REVIEW ARTICLE

Laparoscopic-assisted Endoscopic Retrograde Cholangiopancreatogram (ERCP)

Andrew J Kamien

Received on: 18 November 2022; *Accepted on:* 20 November 2022; *Published on:* 31 December 2022

Abstract

Objectives: Describe the indications, technique, and success rates for Laparoscopic-assisted Endoscopic Retrograde Cholangiopancreatogram (ERCP).

Methods: A review of the literature was performed to describe the common indications for imaging of the biliary system in surgically-altered anatomy. A majority of the data is drawn from experiences in patients with choledocholithiasis following bariatric surgery.

Results: Laparoscopic-assisted endoscopic retrograde cholangiopancreatogram (ERCP) has a high technical and therapeutic success rate (98.5–100% and 97.5–99%, respectively). It requires the coordination of both the surgical and endoscopy teams and is associated with long procedural time (134–180 minutes). Complication rate ranges from 0–30% but most of them minor and self-limiting.

Conclusion: Laparoscopic-assisted Endoscopic Retrograde Cholangiopancreatogram (ERCP) can be technically and logistically challenging but has a high technical success rate. Complications occur but are seldom of significant clinical consequence.

Keywords: Altered anatomy, LA-ERCP, Y de Roux.

Abstracto

Objetivos: Describir las indicaciones, la técnica y las tasas de éxito para La Colangiopancreatografía Retrógrada Endoscópica laparoscópicamente asistida.

Métodos: Se realizó una revisión de la literatura para describir las indicaciones comunes para obtener imágenes del sistema biliar en la anatomía alterada quirúrgicamente. La mayoría de los datos provienen de experiencias en pacientes con coledocolitiasis después de una cirugía bariátrica.

Resultados: La Colangiopancreatografía Retrógrada Endoscópica laparoscópicamente asistida tiene una alta tasa de éxito técnico y terapéutico (98.5–100% and 97.5–99%, respectivamente). Requiere la coordinación de los equipos quirúrgico y de endoscopia y se asocia con un tiempo de procedimiento prolongado (134–180 minutos). La tasa de complicaciones varía de 0 a 30%, pero la mayoría de ellas son menores y autolimitadas.

Conclusión: La Colangiopancreatografía Retrógrada Endoscópica laparoscópicamente asistida puede ser un desafío técnico y logístico, pero tiene una alta tasa de éxito técnico. Ocurren complicaciones, pero rara vez tienen consecuencias clínicas significativas.

Palabras clave: Anatomía alterada, LA-CPRE, Y de Roux.

Panamerican Journal of Trauma, Critical Care & Emergency Surgery (2022): 10.5005/jp-journals-10030-1400

Introduction

Alterations in the alimentary tract can pose challenges to patients presenting with biliary disease. The focus of this discussion will be the access to the biliary tree in those with Roux-en-Y anatomy following metabolic surgery, however, the indications for surgically altered anatomy also include those with Billroth reconstruction for oncologic or peptic ulcer disease, pancreaticoduodenectomy for pancreatic and biliary disease, and Roux reconstructions for other indications, oncologic or traumatic. Historically, oncologic indications were more common for Roux alterations in anatomy.[1] Cesar Roux (1857–1934) first described the procedure to bypass the obstructed gastric outlet due to the sequelae of severe peptic ulcer disease.[2] The more common indication in the current era, however, is for bariatric purposes.

The obesity epidemic continues to grow worldwide. In the United States, over 41.7% of Americans are noted to be obese [body mass index (BMI) > 30 mg/kg^2], and rates of severe obesity (BMI > 40) have nearly doubled in the last 20 years (4.7% in 2000–9.2% in 2020).[3] This incurs a significant amount of morbidity for those affected individuals, as obesity account for 400,000 deaths in the United States[4] and leads to a significant increase in healthcare costs. Adults with obesity in the United States compared with those with normal weight experienced higher annual medical care costs by $2505 or 100%, with costs increasing significantly with the class of obesity, from 68.4% for class I to 233.6% for class III.[5]

Mirroring these trends, there has been a significant raise in the number of bariatric operations that have been performed annually. Current estimates for the number of total bariatric operations approach nearly 200,000[6] in the United States, which vastly overshadows estimates of 13,365 cases from nearly 25 years ago.[7] The Roux-en-Y Gastric Bypass (RYGB) had long been the more commonly performed operation for the achievement of weight loss in previous decades, however, the sleeve

Department of Surgery, University of Nebraska Medical Center, Omaha, Nebraska, United States

Corresponding Author: Andrew J Kamien, Department of Surgery, University of Nebraska Medical Center, Omaha, Nebraska, United States, Phone: +1402-559-7933, e-mail: andrew.kamien@unmc.edu

How to cite this article: Kamien AJ. Laparoscopic-assisted Endoscopic Retrograde Cholangiopancreatogram (ERCP). Panam J Trauma Crit Care Emerg Surg 2022;11(3):151–155.

Source of support: Nil

Conflict of interest: None

gastrectomy has become the predominant operation performed since 2012.[6] Nevertheless, there is an estimated over 490,000 RYGB operations that have been performed in the United States this past decade, from 2011 to 2020.

RYGB and Risk for Biliary Disease

Laparoscopic RYGB for bariatric purposes was first described in 1994 by Wittgrove et al.[8] and remains one of the most performed bariatric operations.[6] The RYGB operation achieves weight loss in being both restrictive (creation of a small gastric pouch) and malabsorptive (gastric pouch anastomosed to a Roux limb of small bowel that varies from 75 to 150 cm in length). This proves to be a very effective means of weight loss and has the longest-lasting effects to combat the effects of obesity and obesity-related complications, such as diabetes, hypertension, and dyslipidemia.[9]

The rapid weight loss achieved after RYGB is, unfortunately, a risk factor for the development of cholelithiasis and biliary tree disease. The presence of diabetes, hyperlipidemia, or class III or higher obesity does not appear to play a role,[10] but an excessive weight loss of either greater than 30 kg over a 6-month period,[11] or postoperative weight loss of >25% of the patient's preoperative weight,[10] appears to be the most consistent risk factor.

Nevertheless, the risk of developing cholelithiasis is relatively low when followed longitudinally, and the need for cholecystectomy tends to remain under 15%, with most of the cholecystectomy postbariatric surgery occurring within the first six months postoperative.[12] Mishra et al. followed a cohort of 418 RYGB patients for a period of 18–88 months (average of approximately 3 years) and found the rate of cholelithiasis required to be 13.4%.[13] Li et al. demonstrated that 9.5% of post-RYGB patients (total cohort 496 patients) followed for a period of 12–42 months required cholecystectomy.[10] Routine cholecystectomy at the time of bariatric surgery is commonly not generally recommended. There is a significantly increased operative time greater than 30 minutes when performing concomitant cholecystectomy at the time of bariatric surgery when compared to bariatric surgery alone, and there is a small increase in complications as well when reviewed in the meta-analysis.[14]

While noncomplicated cholelithiasis can be managed with simple cholecystectomy, especially with the benefit of improved visualization following weight loss, there is a small rate of these patients that develop choledocholithiasis as well. Mishra et al. had a rate of 0.96% in their cohort of 418 patients to have choledocholithiasis,[13] while Li et al. had a rate of 1.01% of "complicated cholelithiasis," marked by deranged liver function test, acute cholangitis, or biliary pancreatitis.[10]

Given the long length of the bypass limb of 100–200 cm, access to the biliary tree is challenging for the endoscopist and surgeon, as cannulation of the biliary tree with traditional duodenoscopes transorally is low.

Other Indications for ERCP

Similar challenges in a patient with altered surgical anatomy are found in those with other biliary pathology. Sphincter of Oddi dysfunction (SOD) is another indication for access to the biliary tree following RYBG in those with non-specific abdominal pain. SOD is estimated to affect approximately 1.5% of the population,[15] and it can be responsible for up to half of the indications for LA-ERCP.[16–19] Other indications for access to the biliary tree include bile leak, pancreatic duct leak pancreas divisum, iatrogenic clipping of the bile duct, investigation for malignancy,[17] and hepatic duct injury from trauma.[20]

Endoscopic-assisted ERCP and Operative Options

Initial endoscopic evaluation of the biliary tree in post-RYGB patients was first described in 1988 *via* the use of a pediatric colonoscope.[21] One of the first series describing the technique achieved an impressive rate of the overall success of 84%,[22] however these accomplishments were performed using a forward viewing scope and lacked the technical capabilities of a side-viewing duodenoscope, precluding the use of conventional stents and other accessories, such as an elevator that assists with the orientation of the scope during cannulation.[23]

Other options are to use balloon-assisted ERCP, however, both single-balloon and double-balloon techniques have somewhat poor success rates, ranging from 70.7 to 96% and 73 to 92.9%, respectively. Thus, an endoscopy—first approach would result in about two-thirds of patients needing an additional procedure.[19] Operative exploration of the biliary tree, such as common bile duct exploration, has previously documented mortality rates of 1.3–4% and high morbidity rates that approach 50%. Minimally invasive operative techniques, such as laparoscopic common bile duct exploration, can be technically challenging unless CBD > 9 mm and still has a failure rate of 5–14% and complication rate of 5–18%.[24]

Thus, additional options to evaluate and clear the biliary tree became necessary. The first description of laparoscopic-assisted endoscopic retrograde cholangiopancreatogram was in 1992, in a patient with biliary colic and a history of gastrostomy tube placement for severe esophageal obstruction.[25] This technique was later adopted by Barron and Vickers years later, however in this case the gastrostomy tube tract was created for the sole purpose of ERCP.[26]

LA-ERCP Logistical and Technical Considerations

The procedure involves coordination with operating room staff, the endoscopist, and their associated staff, as well as the surgeon. As previously mentioned, the creation of the gastrostomy tract can be performed at the time of the ERCP or in advance, with some waiting up to 6 weeks for the tract to mature prior to endoscopy attempts.[17] There have been several descriptions of the procedure itself, however, many of which follow a consistent pattern. The patient lay on the operating room table in lithotomy positioning, legs abducted and secured so that one may achieve appropriate tilt of the operating room table to help facilitate visualization of structures during laparoscopy and endoscopic maneuvering.

The surgeon positions themselves between the patient's legs, and the endoscopist is to the patient's left side. Laparoscopic video monitors are placed at the patient's head, and endoscopic monitors are placed on the patient's right side. As few as three surgical ports can be utilized for the laparoscopic-assisted ERCP (two workings and one for the passage of the endoscope),[17] but others describe the use of four (up to five if performing concomitant cholecystectomy).[23] Access into the abdominal cavity can be left to the surgeon's preference, and the abdomen is insufflated to 15 mm Hg. Ports are placed peri-umbilically (5 mm), right mid-clavicular line (5 mm), and left mid-clavicular line at or below the umbilicus (10 mm). A right anterior axillary line port may be placed for gallbladder retraction if performing cholecystectomy. Any adhesions encountered are lysed and then gastric remnant is identified. An energy-sealing device, such as a LigaSure or

Harmonic device, is used to divide the greater omentum to get to the lesser sac. Division of the hepatogastric ligament may assist in the ability to mobilize the remnant stomach, whose mobilization to the left upper quadrant abdominal wall for a left hypogastric trocar placement may be helpful. Tzedakis et al. recommend gastrotomy near the gastric antrum, as they found this to help facilitate passage of the duodenoscope and minimize the need for additional assistance to maintain torque on the scope when performing ERCP.[23]

Securing the remnant wall to the anterior abdominal wall is suggested, either *via* stay sutures[23] or purse string sutures.[16] This may reduce leakage of carbon dioxide insufflation and enteric contents, as failure to do so may result in technical challenges or postoperative infection, respectively. Balloon trocars can help provide an adequate seal and securement of the remnant to the abdominal wall, but these trocars are typically <15 mm and cannot facilitate the passage of a standard duodenoscope.[16] Draping the gastrotomy/ERCP port can maintain sterility during the case and prevent surgical site infection.[27]

Following cannulation of the remnant stomach with the endoscope, the intra-abdominal pressure is decreased to 5 mm Hg. A bowel clamp proximal to the jejunojejunostomy can help prevent distension of the small bowel, which is particularly helpful in performing concurrent cholecystectomy. Alternatively, cholecystectomy can be performed prior to gastric cannulation, so one need not worry about intestinal dilation obscuring one's view. The placement of a trans-cystic duct wire can help identify the ampulla of Vater endoscopically *via* a rendezvous approach. If cholecystectomy is performed first and ERCP is unsuccessful, however, there is a small risk of cystic duct stump leak until the biliary tree is cleared. After completion of the endoscopy portion, partial gastrectomy, and gastrostomy closure are achieved using an endo-GIA stapler device.[16] Transfascial sutures are used to close any defects greater than 5 mm, and the abdomen is desufflated.[23]

Patients are monitored in an inpatient setting postoperatively to ensure no major complications have occurred from either the laparoscopic portion or the endoscopic portion of the case. Most tend to discharge two days after the procedure is completed.[16,23,27]

Outcomes

High rates of success are observed in those patients having undergone laparoscopic-assisted ERCP, in nearly all classes of indications. The review of the literature defines success as two-fold: technical success is a visualization of the ampulla of Vater, while therapeutic success is the completion of the treatment itself (commonly sphincterotomy, stone extraction, or both).

Consistently throughout the literature, both in small case series and larger meta-analyses, there is high success rates of LA-ERCP. The technical success rate for LA-ERCP has been described as high as 100%[16,19,23,27] and otherwise approaching 100% (98.9% in Banerjee's review,[17] 98.5% in Ayoub's review[18]). Therapeutic success rates have been listed as 97.5%,[18] 98.5%,[17] and 99%[16] when dealing primarily with the management of stones. SOD was found to have complete resolution of symptoms in 72% of patients, with a 100% likelihood of success in Milwaukee Type I SOD patients.[19]

A small portion of patients requires to repeat LA-ERCP in order to complete 100% technical success.[27] While a technical failure of the laparoscopic-assisted portion of the procedure, AlMasri et al. demonstrated a 100% technical success rate but with the need for 11% of patients to need conversion to open surgery in order to facilitate completion of the case.[16]

Challenges and Drawbacks

Despite the near-perfect success rate of the LA-ERCP, it is not without its drawbacks. Firstly, this procedure involves the coordination of multiple individuals and teams, specifically the operating surgeon and endoscopist, as well as the anesthesia team and the ancillary staff that help these individuals to perform their portions of the case. Secondly, differences in the positioning of the patient and the equipment involved pose challenges for the endoscopy portion. In the operating room, the patient lay in a supine position, compared to the prone positioning in traditional ERCP. This affects the orientation of the scope and the quality of the X-ray imaging. One often obtains suboptimal imaging on C-arm during laparoscopic-assisted procedures.[27]

As such, there is a learning curve to performing these procedures, for each surgeon (five procedures estimated); the endoscopist (nine procedures); and the institution (27 procedures).[16] This experience can be difficult to achieve, as the relative risk of developing choledocholithiasis in this patient population is only approximately 1% of nearly 500 patients studied over 3.5 years.[10]

Once the procedure is coordinated amongst the teams, however, there remains a significant time commitment. Some studies have demonstrated a procedural duration time of 80 minutes (mean, range of 35–210 minutes),[27] however most series have procedural time averages closer to the 2–3 hour range: 134 minutes (range 66–200), 180 minutes (range not given), 158.4 minutes (range not given), and 3.1 hours (standard deviation of 1.3 hours).[16,18,19,23] Additional time is required if needing to perform cholecystectomy at the time of surgery, as well, which is indicated in approximately one-third of cases.[27] Commonly attributed reasons for additional time needed in the operating room have been due to the need to repair an internal hernia (8% of cases), control perioperative bleeding (7% of cases), and management of adhesions (6% of cases). Efficiency through experience appears to hold true for LA-ERCP, as the 80-minute average time published by Koggel et al. reviews 100 patients treated at a single nonacademic bariatric surgical center over a 10-year period.[27]

Adverse Events

Laparoscopic-assisted ERCP is not without its complications, although most are classified as minor. The morbidity can be categorized between those related to the laparoscopic/surgical portion and those relegated to the endoscopic portion. Fairly ubiquitously, most complications are self-limiting. The rate of complications ranges from 0 to 30%, dependent on the series.[16–18,23,27] No deaths are reported in patients related to the procedure. Interestingly, when concurrent cholecystectomy is performed, the rates of adverse events increase from 25 to 33.5% in one case series.[27]

Of the endoscopic complications described, the most common include post-ERCP pancreatitis (PEP), ERCP-related hemorrhage, and ERCP-related perforation.[23,27] Both Tzedakis and Koggel describe the hemorrhage and perforation related to ERCP as limited and not requiring further intervention. PEP rates ranged from 0%[19] to 1.4%,[17] to 3.8%,[16] to 6%,[27] and as high as 6.2%.[18] Most of these cases are listed as mild pancreatitis without significant sequelae. Some authors have suggested that their use of peri-procedural rectal NSAIDs prevented PEP.[19]

Complications related to the laparoscopic portion of the case largely relate to the gastrostomy and are infectious in nature. Perhaps not an adverse event per se, conversion to open occurs in approximately 11% of cases[16] and largely present in patients with

a history of multiple abdominal operations in the past. Koggel et al.[27] describe a rate of laparoscopic-related complications of 14%, all of which are mild in classification [wound infection (3%), hemorrhage (5%), nerve entrapment (2%), infected hematoma (1%), gastrostomy tube leak (1%)]. AlMasri et al., however, describe a surgical site infection rate of 9.2% and 7% with major complications (colonic injury, gastric leak requiring reoperation, small bowel obstruction requiring operative intervention, wound debridement, and aspiration pneumonia).[16] Ayoub et al. similarly describe 6/459 patients (1.31% of the cohort) that suffered small bowel perforation at the time of surgery.[18] Banerjee et al.,[17] had a rate of laparoscopic-related complications of 14%, with nearly half of them being related to wound issues at the gastrostomy tube site, but also included several bleeding episodes, some of which required transfusion; gastric tube dislodgements; enterocutaneous fistula; enterotomy of the Roux limb; incisional hernia; wound dehiscence; intra-abdominal leak and posterior remnant gastric wall injury, a majority of which required reoperation.

While many of these complications may be self-limited, approximately 10–15% of these patients will seek reevaluation in the emergency department in the first 30 days following the procedure, with 12% of patients requiring readmission to the hospital. Awareness of the types and severity of adverse events following LA–ERCP may help guide decision-making when considering patients with significant comorbidities for the procedure. While cannulation rates are lower in endoscope-assisted ERCP, a second attempt at cannulation may prove to be the better part of valor.[18]

EUS-directed Transgastric ERCP (EDGE)–Possible Alternative for the Future

Despite the high technical success rate of LA-ERCP, the procedure has its limitations with logistical concerns, procedural time, and adverse side effects. As a result, alternative therapies have been developed in this past decade as possible alternatives for the future.

Kedia et al. first described their single-stage EDGE procedure in 2014.[28] The technique has the benefit of needing to utilize only a single endoscopy team in a single-stage procedure. The procedure utilizes lumen-apposing metal stents (LAMS) by creating an internal fistula into the gastric remnant. This can be performed from the gastric pouch to the remnant stomach (gastro-gastric fistula) or from the alimentary jejunal limb to the remnant stomach (jejuno-gastric fistula. Initial descriptions demonstrated challenges in passing the scope through the LAMS, successful cannulation of the ampulla, and having issues with LAMS stent dislodgment, but more recent series have demonstrated a high technical success when compared to LA-ERCP. At the completion of the procedure, the stent can be removed, and the fistula tract can be repaired endoscopically or be allowed to close over a double-J stent. The cannulation rate has been demonstrated to be 99.3% in both EDGE and LA-ERCP, with therapeutic success at 98.3% in EDGE and 97.4% in LA-ERCP.[29]

In comparing EDGE to LA-ERCP, rate of adverse events is similar (24% in EDGE and 19% in LA-ERCP), with similar severity of adverse events. The benefits, however, are significantly reduced procedural time (79 minutes in EDGE vs 183.5 minutes for LA-ERCP), reduced length of stay (0.7 days EDGE vs 2.65 days LA-ERCP), and cost ($1431 for EDGE vs $9312 for LA-ERCP.[30] There remain concerned regarding the technique in that there is potential for LAMS migration (6.5% occurrence rate) and possible weight gain in the persistence of the fistulous tract (roughly 5% of the time).[31] EDGE has a favorable profile with the logistical concerns discussed regarding LA-ERCP and may be an attractive option for those patients that may need repeated procedures or are at higher risk of laparoscopic-associated adverse events.[19]

Conclusion

In patients with surgically altered anatomy, traditional transoral ERCP can be difficult and nonfeasible given the technical challenges in attempting to traverse the long alimentary limb. Forward-facing scopes have low success given the challenges of reaching the ampulla and then being able to cannulate the biliary tree. Laparoscopic-assisted ERCP is a highly successful technique in diagnosing and treating biliary disease in those patients with altered anatomy. It is, however, with its own logistical challenges, long operating room times, and risk of complications. EUS-Directed Transgastric ERCP is a novel technique that involves the creation of an internal fistula to access the remnant stomach to access the biliary tree with similar rates of success and adverse events. EDGE may be an attractive option for patients based on local expertise and coordination of services.

References

1. Elsharif M, Hague AG, Ahmed H, et al. After you Roux, what do you do? A systematic review of most successful advanced assisted ERCP techniques in patients with various altered upper gastrointestinal surgical anatomical reconstructions with particular focus on RYGB (last 10 years). Clin J Gastroenterol 2020;13(6):985–1009. DOI: 10.1007/s12328-020-01201-9
2. C. Roux: De la gastroenterostomie Revue de chirurgie, 1893;13:402–403.
3. https://www.cdc.gov/obesity/data/adult.html
4. Mokdad AH, Marks JS, Stroup DF, et al. Actual causes of death in the United States, 2000. JAMA 2004;291(10):1238–1245. DOI: 10.1001/jama.291.10.1238
5. Cawley J, Biener A, Meyerhoefer C, et al. Direct medical costs of obesity in the United States and the most populous states. J Manag Care Spec Pharm 2021;27(3):354–366. DOI: 10.18553/jmcp.2021.20410
6. https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers
7. Santry HP, Gillen DL, Lauderdale DS. Trends in bariatric surgical procedures. JAMA 2005;294(15):1909–1917. DOI: 10.1001/jama.294.15.1909
8. Wittgrove AC, Clark GW, Tremblay LJ. Laparoscopic gastric bypass, Roux-en-Y: preliminary report of five cases. Obes Surg 1994;4(4):353–357. DOI: 10.1381/096089294765558331
9. Adams TD, Davidson LE, Litwin SE, et al. Weight and metabolic outcomes 12 years after gastric bypass. N Engl J Med 2017;377(12):1143–1155. DOI: 10.1056/NEJMoa1700459
10. Li VK, Pulido N, Fajnwaks P, et al. Predictors of gallstone formation after bariatric surgery: a multivariate analysis of risk factors comparing gastric bypass, gastric banding, and sleeve gastrectomy. Surg Endosc 2009;23(7):1640–1644. DOI: 10.1007/s00464-008-0204-6
11. Coupaye M, Castel B, Sami O, et al. Comparison of the incidence of cholelithiasis after sleeve gastrectomy and Roux-en-Y gastric bypass in obese patients: a prospective study. Surg Obes Relat Dis 2015;11(4):779–784. DOI: 10.1016/j.soard.2014.10.015
12. Tsirline VB, Keilani ZM, El Djouzi S, et al. How frequently and when do patients undergo cholecystectomy after bariatric surgery? Surg Obes Relat Dis 2014;10(2):313–321. DOI: 10.1016/j.soard.2013.10.011
13. Mishra T, Lakshmi KK, Peddi KK. Prevalence of cholelithiasis and choledocholithiasis in morbidly obese South Indian patients and the further development of biliary calculus disease after sleeve gastrectomy, gastric bypass and mini gastric bypass. Obes Surg 2016;26(10):2411–2417. DOI: 10.1007/s11695-016-2113-4

14. Tustumi F, Bernardo WM, Santo MA, et al. Cholecystectomy in patients submitted to bariatric procedure: a systematic review and meta-analysis. Obes Surg 2018;28(10):3312–3320. DOI: 10.1007/s11695-018-3443-1
15. Drossman DA, Li Z, Andruzzi E, et al. U.S. householder survey of functional gastrointestinal disorders. Prevalence, sociodemography, and health impact. Dig Dis Sci 1993;38(9):1569–1580. DOI: 10.1007/BF01303162
16. AlMasri S, Zenati MS, Papachristou GI, et al. Laparoscopic-assisted ERCP following RYGB: a 12-year assessment of outcomes and learning curve at a high-volume pancreatobiliary center. Surg Endosc 2022;36(1):621–630. DOI: 10.1007/s00464-021-08328-x
17. Banerjee N, Parepally M, Byrne TK, et al. Systematic review of transgastric ERCP in Roux-en-Y gastric bypass patients. Surg Obes Relat Dis 2017;13(7):1236–1242. DOI: 10.1016/j.soard.2017.02.005
18. Ayoub F, Brar TS, Banerjee D, et al. Laparoscopy-assisted versus enteroscopy-assisted endoscopic retrograde cholangiopancreatography (ERCP) in Roux-en-Y gastric bypass: a meta-analysis. Endosc Int Open 2020;8(3):E423–E436. DOI: 10.1055/a-1070-9132
19. May D, Vogels E, Parker D, et al. Overall outcomes of laparoscopic-assisted ERCP after Roux-en-Y gastric bypass and sphincter of Oddi dysfunction subgroup analysis. Endosc Int Open 2019;7(10):E1276–E1280. DOI: 10.1055/a-0832-1898
20. Portelli Tremont JN, Kratzke IM, Motameni A, et al. Laparoscopic-assisted transgastric endoscopic retrograde cholangiopancreatography with placement of a biliary stent to treat traumatic intrahepatic bile duct disruption in a patient with Roux-en-Y gastric bypass. Am Surg 2021;31348211025756. DOI: 10.1177/00031348211025756
21. Gostout CJ, Bender CE. Cholangiopancreatography, sphincterotomy, and common duct stone removal via Roux-en-Y limb enteroscopy. Gastroenterology 1988;95(1):156–163. DOI: 10.1016/0016-5085(88)90305-8
22. Elton E, Hanson BL, Qaseem T, et al. Diagnostic and therapeutic ERCP using an enteroscope and a pediatric colonoscope in long-limb surgical bypass patients. Gastrointest Endosc 1998;47(1):62–67. DOI: 10.1016/s0016-5107(98)70300-1
23. Tzedakis S, Memeo R, Nedelcu M, et al. Laparoscopy-assisted transgastric endoscopic retrograde cholangiopancreatography: preliminary experience and technique description. J Visc Surg 2019;156(5):381–386. DOI: 10.1016/j.jviscsurg.2019.02.009
24. Riciardi R, Islam S, Canete JJ, et al. Effectiveness and long-term results of laparoscopic common bile duct exploration. Surg Endosc 2003;17(1):19–22. DOI: 10.1007/s00464-002-8925-4
25. Gray R, Leong S, Marcon N, et al. Endoscopic retrograde cholangiography, sphincterotomy, and gallstone extraction via gastrostomy. Gastrointest Endosc 1992;38(6):731–732. DOI: 10.1016/s0016-5107(92)70586-0
26. Baron TH, Vickers SM. Surgical gastrostomy placement as access for diagnostic and therapeutic ERCP. Gastrointest Endosc 1998;48(6):640–641. DOI: 10.1016/s0016-5107(98)70052-5
27. Koggel LM, Wahab PJ, Robijn RJ, et al. Efficacy and safety of 100 laparoscopy-assisted transgastric endoscopic retrograde cholangiopancreatography procedures in patients with Roux-en-Y gastric bypass. Obes Surg 2021;31(3):987–993. DOI: 10.1007/s11695-020-04946-x
28. Kedia P, Sharaiha RZ, Kumta NA, et al. Internal EUS-directed transgastric ERCP (EDGE): game over. Gastroenterology 2014;147(3):566–568. DOI: 10.1053/j.gastro.2014.05.045
29. Kedia P, Tarnasky PR, Nieto J, et al. EUS-directed transgastric ERCP (EDGE) versus laparoscopy-assisted ERCP (LA-ERCP) for Roux-en-Y gastric bypass (RYGB) anatomy: a multicenter early comparative experience of clinical outcomes. J Clin Gastroenterol 2019;53(4):304–308. DOI: 10.1097/MCG.0000000000001037
30. James HJ, James TW, Wheeler SB, et al. Cost-effectiveness of endoscopic ultrasound-directed transgastric ERCP compared with device-assisted and laparoscopic-assisted ERCP in patients with Roux-en-Y anatomy. Endoscopy 2019;51(11):1051–1058. DOI: 10.1055/a-0938-3918
31. Khara HS, Parvataneni S, Park S, et al. Review of ERCP techniques in Roux-en-Y gastric bypass patients: highlight on the novel EUS-directed transgastric ERCP (EGDE) technique. Curr Gastroenterol Rep 2021;23(7):10. DOI: 10.1007/s11894-021-00808-3