

# Current Research Status of Primary Closure after Laparoscopic Biliary Exploration

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**Abstract:** Choledocholithiasis is a biliary system disorder that plagues people's health. With the use and development of minimally invasive techniques, laparoscopy, duodenoscopy, and choledochoscopy, the treatment of choledocholithiasis has become more demanding, and in recent years, several studies have shown that primary closure after laparoscopic biliary exploration demonstrates a therapeutic efficacy not inferior to the placement of a T-tube for drainage in the postoperative period. Summarizing the studies published in the last 5 years on primary closure after laparoscopic biliary exploration, the results show that in appropriate cases, primary closure after laparoscopic biliary exploration is safe and effective, and compared with T-tube drainage, it can reduce the length of hospital stay, the hospitalization cost, and improve the quality of life of patients.

**Keywords:** Primary Closure; Choledocholithiasis; Laparoscopy; Post-biliary Exploratory Surgery.

## 1. Introduction

Choledochal stones are a common disorder of the biliary system. The prevalence of gallbladder stones ranges from 5-15%, while 5-30% of them are combined with common bile duct stones [1]. The main treatment modalities for patients with common bile duct stones include cesarean section, laparoscopic or robotic surgery, endoscopic retrograde cholangiopancreatography (ERCP) [2], Laparoscopic biliary exploration for the treatment of choledocholithiasis is recognized as a widely used, safe and effective treatment modality [3-4]. The clinical management strategy after choledochotomy is still controversial, and the placement of T-tube drainage has been used in the past, which shows great advantages in the treatment of residual stones, prevention of biliary stricture, reduction of biliary pressure, prevention of biliary fistula and other complications, and secondary exploration, etc. At the same time, the T-tube drainage can also lead to loss of fluids induced by water-electrolyte disorders, loss of appetite, bile leakage in the early stage of inadvertent dislodgement of the T-tube, and difficulty in T-tube removal. Based on this, primary closure after biliary tract exploration entered people's vision. In the early stage of exploration, due to the limited medical level at that time and the inexperience of surgeons, Halstead reported that after choledochotomy, a primary closure was performed, and serious complications such as bile leakage, bile duct stones, and choledochal stenosis appeared in the postoperative period, and the post-biliary exploration primary closure was once put on hold. In recent years, with the development of minimally invasive techniques such as laparoscopy, choledochoscopy and duodenoscopy, as well as the application of new sutures and the improvement of surgeon's surgical operation level, primary closure has been widely emphasized by clinicians again, and several studies have shown that primary closure is beneficial to overcome the adverse consequences of T-tube placement. [5, 6] This article summarizes the current status of primary closure after laparoscopic biliary exploration in recent years, with the aim of providing new ideas for the management of laparoscopic biliary exploration.

## 2. Indications

Currently, there are no guidelines or expert consensus on primary closure after laparoscopic choledochotomy, and the indications for primary closure are different in many studies, which are summarized as follows: 1. Patients with preoperative choledochal stones identified by ultrasound, CT, MRCP, 2. Diameter of choledochal ducts larger than 8 mm is considered safe and feasible, and a diameter too small can easily lead to bile leakage and biliary stenosis, 3. No preoperative combination of acute obstructive septic cholangitis or acute pancreatitis, 4. Intraoperative cholangioscopy suggests that there is no intra- or extra-hepatic bile ducts without stone residue, 5. The end of the choledochal duct is patent, and the sphincter of oddis has no obvious edema and opening and closing dysfunction, 6. No combination of obvious biliary stenosis or deformity, 7. No combination of biliary malignant tumors and mirizzi syndrome, 8. no biliary bleeding, 9. No combination of biliary or digestive tract fistulae, 10. Previous history of biliary and gastrointestinal tract fistulas, 11. History of previous upper abdominal surgery with detachable adhesions, 12. Choledochal stone less than 5 [7-10]

## 3. Surgical Approach

### 3.1. Simple Primary Closure

Laparoscopic biliary exploration is routinely performed, and after the stones are removed via choledochoscope, no stent or drain is placed, and an abdominal drain is placed only at the greenhole after direct suturing of the common bile duct incision. The way of suturing, the choice of suture and the margin and stitch spacing of the suture have not been clearly defined, absorbable suture is widely used, for example, there is a study suture using 3-0 or 4-0 absorbable suture interrupted or continuous suture of the common bile duct, according to the margin of about 1.0 mm, the stitch spacing is about 1.5 mm, the intraoperative bile leakage, most of the interrupted suture for repair [11] The intraoperative bile duct is often repaired with interrupted sutures. Some studies have

also used 4 ~ 0 absorbable sutures to close the common bile duct continuously or interruptedly, 2 mm beyond the upper and lower ends of the incision, with margins of 1 ~ 1.5 mm and stitch spacing of 1.5 ~ 2 mm [10]. Recently, unidirectional barbed consecutive sutures have shown good performance in terms of suture duration, postoperative bile leakage, and postoperative biliary stricture.[12]

### 3.2. Simple Primary Closure Combined with External Drainage

Some scholars believe that the incidence of bile leakage and biliary stenosis after primary closure alone is high, so they investigated whether primary closure combined with external or internal drainage could reduce the incidence of postoperative complications. Laparoscopic choledochal exploration with primary closure combined with external drainage is divided into: 1. Laparoscopic choledochal exploration with primary suture combined with ENBD tube drainage 2. Laparoscopic choledochal exploration with primary suture combined with PTCD tube drainage 3. Laparoscopic choledochal exploration with primary suture combined with C tube drainage. Some studies have shown that intraoperative or preoperative placement of ENBD combined with primary closure suture can drain bile, reduce bile duct pressure, decrease the occurrence of bile leakage, and support the bile duct to reduce biliary stricture [13, 14]. Some studies have shown that laparoscopic choledochal exploration with primary closure suture combined with PTCD tube is effective in reducing operative time and postoperative hospitalization compared with T-tube drainage [15] However, Primary suture combined with PTCD can also reduce bile drainage and biliary pressure, which can reduce the incidence of postoperative bile leakage and biliary stricture to a certain extent, but there are more steps to be performed, longer time to carry the tube, and the placement of PTCD has the corresponding complications.

### 3.3. Primary Suture Combined with Internal Drainage

After routine LCBDE for stone extraction, internal drainage devices are placed via choledochoscope through the common bile duct incision and primary suture of the common bile duct is performed, and the placement of internal drainage has also demonstrated good feasibility and safety. Currently, internal drainage devices include non-self-dislodging stents such as D-J tubes and self-dislodging stents such as (J tubes, umbrella J tubes), Yu [16] 's study demonstrated the use of a D-J tube compared to a T-tube without increasing postoperative complications, while decreasing operative time and reducing T-tube related complications, but the D-J tube not only requires better choledochoscopic and duodenoscopic techniques to support it, but also a second hospitalization to remove the stent transendoscopically. Self-removable stents work similarly to self-removable stents, which reduces secondary hospitalization and the mental burden on the patient, and is also more acceptable. When the inflammation of the common bile duct is severe and sludge-like stones are still visible in the hepatic bile duct, stent implantation increases the risk of postoperative complications such as blockage and bile leakage, and the choice of T-tube may be a good option.

## 4. Postoperative Complications

Postoperative complications after laparoscopic choledochotomy and lithotripsy with primary suture include: postoperative bleeding, bile leakage, bile duct stenosis, incision infection, cholangitis, residual stones, and stone recurrence [10, 17] The main complications include bile leakage and bile duct stenosis, while the rest of the complications are less well researched and will not be further investigated. In this paper, we only summarize the causes of the major complications.

### 4.1. Bile Leakage

Bile leakage is the most common complication of primary suture after choledochotomy, which not only affects the patient's prognosis, but also increases the hospitalization time and cost, and the common reasons are 1. the diameter of the choledochotomy is too small, and the thickness of the choledochotomy is less than 8 mm, 2. the surgeon's experience is poor, and the surgical technique and suturing technique are not skillful.[1] 3. preoperative combination of abnormal liver function and low albumin, which affects wound healing,4. severe uncontrolled inflammation of the common bile duct and wrong timing of surgery,5. blockage or premature dislodgement of the internal or external drainage stent tubes,6. stone entrapment or improper stone retrieval aggravates the loss of the bile duct wall or duodenal papilla edema

### 4.2. Biliary Stenosis

Choledochal stenosis is caused by intraoperative bile duct injury and recurrent cholangitis, resulting in fibrous tissue proliferation, wall thickening, and scarring narrowing of the bile duct lumen. Common causes include 1). barely one-stage suture of small diameter common bile duct 2). poor surgical suture technique 3). failure to select the appropriate suture based on the thickness of the common bile duct wall 4). intraoperative loss of the bile duct wall, which causes inflammatory stricture 5). repeated irritation of the suture with intraoperative stones that cannot be removed, scar healing and inflammatory stricture. The incidence of biliary stricture was significantly lower than bile leakage in several current studies, probably related to the fact that primary sutures after luminal biliary exploration are more often found in large hospitals and in surgeons with surgical experience.

## 5. Summarize

Although there is still no consensus on the indications for primary suture for laparoscopic choledochal exploration and a lack of guidelines, primary postoperative suture is safe and feasible in appropriate cases, and it can effectively avoid the risks of postoperative acid-base balance imbalance, electrolyte disorders, and bile leakage after the T-tube is dislodged and after it is removed due to the retention of a T-tube, and it realizes rapid postoperative recovery and improves the postoperative quality of life, which shows the superiority of minimally invasive treatments. The minimally invasive treatment is superior. The combination of primary suture with internal or external drainage stent can expand the indications for primary suture, but also increase the occurrence of corresponding drainage complications. Compared with T-tube drainage, primary suturing did not show a significant increase in postoperative complications such as bile leakage and biliary stricture in several studies,

while the operative time and cost were reduced and the quality of life of patients was improved. In some cases of severe infection, critical condition, and non-extraction of stones, primary suture may enhance the occurrence of postoperative complications, and indwelling T-tube is a better choice. In conclusion, the choice of surgical procedure is not a fixed formula, and clinicians should strictly control different surgical indications and choose the appropriate surgical treatment based on imaging and medical history in practice. In appropriate cases, Primary suturing is feasible in experienced surgeons after laparoscopic choledochotomy, which contributes to rapid clinical recovery and precise treatment.

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## Authors' Contributions

Y H wrote the main manuscript text and delivered manuscript, T X Collected literature, Y L Collected and Summarized literature. C Y revised the manuscript.

## Conflict of Interest Declaration

The authors have no conflicts of interest to disclose

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