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【 CASE REPORT 】

Mirizzi Syndrome Type IV Successfully Treated with Peroral Single-operator Cholangioscopy-guided Electrohydraulic Lithotripsy: A Case Report with Literature Review

Hirokazu Kawai[1], Toshifumi Sato[1], Masaaki Natsui[1], Kotaro Watanabe[1], Ryosuke Inoue[1], Mayuki Kimura[1], Kazumi Yoko[1], Syun-ya Sasaki[1], Masashi Watanabe[1], Taku Ohashi[2], Akihiro Tsukahara[2], Norio Tanaka[2] and Yoshihisa Tsukada[1]

Abstract:

A 76-year-old man presented with liver dysfunction and intrahepatic bile duct dilatation. Imaging studies showed two large stones that had become impacted in the common hepatic duct, which was fused with the gallbladder. The patient was diagnosed with Mirizzi syndrome type IV. Hepaticojejunostomy and stone removal failed due to dense gallbladder adhesions involving the right hepatic artery. The bile flow was temporarily restored; however, the patient experienced cholangitis 16 months later. The stones were extracted via peroral single-operator cholangioscopy (SOC)-guided electrohydraulic lithotripsy. This is the first case in which stones were completely removed by SOC-guided treatment in a patient with Mirizzi syndrome type IV.

Key words: Mirizzi syndrome, cholecystobiliary fistula, cholangioscopy, SpyGlass, electrohydraulic lithotripsy, endoscopic nasobiliary drainage

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Introduction

Mirizzi syndrome is an uncommon complication of gallstone disease, characterized by the extrinsic obstruction of the common hepatic duct due to impacted stones in Hartmann's pouch or the infundibulum and/or cystic duct of the gallbladder (1). This syndrome is found only in 0.06% to 5.7% of patients undergoing cholecystectomy (2, 3) and is usually accompanied by chronic inflammation of the gallbladder, often involving the presence of cholecystocholedochal fistulas. Although surgical management is advocated as the primary treatment of Mirizzi syndrome, it is challenging for surgeons. The difficulties surrounding surgery are due to a lack of awareness of this condition, owing to its rarity, and an inaccurate diagnosis in the preoperative period. Furthermore, severe anatomical distortion of the gallbladder and bile ducts due to intense adhesions present a challenge to surgeons because of the potential for injury to the bile duct or massive bleeding during dissection of Calot's triangle (4).

Endoscopic techniques, such as endoscopic retrograde cholangiopancreatography (ERCP), are frequently utilized for not only the diagnosis but also treatment, including biliary decompression with subsequent endoscopic nasobiliary drainage (ENBD), in preoperative patients with Mirizzi syndrome (5). Unfortunately, standard ERCP techniques are typically unsuccessful in extracting impacted stones (6).

We herein report a case of Mirizzi syndrome type IV, characterized by high-grade erosion of bile ducts, that was successfully treated with peroral single-operator cholangioscopy (SOC)-guided electrohydraulic lithotripsy (EHL).

[1]Department of Internal Medicine, Niigata Prefectural Shibata Hospital, Japan and [2]Department of Surgery, Niigata Prefectural Shibata Hospital, Japan
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Correspondence to Dr. Hirokazu Kawai, kawaih@med.niigata-u.ac.jp

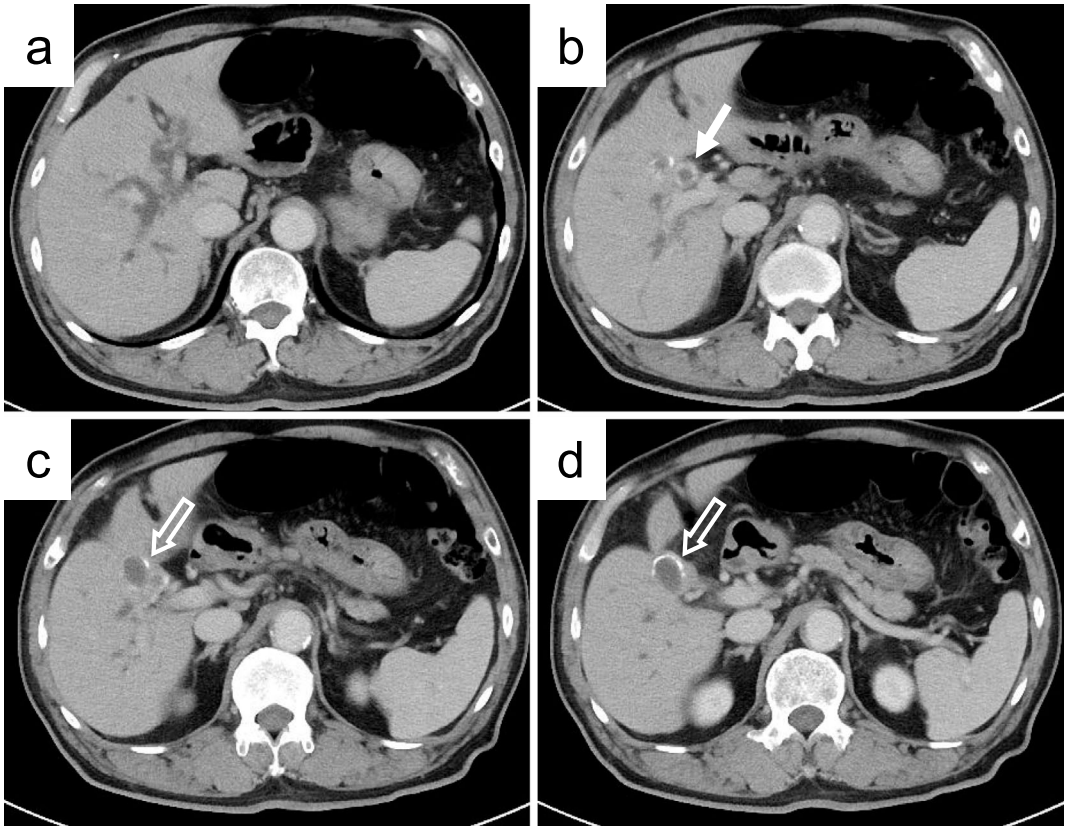

Figure 1. **Contrast-enhanced computed tomography performed at admission, showing a stone at the left side in the common hepatic duct (closed arrow) and another stone at the right side in the same cavity (open arrow). The two stones were impacted in the eroded common hepatic duct, leading to dilatation of the intrahepatic bile ducts (a-d).**

Case Report

A 76-year-old man with a medical history of benign prostatic hyperplasia was referred to our hospital for workup, due to elevated liver enzymes and intrahepatic bile duct dilatation. His physical examination findings were unremarkable, and his laboratory results were as follows: total bilirubin, 1.4 mg/dL; direct bilirubin, 0.2 mg/dL; aspartate aminotransferase, 137 U/L; alanine aminotransferase, 168 U/L; alkaline phosphatase, 1,440 U/L; gamma-glutamyl transferase, 2,512 U/L; serum C-reactive protein (CRP), 0.7 mg/dL. Tests for both carcinoembryonic antigens and carbohydrate 19-9 were negative.

Computed tomography (CT) showed dilatation of the bilateral intrahepatic bile ducts with obstruction of the common hepatic duct, which was impacted by 2 stones (27 and 18 mm in diameter) (Fig. 1). The borders of the gallbladder were unclear, suggesting fusion or a large fistula with the common hepatic duct; therefore, the patient was admitted to our hospital for close observation and additional testing.

Magnetic resonance cholangiopancreatography (MRCP) also revealed the occlusion of the common hepatic duct and the primary biliary confluence (Fig. 2a). ERCP showed large filling defects in the dilated common hepatic duct and retrograde outflow of the contrast medium into the cystic duct, indicating fusion of the common hepatic duct and gallbladder (Fig. 2b). Based on the results of these imaging studies, the patient was diagnosed with Mirizzi syndrome type IV, and an ENBD catheter was subsequently placed.

After the elevated biliary enzymes had improved, laparotomy was performed with the goal of achieving subtotal cholecystectomy with choledocoplasty or biliodigestive anastomosis. However, intraoperatively, the right hepatic artery could not be dissociated from the gallbladder due to dense adhesions (Fig. 3). To complete the surgical removal of the stones and gallbladder, right hepatic lobectomy was required; however, as the impaired functional liver reserve did not allow for such an invasive procedure, the surgery was discontinued. After the operation, cholangiography via an ENBD catheter showed spontaneous improvement of bile flow from the intrahepatic bile duct into the common bile duct. The ENBD catheter was withdrawn, and the patient was discharged.

Sixteen months later, the patient presented to our hospital with epigastralgia and a high fever, and his white blood cell count, CRP and biliary enzyme levels were found to be increased. CT showed augmented dilatation of the intrahepatic bile ducts with impacted stones. He was subsequently readmitted with a diagnosis of cholangitis, and an ENBD catheter was placed with concurrent administration of antibiotics.

To ameliorate any cholangitis associated with the bile

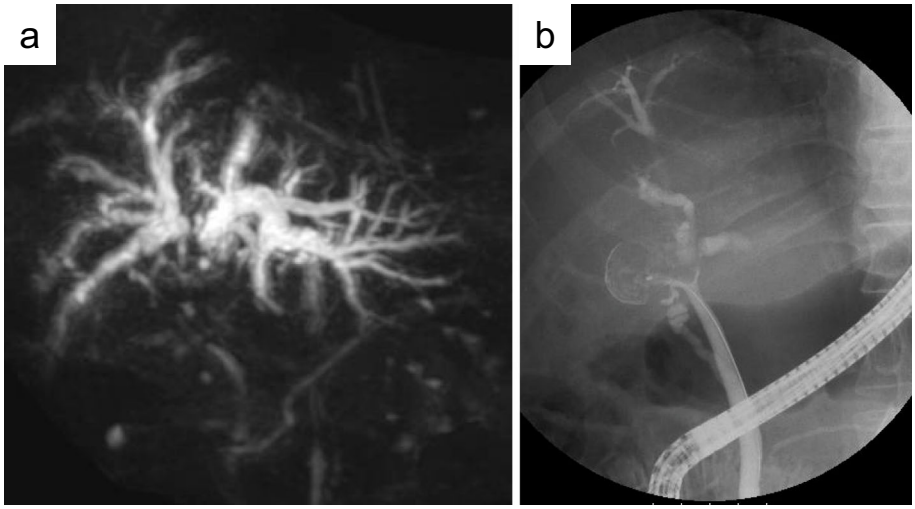

Figure 2. **Preoperative MRCP and ERCP. MRCP showed obliteration of the bilateral hepatic ducts and the common hepatic duct, with dilatation of intrahepatic bile ducts (a). ERCP showed the stones impacted in the common hepatic duct which was fused with the gallbladder (b). ERCP: endoscopic retrograde cholangiopancreatography, MRCP: magnetic resonance cholangiopancreatography**

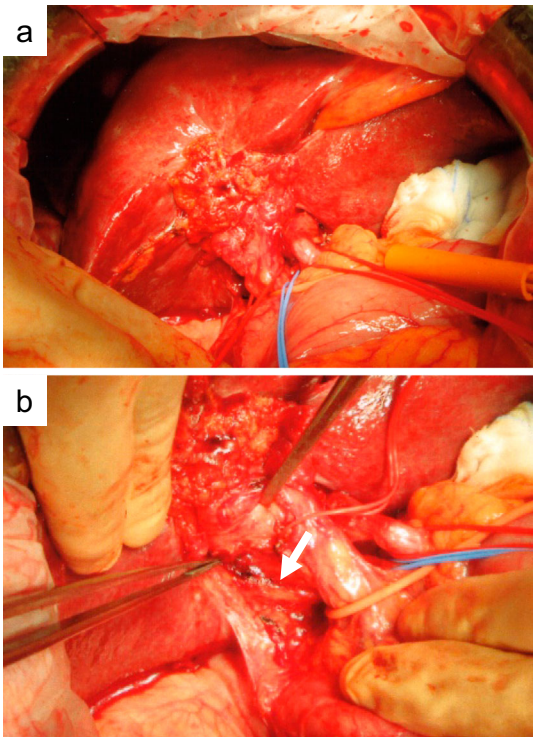

Figure 3. **Intraoperative photograph. The distorted structure of the gallbladder with dense adhesions was shown (a). The right hepatic artery (arrow) could not be dissociated from the gallbladder due to intense adhesions (b).**

duct obstruction, radical treatment for the impacted stones was needed. Although extracorporeal shockwave lithotripsy was performed five times after the cholangitis had improved, it failed to fragment the stones. We then attempted SOC-guided EHL as follows: ERCP was performed (Fig. 4a), with subsequent sphincterotomy; a SpyGlass DS II cholangioscope (Boston Scientific; Marlborough, USA) was then advanced into the common hepatic duct, visualizing a stone located at the right side in the common hepatic duct (Fig. 4b); EHL was next performed using an Autolith (Boston Scientific), and the stone was successfully fragmented (Fig. 4c). The procedure had to be terminated due to poor visibility from the many small fragments that persisted despite ductal clearance using a basket catheter; therefore, another ENBD catheter was placed. SOC-guided EHL was performed again three days later, exposing the other large calculus at the left side in the dilated common hepatic duct (Fig. 4d). The stone was successfully crushed (Fig. 4e), and the fragments were retrieved using a basket catheter. The patient was discharged three days later, and MRCP performed two months post-discharge showed shrinkage of the common hepatic duct as well as two residual stones, <5 mm in diameter in the common bile duct. After the patient was admitted for treatment of the remnant stones, the stones were completely removed using a basket catheter in ERCP, after which the patient was discharged.

Although the stricture of the common hepatic duct remained, the patient's liver function tests normalized, and MRCP detected no recurrence of stones for at least a year after the last endoscopic treatment (Fig. 4f).

Discussion

Mirizzi syndrome was originally described by Pablo Louis Mirizzi in 1948 (1) and was thereafter classified into two types based on the ERCP findings of McSherry et al. in 1982 (7). Type I involves the external compression of the common bile duct by stones impacted in Hartmann's pouch or the cystic duct. Type II involves a cholecystobiliary fistula, caused by a calculus eroding into the bile duct. McSherry's classification was further categorized into four types by Csendes et al. in 1989 (8), where Csendes' type I

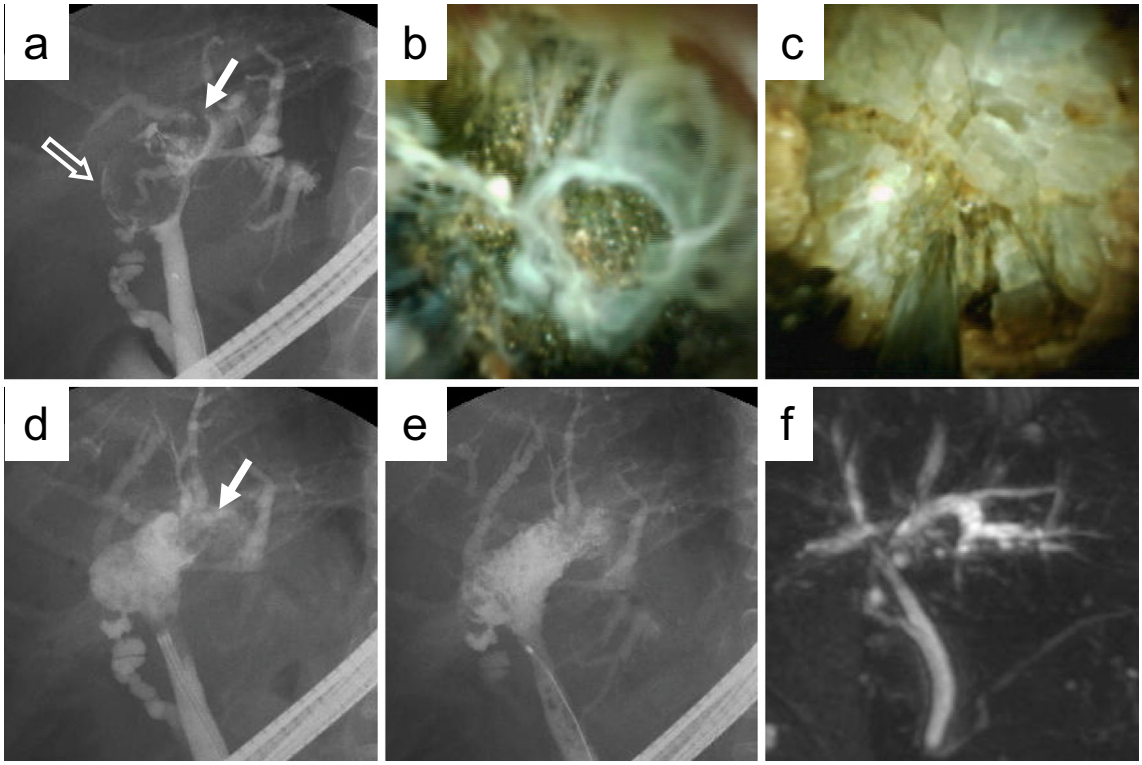

Figure 4. **ERCP with peroral SOC and MRCP after the treatment, showing a stone at the left side in the common hepatic duct (closed arrow) and another stone at the right side in the same cavity (open arrow). The right-sided stone was located in the lower part of the cavity and directly accessible from the common bile duct (a), initially visualized by SOC (b), and crushed by EHL (c). Removal of the right-sided stone enabled SOC to reach the left-sided stone (d) and to fragment it with EHL (e). Post-treatment MRCP demonstrated shrinkage of the common hepatic duct with improvement of intrahepatic bile duct dilatation (f). EHL: electrohydraulic lithotripsy, ERCP: endoscopic retrograde cholangiopancreatography, MRCP: magnetic resonance cholangiopancreatography, SOC: single-operator cholangioscopy**

corresponds to McSherry's type I, type II involves a cholecystobiliary fistula with erosion of up to one-third of the circumference of the bile duct wall, type III involves erosion of up to two-thirds of the circumference of the bile duct, and type IV is defined as a cholecystobiliary fistula with whole circumference impairment of the bile duct wall. In 2008, Beltran et al. validated an additional category of type V, which includes the formation of cholecystoenteric fistula with any other type of Mirizzi syndrome (2). Furthermore, type V is divided into subtypes of Va, involving a cholecystoenteric fistula without a gallstone ileus, and Vb, involving a cholecystoenteric fistula complicated by a gallstone ileus. The incidence rate of type I is the highest (10.5-78%) among the different types of Mirizzi syndrome, while type IV is the rarest form (1-4%) (5). The case we have presented involved impairment of the entire wall of the common hepatic duct, resulting from fusion with the gallbladder, indicating that the patient had Mirizzi syndrome type IV.

Mirizzi syndrome involves substantial changes to the biliary structure, leading to potential morbidity, particularly during laparoscopic surgery (3, 9). To ensure appropriate treatment, the anatomical changes in the bile ducts should be accurately identified. Although ultrasound is recommended as a screening examination, the detection sensitivity for cholecystobiliary fistulas using this modality is not significant (10). CT is efficient for recognizing the cause and location of a biliary obstruction and is useful for differentiating Mirizzi syndrome from malignancy in the hepatic hilum or in the liver, especially in patients with a cholecystobiliary fistula (11). Although MRCP has an accuracy rate of 50% for the diagnosis of Mirizzi syndrome (4), it is not ideal for confirming the presence of cholecystocholedochal fistulas (12). ERCP is regarded as the gold standard for diagnosing Mirizzi syndrome, with a diagnostic accuracy of 55% to 90% (13, 14). In the present case, CT showed the hepatic duct to be occluded by two calculi; however, cholecystobiliary fistulas were not detected on either CT or MRCP. In contrast, ERCP revealed a large cholecystobiliary fistula, with the stones impacted in the destructed bile duct. Consequently, the ERCP findings contributed the most to the diagnosis of this patient as having Mirizzi syndrome type IV.

The primary treatment for Mirizzi syndrome has traditionally been surgical management, including open and laparoscopic surgery. Although open laparotomy is considered relatively safe due to the increased visualization and haptic perception compared to laparoscopic techniques, it is inva-

Table. Outcomes of Peroral Cholangioscopy-guided Lithotripsy for Mirizzi Syndrome in Previous Studies.

Reference	Cases	Csendes type (s)	Endoscope system	Treatment	Lithotripsy success rate (%)
(18)	14	N/A	Mother and baby endoscopes	EHL	100
(20)	50	II* 50	Mother and baby endoscopes	EHL or LL	96
(21)	2	I 2	SpyGlass DS	LL	100
(22)	1	II 1	Ultraslim endoscope	LL	100
(23)	31	I 4, II 17, III 10	SpyGlass DS	LL	100
(24)	1	IV 1	SpyGlass DS	LL	0†
(25)	1	III 1	SpyGlass DS	LL	100
(26)	1	I 1	Ultraslim endoscope	EHL	100
(27)	1	III 1	SpyGlass DS	EHL and LC	100
(28)	3	I 1, III 1, Va 1	SpyGlass DS	EHL	100
(29)	1	IV 1	SpyGlass DS	LL	0‡

*McSherry classification type II. †tunneling through a stone by LL with stent placement. ‡partial fragmentation of a stone with subsequent laparoscopic cholecystectomy and T-shaped drainage tube placement. EHL: electrohydraulic lithotripsy, LC: laparoscopic cholecystectomy, LL: laser lithotripsy, N/A: not applicable

sive, involving a higher complication rate and longer postoperative hospital stays (4). Despite its minimal invasiveness, the utilization of laparoscopic techniques in Mirizzi syndrome remains controversial, due to its high conversion rate (31-100%), complication rate (0-60%), and mortality (0-25%) (5). In principle, surgical procedures are determined depending on the Csendes classification, as follows: total or subtotal cholecystectomy is typical management for type I; types II and III require a subtotal cholecystectomy, leaving a flap of the gallbladder wall to repair the eroded bile duct; type IV requires a Roux-en-Y hepaticojejunostomy; type Va is treated with division and simple suture of bilioenteric fistulas, along with total or subtotal cholecystectomy, depending on the presence of a cholecystobiliary fistula; and for type Vb, after the gallstone ileus is resolved, the gallbladder itself is surgically treated (2, 5, 10). Therefore, a precise preoperative diagnosis of the Mirizzi syndrome type is critical to ensure the appropriate choice of surgical procedures and avoid an increased risk of bile duct injury (15, 16). However, more than 50% of patients with Mirizzi syndrome cannot be preoperatively diagnosed, even using modern imaging modalities (13, 15). For the present case, Mirizzi syndrome type IV was able to be preoperatively diagnosed based on CT and ERCP findings, and the diagnosis led to the decision to perform open laparotomy. However, hepaticojejunostomy and cholecystectomy were not able to be performed intraoperatively due to the intense adhesions involving the right hepatic artery, which had not been recognized by preoperative imaging examinations. These findings underscore the importance of carefully adopting appropriate therapeutic options corresponding to not only the Mirizzi syndrome type but also to the pathognomonic changes surrounding the gallbladder and bile ducts.

ERCP is preferable in patients with Mirizzi syndrome, despite being an invasive procedure, due to not only its superior diagnostic accuracy but also its usefulness as a therapeutic modality, including for papillotomy and biliary stent placement or ENBD (17, 18). Preoperative ENBD allows for biliary decompression, which can reduce the risk of postoperative bile leakage, and confirmation of the outcome of laparoscopic surgery via ENBD cholangiography (19). In the present case, ENBD was found to be effective in the management of cholangitis and obstructive jaundice. Furthermore, subsequent ENBD cholangiography enabled the evaluation of the biliary passage at the stenotic site.

Although ERCP procedures can be an alternative method of stone extraction in patients with Mirizzi syndrome, it is quite difficult to remove an impacted biliary stone by conventional ERCP techniques alone (6). Mechanical lithotripsy frequently fails to remove the stone, as the impacted calculus hampers both the passage of the treatment device through the stricture and the expansion of a basket to entrap the stone in the restricted bile duct lumen. The recent development of an ultraslim endoscope and SOC in the SpyGlass DS has facilitated endoscopic treatment with EHL or laser lithotripsy in patients with Mirizzi syndrome (18, 20-29) (Table). Although most previous studies have indicated high technical success rates of peroral cholangioscopy-guided lithotripsy, complete lithotripsy has been unsuccessful in cases of Mirizzi syndrome type IV. Soriani et al. reported a patient with Mirizzi syndrome type IV in whom a stone was tunneled through by a laser using a SpyGlass device, after which plastic stents were placed (24). Li et al. described a patient with Mirizzi syndrome type IV in which an impacted stone was partially fragmented using a SpyGlass device, resulting in remnants in the cystic duct, which were subsequently treated via laparoscopic cholecystectomy and the placement of a T-shaped drainage tube (29). To our knowledge, this is the first reported case of successful complete ductal clearance of stones via SOC-guided EHL in a patient with Mirizzi syndrome type IV. Direct visualization of the anatomy using SOC allowed the precise localization of the stones and safe treatment with EHL, despite the complicated biliary anatomy.

In addition to its ample clinical applications, SOC-directed lithotripsy may also be more cost-effective than tra-

ditional ERCP methods in patients with Mirizzi syndrome. Deprez et al. revealed a 27% reduction in the number of ERCP procedures and an 11% reduction in costs for patients with difficult biliary stones who were treated with SOC, compared to those who underwent conventional ERCP procedures (30). However, ERCP is accompanied by known morbidity and mortality risk (5). Furthermore, several studies have shown SOC-associated complication rates of 7-13.2%, with cholangitis as the most common complication (1-12.8%) (31, 32). Another potential complication of cholangioscopy is that intraductal irrigation may lead to retrograde bacterial flow (33). Considering both the benefits and risks, the indication of ERCP and SOC-directed treatment should be carefully determined in patients with Mirizzi syndrome.

In one year of follow-up with the patient presented herein, there was no recurrence of the stones. Periodic work-ups, including laboratory tests and imaging studies, must be continued for the surveillance of gallbladder cancer as well as any recurrent stones. Gallbladder cancer is a comorbidity in 6-28% of patients with Mirizzi syndrome (9, 15), as the entities have a common etiological risk factor in long-standing gallstone disease causing chronic inflammation of the gallbladder (5, 34). Unfortunately, in the present case, the gallbladder could not be resected due to the presence of dense adhesions caused by chronic inflammation, which warrants periodic surveillance for the development of cancer from the retained gallbladder.

In conclusion, SOC-guided EHL may be an effective and safe treatment approach for the management of Mirizzi syndrome type IV. However, because of the paucity of documented cases and a lack of standardized guidelines, the feasibility of the endoscopic procedures should be assessed based on a thorough investigation of the localization and size of stones, biliary anatomic alterations, and physical conditions in those patients.

The authors state that they have no Conflict of Interest (COI).

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