Preoperative Radiologic Evaluation of Cholangiocarcinoma

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In patients with cholangiocarcinoma, surgical resection with curative intent is the only way to achieve cure. Since surgical resection of cholangiocarcinomas is technically demanding, determination of resectability and accurate preoperative staging are crucial. For these purposes, high quality imaging including multidetector computed tomography and magnetic resonance imaging with magnetic resonance cholangiopancreatography, is mandatory. This article will present recent advances in imaging techniques for cholangiocarcinomas, potential pitfalls in imaging evaluation, and a checklist for preoperative radiologic assessment of resectability in these patients with an emphasis on perihilar cholangiocarcinoma. (Korean J Gastroenterol 2017;69:159-163)

Key Words: Cholangiocarcinoma; Multidetector-row computed tomography; Magnetic resonance imaging; Imaging, diagnostic; Neoplasm staging

INTRODUCTION

Cholangiocarcinoma (CCA) is an epithelial cell malignancy arising from varying locations within the biliary tree showing markers of cholangiocyte differentiation. Most CCAs are adenocarcinomas which tend to develop desmoplastic reactions and early perineural invasion. CCA can be classified according to its morphology and anatomic location. Based on its anatomic location, CCA is classified as intrahepatic CCA (iCCA), perihilar CCA (pCCA), and distal CCA (dCCA). CCA exhibits three growth patterns: mass-forming (MF), periductal infiltrating (IF), and intraductal growing. The MF type is the most common form of iCCA, representing 86% of them, while the majority of pCCA and dCCA is the periductal IF type. This classification can be helpful in determining treatment options and optimal imaging modalities. iCCA frequently requires hemihepatectomy or sectionectomy for resection of the tumors, whereas dCCA is treated with Whipple’s operation or pylorus preserving pancreatoduodenectomy. For pCCA, resection of the involved intrahepatic and extrahepatic bile ducts as well as the ipsilateral liver is the standard surgical treatment. In addition, different macroscopic growth patterns can be associated with the mode of spread, which should be considered during preoperative evaluation. Submucosal extension is commonly seen in IF type CCA, while mucosal spread frequently occurs in intraductal growing type CCA.

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with CCA, high quality imaging modalities are prerequisites for the determination of resectability and accurate preoperative staging. Thus, this review will present recent advances in imaging techniques for CCAs considering locations and growth patterns of CCA, potential pitfalls in preoperative evaluation, and a checklist for preoperative radiologic assessment of resectability with a special emphasis on pCCA.

Imaging modalities and their performances

Multidetector computed tomography (MDCT) is the imaging modality of choice for the evaluation and staging of CCA owing to its wide availability and high spatial and temporal resolution, which allow detailed evaluation of tumor extent and the relationship between important structures such as hepatic vessels and liver parenchyma as well as a review of the entire abdomen for distant metastasis. Noncontrast and multiphase MDCT images including the arterial and portal phases, are necessary for patients with CCA. Computed tomography (CT) arteriography and CT venography images reconstructed with variable techniques including multiplanar reformatted images, maximum intensity projection images or volume rendering images help surgeons understand vascular anatomy and plan surgery with a reduced risk of complications (Fig. 1). According to a recent meta-analysis, the accuracy of ductal involvement of MDCT was 86%, while MDCT significantly underestimates longitudinal extent. It showed 84% sensitivity and 93% specificity to detect hepatic arterial involvement. The accuracy for detection of portal vein has been reported as 87%. Regarding lymph node metastasis, the sensitivity was 61% and the specificity was 88%.

As recent advances in abdominal magnetic resonance (MR) imaging, MR imaging with MR cholangiography also became an important imaging modality for patients with CCA.
The imaging protocol typically includes MR cholangiography, conventional T1- and T2-weighted abdominal MR imaging sequences, diffusion-weighted imaging and dynamic contrast-enhanced imaging. Especially, MR imaging with MR cholangiography is better than CT in assessing intraductal lesions. Standard MR cholangiography protocols generally consist of two-dimensional (2D) MR cholangiography and three-dimensional (3D) MR cholangiography that provide complementary information. 2D thick slab MR cholangiography can provide an overview of the biliary system, while 3D MR cholangiography techniques over 2D has the capacity for use of thinner sections without interslice gaps and for various postprocessing manipulation including multiplanar reformatted images, maximum intensity projection images or volume rendering. Thus, 3D MR cholangiography is advantageous in detecting small intraductal lesions and minor ductal strictures. Even though typical T2-weighted MR cholangiography sequences have long echo time typically more than 600 msec, the thin-section multisection sequence with a single-shot, moderately T2-weighted rapid acquisition with relaxation enhancement sequence (echo time ≤180 msec) in contiguous 2-5 mm sections enables visualization of periductal ductal anatomy. MR imaging was reported to have an accuracy from 71% to 80% in predicting the extent of bile duct involvement, while MR still understage longitudinal tumor extent. It should be noted that MR imaging has 58-73% sensitivity and 93% specificity for diagnosing hepatic arterial invasion and 78% sensitivity and 91% specificity for portal vein invasion. As for determining metastatic lymph nodes, MR imaging showed accuracy of 66%. Diffusion-weighted imaging is a valuable addition to conventional MR sequences for the capacity to better detect hepatic lesions as well as bile duct lesions. For MFCCA or iCCA, gadoxetic acid-enhanced MR imaging appears to be helpful in detecting satellite lesions with better lesion conspicuity during the hepatobiliary phase. However, in cases of pCCA and dCCA, extracellular contrast agents are preferred as a MR contrast agent, as gadoxetic acid-enhanced MR imaging hardly provides satisfactory hepatobiliary phase images, when biliary obstruction is present. In addition, ga-

**Fig. 2.** Effects of biliary stent in a patient with CCA. (A) Coronal reformatted contrast-enhanced CT image demonstrates the distal CCA (arrows). (B) The longitudinal tumor extent is difficult to determine in CT after biliary stent insertion. (C) On contrast enhanced coronal MR images, there is a diffuse bile duct wall thickening at the entire bile duct (arrows) due to postinverventional inflammatory changes which may cause overstaging of disease extent. CCA, cholangiocarcinoma; CT, computed tomography; MR, magnetic resonance.
doxetic acid has some limitation in arterial phase imaging due to weaker enhancement and transient respiratory motion, which can possibly present poor quality arterial phase images.\textsuperscript{26,27}

Of note, imaging studies are supposed to be obtained before biliary drainage, as the lesion can be obscured by the inserted drainage catheter. Moreover, biliary stent insertion can cause mural thickening and enhancement mimicking the tumor spread due to postinterventional inflammatory changes, which may cause overstaging of disease extent particularly on MR imaging.\textsuperscript{15,28} If imaging is performed after biliary drainage, radiologists should be careful not to overestimate the tumor extent (Fig. 2).

Biliary obstruction is frequently present in patients with pCCA or dCCA.\textsuperscript{29} In this circumstance, liver abscesses can develop manifesting as peripheral enhancing lesions in the liver, which resembles the appearances of intrahepatic metastases. Even though some previous work suggested imaging features on MR imaging differentiating hepatic abscesses from metastases,\textsuperscript{30} it is challenging to distinguish these two conditions particularly when the lesions are small. In some confusing cases, follow-up imaging after biliary drainage could be a solution.

**Staging systems and resectability for pCCA**

The surgical resection of pCCA is technically demanding, and various staging system for preoperative staging have been propounded over the decades. The modified Bismuth-Corlette system is commonly used to describe the proximal tumor extent.\textsuperscript{31} However, there are limitations in determining resectability of pCCA based on the modified Bismuth-Corlette system, as it does not describe the lateral extension of the tumor nor consider variation in biliary anatomy. The Blumgart group at the Memorial Sloan-Kettering Cancer Center suggested a system to describe not only the proximal tumor extent, but also portal venous invasion and hepatic lobar atrophy which are important factors in determining resectability.\textsuperscript{32} However, this system does not evaluate the presence of nodal or distant metastases. Recently, a new system reporting the size of the tumor, the extent of the disease in the biliary system, the involvement of the hepatic artery and portal vein, the involvement of lymph nodes, distant metastases, and the volume of the putative remnant liver after resection, was proposed.\textsuperscript{33} To test the validity and further refinement of this system, further study is warranted.

The standard of treatment for surgical candidate with pCCA is resection of the involved intrahepatic and extrahepatic bile ducts as well as the ipsilateral liver.\textsuperscript{5} Thus, any of the following criteria generally categorize pCCA as unresectable: (i) bilateral segmental ductal extension; (ii) unilateral atrophy with either contralateral segmental ductal or vascular inflow involvement, and (iii) unilateral segmental ductal extension with contralateral vascular inflow involvement, although some surgeons may try to resect vascular involvement and perform vascular reconstruction.\textsuperscript{5}

With these criteria in mind, radiologic reports in preoperative assessment of pCCA should include the following items: longitudinal and radial tumor spread; vascular involvement; lymph node involvement; distant metastases; liver volume; anatomic variation of biliary, arterial, and portal vein anomalies.\textsuperscript{15} In contrast to pancreas cancer which has a definition for vascular involvement including “abutment” and “encasement”, the definition for vascular involvement in pCCA is not clearly set. Therefore, descriptive language should be used in the radiologic reports when describing vascular involvement. Useful descriptors for this purpose can be the presence of a fat plane between the vessels and tumor, abutment, an estimate of degrees of encasement, occlusion, stenosis, and contour deformity.\textsuperscript{34}

**CONCLUSION**

Because the only curative treatment of CCA is resection, preoperative evaluation of CCA requires attention to tailored MDCT and MR imaging protocols and the thoughtful interpretation of imaging features to provide key features guiding therapy.

**REFERENCES**


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