

# The effectiveness of laparoscopic choledochoduodenostomy for management of persistent common bile duct stones and advanced malignant obstructive jaundice

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Endoscopic clearance of common bile duct (CBD) stones and stenting for distal biliary obstruction are standard treatments, but can fail in cases of large calculi or advanced malignancy. Laparoscopic choledochoduodenostomy (LCCD) offers an internal bypass of the obstructed bile duct.

**OBJECTIVE** – to evaluate the safety and effectiveness of LCCD in patients with persistent CBD stones after failed endoscopic clearance and in those with advanced malignant obstructive jaundice.

**MATERIALS AND METHODS.** We reviewed 55 patients who underwent LCCD at our center between 2018 and 2024. Of these, 26 patients had large CBD stones not cleared by endoscopic retrograde cholangiopancreatography, and 29 had unresectable distal malignant obstruction (pancreatic or ampullary carcinoma). All procedures were performed laparoscopically using five trocars, with a longitudinal choledochotomy and duodenotomy, a side-to-side biliary–enteric anastomosis hand-sewn with absorbable barbed sutures (V-Loc™ 3-0), and concurrent cholecystectomy. Perioperative outcomes, complications, and follow-up results were analyzed.

**RESULTS.** LCCD was completed successfully in all 55 patients with no conversions to open surgery. The mean operative time was 76 minutes (range: 55–110 minutes). There were no major postoperative complications or 30-day mortality. The average hospital stay was  $5.2 \pm 2.1$  days. Stone patients had 92% clearance of CBD stones with no residual obstruction or recurrent cholangitis observed over a follow-up of up to 5 years. In the malignant group, jaundice was effectively palliated in all cases, with no patient requiring repeat biliary bypass surgery during their remaining life span.

**CONCLUSIONS.** Laparoscopic choledochoduodenostomy proved to be a safe and effective procedure for both complex CBD stones after failed endoscopic retrograde cholangiopancreatography and for palliative relief of malignant obstructive jaundice. The technique achieved durable biliary drainage with minimal morbidity and short hospital stay. LCCD should be considered as an alternative when endoscopic management is unsuccessful or not feasible, offering definitive resolution of CBD stones and excellent palliative outcomes in advanced malignancies.

## KEYWORDS

laparoscopy, choledochoduodenostomy, common bile duct stone, malignant obstructive jaundice, biliary bypass, endoscopic retrograde cholangiopancreatography failure.

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Choledochoduodenostomy (CDD), the surgical creation of a side-to-side anastomosis between the common bile duct (CBD) and the duodenum, has long been recognized as an effective internal drainage procedure for obstructed bile ducts [5].

Historically, open CDD was frequently employed for large or recurrent CBD stones and distal biliary obstructions before the endoscopic era [10]. However, with the advent of endoscopic retrograde cholangiopancreatography (ERCP) and improvements

in laparoscopic CBD exploration, the use of CDD declined, and its indications became more limited. ERCP with endoscopic sphincterotomy and stone extraction is now the first-line therapy for choledocholithiasis, achieving CBD clearance in the majority of cases [1]. Nevertheless, ERCP can fail in a significant subset of patients – approximately 5–10% in various series – due to factors such as large or impacted stones, challenging anatomy, or inaccessible papilla. Furthermore, ERCP itself carries risks (e.g., pancreatitis, bleeding, perforation), and stones may recur in up to 4–24% of patients after endoscopic treatment [3, 15].

In cases where ERCP fails to clear the duct, surgical intervention becomes necessary to prevent ongoing biliary obstruction and cholangitis. Traditionally, open surgical options include choledocholithotomy with T-tube drainage or biliary-enteric bypass. In the minimally invasive era, laparoscopic approaches to the CBD have been developed [2]. Laparoscopic choledochoduodenostomy (LCCD) is one such approach that can serve as a salvage procedure for difficult CBD stones that cannot be removed endoscopically [5, 6]. Proponents of LCCD note that it provides a definitive, internal drainage solution for multiple or large stones and benign distal strictures while avoiding the morbidity of open surgery and the repeated instrumentation associated with multiple ERCP attempts [9, 10]. CDD creates a wide stoma between the dilated CBD and duodenum, which can facilitate the passage of small residual stones and prevent future stone impaction. Reports have demonstrated low rates of recurrent cholangitis or «sump syndrome» following CDD, particularly when the gallbladder and cystic duct are removed and the anastomosis is constructed with an adequate diameter [8, 11]. Recent studies and case series confirm that laparoscopic CDD is feasible and safe in experienced hands, suggesting this technique is a viable alternative for difficult or failed endoscopic cases [8].

Malignant distal biliary obstruction is another challenging scenario. Pancreatic head carcinoma and ampullary carcinoma can cause advanced malignant obstructive jaundice (AMOJ) in patients who are often not candidates for curative resection due to locally advanced disease or metastases. Endoscopic biliary stenting (via ERCP or EUS-guided approaches) is the preferred palliative treatment for malignant obstructive jaundice, but stent placement is not always successful or sustainable [7]. Tumor bulk or prior surgical anatomy may prevent successful stenting, and even when placed, stents have a limited patency and frequently require re-intervention due to occlusion. Surgical biliary bypass

(such as hepaticojejunostomy or choledochojejunostomy) offers more durable relief of jaundice, at the cost of open surgery [17, 22]. A laparoscopic biliary bypass, if achievable, could combine the long-term patency of surgical anastomosis with the lower morbidity of minimally invasive surgery. Laparoscopic choledochoduodenostomy has been explored as an alternative palliative method for distal malignant obstruction, effectively creating an internal drainage route that bypasses the tumor [18]. Unlike hepaticojejunostomy, a CDD keeps bile flow in the upper gastrointestinal tract and avoids an entero-enteric anastomosis, making it a simpler and more physiological bypass in distal obstruction cases. Early reports (mostly from high-volume centers in recent years) indicate that laparoscopic biliary bypass for malignancy is associated with high success in jaundice relief, low complication rates, and no need for external drainage tubes [18, 20].

Despite these potential advantages, LCCD remains a specialized procedure that is not yet widely adopted. The technical challenge of intracorporeal suturing for a biliary-enteric anastomosis has been a barrier, but advances such as barbed sutures and increased laparoscopic expertise are overcoming this hurdle. To date, most published experience with LCCD has been limited to small series or case reports [5, 8, 12]. In this context, we present our single-center experience with LCCD in two distinct patient groups: (1) those with large or refractory CBD stones after failed ERCP and (2) those with advanced malignant obstructive jaundice due to unresectable tumors. We report the perioperative outcomes, long-term follow-up, and clinical effectiveness of LCCD in these populations.

**OBJECTIVE** – to evaluate the safety and effectiveness of LCCD in patients with persistent CBD stones after failed endoscopic clearance and in those with advanced malignant obstructive jaundice.

## Materials and methods

**Study Design and Patients:** This study is a retrospective analysis of all patients who underwent LCCD at our tertiary referral center between 2018 and 2024. A total of 55 patients were identified. Indications for LCCD fell into two categories. Group 1 (Benign Stones): 26 patients had persistent choledocholithiasis (CBD stones) that could not be removed via ERCP. These cases typically involved large (giant: 25–35 mm) CBD stones or multiple stones in a dilated duct, where endoscopic extraction had failed due to stone size, impaction, or challenging anatomy (such as a diverticulum or stricture preventing papilla access). Group 2 (Malignant

Obstruction): 29 patients had advanced malignant obstructive jaundice caused by distal bile duct compression from unresectable malignancies. This group included patients with pancreatic head carcinoma and those with ampullary carcinoma with distal CBD involvement. All malignancies were confirmed via imaging and/or biopsy, and a multidisciplinary tumor board had deemed them unsuitable for curative resection. In these patients, palliative biliary bypass was indicated either due to failed endoscopic stenting or because a surgical bypass was preferred for longer-term relief of jaundice.

### Preoperative Preparation

All patients underwent preoperative laboratory evaluation and imaging. The presence of CBD dilation was confirmed in all cases (a dilated biliary tree was a prerequisite for CDD to ensure a sizeable anastomosis). In Group 1, the mean stone size and number varied (data not shown); many had stones > 15 mm or multiple stones. In Group 2, the level of obstruction was distal (no hilar tumors were included), and some patients had plastic stents placed during prior ERCP attempts, which were either ineffective or had occluded. Patients with cholangitis received antibiotics and, if necessary, temporary percutaneous biliary drainage before definitive surgery. All patients provided informed consent for laparoscopic surgery with the understanding that conversion to open surgery could be required if difficulties arose.

### Surgical Technique

All procedures were performed under general anesthesia with the patient in the supine position. A standard 4-trocar configuration was used in all cases (including epigastric, subcostal, and right flank ports to allow optimal access to the hepatic hilum and duodenum). First, a laparoscopic cholecystectomy was performed (in patients with a gallbladder *in situ*) as part of the procedure. Cholecystectomy serves two purposes: it prevents potential future gallstone issues and eliminates the cystic duct, thereby reducing the risk of sump syndrome from an undrained gallbladder remnant. Next, the hepatoduodenal ligament was carefully dissected to expose the dilated CBD. The first part of the duodenum was mobilized only if needed. In our series, a full Kocher's maneuver was not routinely required because the duodenum was typically reachable for anastomosis without extensive mobilization.

A longitudinal choledochotomy approximately 2–3 cm in length was made on the anterior wall of the CBD, usually just above the duodenum. A matching longitudinal duodenotomy was created

on the anterior wall of the duodenum (first or second portion) adjacent to the CBD incision. In Group 1 (stones), before proceeding to the anastomosis, we ensured clearance of stones from the CBD. Stones were removed through the choledochotomy by using a flexible choledochoscope and graspers/baskets as needed, or by flushing saline through the cystic duct stump or choledochotomy. In some instances, very large stones were fragmented using a lithotripter device for removal. Once the duct was cleared of calculi, attention turned to creating the bilio-duodenal anastomosis.

The CDD anastomosis was fashioned in a side-to-side manner. We performed a single-layer hand-sewn anastomosis using a running barbed suture (absorbable 3–0 V-Loc™). A continuous posterior row of suturing was done first: the suture was started at the rightmost end of the incision (proximal side) and ran toward the leftmost end (distal side) to approximate the posterior walls of the CBD and duodenum. After completing the posterior wall, the suture was tied or locked. A second continuous suture was then used for the anterior wall in a similar fashion, creating a watertight anastomosis. We found that the barbed suture allowed effective tissue approximation without the need for frequent knot tying, streamlining the construction of the anastomosis. Care was taken at the corners of the incisions to avoid leakage (adding an extra stitch or two at the ends if necessary). The resulting anastomosis was roughly the full length of the choledochotomy (approximately 2 cm), providing a wide stoma. A closed-suction drain (Jackson-Pratt) was placed near the anastomosis in all cases as a precaution to detect any early bile leak.

After ensuring hemostasis and clean irrigation, all port sites were closed. No T-tube or internal stent was used across the anastomosis in our series (unlike some techniques that use a T-tube as a bridging stent, we relied on meticulous suturing and omental coverage of the anastomosis to prevent leakage). The gallbladder specimen and any retrieved stones were removed through an enlarged umbilical port incision using a specimen bag.

### Postoperative Care and Follow-up

Patients were typically extubated in the operating room and sent to the surgical ward. Standard postoperative management included analgesia and early mobilization. The nasogastric tube (if placed) was removed at the end of surgery or on the first postoperative day. A liquid diet was started on postoperative day 1 or 2 once bowel function resumed. The abdominal drain was monitored and removed within 2–4 days if no significant bile leakage was

observed. Liver function tests were checked daily for the first few days to monitor bilirubin trends. Criteria for discharge included adequate pain control with oral analgesics, tolerance of diet, and no signs of complications.

Patients in the malignant group were also monitored by the oncology service for any further adjuvant therapies or hospice care, but importantly, we tracked whether any biliary re-intervention was needed post-LCCD. All patients had scheduled follow-up visits at one month post-surgery, then at three-month intervals for the first year, and every 6–12 months thereafter (stone patients continued long-term follow-up up to 5 years, whereas malignant patients often had follow-up until death). At follow-up, clinical status, liver function tests, and ultrasound or CT imaging (when indicated) were reviewed to assess the patency of the biliary-enteric anastomosis. We defined a successful outcome as relief of biliary obstruction without the need for additional biliary drainage procedures. Any complications were classified using the Clavien-Dindo grading system for surgical complications.

## Results

### Patient Characteristics

A total of 55 patients underwent LCCD during the study period (38 women and 17 men). The overall mean age was  $67.8 \pm 8.6$  years (range 50–85 years), reflecting an older patient population in both groups. Table 1 summarizes the baseline demographics and characteristics of the two patient groups. Patients in the stone group (Group 1,  $n = 26$ ) had a mean body mass index (BMI) of  $28.4 \pm 4.5$  kg/m<sup>2</sup>, whereas those in the malignant group (Group 2,  $n = 29$ ) had a slightly lower mean BMI of  $26.5 \pm 3.5$  kg/m<sup>2</sup>. The gender distribution showed a female predominance in both groups, more pronounced in the benign

stone group (approximately 77% female), consistent with the higher incidence of gallstone disease in women. In the malignant group, about 62% were female. The diagnoses in the malignant cohort included pancreatic head carcinoma (the majority of cases) and ampullary carcinoma; all had distal CBD obstruction causing significant jaundice. Prior to LCCD, 26/26 stone patients had one or more failed ERCP attempts at stone extraction, and 19/29 malignant patients had attempted endoscopic stenting that was unsuccessful or not durable (the remaining malignant cases proceeded directly to surgical bypass due to tumor anatomy or recurrent stent occlusion). All patients had dilated CBD on imaging, with a median CBD diameter of  $\sim 19 \pm 3$  mm in the stone group (due to chronic obstruction by stones) and  $22 \pm 5$  mm in the malignant group (due to distal tumor blockage). There were no significant differences in age between the groups. Comorbid conditions (such as cardiovascular disease or diabetes) were common given the age range, but these were well-managed and did not preclude laparoscopic surgery.

### Intraoperative Findings

All 55 procedures were completed fully laparoscopically, with no conversions to open surgery. The laparoscopic exposure of the CBD and duodenum was generally straightforward, given the prior biliary dilation; adhesions from cholangitis were present in a few cases but were manageable. In the stone group, multiple CBD stones were encountered in 12 patients, while single large stones were observed in 14 patients. Successful stone clearance was achieved in 24 out of 26 cases through choledochotomy using choledochoscopic guidance and retrieval tools. In two cases, a large stone was fragmented *in situ* to facilitate removal. The duodenum was accessible for all anastomoses without needing a full Kocher mobilization

Table 1. **Baseline patient characteristics by group**

Characteristic	Stones group (n = 26)	Malignant group (n = 29)	All patients (n = 55)
Age, years (mean $\pm$ SD)	66.1 $\pm$ 9.5	69.3 $\pm$ 7.8	67.8 $\pm$ 8.6
Female	20 (76.9%)	18 (62.1%)	38 (69.1%)
Male	6 (23.1%)	11 (37.9%)	17 (30.9%)
Body mass index, kg/m <sup>2</sup> (mean $\pm$ SD)	28.4 $\pm$ 4.5	26.5 $\pm$ 3.5	27.4 $\pm$ 4.0
Diagnosis/Indication	Large CBD stones after failed ERCP (100%)	Distal malignant biliary obstruction (100%)	–
Pancreatic carcinoma	–	20 (69%)*	–
Ampullary carcinoma	–	9 (31%)*	–

Note. \* Breakdown of malignancy types in Group 2 (approximate proportions; all had distal CBD involvement).

in our series, which helped save operative time. Anastomosis construction was smooth in all cases – the use of continuous barbed sutures enabled secure closure without difficulty. There were no intraoperative complications such as significant bleeding or injury to surrounding structures. Estimated blood loss was minimal (median ~50 mL, none exceeding 200 mL). No patients required intraoperative transfusions. All patients had a cholecystectomy completed; in several malignant cases, the gallbladder was distended (Courvoisier's sign) and filled with bile, which was removed without incident.

The mean total operative time for the entire cohort was 76 minutes (range: 55–110 minutes). This reflects the streamlined nature of the combined procedure (cholecystectomy + CDD) in our hands. Group-wise, the operative times were not markedly different – stone cases involved time for stone extraction, but malignant cases occasionally involved more time dissecting around a tumor; overall, both groups averaged roughly 1 hour to 1 hour 20 minutes. As experience was gained, later cases were on the shorter end of the range, with some LCCD procedures being completed in under 60 minutes.

**Postoperative Outcomes:** Recovery was generally rapid and uneventful. There were no major postoperative complications (defined as Clavien-Dindo grade III or above) in this series (0% major morbidity). In particular, no anastomotic leaks were detected: drain outputs were minimal and not bilious, and no patient developed peritonitis or required re-operation. Two patients (3.6%) experienced minor complications: one patient had a mild ileus that prolonged their nasogastric decompression by one day, and another developed a superficial port-site infection managed with antibiotics and local care. Importantly, there were no instances of postoperative cholangitis or pancreatitis. All patients had improved liver function tests after surgery; in the malignant group, serum bilirubin levels declined dramatically within the first week post-op as bile flow was restored internally. The average length of hospital stay was  $5.2 \pm 2.1$  days. This phase included routine post-surgical observation; many patients (especially those with stones) were fit for discharge by postoperative days 3–5. Malignant cases sometimes stayed a day or two longer for optimization or arrangement of follow-up care, but there was no significant difference in the mean stay between groups.

There was no 30-day mortality in this series. All 55 patients survived to hospital discharge. One elderly patient in the malignant group (with metastatic pancreatic cancer) died 3 months later due to progression of cancer, but had no biliary issues in the interim.

## Follow-up Results

All patients underwent postoperative follow-up to assess long-term effectiveness. In Group 1 (CBD stones), follow-up duration ranged from 6 months for the most recent cases up to 5 years for those operated on in 2018 (mean follow-up was 3 years). None of the stone patients had any recurrence of CBD stones or cholangitis during follow-up. They remained symptom-free (no jaundice, no biliary pain). Follow-up imaging (ultrasound or MRCP in some cases) showed a patent CDD with no dilation of intrahepatic ducts. Notably, no patient in the stone group developed evidence of «sump syndrome» or biliary gastritis. The surgical anastomosis provided durable drainage, with no late strictures observed in the CDD anastomosis. One patient in the stone group did have an unrelated issue (a ventral hernia repair) two years later, but their biliary tract remained healthy.

In Group 2 (malignant obstructive jaundice), follow-up was limited by the patients' overall prognosis. Nonetheless, the palliative benefit of LCCD was maintained in all 29 patients until the end of follow-up. Jaundice and pruritus resolved in all cases after surgery and did not recur, indicating sustained biliary decompression. No patient required a repeat biliary intervention, such as another bypass or stenting. Three patients lived beyond one year post-surgery (survival of 15, 19, and 26 months, respectively, with diagnoses of ampullary carcinoma or slower-progressing pancreatic cancer). These longer-term survivors had no episodes of cholangitis or biliary obstruction; the LCCD anastomosis remained functional throughout. The majority of the malignant group (particularly those with pancreatic head cancer) succumbed to their disease within 7–13 months of surgery due to tumor progression or systemic causes, but critically, none suffered recurrent biliary obstruction. For the time they survived, they were free of the need for external biliary drains or repeat hospitalizations for stent occlusions. This outcome underscores that LCCD provided an effective one-time solution for biliary drainage in this palliative context.

Overall, the results demonstrate that LCCD achieved its intended goals in both groups: definitive clearance of stones and prevention of cholangitis in the failed-ERCP patients, and sustained relief of jaundice in the advanced malignancy patients, with very low complication risk (Table 2). Both the stone and malignant groups benefited from the minimally invasive approach, with short hospital stays and avoidance of more morbid open surgeries or external drainage devices. The high success rates and lack of major complications in our series support LCCD as a reliable technique in these challenging situations.

Table 2. **Surgical outcomes for patients undergoing LCCD (combined results)**

Indicator	Result
Operative time, minutes	76 (range: 55–110)
Conversion to open surgery	0 patients
Intraoperative blood loss, mL	~50 median (none > 200)
Postoperative hospital stay, days (mean ± SD)	5.2 ± 2.1
Major complications (Clavien ≥ 3)	0
Minor complications (Clavien 1–2)	2 (3.6%) – no bile leaks, no cholangitis
30-day mortality	0 patients
Stone clearance rate (Group 1)	92% (24/26 patients)
Jaundice relief rate (Group 2)	100% (29/29 patients)

## Discussion

This study highlights the efficacy of LCCD as a versatile solution for two complicated clinical scenarios: refractory bile duct stones and palliative management of distal malignant obstruction. Our key findings were that LCCD achieved a 100% rate of biliary decompression in both contexts. Moreover, this was accomplished with zero perioperative mortality and no major complications, attesting to the safety of the procedure in experienced hands. The mean operative time (~76 minutes) and hospital stay (~5 days) in our series indicate that LCCD can be performed efficiently with a quick postoperative recovery. These outcomes compare favorably with historical results from open surgery and align with other recent reports of laparoscopic biliary bypass. For instance, P. Senthilnathan et al. [19] reported that laparoscopic CBD exploration with CDD was safe and effective after failed ERCP, yielding stone clearance in all patients with a median hospital stay of 5 days. Our findings reinforce that laparoscopic CDD is a reliable salvage technique when endoscopic stone extraction is unsuccessful.

One of the remarkable aspects of this study is the absence of bile leaks or anastomotic complications. Biliary-enteric anastomosis, especially to the duodenum, traditionally raised concerns for leak or fistula. However, with careful technique, we observed no leaks; this mirrors other laparoscopic series where leak rates have been low (on the order of 3% or less) and typically managed conservatively [8, 9, 11]. In our practice, several technical factors likely

contributed to secure anastomoses: the use of a longitudinal incision (~2 cm) on both the CBD and duodenum to create a wide stoma, a tension-free alignment of the two structures (a key principle to prevent leaks/strictures), and the use of continuous barbed sutures which provided even distribution of tension and a water-tight seal. We also routinely placed an omental patch over the completed anastomosis (by laying a tongue of the greater omentum between the CBD and duodenum) to augment healing, similar to strategies reported by T. Lianyuan et al [14]. These steps likely minimized the risk of leakage. Our zero leak rate is comparable to the report by T. Lianyuan et al. [14] on laparoscopic bridge CDD for malignant jaundice, where only 1 out of 35 patients (2.8%) had a bile leak, which was controlled nonoperatively. The low complication profile of LCCD in our series and others underscores that, far from being an experimental procedure, it is a mature and safe technique when performed by surgeons adept in advanced laparoscopy.

In the context of persistent choledocholithiasis (Group 1), our results demonstrate that LCCD offers a definitive one-stage solution. All 26 patients who had failed ERCP for large CBD stones were rendered stone-free in 24 patients, with no evidence of recurrent stones on follow-up. By creating a side-to-side biliary outflow tract into the duodenum, LCCD effectively prevents future stone impaction by giving any new stones a large conduit to pass into the intestine. This is an advantage over simple T-tube drainage or repeat ERCP attempts. The long-term patency of the CDD in our series (no strictures or sump syndrome up to 5 years) is consistent with prior studies that found very low rates of recurrent cholangitis or sump syndrome after CDD [8, 13]. Sump syndrome – characterized by stagnation of debris in the distal bile duct remnant – was historically a concern, but in practice it appears to be quite rare with modern surgical technique [4]. In our patients, removal of the gallbladder and cystic duct and creation of a wide stoma likely mitigated any tendency for debris accumulation. Literature supports that properly performed CDD has a < 5% incidence of recurrent cholangitis [10], and our experience of 0% cholangitis reinforces that. Additionally, we did not observe any case of duodenal content reflux causing symptoms. Some degree of biliary-enteric reflux is inevitable, but it did not translate into clinical cholangitis in our cohort, echoing other reports that found reflux cholangitis to be uncommon and often related more to anastomotic stricture than to the reflux itself.

Compared to alternative surgical approaches for difficult stones (such as laparoscopic trans-cystic or

trans-ductal exploration with T-tube), LCCD has the benefit of providing an internal drainage route with no external appliances. Patients avoid the discomfort and infection risk of a T-tube and do not require a second procedure for tube removal. Our findings support that when ERCP fails (which happens in about 4–10% of CBD stone cases) [16], proceeding to a laparoscopic surgical solution can be done in the same hospital stay with excellent outcomes. Importantly, none of our stone patients needed any further ERCP or surgery after LCCD – a testament to the durability of the procedure. This spares patients the cycle of repeat endoscopic attempts or chronic interventions. Other authors have reported similarly that LCCD definitively resolves choledocholithiasis in challenging cases, with one review noting a 100% CBD clearance and only ~1% recurrence in mid-term follow-up [11, 19]. Thus, our study adds to the growing evidence that laparoscopic CDD is an effective permanent cure for choledocholithiasis in the subset of patients where standard endoscopic methods are insufficient.

In the malignant obstructive jaundice group, LCCD functioned as a palliative bypass with excellent results. Relief from jaundice was universal and maintained until patient deaths or the last follow-up, without any need for stent placements or reoperations. This is particularly noteworthy because managing biliary obstruction in advanced cancer can often be a recurrent challenge due to stent occlusions. By performing a surgical bypass, we essentially eliminated the issue of stent clogging. Our outcomes mirror those reported by recent studies on laparoscopic biliary bypass for malignancy. For example, a two-center study from China [14, 23] on 35 patients with advanced malignant jaundice found that laparoscopic CDD had a 100% technical success rate, with significant bilirubin reduction postoperatively and no instances of delayed cholangitis or anastomotic stricture during follow-up. They concluded LCCD is a safe and efficient palliative surgery for these patients. Our series, with 29 malignant cases, represents one of the larger single-center Western experiences and reinforces those conclusions. The avoidance of external biliary drains in these often frail patients is a major benefit of LCCD – external drainage via percutaneous catheters can lead to electrolyte imbalances, infection, and decreased quality of life with a catheter in place. In contrast, internal drainage via LCCD allowed our patients to be free of tubes, eat normally, and have stable biliary decompression.

It is worth comparing LCCD to the more conventional surgical bypass for distal biliary obstruction, which is a hepaticojejunostomy (HJ) or

choledochojejunostomy. While HJ is a well-established operation, doing it laparoscopically is complex, and open HJ carries significant morbidity in the context of advanced cancer. LCCD, by anastomosing to the duodenum, is less invasive – no intestinal anastomosis or Roux-en-Y limb is required [18]. This makes the procedure shorter and potentially lowers the risk of postoperative complications like delayed gastric emptying. Indeed, our mean operative time of ~76 minutes for LCCD is far shorter than typical times reported for open surgical bypass (often 2–3 hours). Even within our series, the malignant cases had average operative times around or under 1 hour once the surgical team was past the initial learning curve, which is remarkably efficient for a biliary bypass. T. Lianyan et al. [14] described that after about 13 cases, their operative time plateaued around 60 minutes as well. Thus, once the learning curve is overcome, LCCD can be completed in roughly an hour, making it very competitive with endoscopic or percutaneous alternatives in terms of procedure time, but with the advantage of a one-time, durable fix. Furthermore, we had no conversions to open, reflecting that with proper patient selection (distal obstruction, dilated duct) and technique, laparoscopic access is sufficient to perform the bypass in essentially all cases.

Our study also underlines the importance of concomitant cholecystectomy during LCCD. We removed the gallbladder in all patients to eliminate the possibility of the gallbladder acting as a reservoir for bile and stones (so-called «sump»). Some older series of open CDD noted sump syndrome, particularly when the gallbladder and cystic duct were left *in situ* [10]. By doing cholecystectomy, we likely contributed to the zero incidence of sump-related problems. Additionally, removing the gallbladder addresses any gallstones that might be present (and indeed, in many of our stone-group patients, cholecystectomy was indicated due to cholelithiasis). This comprehensive approach aligns with modern surgical teaching that any biliary bypass for benign disease should include cholecystectomy to prevent future issues.

While interpreting the positive outcomes of LCCD, it is important to consider patient selection and limitations. The success of CDD hinges on having a distal obstruction (whether stone or tumor) with a sufficiently dilated proximal duct. We did not include patients with hilar cholangiocarcinoma or small nondilated ducts, as those are not suitable for CDD. In high biliary obstruction, other techniques like hepaticojejunostomy or multiple stents would be needed. Also, our malignant group was limited to distal lesions, so our results specifically

support LCCD in that context. Patients with very short life expectancy (just a few weeks) might still be better served with a quick endoscopic or percutaneous stent rather than surgery; however, all our malignant patients were expected to live at least a couple of months and had either failed stenting or were deemed likely to benefit from a longer-term solution. The threshold for choosing surgical bypass over stents in malignant cases remains individualized: factors include predicted survival, performance status, and local expertise. Our data suggest that if a patient is a reasonable surgical candidate and has a life expectancy beyond a few months, performing an LCCD can spare them recurrent endoscopic procedures and maintain biliary patency throughout their remaining life. This is supported by studies indicating that surgical bypass has superior long-term patency compared to stents, especially if survival exceeds 6–12 months [20].

We acknowledge some limitations of this study. It was a retrospective analysis without a control group. We did not directly compare LCCD outcomes to alternative treatments (such as repeat ERCP, open surgery, or percutaneous drainage) in a randomized fashion. However, given the scenarios (failed ERCP or unresectable cancer), randomization would have been ethically difficult; our patients received the treatment deemed necessary after standard care had failed or was not an option. Another limitation is the relatively small sample size, especially for subgroup analyses. While 55 patients is a respectable series for this uncommon procedure, subgroup comparisons (e.g., minor differences in operative time or hospital stay between stone vs. malignant cases) were not statistically analyzed. Nonetheless, the uniform success across all patients is a strength in itself. Follow-up for the stone group was robust (up to 5 years), confirming durability, but follow-up for malignant patients was inherently shorter due to their disease – we cannot comment on anastomosis patency beyond 2 years in malignancy, since few survived that long. That said, in the palliative setting, maintaining patency for the duration of patients' lives (as we achieved) is the relevant measure of success.

In summary, LCCD proved to be an effective, safe, and durable solution for persistent biliary obstruction in both benign and malignant contexts. It essentially converted what would otherwise be chronic problems requiring multiple interventions into a one-time fix. The procedure leveraged the advantages of minimally invasive surgery – less postoperative pain, quick recovery, and short hospitalization – without compromising on the effectiveness of biliary drainage. Given our positive

experience, we advocate that LCCD should be considered more often, especially at centers with advanced laparoscopic expertise, when confronted with large irretrievable CBD stones or when facing a distal biliary obstruction that cannot be stented. The surgical community's initial reservations about laparoscopic biliary-enteric anastomosis are being dispelled by results like ours and those in the literature. As techniques continue to improve, we anticipate that LCCD and similar minimally invasive biliary bypasses will become standard alternatives in the algorithm of biliary disease management.

## Conclusions

Laparoscopic choledochoduodenostomy is a safe and minimally invasive procedure that provides effective internal biliary drainage in patients with complex CBD stones and malignant obstruction. In our series of 55 patients, LCCD achieved high success rates without major complications or the need for reintervention. Its durability and rapid recovery support its use as a definitive option when endoscopic methods fail. LCCD should be considered a valuable alternative in the surgical management of difficult biliary conditions.

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## DECLARATION OF INTERESTS

The authors declare no conflicts of interest relevant to this manuscript.

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## ETHICS APPROVAL AND WRITTEN INFORMED CONSENT STATEMENTS

This study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee of Odesa National Medical University. Written informed consent was obtained from all patients prior to their participation in the study.

## AUTHORS CONTRIBUTIONS

V.V. Grubnik: study concept and design, critical revision of the manuscript, supervision; Y.V. Grubnik: data analysis and interpretation, manuscript editing; V.V. Ilyashenko: data collection, literature review, manuscript drafting; M.Y. Grubnik: data analysis, manuscript drafting, and revision; V.V. Grubnyk: clinical procedures, patient follow-up, critical revision of the manuscript.

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# Ефективність лапароскопічної холедоходуоденостомії при лікуванні каменів у загальній жовчній протоці, що персистують, і прогресуванні злоякісної обструктивної жовтяниці

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Ендоскопічне видалення каменів із загальної жовчної протоки (ЗЖП) та стентування при дистальній біліарній обструкції є стандартними методами лікування, але можуть бути неефективними у випадках великих конкрементів або злоякісного процесу, що прогресує. Лапароскопічна холедоходуоденостомія (ЛХД) є альтернативним методом, що забезпечує внутрішнє шунтування жовчної протоки з обструкцією.

**Мета** — оцінити безпечність та ефективність ЛХД у пацієнтів із каменями в ЗЖП, що персистують після невдалого ендоскопічного лікування, та у хворих зі злоякісною обструктивною жовтяницею, що прогресує.

**Матеріали та методи.** Проаналізовано післяопераційні результати, ускладнення та дані спостереження 55 пацієнтів (38 жінок та 17 чоловіків, віком 50—85 років (середній вік —  $67,8 \pm 8,6$  року), яким було виконано ЛХД у нашому центрі в період із 2018 до 2024 р., із них 26 мали великі камені в ЗЖП, які не вдалося видалити за допомогою ендоскопічної ретроградної холангіопанкреатографії, 29 — нерезектабельну дистальну злоякісну обструкцію (рак підшлункової залози або ампули Фатера). Усі операції проводили лапароскопічно з використанням п'яти троакарів, подовжньої холедоходотомії та дуоденотомії, бічного холедоходуоденального анастомозу, виконаного вручну розсмоктувальними швами (V-Loс™ 3—0), та одночасної холецистектомії.

**Результати.** Усі 55 операцій успішно виконано лапароскопічно без необхідності переходу до відкритої операції. Середній час операції становив 76 хв (від 55 до 110 хв). Серйозних післяопераційних ускладнень або летальності протягом перших 30 днів не зафіксовано. Середня тривалість госпіталізації становила  $(5,2 \pm 2,1)$  доби. У пацієнтів із каменями в ЗЖП досягнуто 92% очищення протоки без залишкової обструкції або рецидиву холангіту протягом 5-річного періоду спостереження. У групі пацієнтів зі злоякісною обструкцією жовтяницю ефективно куповано в усіх випадках. Жодному не знадобилося повторного хірургічного втручання на жовчних шляхах.

**Висновки.** Лапароскопічна холедоходуоденостомія є безпечним та ефективним методом лікування як у складних випадках холедохолітіазу після невдалої ендоскопічної ретроградної холангіопанкреатографії, так і для паліативного усунення злоякісної обструктивної жовтяниці. Ця методика забезпечує тривале біліарне відведення з мінімальною кількістю ускладнень і коротким періодом госпіталізації. Лапароскопічну холедоходуоденостомію слід розглядати як альтернативу за неможливості або неефективності ендоскопічного лікування, оскільки вона забезпечує остаточне вирішення проблеми обструкції та якісну паліативну допомогу при онкологічних захворюваннях.

**Ключові слова:** лапароскопія, холедоходуоденостомія, камені в загальній жовчній протоці, злоякісна обструктивна жовтяниця, біліарне шунтування, невдача ендоскопічної ретроградної холангіопанкреатографії.

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