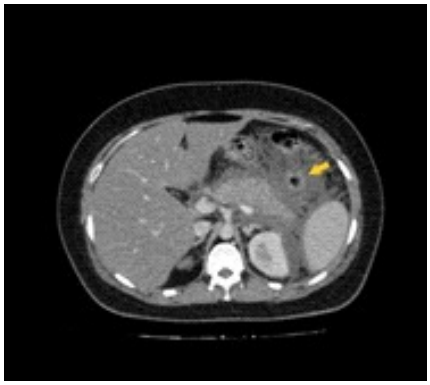

Figure 2: Axial enhanced CT shows that edematous pancreatitis with bowel involvement (Arrow)

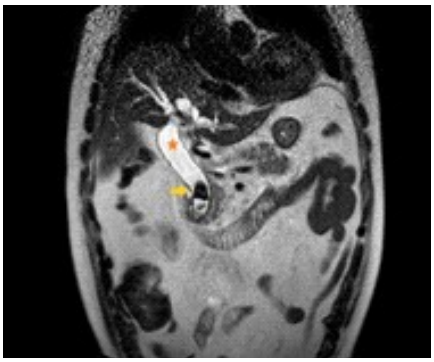

Figure 3: Coronal T2W MRI shows that common bile duct is dilated with mild intrahepatic duct dilatation (Asterisk). Filling defect within the distal common bile duct keeping with choledocholithiasis (Arrow)

The parameters of the MRCP sequences used are given in Table 1. Only intravenous contrast agent was used during the examination. The resulting sections were examined in terms of the biliary tract and pancreatic duct structure, gallbladder, common bile duct stones and complications (Figure 3).

Statistical analysis

The statistical analysis of all variables was made using SPSS version 23.0. Continuous variables were expressed as mean ± standard deviation in the analysis of data. Frequency and percentage (%) were used for categorical data. Pearson's chi-squared test was used to evaluate the variables. In the comparison of the positive findings in CT and MRCP groups, Student's t-test was used for variables with normal distribution, and the Mann-Whitney U test was used for variables without normal distribution. The value of $p<0.05$ was considered statistically significant.

Ethical clearance

This study was approved by the Ethics Committee Antalya Training and Research Hospital under no.2020/135 and patients signed a consent form before inclusion to the study

RESULTS

Seventy-five patients who met the inclusion criteria were included in the study. Of all the included patients, 44 were male (58.7%), and the mean age was 59.27 ± 17.37. Patients were divided into two groups according to their imaging findings: positive on CT and positive on MRCP. Although the mean age was higher in the CT group compared to MRCP, it was not statistically significant ($p=0.792$). There was no significant difference between the groups in terms of gender ($p=0.621$). In CT findings, the percentage of AP complication findings such as pancreatic necrosis, extrapancreatic complications, the pancreatic or peripancreatic fluid collection was significantly higher than the MRCP group ($p<0.05$).

Biliary results such as cholelithiasis, gallstone, common duct dilatation, intra-hepatic biliary duct (IHBD) dilatation, choledochal stone and pancreatic duct dilatation had a higher percentage in MRCP compared to CT ($p <0.05$ for all parameters). No significant differences were found in serum WBC, amylase, lipase, AST, ALT and calcium levels between the groups. Demographic data, imaging findings and laboratory values of the groups are compared in Table 2.

DISCUSSION

The present results show that MRCP is a reliable alternative to CT for assessing AP. While MRCP is superior to CT in cases such as cholelithiasis, gallstone, common duct dilatation, IHBD dilation, choledochal stone and pancreatic dilatation; CT was superior in complications such

Table 1: Magnetic resonance sequence parameters using in MRCP

	Axial 2D FIESTA	Coronal oblique T2-weighted 3D FRFSE-XL	Thick-slab T2-weighted SSFSE (HASTE)	Thin slice, coronaloblique T2-weighted SSFSE (HASTE)
TR (msec)	428	1324	466	1324
TE (msec)	80	700	80	700
Matrix	276x242	256x256	268x232	256x256
Slice thickness (mm)	5	37	5	2,5
Gap (mm)	0	0,3	0,3	0
FOV(mm)	385	252	375	260
Number of Signals Acquired	1	1	2	1
Flip Angle	90	90		90

2D FIESTA: two-dimensional Fast Imaging Employing Steady State Acquisition, FRFSE-XL: fast recovery fast spin echo-accelerated, SSFSE: single-shot fast spin-echo, HASTE: half-Fourier single-shot turbo spin-echo, TR: repetition time, TE: echo time, FOV: field of view

Table 2. Comparison of demographic characteristics and imaging findings between CT and MRCP

	CT findings positive	MRCP findings positive	p value
Age (years)[a]	61.39 ± 18.05	60.4 2± 17.78	0.792
Gender; male (%)[b]	29 (38.7)	33 (44.6)	0.621
Presence of cholelithiasis n(%) [b]	9 (12)	11 (14.7)	0.328
Gallstone[b]	18 (24)	27 (36)	<0.001
Common bile duct dilatation[b]	20 (26.7)	23 (30.7)	0.003
IHBD dilatation[b]	19 (25.3)	21 (28)	0.043
Choledochal stone [a]	8 (10.7)	22 (29.3)	0.022
Pancreatic duct dilatation[b]	11 (14.7)	14 (18.7)	0.033
Ranson score[a]	1.59 ± 1.07	1.49 ±1.08	0.368
Balthazar score[b]			0.014
Mild pancreatitis (A, B, C)	61 (81.3)	57 (76)	
Severe pancreatitis (D, E)	14 (18.7)	18 (24)	
Pancreatic necrosis[b]	17 (22.7)	5 (6.7)	<0.001
Extrapancreatic complications[b]	14 (18.7)	8 (10.7)	0.005
Pancreatic or peripancreatic fluid collection[b]	28 (37.3)	17 (22.7)	<0.001
White blood cell [a]	12.54 ± 5.07	12.13 ± 4.81	0.74
ALT [a]	75.5 (8-791)	80 (8-791)	0.449
AST [a]	63.5 (18-578)	69 (18-683)	0.682
Calcium [a]	8.75 ± 0.94	8.77 ± 0.78	0.977
Amylase [a]	444 (153-4673)	438 (53-4622)	0.635
Lipase [a]	598 (59-8157)	585 (66-9626)	0.528

Data presented as mean ± SD, percentage and range, [a]:Mann-Whitney U test b: chi-square test; AST : aspartate transaminase; ALT : alanine transaminase

as pancreatic necrosis, extrapancreatic complications, pancreatic or peripancreatic fluid collection. Unlike our study, it was found in a study that CT showed bile and choledochal stone as effectively as MRCP, it was reported that it was not so effective in showing the peripancreatic fluid collection.[11]. In another study, similar to our findings, it was emphasized that CT is a superior imaging method for pancreatic necrosis and extrapancreatic complications than MRCP.[9]

Radiological imaging methods are of great importance in the evaluation of patients with AP or biliary problems admitted to the emergency department. Therefore, although US is the first choice as it is both easily accessible in almost all emergency departments and fast, there are some limitations, the first one of which is its administrator-dependent nature and low sensitivity. Besides, although it can easily detect dilatation in the biliary tract, it may be insufficient for determining the cause.[12] Even though ERCP is the gold standard for biliary imaging in these examinations, CT and MRCP stand out as an alternative to US due to the need for experienced personnel, being invasive and the low possibility of emergency application.[13]

Different reasons play a role in the etiology of AP and gallstone and alcohol accounts for approximately 90% of these cases. Other most frequent etiologic causes are trauma, hyperlipidemia, drugs, endoscopic retrograde cholangiography or surgical procedures.[14] Another study reports that AP is most frequently diagnosed in the sixth decade and alcohol, gallbladder stones and idiopathic causes account for the etiology. This study also indicates that alcohol is the primary cause in European countries.[15] A study conducted in Turkey reports that gallbladder stones are diagnosed in 72% of patients etiologically with mild AP, while the figure increases to 58% in patients with severe AP.[16] In our study, the most common causes were found to be gallbladder stones and idiopathic causes.

Magnetic resonance imaging is sensitive to detect subtle changes of AP; especially minor peripancreatic inflammatory changes; even in a morphologically normal pancreas state in CT imaging; It may appear normal in 15% to 30% of patients with clinical features of AP. The sensitivity of Magnetic resonance imaging exceeds the sensitivity of CT imaging and

emphasizes its role in the evaluation of patients with clinically suspected AP. [17] As CT can conveniently demonstrate bile ducts and surrounding tissue, it can quickly determine metastasis or vascular invasion in malignant cases.[18] CT images of gallstones, especially cholesterol stones, may sometimes be impossible to detect depending on their chemical contents. In a recent study, chemical analyzes of stones were compared and cholesterol-containing stones were reported to be isodense with bile, while those with high calcium content were reported to be dense.[19] Another recent study indicates that CT examination of AP patients within the first 72 hours is useful in the diagnosis of pancreatic necrosis, but the examinations within the first 24 hours may be false negative.[20] Similarly, our study revealed that CT was superior to MRCP in detecting complications, but we think that CT, together with MRCP, may be able to determine the Baltazar score at a higher rate in patients with severe AP.

Magnetic resonance cholangiopancreatography will soon change the approach to patients presenting with biliary obstruction that is because it can totally replace the diagnostic role of CT. Noninvasive and radiation-free MRCP imaging method should be used more and more in emergency departments in the examination of the biliary tract.

Our study is a single-centered, retrospective study, which constitutes the most important limitations of our study. Failure to ascertain the minute of applying CT and MRCP imaging methods and interpretation of images by a single radiologist are other limitations. Besides, the effects of clinic, symptoms and additional diseases of patients on mortality are not included in the study, which is another limitation. It is suggested that future studies should evaluate MRCP is a superior radiological imaging method in AP patients, especially in emergency departments. Further well-designed prospective studies enrolling larger populations are needed.

CONCLUSION

Magnetic resonance cholangiopancreatography was superior to CT in gallbladder and choledochal stone and biliary tract dilatation but not in AP complications. Therefore, non-invasive and radiation-free MRCP can be used more widely in AP patients, especially in emergency departments.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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CONTRIBUTORS

All authors contributed to compilation of the subject matter, writing of the manuscript drafts, data collection, and data analysis. CB and MK contributed to manuscript finalization. KE and AA contributed to the study concept and design. CB, MK and KE contributed to manuscript revision. All authors have read and approved the final manuscript.

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