Multidetector-Row CT in Patients with Suspected Obstructive Jaundice: Comparison with Non-Contrast MRI with MR Cholangiopancreatography

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We compared the diagnostic accuracy of multidetector-row computed tomography (MDCT) with multiplanar reconstruction (MPR) images to non-contrast magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP) (MRI/MRCP) for evaluating obstructive jaundice. MDCT and MRI/MRCP images from 53 patients with suspected obstructive jaundice were interpreted by two radiologists. These readers evaluated the images to determine level of obstruction, to differentiate between benign and malignant lesions, and to state the first-choice diagnosis with degree of confidence. We analyzed the obstruction levels in 50 patients excluding 3 patients who did not undergo direct cholangiography (DC). Both MDCT and MRI/MRCP showed almost perfect agreement with DC in two readers (statistic weighted kappa $\geq$ 0.80) in the determination of obstruction level. The mean area under the receiver operating characteristic curve for differentiating benign from malignant lesions was significantly (p=0.02) larger in MDCT (0.98) than in MRI/MRCP (0.86). We analyzed the first-choice diagnoses for 39 patients excluding 14 patients without final diagnosis confirmed. Readers had, out of 78 interpretations, a high confidence level in their first-choice diagnoses for 44 (56%) and 23 (29%) interpretations using MDCT and MRI/MRCP, respectively. In the interpretations made with high confidence level, 98% (43/44) and 91% (21/23) were correct for MDCT and MRI/MRCP, respectively. In conclusion, MDCT with MPR images is as accurate as MRI/MRCP for evaluating the biliary duct obstruction level, and has high diagnostic accuracy in evaluating the cause of jaundice. MDCT can provide sufficient information on the level of biliary obstruction and cause of obstructive jaundice.

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Introduction

In the evaluation of obstructive jaundice, diagnosing the cause and the level of biliary obstruction is crucial since the choice of therapy may depend on the cause and location of the obstruction.[1] It has been reported that magnetic resonance cholangiopancreatography (MRCP) can replace diagnostic direct cholangiography (DC), e.g., endoscopic retrograde cholangiography (ERC), or percutaneous transhepatic cholangiography (PTC), in many instances,[2-9] and that computed tomography (CT) cholangiography without cholangiographic agent also delineates the bile duct well.[10-13] Recent development in multidetector-row computed tomography (MDCT) allows acquisition of high Z-axis resolution data using a very thin collimation, and MDCT with multiplanar reconstruction (MPR) images is often sufficient for diagnosing biliary disease.[13] To our knowledge, however, there have been only a few studies comparing the diagnostic accuracy of CT and MRI for determining the level of biliary obstruction.[14]

This study compares the diagnostic accuracy of MDCT with MPR images to non-contrast MRI with MRCP (MRI/MRCP) for determining obstruction level. In addition, to evaluate the usefulness of MDCT in diagnosing the cause of obstructive jaundice, this study also compares the diagnostic accuracy of MDCT to MRI/MRCP for cause of obstructive jaundice.

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Materials and Methods

Patient population

Reports from our database from September 2001 to February 2004 were reviewed to identify patients who underwent MDCT and MRI/MRCP for the evaluation of obstructive jaundice, and examination results in 65 consecutive patients were retrieved. Clinical suspicion of obstructive jaundice was aroused by blood test or by ultrasonography. All patients who were suspected of having biliary obstruction underwent both MDCT and MRI/MRCP in our institution. Twelve patients were excluded from the study for the following reasons: MDCT was not performed using our protocol (described later) (n=5); biliary drainage was performed without prior imaging studies (n=4); or, pathological confirmation and follow-up imaging studies were not obtained (n=3). Consequently, 53 patients were enrolled in this study. There were 28 male and 25 female patients (aged 45-89 years with the mean of 70.9 years). The median interval between CT and MRI/MRCP was 5 days (ranged 0-16 days).

For the level of obstruction, the standard of reference was based on the findings in DC (ERC, PTC or intraoperative cholangiography). For the final diagnosis, the standard of reference was based on histopathological findings, cytological findings, and/or a combination of imaging findings. In 50 patients, DC was performed. The remaining three patients who did not undergo DC were excluded from the interpretation of the level of biliary obstruction, while they were included in the interpretation of the cause of obstructive jaundice. Two radiologists not involved in the interpretation of the MDCT or MRI/MRCP images interpreted DC images from 50 patients, determined the level of biliary obstruction in these patients by consensus and established the imaging diagnosis including MDCT, MRI and DC.

Thirty-four patients had malignant biliary obstruction that included bile duct carcinoma (n=14), pancreatic carcinoma (n=3), ampullary carcinoma (n=2), gallbladder carcinoma (n=2), and a malignant tumor involving the lower bile duct that was otherwise nonspecific (n=13). All pancreatic and ampullary carcinomas were confirmed by surgery. Of the 2 gallbladder carcinomas, one case was confirmed by surgery, and the other was diagnosed by characteristic imaging findings (diffuse thickening of the gallbladder wall and multiple liver metastases) with evidence of disease progression in follow-up imaging studies. Among the 14 bile duct carcinomas (2 cases of intrahepatic, 3 of hilar, 5 of common hepatic bile duct, and 4 of lower common bile duct carcinoma), 5 cases (1 common hepatic bile duct and 4 lower common bile duct carcinomas) were confirmed by surgery, and 9 (6 of periductal infiltrating tumor and 3 of intraductal polypoid mass) were diagnosed by other cytological studies and characteristic imaging findings. In the remaining 13 patients with lower bile duct stricture, malignancy was confirmed by cytological studies and/or clinical course; however, they did not undergo surgery and we could not classify those tumors as bile duct carcinomas or pancreatic carcinomas or malignant papillary tumors.

Nineteen patients had benign diseases including choledocholithiasis (n=13), primary sclerosing cholangitis (n=2), chronic pancreatitis (n=2), Mirizzi's syndrome (n= 1), and a benign bile duct stricture that was otherwise nonspecific (n=1). Final diagnoses of all choledocholithiasis were based on ERC findings. Two cases of primary sclerosing cholangitis, 2 cases of chronic pancreatitis and a case of Mirizzi's syndrome were diagnosed by typical imaging findings, and follow-up examinations over more than 6 months, which disclosed no evidence of malignancy. The one remaining patient was clinically suspected of having primary sclerosing cholangitis accompanied by retroperitoneal fibrosis, with no interval change for at least 6 months at follow-up examinations, but histopathological confirmation was not obtained and the imaging finding (segmental stricture of the lower common bile duct) was atypical.

MDCT protocol

CT examinations were performed using Somatom Plus4 Volume Zoom (Siemens, Erlangan, Germany) with four high-resolution detectors. CT (7-mm section thickness) of the upper abdomen was first obtained at 120 kVp and 100 effective mA, with a 4×2.5 mm collimation to define the craniocaudal extent of the bile duct system. Table feed was 12.5 mm per 0.5 seconds of scanner rotation (25 mm/sec). We infused nonionic iodinated contrast material (iohexol (Omnipaque 300); Daiichi Pharmaceutical, Tokyo, Japan) at 2 mL per kilogram of body weight with the upper limit of 150 mL by means of a calibrated power injector. At 40 seconds after the intravenous injection of contrast material, at a rate of 3-4 mL/sec (pancreatic phase), a 16 to 20 cm length from the dome of the liver through to the horizontal portion of the duodenum was scanned using a 4×1 mm collimation at 120 kVp and 140-150 effective mA. Table feed was 5 mm per 0.5 seconds of scanner rotation (10 mm/sec). Images of 1 mm thickness were reconstructed at 0.8 mm intervals, and the image data were transferred to a workstation (Volume Wizzerd; Siemens, Erlangan, Germany). Oblique, coronal, reformatted images of 2 mm thickness were reconstructed at 1 mm intervals by plotting an oblique, coronally-oriented plane through the biliary tract. Use of this plane improves visualization of the craniocaudal extent of lesions.[15] Multiplanar reconstructions were performed by one operator. Minimum-intensity-projection images and maximum-intensity-projection images were not reconstructed. At 90 seconds after the contrast injection (portal venous phase), CT (7 mm section thickness) of the upper abdomen was obtained using the same parameters as the precontrast CT.

MRI protocol

MR examinations were performed with a 1.5-T unit (Gyroscan Intera; Philips Medical Systems, Best, Netherlands) and a phased-array torso surface coil. Prior to MR examination, all patients ingested a mixture of 1200 mg of ferric ammonium citrate (FerriSeltz; Ohtsuka Pharmaceuticals, Tokyo, Japan) and 50 mL of water.

Prior to MRCP, both transverse T2-weighted turbo spin-echo images (1,600-3,000/100 (repetition time (msec)/echo time (msec)), field of view of 350×245 mm^2, matrix of 400×320 interpolated to

512×512; 2 excitation; and section thickness of 7 mm) with respiratory triggering, and transverse breath-hold T1-weighted field echo images (147/2.3 and 4.6 (repetition time (msec)/echo time (msec)); flip angle of 80°, field of view of 350×245 mm^2, matrix of 256×180 interpolated to 512×512; 1 excitation; and section thickness of 7 mm) were obtained.

Breath-hold single-shot MRCP with half-Fourier technique was performed with T2-weighted turbo spin-echo sequences (8,000/1,000 (repetition time (msec)/echo time (msec)); turbo factor of 256; field of view of 250×250 mm^2; matrix of 256×256 interpolated to 512×512; section thickness of 60 mm; and one acquisition) in 7 oblique, coronal orientations (-45° through 45°).

Three-dimensional MRCP was also obtained using turbo spin-echo sequences with respiratory triggering in each patient. Imaging parameters used for the three-dimensional, fast spin-echo sequence were as follows: 2,200-5,300/700 (repetition time (msec)/effective echo time (msec)); partition thickness of 1.5 mm with 50% overlap (40 slices); one acquisition; field of view of 320×256 mm^2; matrix of 256×230 interpolated to 512×512; turbo factor of 184; and acquisition time was about 4 to 8 minutes.

Image analysis

Images were stored in a digital picture archiving and communication system. Two specialists in radiology (KI and HH), who have similar experience of more than 10 years in both CT and MR abdominal imaging and had not seen these cases previously, independently reviewed images on the monitor. Two sets of images were obtained in each patient: one set included contrast enhanced dynamic MDCT axial images and MPR images, and the second set included T1- and T2-weighted axial images and MRCP images. A total of 106 sets of images from 53 patients were examined as follows: (1) the patients were randomly divided into two groups, say, A and B; (2) one reader reviewed MDCT of patients in group A and MRI/MRCP of patients in group B, while the other reader reviewed MDCT of patients in group B and MRI/MRCP of patients in group B; and (3) the remaining sets of images were reviewed by respective readers 4 weeks later to avoid memory-recollection bias. The readers were told the age and sex of the patient and that the patients suffered from obstructive jaundice, but they were blinded as to the final results. The readers were unaware of the types or rates of the diseases included in this study.

The readers were asked for the following in reviewing both MDCT and MRI/MRCP: (1) to define the level of obstruction (obstruction was defined as an abrupt caliber change of the bile duct, and the level was classified as ampulla, common bile duct, common hepatic duct, hilum, or intrahepatic bile duct); (2) to differentiate benign from malignant lesions using a five-point scale based on the individual reader's assessment (1=definitely benign, 2=probably benign, 3=possibly malignant, 4=probably malignant, 5=definitely malignant); and (3) to record the first-choice diagnoses and their degree of confidence on a three-point scale (1=definite, 2=probable, 3=possible). We consider it important to make a specific diagnosis as well as differentiating benign from malignant lesions, because treatments are different even in benign lesions.

For the level of obstruction, the statistic weighted kappa (κ) was calculated to determine agreement between DC and MDCT or MRI/MRCP.[16] The statistic weighted kappa allows for difference in the seriousness of disagreements, and we assign weights to extent of disagreement among categories of the level (ampulla, common bile duct, common hepatic duct, hilum, or intrahepatic bile duct). Interobserver variability in the assignment of obstruction level was also calculated using weighted kappa. The weighted kappa exceeding 0 was considered a positive correlation: slight, 0.01-0.20; fair, 0.21-0.40; moderate, 0.41-0.60; substantial, 0.61-0.80; and almost perfect, 0.81-1.00.

The performance of MDCT and MRI/MRCP in differentiating benign from malignant lesions was compared on the basis of their receiver operating characteristic (ROC) curves constructed from the data by the two readers. The distribution of area under ROC curve (AUC) was compared between MDCT and MRI/MRCP for each reader as well as for both readers using jackknife method,[17,18] which created the AUC pseudovalue for each subject; the AUC pseudovalue (pAUC) corresponding to subject *i* was defined by

$$pAUC_i = 53AUC\text{-}52AUC_{(-i)},$$

where AUC is the are calculated from the data of 53 subjects and $AUC_{(-i)}$ is the area calculated from the data of 52 subjects excluding subject *i.* A total of 53 pairs of AUC pseudovalues calculated for MDCT and MRI/MRCP corresponding to each subject were treated as independent observations of two correlated variates to compare the AUC of the two modalities. These analyses were performed by using a subroutine (laboratory multiple readers, multiple cases, or LABMRMC) of a ROC analysis program (ROCKIT; C. Metz, University of Chicago, Chicago, IL).[19]

For each data set, we calculated the proportion of correct interpretations regardless of confidence level as the total number of correct interpretations by the two readers divided by the total number of interpretations. We also calculated the proportion of diagnoses with high level of confidence (level 1=definite) and the proportion of correct interpretations in those with high level of confidence. The correct interpretations regardless of confidence level and those with high confidence were compared between MDCT and MRI/MRCP by McNemar test.[20]

Results

The level of obstruction

In 50 patients who underwent DC, agreement of interpretations by MDCT and DC was almost perfect in both reader 1 (κ=0.81) and reader 2 (κ=0.83), and that by MRI/MRCP and DC was substantial in reader 1 (κ=0.80) and almost perfect in reader 2 (κ=0.93). MDCT and MRI/MRCP were equally accurate for the evaluation of obstruction level (Figure 1). Agreement of interpretations by readers 1 and 2 was almost perfect for both MDCT (κ=0.88) and MRI/MRCP (κ=0.88).

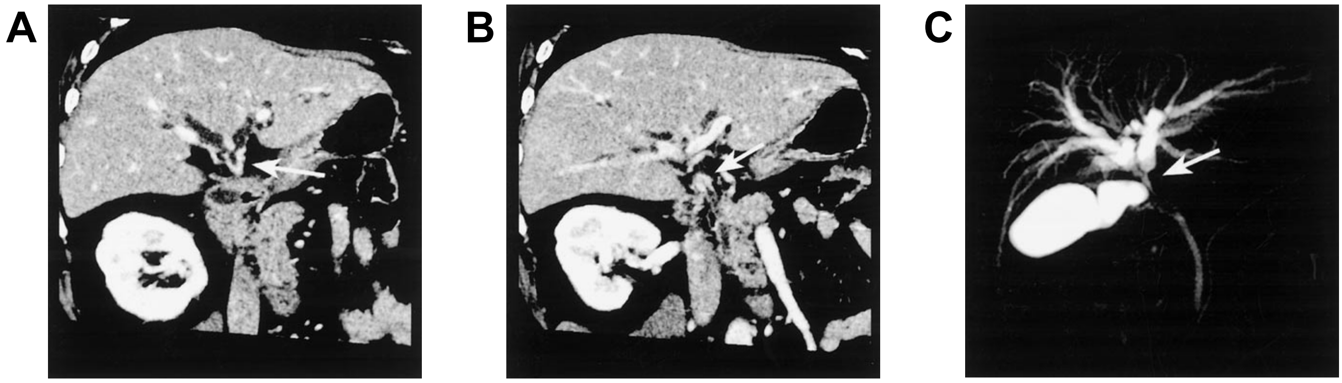


Figure 1. A 67-year-old man with bile duct carcinoma. **A, B.** Oblique, coronal reconstructed images of MDCT showing enhanced, thickened bile duct wall (arrow) and a severe stricture at the common hepatic duct involving both hepatic ducts. Both readers correctly diagnosed the level of obstruction and the cause of obstruction as bile duct carcinoma with definite confidence (level 1=definite). **C.** MRCP showing a severe stricture from both hepatic ducts to the common hepatic duct (arrow). On MRI/MRCP, both readers correctly diagnosed the obstruction level and the cause of obstruction as bile duct carcinoma with definite confidence (level 1=definite).

Table 1. Frequency of correct first-choice diagnosis regardless of confidence level by disease and modality

Disease	Number of patients	Modality[a]	
		MDCT	Non-contrast MRI/MRCP
Choledocholithiasis	13	25 (96)[b]	25 (96)
Radiopaque stone	9	17 (94)	17 (94)
Radiolucent stone	4	8 (100)	8 (100)
Primary sclerosing cholangitis	2	1 (25)	0 (0)
Chronic pancreatitis	2	3 (75)	0 (0)
Mirizzi's syndrome	1	2 (100)	2 (100)
Bile duct carcinoma	14	27 (96)	22 (79)
Pancreatic carcinoma	3	6 (100)	6 (100)
Ampullary carcinoma	2	3 (75)	1 (25)
Gall bladder carcinoma	2	4 (100)	1 (25)
All	39	71 (91)	57 (73)

[a]MDCT=Multidetector-row computed tomography; MRI/MRCP=Magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP).
[b]Total number of interpretations correctly diagnosed by two readers (percentage in parentheses).

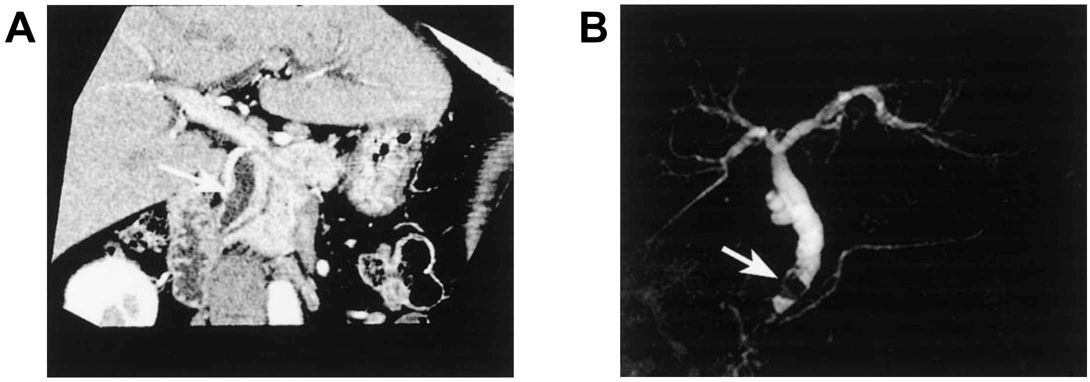
Differentiation of benign from malignant lesions

In reader 1, the mean AUC was 0.96 and 0.81 for MDCT and MRI/MRCP, respectively, showing no significant difference (p> 0.05), while in reader 2, the mean AUC was 1.00 and 0.92 for MDCT and MRI/MRCP, respectively, showing a significant difference (p<0.05). The mean AUC of MDCT and MRI/MRCP for both readers combined was 0.98 and 0.86 showing a significant (p=0.02) difference in AUC between the two modalities.

The first-choice diagnosis and confidence level

Table 1 presents the frequency of the first-choice diagnosis made correctly by MDCT and MRI/MRCP in 39 patients excluding 14 patients (1 with suspected primary sclerosing cholangitis and 13 with malignant tumor involving the lower bile duct not confirmed surgically). The frequency of correct interpretation as a whole irrespective of the degree of confidence was significantly (p=0.008) higher in interpretations by MDCT (91%) than in those by MRI/MRCP (73%). Furthermore, the frequency of correct first-choice diagnosis for each disease irrespective of the degree of confidence was higher in the case with MDCT than in that with MRI/MRCP except for choledocholithiasis (including radiolucent stones) (Figure 2), Mirizzi's syndrome and pancreatic carcinoma; the frequency of correct interpretation irrespective of the degree of confidence was same in both cases with MDCT and with MRI/MRCP for these three diseases.

Table 2 presents the frequency of interpretations with definite level of confidence which the two readers made with MDCT and MRI/MRCP. The table also presents the frequency of correct interpretations in those with definite level of confidence. The frequency of interpretations with definite level of confidence was significantly (p



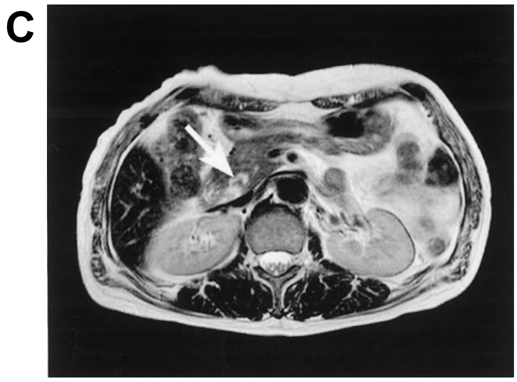


Figure 2. A 56 -year-old female with choledocholithiasis. **A.** On the MPR image from MDCT, a faint lesion is suspected in the common bile duct (arrow), but is not conspicuous. A non-calcifying stone is the most likely cause because no tumorous lesion is identified, but confident diagnosis is difficult. Both readers diagnosed a probable benign stricture and correctly interpreted it as possible choledocholithiasis (confidence level 3=possible). **B.** MRCP clearly shows a signal defect suggestive of choledocholithiasis (arrow). **C.** On a T2-weighted axial image, an intraductal, multifaceted lesion is identified (arrow). Differentiating between choledocholithiasis and tumor is difficult because intraductal lesions do not appear as an obvious low signal. On MRI/MRCP, both readers diagnosed a probable benign stricture and correctly interpreted it as choledocholithiasis with medium confidence level (level 2=probable).

Table 2. Frequency of the first-choice diagnoses with definite level of confidence and the correct diagnoses among them by disease and modality

Disease	Number of patients	Modality[a]			
		MDCT		Non-contrast MRI/MRCP	
		Confident interpretation	Correct interpretation	Confident interpretation	Correct interpretation
Choledocholithiasis	13	15 (58)[b]	15 (100)[c]	16 (62)	16 (100)
Radiopaque stone	9	15 (83)	15 (100)	11 (61)	11 (100)
Radiolucent stone	4	0	NA[d]	5 (63)	5 (100)
Primary sclerosing cholangitis	2	1 (25)	0 (0)	0	NA
Chronic pancreatitis	2	0	NA	0	NA
Mirizzi's syndrome	1	2 (100)	2 (100)	2 (100)	2 (100)
Bile duct carcinoma	14	16 (57)	16 (100)	2 (7)	2 (100)
Pancreatic carcinoma	3	5 (83)	5 (100)	1 (17)	1 (100)
Ampullary carcinoma	2	2 (50)	2 (100)	0	NA
Gall bladder carcinoma	2	3 (75)	3 (100)	2 (50)	0
All	39	44 (56)	43 (98)	23 (29)	21 (91)

[a]MDCT=Multidetector-row computed tomography; MRI/MRCP=Magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP).
[b]Total number of interpretations diagnosed with definite level of confidence by two readers (percentage in parentheses).
[c]Total number of interpretations correctly diagnosed in those diagnosed with definite level of confidence by two readers (percentage in parentheses).
[d]NA=Not available.

=0.0003) higher in the case with MDCT (56% or 44/78) than in the case with MRI/MRCP (29% or 23/78). Of these highly confident interpretations made with MDCT, 59% (26/44) were malignancy (Figure 3) and 34 % (15/44) were choledocholithiasis. Of the highly confident interpretations using MRI/MRCP, 70% (16/23) were choledocholithiasis, and 22% (5/23) were malignancy.

Except for the primary sclerosing cholangitis, the interpretations with high level of confidence made with MDCT images were all

A B C

Figure 3. A 77-year-old man with bile duct carcinoma. **A.** MPR image from MDCT showing a dilated common bile duct and an enhanced tumor in the lower common bile duct (arrow). Both readers diagnosed malignant biliary obstruction and correctly identified it as a bile duct carcinoma with high confidence level (level 1=definite). **B.** MRCP images showing biliary dilatation and a round signal defect that mimics a stone in the lower common bile duct (arrow). **C.** T2-weighted images showing a round lesion with intermediate to high signal intensity within a dilated common bile duct (arrow). The shape of the lesion was likely to represent a stone, but the signal intensity of lesion was likely to represent a neoplasm. On MRI/MRCP, reader 1 diagnosed a benign stricture, and misinterpreted it as choledocholithiasis with medium confidence (level 2=probable). Reader 2 diagnosed malignant obstruction caused by bile duct carcinoma with low confidence (level 3=possible).

correct (98% or 43/44); reader 1 interpreted the MDCT images of primary sclerosing cholangitis as bile duct carcinoma. Similarly, in the interpretations with high level of confidence with MRI/MRCP, 91% (21/23) were correct; both readers misinterpreted 1 case of gall bladder carcinoma as bile duct carcinoma.

Discussion

In the evaluation of obstructive jaundice, diagnosis of the level of biliary obstruction is crucial.[1] Many recent studies demonstrated high sensitivity and specificity of MRCP for evaluating biliary obstruction.[2-9] On the other hand, there are studies of CT cholangiography using oral or intravenous biliary contrast agent,[21-25] which reported the accuracy of this modality in the assessment of the biliary system. Unfortunately, CT cholangiography is restricted by its insufficient opacification of bile ducts that may occur in patients with elevated bilirubin levels or liver insufficiency.[21] According to recent studies, CT cholangiography without biliary contrast agent also delineates the biliary duct well.[10-13] In our study, there was almost perfect agreement between MDCT and DC, as well as between MRI/MRCP and DC, in the determination of obstruction level. We think that MPR images with high spatial resolution were a primary contributing factor to the agreement between MDCT and DC. When the bile duct is dilated, contrast resolution of contrast-enhanced CT without biliary contrast agent seems sufficient to isolate the intra- and extra-hepatic bile ducts from the surrounding parenchyma. MDCT as well as MRCP would be a good choice for determining the exact level of biliary obstruction in patients with obstructive jaundice.

Diagnosing the malignant biliary obstruction is also crucial in the evaluation of obstructive jaundice, and we found MDCT to have significantly improved ability for distinguishing between benign and malignant biliary obstructions. The correct first-choice diagnoses for malignant tumor were provided by MDCT images more often than by MRI/MRCP images, and the confidence level of diagnosis for malignant tumor with MDCT increased compared with MRI/MRCP. A lesion which causes malignant biliary stricture is often small; therefore, correctly diagnosing malignant strictures will require a high spatial resolution and good contrast resolution. MDCT has the advantages of improved spatial resolution using thin collimation, which enable the acquisition of large volumetric data sets to create reconstructed images.[15,26] In our series, the data obtained by using 1 mm collimation during the pancreatic phase were reconstructed at 0.8 mm intervals. This phase of enhancement optimizes the contrast between pancreaticobiliary tumor and normal parenchyma.[27,28] These data sets contributed to MPR images of higher quality that combine high spatial resolution and good contrast resolution to differentiate tumor from normal parenchyma. We believe that MPR images of high quality led to an increase in the correct diagnoses of malignant strictures.

Superiority of MDCT in the interpretation of the first-choice diagnoses and the confidence level would also be attributed to the addition of contrast-enhanced dynamic study. We compared MDCT with contrast-enhanced dynamic study to MRI/MRCP performed without intravenous contrast. In our institution, we do not generally perform three-dimensional contrast-enhanced dynamic MR imaging with MRI/MRCP during a single examination. The lack of contrast-enhanced dynamic study for the MR examination is a limitation of this study. Addition of three-dimensional contrast-enhanced dynamic MR images could increase reader's ability to differentiate benign from malignant lesions and lead to more correct first-choice diagnoses because three-dimensional contrast-enhanced dynamic MR images provide high spatial resolution and good contrast resolution simultaneously.[29] It is still controversial as to whether contrast-enhanced dynamic CT or contrast-enhanced dynamic MRI is more accurate for diagnosing malignant tumor,[30-32] but our results suggest that MDCT can be used to diagnose the cause of obstructive jaundice with high diagnostic accuracy.

MDCT is not more accurate than MRI/MRCP in the diagnosis of radiolucent stone because CT clearly depicts only calcified stones. To confirm suspected radiolucent stone on MDCT, combination with other imaging techniques may be necessary. Radiolucent stones generally account for 15-25% of all choledocholithiasis cases.[33] In 13 cases of choledocholithiasis in our series, four patients (31%) had radiolucent stones which were not detectable on CT but were clearly identified on MRCP. Surprisingly, in this study, the frequency of correct interpretations irrespective of the degree of confidence for radiolucent stones did not differ between MDCT and MRI/MRCP. Although the confidence level was low, the two readers diagnosed the patients with radiolucent stones correctly on MDCT. The readers probably excluded malignant tumor confidently on MDCT and thought that there might be a radiolucent stone since they knew the patients suffered from obstructive jaundice. When we cannot detect a tumorous lesion on MPR images with high resolution and contrast, we should consider the possibility of a radiolucent stone. Confident exclusion of malignant tumor on MDCT probably aids in the diagnosis of radiolucent stone with this modality.

A highly confident diagnosis of choledocholithiasis may be difficult on MRCP alone since MRCP is based on the use of heavily T2-weighted sequences, and both stones and intraductal polypoid tumors will result in identical T2 shortening. Therefore, a signal de fect within the bile duct is not specific for choledocholithiasis.[34-37] Axial T2-weighted images often allow the radiologist to diagnose choledocholithiasis, which generally shows up as low signal intensity. However, on MRI using 7 mm thickness sections, small stone does not appear as obvious low signal because of the partial volume effect from bile.[35] Differentiation between stones and intraductal tumors on MRI/MRCP is sometimes difficult, and gadolinium-enhanced MR images would be needed for confident diagnosis. Consequently, in the diagnosis of choledocholithiasis, MRI/MRCP is not always more accurate than MDCT.

In addition, contrast-enhanced CT will be able to provide additional information on lesion extent and metastatic disease, which are important issues in tumor staging and surgical planning.[38] MDCT allows shorter acquisition time and wider coverage than MRI/MRCP. We believe that MDCT could be performed as the one-stop shop imaging modality to establish the diagnosis and to decide on the therapeutic options. This may serve to decrease the total cost of the diagnostic work-up by eliminating the need for multiple imaging studies.

In conclusion, MDCT with MPR images provides exact information for determining obstruction level as well as MRCP. The correct first-choice diagnoses were provided by MDCT with high diagnostic accuracy. MDCT can provide sufficient information on the level of biliary obstruction and cause of obstructive jaundice. MDCT is very useful to make a specific diagnosis especially for malignant tumor. We suggest that MDCT should be performed as the first imaging modality to evaluate obstructive jaundice. To confirm suspected radiolucent stone on MDCT, MRCP will be necessary.

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