Laparoscopic-Assisted Endoscopic Retrograde Cholangiopancreatography (ERCP) Versus Endoscopic Ultrasound-Directed Transgastric ERCP in Patients With Roux-en-Y Gastric Bypass: A Systematic Review and Meta-Analysis

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Abstract

Endoscopic retrograde cholangiopancreatography (ERCP) is a therapeutic procedure for skilled endoscopists that can be even more challenging in some situations, including patients’ post-Roux-en-Y Gastric Bypass (RYGB) surgery. There is still no consensus on whether laparoscopic-assisted ERCP (LA-ERCP) or endoscopic ultrasound (EUS)-directed transgastric ERCP (EDGE) is the most appropriate, safe, and feasible approach in patients with this type of post-surgical anatomy. This systematic review and meta-analysis aimed to examine both approaches’ feasibility, efficacy, and safety in this situation.

We searched for electronic databases (MEDLINE, EMBASE, Lilacs, Google Scholar, and Central Cochrane) to identify studies comparing LA-ERCP versus EDGE. Outcomes measured included technical success, adverse events (AEs), and serious AEs, length of stay (LOS), and procedural time. Descriptive data related to the EDGE procedure was also extracted. The risk of bias and the quality of evidence of the enrolled studies were assessed.

Five studies, totaling 268 patients (176 LA-ERCP and 92 EDGE), were included. There was no statistical difference in technical success and AEs between groups; however, the LOS and procedural times were shorter for the EDGE group. High rates of fistula closure and no weight regain were observed in EDGE. Both methods are feasible and safe techniques to perform ERCP in patients with RYGB anatomy, with comparable technical success and adverse events rate. However, EDGE is associated with shorter LOS and procedural time.

Categories: Gastroenterology, General Surgery
Keywords: laparoscopy, endoscopic ultrasound (eus), endoscopic retrograde cholangiopancreatography (ercp), roux-en-y gastric bypass (rygb), surgery, endoscopy

Introduction And Background

Obesity is a public health problem that leads to increasing bariatric and metabolic surgical interventions, including Roux-en-Y Gastric Bypass (RYGB) surgery. The abrupt weight loss raises the risk of developing gallstones and, consequently, choledocholithiasis and its complications [1], requiring endoscopic retrograde cholangiopancreatography (ERCP) as a therapy. However, accessing the biliary tree in these patients is challenging, especially by endoscopy, due to increased difficulty in biliary cannulation, limited devices available for therapy of choledocholithiasis while using an endoscope, and the need for special devices (due to the narrow diameter and long length of the working channel) [2]. Therefore, alternative techniques have been recently proposed and demonstrated superior results compared to enteroscopy-assisted ERCP (EA-ERCP) [3-5].

Laparoscopy-assisted ERCP (LA-ERCP) was first described in 2002 and consisted of creating a gastrostomy at the excluded stomach followed by the insertion of a conventional duodenoscope through the laparoscopic port. This procedure allows for performing a standard ERCP immediately during intraoperative [6]. The demand for increased coordination between endoscopic and surgical teams and the difficulty of performing consecutive ERCPs by this method are significant limitations of this approach [7,8].

Endoscopic ultrasound (EUS)-directed transgastric ERCP (EDGE) was initially reported in 2014 [9] and is typically performed by creating transluminal access between the gastric pouch or the proximal efferent limb and the gastric remnant using a lumen-apposing metal stent (LAMS) under EUS and fluoroscopic guidance. The risk of fistula persistence after LAMS removal and its associated complications, such as weight regain,
especially in fistulas with long-term patency, have always been a concern of this therapeutic modality [8].

To better understand and evaluate each approach’s feasibility, efficacy, and safety for this challenging population, we conducted this systematic review and meta-analysis. We examined the most recent and best quality of evidence available in the literature to compare EDGE and LA-ERCP outcomes directly.

**Review**

**Materials and methods**

**Protocol and Registration**

This systematic review and meta-analysis were conducted according to the Cochrane Handbook of Systematic Reviews of Interventions and the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines [10]. The study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the file number CRD42021257219 and was approved by the Ethics Committee.

**Eligibility Criteria**

To provide a better quality of evidence and limit the heterogeneity between study groups, only studies directly comparing EDGE and LA-ERCP in post-RYGB patients were included, either with prospective or retrospective design. All relevant articles (abstracts or full-text manuscripts) were considered for inclusion, regardless of language and year of publication. Exclusion criteria included non-comparative studies (case reports, case series, narrative reviews, editorials), studies in patients with any other surgical altered anatomy, and studies that did not report at least technical success rate and adverse events (AEs) outcomes. When articles with a concern of sample duplication were identified, only the most recent was included. Studies with missing data and failed contact with the author to retrieve data were also excluded.

**Search Strategy and Information Sources**

Individualized searches of electronic databases (MEDLINE, EMBASE, Lilacs, Google Scholar, and Central Cochrane) and grey literature were conducted from inception through October 10, 2022. The search strategy was the same in all databases as follows: (Gastric Bypass OR Gastrojejunostomy OR Gastrojejunostomies OR Gastroileal Bypass OR Transgastric OR Roux-en-Y) AND (Retrograde Cholangiopancreatography, Endoscopic OR Endoscopic Retrograde Cholangiopancreatographies OR ERCP OR Endoscopic Ultrasound OR Endosonography OR Endosonographies OR Endoscopy, Ultrasonic OR Ultrasonic Endoscopies OR Endoscopic Ultrasonography OR Endoscopic Ultrasonographies). From the initial results, duplicate articles were removed, and then titles and abstracts were assessed for eligibility by two independent investigators. Any disagreements were resolved by consultation with a third reviewer.

**Data Collection Process and Measured Outcomes**

Studies considered relevant were selected for full-text analysis, and Excel sheets were used to collect the appropriate data and results. Descriptive data extracted included age, sex, the indication of the procedure, and time from RYGB to the procedure. For the EDGE group of patients, specific outcomes and procedural details (weight regain, fistula closure rate, access type, LAMS size, and single/two-stage procedure) were also extracted and registered. However, they could not take a comparative analysis.

The primary outcomes included technical success and AEs to establish an adequate comparison of the feasibility and safety of both procedures. Other secondary outcomes measured were procedural time and length of hospitalization (LOS). Technical success was defined as the capacity to reach the ampulla and perform therapeutic ERCP after accessing the excluded stomach. All the studies analyzed assumed that clinical success was achieved after successful therapeutic ERCP. Thus, we considered only technical success as an outcome of meta-analysis.

The AEs were classified according to the 2010 American Society for Gastrointestinal Endoscopy (ASGE) lexicon for endoscopic AEs [11] or graded according to the Clavien-Dindo classification [12] if surgical complications, with grade III and IV defined as severe. For the serious AEs analysis, both mild and moderate AEs were grouped as non-serious AEs. Secondary outcomes evaluated included the LOS and procedural time.

**Risk of Bias in Individual Studies and Quality of Evidence**

The risk of bias was assessed by Cochrane’s Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) [13]. The quality of the evidence was assessed using the objective criteria of Grading of Recommendations Assessment, Development, and Evaluation (GRADE) for each outcome using the GRADEpro - Guideline Development Tool software [14].
Data Analysis

The software Review Manager (RevMan), version 5.4 - Cochrane Collaboration Copyright © 2014, was used to create tabular and graphical displays and perform the statistical analysis. Absolute values, means, and standard deviations (SD) were used in the data analysis. If a study provided medians and measures of variance, mathematical formulae were used to estimate means and SD, thus promoting data standardization [15]. We calculated the risk difference (RD) for dichotomous variables using the Mantel-Haenszel test. The mean difference (MD) value was calculated using means and SD by inverse variance test for continuous variables. A confidence interval (CI) of 95% was established for both measures. All calculated p values were two-sided, and p values < 0.05 were considered statistically significant. Heterogeneity was assessed employing the Higgins method (I²) and Chi-Squared test (X²). Values of heterogeneity less than 50% were considered low, and fixed-effects models were applied.

Results

Search Results and Study Characteristics

A total of 8642 studies were identified from the initial search. A total of four retrospective studies [16-19] and one abstract of a retrospective cohort [20] were included in this study, as summarized in Figure 1. These five studies represented a sample of 268 patients, 92 in the EDGE group and 176 in the LA-ERCP group, whose individual characteristics are summarized in Table 1.

![Flow diagram showing the study selection process for meta-analysis.](image-url)
| Author (year) | Intervention (n) | Study Design | Age, years (variance) | Indication, n (%) | Time from RYGB, years (variance) | Outcomes |
|--------------|------------------|--------------|-----------------------|-------------------|-------------------------------|----------|
| Kedia (2019) [16] | EDGE (29) | Retrospective Cohort | 56 (35-82) | Biliary: 23 (79%) Pancreatic: 6 (21%) | 5.5 (NI) | Technical Success, Adverse Events, Severe Adverse Events, Length of Hospitalization, Procedure Time |
| | LA-ERCP (43) | | | | | |
| | | | | | | |
| Parvataneni (2019) [20] | EDGE (17) | Retrospective Cohort | 55.9 (NI) | NI | NI | Technical Success, Adverse Events |
| | LA-ERCP (59) | | | | | Procedure Time |
| | | | | | | |
| Kroll (2020) [18] | EDGE (2) | Retrospective Cohort | 50.5 (49-52) | Biliary: 2 (100%) | 5 (0-12) | Technical Success, Adverse Events, Severe Adverse Events, Length of Hospitalization, Procedure Time |
| | LA-ERCP (14) | | | | | |
| | | | | | | |
| Kochhar (2020) [17] | EDGE (26) | Retrospective Cohort | 60.77 (11.44) | Biliary: 22 (85%) Pancreatic: 4 (15%) | 10.7 (NI) | Technical Success, Adverse Events, Severe Adverse Events, Length of Hospitalization, Procedure Time |
| | LA-ERCP (18) | | | | | |
| | | | | | | |
| Wang (2021) [19] | EDGE (18) | Retrospective Cohort | 59.3 (6.5) | Biliary benign: 14 (78%) Malignance: 4 (22%) | 13.2 (7.6) | Technical Success, Adverse Events, Severe Adverse Events, Length of Hospitalization |
| | LA-ERCP (42) | | | | | |

**TABLE 1: Characteristics of patients and interventions**

EDGE: Endoscopic Ultrasound-Directed Transgastric ERCP; LA-ERCP: Laparoscopic-Assisted Endoscopic Retrograde Cholangiopancreatography; RYGB: Roux-en-Y Gastric Bypass; NI: Not Informed

**Risk of Bias and Quality of Evidence Assessment**

All studies [16-20] presented a severe overall risk of bias (Figure 2). The quality of evidence for each outcome is described in Table 2.
### FIGURE 2: ROBINS-I – Risk of Bias assessment

Studies represented in the figure [16-20]

| Study               | D1 | D2 | D3 | D4 | D5 | D6 | D7 | Overall |
|--------------------|----|----|----|----|----|----|----|---------|
| Wang, 2021         | ✗  | +  | ✗  | +  | +  | +  | +  | ✗       |
| Kochhar, 2020      | ✗  | +  | ✗  | +  | +  | +  | +  | ✗       |
| Kroll, 2020        | ✗  | +  | ✗  | ✗  | +  | +  | +  | ✗       |
| Parvataneni, 2019  | ✗  | ?  | ?  | ✗  | ?  | ?  | ?  | ✗       |
| Kedla, 2019        | ✗  | +  | ✗  | +  | +  | +  | +  | ✗       |

Domains:
- D1: Bias due to confounding
- D2: Bias due to selection of participants
- D3: Bias in classification of interventions
- D4: Bias due to deviations from intended interventions
- D5: Bias due to missing data
- D6: Bias in measurement of outcomes
- D7: Bias in selection of the reported result

Judgement:
- Serious
- Moderate
- Low
- No information
| Study event rates | Relative effect (95% CI) | Anticipated absolute effects |
|-------------------|--------------------------|-----------------------------|
| Risk of bias with LA-ERCP | Risk difference with EDGE |
| Technical Success | 268 (5 observational studies) [16-20] |
| serious | not serious | not serious | not serious | none | ⨁⨁⨁◯ | Moderate | 173/176 (98.3%) | 90/92 (97.8%) | RR 1.00 (0.95 to 1.05) | 983 per 1.000 | 0 fewer per 1.000 (from 49 fewer to 49 more) |
| Adverse Events | 268 (5 observational studies) [16-20] |
| very serious | not serious | not serious | not serious | none | ⨁◯◯◯ | Very low | 36/176 (20.5%) | 12/92 (13.0%) | RR 0.63 (0.33 to 1.20) | 205 per 1.000 | 76 fewer per 1.000 (from 127 fewer to 41 more) |
| Severe Adverse Events | 192 (4 observational studies) [16-19] |
| very serious | not serious | not serious | not serious | none | ⨁◯◯◯ | Low | 5/117 (4.3%) | 2/75 (2.7%) | RR 0.68 (0.18 to 2.55) | 43 per 1.000 | 13 fewer per 1.000 (from 35 fewer to 66 more) |
| Length of Hospitalization | 192 (4 observational studies) [16-19] |
| serious | not serious | not serious | not serious | none | ⨁⨁◯◯ | Moderate | 117 | 75 | - | The mean length of hospitalisation was 0 MD 1.2 lower (1.48 lower to 0.32 lower) |
| Procedural Time | 208 (4 observational studies) [16-18, 20] |
| serious | not serious | serious | not serious | none | ⨁◯◯◯ | Low | 134 | 74 | - | The mean procedure time was 0 MD 66.62 lower (113.62 lower to 83.63 lower) |

### TABLE 2: GRADE analysis for the EDGE vs. LA-ERCP comparison

CI: confidence interval; MD: mean difference; RR: risk ratio; LA-ERCP: Laparoscopic-assisted endoscopic retrograde cholangiopancreatography;

Explanations

a. Confounding Factors were not controlled

b. Classification of intervention groups not well-defined

c. Large Range of results

d. Not all studies clearly stratified adverse events severity

e. The outcome does not represent directly the superiority of the technique
### Meta-analysis

#### Technical Success

All studies reported technical success [16-20]. The rates of technical success were similar, 97.8% and 98.3% in the EDGE and LA-ERCP groups, respectively, with a RD of 0.00 (95% CI − 0.06 to 0.06; I² = 0%; p = 0.96) (Figure 3).

![FIGURE 3: Forest Plot of Technical Success](image)

#### Adverse Events and Serious Adverse Events

All studies presented data concerning AEs [16-20]. The rates of AEs were also comparable between the groups, 13% in the EDGE group and 20.4% in the LA-ERCP group, with a RD - 0.08 (95% CI − 0.17 to 0.01; I² = 33%; p = 0.09) (Figure 4). A separate analysis of serious AEs was performed, including four studies [16-19]. Only 0.03% and 0.04% of these events were reported in the EDGE and LA-ERCP groups, respectively (RD - 0.02: 95% CI − 0.09 to 0.05; I² = 0%; p = 0.55) (Figure 5).
FIGURE 4: Forest Plot of Adverse Events

EDGE: Endoscopic Ultrasound-Directed Transgastric ERCP; LA-ERCP: Laparoscopic-Assisted Endoscopic Retrograde Cholangiopancreatography; M-H: Mantel-Haenszel; CI: Confidence interval

Studies represented the forest plot [16-20]

FIGURE 5: Forest Plot of Serious Adverse Events

EDGE: Endoscopic Ultrasound-Directed Transgastric ERCP; LA-ERCP: Laparoscopic-Assisted Endoscopic Retrograde Cholangiopancreatography; M-H: Mantel-Haenszel; CI: Confidence interval

Studies represented the forest plot [16-19]

Length of Hospitalization

This analysis included four studies [16-19]. The MD of hospital stay between EDGE and LA-ERCP groups was -1.2 days (95% CI - 1.86 to -0.53; I² = 47%; p = 0.0004), highlighting a lower LOS for the EDGE group (Figure 6).

FIGURE 6: Forest Plot of Length of Hospitalization

EDGE: Endoscopic Ultrasound-Directed Transgastric ERCP; LA-ERCP: Laparoscopic-Assisted Endoscopic Retrograde Cholangiopancreatography; SD: Standard deviation; IV: Inverse variance; CI: Confidence interval

Studies represented the forest plot [16-19]

Procedural Time

Four studies were included in this analysis [16-18,20]. There was a significantly lower time (in minutes) in the EDGE group in comparison with the LA-ERCP group (MD - 98.62 min: 95% CI - 113.62 to -83.63; I² = 16%; p = 0.00001) (Figure 7).
FIGURE 7: Forest Plot of Procedural Time

EDGE: Endoscopic Ultrasound-Directed Transgastric ERCP; LA-ERCP: Laparoscopic-Assisted Endoscopic Retrograde Cholangiopancreatography; SD: Standard deviation; IV: Inverse variance; CI: Confidence interval

Studies represented the forest plot [16-18,20]

Discussion

To the best of our knowledge, this is the first systematic review and meta-analysis comparing EDGE versus LA-ERCP techniques in patients with RYGB anatomy in a dichotomic design and including only comparative studies to strengthen the quality of results. A previous meta-analysis [4] had already compared these two techniques and EA-ERCP with results consistent with ours. However, the great majority of the studies involved were not comparative, and four comparative studies included in our meta-analysis were not present in this manuscript. Although our review includes a smaller sample of patients, we prioritized quality of evidence over quantity, updated the literature search, and added different outcomes (LOS and procedural time) to the final analysis.

We decided not to include EA-ERCP in our comparison because several studies, either retrospective cohorts [21,22] or meta-analysis [5,7], had already reported lower technical and clinical success rates. These worse outcomes can be explained by some technical features inherent to the procedure, such as longer length navigated by the device causing instability, forward-viewing nature of the scope, lack of elevator mechanism, and difficulty of adequate accessories due to the narrow diameter and longer length of the working channel [2]. Thus, it is clear to us that the decision of the most appropriate approach, due to its high clinical relevance, to perform ERCP in this setting of patients rests between EDGE and LA-ERCP. However, EA-ERCP remains an acceptable option in centers where only this technique is available.

In this meta-analysis, we found similar high technical success rates and a low incidence of AEs in EDGE and LA-ERCP groups with a trend of lower AEs rates in EDGE. These results are consistent with previous non-comparative systematic reviews [23,24], demonstrating that both techniques are safe and feasible in current clinical practice. Although EDGE has the advantage of solving the clinical problem through a completely endoscopic procedure, it has the limitation of being a novel technique performed only by a select group of skilled endoscopists with therapeutic EUS training settled in tertiary hospital centers with special devices and resources. On the other hand, with the increasing availability of LAMS, there is a trend to expand its use to other transgastric procedures, enhancing its popularity among endoscopists. This context expects even higher success rates with lower AEs in this procedure.

One of the significant advantages of LA-ERCP is the possibility to perform cholecystectomy simultaneously in patients with gallbladder in situ. However, this time-consuming procedure involves a complex logistic process that demands precise time synchronization between surgical and endoscopic teams [7]. Also, it demands an operating room for execution. It has other inconveniences, such as surgical site infections, the presence of scars, longer LOS, higher costs, and the problematic performance of a consecutive ERCP if needed. For this specific context, laparoscopic-assisted intraducal exploration of the bile duct appears to be the best approach, especially if diagnosed intraoperatively [25]. Nevertheless, laparoscopic-assisted intraducal interventions are not widely performed by surgeons outside centers of excellence. On the other hand, EDGE adds the facility to allow further ERCP procedures when needed or other endoscopic interventions such as EUS-guided fine-needle aspiration/biopsy (FNA/FNB) in suspected pancreas head lesions, EUS-guided biliary drainage if traditional ERCP fails, and EUS-guided gallbladder drainage in concomitant acute cholecystitis in a non-surgical candidate for laparoscopic cholecystectomy. The aforementioned interventions are feasible since LAMS may stay in situ for days or weeks, not demanding consecutive surgical reinterventions or leaving a gastrostomy tube in situ, as in LA-ERCP, if a subsequent procedure is needed [8].

In addition, LA-ERCP may be a preferred method for urgent clinical indications demanding prompt resolution, notably cholangitis, once performed at one time. This scenario may be unfavorable for EDGE since it is well established that a two-stage procedure is preferred, with a 10-14 day interval between the stages [26,27]. This approach decreases the rate of AEs [26,27] when compared to an intermediate approach using larger (20 mm) LAMS associated with a shortened interval of two to four days between the stages and anchoring of the stent via an over-the-scope clip or endoscopic suturing [26].
performed with similar technical success and AEs rates for this challenging population. Despite the lower Conclusions

biliary, pancreatic, benign, or malignant, which could have modified the outcomes. The included studies did not separate the results according to the primary disease, either procedure broadly performed. Another limitation of this systematic review is regarding the indication of the reported in the literature, particularly in the EDGE group, this is a significant number since it is not a small sample of patients included in our analysis. However, compared with the total number of procedures after the metaanalysis. In addition, despite the high individual risk of bias, the evidence grade is augmented in the literature comparing both techniques, and retrospective cohorts currently represent the best quality retrospective design. However, no prospective cohorts or randomized controlled trials (RCTs) are available due to confounding factors and the absence of control in selecting inclusion criteria due to their retrospective design. However, no prospective cohorts or randomized controlled trials (RCTs) are available in the literature comparing both techniques, and retrospective cohorts currently represent the best quality of evidence. Even though one of the studies included was an abstract, its data did not modify the final results after the metaanalysis. In addition, despite the high individual risk of bias, the evidence grade is augmented by a low heterogeneity and a low risk of publication bias amongst the articles. Another limitation is the small sample of patients included in our analysis. However, compared with the total number of procedures reported in the literature, particularly in the EDGE group, this is a significant number since it is not a procedure broadly performed. Another limitation of this systematic review is regarding the indication of the procedures once the included studies did not separate the results according to the primary disease, either biliary, pancreatic, benign, or malignant, which could have modified the outcomes.

This meta-analysis has limitations, for example, the high risk of bias of the studies included. This is mainly due to confounding factors and the absence of control in selecting inclusion criteria due to their retrospective design. However, no prospective cohorts or randomized controlled trials (RCTs) are available in the literature comparing both techniques, and retrospective cohorts currently represent the best quality of evidence. Even though one of the studies included was an abstract, its data did not modify the final results after the metaanalysis. In addition, despite the high individual risk of bias, the evidence grade is augmented by a low heterogeneity and a low risk of publication bias amongst the articles. Another limitation is the small sample of patients included in our analysis. However, compared with the total number of procedures reported in the literature, particularly in the EDGE group, this is a significant number since it is not a procedure broadly performed. Another limitation of this systematic review is regarding the indication of the procedures once the included studies did not separate the results according to the primary disease, either biliary, pancreatic, benign, or malignant, which could have modified the outcomes.

In summary, this systematic review and meta-analysis demonstrated that both approaches could be performed with similar technical success and AEs rates for this challenging population. Despite the lower
procedural time and shorter hospital stay related to the endoscopic approach, the best approach should be individualized by considering personal and local experience, availability of material and devices, and specific circumstances such as the need for cholecystectomy or endoscopic reinterventions.

Therefore, EDGE and LA-ERCP are good techniques for performing ERCP in patients with RYGB, with high technical success and low AEs rates. Nonetheless, when compared to LA-ERCP, EDGE is associated with a shorter procedural time and a lower length of hospitalization. However, more prospective studies, preferably RCTs comparing these methods directly are required to provide more data about this topic to guide clinical decision-making.

Additional Information

Disclosures

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: Eduardo Guimarães H de Moura declare(s) personal fees from Olympus and Boston Scientific. Consultant (consulting fees). Sergio A. Sánchez-Luna declare(s) receipt of award from ASGE and Fujifilm. Recipient of the 2021 American Society for Gastrointestinal Endoscopy (ASGE) Endoscopic Training Award by the ASGE and Fujifilm. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Byrne TK: Complications of surgery for obesity. Surg Clin North Am. 2001, 81:1181-95. 10.1016/s0039-6109(05)70190-0
2. Wang TJ, Ryoo M: Evolving techniques for endoscopic retrograde cholangiopancreatography in gastric bypass patients. Curr Opin Gastroenterol. 2018, 54:444-50. 10.1097/mog.0000000000000474
3. da Ponte-Neto AM, Bernardo WM, de A Coutinho LM, et al.: Comparison between enteroscopy-based and laparoscopy-assisted ERCP for accessing the biliary tree in patients with Roux-en-Y gastric bypass: systematic review and meta-analysis. Obes Surg. 2018, 28:4064-76. 10.1007/s11695-018-3507-2
4. Dhindsa BS, Dhalawi A, Mohan BP, et al.: EDGE in Roux-en-Y gastric bypass: how does it compare to laparoscopy-assisted and balloon enteroscopy ERCP: a systematic review and meta-analysis. Endosc Int Open. 2020, 8:E163-71. 10.1055/a-1067-4411
5. Ayoub F, Brar TS, Banerjee D, Abbas AM, Wang Y, Yang D, Dragonov PV: Laparoscopy-assisted versus enteroscopy-assisted endoscopic retrograde cholangiopancreatography (ERCP) in Roux-en-Y gastric bypass: a meta-analysis. Endosc Int Open. 2020, 8:E423-56. 10.1055/a-1070-9152
6. Peters M, Papasavas PK, Cauhaif PF, Kania RJ, Gagné DJ: Laparoscopic transgastric endoscopic retrograde cholangiopancreatography for benign common bile duct stricture after Roux-en-Y gastric bypass. Surg Endosc. 2002, 16:1106. 10.1007/s00464-001-4180-3
7. Abbas AM, Strong AT, Diehl DL, et al.: Multicenter evaluation of the clinical utility of laparoscopy-assisted ERCP in patients with Roux-en-Y gastric bypass. Gastrointest Endosc. 2018, 87:1051-9. 10.1016/j.gie.2017.10.044
8. Runge TM, Chiang AL, Kowalski TE, et al.: Endoscopic ultrasound-directed transgastric ERCP (EDGE): a retrospective multicenter study. Endoscopy. 2021, 53:611-8. 10.1055/a-1254-3942
9. Kedia P, Sharaiha RZ, Kumta NA, Kahaleh M: Internal EUS-directed transgastric ERCP (EDGE): game over. Gastroenterology. 2014, 147:566-8. 10.1053/j.gastro.2014.05.045
10. Page MJ, McKenzie H, Bossuyt PM, et al.: The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021, 572:n71. 10.1136/bmj.n71
11. Cotton PB, Eisen GM, Aabakken L, et al.: A lexicon for endoscopic adverse events: report of an ASGE workshop. Gastrointest Endosc. 2010, 71:446-54. 10.1016/j.gie.2009.10.027
12. Dindo D, Demartines N, Clavien PA: Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004, 240:205-15. 10.1097/01.sla.0000135308.54954.ae
13. Sterne JA, Hernán MA, Reeves BC, et al.: ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016, 355:i4919. 10.1136/bmj.i4919
14. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Schünemann HJ: GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ. 2008, 336:924-6. 10.1136/bmj.39489.470347.AD
15. Hozo SP, Djulbegovic B, Hozo I: Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol. 2005, 5:15. 10.1186/1471-2288-5:13
16. Kedia P, Tarnasky PR, Nieto J, et al.: Multicenter early comparative experience of clinical outcomes with EUS-directed transgastric endoscopic retrograde cholangiopancreatography versus laparoscopy-assisted ERCP for Roux-en-Y gastric bypass (RYGB) anatomy: a multicenter early comparative experience of clinical outcomes. J Clin Gastroenterol. 2019, 53:304-8. 10.1097/MCG.0000000000001037
17. Kochhar GS, Mohy-Ud-Din N, Grover A, et al.: EUS-directed transgastric endoscopic retrograde cholangiopancreatography versus laparoscopic-assisted ERCP versus deep enteroscopy-assisted ERCP for patients with RYGB. Endosc Int Open. 2020, 8:E877-82. 10.1055/a-1164-6282
18. Krüll D, Müller AC, Nett PC, et al.: Tailored access to the hepatobiliary system in post-bariatric patients: a tertiary care bariatric center experience. Surg Endosc. 2020, 34:5469-76. 10.1007/s00464-019-07345-3
19. Wang TJ, Cortes P, Irijapinto P, Thompson CC, Ryoo M: A comparison of clinical outcomes and cost utility among laparoscopy, enteroscopy, and temporary gastric access-assisted ERCP in patients with Roux-en-Y gastric bypass anatomy. Surg Endosc. 2021, 35:4469-77. 10.1007/s00464-020-07952-3
20. Parvataneni S, Kumar V, Confer B, Diehl DL, Khara HS: 917 EUS-directed transgastric ERCP (EDGE) versus laparoscopy-assisted ERCP (LAERCP) for Roux-en-Y gastric bypass (RYGB): a single center experience. Am J Gastroenterol. 2019, 114:536-536. 10.14309/01.ajg.000059204.5987.e7

21. Bukhari M, Kowalski T, Nieto J, et al.: An international, multicenter, comparative trial of EUS-guided gastrogastrostomy-assisted ERCP versus enteroscopy-assisted ERCP in patients with Roux-en-Y gastric bypass anatomy. Gastrointest Endosc. 2018, 88:486-94. 10.1016/j.gie.2018.04.2556

22. Schreiner MA, Chang L, Gluck M, et al.: Laparoscopy-assisted versus balloon enteroscopy-assisted ERCP in bariatric post-Roux-en-Y gastric bypass patients. Gastrointest Endosc. 2012, 75:748-56. 10.1016/j.gie.2011.11.019

23. Prakash S, Elmunzer BJ, Forster EM, Cote GA, Moran RA: Endoscopic ultrasound-directed transgastric ERCP (EDGE): a systematic review describing the outcomes, adverse events, and knowledge gaps. Endoscopy. 2022, 54:52-61. 10.1055/a-1376-2394

24. Hajibandeh S, Hajibandeh S, Tarazi M, Mansour M, Satyadas T: Procedural outcomes of laparoscopic-assisted endoscopic retrograde cholangiopancreatography in patients with previous Roux-en-Y gastric bypass surgery: a systematic review and meta-analysis. Obes Surg. 2021, 31:282-98. 10.1007/s11695-020-04954-x

25. Pan L, Chen M, Ji L, et al.: The safety and efficacy of laparoscopic common bile duct exploration combined with cholecystectomy for the management of cholecysto-choledocholithiasis. Ann Surg. 2018, 268:247-53. 10.1097/SLA.0000000000002731

26. Krafft MR, Fang W, Nasr JY: Shortened-interval dual-session EDGE reduces the risk of LAMS dislodgement while facilitating timely ERCP. Dig Dis Sci. 2021, 66:2776-85. 10.1007/s10620-020-06551-5

27. Shinn B, Boortalary T, Raisman I, et al.: Maximizing success in single-session EUS-directed transgastric ERCP: a retrospective cohort study to identify predictive factors of stent migration. Gastrointest Endosc. 2021, 94:727-32. 10.1016/j.gie.2021.04.022

28. James TW, Baron TH: Endoscopic ultrasound-directed transgastric ERCP (EDGE): a single-center US experience with follow-up data on fistula closure. Obes Surg. 2019, 29:451-6. 10.1007/s11695-018-3531-2

29. Krafft MR, Lorenzen A, Croglio MP, Fang W, Baron TH, Nasr JY: ‘Innocent as a LAMS’: does spontaneous fistula closure (secondary intention), after EUS-directed transgastric ERCP (EDGE) via 20-mm lumen-apposing metal stent, confer an increased risk of persistent fistula and unintentional weight gain?. Dig Dis Sci. 2022, 67:2337-46. 10.1007/s10620-021-00703-4

30. Elsharif M, Hagua AG, Ahmed H, Ackroyd R: 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, 13:985-1009. 10.1007/s12328-020-01201-9

31. James HJ, James TW, Wheeler SB, Spencer JC, Baron TH: 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, 51:1051-8. 10.1055/a-0938-3918