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Endoscopic retrograde cholangiopancreatography in the management of bile duct stones

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ABSTRACT

Gallstone disease is a major cause of the need for abdominal surgery, and the most common indication for endoscopic retrograde cholangiopancreatography (ERCP). Although it is a mature technology, ERCP remains a robust solution for the management of bile duct stones and, in most such cases, the treatment of choice. Although the diagnostic role of ERCP as a diagnostic pancreaticobiliary procedure has declined, its role as an effective therapeutic platform has continued to grow. The ability of ERCP to retain its go-to status in the great majority of bile duct stone cases is the result not only of the continued development of new technology but is also the end effect of continued refinement of existing technologies as well as the successful adaptation and adoption of new techniques.

1. Introduction

Gallstone disease remains the most common abdominal cause for hospital admission in developed nations. More than 20 million people in the United States have gallstone disease, with a prevalence of 10% to 30% overall in adult Americans. The Hispanic population represents the fastest-growing sector of the United States demographic presently, and studies consistently demonstrate a higher prevalence of gallstone disease in this group as compared with the non-Hispanic white and non-Hispanic black population. Age, diabetes, and primary liver disease are also independent risk factors, as are obesity and—ironically—rapid weight loss, as encountered after some diet regimens and after bariatric surgical procedures. With all of these risk factors on the rise, and with durable medical or other nonsurgical means of definitively treating or otherwise eliminating gallstone disease still elusive, cholecystectomy remains the mainstay of management for symptomatic gallbladder disease, with upward of 700,000 laparoscopic cholecystectomies performed every year in the United States.

The description of endoscopic cholangiography by McCune et al. [1] in 1968 represented the nascence of biliary endoscopic retrograde cholangiopancreatography (ERCP), and the report of endoscopic sphincterotomy in 1974—nearly simultaneously—by Kawai et al. [2] and Classen and Demling [3] ushered ERCP into its interventional era. It is this therapeutic role of ERCP that has proven to be its most durable. Although the utility of ERCP in bile duct stone diagnosis has been largely eclipsed by the lack of invasiveness of magnetic resonance cholangiopancreatography and the higher sensitivity of endoscopic ultrasonography [4], the effectiveness of endoscopic retrograde cholangiography (ERC) for the treatment of most presentations of choledocholithiasis has remained largely unchallenged and unequaled. Although intraoperative cholangiography or intraoperative bile duct ultrasonography have been developed as adjunctive techniques for the laparoscopic management of bile duct stones at the time of cholecystectomy, usage of these techniques is variable and far from universal. Also, not all patients have anatomy or stone burden amenable to transcystic bile duct clearance, and the majority of patients do not undergo routine intraoperative bile duct imaging during cholecystectomy. Thus, as magnetic resonance cholangiopancreatography, endoscopic ultrasonography, and intraoperative cholangiography have gained traction in detecting choledocholithiasis, ERCP has remained a strong platform for the treatment of bile duct stones [5,6].

2. Diagnostic endoscopic retrograde cholangiography

Most bile duct stones are easily diagnosed at ERCP and effectively removed after biliary sphincterotomy via basket or balloon extraction. However, before sphincterotomy can be undertaken, biliary access must be obtained. Although biliary access and entry are discussed in detail elsewhere in this volume of *Therapeutic Gastrointestinal Endoscopy*, certain caveats bear specific mention here. First, attention should be directed toward avoiding the unnecessary introduction of air bubbles into the bile duct by removing excess air in the contrast syringe and in the contrast lumen of the catheter before guidewire insertion and contrast injection. More importantly, great care must be taken in initial cannulation and contrast injection to avoid the unin-

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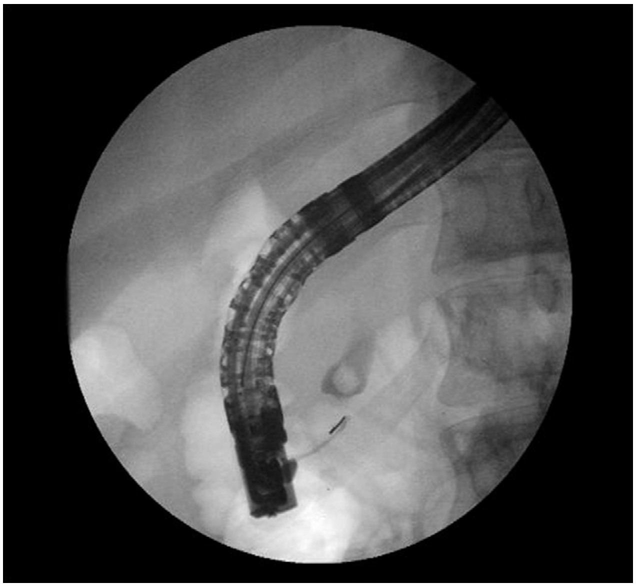

Fig. 1. Inject contrast slowly and carefully to avoid proximal displacement of distal common bile duct stones. Proximal displacement into the cystic or intrahepatic ducts can make bile duct stones substantially more difficult to capture and extract.

tentional proximal displacement of stones and related debris into the intrahepatic ducts or the cystic duct or cystic duct remnant, where they may be more difficult to identify and will likely be considerably more challenging to capture and extract. Such misadventures may be prevented by slowly and incrementally injecting contrast into the bile duct after catheter entry only into the distal bile duct, and by avoiding blindly inserting a guidewire deeply into the more proximal biliary tree before opacifying and visualizing any stones that may be present in the distal common bile duct (CBD) (Fig. 1). Furthermore, the intrahepatic radicles and cystic duct also must be opacified well to exclude occult stones retained in these areas, which could otherwise descend into the CBD and cause latent obstruction, cholangitis, or pancreatitis. Stone detection in large-caliber bile ducts may be enhanced by diluting the contrast agent with water or saline. Differentiation of stones from air bubbles may be effected by tilting the patient or the fluoroscopy table to take advantage of the effect of gravity on stones, which will generally sink, as compared with air bubbles, which will typically rise or float cephalad, when the patient is tilted in an anti-Trendelenburg fashion. The visualization of smaller ducts and stones may be enhanced by magnifying the fluoroscope image, and resolution may be improved by obtaining spot images and examining them during the procedure. Finally, the increased tissue attenuation encountered in patients with greater abdominal girth or ascites may require an increase in the fluoroscope voltage.

3. Sphincterotomy

Sphincterotomy is covered in detail elsewhere in this volume of *Therapeutic Gastrointestinal Endoscopy*. Sphincterotomy related to the extraction of CBD stones requires care in accurately matching the size of sphincterotomy to the diameter of the stones at hand. Many experts consider it unnecessary to extend a sphincterotomy flush to the duodenal wall unless stone size absolutely dictates this. However, the sphincterotomy must be large enough to allow safe extraction of the stones without undue risk of trauma to the ampullary outlet, which can result in bleeding, retroperitoneal perforation, and secondary infection. Where anatomical and technical limitations restrict the size of a sphincterotomy to an aperture inadequate for extraction of a larger stone—examples include difficulty in obtaining alignment of the endoscope or sphincterotome with the papilla and ampullary bile duct tunnel, or a stone that is simply larger than the size of sphincterotomy that can be performed safely—postsphincterotomy ampullary balloon dilation (postsphincterotomy ampulloplasty) or a number of lithotripsy techniques may render stone fragments that can be retrieved successfully. Much enthusiasm has developed in the past decade for postsphincterotomy large-diameter balloon ampulloplasty as an alternative to, and even an adjunct to, lithotripsy for the clearance of large bile duct stones and for removal of stones in situations where the sphincterotomy cannot be made large enough to accommodate stone extraction [7-9]. Wire-guided balloons measuring 10 to 20 mm in diameter are used to dilate, incrementally and carefully under fluoroscopic guidance, the ampullary outlet postbiliary sphincterotomy, to allow extraction of large stones using extraction balloons and Dormia baskets (Fig. 2). Excellent results have been demonstrated in multiple series, with acceptable rates of bleeding, perforation, and pancreatitis, which are—not surprisingly—the most commonly experienced complications of this technique [10-12]. The technique typically obviates the need for mechanical or other lithotripsy, but not always [13]. Balloon sphincteroplasty is seldom performed without a biliary sphincterotomy because of the risk of post-ERCP pancreatitis [14,15].

4. Stone extraction

Successful extraction of bile duct stones depends on more than successful biliary access and adequate sphincterotomy. Once these have been achieved, clearance of duct stones requires capturing, and then delivering, all stones, stone fragments, and sludge, including those which may be in, or have been displaced to, the intrahepatic ducts or the cystic duct. Stone-extraction balloons are chosen most frequently for this task, and for good reason, balloons, particularly the wire-guided variety, are easy to use. Many have variable inflation diameters, and thus can be used in multiple ducts of different sizes throughout the procedure. An extraction balloon requires the operator to simply place the balloon upstream from the stone to simply engage it—making the exercise of stone capture unnecessary. The balloon catheter also may be used to perform an occlusion cholangiogram to assess fully the intrahepatic ducts and cystic duct remnant, and can act as a fulcrum to aid in selectively accessing specific intrahepatic radicles. And—importantly to many operators— unlike baskets, they possess no risk of impaction when a stone is engaged but unable to be successfully extracted: one simply deflates the balloon and withdraws the catheter. However, balloons have their downsides. They lack mechanical advantages possessed by Dormia baskets, and thus may be less efficient in delivering stones, particularly in certain types of duct anatomy. This mechanical advantage stems from the physical property represented by the basket's axis of pull force going right through the axis of the stone—the middle of the stone—and, thus, the sum of the vector forces being applied to the basket wires being applied directly and wholly to the axis of stone extraction. This differs importantly from stone extraction with a balloon, wherein the stone is prevented from occupying the axis of the balloon catheter by the catheter itself—the stone is forced to dwell lateral to the catheter of the extraction balloon. Thus, the force exerted on the stone by the balloon is a combination of 2 vector forces: the downward vector represented by the axis of catheter pull force, and the angular lateral vector force away from the balloon catheter that is a result not only of the catheter pull axis not going through the middle of the stone, but along the lateral surface of the stone, but also of the deformation the balloon undergoes because the stone prevents the balloon from passing uniformly across the lumen of the duct occupied by the stone. This property sometimes leads to the balloon depositing the stone in a lateral sulcus of the distal CBD before the balloon deforms and slips past the stone while still fully inflated, resulting in failed extraction (Fig. 3).