



## Original article

# Laparoscopic transcystic common bile duct exploration versus transgastric endoscopic retrograde cholangiography during cholecystectomy after Roux-en-Y gastric bypass

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**Abstract**

**Background:** Treatment of common bile duct (CBD) stones after Roux-en-Y gastric bypass (RYGB) poses a particular challenge given the altered anatomy and inability to perform a standard endoscopic retrograde cholangiogram (ERC). The optimal treatment strategy for intraoperatively encountered CBD stones in post-RYGB patients has not been established.

**Objectives:** To compare outcomes following laparoscopic transcystic common bile duct exploration (LTCBDE) and laparoscopy-assisted transgastric ERC for CBDs during cholecystectomy in RYGB-operated patients.

**Setting:** Swedish nationwide multi-registry study.

**Methods:** The Swedish Registry for Gallstone Surgery and ERCs, GallRiks (n = 215,670), and the Scandinavian Obesity Surgery Registry (SOReg) (n = 60,479) were cross-matched for cholecystectomies with intraoperatively encountered CBD stones in patients with previous RYGB surgery between 2011 and 2020.

**Results:** Registry cross-matching found 550 patients. Both LTCBDE (n = 132) and transgastric ERC (n = 145) were comparable in terms of low rates of intraoperative adverse events (1% versus 2%) and postoperative adverse events within 30 days (16% versus 18%). LTCBDE required significantly shorter operating time ( $P = .005$ ) by on average 31 minutes, 95% confidence interval (CI) [10.3–52.6], and was more often used for smaller stones <4 mm in size (30% versus 17%,  $P = .010$ ). However, transgastric ERC was more often used in acute surgery (78% versus 63%,  $P = .006$ ) and for larger stones >8 mm in size (25% versus 8%,  $P < .001$ ).

**Conclusions:** LTCBDE and transgastric ERC have similarly low complication rates for clearance of intraoperatively encountered CBD stones in RYGB-operated patients, but LTCBDE is faster while transgastric ERC is more often used in conjunction with larger bile duct stones. (Surg Obes Relat Dis 2023;■:1–7.) © 2023 American Society for Metabolic and Bariatric Surgery. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Keywords:**

Adult; Adverse events; Choledocholithiasis; Cholangiopancreatography; Endoscopic retrograde; Cholecystectomy; Gastric bypass; Postoperative complications; Treatment outcome

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Common bile duct (CBD) stones are encountered by routine intraoperative cholangiography in 7%–18% of elective laparoscopic cholecystectomies and even more frequently in the acute setting [1,2]. CBD stones are particularly challenging to treat after a Roux-en-Y gastric bypass (RYGB) because of the altered anatomy and the inability to perform a standard endoscopic retrograde cholangiography (ERC). Additionally, these patients have an increased risk of gallstone formation because of their obesity and rapid weight loss after the bariatric procedure [3,4].

Treatment options for CBD stone include preparation for two-stage management, laparoscopic or open choledochotomy, or single-stage intraoperative ERC and laparoscopic transcystic common bile duct exploration (LTCBDE). Other uncommon approaches include percutaneous transhepatic stone removal by employing interventional radiology. Surgeons in Sweden are trained in performing endoscopies with some also mastering ERCs. As intraoperative cholangiography is routine in Sweden, most hospitals have arrangements in place to perform either an intraoperative ERC or LTCBDE to handle any encountered CBD stones. Since many surgeons in Sweden already regularly perform intraoperative ERCs, the laparoscopy-assisted transgastric approach developed in 2002 for the Roux-en-Y anatomy is widely adopted [5]. It has been shown to be a safe procedure at experienced centers [6–8]. Another common management option is the laparoscopic transcystic CBT exploration, which has also been proven safe and effective [9–12].

Nearly all cholecystectomies and ERCs performed in Sweden are reported to the nationwide, population-based Swedish Registry for Gallstone Surgery and ERCs GallRiks [13]. GallRiks reports successful intraoperative cholangiography in >87.5% of patients [14]. Patients undergoing bariatric surgeries and reversal of their bariatric procedures are similarly reported to the validated Scandinavian Obesity Surgery Registry (SOReg) [15,16]. Both registries have excellent coverage rates of >90% and >95% respectively [17].

The optimal treatment strategy for intraoperatively encountered CBD stones in RYGB-operated patients has yet to be established. Studies have shown that single-stage intraoperative management is more cost-effective and efficient than two-stage management [18,19]. In this study, a registry-based comparison is made between, 2 single-stage procedures, LTCBDE and laparoscopy-assisted transgastric ERC for the management of CBD stones in RYGB-operated patients over a 10-year period.

## Method

A nationwide multi-registry study was performed to include adult patients (>18 years old) with a history of RYGB, and having a cholecystectomy with an intraoperative finding of CBD stones. Patients were retrieved by

cross-matching data from the national registries GallRiks (n = 215,670) and SOReg (n = 60,479). Data were extracted for cholecystectomies performed during 2011–2020. Exclusion criteria were any indication other than gallstone-related for the cholecystectomy, reversal of the Roux-en-Y anatomy before the cholecystectomy, and if the cholecystectomy was not the primary operation.

### *Laparoscopic transcystic CBD exploration*

The indications for LTCBDE are fillings or equivocal defects at cholangiography, i.e., stones that are <10 mm and fewer than 10. Contraindications include stones  $\geq 10$  mm in size, stones located in the common hepatic duct, a fragile cystic duct, or  $\geq 10$  stones [11]. However, in the Roux-en-Y setting, the procedure may be attempted outside of these guidelines as a minimally invasive alternative to transgastric ERC. It may also be performed more liberally for smaller stones to ensure bile duct clearance at the end of the surgery.

LTCBDE is performed by the operating surgeon with the aid of an assistant at their normal positions on the patient's left side. An additional long 5 mm trocar is placed under the right costal margin to achieve proximity to the cystic duct to facilitate the introduction of the choledochoscope (KARL STORZ SE & Co. KG:s, Tuttlingen, Germany). An introducer and a guidewire may be used to further facilitate the entry into the cystic duct. A winding cystic duct may require dilatation using a balloon catheter to allow for the passage of the endoscope. The choledochoscope is entered into the cystic duct while saline is flushed through the device with manual pressure to increase visibility and locate the papilla of Vater and any CBD stones. Smaller stones may be pushed or flushed out into the duodenum while larger stones are extracted using retrieval baskets (Gemini, Zero-tip, Boston Scientific, MA, USA). Stones that are wider than the cystic duct can either be crushed by the retrieval basket if fragile or fragmented using laser lithotripsy.

### *Laparoscopy-assisted transgastric ERC*

The GallRiks database does not differentiate between different techniques of performing an intraoperative ERC, i.e., transgastric or using push-enteroscopy or similar techniques [20]. Based on practical knowledge of available surgical and endoscopic techniques in Sweden, a clinical assumption was made that the procedures were most likely performed using laparoscopy-assisted transgastric access [21]. This is achieved by placing a trocar into the stomach remnant under laparoscopic visualization through which the endoscope can be inserted. A standard ERC or a rendezvous ERC can then be performed. The rendezvous technique involves using a guidewire placed through the cystic duct to facilitate entry into the CBD and reduce the risk of pancreatitis.

### Statistical analysis

Data were stored and analyzed using SPSS version 28 (IBM Corporation, Armonk, NY, USA). Results were expressed as median with minimum and maximum values. Mann-Whitney *U* test was used for group comparisons of continuous values. Pearson's chi-squared test was used for the comparison of categorical variables, except for values fewer than 5, where Fisher's exact test was used instead. All group comparisons were unpaired. A 2-sided *P* value of  $\leq .05$  was considered statistically significant.

### Ethical considerations

The study was approved by the Swedish Ethical Review Authority (2021-05,564-01) on November 10th, 2021. This retrospective study did not require informed consent.

## Results

### Demographics and overall handling of CBD stones

The data retrieved from the cross-matched registries found 550 patients with intraoperatively encountered CBD stones following RYGB. Nationwide 145 patients were managed with intraoperative transgastric ERC and 132 patients with LTCBDE. The procedures ( $n = 277$ ) were reported from 47 hospitals (1–24 procedures/hospital), with 23 hospitals reporting fewer than 5 procedures. Study population demographics showed no statistical difference in body mass index, sex, or ASA (American Society of Anesthesiologists) scores between the 2 treatment modalities (Table 1). The remaining patients had their CBD stones flushed out with saline ( $n = 143$ ), left without intervention ( $n = 38$ ), had preparation for postoperative ERC ( $n = 14$ ), or were treated by either laparoscopic choledochotomy ( $n = 18$ ) or open choledochotomy ( $n = 58$ ). Data on CBD stone management was missing for 2 patients (.4%).

The studied procedures, LTCBDE and transgastric ERC were most often performed in the acute setting, where transgastric ERC was overrepresented (Table 2). Elevated bilirubin or icterus as a preoperative indication of cholestasis was significantly more common in the transgastric ERC group compared to the LTCBDE group (64% versus 45%,  $P = .002$ ).

### Intraoperative and postoperative outcome comparisons

One intraoperative adverse event occurred in the LTCBDE group and 3 adverse events including 1 intestinal perforation occurred in the transgastric ERC group. The data did not specify whether the intestinal perforation was a consequence of the cholecystectomy or the ERC procedure. Postoperative adverse event rates were similar with more abscesses after ERC and more remaining CBD stones after LTCBDE, although lacking statistical significance (Table 2). The treated CBD stone sizes showed a difference between the techniques, with significantly larger stones being treated by transgastric ERC ( $P < .001$ ) (Fig. 1). The total surgery time was significantly shorter for LTCBDE, being on average 31 minutes faster, 95% confidence interval (CI) [10.3–52.6] ( $P = .005$ , Fig. 2). LTCBDE also had a significantly shorter postoperative stay ( $P = .041$ ), although the real difference was small with a median of 2 days for both procedures.

### Other treatment options

Laparoscopic choledochotomy was uncommon (18/550) with no center reporting more than 2 procedures. One intraoperative and 4 postoperative adverse events were reported. One patient was reported to have suffered both a postoperative biliary obstruction and a bile leak needing an ERC within 30 days. Open choledochotomy was complicated by 2 intestinal perforations and 14/58 (24%) suffered postoperative adverse events. Both open and laparoscopic

Table 1  
Demographics and ASA score of the study population

Variables	Transcystic common bile duct exploration $n = 132$	Transgastric endoscopic retrograde cholangiography $n = 145$
Age (yr)	46 (19–69)	47 (19–74)
BMI ( $\text{kg}/\text{m}^2$ )	28.9 (17.8–48.4)	30.8 (20.0–45.2)
missing	29 (22%)	43 (30%)
Sex		
Female	110 (83%)	120 (83%)
Male	22 (17%)	25 (17%)
ASA score		
I	38 (29%)	37 (26%)
II	76 (58%)	87 (60%)
III	18 (13%)	21 (14%)

BMI = Body mass index; ASA = American society of anesthesiologists.

Age and BMI are presented as median (min–max), while Sex and ASA scores are presented as count (percentage).

Table 2  
Outcome comparison between transcystic CBD exploration and transgastric ERC

Variables	Transcystic common bile duct exploration	Transgastric endoscopic retrograde cholangiography	P value
Procedures	132	145	
Hospitals	33	33	
Hospitals >5 procedures	10	9	
Preoperative data			
Elevated bilirubin	60 (45%)	93 (64%)	.002*
Acute cholecystitis	29 (22%)	46 (32%)	.068*
Acute pancreatitis	11 (9%)	11 (8%)	.818*
Surgical data			
Acute surgery	83 (63%)	113 (78%)	.006*
Surgery time (min)	159 (47–415)	200 (40–480)	.005‡
Completed laparoscopically	114 (86%)	129 (89%)	.510*
Size of largest common bile duct stone:			
>8 mm	11 (8%)	36 (25%)	<.001*
4–8 mm	82 (62%)	85 (58%)	
<4 mm	39 (30%)	24 (17%)	
Intraoperative adverse events	1 (1%)	3 (2%)	.624†
Postoperative data (30 d)			
Postoperative adverse events	21 (16%)	25 (18%)	.710*
Abscess	1 (1%)	6 (4%)	.122†
Bleeding	4 (3%)	3 (2%)	.714†
Bile leak	3 (2%)	3 (2%)	1.0†
Bowel perforation	1 (1%)	1 (1%)	1.0†
Remaining stone	2 (2%)	0	.230†
Cholangitis	2 (2%)	0	.230†
Additional postoperative ERC	2 (2%)	2 (2%)	1.0†
Reoperation	2 (2%)	3 (2%)	1.0†
Postoperative length of stay (d)	2 (0–27)	2 (0–35)	.041‡

ERC = Endoscopic retrograde cholangiography.

Numbers are presented as count (percentage), while time is presented as median (min–max).

\* Pearson's chi-squared test.

† Fisher's exact test.

‡ Mann Whitney *U* non-parametric test.

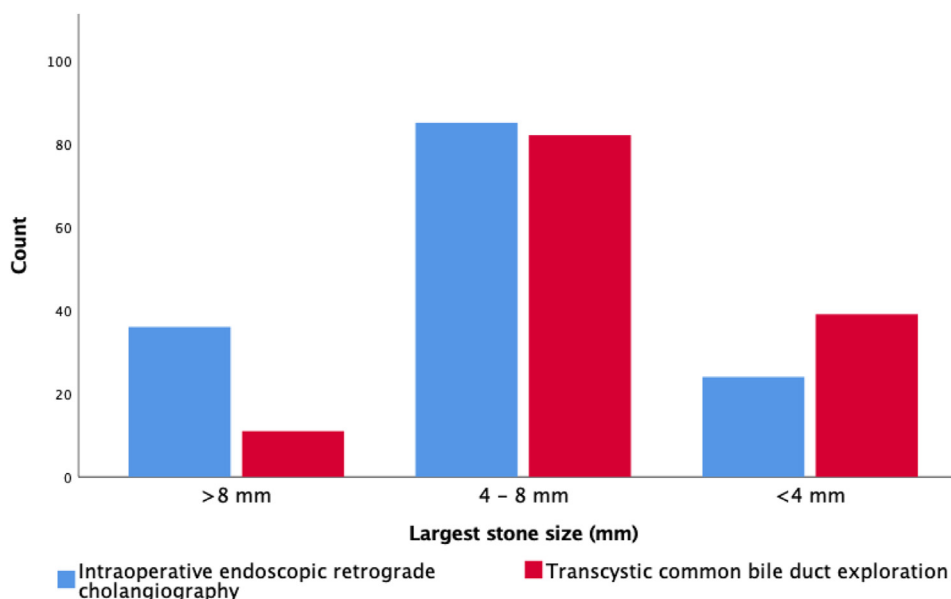


Fig. 1. Bar chart showing the distribution of the largest stone sizes in millimeters by treatment method.

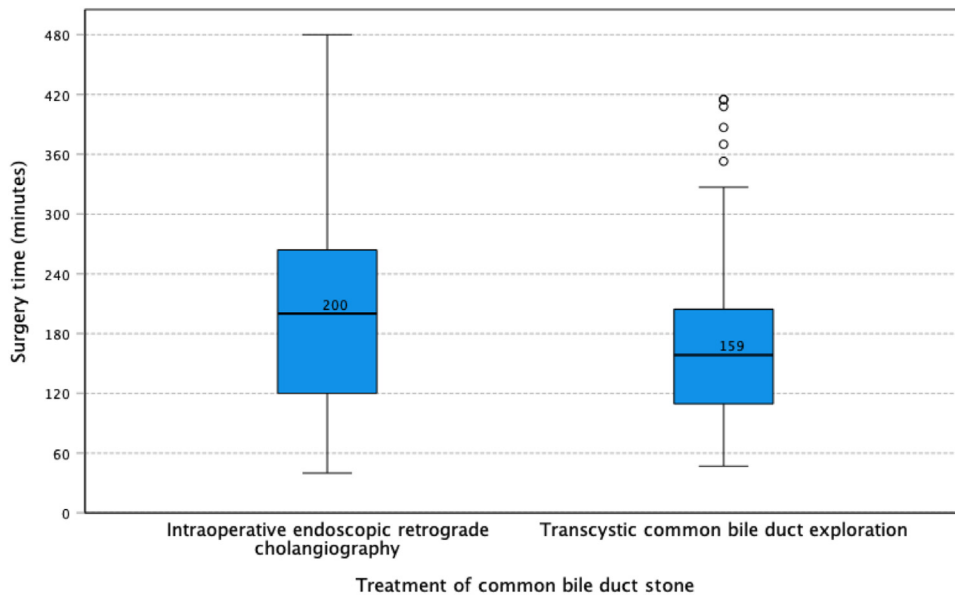


Fig. 2. Boxplot of operating time of cholecystectomies with intraoperative ERC or LTCBDE for treatment of CBT stones in RYGB patients.

choledochotomy resulted in longer postoperative stays of in median of 8 and 4 days respectively. The decision to leave CBD stones untreated was most frequent for the smallest stones of less than 4 mm in size (29/38) and resulted in a shorter surgery time of a median of 102 minutes. Among these patients, 4 postoperative adverse events were reported. One patient required an ERC within 30 days for bile leakage, another patient was reported with biliary obstruction, and 2 patients were treated for abscesses.

## Discussion

In the present study, routine intraoperative cholangiograms were performed during cholecystectomies which may not be the case in other countries. Interestingly, 45% of patients with CBD stones did not have a preoperative suspicion, suggesting that an intraoperative cholangiogram is probably advisable for post-RYGB cholecystectomies. LTCBDE and transgastric ERC were the most common treatment options together with those simply flushed out with saline. While laparoscopic choledochotomy may be safe in experienced hands, it is uncommon in Sweden with no hospital reporting more than 2 procedures. Open choledochotomy caused the highest morbidity with higher adverse event rates and the longest postoperative stay.

The comparison between LTCBDE to transgastric ERC found that overall, both procedures showed comparable results with few complications. The main difference was related to the size of extracted CBD stones. LTCBDE was used to a higher extent in patients with small stones. Possible explanations may be the relative ease by which the procedure is performed, increasing its use even for

smaller stones <4 mm, or the fact that fewer had preoperative cholestasis suggesting a relatively easier clearance of the observed stones. Since transgastric ERC is more invasive, surgeons may hesitate to perform the procedure when anticipating that smaller stones can pass spontaneously. The stones left for spontaneous passage in this study did not show an increased risk for adverse events, however, the numbers are too few to draw any definitive conclusions and follow-up beyond 30 days was not available. Previous studies have shown that the spontaneous passage of ductal stones without symptoms or complications cannot be predicted by the number or size of stones, or by the diameter of the bile duct [1,22]. It is not possible to anticipate which patients will experience complications related to residual stones, such as biliary colic, jaundice, or pancreatitis, which may be severe or potentially fatal [23]. An attempt to reach stone clearance intraoperatively can therefore be advocated in the post-RYGB patient, particularly since the LTCBDE technique allows for a minimally invasive approach to ascertain bile duct clearance.

Intraoperative transgastric ERC required a laparoscopy-assisted transgastric access route to enable an otherwise standard ERC technique [5–8,20,21]. This approach may be preferable if a setup for a single-stage ERC procedure is already in place. Of note, LTCBDE requires the training of a new technique that is minimally invasive, resource-effective, non-specific to the Roux-en-Y anatomy and has a modest learning curve enabling surgeons to perform a single-stage procedure on their patients [9–12,18,24].

Analysis of the total cohort also showed significantly shorter surgery time for patients treated with LTCBDE. Some confounding factors could be that intraoperative

ERCs were used more frequently in the acute setting, that more patients had cholecystitis, or that the larger stones, more often treated with ERC, took longer to clear.

The usage of validated national registries with excellent coverage over a 10-year period was a major strength of the current study [15,16,25,26]. The study population was therefore significant and allowed for intervention comparisons in groups for CBD stone extraction in RYGB patients. Since both LTCBDE and transgastric ERC have been used in Sweden for several years, the study design using GallRiks enabled comparison of the procedures in a relatively large cohort, given the rare condition. A limitation of the study is that the registry only reliably reports adverse events that occur intraoperatively or postoperatively within 30 days and the comparison can therefore miss later events. Furthermore, adverse events are not specified as being caused by the cholecystectomy or the intervention for the CBD stones. In addition, registration was done postoperatively, and a failed or aborted procedure may not have been reported, as only the final procedure was registered. Furthermore, the study showed that larger stones were more often handled by ERC. If more than 1 procedure was available, the stone size may cause a bias by influencing the surgeon's choice of intervention. However, it is unlikely that many hospitals and surgeons had access to more than 1 of these 2 procedures.

## Conclusion

This study shows that both LTCBDE and transgastric ERC procedures can be used for the single-stage extraction of CBD stones during cholecystectomies in RYGB patients with good outcomes and low adverse event rates. LTCBDE is faster and was more often used for smaller CBD stones, while transgastric ERC is more often used in conjunction with larger bile duct stones.

## Disclosures

*The authors have no commercial associations that might be a conflict of interest in relation to this article.*

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