Laparoscopy-assisted versus balloon enteroscopy-assisted ERCP after Roux-en-Y gastric bypass

Authors
Christer Julseth Tønnesen1,2, Juliet Young1, Tom Glomsaker3, Tom Mala3, Magnus Loborg1,2, Michael Bretthauer1,2, Erle Refsum1, Lars Aabakken1,2

Institutions
1 Clinical Effectiveness Research Group, Department of Health Management and Health Economics, University of Oslo, Oslo, Norway
2 Section of Gastroenterology, Department of Transplantation Medicine, Oslo University Hospital, Oslo, Norway
3 Department of Gastrointestinal and Pediatric Surgery, Oslo University Hospital, Oslo, Norway

Submitted 7.10.2019
Accepted after revision 17.2.2020

Bibliography
DOI https://doi.org/10.1055/a-1139-9313
Published online: 21.4.2020 | Endoscopy 2020; 52: 654–661
© Georg Thieme Verlag KG Stuttgart · New York
ISSN 0013-726X

Corresponding author
Christer Julseth Tønnesen, MD, Department of Transplantation Medicine, Oslo University Hospital, Sognsvannsveien 20, 0372 Oslo, Norway
Fax: +47-23072410
c.j.tonnesen@medisin.uio.no

ABSTRACT

Background Patients who have undergone Roux-en-Y gastric bypass (RYGB) are at increased risk of biliary disease necessitating endoscopic retrograde cholangiopancreatography (ERCP). The most widely used approaches to perform ERCP after RYGB are laparoscopy-assisted ERCP (LA-ERCP) and balloon enteroscopy-assisted ERCP (BEA-ERCP). There are few studies comparing these procedures. We aimed to compare the performance, benefits, and harms of LA-ERCP and BEA-ERCP in RYGB patients.

Methods We identified all RYGB patients who underwent ERCP at two tertiary care endoscopy centers in Oslo, Norway between May 2013 and December 2017. One center performed BEA-ERCP, the other LA-ERCP. Procedure success was defined as fulfillment of the therapeutic or diagnostic aim, according to the procedure description. Adverse events were classified according to the Clavien–Dindo grading system.

Question: What is the best ERCP method for gastric bypass patients?

Conclusion: In experienced hands, both laparoscopic-assisted ERCP and balloon enteroscopy-assisted ERCP have high success rates.
Results During the study period, 40 BEA-ERCP and 39 LA-ERCP procedures were performed in 68 patients. Procedure success rate was 72.5% for BEA-ERCP and 87.2% for LA-ERCP (P = 0.14). Adverse events occurred in 18% of BEA-ERCP and 28% of LA-ERCP (P = 0.23). Serious adverse events (Clavien–Dindo grade ≥ 3b) occurred in 2.5% of BEA-ERCP and 7.7% of LA-ERCP procedures (P = 0.36). Concomitant cholecystectomy was performed in 25 of the 39 LA-ERCP procedures. The median procedure times for LA-ERCP performed with and without concomitant cholecystectomy were 201 minutes and 140 minutes, respectively, and for BEA-ERCP was 125 minutes.

Conclusions In experienced hands, both LA-ERCP and BEA-ERCP have high success rates after RYGB. The choice of approach should be individualized according to patient characteristics and available physician competence.

Introduction
Obesity is a global challenge with a three-fold increase in prevalence since 1975 [1]. Bariatric surgery is the most effective method for sustained weight loss for obese patients who fail conventional lifestyle intervention therapy [2, 3]. Roux-en-Y gastric bypass (RYGB) has been one of the most commonly performed bariatric procedures [4].

Patients with a body mass index (BMI) of more than 40 kg/m² have an eight-fold increased risk of cholelithiasis compared with patients with a lower BMI [4]. The risk for cholelithiasis is further increased after RYGB, which may be due to increased bile cholesterol saturation during rapid weight loss and gallbladder hypomotility owing to the duodenal bypass [4–6].

Endoscopic retrograde cholangiopancreatography (ERCP) in patients with altered anatomy due to RYGB is technically challenging owing to the long intestinal access route to the major papilla, which cannot be reached by a conventional duodenoscope.

The most common interventional strategies for this patient group are laparoscopy-assisted ERCP (LA-ERCP) and balloon enteroscopy-assisted ERCP (BEA-ERCP). LA-ERCP has the advantage that no specific training or instruments are needed, and cholecystectomy can be performed concomitantly. However, it requires that both an ERCP and gastrointestinal laparoscopy team collaborate on the procedure. BEA-ERCP, on the other hand, requires specialized endoscopic training and instruments, but only a single endoscopy team, is less invasive, and can be performed in an endoscopy room as opposed to an operating theatre.

In 2007, we described the first cases of BEA-ERCP in this journal [7]. Since then, clinical experience with LA- and BEA-ERCP for RYGB has been documented in several case series and systematic reviews [8–14], but few studies have compared the two methods. The largest comparative study to date included 72 patients, but gastrostomy was performed both by open and laparoscopic surgery in this study, and in most cases the gastrostomy was allowed to mature for 4–6 weeks [15].

The purpose of our study was to expand the knowledge of how LA- and BEA-ERCP compare in terms of their performance, benefits and harms for post-RYGB patients. For this purpose, we compared the two methods at two tertiary care endoscopy centers.

Methods
Patients and settings
Oslo University Hospital in Oslo, Norway has two gastrointestinal endoscopy centers that both offer ERCP services for patients with altered anatomy due to RYGB. One center performs BEA-ERCP and, having started its service for this patient group in 2008, had experience of more than 400 BEA-ERCP procedures with various forms of altered gastrointestinal anatomy by 2018. The other center performs LA-ERCP and started this service in 2013. The two centers have separate geographic patient catchment areas and referral structures.

We retrieved data from our administrative hospital databases for all patients with RYGB anatomy who had either an LA-ERCP or a BEA-ERCP performed at one of the two centers in Oslo University Hospital during the period after both procedures had become available (May 2013 to December 2017). The electronic patient records were reviewed by two investigators (C.J.T. and T.G.) to assess the performance, benefits, and harms of the procedures according to a predefined case report form. The BMI and procedure duration were obtained from the general anesthesia chart, and these data were consequently not obtainable for patients receiving conscious sedation in the BEA-ERCP group.

Procedures
Balloon enteroscopy-assisted ERCP
BEA-ERCP was performed in the endoscopy suite, with the patients under either conscious sedation with a combination of midazolam and fentanyl or general anesthesia. The balloon enteroscope (Olympus SIF-Q180, Tokyo, Japan) or a prototype single-balloon enteroscope [200 cm in length with a 3.2-mm working channel], Fujinon EN-580T, Tokyo, Japan) was introduced transorally. All procedures were performed with a distal attachment cap to facilitate cannulation of the papilla [16].

After the upper gastrointestinal tract had been passed, the enteroscope was introduced through the alimentary limb by the push–pull technique. At the entero–entero anastomosis, the endoscope was advanced into the biliopancreatic limb to the duodenum (Fig. 1a), where the major papilla was identified. ERCP was conducted by long catheters and guidewires designed for the enteroscope (Fig. 1b). Sphincterotomy was performed by partial needle-knife sphincterotomy alongside a guidewire, followed by balloon dilation sphincteroplasty adapted to the duct diameter and stone size (Video 1).
Stone extraction was performed with extraction balloons or baskets (▶Fig.1c). Lithotripter baskets were not available for enteroscopes. In selected patients who had a dilated common bile duct, it was possible to introduce the enteroscope into the common bile duct after sphincteroplasty to enable lithotripsy with an electrohydraulic probe through the working channel of the endoscope (▶Fig.1d).

The enteroscope working channel allows the introduction of 7-Fr plastic stents, but not self-expandable metal stents (SEMSs). It was however possible to use a SEMS by placing a guidewire in the bile duct, while withdrawing the enteroscope and leaving the overtube in place. The SEMS could then subsequently be introduced over the guidewire, through the overtube, under fluoroscopic guidance (▶Video 2).

**Laparoscopy-assisted ERCP**

LA-ERCP was performed with the patients under general anesthesia in the operating theatre and involved both a surgical team and an endoscopy team. Antibiotic and thrombosis prophylaxis were administered. The surgeon placed a 15-mm port under the left costal arch laterally into the excluded stomach, following the establishment of a gastrostomy under laparoscopic guidance (▶Fig.1e). We aimed to keep some distance from the trocar insertion site to the pylorus to facilitate the subsequent ERCP. The endoscopist then introduced a standard duodenoscope (Olympus TJF-Q180V, Tokyo, Japan) through the trocar and advanced it to the duodenum. A purse-string suture around the gastrostomy reduced air leakage during endoscopy and assisted in approximating the gastric remnant to the abdominal wall. After the ERCP procedure, the gastrotomy was closed by stapling.

When indicated, laparoscopic cholecystectomy and cholangiography through the cystic duct were performed during the same procedural session, but prior to the ERCP to avoid compromised laparoscopic access owing to endoscopic bowel insufflation.

▶Fig.1 Images of the two endoscopic retrograde cholangiopancreatography (ERCP) procedures performed with: a – d balloon enteroscopy (BEA-ERCP); and e laparoscopy (LA-ERCP). a Radiograph of the balloon enteroscope positioned in the duodenum at the level of the papilla. b Endoscopic view of bile duct cannulation. c Radiographic image of stone extraction with a basket. d Enteroscopic view of intraductal electrohydraulic lithotripsy (EHL). e Laparoscopic view of the gastrostomy with a 15-mm port that has been introduced through the abdominal wall and into the gastric remnant to facilitate passage of the duodenoscope.
Outcome measures

The primary outcomes were procedure-related success and adverse events. Learning curve trends and procedure duration were secondary outcomes. Procedure success was defined as fulfillment of the therapeutic or diagnostic aim, according to the specified procedure indication, without the need for conversion to a more invasive procedure. For example, LA-ERCP procedures that were converted to a laparotomy or cholecotemy and BEA-ERCP procedures that needed surgical assistance were deemed to be failures, irrespective of whether the primary aim of the procedure was achieved.

We also explored the effect of experience by comparing the first quintile of procedures with the last quintile. Adverse events which occurred during or after the procedure were classified according to Clavien–Dindo grading system for surgical complications. Serious adverse events were defined as Clavien–Dindo grade ≥3b [17, 18]. Procedure-related pancreatitis was defined as an amylase level at least three times normal more than 24 hours after the procedure that required re-admission or prolongation of the planned admission by at least 2 days [19]. To address the possibility of bias related to patients having repeated procedures, we also conducted per-patient analyses of success rates where repeat procedures were excluded.

Ethics and approvals

We obtained approval from the Data Protection Officer at Oslo University Hospital prior to data collection. The study was waived approval by the Regional Ethics Committee.

Statistical analyses

Continuous variables are expressed as means (with ranges) or medians (with interquartile ranges) and were analyzed with a t test or Mann–Whitney U test, depending on distribution. Categorical and ordinal variables are presented as percentages and were analyzed using the Fisher’s exact test or chi-squared test, depending on the number of observations. Overall success rates and complication rates between the groups were compared by logistic regression models with a robust estimator of variance to allow for intragroup correlation due to patients with repeated procedures. The change in success rates with increasing training and competence was evaluated by dividing the procedures into quintiles by chronological order. A linear regression model, with success rate as the dependent variable and quintile number as the independent variable, was used to test for trends. A two-sided P value of < 0.05 was considered to be statistically significant. All analyses were performed using Stata Statistical Software version 15.1 (2017; Stata Corp LLC, College Station, Texas, USA).

Results

A total of 79 procedures (40 BEA-ERCP and 39 LA-ERCP) were performed in 68 patients. Concomitant cholecystectomy was performed in 25 of the LA-ERCP procedures. Of the BEA-ERCP procedures, 31 were performed with the patient under general anesthesia, with the remainder under conscious sedation. BEA-ERCP was performed by six experienced endoscopists, and nine video 1 Balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography (BEA-ERCP) with needle-knife sphincterotomy and balloon sphincteroplasty. After the balloon enteroscope is advanced retrogradely through the biliopancreatic limb to the duodenum, the major papilla is identified. Cannulation is conducted by long catheters and guidewires designed for the enteroscope. Sphincterotomy is performed by partial needle-knife sphincterotomy alongside a guidewire, followed by balloon dilation sphincteroplasty adapted to duct diameter and stone size.

Video 1

Online content viewable at:
https://doi.org/10.1055/a-1139-9313

Video 2 Deployment of a fully covered self-expandable metal stent (c-SEMS) with balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography (BEA-ERC). A guidewire has been placed in the bile duct and the enteroscope has been removed, leaving the overtube in place secured by the balloon inflated at the ligament of Treitz. The stent is inserted through the overtube, advanced into the bile duct, and deployed under fluoroscopic guidance.

Online content viewable at:
https://doi.org/10.1055/a-1139-9313
experienced surgeons where involved in placing the gastrostomy ports in LA-ERCP. Patient characteristics and procedure indications are presented in Table 1.

For BEA-ERCP, 26 patients (84%) had one procedure, three (9.7%) had two procedures, one (3.2%) had three procedures, and one (3.2%) had five procedures. For LA-ERCP, 35 patients (95%) had one procedure and two (5.4%) had two procedures. Of the 11 repeated procedures, two BEA-ERCP procedures and two LA-ERCP procedures were repeated because of failure; the other repeated procedures were performed for new or recurrent indications.

The overall procedure success rate was 72.5% for BEA-ERCP and 87.2% for LA-ERCP (P = 0.14) (Fig. 2a). From the first quintile to the last, BEA-ERCP procedures went from a success rate of 50% to 75% (P = 0.002). For LA-ERCP procedures, the success rate went from 88% to 100% (P < 0.001) (Fig. 2b). The rates of endoscopic success, defined as reaching the papilla with the endoscope, and diagnostic success, defined as performing a cholangiogram, are presented in Table 2.

The median procedure time for LA-ERCP performed with and without concomitant cholecystectomy was 201 minutes (IQR 172–249) and 140 minutes (IQR 114–196), respectively, and for BEA-ERCP was 125 minutes (IQR 80–155) (Fig. 2d).

Adverse events occurred in seven patients (18%) after BEA-ERCP, and in 11 patients (28%) after LA-ERCP procedures (P = 0.23) (Table 3). Serious adverse events occurred in one patient (2.5%) and three patients (7.7%) of BEA-ERCP and LA-ERCP procedures, respectively (P = 0.36) (Fig. 2c). One of the patients with a serious adverse event after LA-ERCP also had a cholecystectomy performed. Pancreatitis (all Clavien–Dindo grade I) occurred in four patients (10%) after BEA-ERCP and five patients (13%) after LA-ERCP (P = 0.74).

In per-patient analyses (only counting the first procedure for each patient), the procedural success rate per patient was 71.0% for BEA-ERCP and 89.2% for LA-ERCP (P = 0.51); serious adverse events rates were 3.2% for BEA-ERCP and 8.1% for LA-ERCP (P = 0.62).

### Discussion

Our study shows that both BEA-ERCP and LA-ERCP are feasible and effective procedures for patients with altered anatomy due to RYGB surgery. In experienced hands, LA-ERCP and BEA-ERCP both have high success rates.

Many case reports and retrospective series have documented the feasibility of LA- and BEA-ERCP separately [8–12], and two systematic reviews, including 266 BEA-ERCP procedures on RYGB and 146 BEA-ERCP procedures on Roux-en-Y anatomy

### Table 1  Patient characteristics and indications for balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography (BEA-ERCP) and laparoscopy-assisted ERCP (LA-ERCP).

<table>
<thead>
<tr>
<th>Procedure indications, n (%)</th>
<th>BEA-ERCP n = 31</th>
<th>LA-ERCP n = 37</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common bile duct stones</td>
<td>17 (43)</td>
<td>31 (79)</td>
<td></td>
</tr>
<tr>
<td>Papillary pathology</td>
<td>9 (23)</td>
<td>4 (10)</td>
<td></td>
</tr>
<tr>
<td>Stent removal</td>
<td>5 (13)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Biliary stricture</td>
<td>4 (10)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Biliary leak</td>
<td>3 (8)</td>
<td>2 (5)</td>
<td></td>
</tr>
<tr>
<td>Pancreatic leak</td>
<td>2 (5)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Bile duct cyst</td>
<td>0 (0)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>Pancreas divisum</td>
<td>0 (0)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>ASA score, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASA 1</td>
<td>0 (0)</td>
<td>1 (3)</td>
<td>0.49</td>
</tr>
<tr>
<td>ASA 2</td>
<td>22 (71)</td>
<td>21 (57)</td>
<td>0.28</td>
</tr>
<tr>
<td>ASA 3</td>
<td>9 (29)</td>
<td>14 (38)</td>
<td></td>
</tr>
<tr>
<td>ASA 4</td>
<td>0 (0)</td>
<td>1 (3)</td>
<td></td>
</tr>
<tr>
<td>Gall bladder in situ, n (%)</td>
<td>10 (32)</td>
<td>27 (73)</td>
<td>0.001</td>
</tr>
<tr>
<td>Concomitant cholecystectomy, n (%)</td>
<td>N/A</td>
<td>25 (68)</td>
<td></td>
</tr>
</tbody>
</table>

BMI, body mass index; IQR, interquartile range; ASA, American Society of Anesthesiology classification; N/A, not applicable.

* Patient characteristics for the first procedure are displayed for patients with repeated procedures.

** n = 24 for BEA-ERCP (24 missing) and n = 37 for LA-ERCP (0 missing).
with a native papilla, have shown success rates of 70 % and 60 %, respectively [13, 14].

Few studies have investigated the two methods head-to-head. A retrospective study from Indiana, USA with 72 RYGB patients, of whom 28 were treated with BEA-ERCP and 44 with ERCP via a gastrostomy performed with laparoscopy or open surgery, showed a BEA success rate of 53 % [15]. Another retrospective study [20], with 56 RYGB patients, 32 of whom underwent BEA-ERCP and 24 LA-ERCP, also suggested that LA-ERCP was superior to BEA-ERCP in terms of therapeutic success (100 % vs. 59 %; \( P < 0.001 \)). A plausible contributing reason for the high procedural success rate in our study may be the high volume of BEA-ERCPs performed for patients with other cases of altered anatomy, such as Roux-en-Y hepaticojejunostomy and gastrectomy, and pancreaticoduodenectomy performed at the BEA-ERCP center. Our success rate for LA-ERCP is, as described by other authors, comparable to regular ERCP provided by proficient gastrostomy port placement. Of note, procedural success was higher than diagnostic success in the BEA group. This is due to two patients (with procedural success) who had bile duct stents removed without cholangiography being performed.

The rate of mild pancreatitis is higher for both procedures than for regular ERCP, which may be due to compression of the pancreas during instrumentation. Difficult cannulation and different sphincterotomy techniques for BEA-ERCP may also be contributing factors. The comparison of adverse events should be interpreted with caution, as LA-ERCP was typically associated with concomitant cholecystectomy that has an independent risk of complications.

No randomized controlled trial has yet compared the two procedures. The present study, involving two endoscopy centers at the same hospital in parallel and with a high number of patients, many undergoing multiple procedures, provides one of the largest comparisons to date. However, relevant for interpretation of our observations is the somewhat greater varia-
ity in the indications for BEA-ERCP as compared with those for LA-ERCP and the retrospective design of the study. As in any retrospective study, bias, such as differences between the centers in indications, catchment areas, referral structures, and procedure experience, is inherent to the nature of the retrospective design. There were only small differences in the success rates between LA-ERCP and BEA-ERCP in the per-patient analysis as compared with the per procedure analysis.

Both procedures have advantages and disadvantages. BEA-ERCP requires less personnel and resources, and is less invasive. The BEA-ERCP procedure is complex owing to the passage of enteroscope, and the limited choice of ERCP accessories. Improved success rates over time for LA-ERCP may in part be related to improved understanding and standardization of the procedure, such as aiming for distance from the trocar insertion site to the pylorus and involving surgeons with previous experience and with the procedure performed in the day time.

As our study also shows, high success rates can be achieved with BEA-ERCP in experienced hands, and therefore it may be attractive for a high quality centralized tertiary care service. The advantages of LA-ERCP are the technical similarity to ordinary ERCP, so more availability without the need for highly specialized endoscopists, and the option of concomitant cholecystectomy. Laparoscopy also allows for inspection and closure of any mesenteric defects. In a subgroup of patients, access to the gastric remnant can be challenging and a transjejunal approach may be an alternative [21].

Based on the presented results, as a rule of thumb at our institution, we currently recommend LA-ERCP as the first-line approach to RYGB patients who also have an indication for cholecystectomy or a need for inspection of a mesenteric defect. The remaining patients are scheduled for BEA-ERCP. In selected patients, transcystic extraction of bile duct stones or cholecystotomy may be an option [22]. EUS-directed transgastric ERCP (EDGE) is a new and interesting approach [23–26]. Until the effectiveness, safety, and cost-benefit of EGDE is evaluated through larger studies, we will only consider it for carefully selected patients after failed BEA-ERCP. The decisions regarding therapeutic approach are also influenced by a patient’s comorbidity and the requirement for endoscopy or laparoscopy due to concomitant circumstances. These considerations may also apply to ERCP after single anastomosis gastric bypass (mini-gastric bypass) [27]. Percutaneous transhepatic cholangiography may be an alternative for patients in a situation of cardiovascular compromise, such as septic shock.

In conclusion, both BEA-ERCP and LA-ERCP have high success rates. The choice of ERCP modality in RYGB patients should be based on patient characteristics, available resources, and physician competence.

Acknowledgments

This work was supported by a PhD scholarship from the Health Trust of South-East Norway for Christer Julseth Tønnesen, and by research grants from the Norwegian Research Council (no. 250256) and Norwegian Cancer Society (no. 6741288) for Michael Bretthauer.

Competing interests

Lars Aabakken is a member of Olympus advisory board.

References


