

# Puncture and discission with a needle: A new method for laparoscopic common bile duct exploration

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## Abstract

This study aimed to describe a novel puncture and discission with a needle (PDN) method facilitating laparoscopic common bile duct exploration (LCBDE).

The clinical data of 81 patients with cholelithiasis or choledocholithiasis who underwent LCBDE with PDN between January, 2017 and December, 2017 were retrospectively analyzed. Time for puncture and discission of the bile duct, blood loss, postoperative complications (such as bile leakage, common bile duct [CBD] strictures, and recurrence of choledocholithiasis), and postoperative hospital stay were recorded to evaluate the safety of the method.

PDN was performed in all 81 patients with a 100% surgical success rate. Surgery went smoothly. Neither mortality nor complications associated with PDN (portal vein injury or biliary leakage) were observed. The mean time for puncture and discission of the CBD was 2.4 minutes and the maximum blood loss was 100 mL. CBD strictures or recurrence of choledocholithiasis were not noted after 12 to 24 months of follow-up.

LCBDE with PDN is a novel method and has the advantages of reliability, convenience, and efficiency without additional costs or complications.

**Abbreviations:** BMI = body mass index, CBD = common bile duct, LCBDE = laparoscopic common bile duct exploration, PDN = puncture and discission with a needle.

**Keywords:** choledocholithiasis, choledochotomy, laparoscopic common bile duct exploration, puncture and discission with a needle

## 1. Introduction

Common bile duct (CBD) stones are reported to occur in between 10% and 20% of patients with cholelithiasis, which can result in acute pancreatitis, obstructive jaundice, and fatal acute obstructive suppurative cholangitis.<sup>[1–4]</sup> In the past, the most popular management technique for cholecystolithiasis concom-

itant with choledocholithiasis was endoscopic retrograde cholangiopancreatography (ERCP) with sphincterotomy and stone extraction, followed by laparoscopic cholecystectomy.<sup>[5,6]</sup> With recent advances in laparoscopic techniques, laparoscopic common bile duct exploration (LCBDE) has become more popular because it is a single-stage procedure with technical success, no damage to the sphincter of Oddi, and shorter hospital stays.<sup>[2,6,7]</sup> However, the identification and discission of the CBD are critically important approaches in LCBDE with well-reported difficulties. Available methods for the identification and discission of the CBD include primary identification of the CBD using transcystic cholangiography or puncture with a specialized syringe, followed by discission of the CBD using a retractable scalpel or electric hook.<sup>[6]</sup> However, owing to the high risk of ductal strictures, injury to the posterior CBD wall or the portal vein, intra-operative hemorrhaging, and the extra cost of puncturation instruments, this procedure requires technical innovation.

This study aimed to describe a novel puncture and discission with a needle (PDN) method facilitating LCBDE. PDN involves using a small triangular needle with a 5-cm suture that can identify the CBD and make a linear incision.

## 2. Methods

PDN for LCBDE has been performed by an experienced laparoscopic surgeon since 2016. The data of 81 patients with cholelithiasis or choledocholithiasis (33 men and 48 women) who underwent LCBDE with PDN at the Affiliated Zhuzhou Hospital of Xiangya Medical College, Central South University, China

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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Table 1	
Patient characteristics.	
Age (yr) <sup>a</sup>	55 (21–82)
Sex ratio (F:M)	48:33
Body mass index (kg/m <sup>2</sup> )	23.9(17.3–36.4)
Previous abdominal operations	
Biliary operations	6
Other abdominal operations	11
Disease diagnosis	
Simple choledocholithiasis	7
Cholecystocholedocholithiasis	74
Complicated disease	
Acute biliary pancreatitis	5
Acute obstructive suppurative cholangitis	6
Diameter of common bile duct (mm)	13.7 (7–30)

Values are mean (range) unless indicated otherwise.

<sup>a</sup> Values are median (range).

between January, 2017 and December, 2017 were retrospectively analyzed. The following clinical information was collected: age, sex, body mass index, CBD diameter, history of abdominal operations, and diagnosis. The CBD diameter was measured using preoperative magnetic resonance cholangiopancreatography rather than perioperative cholangiography.<sup>[8]</sup>

From the 81 patients, 17 had a history of abdominal surgery as follows (Table 1). After adequate extraction of the CBD stones, primary closure of the CBD was performed in 6 patients. Choledochorrhaphy protected by a T-tube was performed in 75 patients, with the T-tube being postoperatively removed within 6 to 8 weeks of the procedure. From these 75 patients, 6 developed residual choledocholithiasis and underwent choledochoscopy and basket extraction of the CBD stones once.

The study was approved by the Ethical Committee of The Affiliated Zhuzhou Hospital in 2016, and all patients provided informed consent for participating in the study.

The patients were administered endotracheal general anesthesia. After pneumoperitoneum was established, a standard 4-trocar 30° laparoscopy was introduced to detect lesions. The gallbladder was removed and dissection was performed along the stump of the cystic duct until the CBD was exposed. A triangular needle with 2-0 silk suture (approximately 4–5 cm) was

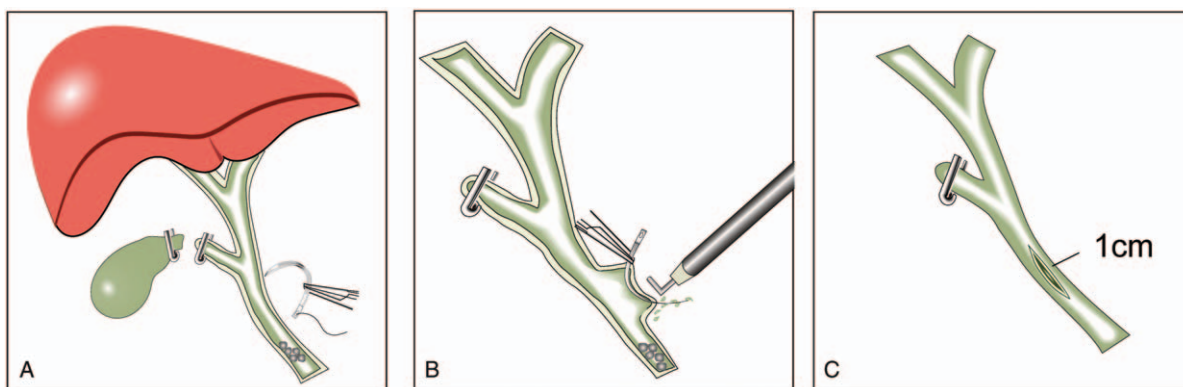
introduced using a needle-holder into the peritoneum via a 10-mm sub-xiphoid trocar. The anterior wall of the CBD was vertically punctured while avoiding longitudinal vascularization of the choledochus, and the puncture was extended to the nonvascular covered duct; yellow-green bile leaked along the needle head, reflecting the genuine CBD structure. After confirmation, the needle head was completely removed from the CBD wall. The CBD was lifted using the triangular needle body and an approximately 1.0-cm linear incision was made along the needle using an electric hook (Figs. 1 and 2). The intra- and extra-hepatic bile ducts were explored using choledochoscopy, and the CBD stones were extracted using basket or electrohydraulic lithotripsy as well as irrigation with normal saline. Once a second choledochoscopy confirmed the patency of the CBD, either T-tube drainage or primary closure of the CBD was performed, depending on the diameter. Finally, the CBD incision was closed using interrupted absorbable sutures. The selection criteria of direct closure were:

- (1) Hepatolithiasis has been ruled out;
- (2) Diameter of CBD  $\geq 0.8$  cm;
- (3) All stones were removed during the operation;
- (4) There was no severe edema in the mucosa of CBD and no stenosis in the lower end.<sup>[9]</sup>

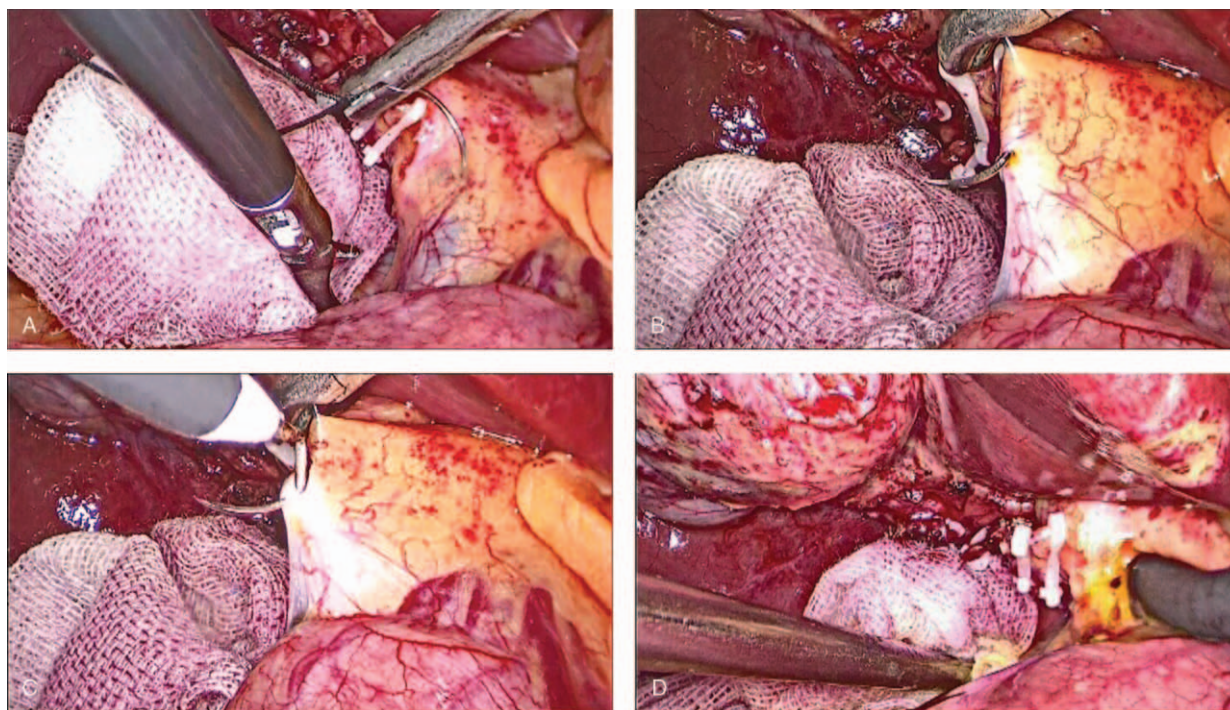
The operative time for puncture and dissection of the CBD was defined as the time required from insertion of the needle tip into the CBD wall until CBD incision. The time for puncture and dissection of the CBD, intra-operative hemorrhage volume, duration of postoperative hospital stay, and complications (bile duct hemorrhage, post-operative yellow-green bile leakage, CBD strictures, and choledocholithiasis recurrence) were recorded.

The follow-up plan involved patients visiting the outpatient department center 1 month after surgery, and phone interviews every three months. Concurrently, patients were instructed to visit the outpatient department if they felt unwell. This plan lasted for 2 years and no patient lost to follow-up.

All data were summarized using SPSS version 19 (IBM, Armonk, NY). Continuous variables are described as means with either full range or standard deviation, and count data are described by absolute number, ratio, and constituent ratio, according to the most appropriate indicators for different variables.



**Figure 1.** Schematic representation of PDN. (A) A triangular needle was vertically manipulated to puncture the CBD. (B) The triangular needle was longitudinally manipulated avoiding blood vessels. Subsequent yellow bile leak confirmed the CBD structure. The triangular needle was lifted to maintain the CBD under certain amount of tension, and an electric hook was introduced to linearly incise the CBD. (C) A 1-cm long linear incision was made and then prepared for LCBD.



**Figure 2.** Intra-operative photographs of PDN corresponding to schematic representation in Figure 1. (A) Puncture. (B) CBD confirmation. (C) CBD discission. (D) Exploration with a choledochoscope.

### 3. Results

The median age of the 81 patients was 55 (range 21–82) years, and the mean body mass index was  $23.8 \pm 4.1 \text{ kg/m}^2$  (range 17.3–36.4) (Table 1). Neither mortality nor complications associated with PDN were observed (portal vein injury or bile leakage). The surgery went smoothly in all cases, the mean time was  $151.9 \pm 65.6$  minutes (range 70–485 minutes), and the surgical success rate was 100%. The mean operative time for PDN was  $2.4 \pm 0.9$  minutes (range 1.5–6.5 minutes), and the mean postoperative hospital stay was 6.4 days. The range for total intra-operative hemorrhage volume was 10 to 100 mL. Follow-up scheduled 12 to 24 months postoperatively revealed no anastomotic CBD strictures or choledocholithiasis recurrence (Table 2).

**Table 2**

**Operative results of patients who underwent laparoscopic common bile duct exploration with puncture and discission with a needle.**

Surgical success rate	100%
Intraoperative blood loss* (ml)	44.8 (10–100)
Operation time(min)	151.9 (65.6)
Operative time for puncture and discission of bile duct(min)	2.4 (0.9)
Primary closure of CBD† (n)	6
Drainage with T tube(n)	75
Mortality or complications(n)	none
Postoperative hospital stay(days)*	6.4 (3–13)
Postoperative residual stones of CBD	6
Anastomotic stricture or stone recurrence of CBD after follow-up	none

Values are mean (s.d.) unless indicated otherwise.

\* Values are mean (range).

† CBD means common bile duct.

In a patient with a preoperative CBD diameter of 7 mm, we found no occurrence of CBD strictures postoperatively at 16-month follow-up. None of the 81 patients developed mechanical injury of the CBD or portal vein.

### 4. Discussion

Over the past 20 years, LCBDE has undergone a brisk process of maturation, progression, and innovation,<sup>110]</sup> becoming the gold standard technique for cholecystocholedocholithiasis,<sup>[6,11–13]</sup> although a few key problems are yet to be resolved. Direct discission using a retractable scalpel or an electric hook is the most popular current approach; however, this method involves a high risk of CBD injury, bile leakage after primary choledochor-rhaphy, scar contracture–induced CBD strictures, and necrosis of the incision margin. Therefore, we developed a novel and simple method called PDN, which resolves these potential problems. Here, we summarize data from operations performed in 2017 and demonstrate progressive results with patients who were followed up for more than 1 year.

First, PDN involves the simple combination of a laparoscopic needle-holder, a small triangular needle, and a silk suture, which helps the surgeon to not only conveniently enter and exit the trocar and precisely puncture the CBD, but also to effectively confirm the CBD structure by the yellow-green bile leakage around the needle tip. This is an easy and inexpensive procedure. Second, as the needle is manipulated parallel to the longitudinal axis of the CBD after insertion, PDN can effectively avoid damaging the portal vein, duodenum, and other important organs compared with routinely irregular discission. Third, compared with traditional incising techniques, which increase the risk of CBD strictures, linear incising and stitching assisted by a

needle causes the scar to heal parallel to the longitudinal axis of the CBD, with minimal risk of CBD strictures.

Furthermore, PDN may cause less thermal damage compared with conventional direct electrocision of the CBD. In addition, the distance between the needle entry and exit points is approximately 1 cm, which is close to the expected length of incision; in our experience, no other surgical instruments have a shorter CBD puncture and dissection time. For patients with CBD wall thickening and vascular proliferation caused by tissue adhesion and scar formation from previous biliary surgery, in LCBDE with PDN, the surgeon can flexibly control the force and angle of puncturation using a curved triangular needle. Even if the needle punctures the blood vessels of the CBD, effective hemostasis can be achieved simply by electrocoagulating the surrounding tissue.

Our preliminary outcomes are encouraging and we conclude that PDN is a useful technique, particularly in cases of multiple CBD operations. However, its success depends on the laparoscopist being experienced, and the procedure is not appropriate for beginners. In addition, its application is subject to some restrictions, such as disease type. When the CBD is full with stones, the needle cannot puncture into the bile duct and PDN is unsuitable in this scenario. If the laparoscopic equipment is inappropriate, the technique cannot be performed. In addition, PDN should be used cautiously in cases of CBD variation and inability to distinguish the duct, so as to avoid further injury.

Overall, these findings indicate that PDN is a novel, simple method for LCBDE with the advantages of reliability, convenience, and efficiency without additional costs or complications. However, the technique still needs to be further validated by prospective, high-quality case-control studies or randomized controlled trials, with a greater number of patients.

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### Author contributions

**Data curation:** Zhi-Qin Xie, Hong-Xia Li, Yong-Kang Sun, Xun Chen.

**Formal analysis:** Zhi-Qin Xie, Hong-Xia Li.

**Funding acquisition:** Cai-Xi Tang.

**Resources:** Zhi-Qin Xie, Yong-Kang Sun.

**Writing – review & editing:** Zhi-Qin Xie, Hong-Xia Li, Xun Chen, Cai-Xi Tang.

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