

## Original Article

# Clinical observation study of common bile duct remnant stones by saline injection through ENBD under the guidance of transabdominal ultrasound

Yanbo Liu, Shuodong Wu, Shaoshan Tang, Dianbo Yao

*Department of The Second General Surgery, Shengjing Hospital of China Medical University, Shenyang, Liaoning, People's Republic of China*

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**Abstract:** Purpose: To investigate the observation accuracy of common bile duct (CBD) remnant stones by saline injection through endoscopic nasobiliary drainage (ENBD) under the guidance of transabdominal ultrasound. Methods: Endoscopic stone extraction was performed and ENBD was routinely placed in patients with CBD stones. Routine ultrasound examination was performed and the examination was repeated when 50-200 mL saline was injected through ENBD at 1 to 3 postoperative days slowly. Ultrasonic results were compared. Results: Among the 84 patients, no CBD remnant stones were observed in 77 patients by ENBD cholangiography. Among the 77 patients, CBD remnant stone was detected in 7 patients by ENBD transabdominal ultrasound by saline injection (TAUSI). In the 7 patients with CBD remnant stone detected by ENBD cholangiography, 5 patients were detected by ENBD TAUSI. The observed diameter and length of CBD was obviously increased in 82 patients after injection, especially for the lower part of CBD. Of the 14 patients with CBD remnant stone, CBD remnant stone was detected by ENBD cholangiography in 7 patients, with the detection rate 50% (7/14), while CBD remnant stone was detected by ENBD TAUSI in 12 patients, with the detection rate 85.7% (12/14). Conclusions: For the patients with ENBD, detection of CBD remnant stones by ENBD TAUSI is feasible, non-invasive, non-radiation, inexpensive, repeated and can be observed dynamically. It may be helpful to improve the accuracy of detecting CBD remnant stones.

**Keywords:** Common bile duct remnant stones, ultrasound, ENBD, saline injection

## Introduction

Choledocholithiasis is a common disease. The incidence of choledocholithiasis in cholelithiasis patients was 10-20%. Of which 7-14% are patients after cholecystectomy, and 18-33% are with acute biliary pancreatitis [1]. Most patients with CBD stones were hospitalized for abdominal pain, fever or jaundice. The principle and purpose of surgical treatment of CBD stones is to remove stones completely, relieve biliary obstruction, drainage bile and prevent infection [2]. For the treatment of CBD stones, especially stones in the lower part of CBD, endoscopic sphincterotomy (EST) are more and more accepted by the majority of doctors and patients. Remnant stone is the main factor related to the recovery and quality of life after

treatment for patients. Therefore, an accurate estimate of remnant stone after therapy is the most important. However, kinds of methods to detect the remnant stone have their own disadvantages. Although ultrasound has become a preferred examination for diagnosis of biliary diseases, routine transabdominal ultrasound is always interfered by intestinal gas especially for the lower part of CBD, making the diagnostic accuracy not ideal. Previous research has showed that drinking water could obviously improve the display rate of CBD and ultrasound diagnosis accuracy rate of the lower part of CBD [3]. In this study, we attempted to observe CBD remnant stones by an innovative approach of ENBD transabdominal ultrasound by saline injection for patients who placed ENBD, and investigate its observation accuracy.

## To observe CBD remnant stones by saline injection through ENBD under ultrasound

**Table 1.** Basic information and clinical features of patients

Number (male/female)	48/36
Average age (range of age)	57.9 (14-85)
CBD stone (single/multiple/muddy/suspected)	58/17/5/4
Complications and Accompanying symptoms	
Gallbladder stones	55
Cholangitis	6
Pancreatitis	2
Jaundice	31
Cholecystectomy	17

### Materials and methods

#### *Clinical materials*

From October 2014 to December 2015 in Department of The Second General Surgery, Sheng-jing Hospital of China Medical University, all the patients diagnosed or suspected with CBD stones based on the clinical manifestations, biochemical tests, and ultrasound, endoscopic ultrasonography (EUS), computed tomography (CT), or magnetic resonance cholangiopancreatography (MRCP), and treated by endoscopic stone extraction with ENBD, were included in this study. All the patients have indications of EST, without severe cardiopulmonary dysfunction, iodinated contrast allergy and dysfunction of coagulation. Operation risks, postoperative complications and the possibility of remnant stone were explained, and informed consent before operation was signed.

#### *Methods*

Operations were carried out by a professional operator. Iodine contrast examination was made after stone extraction to detect the existence of remnant stone. If there was significant filling defect, we will undergo stone extraction once more until no remnant stone was detected by cholangiography. ENBD was placed in the patients when no significant filling defect was detected. ENBD cholangiography was made to detect remnant stone. Transabdominal ultrasound examination at 1 to 3 postoperative days was performed. Routine ultrasound examination was performed by a professional ultrasound doctor to look for CBD and detect remnant stone. Afterwards, 50-200 ml saline was injected through ENBD slowly and injection of

bubble should be avoided. Ultrasound examination was repeated. Doctors should closely monitor patients' vital signs and pay attention to any uncomfortable symptoms of patient. Ultrasonic results, including changes of bile duct diameter and length and detection rate of CBD remnant stones, were compared.

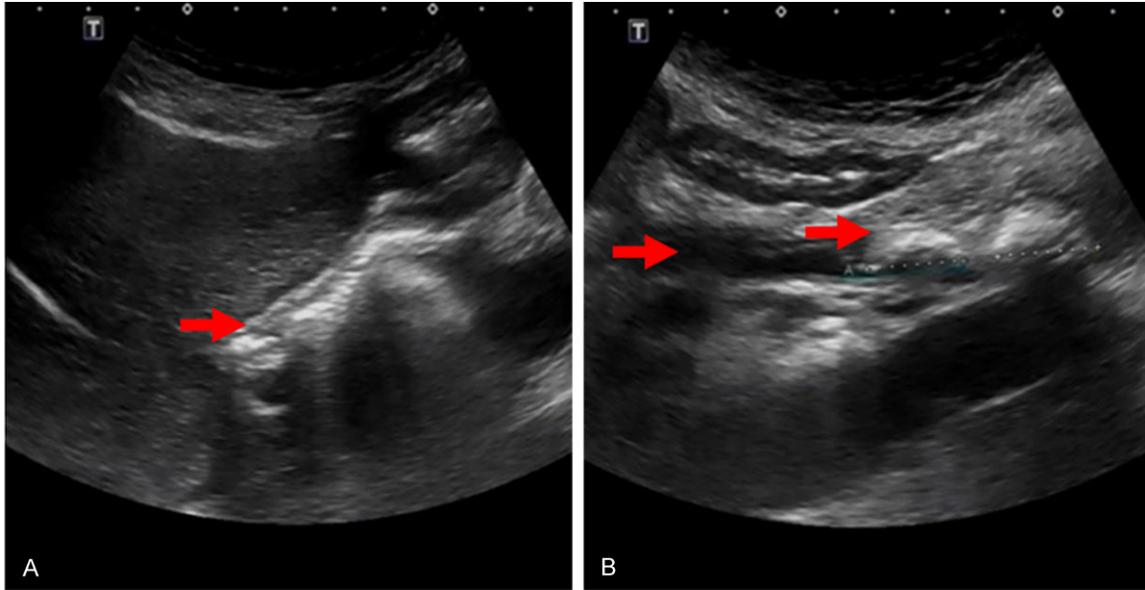
### Results

84 patients were included in this study, consisted of 48 males and 36 females.

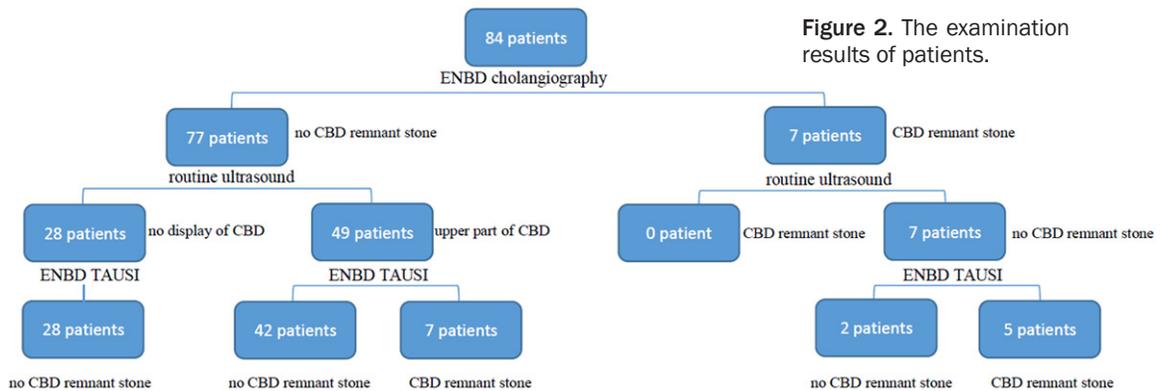
They were 14-85 years old with an average age of 57.9 years. Preoperative diagnosis included 58 cases of CBD single stone, 17 cases of CBD multiple stones, 5 cases of CBD muddy stone and 4 cases of suspected CBD stone. In addition, 55 cases of patients were combined with gallstones, 6 cases were with cholangitis, 2 cases were with pancreatitis, 31 cases were with jaundice and 17 cases were after cholecystectomy (**Table 1**). Among 84 patients, 38 cases underwent ENBD TAUSI to detect CBD remnant stones after endoscopic stone extraction without any other operation. 40 cases combined with gallbladder stones underwent laparoscopic cholecystectomy after endoscopic stone extraction. Among the 40 cases, 30 cases underwent ENBD TAUSI before laparoscopic cholecystectomy, and 10 cases underwent ENBD TAUSI after laparoscopic cholecystectomy. Two patients had difficulty in tubating because of stenosis of papillary caused by severe inflammation of duodenal papilla. These patients underwent laparoscopic cholecystectomy, choledocholithotomy, a suture of CBD, bile duct internal drainage. Afterwards, the drainage tube was removed through endoscope and ENBD was placed at the same time, and they underwent ENBD TAUSI to detect the CBD remnant stones. Four patients were suspected with CBD stone and then underwent ENBD TAUSI after endoscopic stone extraction.

Among the 84 patients, no CBD remnant stones were observed in 77 patients by ENBD cholangiography. Among the 77 patients, 28 patients were with no significant display of CBD and 49 patients were observed the upper part by routine ultrasound examination. Among 28 patients by ENBD TAUSI, 3 patients showed bad tolerance of abdominal pain after injection of 20 ml saline and pain was relieved immediately

To observe CBD remnant stones by saline injection through ENBD under ultrasound



**Figure 1.** Image change of patients who were detected CBD remnant stones after injection. A. It is the image of CBD under routine ultrasound. The place of the arrow is extremely unclear CBD. B. It is the image of CBD under ENBD TAUSI. The place of left arrow is CBD that can observe obvious increase of the diameter and length and also the lower part compared with routine ultrasound. The place of right arrow is CBD remnant stones in the lower part of CBD.



after stopping injection, and the upper part of CBD was observed with ENBD in after injection. Among the other 25 patients, no significant change of the diameter of the CBD after injection that was not displayed before injection was observed in 2 patients; the upper part of CBD was observed in 3 patients; the lower part of CBD was observed with ENBD in 20 patients. The upper part of CBD was observed in 49 patients by routine ultrasound which was observed obvious increase of the diameter and length, and the lower part of CBD and ENBD could be observed by ENBD TAUSI. Seven of 49 patients were detected CBD remnant stone by ENBD TAUSI (Figure 1). One patient underwent laparoscopic cholecystectomy, choledocholi-

thotomy, T-tube drainage and CBD remnant stone was removed out eventually. ENBD cholangiography was taken again before second endoscopic stone extraction in 6 patients. One patient did not remove out any obvious CBD stone while CBD remnant stone could be observed by second ENBD cholangiography. Maybe CBD stone was out by ENBD removal before stone extraction. Two patients removed out multiple stones on the condition that one positive and one negative result happened in second ENBD cholangiography. Two patients removed out single CBD stone. A mass of biliary sludge was considered in 1 patient who underwent 1000 mL saline dropping in slowly through ENBD per day 2 days before examination, and

## To observe CBD remnant stones by saline injection through ENBD under ultrasound

**Table 2.** Changes of CBD under routine ultrasound and ENBD TAUSI

	Routine ultrasound	ENBD TAUSI	
Length (cm)	2.24±2.22	5.01±2.60	P<0.01
Diameter (cm)	0.42±0.36	0.89±0.35	P<0.01

CBD muddy stone was removed out eventually. No CBD stone were observed in these three patients by second ENBD cholangiography.

Seven patients who could not tolerate long stone extraction time were placed ENBD after part of stones removal. CBD remnant stone could be still observed in these patients by ENBD cholangiography. By routine ultrasound, the upper part of CBD could be observed in 4 patients and no significant display of CBD happened in 3 patients, and no CBD remnant stone was observed in all these patients. By ENBD TAUSI, the lower part of CBD could be observed and CBD remnant stone could be observed in 5 patients. Two of these 5 patients were considered a mass of biliary sludge and underwent 1000 ml saline dropping in slowly through ENBD per day 2 days before second endoscopic stone extraction. One patient removed out CBD muddy stone eventually while the other was not; 1 patient did not cooperate and left hospital with ENBD; 2 patients removed out CBD stone at second endoscopic stone extraction. One of 2 patients, who were not observed CBD remnant stone by ENBD TAUSI, removed out CBD stone at second endoscopic stone extraction, and the other one underwent laparoscopic choledocholithotomy, a suture of CBD and removed out stone at the end of CBD (**Figure 2**).

In the 12 patients with CBD remnant stone observed by ENBD TAUSI, only one was detected before saline injection. Obvious increase of the diameter and length of CBD was observed, and the lower part of CBD with ENBD was visible after injection. Among the 84 patients, the observed diameter and length of CBD was obviously increased in 82 patients after injection (**Table 2**), especially for the lower part of CBD, which was always interfered by intestinal gas before injection (**Figure 3**), and in the other 2 cases, the CBD was poorly observed either before or after injection. Of the 14 patients with CBD remnant stone, CBD remnant stone was detected by ENBD cholangiography in 7

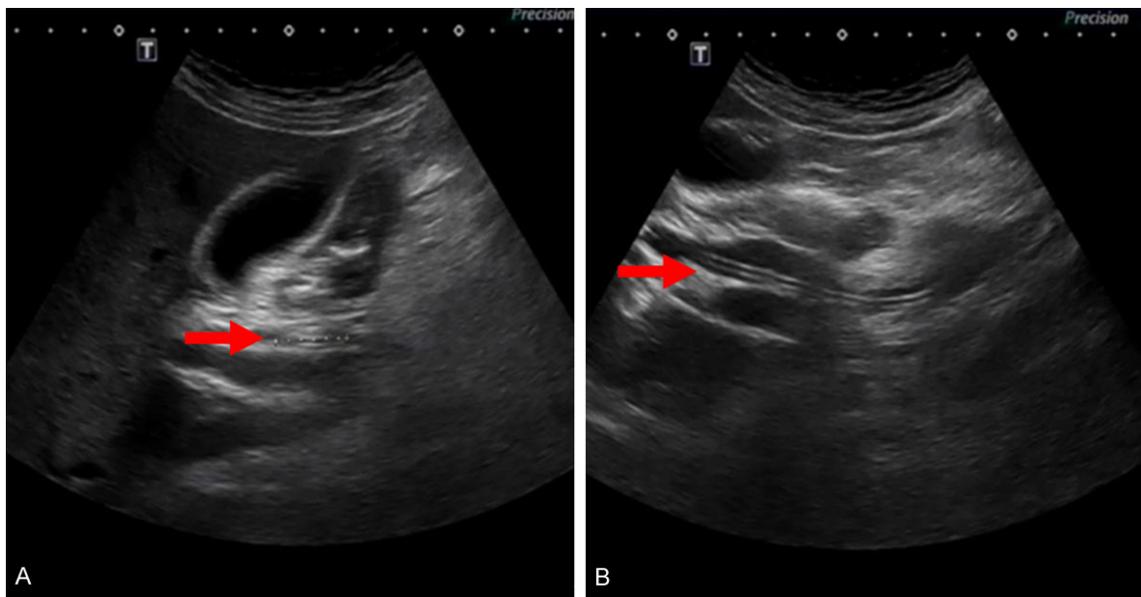
patients, with the detection rate 50% (7/14), while CBD remnant stone was detected by ENBD TAUSI in 12 patients, with the detection rate 85.7% (12/14). By routine ultrasound, in only 1 patient CBD remnant stone was detected (7.1%, 1/14).

### Discussion

For the patients with CBD stones, especially for those with stones in the lower part of the CBD, endoscopic stone extraction is increasingly accepted by the majority of doctors and patients. It was showed that endoscopic stone extraction can reduce the possibility of postoperative complications of traditional open surgery and reduce surgical trauma, shorten the hospitalization time and avoid the pain with T tube drainage for long time [4-6]. However, if there are remnant stones after endoscopic stone extraction, due to indirect observation of the whole CBD, acute suppurative cholangitis and even acute pancreatitis will appear in a short time. Therefore, finding effective diagnostic method has important clinical significance.

For ENBD cholangiography, tiny, sand-like stones are difficult to be detected, to get a false-negative result. In addition, patients will receive radiation exposure, and injection of iodine contrast agent could induce pain or transient biliary irritation. CT examination is easily affected by non-calcium stones and interfered by the presence of ENBD. As the observation of CBD, especially the lower part of CBD, is always interfered by intestinal gas and many other factors, for routine ultrasound examination, the observed effect is not ideal either. Moreover, for patients who underwent EST, making the observation of CBD more unsatisfactory, function of Oddi's sphincter was affected and intestinal gas may retrograde into the biliary tract, the space between ENBD and CBD wall is too small to detect the smaller stones. In our study, we take an innovative method that injecting saline through ENBD under the guidance of transabdominal ultrasound, fill up CBD and exclude the retrograding gas in CBD due to EST. By this way, the condition of the gap between CBD and ENBD were more clearly displayed, which could help detecting the small stones more easily in the gap. Ultrasound examination has the advantages of real-time and dynamic observation. In our study, the patients were at left lateral position as the main position, which

## To observe CBD remnant stones by saline injection through ENBD under ultrasound



**Figure 3.** Image change of some patients who were not detected CBD remnant stones after injection. A. It is the image of CBD under routine ultrasound. The place of the arrow is CBD and barely visible ENBD in it. B. It is the image of CBD under ENBD TAUSI. The place of the arrow is CBD and ENBD. Obvious increase of diameter and length of CBD was observed compared with routine ultrasound and the lower part of CBD could be observed without CBD remnant stone.

made the CBD retrograding gas more easily discharge into intestine and prevented intestinal gas refluxing into CBD again. At the same time, the gas in duodenum may be excluded with the injection of saline, which led to the display of CBD especially the lower part. ENBD TAUSI is simple, easily operated and less expensive. But it could significantly improve the quality of ultrasound examination and the accuracy of observing CBD stones, which could help guide the subsequent relevant treatment. ENBD TAUSI could avoid the possibility of iodine contrast agent allergic events and reduce the chance of patients and their families affected by radiation exposure during ENBD cholangiography. Our study is an innovative examination method. And the cost of ENBD TAUSI is smaller than ENBD cholangiography, which made it easier for patients to accept it. In our study, the detection rate (85.7%, 12/14) of CBD remnant stone by ENBD TAUSI was higher than that (50%, 7/14) by ENBD cholangiography, suggesting that ENBD TAUSI can obviously improve the accuracy of observing CBD remnant stones.

Among all patients in this study, only 3 patients appeared uncomfortable after the injection and pain was relieved immediately after stopping injection. This may be related to probe

scanning with compression and transient increase in biliary pressure. The remaining patients did not have any uncomfortable symptoms. Patients detected no CBD remnant stone by both ENBD TAUSI and ENBD cholangiography were underwent removal of ENBD, and no symptom or complication such as abdominal pain, fever was happened within 3 days. Two patients' CBD was not displayed under routine ultrasound and ENBD TAUSI because of obesity. 2 patients detected no CBD remnant stone by ENBD TAUSI while detected by ENBD cholangiography. One's CBD stone was incarcerated in duodenal wall segment of CBD with bad observing quality. The other one underwent laparoscopic cholecystectomy at the day before ENBD TAUSI, and postoperative intraabdominal residual gas had interference.

The disadvantage of this method is that it is easy to cause the injection of bubble through ENBD into CBD due to the lack of standardized operation, which can lead to the unclear observation. CBD stone is a fixed strong echo group and accompanied with acoustic shadow, while bubble is without characteristic acoustic shadow and can move and disappear, under ultrasound examination. So the operation must be standardized to avoid bubbles entering into

## To observe CBD remnant stones by saline injection through ENBD under ultrasound

CBD. Moreover, before continuous injection, suction of gas in ENBD was necessary until seeing bile. The length of the CBD after injection is significantly increased. However, ultrasound examination imaging condition is limited into a plane, and the measurement of the maximum length is only in the plane. In fact, the visible length that is not in the same plane is longer. So the dynamic observation in the examination process is much better. For obese patients, the effect of ENBD TAUSI is limited. For patients who undergo laparoscopic surgery needing to establish pneumoperitoneum, intraabdominal gas should be released as far as possible, and ENBD TAUSI is taken after intraabdominal gas reducing or even disappearing.

Our study is still in an initial stage and needs to be confirmed by other relevant examinations. Because of the strict indications and the limitations of patients' tolerance, the sample size is a little small and a further large sample of experiments is expected. For ENBD TAUSI, in addition to conventional probe scanning with compression and changing position during examination, further gastrointestinal preparation and drinking water can be taken to improve observation of CBD especially the lower part. In our study, ultrasound doctor is more skilled and tacit cooperation with clinical doctor's injection is better with increase in the number of cases, and every patient's whole CBD can be observed by ENBD TAUSI.

For the patients with ENBD, detection of CBD remnant stones by ENBD TAUSI is feasible, non-invasive, non-radiation, inexpensive, and CBD remnant stone could be repeatedly checked with dynamic observation. It has a very important reference value and may be helpful to improve the accuracy of detecting CBD remnant stones. And of course, the clinical significance of this method needs a further large sample, randomized controlled trials.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Shuodong Wu, Department of The Second General Surgery, Shengjing Hospital, China Medical University, 36 Sanhao Street, Heping District, Shenyang 110004, Liaoning, People's Republic of China. Tel: 0086-24-96615-1-31211; E-mail: wawjlyb@sina.com

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