Original Article

Investigation of the accuracy of magnetic resonance cholangiography and multi-slice spiral computed tomography in the diagnosis of cholangiocarcinoma

Cong Ke[#]^, Tianyou Yang[#], Gaofeng Huang, Chunwei Gu

Department of General Surgery, The Second Affiliated Hospital of Soochow University, Suzhou, China

Contributions: (I) Conception and design: C Ke, T Yang; (II) Administrative support: C Gu; (III) Provision of study materials or patients: C Ke; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: C Ke, T Yang, C Gu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work and should be considered as co-first authors.

Correspondence to: Chunwei Gu, MB. Department of General Surgery, The Second Affiliated Hospital of Soochow University, 1055 Sanxiang Rd., 215004 Suzhou, China. Email: guchunwei1968@suda.edu.cn.

Background: Cholangiocarcinoma (CCA) is a common malignant biliary tract tumor in clinical practice. The detection rate of multi-slice spiral computed tomography (MSCT) with a diameter of 10 mm is low, and it is easy to be misdiagnosed and missed. In addition, patients who are allergic to iodized contrast media are not eligible for MSCT screening. However, magnetic resonance cholangiopancreatography (MRCP) is non-invasive, does not require contrast injection, scans quickly, and is simple to perform. MRCP has good development rate and the ability to recognize human pancreas and biliary tract. MRCP is also non-invasive, does not require contrast injection, has fast scanning speed, and is easy to operate. In addition, MRCP has a good development rate and the ability to recognize human pancreas and biliary tract. Therefore, this study sought to analyze the accuracy of MRCP and MSCT in the diagnosis of CCA.

Methods: In this paper, 186 patients with highly suspected CCA admitted to the Second Affiliated Hospital of Soochow University from March 2020 to May 2022 were selected for MSCT and MRCP examination. We compared the diagnostic accuracy, sensitivity and specificity of MSCT and MRCP with pathological diagnosis and the detection rate of lesions with different diameters between MSCT and MRCP. Finally, the imaging features of MSCT and MRCP of CCA were analyzed.

Results: The results showed that (I) the diagnostic accuracy (95.70%), sensitivity (95.12%), and specificity (96.15%) of MRCP were higher than those of MSCT (69.89%, 60.98%, and 76.92%, respectively; $P<0.05$); (II) MSCT and MRCP were basically consistent with the datum (Kappa value =0.527, Kappa value =0.767, respectively); (III) the detection rate of lesions <0.5 cm in diameter of MRCP (32.05%) was higher than that of MSCT (14.00%; $P<0.05$); and (IV) the detection rates of lesions 0.5–1.0 cm (38.46%) and >1.0 cm (29.49%) in diameter of MRCP were lower those of MSCT (50.00%, and 36.00%, respectively; $P>0.05$).

Conclusions: MRCP can provide relevant imaging feature information, improve the accuracy, sensitivity and specificity of the diagnosis of bile duct carcinoma, and has a high detection rate for small diameter lesions, which has good reference, promotion and reference value.

Keywords: Magnetic resonance cholangiopancreatography (MRCP); cholangiocarcinoma (CCA); diagnostic performance; imaging features

Submitted Dec 20, 2022. Accepted for publication May 19, 2023. Published online Jun 05, 2023.
doi: 10.21037/jgo-22-1294
View this article at: https://dx.doi.org/10.21037/jgo-22-1294

^ ORCID: 0000-0001-9239-3400.

Introduction

Cholangiocarcinoma (CCA) is a common malignant biliary tract tumor in clinical practice, and is characterized by a high degree of malignancy, unknown etiology, insidious onset, difficult treatment, and poor prognosis (1). The incidence of CCA is higher in males than females (1). Early diagnosis and therapy are essential in reducing the mortality of patients and improving the foreknowledge of observers with CCA (2). Surgical pathological diagnosis is the benchmark for the clinical diagnosis of CCA; however, it has a number of shortcomings (e.g., it carries a high risk, the operation is complex, it causes significant trauma, has high costs, and no repeated examination), which are not easily accepted by patients and their families (3). In recent years, magnetic resonance cholangiopancreatography (MRCP) has become a popular examination technique, as it clearly shows the hilar obstruction, accurately evaluates the shape of the broken end, the site of the obstruction, and the extent of obstruction, and thus enables the qualitative diagnosis of lesions (4,5). Maurea *et al.* (6) confirmed the diagnostic potential of MRCP in the study of the pancreatic-bile duct system. In particular, MRCP has been compared with ultrasound and multi-slice spiral computed tomography (MSCT) (6). In the study of D'Antuono *et al.* (7) they found that magnetic resonance imaging (MRI) with MRCP represents a valid alternative to multidetector computed tomography (MDCT) for the diagnostic evaluation of patients with CCA to establish tumor respectability providing multiplanar scanning of high-contrast imaging quality; MDCT should be preferred in uncooperative patients, in the presence of biliary stents or when MRI is absolutely contraindicated for incompatible medical devices. In addition, the MSCT comprises 2 scans (i.e., a plain scan and an enhanced scan), and has a large scanning range, provides a multi-phase enhanced scan, enables rapid examinations, and can be used to perform thin layer reconstruction (8,9). However, for lesions <10 mm in diameter, the detection rate of MSCT is low, and it is prone to misdiagnosis and missed diagnosis (10,11). In addition, the MSCT is not suitable for patients who are allergic to iodine contrast media. Conversely, the MRCP is non-traumatic, does not require the injection of contrast media, and has a fast-scanning speed and a simple operation method (12,13). The MRCP has a good development rate and a good ability to identify the human pancreas and biliary tract. The natural fluid of the patient's pancreaticobile duct is used as a contrast agent in the examination process. Through special scanning and omnidirectional and multi-angle 3D image reconstruction, the structure, shape, scope of the obstruction site and the degree of bile duct dilation can be clearly displayed, which will not be affected by factors, such as the uneven distribution of contrast agents (14,15). To explore the accuracy of MRCP and MSCT in the diagnosis of CCA, this study examined 186 patients, who were highly suspected to have CCA and who had been admitted to the Second Affiliated Hospital of Soochow University from March 2020 to May 2022. We present this article in accordance with the STARD reporting checklist (available at https://jgo.amegroups.com/article/view/10.21037/jgo-22-1294/rc).

Highlight box

Key findings

- MRCP improved the diagnostic accuracy, sensitivity, and specificity of cholangiocarcinoma, and had a higher detection rate for lesions with smaller diameters.

What is known and what is new?

- Cholangiocarcinoma is a common malignant biliary tract tumor, and is characterized by a high degree of malignancy, unknown etiology, insidious onset, difficult treatment, and poor prognosis.
- Our study shows that MRCP improved the detection rate of small diameter lesions, which is related to the high resolution of MRCP and 3D image reconstruction.

What is the implication, and what should change now?

- Clinicians should comprehensively consider each patient's economic status and the costs of the examination and provide the best diagnostic technology for patients.
- Clinicians need to combine the results of other laboratory tests to make a comprehensive judgment about each patient's condition to reduce the rate of missed diagnosis and misdiagnosis as much as possible.

Methods

General information

Selection of research objects: A total of 186 patients with jaundice as the first symptom (106 males and 80 females), who were highly suspected to have CCA through computed tomography (CT) examination and who had been admitted to The Second Affiliated Hospital of Soochow University from March 2020 to May 2022 were included in this study. First, these 186 patients were examined by MSCT and MRCP. The MSCT examination was performed using the PHILIPS Ingenuity CT64 slice spiral CT. The MRCP examination was performed with the 1.5T superconducting MRI examination instrument. The patients had an average age of 57.62±6.04 years (range, 42–73 years), an average lesion diameter of 2.52±0.34 cm (range, 1.2–3.8 cm), and an average body mass index of 25.11±1.04 kg/m^2 (range, 22–29 kg/m^2). The study conformed to the provisions of the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of The Second Affiliated Hospital of Soochow University (No. JD-HG-2023-20). The patients have given their consent for publication.

To be eligible for inclusion in this study, the patients had to meet the following inclusion criteria: (I) present with different degrees of fever, abdominal discomfort, abdominal pain, fatigue, and other symptoms; (II) be a male or female aged >18 years; (III) have stable vital signs, clear consciousness, and be able to cooperate with the doctor to complete the examination; and (IV) voluntarily agree to participate in this study.

Patients were excluded from the study if they met any of the following exclusion criteria: (I) had a previous history of chemoradiotherapy or surgery; (II) were participating in other research at the same time; (III) were a pregnant or lactating female; (IV) had a systemic serious infectious disease; (V) had tuberculosis or another infectious disease; (VI) had a disease of the blood or endocrine system; (VII) had other malignant tumors; (VIII) had a 2-way affective disorder, manic disorder, or other mental disorder; (IX) had abnormal kidney or liver function; and/or (X) had a cardiovascular or cerebrovascular disease.

Study methods

Multi-slice spiral computed tomography (MSCT) examination

The MSCT examination was performed using the PHILIPS Ingenuity CT64 slice spiral CT (Manufacturer: Philips, Shanghai, China). Each patient was instructed to drink 500–800 mL of warm water 20 minutes before the examination to ensure the filling of the gastrointestinal tract. The patient then underwent respiratory function training. The following parameter settings were used: tube current: a 260 mA; tube voltage: 120 kV; pitch: 3 mm; and layer thickness: 7 mm. After the plain scan, 100 mL of iohexol contrast agent was in-flooded through the ulnar vein via a high-pressure injector at an injection rate of 3 mL/s. An arterial phase scan was then undertaken within 25–30 s of the injection. A portal vein scan was performed within 50–60 s. The delay period scan was conducted within 120–180 s. Finally, the obtained image was transferred to the workstation, and maximum intensity projection (MIP), volume reproduction (VR), and multi-plane reconstruction (MPR) were used for image processing.

MRCP

The MRCP examination was performed with the 1.5T superconducting MRI examination instrument (model: Signa; manufacturer: American GE Company, USA). Each patient was told to abstain from drinking water 8–12 hours before the test. The medical staff instructed the patient to take the supine position with the head first and breathe smoothly. The fat background interference signals were removed using a fat suppression sequence, and 3-dimensional (3D) thin-layer scanning was performed using Fast recovery fast spin echo (FRFSE) with a relaxation time: re-T2-weighted single-shot fast spin aftersound sequence. The following parameter settings were used: matrix: 320×224; single layer thickness: 2.0 mm; field of vision: 380 mm; time of echo (TE): 4,000–10,000 ms; layers: 256; and time of repetition (TR): 400–800 ms. The obtained image was transferred to the workstation for MRI (MIP) reconstruction, and the coronal image was obtained by rotating the angle.

The CT and magnetic resonance imaging-diffusion weighted imaging (MRI-DWI) examinations of all the patients were performed by the same 2 radiologists, and the results were reviewed using the double-blind method. If there was any objection to the results, a 3rd radiologist was involved in the discussion to determine the final diagnosis. *Figure 1* shows the examination results of 2 women of different ages.

Observation indicators

The surgical pathological diagnosis results were taken as the benchmark for this study. The surgical pathological diagnosis used as benchmark for each patient. First, we compared the diagnostic accuracy, sensitivity, and specificity of MSCT and MRCP to those of the pathological diagnosis. Second, we compared the detection rates of lesions <0.5, 0.5–1.0, and >1.0 cm in diameter between MSCT and MRCP. Third, we analyzed the imaging features of CCA using the MSCT and MRCP. The following formulas were used:

Accuracy = (true negative + true positive)/(true negative + false negative + true positive + false positive) × 100.00%; Sensitivity = true positive/(false negative + true positive) ×

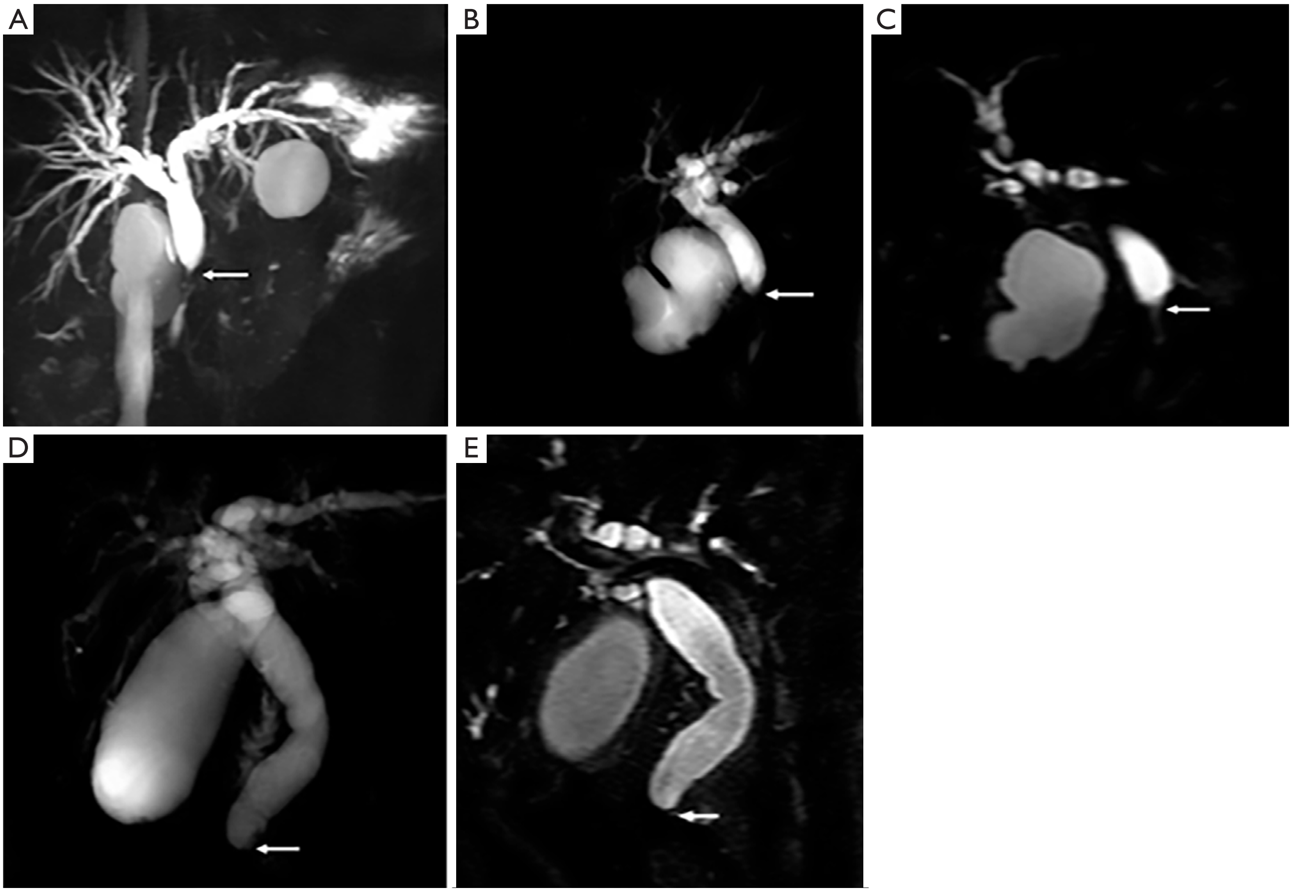

Figure 1 The examination results of 2 women of different ages. (A-C) The patient was a 70-year-old female. The arrows indicate the site of the tumor. The bile duct above was dilated. Pathological diagnosis: moderate-poorly differentiated cholangiocarcinoma. The type of tumor in terms of anatomic site is inter-hepatic. Tumor morphology is mass-like. (D,E) The patient was a 58-year-old female. The arrows indicate the site of the tumor with marked dilatation of the upper bile duct. Pathological diagnosis: moderate-poorly differentiated cholangiocarcinoma. The type of tumor in terms of anatomic site is extra-hepatic. Tumor morphology is nodular.

100.00%; Specificity = true negative/(false positive + true negative) × 100.00%.

Statistical methods

SPSS26.0 software was used for the data processing. For the normally distributed measurement data, a *t*-test was used, and the results are expressed as the $\bar{x} \pm s$. For the enumeration data, the χ^2 test was used, and the results are expressed as the [n/(%)]. The consistency of the MSCT, MRCP, and measurement criteria was tested by the Kappa test. A Kappa value ≥0.75 indicated good consistency; a 0.4≤ Kappa value <0.75 indicated normal consistency; a Kappa value <0.4 indicated poor consistency. A P value <0.05 indicated a statistically significant difference.

Results

Comparison of the diagnostic efficacy of MSCT and MRCP

As *Tables 1-3* show, the diagnostic accuracy (95.70%), sensitivity (95.12%), and specificity (96.15%) of MRCP were higher than those of MSCT (69.89%, 60.98%, and 76.92%, respectively; P<0.05). MSCT was in general agreement with the benchmark (Kappa value =0.527). MRCP was consistent with the benchmark (Kappa value =0.767).

Comparison of the detection rates of lesions with different diameters by MSCT and MRCP

As *Table 4* shows, the detection rate of lesions <0.5 cm in diameter of MRCP (32.05%) was higher than that of

Table 1 Diagnostic results for MSCT

Benchmark	MSCT diagnosis		Total	Kappa value	P
	Positive	Negative			
Positive	50	32	82	0.527	0.029
Negative	24	80	104		
Total	74	112	186		

MSCT, multi-slice spiral computed tomography.

Table 2 Diagnostic results for MRCP

Benchmark	MRCP diagnoses		Total	Kappa value	P
	Positive	Negative			
Positive	78	4	82	0.767	0.000
Negative	4	100	104		
Total	82	104	186		

MRCP, magnetic resonance cholangiopancreatography.

Table 3 Comparison of diagnostic efficacy of MSCT and MRCP

Group	Accuracy (%, n/N)	Sensitivity (%, n/N)	Specificity (%, n/N)
MRCP	95.70 (178/186)	95.12 (78/82)	96.15 (100/104)
MSCT	69.89 (130/186)	60.98 (50/82)	76.92 (80/104)
χ^2	43.481	27.903	16.508
P	0.000	0.000	0.000

MSCT, multi-slice spiral computed tomography; MRCP, magnetic resonance cholangiopancreatography.

MSCT (14.00%), and the P value was <0.05. The detection rate of MRCP for lesions 0.5–1.0 cm (38.46%) and >1.0 cm (29.49%) in diameter was lower than that of MSCT (50.00%, 36.00%, respectively), and the P value was >0.05.

MSCT and MRCP imaging features of CCA

A detailed description of the MSCT and MRCP imaging features of CCA is provided in *Table 5*.

Discussion

Human immunodeficiency virus infection, bile duct stones, primary sclerosing cholangitis, bile duct cystic dilatation, diabetes mellitus, alcoholism, and smoking are all risk factors for CCA (16,17). The incidence of CCA is high in people aged 50–70 years (16,17). The clinical symptoms of patients with CCA at the initial stage are not typical. As the disease progresses, the clinical symptoms include jaundice, upper abdominal pain, and other symptoms that can easily be ignored by patients. Most patients are at the advanced stage at the time of diagnosis, and may suffer from complications, such as shock, hepatorenal syndrome, and malignant obstructive jaundice, and thus the best opportunity for treatment is often missed (18,19). Regulation and functional models of FOSL1 in CCA were observed in the study of Vallejo *et al.* (18). At present, the "early diagnosis and early treatment" principle is followed in clinical practice to manage malignant tumors (20). *Figure 2* shows a flow chart of treatment management and alternative therapy for hepatocellular CCA (21). Our study wants to find an accurate, reliable, sensitive, and simple diagnostic method to improve the diagnostic accuracy of CCA.

Table 4 Comparison of the detection rates of lesions with different diameters by MSCT and MRCP

Group	<0.5 cm, n (%)	0.5–1.0 cm, n (%)	>1.0 cm, n (%)
MRCP (n=78)	25 (32.05)	30 (38.46)	23 (29.49)
MSCT (n=50)	7 (14.00)	25 (50.00)	18 (36.00)
χ^2	5.295	1.655	0.594
P	0.021	0.198	0.441

MSCT, multi-slice spiral computed tomography; MRCP, magnetic resonance cholangiopancreatography.

In the past, percutaneous cholangiography and B-ultrasound were used to diagnose CCA. Percutaneous cholangiography clearly shows the obstruction site and morphology of the bile duct; however, it has low acceptance among patients, as somewhat traumatic complications, such as bleeding and biliary fistula, are easily caused by this procedure (21,22). A B-ultrasound is non-invasive, inexpensive, and does not use radiation; however, it has low diagnostic accuracy and thus is mainly used in the diagnosis of biliary obstruction and bile duct dilatation and cannot meet the diagnostic needs of CCA (23,24).

The present study showed that the diagnostic accuracy (95.70%), sensitivity (95.12%), and specificity (96.15%) of MRCP were higher than those of MSCT (69.89%, 60.98%,

Table 5 MSCT and MRCP imaging features of cholangiocarcinoma

Group	Imaging features
MSCT	When using planar scanning, low-density masses with uneven and unclear edges were observed; punctate or patchy high-density shadows were observed in some lesions. After contrast-enhanced scans, delayed enhancement and irregular and localized stenosis of the hilar bile duct were observed
MRCP	The bile duct was disorderly and stenosis was rigid; that is, the small bile duct was dilated, and displayed the rattan style; there was also a truncated obstruction, irregular stenosis, and eccentric stenosis; there was a slightly high signal on T2WI and a slightly low signal on T1WI, and the bile duct wall displayed irregular thickening

MSCT, multi-slice spiral computed tomography; MRCP, magnetic resonance cholangiopancreatography; T2WI, T2-weighted imaging; T1WI, T1-weighted imaging.

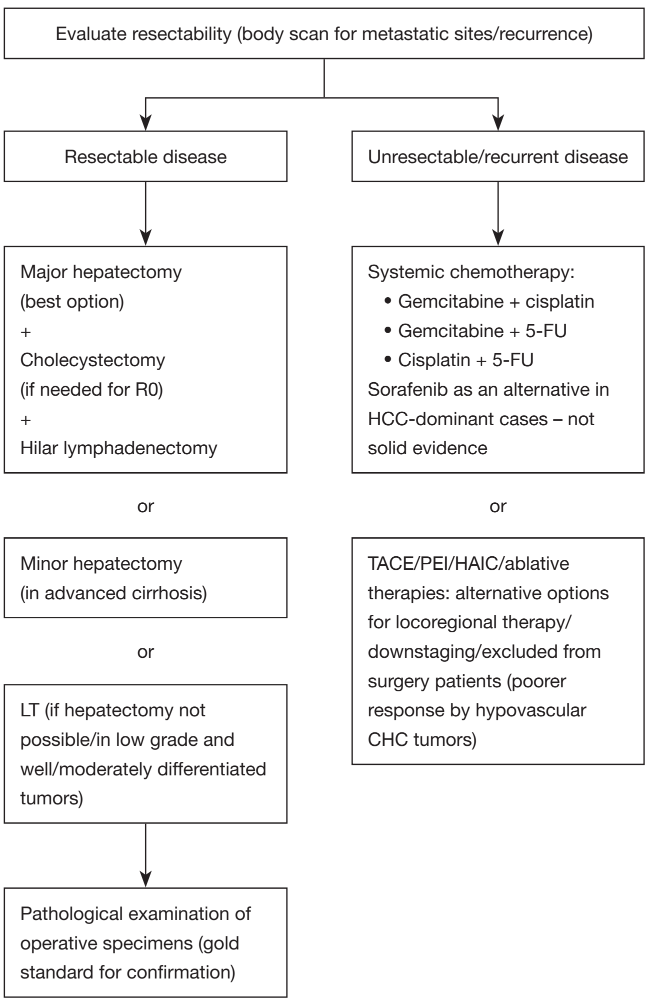

Figure 2 Therapeutic management and alternative treatments for combined hepatocellular cholangiocarcinoma. LT, liver transplantation; HCC, hepatocellular carcinoma; TACE, transarterial chemoembolization; PEI, percutaneous ethanol injection; HAIC, hepatic arterial infusion chemotherapy; CHC, combined hepatocellular-cholangiocarcinoma.

and 76.92%, respectively; P<0.05). According to the previous study, Varghese *et al.* (25) reported high levels of sensitivity (91%), specificity (98%) and diagnostic accuracy (97%) for MRCP. Our results for sensitivity and diagnostic accuracy are slightly higher than those of previous study. Zhang *et al.* (26) found that the sensitivity and specificity of MRCP in the differential diagnosis of gallbladder lesions were 92% and 93%, respectively, which are close to the findings of this study and confirm the high clinical method efficiency of MRCP. This study showed that the detection rate of lesions <0.5 cm in diameter by MRCP (32.05%) was higher than that by MSCT (14.00%; P<0.05). Thus, the MRCP improved the detection rate of small diameter lesions, which is related to the high resolution of MRCP and 3D image reconstruction. In the study of D'Antuono *et al.* (7), they also confirmed that MRI with MRCP imaging represents a valuable alternative to MDCT in the diagnostic assessment of patients with CCA as it provides accurate identification and characterization of tumor lesions as well as appropriate judgement of tumor respectability.

The MRCP examination also has some shortcomings; for example, it is easily affected by volume and other factors, and the specific details of abnormal lumen masses cannot be displayed (27,28). This may be the reason why 4 cases were missed in MRCP examinations in this study. The main disadvantages of the MRCP are as follows: (I) its diagnostic costs are higher than those of MSCT; and (II) some patients and families cannot afford it. Thus, in the specific diagnosis process, clinicians should comprehensively consider each patient's economic status and the costs of the examination and provide the best diagnostic technology for patients. Clinicians also need to combine the results of other laboratory tests to make a comprehensive judgment about each patient's condition to reduce the rate of missed diagnosis and misdiagnosis as much as possible.

Conclusions

In conclusion, the MRCP had better diagnostic accuracy, sensitivity, and specificity than the MSCT in the diagnosis of CCA. The MRCP also provided relevant imaging feature information, which has good reference, promotion, and reference value. The MRCP examinations should be considered to maximize the diagnostic accuracy of CCA when patients are not limited by economic constraints.

Acknowledgments

Funding: This paper was supported by The Second Affiliated Hospital of Soochow University Young Staff Pre-research-Basic Research Special Project (No. SDFEYJC2112) and Suzhou High-tech Zone Medical and Health Science and Technology Plan Project (No. 2019Z016).

Footnote

Reporting Checklist: The authors have completed the STARD reporting checklist. Available at https://jgo.amegroups.com/article/view/10.21037/jgo-22-1294/rc

Data Sharing Statement: Available at https://jgo.amegroups.com/article/view/10.21037/jgo-22-1294/dss

Peer Review File: Available at https://jgo.amegroups.com/article/view/10.21037/jgo-22-1294/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jgo.amegroups.com/article/view/10.21037/jgo-22-1294/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study conformed to the provisions of the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of The Second Affiliated Hospital of Soochow University (No. JD-HG-2023-20). The patients have given their consent for publication.

References

1. Baiocchi L, Sato K, Ekser B, et al. Cholangiocarcinoma: bridging the translational gap from preclinical to clinical development and implications for future therapy. Expert Opin Investig Drugs 2021;30:365-75.
2. Beaufrère A, Calderaro J, Paradis V. Combined hepatocellular-cholangiocarcinoma: An update. J Hepatol 2021;74:1212-24.
3. Charalampakis N, Papageorgiou G, Tsakatikas S, et al. Immunotherapy for cholangiocarcinoma: a 2021 update. Immunotherapy 2021;13:1113-34.
4. Liu Y, Liu C, Liu C, et al. Comparison of 3.0T and 1.5T magnetic resonance cholangiopancreatography (MRCP) in the diagnosis of cholangiopancreatcreatosis. Chinese Journal of Experimental Diagnostics 2021;25:1027-9.
5. Cao M, Gao S. Diagnostic value of endoscopic ultrasound for choledocholithiasis with negative magnetic resonance cholangiopancreatography. J Clinical Gastroenterology 2020;32:146-51.
6. Maurea S, Caleo O, Mollica C, et al. Comparative diagnostic evaluation with MR cholangiopancreatography, ultrasonography and CT in patients with pancreatobiliary disease. Radiol Med 2009;114:390-402.
7. D'Antuono F, De Luca S, Mainenti PP, et al. Comparison Between Multidetector CT and High-Field 3T MR Imaging in Diagnostic and Tumour Extension Evaluation of Patients with Cholangiocarcinoma. J Gastrointest Cancer 2020;51:534-44.
8. Prommajun P, Phetcharaburanin J, Namwat N, et al. Metabolic Profiling of Praziquantel-mediated Prevention of Opisthorchis viverrini-induced Cholangiocyte Transformation in the Hamster Model of Cholangiocarcinoma. Cancer Genomics Proteomics 2021;18:29-42.
9. Heng H, Ding X, Chen G, et al. CT and MRI imaging characteristics of mass intrahepatic cholangiocarcinoma. Chongqing Medical 2020;49:1316-9.
10. Li Z, Wang X, Han W, et al. Application value of MSCT combined with CAl99, ALP, GGT and CRP in the diagnosis of cholangiocarcinoma. Journal of Medical

Imaging 2020;30:239-241,295.
11. Zhang H, He Y. Diagnostic value of CT and magnetic resonance imaging in cholangiocarcinoma. Shanxi Medical Journal 2020;49:410-1.
12. Li X, Zhu Y, Jin D, et al. Comparison of single-breath hold and breath-triggered 3D fast spin echo sequence in MR Cholangiopancreatography. Journal of Practical Radiology 2021;37:1013-6.
13. Wei Z, Song Y, Han H, et al. Comparative analysis of breath-hold 3D gradient-spin echo and respiratory gated triggered 3D fast spin echo MR Cholangiopancreatography. Chinese Journal of Medical Imaging Technology 2020,36:1234-8.
14. Wang Y, Lu T, Zhang T, et al. Comparison of 3D-SPACE-MRCP and 2D-HAster-MRCP in magnetic resonance cholangiopancreatography. Journal of Clinical Radiology 2021;40:1413-6.
15. Fung BM, Tabibian JH. Primary sclerosing cholangitis-associated cholangiocarcinoma: special considerations and best practices. Expert Rev Gastroenterol Hepatol 2021;15:487-96.
16. Moazzami B, Majidzadeh-A K, Dooghaie-Moghadam A, et al. Cholangiocarcinoma: State of the Art. J Gastrointest Cancer 2020;51:774-81.
17. Louis C, Papoutsoglou P, Coulouarn C. Molecular classification of cholangiocarcinoma. Curr Opin Gastroenterol 2020;36:57-62.
18. Vallejo A, Erice O, Entrialgo-Cadierno R, et al. FOSL1 promotes cholangiocarcinoma via transcriptional effectors that could be therapeutically targeted. J Hepatol 2021;75:363-76.
19. Osataphan S, Mahankasuwan T, Saengboonmee C. Obesity and cholangiocarcinoma: A review of epidemiological and molecular associations. J Hepatobiliary Pancreat Sci 2021;28:1047-59.
20. Schizas D, Mastoraki A, Routsi E, et al. Combined hepatocellular-cholangiocarcinoma: An update on epidemiology, classification, diagnosis and management. Hepatobiliary Pancreat Dis Int 2020;19:515-23.
21. Meng F. Effect of endoscopic retrograde cholangiopancreatography biliary stent implantation and real-time ultrasound-guided percutaneous liver puncture biliary drainage in the treatment of malignant obstructive jaundice. Journal of Practical Clinical Medicine 2020;24:63-7.
22. Wa Z, Du T, Xu H, et al. Differential diagnosis of hepatic alveolar echinococcosis and intrahepatic cholangiocarcinoma by conventional ultrasonography and contrast-enhanced ultrasonography. The Liver 2022;27:547-549,560.
23. Chen J, He N, Fang J, et al. Diagnosis of intrahepatic cholangiocarcinoma by conventional ultrasonography and contrast-enhanced ultrasound. Journal of Practical Liver Disease 2021;24:272-5.
24. Wu H, He N, Xie L, et al. Contrast-enhanced ultrasound combined with serum CA19-9 in the differential diagnosis of cholangiocarcinoma and hepatocellular carcinoma. Journal of Practical Hepatology 2021;24:903-6.
25. Varghese JC, Liddell RP, Farrell MA, et al. Diagnostic accuracy of magnetic resonance cholangiopancreatography and ultrasound compared with direct cholangiography in the detection of choledocholithiasis. Clin Radiol 2000;55:25-35.
26. Zhang H, Shi X, Jiang Z, et al. Value of 1.5T magnetic resonance imaging combined with MRCP in differential diagnosis of gallbladder lesions. J Hepatobiliary Surgery 2021;29:292-6.
27. Fu Y, Han W, Xiang F, et al. Diagnostic value of MSCT and magnetic resonance MRCP in common bile duct stones. Chinese Journal of CT and MRI 222;20:119-21.
28. Liu J, Lv S, Huang M, et al. Application value of conventional MRI, DWI and MRCP in the diagnosis of common bile duct sediment stones. Journal of Clinical Radiology 2021;40:2144-7.

(English Language Editor: L. Huleatt)

Cite this article as: Ke C, Yang T, Huang G, Gu C. Investigation of the accuracy of magnetic resonance cholangiography and multi-slice spiral computed tomography in the diagnosis of cholangiocarcinoma. J Gastrointest Oncol 2023;14(3):1496-1503. doi: 10.21037/jgo-22-1294