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A Promising Method for Repairing Low-Level Biliary Strictures After Cholecystectomy

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The purpose of this study is to introduce and evaluate a new technique of repairing bile ducts by the tubular gastric wall with a vascularized pedicle. Both the end-to-end bile duct repair and Roux-en-Y hepatoenterostomy have limitations in the treatment of benign bile duct strictures after cholecystectomy. There are no other good choices to manage these cases, especially the bile duct transection injuries or partly missing common bile duct or hepatic duct. Eleven patients with partly missing common bile ducts in the Chinese People's Liberation Army General Hospital between January 2007 and December 2012 were retrospectively analyzed. The study comprised 8 females and 3 males, whose age ranged from 29 to 56 years. All patients underwent successful bile duct repair. The time of operations ranged from 210 minutes to 240 minutes. The maximal blood loss was less than 220 ml. There was no perioperative mortality and no case of gastric fistula. Postoperative complications occurred in 3 patients, including wound infection, bile leakage, and erosive gastritis. All complications were cured by conservative treatment. The mean follow-up time was 42 months. One patient was classified as Terblanche's grade II and 10 patients were classified as Terblanche's grade I. The observations indicate that this technique is a feasible and effective choice to manage low level biliary stricture after cholecystectomy, especially suitable to repair bile duct transection injuries or partly missing common bile duct or hepatic duct.

Key words: Tubular gastric wall with a vascularized pedicle – Biliary injury – Benign biliary stricture

It is a great challenge for surgeons to manage benign biliary strictures (BBSs) after cholecystectomy. BBS patients often survive for a long time, so surgeons pursue a long-term treatment for BBSs and minimize the effect on the patients' quality of life as they are able. Traditionally, surgery has been used as a means to treat BBSs, and the common procedure includes end-to-end bile duct repair and biliary-enteric anastomosis. However, current studies suggest that the former has a limited role in the

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treatment of benign bile duct strictures due to its narrow indications and poor long-term outcome.[1,2] The latter emphasizes the anatomy and treatment of proximal bile ducts. This approach misses the important "sphincter of Oddi" function of an antireflux device, and therefore, cannot avoid the incidence of reflux cholangitis, which increases not only the pain but also the risk of cholangiocarcinoma in long-term follow-up patients. Moreover, a biliary-enteric anastomosis alters the normal bile flow, changing the physiologic conditions of the gastrointestine and leading to the disorder of gastrointestinal hormone release. Hence, it increases the incidence of postoperative duodenal ulcer and inhibits fat metabolism and absorption due to the lack of bile between the duodenum and jejunum.[3–5]

New technologies should be developed to overcome the above disadvantage of current surgery, and the method of biliary reconstruction should be improved. The ideal surgical procedure for BBSs should be technically simple and should preserve both the physiologic passage of bile and the function of sphincter of Oddi.[6] This article introduced a new method using the tubular gastric wall with a vascularized pedicle to repair iatrogenic biliary strictures based on this idea.

Materials and Methods

We evaluated all patients who had injured biliary stricture after cholecystectomy and were treated by biliary surgery specialists using the tubular gastric wall and vascularized pedicle surgical procedure between January 2007 and December 2012. The operative data and complications, including complications and mortality during the perioperative period, were obtained from medical records. The postoperative follow-up data were collected either prospectively at the time of clinic visits or retrospectively by telephone interviews. The long-term surgical outcome included an assessment of symptoms, liver function tests, and radiographic studies. The criteria for assessing the late results of biliary stricture management were as follows: Terblanche's grade I, no biliary symptoms, and normal liver function; grade II, transitory symptoms but currently no symptoms and normal liver function; grade III, clear-cut related symptoms and deteriorating liver function; grade IV, recurrent strictures requiring endoscopic, percutaneous, and/or surgical therapy.[7] To be included in the study, all patients needed to have received liver function tests and Doppler ultrasonography 3 and 6 months after the surgery.

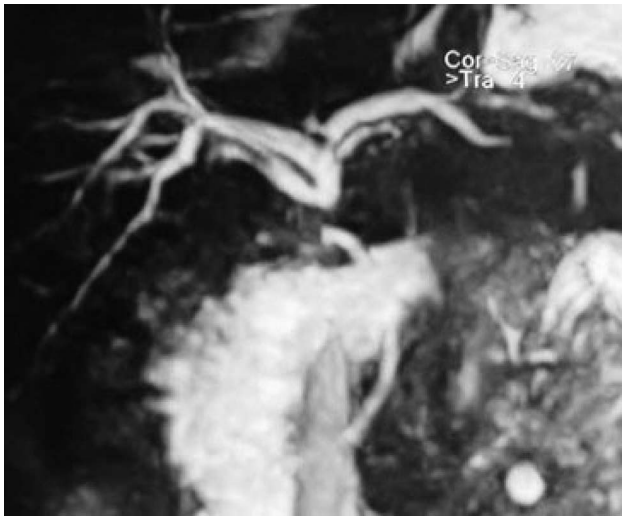

Fig. 1 Preoperative MRCP.

If positive, magnetic resonance cholangiopancreatography or hepatobiliary iminodiacetic acid were used to further investigate the status of the bile duct.

Surgical technique

Stenosis of the bile duct was removed and the healthy bile duct stumps were shaped routinely. The length of the bile duct defect and the duct diameter were measured and further used to estimate the size of the tubular gastric wall. The pulsatility of the right gastroepiploic artery of the gastric greater curvature was detected in order to locate the right gastroepiploic vessels. The gastric wall from the middle of the greater curvature of the stomach with its blood supply based on the right gastroepiploic vessels (13 cm from the pylorus and 1 cm in diameter), was chosen as the repair material. The right gastroepiploic vessels in and out of the tubular gastric flap were maintained, while these vessels in and out of the rest of the gastric wall were ligated and cut. The main branch of the right gastroepiploic vessels was then dissected (Fig. 2). The gastric tube with a vascularized pedicle was collected using a linear cutting anastomat (Figs. 2, 3). Then, the tube was finely reconstructed according to the length of bile duct defect and the shape of the bile duct openings. The condition of the cutting edge was observed and the bleeding was carefully stopped. The posterior walls of the gastric tube with a vascularized pedicle were anastomosed to those of the two bile duct stumps using single-layer interrupted sutures with 4–0 or 6–0 Vicryl (Fig. 4). Then, the long arm of a

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Fig. 2 Taking the tubular gastric wall with a vascularized pedicle by a linear cutting anastomat.

transanastomotic T-tube was taken out of the front hole of the gastric tube using a right-angle forceps. One short arm of the T-tube was placed into the left hepatic duct, and the other short end was placed into the common bile duct. The posterior row of sutures was placed followed by the anterior row. Both anastomoses were mucosa to mucosa. Finally, the long arm of the T-tube was fixed by a stitch of the same suture type (Fig. 4). If the bile duct diameter was too small to accept the T-tube, other straight silicone tubes could be used for biliary drainage.

Results

The study comprised 11 patients (8 females and 3 males), whose age ranged from 29 to 56 years with a mean age of 42.7 (Table 1). All of the patients received laparoscopic cholecystectomy at other hospitals due to gallstones or gallbladder polys with cholecystitis. During the primary cholecystectomy, they got common hepatic bile duct injuries. Among them, the bile duct transection injury was found in 1 case during the surgery. After placing a bile drainage tube, the patient was transferred to our hospital. Peritonitis symptoms appeared in 3 patients within 1 week after the operation, and emergent exploratory laparotomy confirmed that it was due to bile duct injuries and/or bile leaks. Subsequently, 2 cases received peritoneal lavage and the external biliary drainage operation. The other patient was treated with end-to-end anastomosis. The remaining 7 patients had jaundice or recurrent cholangitis 3 months after the surgery. One patient underwent balloon angioplasty without relief and was transferred to our hospital. All 11 patients received bile duct repair by the gastric wall with a vascularized pedicle. All operations were performed 2 weeks after the control of biliary tract infection. During the surgery, 10 cases were confirmed to have Bismuth II injury, and 1 case had Bismuth III injury. The right hepatic artery and portal vein were all intact in these patients. After bile duct reconstruction, it was required to reveal the bile duct confluence and the posterior segment of choledocho duodena. The length of the bile duct defect was more than 2 cm in all patients. All patients underwent successful bile duct repair with the tubular gastric wall with a vascularized pedicle. The time of operations ranged from 210 minutes to 240 minutes with a mean time of 228 minutes. The maximal blood loss was less than 220 ml. There was no perioperative mortality. No cases of gastric fistula were recorded. Postoperative complications oc-

Fig. 3 The tubular gastric wall with a vascularized pedicle (the right gastroepiploic vessels).

Fig. 4 Anastomosis of the gastric tube to the two bile duct stumps and placement of 18 T-tube.

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Table 1 Baseline characteristics

Patient	Gender	Age	Primary operation	Bismuth classification	Presentation	Management prior to referral
1	Female	29	Laparoscopic cholecystectomy	Bismuth II	Intraoperative diagnosis	External drainage
2	Female	45	Laparoscopic cholecystectomy	Bismuth II	Peritonitis/biliary leak	Surgical treatment
3	Female	46	Laparoscopic cholecystectomy	Bismuth III	Jaundice	Balloon dilatation
4	Male	43	Laparoscopic cholecystectomy	Bismuth II	Jaundice	None
5	Male	56	Laparoscopic cholecystectomy	Bismuth II	Jaundice	None
6	Male	37	Laparoscopic cholecystectomy	Bismuth I	Cholangitis	None
7	Female	43	Laparoscopic cholecystectomy	Bismuth II	Cholangitis	None
8	Female	48	Laparoscopic cholecystectomy	Bismuth II	Peritonitis/biliary leak	Surgical treatment
9	Female	52	Laparoscopic cholecystectomy	Bismuth II	Peritonitis/biliary leak	Surgical treatment
10	Female	39	Laparoscopic cholecystectomy	Bismuth II	Cholangitis	None
11	Female	32	Laparoscopic cholecystectomy	Bismuth II	Cholangitis	None

curred in three patients, including 1 case of wound infection, 1 case of bile leakage, and 1 case of erosive gastritis. The patient with erosive gastritis responded to antacids well. All complications were cured by conservative treatment. The follow-up time ranged from 21 months to 83 months with a mean time of 42 months. One patient had transitory episodes of pain or fever during the follow-up time (Terblanche's grade II), and became normal later. The other patients had no biliary symptoms. All patients showed the normal liver function for all tested indicators including alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, total bilirubin, and direct bilirubin. No recurrent strictures were found by the cholangiography or ultrasonography (Terblanche's grade I).

Discussion

Generally, iatrogenic biliary strictures mean the loss of normal bile duct length and lumen width. Hence, it is critical to cut the stricture, enlarge the biliary lumen, and reconstruct the bile duct so that both the physiologic passage of bile and the function of sphincter of Oddi can be retained maximally. How to connect the 2 ends of the bile duct after stricture resection is a question that arises.

According to the literature, multiple materials have been reported to replace biliary defects, including expanded polytetrafluoroethylene, autologous veins, bioabsorbable polymer patch, etc.[8–10] These studies suggest that the best material for duct repair is autologous tissue resistant to bile, so we chose the tubular gastric wall in the present study.

Anatomically, the stomach is near the extrahepatic bile duct. The gastric wall has rich blood supply and communicating branched vessels, which makes it a good material for bile duct repair. In addition, the rest of the gastric wall supplied by the right gastroepiploic vessels will not undergo ischemic necrosis after the removal of these vessels. That is why there were no stomach leakage patients in our study. The arterial supply of the supraduodenal duct is essentially axial, called the 3 o'clock and 9 o'clock arteries, arising from the superior pancreaticoduodenal artery or the right branch of the hepatic artery mostly.[11] It is easily damaged in bile duct injuries. In contrast, the arterial supply of hilar bile duct is a collateral system, where the right and left hepatic arteries communicate freely via the hilar plate arterial plexus.[12] Hence, ischemia seldom happens. The proximal bile duct stump should be dissected at the level of hepatic duct convergence, especially in the case of injury of the right hepatic artery. The arterial supply of lower common bile duct including the posterior duodenum is mainly supplied by the posterior superior pancreaticoduodenal artery. This arterial supply is seldom damaged due to scarce dissection at the primary attempt, so the blood supplies of the proximal and distal bile ducts are preserved. Moreover, the tubular gastric flap has its own blood supply, whose length and width can be regulated along with the shaped defect. All these factors guarantee the sufficient blood supply and free tension at the anastomosis site, which may be one of the reasons for less bile leakage patients in the study. Even bile leakage did happen, it could be cured by conservative treatment. The gastric wall has thicker smooth muscle than that of jejunum, so it is difficult to dilate like biliary cyst compared with jejunal wall, which is obtained from the T-tube Cholangiography (Fig. 5).

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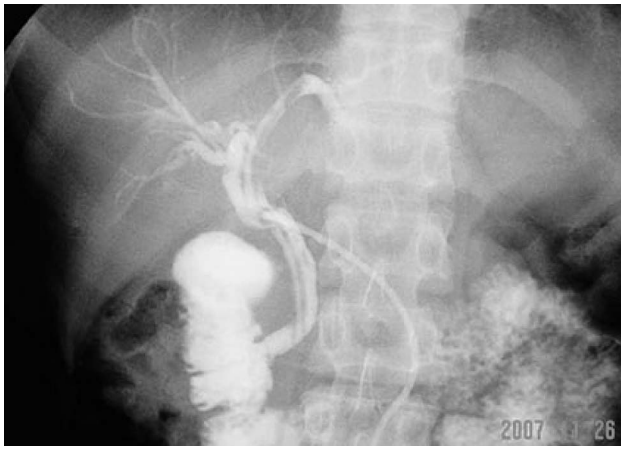

Fig. 5 T-tube Cholangiography: 6 months after operation.

Technically, the key for a successful operation is to locate the proximal and distal bile duct precisely. The difficulty of this procedure is how to identify the distal end from the scar. Generally, the distal target is the retroduodenal part of the common bile duct. After this segment, the common bile duct goes into the pancreatic parenchyma or the pancreas and cannot be anastomosed. In the present cases, division and retraction downward of the horizontal part of duodenum localized the common bile duct near the portal vein. Intraoperative ultrasonography was used as an essential technique for locating the distal end. The proximal bile duct stump could be found by lowering the hilar plate at the base of segment IV.[13]

Compared with RYHJ, the technique we introduced here maintains the function of sphincter of Oddi, which provides a normal biliary duct pressure and a barrier to prevent reflux into the bile duct. Another advantage of this improved technique is to make ERCP or balloon dilatation achievable via repaired bile ducts postoperatively. This approach has wider clinical applicability than end-to-end bile duct repair because of variable length and width of the gastric wall with a vascularized pedicle. Based on our observations, this technique is highly recommended to treat patients with the low level injured biliary, including Bismuth I and II and part of Bismuth III patients. The approach is especially suitable to repair bile duct transection injuries or partly missing of the common bile or hepatic duct due to other causes (Fig. 1), which cannot be fixed by currently reported flake gastric flaps. At least partially continuous bile duct is a must for the application of flake gastric flaps.

In this study, the long-term outcome was excellent. It may be because all operations were performed by experts. The successful rate of primary bile duct repair done by previous surgeons was only 17 to 27%, but it was increased up to 80 to 90% in the special medical center via experts.[2,14] However, the presented technique was only applied in 11 patients. More detailed and large-scale studies are needed and several details of the procedure can be debated. Some research reported that the biopsy of gastric wall taken from the T-tube sinus 3 months after operation showed chronic or acute inflammation.[15] However, how the gastric wall changes in the long-term bile environment and how the gastric wall affects the biliary tract need to be further investigated.

We concluded bile duct repair by the tubular gastric wall with a vascularized pedicle is a feasible and effective choice to manage low level biliary strictures after cholecystectomy, especially suitable to repair bile duct transection injuries or partly missing common bile duct or hepatic duct.

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