

Perpendicular duodenum jejunum anastomosis for conventional postoperative endoscopic access in biliodigestive diversions in Roux in Y

Anastomosis perpendicular duodeno-yeyunal para un acceso endoscópico convencional posoperatorio en las derivaciones biliodigestivas en Y de Roux

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Abstract

Background: Cholecystectomy is one of the most performed abdominal surgical procedures, with approximately 1.5 million procedures performed annually in the United States of America. Most of the biliary duct injuries during laparoscopic cholecystectomy are due to a wrong perception of the anatomy. Two thirds of postsurgical stenosis develop within two and three years after repairing and the other third in the following ten years. **Objective:** To show the adequacy for postoperative endoscopic access in Roux-in-Y biliodigestive diversions. **Method:** The best technique to repair biliary duct injuries is the Roux-in-Y hepaticojejunostomy or choledochojejunostomy, from this procedure we propose a surgical technique that consists to perform a perpendicular anastomosis between the defunctionalized jejunum loop and the duodenum for later endoscopic access of the Roux-en-Y biliodigestive diversion. **Results:** The duodenal-jejunal perpendicular anastomosis procedure was performed in four patients with Roux-Y biliodigestive diversion. **Conclusions:** With the technique that is proposed, we have that advantage of keeping the anastomosis permanently open due to its rhomboidal design and because of the pylorus is kept intact alkaline reflux would not be a problem.

Keywords: Anastomosis. Perpendicular. Hepaticojejunostomy. Choledochojejunostomy.

Resumen

Antecedentes: La colecistectomía es una de las cirugías más frecuentes, con aproximadamente 1.2 millones de procedimientos realizados anualmente solo en los Estados Unidos de América. La mayoría de las disrupciones biliares durante la colecistectomía laparoscópica se deben a una percepción errónea de la anatomía. Dos tercios de las estenosis posquirúrgicas se desarrollan 2-3 años después de la reparación y el otro tercio en los 10 años siguientes. **Objetivo:** Mostrar la adecuación para un acceso endoscópico posoperatorio en las derivaciones biliodigestivas en Y de Roux. **Método:** La mejor técnica quirúrgica reportada para la reparación de las disrupciones biliares es la anastomosis hepático-yeyuno o anastomosis

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colédoco-yeyuno en Y de Roux. Partiendo de este procedimiento, la variante quirúrgica que proponemos consiste en realizar una anastomosis perpendicular entre el asa desfuncionalizada de yeyuno y el duodeno para el posterior acceso endoscópico de la derivación biliodigestiva en Y de Roux. **Resultados:** Se realizó el procedimiento en cuatro pacientes con derivación biliodigestiva en Y de Roux. **Conclusiones:** El procedimiento que proponemos tiene la ventaja de mantener abierta la anastomosis debido a su diseño romboidal, y como el píloro se encuentra indemne, el reflujo gástrico alcalino no sería ningún problema.

Palabras clave: Anastomosis. Perpendicular. Colédoco-yeyuno. Hepático-yeyuno.

Introduction

Cholecystectomy is one of the most commonly performed surgeries in the world, with approximately 1.2 million procedures annually only in the United States of America. Among its most serious complications, the disruption of the biliary duct has been reported in 0.4-0.6% of open cholecystectomies¹, and the rise of the laparoscopic cholecystectomy has led to an increase in the rate of biliary duct disruption, with a range of 0.3% to 0.6%², and with reports of up to 1.4%³ and 1.5%⁴. Among these, around 17-20% are recognized intraoperatively, with a marked incidence during the learning curve⁵. The disruption of the biliary duct following a cholecystectomy is defined as an unintentional injury of any portion of the biliary duct evidenced during or after surgery due to a biliary leak or obstruction⁴. Many of the biliary disruptions during a laparoscopic cholecystectomy are due to a wrong perception of the anatomy more than poor judgement or skill, which means that biliary injuries will continue despite completing the learning curve⁶.

Benign biliary stenosis is a relatively rare condition that, in most cases, is caused by surgical trauma, primarily by an open or laparoscopic cholecystectomy, and the second cause is fibrosis on the biliodigestive anastomosis site⁷. Biliary stenosis can present at any time after 6 weeks and up to 15 years after the biliary disruption. The prevalence of the hepatic atrophy/hypertrophy after biliary injuries is approximately 10% with a prevalence of cirrhosis in these patients of 4-17%⁴.

Percutaneous transhepatic cholangiography is considered the reference method for late diagnosis of the injuries, as it is a decompression approach in case of cholangitis, and therefore, it is recommended prior to surgery. The other study that provides important information and has the advantage of being non-invasive is the cholangioresonance⁶.

Symptoms presented by these patients vary widely: from asymptomatic to a complete obstruction with jaundice, pain, itching, proximal cholelithiasis, intrahepatic

abscesses, cholangitis, and biliary cirrhosis^{4,7}. An incidence of cholangiocarcinoma of 7.6% in patients that undergo a choledochoduodenostomy, and 1.9% in those that undergo a hepaticojejunostomy; this risk increases in patients that primarily present cholangitis during a follow up⁴.

Treatment of these injuries showed better results when referred to multidisciplinary centers specializing in hepatobiliary surgery². Complete rehabilitation has been reported after a biliary injury in 75-98% of cases, this wide range can be explained due to the difference in the injury mechanism and the variability in the final anatomical state of the ducts².

Frequently, the extent of an ischemic injury in the duct is less apparent during immediate repair, which results in a higher incidence of postoperative anastomotic stenosis that require subsequent dilation or surgical repair, as biliary stenosis can be manifested late, even years after the injury⁵. Two thirds of post-surgical stenosis develop within two and three years after repairing and the other third in the following ten years⁴. Negative prognostic factors have been reported for the success of biliary repairs, and success decreases with the severity of the injury, repair attempts while the patient has sepsis and peritonitis, associated vascular injuries, and injuries repaired in centers with no experience. Early repairs perhaps have better results than late repairs and as long as it is performed by an experienced specialist in patients in good condition⁴.

Most injuries were resolved by performing a Roux-in-Y Hepaticojejunostomy^{2,5,7,8}, and this can be considered the preferred reconstruction choice^{9,10}. The best results are obtained by performing a wide tension free anastomosis with the proper suture material in good quality ducts without ischemia¹⁰.

All these procedures require periodic monitoring with the purpose of preventing medical and legal implications, and therefore, these patients must be subject to long-term monitoring⁵.

The quality of life of patients that undergo biliodigestive bypasses must be evaluated for at least

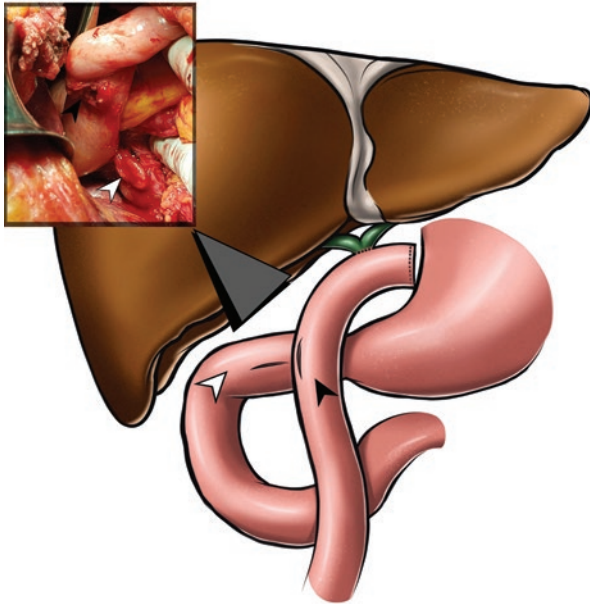


Figure 1. Choledojejunum biliodigestive bypass. White arrow head: duodenum incision. Black arrow head: jejunum incision.

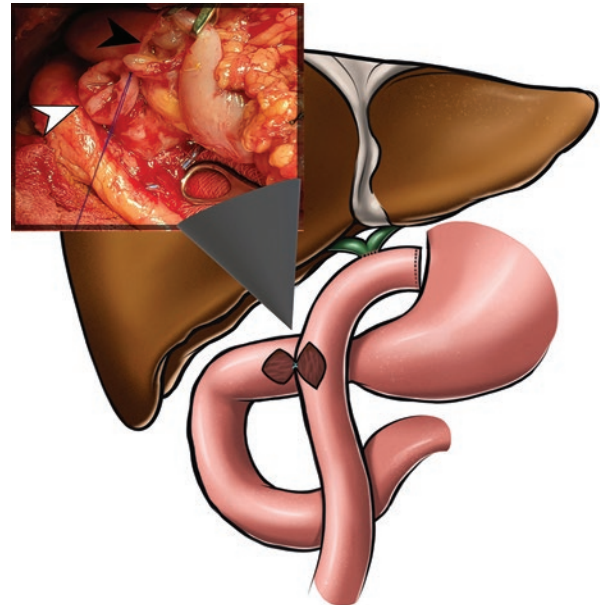


Figure 2. Choledojejunum biliodigestive bypass. Black arrow head: jejunum. White arrow head: duodenum.

5 years after the procedure, in order to identify faults in the treatment, restenosis or cholangitis⁴.

Several procedures have been reported to resolve the Roux-en-Y biliodigestive bypass, especially in cases with a biliary duct injury during a cholecystectomy or in any other case in which the Roux-in-Y bypass was the method of treatment. When this serious complication is present, with the purpose of having postoperative access to the stenosis, several treatment methods have been described.

Method

The best reported surgical technique to repair biliary duct injuries is the Roux-in-Y hepaticojejunostomy or choledochojejunostomy anastomosis^{4,5,7,8,11}. Starting with this procedure, the surgical variant we are proposing involved a perpendicular anastomosis between the dysfunctional jejunum handle, approximately at 10-12 cm from the biliojejunal anastomosis and the duodenum, performing a 3.0 cm long duodenal incision lengthwise, and another incision of the same size along the length of the dysfunctional jejunum handle. Previously, a biliojejunal anastomosis was performed, and in this way both intestinal incisions are perpendicular (Fig. 1), saturating the middle part of the upper edge of the duodenotomy with the upper apex of the jejunotomy (Fig. 2), and then the proximal apex of the duodenotomy with the

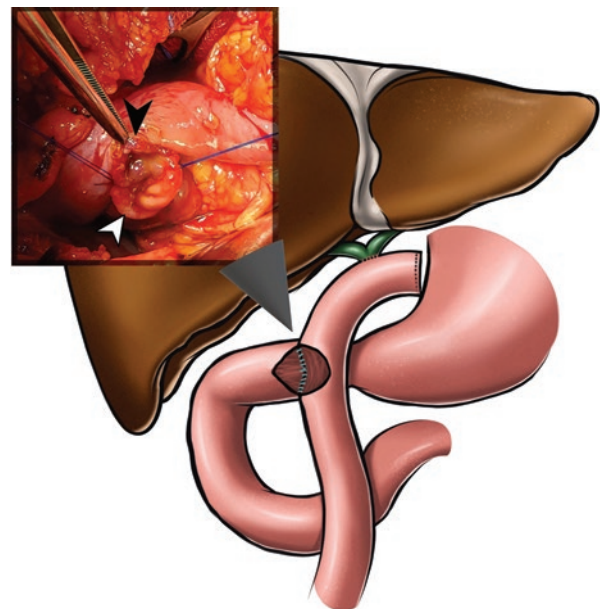


Figure 3. Choledojejunum biliodigestive bypass. Black arrow head: jejunum. White arrow head: duodenum.

middle part of the medial edge of the jejunotomy (Fig. 3). The lower apex of the jejunal incision is immediately sutured with the medial part of the lower edge of the duodenotomy, and interspersed stitches are placed between these points of reference, finishing the anastomosis with a stitch on the distal apex of the duodenum with the middle part of the

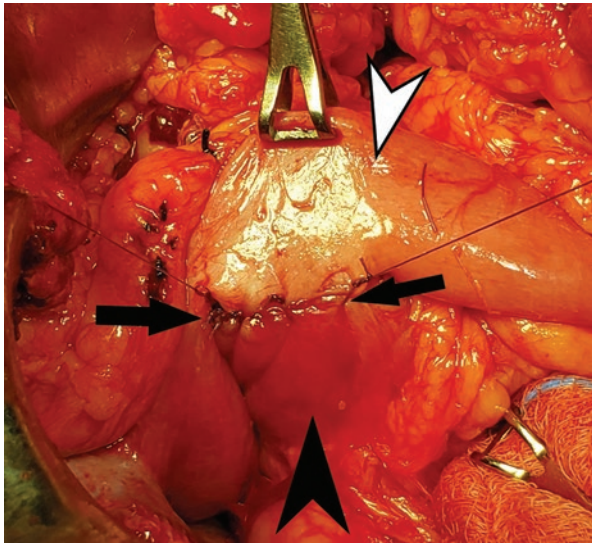


Figure 4. Completed anastomosis. White arrow head: jejunum. Black arrow head: duodenum. Black arrow: jejunoduodenal anastomosis.

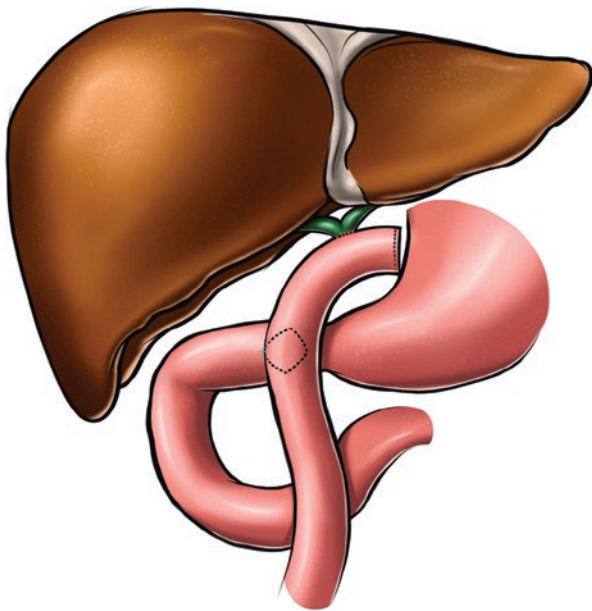


Figure 5. Jejunoduodenal anastomosis.

side edge of the jejunotomy, creating a diamond-shaped anastomosis (Figs. 4 and 5).

This procedure has been designed to approach stenosis of the biliojejunal anastomosis site using a conventional endoscopic approach. It can be performed using an open or laparoscopic approach. The procedure was approved by the bioethics committee of our hospital.

Results

In November 2014, the first experimental cadaver procedure was performed, showing that it was feasible.

Case 1

In November 2016, the first procedure with a live patient was performed, and their preoperative diagnosis was a Type 1 Todani choledochal cyst with successful postoperative evolution using an endoscopic approach of the biliodigestive anastomosis 8 weeks later. This approach was performed with a panendoscope and it showed that the conventional endoscopy approach to anastomosis is feasible.

Case 2

It was performed in March 2017 as a complement to a Roux-in-Y hepaticojejunal anastomosis performed 3 years before. The patient presented jaundice and repeat cholangitis, and for this reason, a catheter is placed for temporary cutaneous draining. During the surgical procedure, an endoscopy was used through a lengthwise incision on the dysfunctional handle of the jejunum, successfully passing through the endoscopy, a guide and a balloon for the dilation of the stenosed anastomosis and placement of the prosthesis, and the procedure was completed with a lengthwise incision to the duodenal axis and the duodenojejunal perpendicular anastomosis on a plane.

Case 3

In July 2019, a procedure was performed on a 50-year-old patient with a Bismuth 3 biliary duct injury following a laparoscopic cholecystectomy referred to our hospital unit. During the same surgery a biliodigestive bypass and a perpendicular jejunoduodenal bypass were performed (Fig. 6).

Case 4

In August 2019, these procedures were performed on a female patient who underwent a biliodigestive bypass in 2010 due to a biliary duct injury in another hospital unit. For 9 years she had recurring episodes of cholangitis and she had undergone eight percutaneous

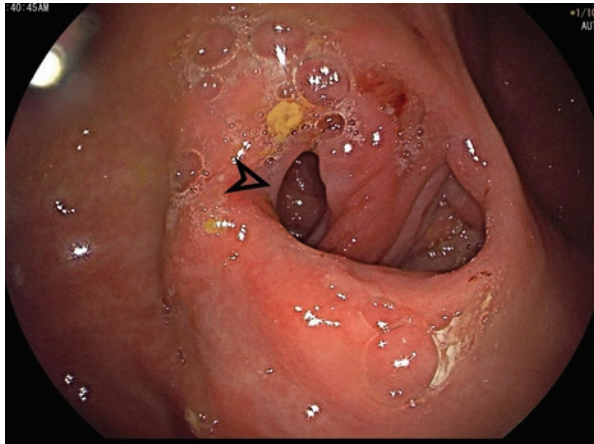


Figure 6. Jejunoduodenal endoscopic view. Arrow-head: entry site for the jejunoduodenal anastomosis.

transhepatic interventions in the last two years. An explored laparotomy was performed for a jejunoduodenal perpendicular anastomosis using the transoperative endoscopic exam through the jejunum before performing the perpendicular jejunoduodenal anastomosis, with calculation findings within the biliary ducts, as well as sutures with the appearance of silk to the light at the level of the biliodigestive anastomosis.

Discussion

The hepaticojejunal anastomosis is considered the method of reference to reconstruct biliary disruptions. When the biliary convergence is interrupted, the left biliary duct is isolated according to the Hepp-Couinaud technique, and then, both ducts, right and left, are anastomosed at the same intestinal openings⁴. There are several classifications for the biliary duct injury, but the most commonly used are Bismuth and Strasberg's classifications¹².

Among the early complications of the Roux-in-Y hepaticojejunal anastomosis is the biliary leak with a frequency of 2.4-5.6%⁸. When the leak is persistent, it is caused by one or more isolated ducts that have been overlooked and were not anastomosed, in order to treat it, sometimes it is necessary to administer an ethanol injection to sclerotize the duct⁸.

Postoperative stenosis is reported with an incidence of 4-10%^{8,13}, and even up to 25% and is usually caused by a surgical injury of the biliary duct during a cholecystectomy. The stenosis of the anastomosis is a serious complication that can lead to repeated cholangitis episodes, biliary cirrhosis, liver failure and

death^{11,13-15}. Therefore, a patient that has undergone a simple cholecystectomy surgery may turn into a candidate for a liver transplant due to a recurring stenosis with development of biliary cirrhosis¹⁶. The recurrence of stenosis is reported in 10% of patients and it requires dilation with balloon, and in some cases dismantling and a new hepaticojejunostomy⁶. The long-term resolution of the stenosis, with any type of therapy, is not higher than 84% currently⁷. The risk factors for the formation of stenosis are biliary duct ischemia, multiple prior repair attempts, intraabdominal abscesses or biliary collections, internal or external fistula, male gender, anastomosis in a non-dilated ducts, percutaneous preoperative or postoperative drainage, and comorbidity that may compromise visceral perfusion^{13,17}. Among late complications we find cholangitis events, which are often associated with intrahepatic lithiasis, although, usually are attributed to a retrograde bacterial infection, and therefore, imaging diagnostics are necessary to rule out an anastomotic stenosis⁸.

Luo, et al.¹⁸, in order to prevent postoperative stenosis from biliodigestive bypasses, report their hepaticojejunostomy using a progressive dilation procedure with balloon by placing a T probe with balloons in the anastomosis, spanning the right and left duct, and extracting the long branch of the T probe through the jejunum handle by counteropening, with a subsequent progressive dilation, thus reporting better results in 52 of 54 patients than with only the hepaticojejunostomy.

Hepatectomy is indicated after one or more unsuccessful repair attempts, whether using the endoscopic or surgical approach, and with secondary sepsis⁴.

Barbier, et al.⁴ report liver transplant as an exceptional indication reserved for patients whose liver function is so deteriorated that a repair or hepatectomy are impossible after a serious biliary vascular injury and biliary injuries in patients with preexisting liver disease⁴.

Parrilla, et al.¹⁹, in Spain, performed a retrospective and multicentric study from January 1987 to December 2010, which included 27 patients on the transplant list after undergoing one or more biliary injury repair attempts, and they concluded that injuries in laparoscopic cholecystectomy are more serious than in open surgery.

The purpose of postoperative biliary stenosis treatment is to establish the biliary flow towards the gastrointestinal tract in order to prevent the appearance of cholestasis, cholangitis, sludge, or gallstones¹⁴. This goal is achieved by suturing healthy tissues and

performing tension-free anastomosis². Several methods have been proposed, including termino-terminal anastomosis, choledocoduodenostomies, hepatojejunostomy, and Roux-in-Y choledocojejunostomies, or mucous grafts, among others¹⁴.

Among the procedures to approach postoperative stenosis are non-surgical techniques, such as percutaneous endoscopy, using dilation balloons, or placement of endoprosthesis^{2,7,13}. De Reuver, et al.³ report an endoscopic approach with endoprosthesis with a success rate for biliary stenosis due to biliary injury of 74%, with a treatment duration with *stents* of 11 months, all with a 4.5 year follow up, although these results have not been homogeneously reproduced in other reports.

There are also surgical techniques, such as reanastomosis of the hepaticojejunostomy, which seems to be the most common surgical method. Thus, Asi, Stilling, et al.¹⁶, in Denmark, reported that, at least 42% of patients presented a long-term complication, with cholangitis being the most frequent (23% of patients), and 30% presented stenosis of the hepaticojejunostomy. In addition, vascular injury occurred in 19% of cases in their series. One of the possible explanations for the high incidence of stenosis is that, in this group, patients were subject to an early biliary reconstruction, 83% of them within 2 weeks after the injury, and the rest within the first 2 days.

A wide variety of surgical procedures with biliary access handles have been performed in order to facilitate endoscopic approaches, and for this reason many authors have attempted to design a series of procedures. Barker and Winkler²⁰ published an additional procedure to hepaticojejunostomy, taking the end of the proximal handle of the Roux-in-Y to the abdominal wall, building a jejunum stoma in the right subcostal area of the abdominal wall. Helmy, et al.^{9,21} report the use of a pedicle gastric tube lodged between the proximal and distal segments of the injured biliary ducts, in a first clinical case, with positive results at the time of the 5-month follow up, and a series of 18 cases with injuries and loss of segment after 2 years without complications. They concluded that it has advantages over other procedures because the functional sphincter of Oddi is preserved, facilitating diagnostics and therapeutic procedures, such as the endoscopic retrograde cholangiopancreatography, which has been proven to be extremely difficult after a Roux-in-Y hepaticojejunostomy. Another option is to connect a gastric tube lodged in the duodenum; note that the gastric tube has superficial mucous epithelium which, when in continuous contact with bile, could suffer alkaline inflammation. Crema, et al.²² report their first

cases of retubularization with a pedicled jejunum lodged between the biliary duct and the duodenum.

Elbir, et al.¹³ report the case of a patient treated with a plasty of the stenosis area using the principles of the Heineke-Mikulicz technique, with good evaluation after 18 months, but in case of restenosis, this patient would have to undergo a new surgical exam or a cutaneous approach with an uncertain result.

The endoscopic approach is the least invasive method, but its main obstacle is the extremely difficulty for the endoscope to reach the *biliocentric* shunt, due to the altered anatomy of the Roux-in-Y reconstruction, although some authors defend the use of single or double balloon enteroscopy in order to overcome this difficulty¹¹.

Other authors build surgical access handles for the endoscopist to reach the hepaticojejunostomy site. These handles can be jejunum superficial or subfacial cutaneous, subparietal hepaticojejunal, described by Beckingham, et al.²³, where the dysfunctional handle is closed and fixed on the subparietal position to the abdominal wall with ligacips placed in order to mark the anastomosis with the purpose of posterior radiological identification (fluoroscopically determining the position of the ligacip), the loops is inserted percutaneously between the clips and a fine caliber needle with intermittent contrast injections and a guide. They report the use of a dysfunctional long jejunum handle (the end of the Roux-in-Y handle is taken for the hepaticojejunostomy) placed in retrocolic and subcutaneous position as if it was a feeding jejunostomy, but with a valve to prevent reflux²⁰ or jejunum handles with gastric access (jejunogastrostomy), such as the procedure reported by Sitaram, et al.²⁴ in his series.

Hamad, et al.¹¹ evaluated the use of three different bilioenterogastrostomy techniques, which involved creating a modified bilioenteric *shunt* with a gastric access handle for an endoscopic access to the hepaticojejunostomy, and in this way being able to approach the postsurgical stenosis, but it has the disadvantage of being complex and the adverse effect of bile on the gastric epithelium.

With the technique we are proposing, the advantage is keeping the anastomosis permanently open due to its rhomboidal design, and since the jejunum handle is dysfunctional and the pylorus is not damaged, the alkaline gastric reflux is not an issue. The proposed procedure can be performed during the biliodigestive bypass or, as in cases 2 and 4 presented, with the addition of the duodenojejunal perpendicular anastomosis in the late postoperative period.

Conclusions

No therapeutic option to approach the Roux-in-Y hepaticojejunal anastomosis, in the postoperative state, has been 100% effective, and therefore, several techniques have been designed with their variants in order to access the remote anastomosis site when there has been a stenosis, as this is one of the most undesirable complications, due to its morbidity and consequences if it is not resolved. With the perpendicular duodenojejunal anastomosis in addition to the hepaticojejunostomy presented here, it is feasible to directly approach the anastomosis site with a conventional endoscopy, and due to its design, it allows repetition on demand in order to maintain the long-term permeability and functionality.

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Ethical disclosures

Protection of People and Animals. The authors state that the procedures followed are in compliance with the ethical standards of the responsible human experimenting and the World Medical Association and the Declaration of Helsinki.

Data Confidentiality. The authors state that the protocols of their work center regarding the publication of patient data have been followed.

Right to privacy and informed consent. The authors have obtained informed consent from the patients and/or subjects mentioned in the article. This document is owned by the corresponding author.

Conflicts of interest

The authors state that they do not have any conflicts of interest

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