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Single-operator holmium laser lithotripsy under direct peroral cholangioscopy using an ultra-slim upper endoscope in a patient with a large stone in the common bile duct

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ABSTRACT

In patients with complicated stones (e.g., large stones) in the common bile duct (CBD), advanced treatment modalities are generally needed. Here we present an interesting case of a large CBD stone treated with holmium laser lithotripsy, which was performed under direct peroral cholangioscopy using an ultra-slim endoscope. An 86-year-old woman underwent endoscopic retrograde cholangiopancreatography for a symptomatic large CBD stone. After the failure of sphincterotomy, balloon sphincteroplasty, and mechanical and extracorporeal shock wave lithotripsy, we attempted to fragment the stone by peroral cholangioscopy using the holmium laser system through the operating channel of an ultra-slim endoscope. No complication was observed at the end of this procedure. Thus, holmium laser lithotripsy under direct peroral cholangioscopy performed using an ultra-slim endoscope is a feasible and safe endoscopic method for removing large CBD stones.

Keywords: Large stones, common bile duct stones, lithotripsy, laser lithotripsy, holmium laser

Case Report

INTRODUCTION

Common bile duct (CBD) stones are observed in up to 12% of patients with symptoms of cholelithiasis and are an indication for endoscopic retrograde cholangiopancreatography (ERCP) with endoscopic sphincterotomy (ES) (1). Unfortunately, up to 15% of all CBD stones cannot be removed using standard techniques (complicated CBD stones), with high risk of possible complications, such as cholangitis and pancreatitis (2).

Pre-extraction fragmentation with mechanical or extracorporeal shock wave lithotripsy, as well as balloon sphincteroplasty, can help endoscopists in such complicated cases (3). Invasive surgical procedures are reserved for cases of endoscopic failure.

In patients with large CBD stones, more advanced approaches, such as laser lithotripsy, are needed to avoid CBD stone-related complications and/or surgery.

Here we present the case of a patient with symptomatic CBD large stone that was treated using cholangioscopy-guided laser lithotripsy.

CASE PRESENTATION

An 86-year-old woman was admitted because of abdominal pain, nausea, vomiting, and jaundice. An abdominal ultrasound showed cholecystic stones and CBD dilatation due to a large blocking stone (35 mm) in the distal coledocus. Biochemical tests revealed high transaminases (Aspartate Aminotransferase [AST]/ Alanine Aminotransferase ALT] 480/520 U/L) and bilirubin (direct/indirect, 9/6 mg/dL) levels without leukocytosis, altered platelet count, or international normalized ratio. Therefore, after obtaining informed consent, ERCP was performed, which confirmed the presence of a large CBD stone (Figure 1a). After sphincterotomy, a wire-guided balloon sphincteroplasty was performed using a balloon dilator trough a controlled radial expansion

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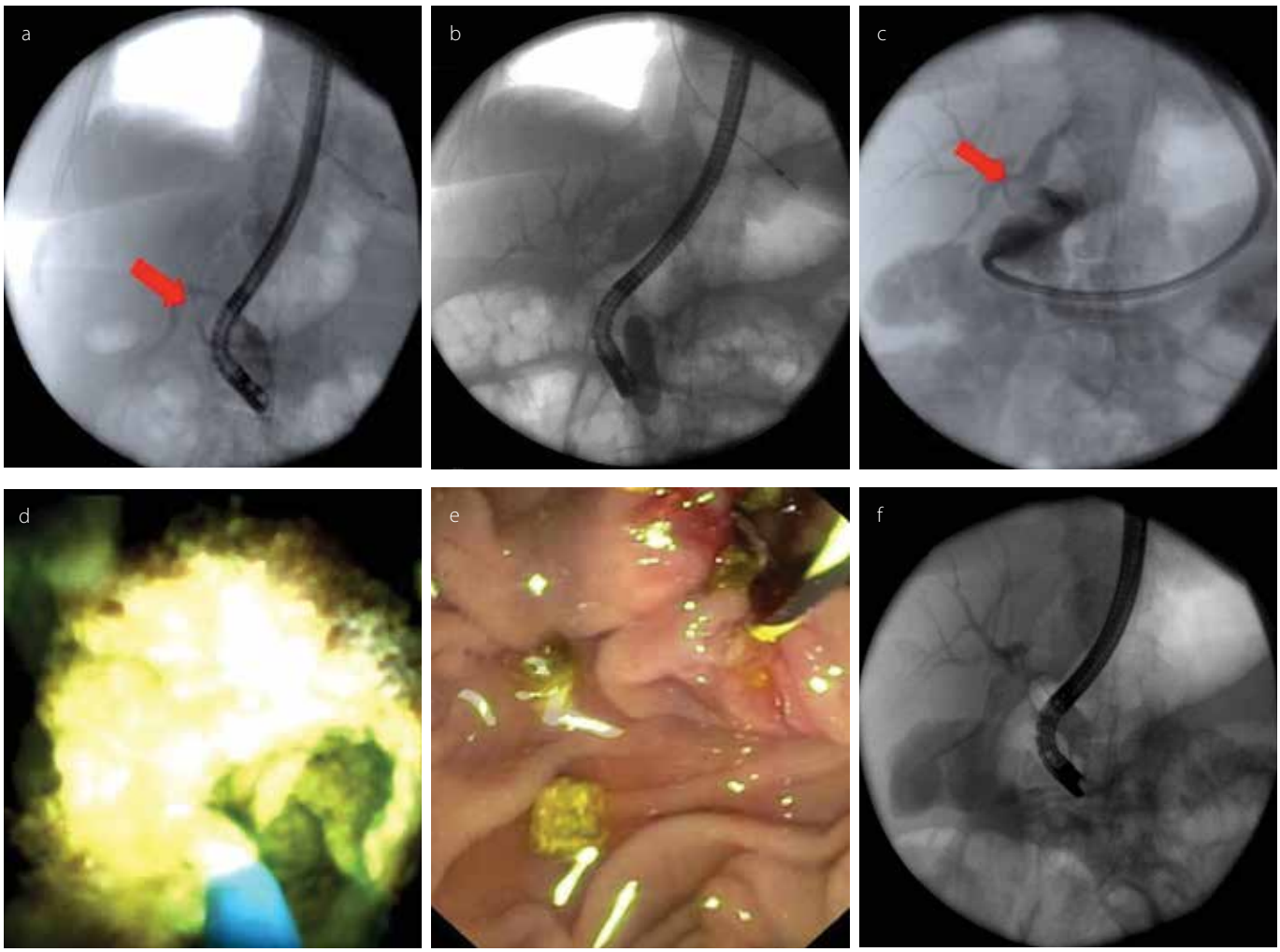

Figure 1. a-f. (a) A large CBD stone (red arrow), (b) balloon sphincteroplasty, (c) ultra-slim endoscope near the large CBD stone (red arrow), (d) laser fiber in contact with the stone, (e) removed stone fragments, (f) CBD without the stone

until a final size of 18 mm [Boston Scientific, Massachusetts, United States (Figure 1b)], followed by mechanical lithotripsy. However, stone extraction failed and an extracorporeal shock wave lithotripsy was scheduled to fragment the stone. The procedure was technically successful, but the stone remained intact. Considering patient's comorbidity and the potential risks secondary to surgery, we planned to fragment the stone using a holmium laser system under direct peroral cholangioscopy (POC). We used conventional saline irrigation during POC to improve stone visualization and to avoid the risk of CO_2 emboli. Using the operating channel of an ultra-slim endoscope [GIF-XP160, 2-mm working channel, 5.9-mm tip diameter, 1.345-mm overall length/1.030-mm effective length (Olympus, Tokyo, Japan)], we advanced "freehand" into the CBD directly without wire- or balloon-guided aid (Figure 1c). The holmium laser system (Storz 25750220 [Storz, Tuttlingen, Germany]) was delivered using a 365-µm diameter fiber (15Hz, 20W), and a green aiming beam was used to target the stone by positioning the laser fiber in contact with the stone (Figure 1d). Lithotripsy with laser was performed under direct view, and the stone was fragmented (Figure 1e,f). Lastly, all fragments were removed using a retrieval balloon. No complication was observed during the procedure. After the procedure AST, ALT, and bilirubin levels progressively decreased until normalization. The abdominal ultrasound showed normalization of the CBD caliber, and the patient was discharged asymptomatic after cholecystectomy.

DISCUSSION

Up to 15% of CBD stones cannot be managed using conventional removal techniques. Many factors can influence CBD stones removal: stone factors (large number of stones, size of stones, and intrahepatic bile duct stones) and patient factors (Roux-en-Y gastrojejunostomy or Billroth type II, periampullary diverticulum, sigmoid-shaped CBD, and bile duct stenosis). To date, complicated stones have been managed using various techniques (4). Mechanical lithotripsy is used routinely as the first approach to fragment CBD stones with great advantage both in terms of procedural simplicity and cost-effectiveness (success rate of approximately 90%). Electrohydraulic lithotripsy and extracorporeal shock wave lithotripsy are the next-step techniques for managing complicated CBD stones. The reported success rate of both techniques is between 70% and 90%.

Table 1. Published reports on lithotripsy performed using an ultra-slim endoscope

Author (year)	Number of patients	Endoscope	DPOC*	Mean size of the stone	Lithotripsy#	Overall success	Complications
Moon et al. (11) (2009)	4	GIF-XP260N GIF-N260 GIF-N230	Wire-guided Intraductal balloon-guided	-	EHL LL	100%	0%
Moon et al. (12) (2009)	18	GIF-XP260N GIF-N260	Intraductal balloon-guided	23 mm	EHL LL	89%	0%
Prachayakul et al. (13) (2011)	1	GIF-N260	Overtube of a single-balloon enteroscope	25 mm	EHL	100%	0%
Kim et al. (14) (2011)	13	GIF-XP260N	Wire-guided	21 mm	LL	85%	0%
Lee et al. (15) (2012)	10	GIFXP260N	Freehand (two patients) Intraductal balloon-guided	19 mm	LL	90%	10% (mild cholangitis)
Nakaji et al. (16) (2013)	1	GIF-XP260N GIF-Q260	Freehand	47 mm	EHL	100%	0%
Lee et al. (17) (2016)	1	GIF-XP180N	Wire-guided	7×3 cm	LL	100%	0%
Di Mitri (2017)	1	GIF-XP160	Freehand	35 mm	LL	100%	0%

EHL: electrohydraulic lithotripsy; LL: laser lithotripsy
*DPOC: Direct peroral cholangioscopy

Two prospective randomized trials comparing electrohydraulic lithotripsy and extracorporeal shock wave lithotripsy showed discordant results; Adamek et al. (5) reported a success rate of 77% and 89% in the electrohydraulic lithotripsy group and the extracorporeal shock wave lithotripsy group, respectively (no difference in term of stone-free rate). Neuhaus et al. (6) reported a bile duct clearance rate of 97% and 73% in the electrohydraulic lithotripsy group and extracorporeal shock wave lithotripsy group ($p<0.05$).

Endoscopic ultrasound-guided (EUS) approaches (EUS-rendezvous technique, EUS-guided antegrade treatment, and EUS-transluminal approach) are limited to selected patients (e.g., those with tumor ingrowths of the ampulla of Vater or surgical anatomy), and results of long-term follow-up remain unclear (4).

Lithotripsy with laser requires direct visualization of complicated and large CBD stones for their effective targeting and successful fragmentation (2). Endoscopic retrograde biliary laser was introduced in 1986 with different technical developments [neodymium:yttrium-aluminum-garnet (Nd:YAG) laser, double-pulse Nd:YAG (FREDDY)] until the holmium laser system was introduced (7-10). The use of the holmium laser system has been demonstrated to be effective and safe in various difficult settings. During ERCP, the holmium laser mechanism of lithotripsy is the result of a photothermal effect that leads to high fragmentation rates of SBD stones. Direct POC using an ultra-slim endoscope, can be effective in managing patients with retained CBD stones. As showed in Table 1, several studies have reported high rates of success using laser lithotripsy of retained CBD stones (11-17). Unfortunately, direct POC has been limited by low biliary insertion rate of the ultra-slim endoscope. Recently, direct retrograde cholangioscopy using a prototype double-bending cholangioscope has been demonstrated to be feasible and safe in selected patients (e.g., those with indeterminate biliary stricture or residual stones), with a final success rate of 97% (18). Conventional "mother-baby" video-cholangioscopy can overcome these difficulties, but it requires two experienced operators to work together (19).

Dedicated accessories (e.g., intraductal balloon catheter) have been used to facilitate direct POC into the biliary tree from the duodenum (20,21). A new intraductal balloon catheter has been used to guide the flexible ultra-slim endoscope (22). This new 5F balloon catheter helps endoscopists in direct visualization. A "combined" endoscopic technique (dilation-assisted stone extraction) is also used in current clinical practice to manage large CBD stones; in this technique, ES (full or partial incision of the transverse fold during ERCP) is associated with balloon dilation of the major papilla based on the final diameter of the distal bile duct (23).

In the last few years, other specialized devices, such as the SpyGlass POC system (Boston Scientific Corp, Natick, Mass), have allowed better access to the biliary tree using a single operator. They could be potentially useful for patients with retained CBD stones (24).

Nevertheless, compared with other devices as dual-operator "mother-baby" POC system, the ultra-slim endoscope provides great advantage, such as a direct visualization of the CBD, with performance comparable to that of a standard gastroscope (e.g., the operating channel).

In our study, we directly introduced the ultra-slim endoscope into the CBD without the aid of a wire guide and/or a balloon catheter. This approach allowed direct visualization of the large stone with precise targeting of the laser on the stone surface until complete fragmentation was achieved.

This type of direct POC has some major limitations: limited stability of the ultra-slim endoscope during lithotripsy, excessive gas insufflation into biliary tree, need for a wide papillary opening, and potential mucosal trauma.

In conclusion, direct POC using cholangioscopy, "mother-baby" choledochoscopy, or ultra-slim endoscope allows direct visualization of large CBD stones during lithotripsy with laser. Our study confirmed that large stone fragmentation with holmium laser through direct POC using an ultra-slim endoscope is a feasible and safe endoscopic method for removing large CBD stones.

Informed Consent: Written informed consent was obtained from the patient who participated in this study.

Peer-review: Externally peer-reviewed.

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