BRIEF COMMUNICATION

Gut and Liver, Vol. 9, No. 4, July 2015, pp. 561-565

Role of Balloon-Sheathed Intraductal Ultrasonography for Patients with Extensive Pneumobilia

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Intraductal ultrasonography (IDUS) is one of the most useful diagnostic tools for various extrahepatic biliary diseases. However, conventional IDUS has some limitations in providing accurate cross-sectional imaging of the bile duct in patients with extensive pneumobilia. Using a balloon-sheathed catheter, the US system (balloon-sheathed IDUS) can overcome these limitations. Sixteen patients underwent balloon-sheathed IDUS during endoscopic retrograde cholangiography. The balloon-sheathed IDUS was inserted via a transpapillary route when visualization of the bile duct with conventional IDUS was distorted by extensive pneumobilia. The patient group had a mean age of 65.5 years, and 56.3% (9/16) were male. The balloon-sheathed IDUS permitted successful visualization of the bile duct in all patients, regardless of the extent of pneumobilia. Using this system, remnant common bile duct stones were detected in five patients (31.3%), and cholangiocarcinoma was detected in one patient (6.3%). The balloon-sheath IDUS aided in stone sweeping. No significant complications, including bleeding, perforation, or pancreatitis, occurred in any of the patients. The balloon-sheathed catheter US system was useful and safe for biliary IDUS in patients with extensive pneumobilia. **(Gut Liver 2015;9:561-565)**

Key Words: Common bile duct diseases; Intraductal ultrasonography

INTRODUCTION

Symptomatic recurrent bile duct stones have been reported in 4% to 24% of cases after endoscopic retrograde cholangiopancreatography (ERCP).[1] Small bile duct stones persisting after endoscopic sphincterotomy (ES) and stone extraction may be a nidus for further stone formation. Gall bladder status, lithotripsy, and pneumobilia were significantly related to the risk of bile duct stone recurrence after ES.[2]

Intraductal ultrasonography (IDUS) is a highly sensitive diagnostic modality in extrahepatic biliary diseases.[3-5] IDUS is more effective in the diagnosis of bile duct stones than ERCP.[6] However, conventional IDUS has known limitations in providing accurate cross-sectional imaging of the bile duct in patients with pneumobilia.[7-11] Therefore, the development of a new IDUS system is necessary to overcome these limitations.

CASE REPORT

From December 2013 to February 2014, 16 patients with pneumobilia underwent IDUS during ERCP, using a balloon-sheathed catheter US system. Before the ERCP, all the patients had been diagnosed with common bile duct (CBD) stones by various imaging modalities. Written informed consent was obtained from all patients. We performed this retrospective study in accordance with the guidelines of the Institutional Review Board.

All of the ERCP procedures were performed using a standard side-viewing duodenoscope (TJF-160F; Olympus, Tokyo, Japan) in an endoscopy suite. During ERCP, conventional IDUS with a 2.0-mm-diameter intraductal US probe (UM-G20-29R; Olympus) was performed to detect remnant CBD stones. If visualization of the bile duct using conventional IDUS was distorted by extensive pneumobilia, a balloon-sheathed catheter US system (UM-BS20-26R; Olympus) was used (Fig. 1). The balloon sheath fits over the probe and is assembled in two pieces. A continuous 205-cm catheter with a latex balloon at the tip locks into

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Received on June 25, 2014. Revised on September 16, 2014. Accepted on October 10, 2014. Published online June 4, 2015
pISSN 1976-2283 eISSN 2005-1212 http://dx.doi.org/10.5009/gnl14231

a separate, watertight housing. The balloon system can only be used with an endoscope with an accessory channel of 3.4 mm or larger. The balloon-sheathed catheter US (balloon-sheathed IDUS) probe was carefully inserted using slow, short strokes after pulling the syringe plunger to deflate the balloon. While viewing the probe's distal end endoscopically, the probe was advanced to the papilla of Vater (POV) with a proper axis, using up and down manipulation. After inserting the probe via a transpapillary route to the confluent portion of the CBD without a guidewire, we inflated the balloon to the desired diameter by pushing the syringe plunger and turned the three-way stopcock to stop water flow, in order to secure a clean visual field without pneumobilia. Then, the balloon-sheathed IDUS probe was slowly withdrawn to the POV. If CBD stones and sludge were detected, basket extraction was attempted. If a suspected cholangiocarcinoma was discovered using this system, biopsy and brush cytology were carried out for diagnosis.

Fig. 1. Balloon-sheathed catheter ultrasonography probe.

During the study period, a total of 158 patients underwent biliary IDUS; of these, 16 patients (16/158, 10.1%) also underwent IDUS with the balloon-sheathed catheter US system. The patients had a mean age of 65.5 years (range, 28 to 90 years), and 56.3% were male. Of the 16 patients, nine (56.3%) had previously undergone ES; seven (43.7%) had no prior history of ES. The mean stone size was 7.7 mm (range, 2.4 to 20 mm), and the mean CBD diameter was 14.2 mm (range, 5 to 23 mm).

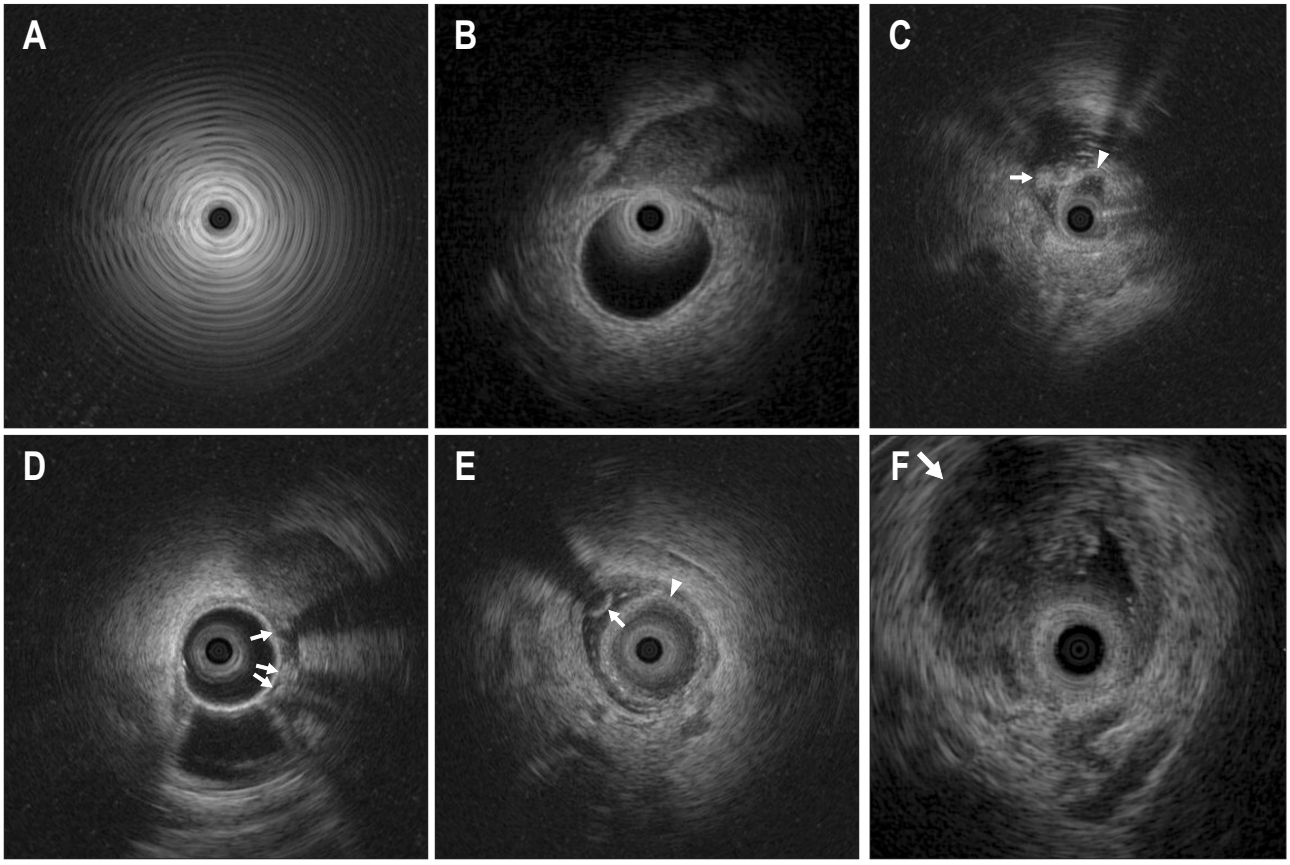

Fig. 2. (A) Extensive pneumobilia as shown by conventional intraductal ultrasonography (IDUS). (B) Extrahepatic bile duct wall (same area in Fig. 2A), visualized with the balloon-sheathed catheter IDUS. (C) Remnant stones (arrow), detected with the balloon (arrowhead)-sheathed catheter IDUS. (D) Remnant stones (arrows), detected with the balloon-sheathed catheter IDUS. (E) Remnant stones (arrow), detected with the balloon (arrowhead)-sheathed catheter IDUS. (F) Cholangiocarcinoma (arrow), detected with the balloon-sheathed catheter IDUS in common bile duct.

Table 1. Baseline Characteristics and Therapeutic Outcomes

Patientno.	Sex/age, yr	Diagnosis	Stone size, mm	Remnant stone	CBD diameter, mm	Procedure time, min
1	M/59	CBD stones	15	No	23	11
2	M/55	CBD stones	2.4	No	5	18
3	M/63	CBD stones	5	No	17	17
		Cholangiocarcinoma				
4	M/28	CBD stones	5	No	7.5	24
5	M/69	CBD stones	9	No	13	40
6	M/57	CBD stones	6.6	No	18	12
7	F/63	CBD stones	9	Yes	20	11
8	F/66	CBD stones	11.5	Yes	15.6	16
9	F/84	CBD stones	7.5	No	11.5	35
10	F/90	CBD stones	6.1	Yes	11	11
11	F/84	CBD stones	3	Yes	20	29
12	F/43	CBD stones	4.5	No	12	20
13	F/88	CBD stones	20	Yes	15.2	32
14	M/79	CBD stones	4	No	13	17
15	M/53	CBD stones	7	No	15	28
16	M/68	CBD stones	7	No	10	15

CBD, common bile duct; M, male; F, female.

All patients had extensive pneumobilia during ERCP, and the visualization of the bile duct using conventional IDUS was distorted by extensive pneumobilia (Fig. 2A). After the balloon-sheathed IDUS probe was inserted, appropriate visualization of the bile duct was achieved in all patients (16/16, 100%). The baseline characteristics and therapeutic outcomes of the patients are summarized in Table 1. The balloon-sheathed IDUS provided excellent imaging of the bile duct without interference by pneumobilia (Fig. 2B). Using this system, remnant CBD stones were detected in five patients (31.3%) (Fig. 2C-E). The mean size of the remnant stones was 3.58 mm (range, 2 to 5 mm). In one patient, intraductal ultrasonography showed asymmetrical wall thickening in the mid to distal CBD (Fig. 2F), although abdominal computerized tomography and magnetic resonance cholangiopancreatography images did not show any evidence of cholangiocarcinoma. Biopsy and brush cytology were performed for diagnosis, and well-differentiated adenocarcinoma was confirmed. In some patients, CBD stones were advanced toward the POV with the balloon-sheathed IDUS probe. No significant adverse events, including cholangitis, pancreatitis, or perforation, occurred in any of the patients.

DISCUSSION

In the present study, balloon-sheathed IDUS was successfully performed in all patients to visualize the bile duct, regardless of the extent of pneumobilia. Using this system, remnant CBD stones were effectively diagnosed, and a case of cholangiocarcinoma was detected. The balloon-sheathed IDUS was also helpful for stone sweeping, and no significant adverse events were observed. Therefore, balloon-sheathed IDUS can be considered a viable new option for performing biliary IDUS in patients with extensive pneumobilia.

ES and stone extraction are safe and effective in the management of patients with CBD stones. However, the risk of stone recurrence is an important issue for patients and physicians. Many factors are associated with stone recurrence. Of these, the presence of pneumobilia after ES may influence the frequency of stone recurrence.[2] The mechanism underlying the relationship between pneumobilia and stone recurrence remains unclear. First, pneumobilia permits reflux of the duodenal contents into the bile duct with ease. Loss of function of the biliary sphincter after ES may contribute to duodenobiliary reflux.[12] Duodenobiliary reflux results in bile infection, which plays an essential role in the formation of brown stones.[2] Second, the presence of pneumobilia during ERCP makes it difficult to detect residual CBD stones. Therefore, pneumobilia might increase the possibility of residual CBD stones after ES and stone extraction.

Conventional IDUS has been reported to accurately discriminate between stones and pneumobilia, as pneumobilia appears as hyperechoic defects and multiple scattering echoes with strong reverberations with IDUS.[1,13,14] However, IDUS cannot always distinguish between pneumobilia and bile duct stones, especially in patients with extensive pneumobilia after undergoing ES.[7-11] All of the patients in our study had considerable pneumobilia in the bile duct after ES. Varadarajulu[10] suggested that flushing normal saline into the CBD during an IDUS examination improves acoustic coupling and enables the reliable

differentiation of CBD stones from pneumobilia. However, complete resolution of pneumobilia is not always achieved by flushing with normal saline, especially in patients with a dilated CBD and extensive pneumobilia. In addition, this technique could cause cholangitis and displace small CBD stones into the intrahepatic bile ducts. Therefore, the use of a balloon-sheathed catheter US system was considered for biliary IDUS. In the present study, the balloon-sheathed IDUS proved very useful for the detection of small CBD stones in these patients. Accordingly, the use of a balloon-sheathed IDUS may be able to significantly reduce the number of residual CBD stones.

IDUS after stone extraction may potentially help to detect occult tumors.[15] Therefore, IDUS after stone extraction can improve the detection rate of early cholangiocarcinoma and thereby patient outcomes. Before ES and stone extraction, IDUS has some difficulty in evaluating the wall of the bile duct behind CBD stones, due to the stones' posterior acoustic shadow. After ES and stone extraction, IDUS can easily evaluate the bile duct wall. However, massive pneumobilia may prevent the clean visualization of the bile duct wall. In the present study, the bile duct was clearly visualized with the balloon-sheathed IDUS, despite extensive pneumobilia. Consequently, a balloon-sheathed IDUS can improve the diagnosis of early cholangiocarcinoma in patients with extensive pneumobilia. It will be necessary to perform a large number of studies to prove the effectiveness of a balloon-sheathed catheter US system in detecting early cholangiocarcinoma.

Although it has great potential, the balloon-sheathed IDUS system has a few limitations. First, the balloon-sheathed IDUS is a wireless system, as it was designed to evaluate subepithelial esophageal lesions. It is difficult to insert the balloon-sheathed catheter via the transpapillary route without ES. Therefore, the development of a guidewire-assisted system is needed. Although probe insertion was feasible without traumatically manipulating the elevator apparatus, it was difficult to insert the probe without the guidewire. For probe insertion without the traumatic manipulation of the elevator apparatus, a therapeutic side-viewing duodenoscope (TJF-160F; Olympus) with a large channel was used for the balloon-sheathed US system. The elevator apparatus was not usually used for inserting the probe. Instead, the axis of the probe was aligned to the same axis of the transpapillary route, after fine manipulation of the bending section of the duodenoscope. Second, the balloon is 10 mm in size, which is too small to ensure a proper visual field in patients with an extremely dilated CBD and pneumobilia. The development of a larger balloon system will be more effective for examination in cases of extreme dilation. Because the balloon-sheathed IDUS was helpful for stone sweeping in the present study, the development of a strong and variable-sized balloon-sheathed IDUS may be helpful for stone removal. In addition, the development of an ultra-slim IDUS with a 0.035-inch diameter would be useful for IDUS-directed therapeutic ERCP without radiation. This ultra-slim IDUS can be used to provide real-time ultrasonic cholangiography and can guide simultaneous retrieval of balloons or baskets.

In conclusion, the balloon-sheathed catheter US system was useful and safe for biliary IDUS in patients with extensive pneumobilia and has good potential for future applications. To confirm our study results, larger multicenter studies, including a comparative study between the balloon-sheathed catheter US system and the balloon sweeping method, are needed.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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