International Journal of Gastrointestinal Intervention

journal homepage: www.ijgii.org

Review Article

Gallbladder stones in bariatrics and management of choledocholithiasis after gastric bypass

Mariano Palermo^{1,*} and Manoel Galvao Neto²

ABSTRACT

It is known that the rapid weight loss is a predisposing factor to develop biliary lithiasis. The physiopathology is related with an oversaturation of bile with cholesterol, bile stasis, and increase in mucin concentration in bile. The incidence of cholelithiasis post gastric bypass is estimated around 37%. Almost 50% developed disease in the first year of monitoring, and 60% in the first 6 months. Meanwhile the patients undergoing sleeve gastrectomy have an incidence of cholelithiasis of 27%. Diverse kinds of protocols exist: prophylactic surgery (simultaneous cholecystectomy and gastric bypass in every patients, whether they have or not cholelithiasis), elective (simultaneous cholecystectomy with conventional gastric bypass in the patients with asymptomatic cholelithiasis), and conventional cholecystectomy only in the presence of cholelithiasis with symptoms. Which way to go is still a topic of discussion among surgeons but the majority agree that prophylactic surgery shouldn't be an option because the number of patients that will develop symptomatic cholelithiasis is low (around 6% to 8% of them) and this leads to an elevated number of patients exposed to an unnecessary procedure with potential complications. The presence of gallstones in the common bile duct (CBD) although is a rare complication after Roux-en-Y gastric bypass (around 0.2% of the bariatric patients) represents an important challenge due to the anatomical modifications of the gastrointestinal tract. This leads to having to pursue other methods to reach the papillae for the resolution of choledocholithiasis: laparoscopy-assisted transgastric endoscopic retrograde cholangiopancreatography (ERCP), balloon enteroscopy assisted ERCP, percutaneous biliary drainage with subsequent trans fistula treatment and laparoscopic exploration of CBD. Which of these methods should we choose must be based on the surgeon experience, the equipment available and the location of the stone. But whatever the method, a special training is needed on endoscopy, percutaneous surgery and laparoscopy.

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Keywords: Choledocholithiasis; Cholelithiasis; Endoscopy; Gastric bypass; Percutaneous

Cholelithiasis

It is known that the rapid weight loss is a predisposing factor to develop biliary lithiasis. The physiopathology is related with a supersaturation of bile with cholesterol, bile stasis, and increase in mucin concentration in bile. Therefore after any bariatric procedure (but gastric bypass especially), where a rapid weight loss occur, this can become a threat. Furthermore the treatment can be challenging because of the anatomical changes due to the bariatric procedure.^{1,2}

Diverse kinds of protocols exist: prophylactic surgery (simultaneous cholecystectomy and gastric bypass in every patients,

whether they have or not cholelithiasis),^{3,4} elective (simultaneous cholecystectomy with conventional gastric bypass in the patients with asymptomatic cholelithiasis),⁵⁻⁷ and conventional cholecystectomy only in the presence of cholelithiasis with symptoms.⁸⁻¹¹

The incidence of cholelithiasis post gastric bypass is estimated around 37%. Almost 50% developed disease in the first year of monitoring, and 60% in the first 6 months. Meanwhile the patients undergoing sleeve gastrectomy have an incidence of cholelithiasis of 27%, being most of the cases developed in the first and a half year.¹²⁻¹⁴

Compared with the general population, the obese have high levels serum cholesterol, determining a higher incidence of lithia-

¹Department of Bariatric Surgery, Centro CIEN – Diagnomed, Affiliated Institution to the University of Buenos Aires and DAICIM Foundation, Buenos Aires, Argentina

²Department of Surgery, Florida International University and Endovita Institute, Sao Paulo, Brazil

Received September 20, 2018; Revised September 20, 2018; Accepted December 1, 2018

* Corresponding author. Department of Bariatric Surgery, Centro CIEN – Diagnomed, Affiliated Institution to the University of Buenos Aires and DAICIM Foundation, Las Heras 16, Ramos Mejia, Buenos Aires CP1704, Argentina.

E-mail address: palermomd@gmail.com (M. Palermo). ORCID: <https://orcid.org/0000-0001-7366-3321>

sis, which is further increased in the patient population undergoing a bariatric procedure. The latter is linked to several factors, among which stands out the large weight loss (especially in the first six months after surgery) which favors a significant mobilization of cholesterol from adipose tissue reservoir and reduced production of bile salts and phospholipids to the gallbladder.

Furthermore, after bariatric surgery occurs a decrease in the gallbladder motility due to nerve damage, deficit in phospholipids and contraction stimulating proteins, and an increase of mucin secretion towards the gallbladder leading to an acceleration of the nucleation process. This predominance of cholesterol over the bile salt and phospholipids in bile promotes the formation of gallstones.¹⁵⁻²⁰

Other factors that promotes the formation of lithiasis post-surgery, such as decreased motility by altering vagal innervation derived from the surgical process are present in some cases but are not constant. Instead, rapid weight loss (more than 50% of excess weight lost 3 months after laparoscopic Roux-en-Y gastric bypass [RYGB]), is an only predictor of gallbladder disease presented in all reported studies.²¹⁻²⁴

Regarding prophylactic surgery (cholecystectomy in patients without gallbladder stones) the majority of surgeons concur that a watchful waiting should be taken and only perform the bariatric procedure, because the number of patients that will develop symptomatic cholelithiasis is low (around 6% to 8% of them) and this leads to an elevated number of patients exposed to an unnecessary procedure with potential complications.^{5,21,25-29} Laparoscopic cholecystectomy in bariatric patients may be challenging due to suboptimal port placement and difficult body habitus. Furthermore, it is accompanied by potential risks such as lengthening of operative time, increased morbidity, and prolonged hospitalization. Serious complications have been reported as high as 2% to 3% of cases.³⁰⁻³³

Some studies have shown that an elective approach (simultaneous cholecystectomy only in the patients with cholelithiasis) may be favored because of better short-term outcomes with significantly lower rates of mortality, morbidity, re-interventions, and shorter hospital when compared with patients that had concomitant cholecystectomy. However, the long-term biliary morbidity requiring subsequent cholecystectomy was not clear in this studies.^{8,34-37}

But other papers have shown that the rate of subsequent cholecystectomy after RYGB is low (6.8%); being the main cause for the subsequent cholecystectomy the uncomplicated biliary disease; while choledocholithiasis and biliary pancreatitis occurred very rarely. It's estimated that the rate of subsequent cholecystectomy due to biliary colic or gallbladder dyskinesia is 5.3%; due to cholecystitis, 1.0%; choledocholithiasis, 0.2%; and biliary pancreatitis, 0.2%.

Furthermore about 95% of the subsequent cholecystectomies are performed laparoscopically with a very low conversion rate and, the risk to suffer a complication from a subsequent cholecystectomy is extremely low (0.1%) for all patients without concomitant cholecystectomy during RYGB. Therefore, a routine concomitant cholecystectomy cannot be recommended when weighting the observed low long-term morbidity against the known potential detrimental effect on the short-term outcome.^{8-10,38,39}

In the other hand when talking about patients with asymptomatic gallbladder stone, currently there is no consensus in the treatment in patients undergoing weight loss surgery. Asymptomatic gallstones (silent gallstones) represent a dilemmatic approach. The natural history of asymptomatic gallstones suggests that many affected individuals will remain asymptomatic. Recent

trend analysis in gastric bypass patients suggests that concomitant cholecystectomy should be considered only in symptomatic gallstones.^{1,9,31,40,41}

The use of ursodeoxycholic acid (UDCA) also has been proposed as a preventive measure for the gallstone formation. The UDCA is a bile acid that dissolves gallstones by decreasing biliary cholesterol secretion to lower bile cholesterol saturation and by decreasing biliary glycoprotein secretion to lower biliary nucleating factors. It was reported that the oral dose of 600mg UDCA following gastric bypass for 6 months or even until gallstone formation was associated with decreased rate of gallstone formation.⁴²⁻⁴⁵ However, the cost-effectiveness of the treatment is a matter of debate because even though the use of UDCA lessened the costs of concurrent cholecystectomy and reduced the hospital stay along with logical cost raise in selective cholecystectomy, the prescription of UDCA tend to be unaffordable as an additional cost.⁴⁶

Due to the previously exposed it is possible to conclude that cholecystectomy should be performed only in patients with cholelithiasis and symptoms. Regarding to patients with silent cholelithiasis the surgeon must evaluate every case in particular, but it's admissible to choose a conservative management, follow up the patient and in case of developing symptoms perform the cholecystectomy.^{47,48}

Cholelithiasis

The presence of gallstones in the common bile duct (CBD) although is a rare complication after RYGB (around 0.2% of the bariatric patients)⁹ represents an important challenge due to the anatomical modifications of the gastrointestinal tract (Fig. 1). The duodenum remains adjacent to the surgically excluded stomach. Therefore, for the endoscopist, accessing the ampulla is technically very difficult. The endoscope must pass through the mouth, esophagus, gastric pouch, Roux limb, and then return retrograde through the afferent limb to reach the ampulla. This total length may easily exceed 300 cm, making almost impossible for traditional endoscopy access to the papilla to perform an endoscopic retrograde cholangiopancreatography (ERCP).

This leads to having to pursue other methods to reach the papillae for the resolution of choledocholithiasis. Which of this methods should we choose, must be based on the surgeon experience, the equipment available and the location of the stone. But whatever the method, a special training is needed on endoscopy, percutaneous surgery and laparoscopy.

The methods that have been described can be listed as follow:

- Laparoscopy-assisted transgastric ERCP (LAT-ERCP)
- Balloon enteroscopy assisted ERCP (BEA-ERCP)
- Percutaneous biliary drainage with subsequent trans fistula treatment

- Laparoscopic exploration of CBD

Due to the long anatomical route required to reach the bilio-pancreatic limb in patients with RYGB, a solution that has been found is to access the excluded stomach through laparoscopy and inserting the endoscope through a gastrotomy allowing to perform an ERCP like in a traditional way. The success rate of this procedure has been shown to be superior to BEA-ERCP, biliary cannulation rates up to 100% have been described and is associated with a significantly shorter endoscopic procedure time, but not a shorter total procedure time (laparoscopy plus ERCP).⁴⁹⁻⁵³

In this procedure a standard laparoscopic access to the abdominal cavity is performed with insertion of four trocars, then the greater curve of the antrum is mobilized and a gastrotomy

Fig. 1. (A) Green arrow showing the endoscopy path to the ampulla in normal anatomy. (B) Green arrow showing the endoscopy path to the ampulla in altered anatomy by gastric bypass.

Fig. 2. Creation of a gastrotomy on the anterior wall of the greater curvature in the gastric remnant (arrow).

Fig. 3. Placement of a 15 mm trocar into the gastric remnant through the gastrotomy.

and purse-string suture are fashioned on the anterior side of the greater curvature of the gastric remnant near the antrum (Fig. 2). An additional 15 mm or 18 mm trocar must be placed in the left upper quadrant and inserted into the gastrotomy in the center of the purse-string suture (Fig. 3). This purse-string has to be tightly fixed around the trocar to prevent loss of insufflation pressure, and the gastrotomy should be made as lateral as possible along the greater curvature to permit smooth intubation of the pylorus. It's also recommended to occlude the biliopancreatic limb with an intestinal clamp to prevent over-insufflation of the small bowel that blocks the perioperative visualization.

Finally, a side-viewing endoscope is introduced through the 15 mm or 18 mm trocar secured into the gastrotomy, and ERCP can be performed under fluoroscopic guidance (Fig. 4). After the removal of the scope and the trocar, the purse-string is tied and

the gastrotomy incision sutured (Fig. 5).

In case of patients with gallbladder *in situ*, delaying the definitive cholecystectomy until ERCP is performed is considered to be the safest option because in case of a difficult cannulation of the papilla, a guidewire can be inserted into the cystic duct to perform a *rendezvous* technique in order to achieve the cannulation. In this technique the guidewire that was inserted through the cystic duct is then moved into the main biliary duct and passed through the papilla. Therefore, the flexible wire is taken by the endoscopist and used as a guide to enter the papilla.

Performance of the LAT-ERCP technique is influenced by the presence of postoperative adhesions, which renders the transgastric access more difficult, sometimes being necessary to perform a mini laparotomy to achieve the transgastric access. This is expected in case of a history of open surgery, multiple laparoscopic

interventions, and previous peritonitis or abscess formation.

When the need for repeat ERCP is anticipated during the first LAT-ERCP procedure, a gastrostomy tube can be inserted through the gastrotomy incision into the lumen of the stomach. Repeat ERCP can be performed percutaneously after the surgical gastrotomy tract has matured.^{54,55}

The LAT-ERCP although it's a complex procedure, in experienced hands allows to successfully treat the choledocholithiasis with a biliary cannulation rates up to 100% and a low rate of complications like pancreatitis or post-sphincterotomy bleeding. In no case a leak of the gastrostomy suture was described.^{50,56,57}

The second option that we have to treat choledocholithiasis in patients with RYGB is the BEA-ERCP. The major advantage of balloon-assisted over conventional enteroscopy is the ability to reduce loops of small bowel which facilitates advancement of the endoscope in patients after Roux-en-Y reconstruction. In patients with Roux-en-Y anatomy, success rates varying from 60% to 90% for reaching the biliopancreatic limb, and successful ERCP ranging from 46 to 80% have been reported,^{53,58-60} clearly inferior to the success rate of the LAT-ERCP. The devices that are used for the BEA-ERCP can consist in a single or double balloon system (Fig. 6, 7).

The system is composed of a 200-cm, thin endoscope, with a

145-cm soft overtube. Latex balloons are attached to the end of the endoscope and to the end of the overtube. By using a series of inflations and deflations of the balloons, along with reductions, the endoscopist may advance the scope through the lumen in an "accordion-like" fashion and reach the distal small bowel.^{53,61-63} (Fig. 8, 9)

The major problems that this technique must face are the long length of bowel that the scope must pass through and the acute angle of the afferent limb and Roux limb anastomosis, which is also very difficult to navigate. Furthermore, attaching the balloon on the tip of the endoscope is often troublesome and the balloon on the tip of the enteroscope can occasionally decrease the field of view if it becomes dislodged distally. It's an invasive and time-consuming procedure but in the other hand the morbidity rate is low, especially for diagnostic procedures, the complication rate of diagnostic double balloon endoscopies is 0.8% and of therapeutic procedures 4.3%.^{29,64-66}

Fig. 4. Endoscopic retrograde cholangiopancreatography with sphincterotomy and stone extraction.

Fig. 5. Suture of the gastrostomy incision.

Fig. 6. Double-balloon endoscope.

Fig. 7. Single-balloon endoscope.

Fig. 8. Illustration of endoscopic technique with single balloon.

Fig. 9. Illustration of endoscopic technique with double balloon.

Another important drawback of this technique is that the highest success rate are described in patients with hepatico-jejunostomy, while the success rate in patients with native papilla

tend to be lower due to the fact that the endoscope is forward viewing and the straight angle with which accessories can be advanced.⁶⁷ The cannulation rates of intact papilla using double

balloon enteroscope have ranged from 25% to 80%.^{53,63,68-71}

There is also another problem, there is a limited availability of suitable equipment, as all accessories have to be of sufficient length. Unfortunately for double balloon technique, there is a current trend in ERCP equipment to develop shorter rather than longer accessories. There is a lack of needle knives, sphincterotomes, extraction balloons, lithotripsy devices and retrieval baskets customised for the double balloon system.^{58,72-74}

Due to the previously described BEA-ERCP should not be considered as a first option when treating choledocholithiasis, especially if the physician is not an expert endoscopist. And if choledocholithiasis coexist with cholelithiasis, considering that the gallbladder will be removed it is recommended a laparoscopic approach (whether with a full laparoscopic resolution with CBD exploration or with a LAT-ERCP).

The third option available to treat the lithiasis of the CBD is the percutaneous approach. With this technique is necessary first

to perform a percutaneous biliary drainage, and later when the fistula between the biliary system and the skin is consolidated a session to remove the stones can be performed.^{13,68,75}

The first step of the procedure consist on an ultrasound-guided puncture of the intrahepatic bile duct by using a 22 G Chiba needle (Fig. 10), and then a percutaneous transhepatic cholangiogram should be performed to confirm the presence, location, number and size of stones (Fig. 11). The choice whether to use a left-sided sub-xyphoid approach or a right-sided subcostal or intercostal approach must be based on individual and anatomic considerations, such as the position of the liver, bile duct anatomy (as seen on pre-procedural imaging) and number, position, and size of the bile duct stones.

The percutaneous transhepatic cholangiogram can be achieved in 98% of the patients with dilatation of the bile ducts and in 90% of those without dilatation.⁷⁶⁻⁷⁹

Once we gain access to the biliary system with the Chiba

Fig. 10. 22 G Chiba needle.

Fig. 12. Percutaneous biliary drainage with "pig-tail" in duodenum.

Fig. 11. Percutaneous transhepatic cholangiogram showing a big stone on distal common bile duct.

Fig. 13. Sphincter dilation with a 10 mm balloon. A waist can still be seen on the balloon.

needle, a guide wire must be introduced and by using Seldinger technique an 8 Fr or 10 Fr biliary drainage must be placed (Fig. 12).

After 7 to 10 days when the biliary system is decompressed, the symptoms of cholangitis (if were presents) are relieved and the fistula starts to consolidate, is possible to perform the treatment of the stones. By working through the biliary-cutaneous fistula is possible to push the stones into the duodenum or extracting them through the skin's hole. In order to achieve this, a standard percutaneous transluminal angioplasty balloon catheter is advanced beyond the stones and positioned across the papilla. Then the sphincter is dilated by an 8 to 12 mm balloon, depending of the size of the largest stone, until no waist could be seen in the balloon on fluoroscopy (Fig. 13). Once this is achieved, the balloon is deflated and the catheter withdrawn and positioned proximal to the stones. After re-inflating the balloon, the stones are pushed forward through the dilated sphincter into the duodenum.^{1,80,81}

If the stone size exceeded 10 mm, mechanical lithotripsy with Dormia basket is recommended.⁸² The stone fragments are then evacuated into the duodenum by using the balloon catheter or Dormia basket (Fig. 14).

If the stone's size is not too big another option is to grab the stone with the Dormia basket and pull it out through the skin's hole. This maneuver could be dangerous if the stone is larger than the fistula diameter because the fistula could be damaged thus it is recommended to place a second (safety) wire through the papilla in order to preserve the biliary access.^{83,84}

When all the stones seem to have been extracted, cholangiography must be performed to confirm complete stone clearance. Then a biliary drainage is placed in the CBD.

After approximately 24 hours later a cholangiography must be performed to confirm CBD clearance and if so, the external drain is removed. If residual stones are found, the procedure must be repeated until all stones are removed.

The success rate reported with this approach varies between

93%–96% and the complications between 4.7%–6.7%.^{82,85–87} The complications described include: hemobilia, pancreatitis, cholangitis, pleural effusion due to a trans pleural biliary drainage and bile peritonitis due to fistula disruption.

The last option that available to treat the choledocholithiasis is the laparoscopic approach with exploration of the CBD. In case we are treating, a that patient has already underwent a laparoscopic cholecystectomy should be considered as a second option, after the others minimal invasive approaches failed (endoscopic percutaneous) as the patient's abdomen could be hostile due to adhesions which will make difficult the CBD exploration. But if the patient also has cholelithiasis and laparoscopic cholecystec-

Fig. 14. A stone being grabbed with a Dormia basket.

Fig. 15. (A, B) A stone being pulled out with a Dormia basket through the cystic duct.

Fig. 16. (A, B) A stone being removed by using a Dormia basket through an incision on the common bile duct.

Fig. 17. Primary closure of the common bile duct after laparoscopic exploration.

tomy must be performed it is possible to do the treatment fully laparoscopic.^{75,88}

It is recommended to try first a transcystic approach to treat the stones. A technique similar to the percutaneous technique can be performed, and by introducing a percutaneous transluminal angioplasty balloon catheter through the cystic duct the sphincter is dilated and then, with the same balloon the stone is pushed to the duodenum. It is also possible to do this maneuver with a Dormia basket through the cystic duct (Fig. 15). If this fails, one should consider to open the CBD and perform an exploration (Fig. 16).

If we decided to explore the CBD and after the stones extraction we perform cholangiography and we are sure that there are no more stones, and the bile duct is dilated, we can perform a primary closure of the CBD (Fig. 17). In the other hand, if the bile duct is thin, this measure is not so strongly recommended due to possible strictures at the sutures site. In case we doubt the presence of more stones we must place a T-tube in order to avoid a pressure increase inside the CBD and a bile leakage and, of course, to perform then a percutaneous approach through the T-tube to extract the remaining stones.^{60,89}

In conclusion, with the set of therapeutic tools mentioned previously one should be able to face the problem of the cholelithiasis. A proper training is needed in laparoscopic surgery, endoscopy and percutaneous surgery due to the high technical difficulty of treating CBD stones in patients with Roux-en-Y anatomy. Which path to follow should be based on details of every case and personal experience with every mentioned technique, and in case of lack of personal experience is strongly recommended to derivate this patients to a specialist.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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