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Pancreaticobiliary direct imaging and novel therapies

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ABSTRACT

Known or suspected pathology within the pancreaticobiliary system is a common clinical problem which can often be assessed with data such as history, physical examination, and laboratory tests. Noninvasive or indirect imaging techniques, such as ultrasound, computed tomography, and magnetic resonance cholangiopancreatography are widely available and can provide useful information in the evaluation of pancreaticobiliary pathology. The gold standard for direct imaging and evaluation of the pancreaticobiliary tree is endoscopic retrograde cholangiopancreatography. This technique not only allows for diagnostic imaging with injection of contrast dye into the biliary and pancreatic ducts but also allows for therapeutic interventions such as stone extraction, dilation, stent placement, and tissue sampling. Endoscopic ultrasound (EUS) is another commonly used direct imaging modality which allows for more precise images and directed therapy such as aspiration or ablation. EUS is considered to be one of the most sensitive tests for staging malignancy and detecting a wide range of pancreaticobiliary illnesses, and has also been shown to be useful in evaluation of indeterminate biliary strictures. Despite the accuracy and widespread use of these modalities, there are limitations to their diagnostic and therapeutic utility. For this reason, novel imaging and therapy techniques have been and continue to be developed. Although some of these modalities have been used for many years, recent advances in technology have enabled these modalities to have greater clinical utility, as well as allowing endoscopists more experience. This article focuses on these "novel" techniques, including direct pancreaticobiliary imaging with cholangioscopy and pancreatoscopy, and probe-based technologies such as intraductal ultrasonography, probe-based confocal laser endomicroscopy, and optical coherence tomography. Endoscopic ablative techniques such as radiofrequency ablation and intraductal argon plasma coagulation as well as stent and lithotripsy technologies would be described as they pertain to the pancreaticobiliary tree. Briefly discussed would be fiber-optic scopes through an fine needle aspiration to directly image cystic lesions, as well as novel guidewire and EUS-based technologies.

1. Introduction

Known or suspected pathology within the pancreaticobiliary system is a common clinical problem. Noninvasive or indirect imaging techniques, such as ultrasound, computed tomography, and magnetic resonance cholangiopancreatography are widely available and can provide useful information in the evaluation of pancreaticobiliary pathology [1]. The gold standard for direct imaging and evaluation of the pancreaticobiliary tree is endoscopic retrograde cholangiopancreatography (ERCP). This technique not only allows for diagnostic imaging with injection of contrast dye into the biliary and pancreatic ducts but also allows for therapeutic interventions such as stone extraction, dilation, stent placement, and tissue sampling [2,3]. Endoscopic ultrasound (EUS) is another commonly used direct imaging modality that allows for more precise images and directed therapy such as aspiration or ablation [4]. EUS is considered to be one of the most sensitive tests for staging malignancy and detecting a wide range of pancreaticobiliary illnesses, and it has also been shown to be useful in evaluation of indeterminate biliary strictures [5,6].

Despite the accuracy and widespread use of these modalities, there are limitations to their diagnostic and therapeutic utility. For this reason, novel imaging and therapy techniques have been and continue to be developed. Although some of these modalities have been used for many years, recent advances in technology have enabled these modalities to have greater clinical utility, as well as allowing endoscopists more experience [7,8].

This article focuses on these "novel" techniques, including direct pancreaticobiliary imaging with cholangioscopy and pancreatoscopy, and probe-based technologies such as intraductal

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Fig. 1. Cholangioscopy image of a retained CBD stone. CBD, common bile duct. (Color version of figure is available online.)

ultrasonography (IDUS), probe-based confocal laser endomicroscopy (pCLE), and optical coherence tomography (OCT). Endoscopic ablative techniques such as radiofrequency ablation (RFA) and intraductal argon plasma coagulation (APC), as well as stent and lithotripsy technologies would be described as they pertain to the pancreaticobiliary tree. Briefly discussed would be fiberoptic scopes through fine needle aspiration (FNA) to directly image cystic lesions, as well as novel guidewire and EUS-based technologies.

2. Cholangioscopy and pancreatoscopy

2.1. Background

Cholangioscopy and pancreatoscopy involve the use of a miniature endoscope during ERCP that provides direct visualization of the biliary or pancreatic ducts, allowing for a variety of diagnostic and therapeutic applications. The placement of a smaller scope passed through the instrument channel of a larger endoscope is known as “mother-baby” or “mother-daughter” systems, and it was first described in the 1970s [9]. Although earliest models required 2 skilled endoscopists to simultaneously work each scope, the most widely used modern choledochoscopes are single-operator devices [10]. Cholangioscopy may be performed for diagnostic indications including evaluation of strictures, staging of malignancy, to evaluate filling defects seen on ERCP, as well as to guide tissue acquisition via standard brush cytology or via directed cholangioscopic biopsies. It is also performed for therapeutic indications including lithotripsy, tumor ablation, application of pCLE, and IDUS as well as guidewire advancement and opening of existing stents. The most common indications for cholangioscopy are management of difficulty to treat bile duct stones as well as the assessment of indeterminate biliary strictures, with pancreatic indications being much less common [11].

2.2. Choledocholithiasis

Approximately 10%-20% of patients with cholelithiasis have concurrent choledocholithiasis, and current guidelines suggest additional biliary imaging before or during cholecystectomy in patients at intermediate or high risk [12]. Although noninvasive imaging techniques clearly have limitations in sensitivity of stone detection, ERCP may also miss stones in patients with large ducts or the presence of significant pneumobilia [7]. Cholangioscopy can be used to identify retained common bile duct stones (Figure 1). A study that used cholangioscopy immediately after ERCP to assess for retained stones found an incidence of missed stones in 29% of patients [10]. In another study involving patients with primary sclerosing cholangitis (PSC), 30% of patients with a normal ERCP were found to have stones when cholangioscopy was used for direct visualization [13]. Many of these likely represented small stones or stone fragments that might have passed spontaneously, whereas some stones found in this setting may have been clinically significant.

Cholangioscopy can be helpful in the setting of difficult to remove choledocholithiasis. Persistent stones need to be removed because of the high risk of cholangitis, pancreatitis, or both. Stone removal is achieved in up to 95% of cases in 1 procedure with ERCP [14]. In the refractory cases (usually comprised of patients with large stones, intrahepatic stones, or stones above strictures), stones can be removed using a variety of advanced techniques to fragment them before removal. These techniques include mechanical lithotripsy (ML), electrohydraulic lithotripsy (EHL), and laser lithotripsy (LL) [7]. EHL uses shockwaves created in a fluid-filled duct to fracture stones whereas LL uses laser energy to directly fracture stones (Figure 2). Both of these techniques can be applied to pancreatic duct stones as well. Although EHL and LL can be used without cholangioscopy, direct imaging allows for distinction between stone fragments, air bubbles, or blood clots which may be difficult to differentiate via cholangiography alone [15]. ML does not require cholangioscopy, but is frequently used after cholangioscopy-guided techniques have fragmented stones. Although there have been few studies directly comparing different lithotripsy techniques, the procedure success rate of LL in several studies has been between 79% and 92% [10,16]. A recent multicenter study using a holmium:YAG laser reported complete stone clearance in 97% of patients [17]. In EHL, successful stone fragmentation has been described in 77%-83% of cases, with overall rates of complete stone clearance in $>90\%$ of patients when

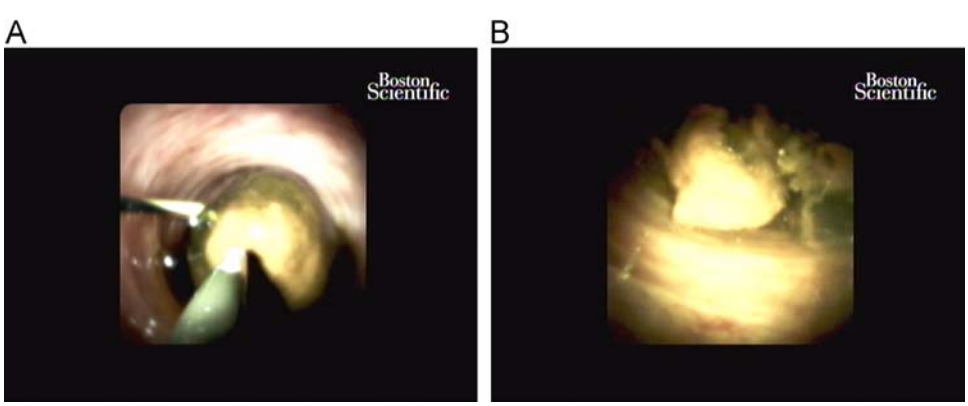

Fig. 2. (A) Cholangioscopy image of a large CBD stone. To the left is the biliary guidewire and in the center of the image is the EHL probe. (B) Same stone after fragmentation via EHL. CBD, common bile duct. (Color version of figure is available online.)