

—Case Report—

Difficult Stones in the Common Bile Duct Successfully Treated by Electrohydraulic Lithotripsy using a Double Lumen Balloon Catheter and Rotating Hemostatic Valve under 180 Degree Revolving X-ray System.

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The effectiveness of electrohydraulic lithotripsy (EHL) for stones in the common bile duct (CBD) is well established. It is recommended that the procedure is performed under cholangioscopic control for correct positioning of the probe onto the surface of the stones and prevention of complications arising from contact between the tip of the probe and biliary mucosa. However problems are encountered if insertion of the babyscope into the bile duct is not successful particularly in the presence of duct stenosis or technical difficulties, or when the mother-baby system can not be prepared. For the latter reason, large difficult stones in the CBD were treated by EHL using a double lumen balloon catheter and rotating hemostatic valve (EHLB) under 180 degree revolving X-ray system. The tip of the EHL probe was placed at 2-3 mm out of the balloon catheter, which was used to avoid contact between the tip of the probe and mucosa of the CBD under fluoroscopic control. Rotating hemostatic valve was used to allow examination of the effect of EHL without changing the catheter or pulling out the probe during operation. After endoscopic sphincterotomy, the device was delivered close to the surface of the stone under fluoroscopic guidance. After inflation of the balloon, we confirmed that the tip of the device was set at almost the center of the CBD by 180 degree revolving X-ray system. Partial fragmentation and complete removal of the stones was achieved by combined treatment including EHLB, basket or balloon catheter for stone extraction. There were no serious procedure-related complications.

Key words: electrohydraulic lithotripsy, double lumen balloon catheter, rotating hemostatic valve, 180 degree revolving X-ray system, stones in the common bile duct

Introduction

Endoscopic sphincterotomy (EST) for removal of stones from the common bile duct (CBD) is considered the most appropriate method, particularly in patients with high surgical risk. However, large immobile stones still continue to present a therapeutic challenge. Extracorporeal and various intracorporeal lithotripsy procedures have been advocated for the treatment of this type of stones. In the latter method, electrohydraulic lithotripsy (EHL) has been widely applied and now is performed under direct visualization in order to prevent possible complications due to the contact of the tip of the device with the mucosa of CBD. However problems are encountered when mother-baby technique fails or is not available. To overcome this problem and to examine the effects of EHL without changing the catheter or pulling out the probe during operation, EHL using a double lumen balloon catheter and rotating hemostatic valve (EHLB) was applied under fluoroscopic control by 180 degree revolving X-ray system. Here, we report a case of large difficult stones in the CBD successfully treated by this method.

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Case report

A 68-year-old man was admitted to our hospital because of upper abdominal pain. On admission, systolic-diastolic heart murmur was noted. There was no anemia, jaundice or abdominal tenderness. Laboratory tests

showed the following results; white blood cell count $4800/\text{mm}^3$, total bilirubin 0.5 mg/dl , aspartate aminotransferase 20 U/l , alanine aminotransferase 13 U/l , alkaline phosphatase 175 U/l , leucine aminopeptidase 86 U/l , amylase 228 U/l . Abdominal ultrasonography and computed tomography scan demonstrated cholecysto-choledocholithiasis. Endoscopic retrograde cholangiography (ERC) showed multiple stones in CBD, ranging from 5 to 22 mm in diameter (Fig. 1). Endoscopic treatment was selected due to the associated cardiac disease. This consisted of EST, where a number of small stones were successfully removed by conventional methods such as basket, balloon catheter for stone extraction, or flushing with normal saline solution. However, a few large stones proved difficult to entrap in the mechanical lithotripter and could not be removed. To prevent cholangitis, endoscopic naso-biliary drainage tube was placed for 1 week.



Fig 1. Endoscopic retrograde cholangiography showing multiple stones in the CBD, ranging from 5 to 22 mm in diameter.

Though EHL under direct vision was one of some appropriate treatments for the difficult stones, mother-baby endoscope system was not available. So we adopted EHL using balloon catheter under fluoroscopic control, which was rarely applied for difficult stones in the CBD before the development of mother-baby endoscope system, and slightly modified the instruments or method. We used 1.9 Fr probe for Autolith lithotripter (Nortech) as EHL probe and Escort II (Wilson Cook) of double lumen type as balloon catheter. Escort II was made of polyethylene and its outer and inner size were 6.8-5.0 Fr and 0.035 inch, respectively. The balloon component of this catheter was constructed of natural latex rubber and its inflated

diameter was 15 mm. A rotating hemostatic valve (Target) was fitted at the proximal site of the catheter. The tip of probe was placed 2-3 mm out of the balloon catheter and was fixed by rotating hemostatic valve (Fig. 2). Although 1.9 Fr EHL probe was quite fragile, the combined device was easier to handle. Our initial experience using a transparent hose with an angle of 0-60 degrees demonstrated that the tip of this device does not make contact with the mucosa of CBD (Fig. 3). We obtained an informed consent, and all procedures were performed under mild sedation.

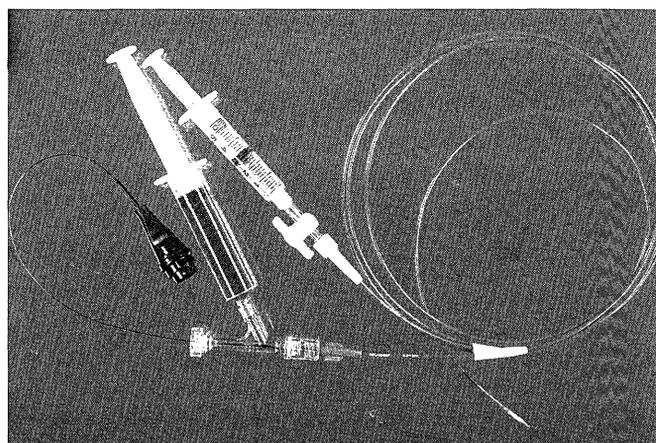


Fig 2. EHL using a double lumen balloon catheter and rotating hemostatic valve.

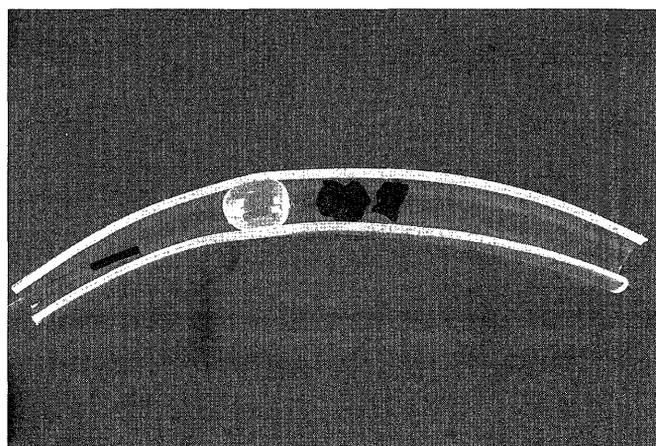


Fig 3. The tip of EHL probe, which is placed at 2-3mm out of the balloon catheter, does not make contact with the wall of a hose.

The device consisted of EHL probe and double lumen balloon catheter was transpapillary (EST opening) inserted into the CBD through the working channel of a duodenoscope (Fig. 4) and the tip of the catheter was placed in close proximity to the surface of the stone under fluoroscopic guidance (Fig. 5). After inflation of the balloon, we confirmed that the tip of the device was set at almost the center of the



Fig 4. The device composed of EHL probe and double lumen balloon catheter is inserted into the common bile duct through EST opening.

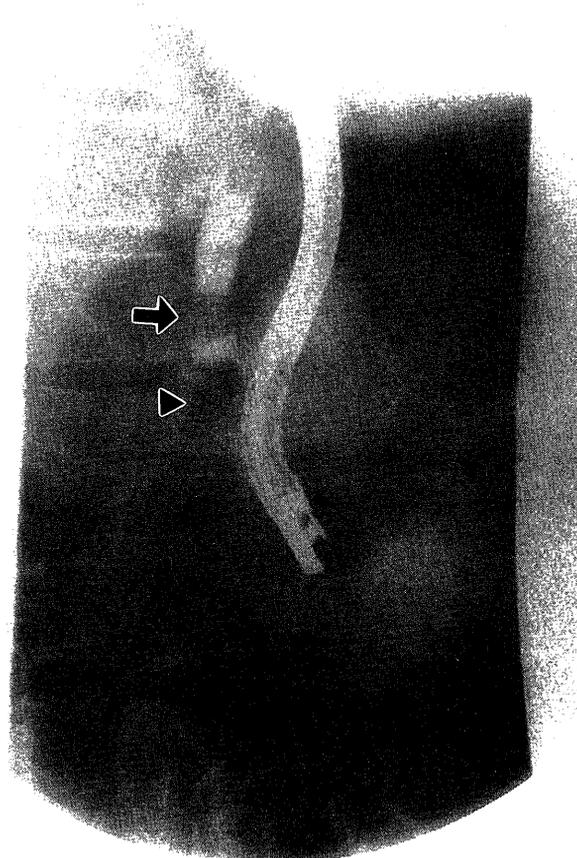


Fig 5. The device is in close proximity to the stone (arrow) under fluoroscopic guidance and after inflation of the balloon (arrow head). Once in position, EHL is performed.



Fig 6. Endoscopic retrograde cholangiography showing complete clearance of the stones in the CBD after EHLB.

CBD by 180 degree revolving X-ray system (CSII, Toshiba). Using a rotating hemostatic valve, EHL was applied under fluoroscopic control from the ventral side of the balloon. Partial disintegration of the giant stones occurred following the use of EHL (3367 Volt, 0.57 Joule, 20 cycle/sec, automatic continuous emission) and the stones were subsequently removed completely by combined treatment including basket or balloon catheter for stone extraction (Fig. 6). No intra- or post-operative complications or significant biliary mucosal damage were noted.

Discussion

In recent years, alternatives to surgery for stones in the CBD have been developed. Endoscopic management of these stones has become the approach of choice, especially in patients with high surgical risk, and today, nearly 90% of stones in the CBD are extracted endoscopically. The route used for non-operative retrieval is either the peroral retrograde approach or percutaneous transhepatic approach. In the former, EST and endoscopic papillary balloon dilation (EPBD) are widely used. Although EPBD may be a better technique when there is a risk of bleeding, it is usually limited by the diameter or number of stones in the CBD¹⁾. On the other hand, EST has become the established method for management of stones in the CBD, particularly in patients with previous cholecystectomy or high surgical risk²⁾. However stone removal or mechanical lithotripsy fails in about 5%, mainly because of the large size of the stones, impaction of stones, or the presence of biliary stricture³⁾. For these difficult stones, extracorporeal shock wave lithotripsy (ESWL)⁴⁾

or various other intracorporeal lithotripsy procedures, e.g., EHL and laser lithotripsy⁵), have been proposed. Although a "smart" laser, which could be used safely without requiring direct vision, has been introduced, the disadvantages of such procedure are cost and reliability⁶).

In 1959, electrohydraulic effect was first used in transurethral treatment of bladder stones⁷). The application of EHL for removal of stones in the biliary tree was introduced by Burhenne HJ in 1975⁸). In the last 20 years, several studies have confirmed the effectiveness of EHL for stones in the CBD. For example, Burton KE and coworkers⁹) reported that EHL lithotripsy was effective in fragmenting all biliary stones in 69 of 71 patients (97%), and all stone fragments were removed in 67 of these 69 patients (94%). Adamek HE et al¹⁰) reported a successful fragmentation of stones in the CBD by EHL in 38 of 46 patients; 34 patients (74%) eventually became stone-free, and furthermore, combined treatment including ESWL, EHL, and intracorporeal laser lithotripsy was finally successful in 94% of cases.

As mentioned above, the route for EHL is either peroral approach or percutaneous approach. In the former, at first, EHL was applied under fluoroscopic control. However previous experimental and clinical studies have demonstrated that the contact of the tip of the probe with the mucosa of the bile duct may cause certain complications such as bleeding or perforation⁷). Therefore, after the development of mother-baby endoscope system, it is recommended that the procedure should be performed under cholangioscopic control for a correct contact of the probe with the stone surface to avoid possible complications. However problems are encountered if insertion of the babyscope into the bile duct is not successful due to duct stenosis or technical difficulties, or the mother-baby system can not be prepared.

Several investigators challenged EHL under fluoroscopic control by using specially designed instruments^{11)–15}). Tanaka M et al¹³) reported that in the presence of technical difficulties associated with insertion of the babyscope, EHL probe with four legs, produced by trial, might be useful for lithotripsy under ERC. Although a few brief reports showed that a balloon catheter was necessary to prevent contact between EHL probe and ductal tissue¹⁴), details of the technique are not available at present. Finally the risks of tissue injury by EHL, performed under fluoroscopic control, were not settled completely. Besides EHL, centering of the catheter by balloon in the CBD has been investigated. Cotton PB et al¹⁶) reported that laser lithotripsy using the standard balloon catheter under fluoroscopic

control was easy to place against a stone. Ishihara T et al¹⁷) reported that the vascular endoscopic catheter was used for peroral cholangiopancreatography and could be centered by inflating the balloon. With the development of slender EHL probe and improved balloon catheter, we used Nortech Autolith lithotripter with a 1.9 Fr probe and Escort II, balloon catheter of double lumen type, under 180 degree revolving X-ray system. In Escort II, the length of ahead part from the balloon is very short (2 mm) and the expansion of the balloon keeps balance. It was suitable to avoid contact between the tip of the device and mucosa of the CBD. With regard to the use of Autolith lithotripter with a 1.9 Fr probe, it has been recently reported that the maximum shockwave emission was produced when the probe was about 1 mm from the stone surface, whereas the maximum jet velocity was produced when the probe tip was at a distance equivalent to the maximum bubble radius of about 3 mm¹⁸). In our case, the tip of the probe was fixed at 2-3 mm out of the balloon catheter and transpapillary delivered close to the surface of stone under fluoroscopic guidance. The double lumen balloon catheter and rotating hemostatic valve were easy to handle and the technique allowed repeated operation under clear cholangiography without the need to change the catheter or pull out the probe. Under 180 degree revolving X-ray system, we believe that the device did not contact the wall of the CBD due to the presence of the balloon. In fact, no complications related to EHLB were observed and stones were later removed completely through EST opening. However, further study is needed to establish the true security of the device because our initial experience using a transparent hose is not compatible to the actual state.

In conclusion, EHL for difficult stones in the CBD should be performed under cholangioscopic control to avoid possible complications. However, EHL using a double lumen balloon catheter and rotating hemostatic valve under 180 degree revolving X-ray system may be safe and effective therapeutic option when the mother-baby technique is not successful or not available.

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