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Respiratory variation of the extrahepatic bile duct: evaluation with deep inspiratory and expiratory MRCP

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Abstract

Purpose: The purpose of the study was to evaluate the respiratory variation of the extrahepatic bile duct in morphology including shape, length and duct diameter on the breath-hold magnetic resonance cholangiopancreatography (MRCP) obtained during deep inspiration and deep expiration in patients with or without biliary diseases.
Materials and Methods: This study included 102 patients with or without biliary diseases. Breath-hold MRCP was obtained twice during the end-inspiration and the end-expiration. MRCP images were evaluated for the length, maximal diameter and "bowing" of the extrahepatic bile duct.
Results: In the normal group, the mean maximal diameter of the extrahepatic bile duct was significantly larger on the end-inspiratory MRCP (8.0±2.0 mm) than on the end-expiratory MRCP (7.3±1.8 mm) ($P<.0001$), while it was not significantly different in the dilated group. In the normal group, 25 (39%) of 65 patients had an increase in the mean maximal diameter of more than 1 mm at the end-inspiration, whereas 4 (11%) of 37 patients in the dilated group had it. The bowing of the extrahepatic bile duct on the end-inspiratory MRCP was observed in 60 (92%) of 65 normal patients, while it was seen in 22 (60%) of 37 patients with biliary dilatation ($P<.0001$).
Conclusion: Deep inspiratory and expiratory MRCP demonstrated the respiratory variations of the extrahepatic bile duct in the shape (bowing), length and maximal duct diameter in patients with nondilated bile ducts. Awareness of this normal phenomenon will be important for the correct interpretation of MRCP in patients with or without biliary diseases.

Keywords: Bile duct; MRCP; Respiration; Biliary dilatation

1. Introduction

The extrahepatic bile duct is originated from the liver superiorly, coursing downward, and attached to the pancreas inferiorly. Diaphragmatic descent during deep inspiration causes more displacement of the liver as the intraperitoneal organ than of the pancreas as the retroperitoneal organ, causing morphologic changes of the extrahepatic bile duct during deep respiration. However, respiratory changes in morphology of the extrahepatic bile duct have not been fully investigated. One previous study demonstrated that maximal common bile duct diameter measured with ultrasonography can increase during deep inspiration [1]. However, ultrasonography cannot show the whole extrahepatic bile duct well on a single section, disenabling the evaluation of changes of the extrahepatic bile duct in shape and length during deep respiration [2,3]. Magnetic resonance cholangiopancreatography (MRCP) is a noninvasive modality for examining the bile duct system in patients with biliary diseases. On MRCP images obtained with breath-hold techniques, the normal and abnormal extrahepatic bile duct can be visualized routinely throughout its entire course [4–8]. The purpose of this study was to evaluate the respiratory variation of the extrahepatic bile duct in morphology including shape, length and duct diameter on breath-hold MRCP obtained during deep inspiration and deep expiration in patients with or without biliary diseases.

2. Materials and methods

2.1. Patient population

Approval for this retrospective study was obtained from our institutional review board, which waived the

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requirement for informed consent from individual patients. Based on MR records from our institution, we searched patients with suspected pancreaticobiliary diseases who underwent end-inspiratory and end-expiratory MRCP obtained during a breath-hold as a part of our pancreaticobiliary MR examination, and identified 120 patients who satisfied the inclusion criteria for this study. Among these, 18 patients were excluded from this study because the entire course of the extrahepatic bile duct was unclear due to motion artifacts, overlap of intraduodenal fluid or tumor involvement at MRCP. As a result, a total of 102 patients (45 women, 57 men; age range 26–82 years; mean age, 63.5 years) were included in this study. Reasons for patient referral for MR imaging included further evaluation of biliary abnormalities detected by ultrasonography and/or computed tomography (n=50; gallstone=19, bile duct cancer=7, adenomyomatosis=7, benign biliary stricture=8, common bile duct stone=4, cholangitis=1, gallbladder cancer=2, GB polyp=1, cholecystitis=1); suspicion of pancreatic lesions (n=20), pancreatitis (n=9) or ampullary cancer (n=2); elevated serum alkaline phosphatase level (n=14) or epigastralgia (n=7).

2.2. MR imaging techniques

MR imaging was performed with a 1.5-T system (Magnetom Vision; Siemens Medical System, Erlangen, Germany) using a phased-array torso coil. As a part of pancreaticobiliary MR examination, breath-hold MRCP was obtained twice during the end-inspiration and the end-expiration using a two-dimensional single-shot fast spin-echo thin-section sequence in the coronal plane. The parameters were as follows: repetition time =infinite, echo time=95 ms, echo train length=120, echo spacing time=11.9 ms, field of view=280 mm, matrix=240×256, one acquisition. Chemical selective fat suppression was applied. Eleven sequential sections of 4-mm thicknesses were acquired during a single breathhold (acquisition time, 22 s). Then, maximal intensity projection images were reconstructed with the MR console. At first, the patient was instructed to take a deep breath and suspend respiration, and end-inspiratory MRCP was obtained. Subsequently, the patient was instructed to completely exhale and suspend respiration, and end-expiratory MRCP was obtained using a same technique. The patients were asked to fast for at least 8 h before examination.

2.3. Imaging interpretation

All examinations were reviewed retrospectively by two radiologists (A.S. and K.I.) experienced in abdominal MR imaging (15 and 18 years) and without knowledge of the final diagnosis on a clinical workstation (imageVINS, Yokogawa Electric Corporation, Tokyo). The images were magnified, and electronic calipers were used for measurements. All measurements and image evaluations were performed by both radiologists in consensus. MRCP images were evaluated for (1) the length of the extrahepatic bile duct between the bifurcation of the left and right hepatic duct and the end at the papilla of Vater, (2) the maximal diameter of the extrahepatic bile duct and (3) the presence and its grade (3-point scale; 1=mild, 2=moderate, 3=severe) of "bowing" of the extrahepatic bile duct during deep inspiration. The maximal diameter was measured at the widest portion of the common bile duct perpendicular to its long axis. Bowing of the extrahepatic bile duct was defined as a laterally convex configuration of the extrahepatic bile duct on end-inspiratory MRCP, compared with the appearance of the extrahepatic bile duct on end-expiratory MRCP (Fig. 1). MRCP findings and measurements were compared between inspiratory and expiratory MRCP.

Statistical analysis was performed by using paired Student's t test for the comparison between inspiratory and expiratory MRCP. For the prevalence of "bowing" and inspiratory increase in the mean maximal diameter of the extrahepatic bile duct, χ^2 test was used. A value of $P<.05$ was considered significant.

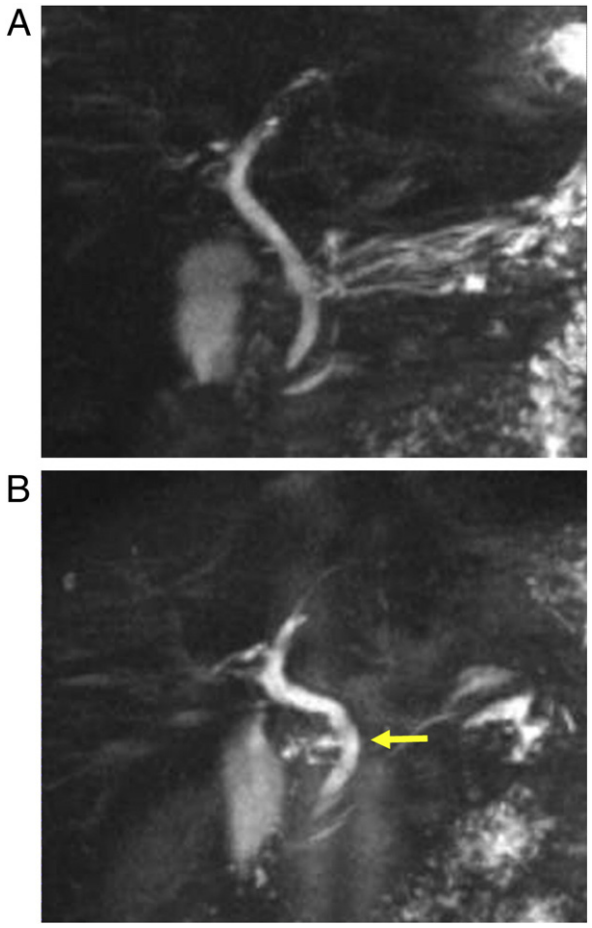

Fig. 1. Deep respiratory MRCP obtained in a patient without biliary dilatation. (A) Breath-hold MRCP obtained during the end-expiration shows the overview of the normal extrahepatic bile duct. (B) Breath-hold MRCP obtained during the end-inspiration demonstrates the "bowing" and shortening of the extrahepatic bile duct (arrow).