ISSN 1948-5190 (online)

World Journal of *Gastrointestinal Endoscopy*

World J Gastrointest Endosc 2022 October 16; 14(10): 581-656

Published by Baishideng Publishing Group Inc

W J G E

World Journal of Gastrointestinal Endoscopy

Contents

Monthly Volume 14 Number 10 October 16, 2022

World Journal of Gastrointestinal Endoscopy

Monthly Volume 14 Number 10 October 16, 2022

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The *WJGE* is now abstracted and indexed in Emerging Sources Citation Index (Web of Science), PubMed, PubMed Central, Reference Citation Analysis, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Superstar Journals Database. The 2022 edition of Journal Citation Reports® cites the 2021 Journal Citation Indicator (JCI) for *WJGE* as 0.33.

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Production Editor: *Yi-Xuan Cai*; **Production Department Director:** *Xu Guo*; **Editorial Office Director:** *Jia-Ping Yan.*

NAME OF JOURNAL
World Journal of Gastrointestinal Endoscopy

ISSN
ISSN 1948-5190 (online)

LAUNCH DATE
October 15, 2009

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Anastasios Koulaouzidis, Bing Hu, Sang Chul Lee, Joo Young Cho

EDITORIAL BOARD MEMBERS
https://www.wjgnet.com/1948-5190/editorialboard.htm

PUBLICATION DATE
October 16, 2022

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ONLINE SUBMISSION
https://www.f6publishing.com

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World Journal of
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World J Gastrointest Endosc 2022 October 16; 14(10): 581-596

DOI: 10.4253/wjge.v14.i10.581

ISSN 1948-5190 (online)

REVIEW

Endoscopic palliation of malignant biliary obstruction

Andrew Canakis, Michel Kahaleh

Specialty type: Gastroenterology and hepatology

Provenance and peer review: Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): A
Grade B (Very good): B, B
Grade C (Good): C
Grade D (Fair): 0
Grade E (Poor): 0

P-Reviewer: Hu B, China; Okamoto T, Japan; Okamoto T, Japan; Zorron Cheng Tao Pu L, Australia

Received: July 3, 2022
Peer-review started: July 3, 2022
First decision: August 1, 2022
Revised: August 20, 2022
Accepted: October 4, 2022
Article in press: October 4, 2022
Published online: October 16, 2022

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Abstract

Malignant biliary obstruction often presents with challenges requiring the endoscopist to assess the location of the lesion, the staging of the disease, the eventual resectability and patient preferences in term of biliary decompression. This review will focus on the different modalities available in order to offer the most appropriate palliation, such as conventional endoscopic retrograde cholangiopancreatography, endoscopic ultrasound guided biliary drainage as well as ablative therapies including photodynamic therapy or radiofrequency ablation.

Key Words: Biliary obstruction; Endoscopic retrograde cholangiopancreatography; Endoscopic ultrasonography; Stenting; Ablation therapy

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Core Tip: Endoscopic palliation of malignant biliary obstruction can often be challenging. Endoscopic retrograde cholangiopancreatography remains the gold standard for biliary decompression. Its widespread use and high success rate, especially in expert hands, makes it an effective modality for biliary decompression. Yet, recent advances in endoscopic ultrasound guided biliary drainage have emerged from a rescue therapy to a reliable tool with high technical and clinical success rates with moderate adverse event rates. Growing evidence suggest that this can be considered as a first line option in the future. Lastly, photodynamic therapy and radiofrequency ablation of the bile duct can also optimize stent patency, palliate symptoms and prolong survival. While there are limited head to head studies, radiofrequency ablation may be a more cost effective option with lower adverse events.

Citation: Canakis A, Kahaleh M. Endoscopic palliation of malignant biliary obstruction. *World J Gastrointest Endosc* 2022; 14(10): 581-596
URL: https://www.wjgnet.com/1948-5190/full/v14/i10/581.htm
DOI: https://dx.doi.org/10.4253/wjge.v14.i10.581

INTRODUCTION

Palliation of unresectable malignant biliary obstruction is recommended to achieve biliary decompression and allow for symptomatic relief (*i.e.*, jaundice and pruritis). Minimally invasive endoscopic biliary drainage techniques have garnered significant attention as an effective patient friendly treatment option that can improve one's quality of life when comparing it to the more invasive nature of surgery and/or percutaneous transhepatic biliary drainage (PTBD) approaches. At the present, endoscopic retrograde cholangiopancreatography (ERCP) serves as the cornerstone of biliary decompression. However, in instances of failed or inaccessible cannulation endoscopic ultrasound guided biliary drainage techniques have emerged as second line options with comparable clinical outcomes. Furthermore, localized endobiliary ablative tools *via* photodynamic therapy and radiofrequency ablation have proven to be supplementary methods to palliate symptoms and optimize stent patency. As such this state-of-the-art review will shed light on palliative endoscopic modalities for the effective management of biliary drainage.

CONVENTIONAL ERCP

Malignant biliary obstruction can be categorized as a distal or hilar obstruction. This distinction is important as management options and outcomes differ. As such, the following two sections are subdivided to describe the ERCP approach in draining malignant distal biliary obstruction (MDBO) and malignant hilar biliary obstruction.

MDBO

MDBO represents a wide clinicopathologic spectrum of intrinsic and extrinsic bile duct compression arising within the pancreaticobiliary system. The most common etiologies are pancreatic adenocarcinoma and cholangiocarcinoma; in fact, up to 70% of patients with pancreatic cancer present with distal biliary obstruction[1,2]. Since the majority of patients are diagnosed at advance stages, management *via* palliative endoscopic decompression is increasingly encountered.

ERCP with transpapillary stenting is the gold standard for decompressing unresectable MDBO with a success rate of 90%-95%[3,4]. Palliative endoscopic biliary drainage is indicated as a means to treat cholangitis while providing symptomatic relief with improved quality of life measures[5,6]. As an established therapeutic modality for over 40 years, ERCP has emerged as a more effective and less invasive option compared to surgery and PTBD. While surgical bypass may decrease rates of recurrent jaundice, it is associated with a significant morbidity and mortality[2,7,8]. A meta-analysis of five randomized controlled trials (RCT) (379 patients) found that post-operative complications and 30 d mortality (16.3% *vs* 9.6%) were higher in surgical cohort[8]. In general many of these patients are poor operative candidates, whereby complications associated with surgical intervention can delay palliative chemotherapy options as well. Similarly, ERCP is often preferred over PTBD due to lower rates of adverse events, fewer re-interventions, decreased costs, shorter duration of hospital stay, and the lack of an external drain needed[4,6,9]. A large national database comparing 7445 ERCPs *vs* 1690 PTBD procedures at community and tertiary care centers associated lower adverse events with ERCP (8.6% *vs* 12.3%, $P < 0.001$) regardless of the centers PTBD volume of expertise[9]. There is also a risk of seeding metastasis with PTBD[10]. That being said, PTBD is typically used as rescue therapy in cases of ERCP failure (which we highlight later on the EUS-BD section).

Stent selection

In order to ensure long term stent patency, placing a self-expandable metal stents (SEMS) is a well-established and cost-effective approach for patients with a life expectancy greater than 3 mo[4,11,12]. The type of stents available include covered self-expandable metal stents (CSEMS) and uncovered self-expandable metal stents (USEMS). The optimal stent type remains uncertain due to varying RCTs with mixed results (Table 1)[13-21]. A recent meta-analysis of 11 randomized controlled trials involving 1272 patients (643 CSEMS and 629 USEMS) reported no significant difference in rates of recurrent biliary obstruction or mortality[22]. While there was a 32% risk reduction for stent failure and mortality favoring CSEMS, this possibly benefit was offset but higher rates of sludge formation and stent migration[22]. Another meta-analysis of 9 RCTs (1061 patients) found no difference in length of stent patency[23]. In terms of adverse events (including pancreatitis and cholecystitis), there appears to be no

Table 1 Covered versus uncovered self-expandable metal stents in malignant distal biliary obstruction

Ref.	Study design; country	Total number subjects	Number of SEMS Placed, CSEMS *vs* USEMS	Recurrent biliary obstruction; CSEMS *vs*USEMS, *n* (%)	Stent patency CSEMS *vs* USEMS, d	Procedure related adverse events, CSEMS *vs*USEMS, % (*n* = #)
Sakai *et al* [13], 2021	Multicenter randomized control trial; Japan	92	44 *vs* 48	10 (22.7%) *vs* 21 (43.8%), *P* = 0.0467	455 *vs* 301, *P* = 0.0112	6.8% (2 cholangitis, 1 cholecystitis) *vs* 8.3% (2 pancreatitis, 2 cholangitis), *P* = 0.549
Conio *et al* [14], 2018	Multicenter randomized control trial; Italy	158	78 *vs* 80	12 (16.7%) *vs* 10 (13.2%), *P* = 0.65	240 *vs* 541, *P* = 0.031	18% (6 cholangitis, 2 cholecystitis, 5 migrations) *vs* 7.9% (6 cholangitis), *P* = 0.061
Yang *et al* [15], 2015	Single center randomized control trial; South Korea	103	51 *vs* 52	17 (33.3%) *vs* 15 (28.8%), *P* = 0.623	395 *vs* 365, *P* = 0.467	17.6% (5 cholecystitis, 3 pancreatitis, 1 cholangitis) *vs* 9.6% (3 cholecystitis, 2 cholangitis), *P* = 0.378
Lee *et al* [16], 2013	Single center randomized control trial; South Korea	40	20 *vs* 20	10 (50%) *vs* 4 (20%), *P* = 0.047	207 *vs* 413, *P* = 0.041	5% (1 cholecystitis) *vs* 0%, NS
Lee *et al* [17], 2014	Retrospective, single center; USA	749	171 *vs* 578	33 (19%) *vs* 123 (21%), *P* < 0.001	468 *vs* 799, *P* = 0.61	8.2% (10 pancreatitis, 4 cholangitis) *vs* 6.4% (6 pancreatitis, 3 cholecystitis, 28 cholangitis), *P* = 0.20
Kitano *et al* [18], 2013	Multicenter randomized control trial; Japan	120	60 *vs* 60	14 (23%) *vs* 22 (36%), *P* = 0.08	583 *vs* 314, *P* = 0.019	3.3% (1 pancreatitis, 1 cholecystitis) *vs* 3.3% (2 cholecystitis), NS
Telford *et al*[19], 2010	Multicenter randomized control trial; Canada	129	68 *vs* 61	20 (29%) *vs* 11 (18%), NS	357 *vs* 711, *P* = 0.530	4.4% (3 cholecystitis) *vs* 6.6% (3 cholecystitis, 1 pancreatitis), *P* = 0.046
Kullman *et al*[20], 2010	Multicenter randomized control trial; Sweden	379	188 *vs* 191	47 (25%) *vs* 45 (24%), *P* > 0.50	154 *vs* 199, *P* = 0.326	7.5% (2 cholecystitis,3 pancreatitis, 8 cholangitis, 1 perforation) *vs* 10.5% (2 cholecystitis,4 pancreatitis, 12 cholangitis, 1 perforation, 1 hemorrhage), *P* = 0.370
Isayama *et al*[21], 2004	Single center randomized control trial; Japan	112	57 *vs* 55	8 (14%) *vs* 21 (38.2%), *P* < 0.001	304 *vs* 161, *P* < 0.05	12.3% (5 pancreatitis, 2 cholecystitis) *vs* 5.5% (1 pancreatitis, 2 hemorrhage), NS

NS: Not significant; USA: United States.

major differences based on stent type[23,24].

To combat tumor ingrowth and prolong stent patency, paclitaxel-incorporated drug eluting metal stents have been developed in South Korea. The stent is coated with membrane layers of polytetrafluoroethylene to prevent bile acid degradation and sodium caprate to enhance paclitaxel delivery[25]. A meta-analysis of 5 studies comparing drug eluting stents (197 patients) to SEMS (151 patients) reported a pooled stent patency of 168 d and 149 d, respectively[26]. There were no major differences in rates of cholangitis (17% *vs* 15%) or cholecystitis (6.5% *vs* 5.0%). Further studies are needed to determine if these drugs eluting stents can alter the management of MDBO. None of those stents have received FDA clearance so far.

Malignant hilar lesions

Malignant hilar obstruction poses its own set of unique challenges, especially since the endoscopic intervention is often technically challenging. In a large study analyzing 59437 ERCPs, successful outcomes and reduced adverse events were associated with high volume endoscopists and centers[27]. This highlights the importance of managing these patients in a high volume multidisciplinary center, as technical failure can significantly shorten the median length of survival compared to successful biliary drainage (8.7 mo *vs* 1.8 mo, *P* < 0.001) in type III and IV hilar cholangiocarcinoma[28].

Malignant hilar strictures can be categorized based on their extent of hilar and/or hepatic duct involvement *via* the Bismuth-Corlette classification system[29]. Since the majority of these strictures are inoperable with varying degrees of anatomical complexity, this classification can help guide the palliative approach for biliary decompression[30]. In general Bismuth grades I/II are amenable to ERCP, however grades III/IV are typically managed by a combination of ERCP and/or PTBD[4]. Choosing between ERCP and PTBD for types III/IV was analyzed in a meta-analysis of 9 studies (*n* = 546 patients) where there was a higher success rate seen with PTBD over ERCP in types III/IV with comparable rates of adverse events and 30 d mortality, unfortunately the skillset of the endoscopists involved in that study was not provided[31]. Another study of 110 patients with inoperable Bismuth type III/IV, found that failure of endoscopic stenting was associated with an acute angulation at the common bile duct and intrahepatic duct[32]. While pre-operative imaging may help guide an approach, PTBD can be technically challenging in the setting of liver metastases, ascites, and if intrahepatic bile duct is not fully dilated; thus, ERCP remains the preferred modality for drainage[33].

Choosing between the two modalities is based on multiple factors ranging from local expertise, risk of infection, possible seeding by PTBD, life expectancy, comorbidities and patient preference regarding an external catheter[31]. While there have been studies with mixed results favoring ERCP[34] and PTBD [35,36] the optimal stenting technique should be guided by achieving ≥ 50% of total liver volume drainage in order to relieve jaundice and reduce the risk of cholangitis[37]. Previously it was thought that draining 25% of liver volume was sufficient; however another study found that at least 50% drainage was a predictor of effective drainage and longer overall survival (199 d *vs* 59 d), especially in Bismuth type III strictures[38]. Another retrospective study of 78 patients with unresectable type II-IV hilar strictures found that effective liver volume drainage correlated with liver function: in which biliary drainage ≥ 33% can be obtained with preserved liver function and ≥ 50% with impaired liver function [39]. In addition to liver function, the anatomical difference in liver volume may also effect drainage, as the right lobe accounts for 55%-60% of volume, followed by 30%-35% in left and 10% of the caudate lobes[40,41]. Consequently, utilizing bilateral or multi-sectoral stenting is typically advised in high grade strictures based on varying anatomical involvement of disease[4].

Unilateral vs bilateral drainage

Choosing unilateral and/or bilateral stenting is typically based on the patient's presentation, degree of obstruction and local anatomy. Pre-endoscopic imaging is also imperative to understand and calculate the liver volume drainage needed. It is well established that one stent provides sufficient drainage in Bismuth I. However, for Bismuth II-IV there is no clear consensus.

A recent metanalysis of 21 studies with 1292 patients comparing both techniques noted similar rates of clinical efficacy and complications for both unilateral and bilateral drainage though there were higher rate of technical success in the unilateral group (97% *vs* 89%, $P = 0.003$)[42]. However, these results were not analyzed based on the bismuth classification or etiology of obstruction. A multitude of studies have compared unilateral *vs* bilateral drainage with similar rates of success[43-47]. One multicenter RCT of 133 patients with Bismuth grades II-IV reported no major differences in technical success, however the bilateral group had longer duration of stent patency (252 d *vs* 139 d) and fewer rates of reinterventions (42.5% *vs* 60.3%, $P = 0.049$)[43]. Similarly, a retrospective study of 141 patients found that bilateral drainage portended a longer survival advantage (255 d *vs* 80 d, $P < 0.0001$)[45]. Such advantages come at the expense of higher rates of complications and risk of death with bilateral drainage, irrespective of Bismuth grade[44].

Bilateral stenting techniques

In order to ensure adequate drainage, bilateral stenting techniques using a stent-by-stent (SBS) or stent-in-stent (SIS) have been utilized, though there is no clear consensus on what technique is superior due to limited data. Following deployment of the intrahepatic bile duct a second stent can be placed parallel using the SBS method or sequentially through the mesh within in the initial stent using the SIS approach [37]. These are technically challenging procedures that require high levels of experience with technical success rates ranging from 73% to 100%[33]. One retrospective comparing SIS ($n = 40$) to SBS ($n = 24$) reported similar rates of technical success (100% *vs* 96%), clinical success (93% *vs* 96%) and rates of recurrent biliary (48% *vs* 43%)[48]. Though there was a higher rate of post-procedural related pancreatitis exclusively seen in the SBS group[48]. At the same time another study found no significant difference in early (31.6% *vs* 22.7%) or late (36.8% *vs* 50.0%) complications for SBS *vs* SIS[49]. This was also demonstrated in a meta-analysis of 158 patients that found no significant difference in technical success, complications or stent occlusion[50]. Many centers prefer the SBS approach since deploying multiple stents is relatively easier and in cases of stent dysfunction reintervention is possible[33,51]. Reintervention with plastic stents placed inside SEMS is also possible after the SIS approach. Recently a newly designed Y-shaped bilateral endoscopic stent has been investigated, though further studies are needed to better define its role in clinical practice[52-54]. At our center we use the SBS approach preferentially.

ENDOSCOPIC ULTRASOUND GUIDED BILIARY DRAINAGE

Since its introduction in 2001, EUS-guided biliary drainage (EUS-BD) has emerged as an effective and reliable alternative for managing malignant biliary obstruction[55]. While ERCP remains the current gold standard, it is associated with a failure rate of up to 10%-especially in cases of surgically altered anatomy (SAA), tumor infiltration/obstruction, periampullary diverticulum, prior duodenal stenting or stenosis[4,56,57]. However, unsuccessful ERCPs may vary based on institutional experience. Two studies with extensive ERCP expertise reported unsuccessful canulation in 0.60% to 0.68% of patients [58,59]. Of note, one of those studies described 3 out of 524 failed ERCPS in native papillas with limited instances of SAA (*n* = 2) or duodenal obstruction (*n* = 3)[59]. On the other hand a large prospective study of 4561 patients from 66 hospitals (with varying degrees of expertise) found that 17.2% of ERCPs were unsuccessful[60]. The European guidelines recommend repeating ERCP in select patients, ideally two to four days after the first ERCP, with success rates up to 82%[4].

In instances of ERCP failure where salvage therapy is needed, PTBD has conventionally been pursued; however, as mentioned above it is associated with a significant morbidity, decreased quality of life and need for re-interventions. In this context EUS-BD emerged as another less invasive option with fewer procedure related adverse events (8.80% *vs* 31.22%, P = 0.022) and re-intervention rates (0.34 *vs* 0.93, P = 0.02) when compared with PTBD in a randomized open label study[61]. A meta-analysis with 483 patients confirmed these findings and found that while there was no difference in technical success, the EUS-BD group was associated with better clinical success, less reinterventions and fewer postprocedure adverse events[62].

EUS-BD is an appealing approach, though at the moment it is a specialized technique limited to a high-volume centers. In this regard understanding the associated learning curve is needed before its widespread applicability. A few studies have looked into this, and there appears to be a clear association with significantly decreased adverse events with increased operator procedural volume over time[10,63-67]. In a single center study with 215 procedures performed by one experienced endoscopist over a 6.6 year period, there was a notable decrease in adverse events as procedural volume increased each year[67]. Other studies have proposed that 33 and 100 cases were required to achieve technical proficiency and mastery, respectively[65,66].

The routes of biliary decompression can be accomplished through a rendezvous (RV), antegrade or transluminal (intra- or extrahepatic) approach[3]. The application of EUS-RV is limited to intact gastroduodenal anatomy, when conventional ERCP cannulation fails, in which a guidewire is accessed across the anastomosis in an antegrade fashion-this salvage approach is limited by a success rates of 74%-80% with a relatively high major adverse event rate of 11%[3]. Antegrade stenting has also fallen out of favor as it can be cumbersome with a limited technical success rate of 77%[3]. The puncture site (transgastric into left intrahepatic duct) allows for guidewire placement across the stricture/papilla without the need for fistula tract formation at the puncture site[68]. In instances of technical failure, antegrade stenting can be converted to transmural or PTBD[68]. Overall, direct transmural drainage is preferred *via* extrahepatic or intrahepatic approach.

Extrahepatic approach

EUS-guided choledochoduodenostomy (EUS-CDS) is a transluminal approach that creates a fistula between the duodenum and extrahepatic bile duct using a fully covered SEMS or lumen-apposing metal stents (LAMS)[68]. This biliodigestive anastomosis provides optimal palliation of MDBO; however it cannot be performed in cases of proximal obstruction or instances of gastric outlet obstruction where access to the duodenal bulb may be hindered[69]. A recent multicenter retrospective study compared EUS-CDS (*n* = 28) to PTBD (*n* = 58) and found that EUS-CDS was associated with higher clinical success (84.6% *vs* 62.1%, P = 0.04) with significantly lower rates of reintervention (10.7% *vs* 77.6%, P < 0.001)[70]. As a clinically effective technique (up to 96.2%), EUS-CDS has emerged as reliable alternative with acceptably low adverse events (10.5%)[71].

Recent studies have increasingly been using LAMS, which may be attributing to lower rates of stent malfunction. A large multicenter cohort in the United Kingdom and Ireland found that the technical success, clinical success, adverse events and reintervention rates using LAMS were 90.8%, 94.8%, 17.5%, and 8.3%, respectively[72]. Initially, plastic stents were used when EUS-CDS was first introduced. However, CSEMS quickly replaced plastic stents as a means to reduce bile leaks and stent occlusion[3] with significantly lower rates of adverse events (13.0% *vs* 42.8%, P = 0.01) and improved stent patency when compared to plastic stents[73-75]. At the moment the use of CSEMS *vs* LAMS varies from center to center. The large, tubular and rigid shape of CSEMS can theoretically increase the risk of stent migration [3]. In this context, LAMS were designed as a short, dumbbell shaped stents wit bilateral flanged ends which provide anti-migratory properties by anchoring across non-adherent lumens[3]. Further improvements were made with the development of an electrocautery-enhanced delivery system that enables a faster single step “free-hand” puncture which has led to high rates of technical success by eliminating the need for accessory changes[76]. However, two recent studies comparing LAMS *vs* SEMS found no differences in technical and clinical success or postprocedure related adverse events[77,78].

Intrahepatic approach

In instances of proximal malignant obstruction EUS-guided hepaticogastrostomy (EUS-HGS) creates a fistulized tract between the gastric wall and left intrahepatic duct. Its technical feasibility was first introduced in 2004 and since then it has become a widely used technique[79]. The European Society of Gastrointestinal Endoscopy recommends placement of partially or fully covered SEMS for drainage of malignant obstruction[68]. HGS can be performed where there is dilation of the left intrahepatic duct with segment III being the preferred puncture site[80]. There are a few contraindications to the procedure which include gastric wall tumor infiltration, large volume ascites, and coagulopathy[80,81]. Its role in hilar obstruction is reserved for specific cases as drainage from the left intrahepatic duct does not equate to drainage of a right sided obstruction[69]. A study described access from the proximal duodenum to right intrahepatic duct (hepaticoduodenostomy) for cases of isolated right sided obstruction (with a technical success 100% and clinical success 83%)[82], but widespread use of this technique has not been adopted due to difficulty with scope positioning and proper identification of the duct[83].

In general, this intrahepatic approach has been favored for distal malignant biliary drainage. The HGS route is associated with a lower risk of bile leakage as the localized liver parenchyma around the fistula site can provide a tamponade effect[73]. A prospective randomized trial comparing HGS (n = 24) and CDS (n = 24) in MDBO following failed ERCP reported a higher clinical success rate in the HGS group (91% *vs* 77%) at the expense of slightly more adverse event rates (20.0% *vs* 12.5%)[84]. A multitude of studies have compared CDS and HGS approaches (Table 2)[64,84-95]. A meta-analysis of 10 studies comparing HGS (n = 208) and CDS (n = 226) found no difference in technical success (94.1% *vs* 93.7%), clinical success (88.5% *vs* 84.5%), or rates of adverse events[96].

Recently, a large single center study of 215 patients (130 malignant lesions, 85 benign lesions) undergoing transhepatic biliary drainage by one endoscopist showed that the HGS approach used in up to 90% of cases was technical and clinically effective with few instances of reintervention (17.4%) needed within the malignant cohort that survived > 6 mo[67]. In this study, the endoscopist preferred HGS over CDS to decrease the risk of bleeding, stent misdeployment and potential making pancreatic surgical resection more difficult[67,97]. Of note, a study of 23 patients with concomitant duodenal and biliary obstruction undergoing single session EUS-HGS and gastrojejunostomy found that one patient with pancreatic cancer underwent successful pancreaticoduodenectomy 168 days post-biliary drainage and the fistula remained in situ with no complications[98]. On the other hand, in a large multicenter study comparing HGS (n = 24) to CDS (n = 23), the authors preferred CDS as it takes advantage of the anatomical proximity between the duodenal bulb and extrahepatic duct, by which puncture can be easier with shorter procedure times and less guidewire manipulation[85]. Another large international study of 182 patients (95 HGS, 87 CDS) suggested that CDS was associated with being 4.5 times more likely to achieve longer stent patency at the expense of higher adverse events, which may influence decisions based on patients survival[86]. In light of advancements with oncologic care, the prospect of reduced long reintervention may steer one to use CDS, especially since reintervention is easier due to shorter stent size, cannulation and steering in the duodenum[83].

While both techniques have acceptable outcomes, there is still no clear choice. Yet tailoring the technique based on anatomical features, altered anatomy, duodenal stenosis and dilated bile ducts may help endoscopists choose the right route for each patient[57,99]. A novel individualized algorithm was proposed based on patient anatomy following failed ERCP where the authors suggested using cross-sectional imaging to determine if an intrahepatic or extrahepatic approach based on the presence or absence of intra-hepatic biliary tree dilation[99]. The algorithm favored an intrahepatic approach if possible as a means to preserve anatomy. Yet, if intrahepatic dilation was technically unsuccessful, they recommended converting to an extrahepatic approach. In their prospective cohort of 52 patients, there was a technical success rate of 96% (35 intrahepatic, 17 extrahepatic).

COMPARING ERCP AND EUS-BD FOR MANAGEMENT OF MALIGNANT BILIARY OBSTRUCTION

As detailed above, ERCP remains the first choice when treating malignant biliary obstruction. Its widespread use and high success rate, especially in expert hands, makes it an effective modality for biliary decompression. The application of EUS-BD as a rescue therapy has proven to be a reliable tool with high technical and clinical success rates with moderate adverse event rates. Furthermore, instances of SAA or duodenal invasion may preclude the use of ERCP, and EUS-BD has gained momentum as the preferred therapy (as opposed to PTBD).

There is growing interest in using EUS-BD as a potential first line approach. A multicenter retrospective study comparing ERCP (n = 104) to EUS-BD (n = 104) demonstrated similar rates of technical success (94% *vs* 93%) and adverse events (8.65% *vs* 8.65%); though 4.8% of the ERCP cohort experienced post-procedural pancreatitis[100]. EUS-BD does have an added benefit of shorter procedural times with the possibility of longer stent patency by avoiding the diseased bile duct in question[3,101]. Additionally, in cases of an indwelling gastroduodenal stent, EUS-BD has been proven as a technical and clinically superior option when compared to endoscopic transpapillary stenting[102]. A recent meta-analysis of 9 studies with 634 patients found no significant differences between technical and clinical success, though the EUS-BD cohort had fewer rates of reintervention[103].

ABLATION THERAPY OF THE BILE DUCT

The goals of palliative biliary drainage aim to improve obstructive symptoms and quality of life. Yet endoscopic biliary decompression may only provide temporary relief; hence, the ability to provide

Table 2 Comparative studies of endoscopic ultrasound guided hepaticogastrostomy and choledochoduodenostomy

Ref.	Study design, Country	Number of HGS *vs* CDS	Technical success CDS *vs* HGS, %	Clinical success HGS *vs* CDS, %	Adverse events, HGS *vs* CDS, %
Tyberg *et al*[86], 2022	Multicenter,International	95 *vs* 87	92% *vs* 92%, NS	86% *vs* 100%, NS	21% *vs* 26%, *P* = 0.17
Minaga *et al*[85], 2019	Multicenter, Japan	24 *vs* 23	87.5% *vs* 82.6%, *P* = 0.028	100% *vs* 94.7%, *P* = 0.0475	28.6% *vs* 21%, *P* = 0.583
Cho *et al*[94], 2017	Single Center, Korea	21 *vs* 33	100% *vs* 100%, NS	86% *vs* 100%, *P* = 0.054	19% *vs* 15%, NS
Amano *et al*[93], 2017	Single Center, Japan	9 *vs* 11	100% *vs* 100%, NS	100% *vs* 100%, NS	11% *vs* 18%, NS
Ogura *et al*[92], 2016	Single Center, Japan	26 *vs* 13	100% *vs* 100%	92% *vs* 100%, *P* = 0.0497	8% *vs* 46%, *P* = 0.005
Guo *et al*[91], 2016	Single Center, China	7 *vs* 14	100% *vs* 100%, NS	100% *vs* 100%, NS	14% *vs* 14%, NS
Khashab *et al*[90], 2016	Multicenter,International	61 *vs* 60	92% *vs* 93%, *P* = 0.75	82% *vs* 85%, *P* = 0.64	20% *vs* 13%, *P* = 0.37
Artifon *et al*[84], 2015	Single Center, Brazil	24 *vs* 25	96% *vs* 91%	88% *vs* 70%	20% *vs* 13%
Poincloux *et al*[64], 2015	Single Center, France	66 *vs* 26	94% *vs* 96.7%, NS	93.8% *vs* 93.1%, NS	15% *vs* 7.6%, NS
Kawakubo *et al*[88], 2014	Multicenter, Japan	20 *vs* 44	95% *vs* 95%, NS	95% *vs* 93%, NS	4% *vs* 15%, NS
Park *et al*[89], 2015	Multicenter, Korea	20 *vs* 12	100% *vs* 92%, *P* > 0.99	90% *vs* 92%, *P* > 0.99	25% *vs* 33%, *P* = 0.044
Prachayakul and Aswakul[87], 2013	Single Center, Thailand	15 *vs* 6	93% *vs* 100%, NS	93% *vs* 100%, NS	0% *vs* 33%, NS
Kim *et al*[95], 2012	Single Center, Retrospective	13 (9 CDS; 4 HGS)	100% *vs* 75%, NS	100% *vs* 50%, NS	22% *vs* 50%, NS

NS: Not significant; HGS: Hepaticogastrostomy; CDS: Choledochoduodenostomy.

supplemental biliary ablation as means to induce local tumor necrosis, optimize stent patency, palliate symptoms and possibly enhance long term survival have been investigated with photodynamic therapy (PDT) and radiofrequency ablation (RFA)[104].

Photodynamic therapy

PDT utilizes a photosensitizing agent (which is activated by laser light) to ablate tumor tissue *via* apoptosis, necrosis, and an immunomodulatory effect[105]. The porphyrin phototoxic substance is given intravenously 3-4 d prior to the procedure to allow for preferential accumulation in the malignant tissue-during this period patients are advised to stay in a darkened room to avoid an accidental inflammatory reaction in normal tissue if exposed to light[106,107]. Next a guidewire and catheter position the fiberoptic probe in the bile duct where laser light at certain wavelengths (typically 630 nm) trigger the photosensitizing agent for 750 sec to generate free oxygen radicals that destroy the tumor bed and/or stricture[106,108,109]. An added benefit to this local apoptotic and inflammatory cascade is that these light waves can refract to the proximal biliary tree which are often beyond reach of the guidewire[110]. Following PDT, a stent is often placed. This highly specialized technique is limited to a few centers.

PDT has been shown to improve overall survival, stent patency and quality of life in unresectable cholangiocarcinoma. A sentinel PDT study in 2003 prospectively randomized 20 patients to PDT plus biliary stenting and 19 with stenting alone, and found that the PDT significantly increased the median survival (493 d *vs* 98 d) while also improving quality of life and biliary drainage[111]. Similar findings of improved survival were also confirmed in another randomized trial[112]. Another retrospective comparative study of 48 patients with unresectable cholangiocarcinoma (19 PDT with stent versus 29 with biliary stent only) demonstrated a significant survival advantage (16.2 mo *vs* 7.4 mo) with only three adverse events related to skin phototoxicity that were treated with topical therapy[113]. The survival benefit of PDT plus stenting has been confirmed in three meta-analyses[114-116]. Of note, while one of these studies reported an improved survival rate favoring the PDT cohort (525 *vs* 146), the analysis was limited by its inclusion of endoscopically and percutaneous administration of PDT and/or biliary stents[116]. That being said all studies favored PDT's improved survival benefit, with a relatively low adverse event rate of 11% specific to phototoxic reactions (*i.e.*, blisters, erythema, and pruritis)[115]. In order to avoid such a reaction, it is recommended that patients avoid direct sunlight for 4-6 wk after the procedure[104].

In light of these favorable findings, additional studies have been pursued to characterize the potential benefits of stent patency and effect of combination systematic therapy. A retrospective of 33 patients with unresectable disease found that the PDT cohort (*n* = 18) had noticeable longer periods of stent patency (224 d *vs* 177 d, *P* = 0.002) by which the authors felt that PDT may induce tumor "remodeling" to lessen cholestasis and prolong biliary decompression[117]. A synergistic effect between PDT and systematic chemotherapy has also been prospectively[118] and retrospectively confirmed to enhance overall survival[119,120]. In on such study, 96 patients with unresectable perihilar and distal CCA were stratified by treatment type where median overall survival was 20 mo, 15 mo, and 10 mo in the combination PDT plus chemotherapy (*n* = 36), PDT alone (*n* = 34), and chemotherapy alone (*n* = 26) groups, respectively[120].

These positive findings must also be analyzed in context of the limitations of PDT use. It is a complex and exceedingly expensive procedure that typically is only performed in highly specialized centers[2]. The phototoxic side effects may not acceptable to patients, especially since minimizing direct sunlight one month after the procedure could impair the quality of life in a patient with a potentially short life expectancy[110]. While the last author in this present review has pioneered early PDT studies, we feel that the lack of FDA approval of this therapy, in the biliary tree, has made this therapy very difficult to be offered outside of specialized centers.

Radiofrequency ablation therapy

RFA uses electromagnetic energy and high wave frequencies to deliver thermal energy to targeted tissues[121,122]. This localized thermal energy induces direct coagulative necrosis and an indirect localized inflammatory response and T-lymphocyte activation which have anti-tumor properties[110,122]. Intraductal RFA can be performed during a conventional ERCP where a RFA catheter can pass over the guidewire in order to place the bipolar probes upstream from the stricture site, whereby ablation is applied with 7-10 watts for 1-2 min bursts, along the length of the stricture[104,123]. Afterwards the bile duct is cleared with a balloon sweep to remove residual debris and necrotic tissue followed by placement of plastic or metal stent to maintain adequate drainge[104,123]. Of note, RFA can also be used with balloon enteroscopy-assisted ERCP[124] or an EUS-guided HGS approach[125,126].

The indication for endobiliary RFA is to improve stent patency and survival in cases of inoperable malignant strictures[106,123]. In 2011, a prospective pilot study analyzed the utility of RFA in 21 patients with unresectable malignant biliary obstruction, and found that biliary patency was maintained by 20 and 16 patients at 30 and 90 d, respectively with no adverse events related to RFA[127]. However, a subsequent single center retrospective study of 66 patients demonstrated no added benefit in prolonged stent patency when comparing metal stenting with RFA to stenting alone[128]. Of note, this study did not differentiate their findings based on the stent used. Another study found a significant improvement and durability of stricture diameter using plastic (*n* = 6) and metal stents (*n* = 14)[129]. As such, analyzing endobiliary RFA according to the type of stent used may allow for a better interpretation of stent patency; as etiology of recurrent biliary obstruction varies from sludge formation, migration and tumor ingrowth for plastic stents, covered SEMS and uncovered SEMS, respectively[123,130].

Plastic stents are often used if repeated RFA sessions are planned. Two recent RCTs have examined the stent patency of RFA and plastic stents with conflicting results[131,132]. In one study, of 65 patients (32 RFA plus plastic stent, 33 plastic stent alone), stent patency was significantly longer (6.8 mo *vs* 3.4 mo) with a higher survival time (13.2 mo *vs* 8.3 mo) favoring the RFA and plastic stent arm[133]. While the other RCT also reported a higher survival time (14.3 mo *vs* 9.2 mo) there was no significant difference in stent patency or jaundice control in either group[134]. One possible reason for the discrepancy is that in the first RCT by Yang *et al*[133] patients underwent stent exchange every 3 mo, while the study by Gao *et al*[134] only performed a stent exchange as clinical indicated. In our practice we offer systematic stents revision at three months interval.

The use of SEMS is largely depending on the patient's life expectancy and unresectability. Both uncovered and covered SEMS have been investigated with mixed results[131,132,135]. A retrospective [131] and RCT[132] examining USEMS, found no significant differences in stent patency. Meanwhile, a single center retrospective study using UCSEMS and CSEMS in a cohort of 31 patients favored the use of either stent with RFA with prolonged stent patency (220.0 d *vs* 106.5 d)[135]. One meta-analysis of nine studies with 505 patients demonstrated a favorable mean stent patency of 50.6 d with improved survival in those undergoing RFA with SEMS compared to SEMS alone[136]. However, these findings should be interpreted with caution as four of these studies used a percutaneous route for RFA. In this context, another meta-analysis of 263 patients undergoing endoscopic RFA showed that strictures improved by 3.5 mm when using RFA with a median stent patency of 7.6 mo[137]. Yet, the authors did not stratify their findings based on the type of stent used.

While the findings of stent patency and survival benefit are confounded by study heterogeneity and route of RFA, there is a likely benefit of stent patency and overall survival with RFA in malignant biliary obstruction. In fact a recent RCT found that a combination of oral 5-fluoouracil and RFA improved the median overall survival (16 mo *vs* 11 mo) and period of stent patency (6.6 mo *vs* 5.6 mo)[138]. With more wide spread use, developments of newly automatic temperature controlled RFA systems[139] and endoluminal devices[140] have produced favorable results pertaining to both stent patency and survival. Interestingly, RFA appears to be a relatively safe procedure with few instances of cholecystitis (10%), cholangitis (6.2%), and pancreatitis (2.1%) that did no differ significantly when compared to stenting alone[107,136].

Table 3 Comparing Photodynamic therapy to endobiliary radiofrequency ablation

Treatment type	Mechanism	Adverse events	Pros	Cons
Photodynamic therapy	Photosensitizing agent is given intravenously 3-4 d prior to accumulate in tissue; then, a fiberoptic probe is introduced to transmit laser light (approximately 630 nm)-apoptosis, necrosis, and immunomodulatory effect	Phototoxicity, erythema, pruritus, blistering, and diffuse pain	Light waves can refract to the proximal biliary tree, beyond the reach of the guidewire	Expensive; highly specialized equipment needed; decreased quality of life (avoid direct sunlight 4-6 wk after treatment); limited to high specialized centers; lack of FDA approval
Endobiliary radiofrequency ablation	High frequency electromagnetic energy-cell death *via* thermal energy, coagulative necrosis, and indirect anti-tumor lymphocyte activation	Pancreatitis, cholecystitis, cholangitis hemobilia, abdominal pain	Widely available	Lack of standardization; potentially need > 1 session; can only be performed under fluoroscopy

Only a handful of studies have directly compared RFA to PDT (Table 3). One retrospective study found no statistically significant difference in the survival benefit between RFA (*n* = 16) and PDT (*n* = 32) in their cohort of unresectable cholangiocarcinoma (9.6 mo *vs* 7.5 mo)[141]. However, the other retrospective study showed that RFA was associated with better short-term effects (*i.e.*, reduction in bilirubin with fewer unplanned stent replacements)[142]. A recent meta-analysis of 55 studies comparing PDT (*n* = 1149), RFA (*n* = 545), and stent-only strategy (*n* = 452) found that PDT was associated with an improved overall survival rate (11.9 mo *vs* 8.1 mo *vs* 6.7 mo, respectively) and decreased 30-d mortality (3.3% *vs* 7.0% *vs* 4.9%, respectively)[143]. Though PDT did display higher rates of cholangitis (23.4% *vs* 9.5%) and liver abscess (4.9% *vs* 2.6%) when compared to RFA. The authors felt that RFA may be favored in the setting of lower adverse events, decreased costs (Photofrin dose $37000 *vs* RFA catheter $1200) and similar lengths of stent patency (PDT 6.1 mo *vs* RFA 5.5 mo).

CONCLUSION

In conclusion, the optimal palliation of malignant obstruction remains a challenging task for endoscopists and requires a dedicated team able to offer a variety of intervention based on patient presentation, symptoms and expected survival.

FOOTNOTES

Author contributions: Canakis A was responsible of drafting and reference editing; Kahaleh M was responsible for concept, final drafting, and final approval of manuscript.

Conflict-of-interest statement: Dr. Kahaleh is a consultant for Boston Scientific, Medtronic and Abvvie, he has received research grant from Boston Scientific, Apollo, Olympus, Cook, Microtech and Fuji; Dr Canakis has no disclose.

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S-Editor: Chen YL
L-Editor: A
P-Editor: Chen YL

REFERENCES

1 **Hidalgo M**. Pancreatic cancer. *N Engl J Med* 2010; **362**: 1605-1617 [PMID: 20427809 DOI: 10.1056/NEJMra0901557]

2 **Fernandez Y Viesca M**, Arvanitakis M. Early Diagnosis And Management Of Malignant Distal Biliary Obstruction: A Review On Current Recommendations And Guidelines. *Clin Exp Gastroenterol* 2019; **12**: 415-432 [PMID: 31807048 DOI: 10.2147/CEG.S195714]

3 **Canakis A**, Baron TH. Relief of biliary obstruction: choosing between endoscopic ultrasound and endoscopic retrograde cholangiopancreatography. *BMJ Open Gastroenterol* 2020; **7** [PMID: 32727716 DOI: 10.1136/bmjgast-2020-000428]

4 **Dumonceau JM**, Tringali A, Papanikolaou IS, Blero D, Mangiavillano B, Schmidt A, Vanbiervliet G, Costamagna G, Devière J, García-Cano J, Gyökeres T, Hassan C, Prat F, Siersema PD, van Hooft JE. Endoscopic biliary stenting: indications, choice of stents, and results: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline - Updated October 2017. *Endoscopy* 2018; **50**: 910-930 [PMID: 30086596 DOI: 10.1055/a-0659-9864]

5 **Abraham NS**, Barkun JS, Barkun AN. Palliation of malignant biliary obstruction: a prospective trial examining impact on quality of life. *Gastrointest Endosc* 2002; **56**: 835-841 [PMID: 12447294 DOI: 10.1067/mge.2002.129868]

6 **Nakai Y**, Isayama H, Wang HP, Rerknimitr R, Khor C, Yasuda I, Kogure H, Moon JH, Lau J, Lakhtakia S, Ratanachu-Ek T, Seo DW, Lee DK, Makmun D, Dy F, Liao WC, Draganov PV, Almadi M, Irisawa A, Katanuma A, Kitano M, Ryozawa S, Fujisawa T, Wallace MB, Itoi T, Devereaux B. International consensus statements for endoscopic management of distal biliary stricture. *J Gastroenterol Hepatol* 2020; **35**: 967-979 [PMID: 31802537 DOI: 10.1111/jgh.14955]

7 **Distler M**, Kersting S, Rückert F, Dobrowolski F, Miehlke S, Grützmann R, Saeger H-D. Palliative treatment of obstructive jaundice in patients with carcinoma of the pancreatic head or distal biliary tree. Endoscopic stent placement vs. hepaticojejunostomy. *JOP J Pancreas* 2010; **11**: 568-574

8 **Lima SLA de**, Bustamante FAC, Moura EGH de, Marques WB, Artifon EL de A, Chaves DM, Franzini TAP, Junior CKF. Endoscopic palliative treatment vs surgical bypass in malignant low bile duct obstruction: A systematic review and meta-analysis. *Int J Hepatobiliary Pancreat Dis IJHPD* 2015; **5**: 35-45 [DOI: 10.5348/ijhpd-2015-32-CR-7]

9 **Inamdar S**, Slattery E, Bhalla R, Sejpal DV, Trindade AJ. Comparison of Adverse Events for Endoscopic vs Percutaneous Biliary Drainage in the Treatment of Malignant Biliary Tract Obstruction in an Inpatient National Cohort. *JAMA Oncol* 2016; **2**: 112-117 [PMID: 26513013 DOI: 10.1001/jamaoncol.2015.3670]

10 **Wang L**, Lin N, Xin F, Ke Q, Zeng Y, Liu J. A systematic review of the comparison of the incidence of seeding metastasis between endoscopic biliary drainage and percutaneous transhepatic biliary drainage for resectable malignant biliary obstruction. *World J Surg Oncol* 2019; **17**: 116 [PMID: 31277666 DOI: 10.1186/s12957-019-1656-y]

11 **Isayama H**, Yasuda I, Ryozawa S, Maguchi H, Igarashi Y, Matsuyama Y, Katanuma A, Hasebe O, Irisawa A, Itoi T, Mukai H, Arisaka Y, Okushima K, Uno K, Kida M, Tamada K. Results of a Japanese multicenter, randomized trial of endoscopic stenting for non-resectable pancreatic head cancer (JM-test): Covered Wallstent versus DoubleLayer stent. *Dig Endosc* 2011; **23**: 310-315 [PMID: 21951091 DOI: 10.1111/j.1443-1661.2011.01124.x]

12 **Prat F**, Chapat O, Ducot B, Ponchon T, Pelletier G, Fritsch J, Choury AD, Buffet C. A randomized trial of endoscopic drainage methods for inoperable malignant strictures of the common bile duct. *Gastrointest Endosc* 1998; **47**: 1-7 [PMID: 9468416 DOI: 10.1016/s0016-5107(98)70291-3]

13 **Sakai Y**, Sugiyama H, Kawaguchi Y, Kawashima Y, Hirata N, Nakaji S, Natsui M, Shioji K, Nakahara K, Tsuyuguchi T, Kato N. Uncovered versus covered metallic stents for the management of unresectable malignant distal biliary obstruction: a randomized multicenter trial. *Scand J Gastroenterol* 2021; **56**: 1229-1235 [PMID: 34375164 DOI: 10.1080/00365521.2021.1938207]

14 **Conio M**, Mangiavillano B, Caruso A, Filiberti RA, Baron TH, De Luca L, Signorelli S, Crespi M, Marini M, Ravelli P, Conigliaro R, De Ceglie A. Covered versus uncovered self-expandable metal stent for palliation of primary malignant extrahepatic biliary strictures: a randomized multicenter study. *Gastrointest Endosc* 2018; **88**: 283-291.e3 [PMID: 29653120 DOI: 10.1016/j.gie.2018.03.029]

15 **Yang MJ**, Kim JH, Yoo BM, Hwang JC, Yoo JH, Lee KS, Kang JK, Kim SS, Lim SG, Shin SJ, Cheong JY, Lee KM, Lee KJ, Cho SW. Partially covered versus uncovered self-expandable nitinol stents with anti-migration properties for the palliation of malignant distal biliary obstruction: A randomized controlled trial. *Scand J Gastroenterol* 2015; **50**: 1490-1499 [PMID: 26133200 DOI: 10.3109/00365521.2015.1057219]

16 **Lee JH**, Krishna SG, Singh A, Ladha HS, Slack RS, Ramireddy S, Raju GS, Davila M, Ross WA. Comparison of the utility of covered metal stents versus uncovered metal stents in the management of malignant biliary strictures in 749 patients. *Gastrointest Endosc* 2013; **78**: 312-324 [PMID: 23591331 DOI: 10.1016/j.gie.2013.02.032]

17 **Lee SJ**, Kim MD, Lee MS, Kim IJ, Park SI, Won JY, Lee DY. Comparison of the efficacy of covered versus uncovered metallic stents in treating inoperable malignant common bile duct obstruction: a randomized trial. *J Vasc Interv Radiol* 2014; **25**: 1912-1920 [PMID: 25085230 DOI: 10.1016/j.jvir.2014.05.021]

18 **Kitano M**, Yamashita Y, Tanaka K, Konishi H, Yazumi S, Nakai Y, Nishiyama O, Uehara H, Mitoro A, Sanuki T, Takaoka M, Koshitani T, Arisaka Y, Shiba M, Hoki N, Sato H, Sasaki Y, Sato M, Hasegawa K, Kawabata H, Okabe Y, Mukai H. Covered self-expandable metal stents with an anti-migration system improve patency duration without increased complications compared with uncovered stents for distal biliary obstruction caused by pancreatic carcinoma: a randomized multicenter trial. *Am J Gastroenterol* 2013; **108**: 1713-1722 [PMID: 24042190 DOI: 10.1038/ajg.2013.305]

19 **Telford JJ**, Carr-Locke DL, Baron TH, Poneros JM, Bounds BC, Kelsey PB, Schapiro RH, Huang CS, Lichtenstein DR, Jacobson BC, Saltzman JR, Thompson CC, Forcione DG, Gostout CJ, Brugge WR. A randomized trial comparing uncovered and partially covered self-expandable metal stents in the palliation of distal malignant biliary obstruction. *Gastrointest Endosc* 2010; **72**: 907-914 [PMID: 21034891 DOI: 10.1016/j.gie.2010.08.021]

20 **Kullman E**, Frozanpor F, Söderlund C, Linder S, Sandström P, Lindhoff-Larsson A, Toth E, Lindell G, Jonas E, Freedman J, Ljungman M, Rudberg C, Ohlin B, Zacharias R, Leijonmarck CE, Teder K, Ringman A, Persson G, Gözen M, Eriksson O. Covered versus uncovered self-expandable nitinol stents in the palliative treatment of malignant distal biliary obstruction: results from a randomized, multicenter study. *Gastrointest Endosc* 2010; **72**: 915-923 [PMID:

21034892 DOI: 10.1016/j.gie.2010.07.036]

21 **Isayama H**, Komatsu Y, Tsujino T, Sasahira N, Hirano K, Toda N, Nakai Y, Yamamoto N, Tada M, Yoshida H, Shiratori Y, Kawabe T, Omata M. A prospective randomised study of "covered" versus "uncovered" diamond stents for the management of distal malignant biliary obstruction. *Gut* 2004; **53**: 729-734 [PMID: 15082593 DOI: 10.1136/gut.2003.018945]

22 **Tringali A**, Hassan C, Rota M, Rossi M, Mutignani M, Aabakken L. Covered vs. uncovered self-expandable metal stents for malignant distal biliary strictures: a systematic review and meta-analysis. *Endoscopy* 2018; **50**: 631-641 [PMID: 29342491 DOI: 10.1055/s-0043-125062]

23 **Almadi MA**, Barkun A, Martel M. Plastic vs. Self-Expandable Metal Stents for Palliation in Malignant Biliary Obstruction: A Series of Meta-Analyses. *Am J Gastroenterol* 2017; **112**: 260-273 [PMID: 27845340 DOI: 10.1038/ajg.2016.512]

24 **Li J**, Li T, Sun P, Yu Q, Wang K, Chang W, Song Z, Zheng Q. Covered vs Uncovered Self-Expandable Metal Stents for Managing Malignant Distal Biliary Obstruction: A Meta-Analysis. *PLOS ONE* 2016; **11**: e0149066 [DOI: 10.1371/journal.pone.0149066]

25 **Jang SI**, Lee KT, Choi JS, Jeong S, Lee DH, Kim YT, Lee SH, Yu JS, Lee DK. Efficacy of a paclitaxel-eluting biliary metal stent with sodium caprate in malignant biliary obstruction: a prospective randomized comparative study. *Endoscopy* 2019; **51**: 843-851 [PMID: 30414164 DOI: 10.1055/a-0754-5763]

26 **Mohan BP**, Canakis A, Khan SR, Chandan S, Ponnada S, McDonough S, Adler DG. Drug Eluting Versus Covered Metal Stents in Malignant Biliary Strictures-Is There a Clinical Benefit? *J Clin Gastroenterol* 2021; **55**: 271-277 [PMID: 32554989 DOI: 10.1097/MCG.0000000000001377]

27 **Keswani RN**, Qumseya BJ, O'Dwyer LC, Wani S. Association Between Endoscopist and Center Endoscopic Retrograde Cholangiopancreatography Volume With Procedure Success and Adverse Outcomes: A Systematic Review and Meta-analysis. *Clin Gastroenterol Hepatol* 2017; **15**: 1866-1875.e3 [PMID: 28606848 DOI: 10.1016/j.cgh.2017.06.002]

28 **Paik WH**, Park YS, Hwang JH, Lee SH, Yoon CJ, Kang SG, Lee JK, Ryu JK, Kim YT, Yoon YB. Palliative treatment with self-expandable metallic stents in patients with advanced type III or IV hilar cholangiocarcinoma: a percutaneous versus endoscopic approach. *Gastrointest Endosc* 2009; **69**: 55-62 [PMID: 18657806 DOI: 10.1016/j.gie.2008.04.005]

29 **Bismuth H**, Corlette MB. Intrahepatic cholangioenteric anastomosis in carcinoma of the hilus of the liver. *Surg Gynecol Obstet* 1975; **140**: 170-178 [PMID: 1079096]

30 **Perez-Miranda M**. Combined ERCP and transhepatic endoscopic ultrasound-guided stent placement for biliary drainage in malignant hilar obstruction: not too good to be true. *Endoscopy* 2021; **53**: 63-64 [PMID: 33333568 DOI: 10.1055/a-1296-8207]

31 **Moole H**, Dharmapuri S, Duvvuri A, Boddireddy R, Moole V, Yedama P, Bondalapati N, Uppu A, Yerasi C. Endoscopic versus Percutaneous Biliary Drainage in Palliation of Advanced Malignant Hilar Obstruction: A Meta-Analysis and Systematic Review. *Can J Gastroenterol Hepatol* 2016; **2016**: 4726078 [PMID: 27648439 DOI: 10.1155/2016/4726078]

32 **Jang SI**, Hwang JH, Lee KH, Yu JS, Kim HW, Yoon CJ, Lee YS, Paik KH, Lee SH, Lee DK. Percutaneous biliary approach as a successful rescue procedure after failed endoscopic therapy for drainage in advanced hilar tumors. *J Gastroenterol Hepatol* 2017; **32**: 932-938 [PMID: 27665310 DOI: 10.1111/jgh.13602]

33 **Lee TH**, Moon JH, Park SH. Biliary stenting for hilar malignant biliary obstruction. *Dig Endosc* 2020; **32**: 275-286 [PMID: 31578770 DOI: 10.1111/den.13549]

34 **Choi J**, Ryu JK, Lee SH, Ahn DW, Hwang JH, Kim YT, Yoon YB, Han JK. Biliary drainage for obstructive jaundice caused by unresectable hepatocellular carcinoma: the endoscopic versus percutaneous approach. *Hepatobiliary Pancreat Dis Int* 2012; **11**: 636-642 [PMID: 23232636 DOI: 10.1016/s1499-3872(12)60237-9]

35 **Kloek JJ**, van der Gaag NA, Aziz Y, Rauws EA, van Delden OM, Lameris JS, Busch OR, Gouma DJ, van Gulik TM. Endoscopic and percutaneous preoperative biliary drainage in patients with suspected hilar cholangiocarcinoma. *J Gastrointest Surg* 2010; **14**: 119-125 [PMID: 19756881 DOI: 10.1007/s11605-009-1009-1]

36 **Lee SH**, Park JK, Yoon WJ, Lee JK, Ryu JK, Yoon YB, Kim YT. Optimal biliary drainage for inoperable Klatskin's tumor based on Bismuth type. *World J Gastroenterol* 2007; **13**: 3948-3955 [PMID: 17663508 DOI: 10.3748/wjg.v13.i29.3948]

37 **Rerknimitr R**, Angsuwatcharakon P, Ratanachu-ek T, Khor CJL, Ponnudurai R, Moon JH, Seo DW, Pantongrag-Brown L, Sangchan A, Pisespongsa P, Akaraviputh T, Reddy ND, Maydeo A, Itoi T, Pausawasdi N, Punamiya S, Attasaranya S, Devereaux B, Ramchandani M, Goh K-L. Asia-Pacific consensus recommendations for endoscopic and interventional management of hilar cholangiocarcinoma. *J Gastroenterol Hepatol* 2013; **28**: 593-607 [DOI: 10.1111/jgh.12128]

38 **Vienne A**, Hobeika E, Gouya H, Lapidus N, Fritsch J, Choury AD, Chryssostalis A, Gaudric M, Pelletier G, Buffet C, Chaussade S, Prat F. Prediction of drainage effectiveness during endoscopic stenting of malignant hilar strictures: the role of liver volume assessment. *Gastrointest Endosc* 2010; **72**: 728-735 [PMID: 20883850 DOI: 10.1016/j.gie.2010.06.040]

39 **Takahashi E**, Fukasawa M, Sato T, Takano S, Kadokura M, Shindo H, Yokota Y, Enomoto N. Biliary drainage strategy of unresectable malignant hilar strictures by computed tomography volumetry. *World J Gastroenterol* 2015; **21**: 4946-4953 [PMID: 25945008 DOI: 10.3748/wjg.v21.i16.4946]

40 **Wang CC**, Yang TW, Sung WW, Tsai MC. Current Endoscopic Management of Malignant Biliary Stricture. *Medicina (Kaunas)* 2020; **56** [PMID: 32151099 DOI: 10.3390/medicina56030114]

41 **Bismuth H**. Surgical anatomy and anatomical surgery of the liver. *World J Surg* 1982; **6**: 3-9 [PMID: 7090393 DOI: 10.1007/BF01656368]

42 **Aghaie Meybodi M**, Shakoor D, Nanavati J, Ichkhanian Y, Vosoughi K, Brewer Gutierrez OI, Kalloo AN, Singh V, Kumbhari V, Ngamruengphong S, Khashab MA. Unilateral versus bilateral endoscopic stenting in patients with unresectable malignant hilar obstruction: a systematic review and meta-analysis. *Endosc Int Open* 2020; **8**: E281-E290 [PMID: 32118102 DOI: 10.1055/a-1067-4326]

43 **Lee TH**, Kim TH, Moon JH, Lee SH, Choi HJ, Hwangbo Y, Hyun JJ, Choi JH, Jeong S, Kim JH, Park DH, Han JH, Park SH. Bilateral versus unilateral placement of metal stents for inoperable high-grade malignant hilar biliary strictures: a multicenter, prospective, randomized study (with video). *Gastrointest Endosc* 2017; **86**: 817-827 [PMID: 28479493 DOI:

10.1016/j.gie.2017.04.037]
44 **Staub J**, Siddiqui A, Murphy M, Lam R, Parikh M, Pleskow D, Papachristou G, Sharaiha R, Iqbal U, Loren D, Kowalski T, Noor A, Mumtaz T, Yasuda I, Thomas S, Hsaeeb A, Herrick J, Greene T, Adler DG. Unilateral versus bilateral hilar stents for the treatment of cholangiocarcinoma: a multicenter international study. *Ann Gastroenterol* 2020; **33**: 202-209 [PMID: 32127742 DOI: 10.20524/aog.2020.0451]
45 **Chang WH**, Kortan P, Haber GB. Outcome in patients with bifurcation tumors who undergo unilateral versus bilateral hepatic duct drainage. *Gastrointest Endosc* 1998; **47**: 354-362 [PMID: 9609426 DOI: 10.1016/s0016-5107(98)70218-4]
46 **Naitoh I**, Ohara H, Nakazawa T, Ando T, Hayashi K, Okumura F, Okayama Y, Sano H, Kitajima Y, Hirai M, Ban T, Miyabe K, Ueno K, Yamashita H, Joh T. Unilateral versus bilateral endoscopic metal stenting for malignant hilar biliary obstruction. *J Gastroenterol Hepatol* 2009; **24**: 552-557 [PMID: 19220678 DOI: 10.1111/j.1440-1746.2008.05750.x]
47 **Chang G**, Xia FF, Li HF, Niu S, Xu YS. Unilateral versus bilateral stent insertion for malignant hilar biliary obstruction. *Abdom Radiol (NY)* 2017; **42**: 2745-2751 [PMID: 28477177 DOI: 10.1007/s00261-017-1174-8]
48 **Ishigaki K**, Hamada T, Nakai Y, Isayama H, Sato T, Hakuta R, Saito K, Saito T, Takahara N, Mizuno S, Kogure H, Ito Y, Yagioka H, Matsubara S, Akiyama D, Mohri D, Tada M, Koike K. Retrospective Comparative Study of Side-by-Side and Stent-in-Stent Metal Stent Placement for Hilar Malignant Biliary Obstruction. *Dig Dis Sci* 2020; **65**: 3710-3718 [PMID: 32107675 DOI: 10.1007/s10620-020-06155-z]
49 **Kim KM**, Lee KH, Chung YH, Shin JU, Lee JK, Lee KT, Shim SG. A comparison of bilateral stenting methods for malignant hilar biliary obstruction. *Hepatogastroenterology* 2012; **59**: 341-346 [PMID: 22353496 DOI: 10.5754/hge11533]
50 **Hong W**, Chen S, Zhu Q, Chen H, Pan J, Huang Q. Bilateral stenting methods for hilar biliary obstructions. *Clinics (Sao Paulo)* 2014; **69**: 647-652 [PMID: 25318098 DOI: 10.6061/clinics/2014(09)12]
51 **Boškoski I**, Schepis T, Tringali A, Familiari P, Bove V, Attili F, Landi R, Perri V, Costamagna G. Personalized Endoscopy in Complex Malignant Hilar Biliary Strictures. *J Pers Med* 2021; **11** [PMID: 33572913 DOI: 10.3390/jpm11020078]
52 **Hwang JC**, Kim JH, Lim SG, Kim SS, Yoo BM, Cho SW. Y-shaped endoscopic bilateral metal stent placement for malignant hilar biliary obstruction: prospective long-term study. *Scand J Gastroenterol* 2011; **46**: 326-332 [PMID: 21082874 DOI: 10.3109/00365521.2010.536253]
53 **Kogure H**, Isayama H, Nakai Y, Tsujino T, Ito Y, Yamamoto K, Mizuno S, Yagioka H, Kawakubo K, Sasaki T, Hirano K, Sasahira N, Tada M, Omata M, Koike K. Newly designed large cell Niti-S stent for malignant hilar biliary obstruction: a pilot study. *Surg Endosc* 2011; **25**: 463-467 [PMID: 20602139 DOI: 10.1007/s00464-010-1194-8]
54 **Lee JH**, Kang DH, Kim JY, Lee SM, Kim DH, Park CW, Cho HS, Kim GH, Kim TO, Heo J, Song GA, Cho M, Kim S, Kim CW, Lee JW. Endoscopic bilateral metal stent placement for advanced hilar cholangiocarcinoma: a pilot study of a newly designed Y stent. *Gastrointest Endosc* 2007; **66**: 364-369 [PMID: 17643714 DOI: 10.1016/j.gie.2006.12.061]
55 **Giovannini M**, Moutardier V, Pesenti C, Bories E, Lelong B, Delpero JR. Endoscopic ultrasound-guided bilioduodenal anastomosis: a new technique for biliary drainage. *Endoscopy* 2001; **33**: 898-900 [PMID: 11571690 DOI: 10.1055/s-2001-17324]
56 **Mukai S**, Itoi T, Baron TH, Takada T, Strasberg SM, Pitt HA, Ukai T, Shikata S, Teoh AYB, Kim MH, Kiriyama S, Mori Y, Miura F, Chen MF, Lau WY, Wada K, Supe AN, Giménez ME, Yoshida M, Mayumi T, Hirata K, Sumiyama Y, Inui K, Yamamoto M. Indications and techniques of biliary drainage for acute cholangitis in updated Tokyo Guidelines 2018. *J Hepatobiliary Pancreat Sci* 2017; **24**: 537-549 [PMID: 28834389 DOI: 10.1002/jhbp.496]
57 **Teoh AYB**, Dhir V, Kida M, Yasuda I, Jin ZD, Seo DW, Almadi M, Ang TL, Hara K, Hilmi I, Itoi T, Lakhtakia S, Matsuda K, Pausawasdi N, Puri R, Tang RS, Wang HP, Yang AM, Hawes R, Varadarajulu S, Yasuda K, Ho LKY. Consensus guidelines on the optimal management in interventional EUS procedures: results from the Asian EUS group RAND/UCLA expert panel. *Gut* 2018; **67**: 1209-1228 [PMID: 29463614 DOI: 10.1136/gutjnl-2017-314341]
58 **Ardengh JC**, Lopes CV, Kemp R, Dos Santos JS. Different options of endosonography-guided biliary drainage after endoscopic retrograde cholangio-pancreatography failure. *World J Gastrointest Endosc* 2018; **10**: 99-108 [PMID: 29774089 DOI: 10.4253/wjge.v10.i5.99]
59 **Holt BA**, Hawes R, Hasan M, Canipe A, Tharian B, Navaneethan U, Varadarajulu S. Biliary drainage: role of EUS guidance. *Gastrointest Endosc* 2016; **83**: 160-165 [PMID: 26215648 DOI: 10.1016/j.gie.2015.06.019]
60 **Williams EJ**, Ogollah R, Thomas P, Logan RF, Martin D, Wilkinson ML, Lombard M. What predicts failed cannulation and therapy at ERCP? *Endoscopy* 2012; **44**: 674-683 [PMID: 22696192 DOI: 10.1055/s-0032-1309345]
61 **Lee TH**, Choi JH, Park do H, Song TJ, Kim DU, Paik WH, Hwangbo Y, Lee SS, Seo DW, Lee SK, Kim MH. Similar Efficacies of Endoscopic Ultrasound-guided Transmural and Percutaneous Drainage for Malignant Distal Biliary Obstruction. *Clin Gastroenterol Hepatol* 2016; **14**: 1011-1019.e3 [PMID: 26748220 DOI: 10.1016/j.cgh.2015.12.032]
62 **Sharaiha RZ**, Khan MA, Kamal F, Tyberg A, Tombazzi CR, Ali B, Tombazzi C, Kahaleh M. Efficacy and safety of EUS-guided biliary drainage in comparison with percutaneous biliary drainage when ERCP fails: a systematic review and meta-analysis. *Gastrointest Endosc* 2017; **85**: 904-914 [PMID: 28063840 DOI: 10.1016/j.gie.2016.12.023]
63 **Attasaranya S**, Netinasunton N, Jongboonyanuparp T, Sottisuporn J, Witeerungrot T, Pirathvisuth T, Ovartlarnporn B. The Spectrum of Endoscopic Ultrasound Intervention in Biliary Diseases: A Single Center's Experience in 31 Cases. *Gastroenterol Res Pract* 2012; **2012**: 680753 [PMID: 22654900 DOI: 10.1155/2012/680753]
64 **Poincloux L**, Rouquette O, Buc E, Privat J, Pezet D, Dapoigny M, Bommelaer G, Abergel A. Endoscopic ultrasound-guided biliary drainage after failed ERCP: cumulative experience of 101 procedures at a single center. *Endoscopy* 2015; **47**: 794-801 [PMID: 25961443 DOI: 10.1055/s-0034-1391988]
65 **Oh D**, Park DH, Song TJ, Lee SS, Seo DW, Lee SK, Kim MH. Optimal biliary access point and learning curve for endoscopic ultrasound-guided hepaticogastrostomy with transmural stenting. *Therap Adv Gastroenterol* 2017; **10**: 42-53 [PMID: 28286558 DOI: 10.1177/1756283X16671671]
66 **Tyberg A**, Mishra A, Cheung M, Kedia P, Gaidhane M, Craig C, Tarnasky PR, Ardengh JC, Kahaleh M. Learning curve for EUS-guided biliary drainage: What have we learned? *Endosc Ultrasound* 2020; **9**: 392-396 [PMID: 32687074 DOI: 10.4103/eus.eus_42_20]

67 **Hathorn KE**, Canakis A, Baron TH. EUS-guided transhepatic biliary drainage: a large single-center U.S. experience. *Gastrointest Endosc* 2022; **95**: 443-451 [PMID: 34673007 DOI: 10.1016/j.gie.2021.10.013]

68 **van Wanrooij RLJ**, Bronswijk M, Kunda R, Everett SM, Lakhtakia S, Rimbas M, Hucl T, Badaoui A, Law R, Arcidiacono PG, Larghi A, Giovannini M, Khashab MA, Binmoeller KF, Barthet M, Pérez-Miranda M, van Hooft JE, van der Merwe SW. Therapeutic endoscopic ultrasound: European Society of Gastrointestinal Endoscopy (ESGE) Technical Review. *Endoscopy* 2022; **54**: 310-332 [PMID: 35114696 DOI: 10.1055/a-1738-6780]

69 **Pawa R**, Pleasant T, Tom C, Pawa S. Endoscopic ultrasound-guided biliary drainage: Are we there yet? *World J Gastrointest Endosc* 2021; **13**: 302-318 [PMID: 34512878 DOI: 10.4253/wjge.v13.i8.302]

70 **Sawas T**, Bailey NJ, Yeung KYKA, James TW, Reddy S, Fleming CJ, Marya NB, Storm AC, Abu Dayyeh BK, Petersen BT, Martin JA, Levy MJ, Baron TH, Bun Teoh AY, Chandrasekhara V. Comparison of EUS-guided choledochoduodenostomy and percutaneous drainage for distal biliary obstruction: A multicenter cohort study. *Endosc Ultrasound* 2022; **11**: 223-230 [PMID: 35102902 DOI: 10.4103/EUS-D-21-00031]

71 **Fugazza A**, Fabbri C, Di Mitri R, Petrone MC, Colombo M, Cugia L, Amato A, Forti E, Binda C, Maida M, Sinagra E, Repici A, Tarantino I, Anderloni A; i-EUS Group. EUS-guided choledochoduodenostomy for malignant distal biliary obstruction after failed ERCP: a retrospective nationwide analysis. *Gastrointest Endosc* 2022; **95**: 896-904.e1 [PMID: 34995640 DOI: 10.1016/j.gie.2021.12.032]

72 **On W**, Paranandi B, Smith AM, Venkatachalapathy SV, James MW, Aithal GP, Varbobitis I, Cheriyan D, McDonald C, Leeds JS, Nayar MK, Oppong KW, Geraghty J, Devlin J, Ahmed W, Scott R, Wong T, Huggett MT. EUS-guided choledochoduodenostomy with electrocautery-enhanced lumen-apposing metal stents in patients with malignant distal biliary obstruction: multicenter collaboration from the United Kingdom and Ireland. *Gastrointest Endosc* 2022; **95**: 432-442 [PMID: 34637805 DOI: 10.1016/j.gie.2021.09.040]

73 **Guo**. A multi-institution consensus on how to perform EUS-guided biliary drainage for malignant biliary obstruction. Available from: https://www.eusjournal.com/article.asp?issn = 2303-9027;year=2018;volume=7;issue=6;spage=356;epage=365;aulast=Guo

74 **Gupta K**, Perez-Miranda M, Kahaleh M, Artifon EL, Itoi T, Freeman ML, de-Serna C, Sauer B, Giovannini M; InEBD STUDY GROUP. Endoscopic ultrasound-assisted bile duct access and drainage: multicenter, long-term analysis of approach, outcomes, and complications of a technique in evolution. *J Clin Gastroenterol* 2014; **48**: 80-87 [PMID: 23632351 DOI: 10.1097/MCG.0b013e31828c6822]

75 **Schmidt A**, Riecken B, Rische S, Klinger C, Jakobs R, Bechtler M, Kähler G, Dormann A, Caca K. Wing-shaped plastic stents vs. self-expandable metal stents for palliative drainage of malignant distal biliary obstruction: a randomized multicenter study. *Endoscopy* 2015; **47**: 430-436 [PMID: 25590188 DOI: 10.1055/s-0034-1391232]

76 **Jacques J**, Privat J, Pinard F, Fumex F, Valats JC, Chaoui A, Cholet F, Godard B, Grandval P, Legros R, Kerever S, Napoleon B. Endoscopic ultrasound-guided choledochoduodenostomy with electrocautery-enhanced lumen-apposing stents: a retrospective analysis. *Endoscopy* 2019; **51**: 540-547 [PMID: 30347424 DOI: 10.1055/a-0735-9137]

77 **Amato A**, Sinagra E, Celsa C, Enea M, Buda A, Vieceli F, Scaramella L, Belletrutti P, Fugazza A, Cammà C, Radaelli F, Repici A, Anderloni A. Efficacy of lumen-apposing metal stents or self-expandable metal stents for endoscopic ultrasound-guided choledochoduodenostomy: a systematic review and meta-analysis. *Endoscopy* 2021; **53**: 1037-1047 [PMID: 33246343 DOI: 10.1055/a-1324-7919]

78 **de Benito Sanz M**, Nájera-Muñoz R, de la Serna-Higuera C, Fuentes-Valenzuela E, Fanjul I, Chavarría C, García-Alonso FJ, Sanchez-Ocana R, Carbajo AY, Bazaga S, Perez-Miranda M. Lumen apposing metal stents versus tubular self-expandable metal stents for endoscopic ultrasound-guided choledochoduodenostomy in malignant biliary obstruction. *Surg Endosc* 2021; **35**: 6754-6762 [PMID: 33258038 DOI: 10.1007/s00464-020-08179-y]

79 **Burmester E**, Niehaus J, Leineweber T, Huetteroth T. EUS-cholangio-drainage of the bile duct: report of 4 cases. *Gastrointest Endosc* 2003; **57**: 246-251 [PMID: 12556796 DOI: 10.1067/mge.2003.85]

80 **Boulay BR**, Lo SK. Endoscopic Ultrasound-Guided Biliary Drainage. *Gastrointest Endosc Clin N Am* 2018; **28**: 171-185 [PMID: 29519330 DOI: 10.1016/j.giec.2017.11.005]

81 **Nunes N**, Flor de Lima M, Caldeira A, Leite S, Marques S, Moreira T, Moutinho-Ribeiro P, Bispo M. GRUPUGE PERSPECTIVE: Endoscopic Ultrasound-Guided Biliary Drainage. *GE Port J Gastroenterol* 2021; **28**: 179-184 [PMID: 34056040 DOI: 10.1159/000510026]

82 **Park SJ**, Choi JH, Park DH, Lee SS, Seo DW, Lee SK, Kim MH. Expanding indication: EUS-guided hepaticoduodenostomy for isolated right intrahepatic duct obstruction (with video). *Gastrointest Endosc* 2013; **78**: 374-380 [PMID: 23711555 DOI: 10.1016/j.gie.2013.04.183]

83 **Dhar J**, Samanta J. Role of therapeutic endoscopic ultrasound in gastrointestinal malignancy- current evidence and future directions. *Clin J Gastroenterol* 2022; **15**: 11-29 [PMID: 35028906 DOI: 10.1007/s12328-021-01559-4]

84 **Artifon EL**, Marson FP, Gaidhane M, Kahaleh M, Otoch JP. Hepaticogastrostomy or choledochoduodenostomy for distal malignant biliary obstruction after failed ERCP: is there any difference? *Gastrointest Endosc* 2015; **81**: 950-959 [PMID: 25500330 DOI: 10.1016/j.gie.2014.09.047]

85 **Minaga K**, Ogura T, Shiomi H, Imai H, Hoki N, Takenaka M, Nishikiori H, Yamashita Y, Hisa T, Kato H, Kamada H, Okuda A, Sagami R, Hashimoto H, Higuchi K, Chiba Y, Kudo M, Kitano M. Comparison of the efficacy and safety of endoscopic ultrasound-guided choledochoduodenostomy and hepaticogastrostomy for malignant distal biliary obstruction: Multicenter, randomized, clinical trial. *Dig Endosc* 2019; **31**: 575-582 [PMID: 30908711 DOI: 10.1111/den.13406]

86 **Tyberg A**, Napoleon B, Robles-Medranda C, Shah JN, Bories E, Kumta NA, Yague AS, Vazquez-Sequeiros E, Lakhtakia S, El Chafic AH, Shah SL, Sameera S, Tawadros A, Ardengh JC, Kedia P, Gaidhane M, Giovannini M, Kahaleh M. Hepaticogastrostomy *versus* choledochoduodenostomy: An international multicenter study on their long-term patency. *Endosc Ultrasound* 2022; **11**: 38-43 [PMID: 34494590 DOI: 10.4103/EUS-D-21-00006]

87 **Prachayakul V**, Aswakul P. A novel technique for endoscopic ultrasound-guided biliary drainage. *World J Gastroenterol* 2013; **19**: 4758-4763 [PMID: 23922474 DOI: 10.3748/wjg.v19.i29.4758]

88 **Kawakubo K**, Isayama H, Kato H, Itoi T, Kawakami H, Hanada K, Ishiwatari H, Yasuda I, Kawamoto H, Itokawa F,

Kuwatani M, Iiboshi T, Hayashi T, Doi S, Nakai Y. Multicenter retrospective study of endoscopic ultrasound-guided biliary drainage for malignant biliary obstruction in Japan. *J Hepatobiliary Pancreat Sci* 2014; **21**: 328-334 [PMID: 24026963 DOI: 10.1002/jhbp.27]

89 **Park DH**, Lee TH, Paik WH, Choi JH, Song TJ, Lee SS, Seo DW, Lee SK, Kim MH. Feasibility and safety of a novel dedicated device for one-step EUS-guided biliary drainage: A randomized trial. *J Gastroenterol Hepatol* 2015; **30**: 1461-1466 [PMID: 26146796 DOI: 10.1111/jgh.13027]

90 **Khashab MA**, Messallam AA, Penas I, Nakai Y, Modayil RJ, De la Serna C, Hara K, El Zein M, Stavropoulos SN, Perez-Miranda M, Kumbhari V, Ngamruengphong S, Dhir VK, Park DH. International multicenter comparative trial of transluminal EUS-guided biliary drainage *via* hepatogastrostomy vs. choledochoduodenostomy approaches. *Endosc Int Open* 2016; **4**: E175-E181 [PMID: 26878045 DOI: 10.1055/s-0041-109083]

91 **Guo J**, Sun S, Liu X, Wang S, Ge N, Wang G. Endoscopic Ultrasound-Guided Biliary Drainage Using a Fully Covered Metallic Stent after Failed Endoscopic Retrograde Cholangiopancreatography. *Gastroenterol Res Pract* 2016; **2016**: 9469472 [PMID: 27594881 DOI: 10.1155/2016/9469472]

92 **Ogura T**, Chiba Y, Masuda D, Kitano M, Sano T, Saori O, Yamamoto K, Imaoka H, Imoto A, Takeuchi T, Fukunishi S, Higuchi K. Comparison of the clinical impact of endoscopic ultrasound-guided choledochoduodenostomy and hepaticogastrostomy for bile duct obstruction with duodenal obstruction. *Endoscopy* 2016; **48**: 156-163 [PMID: 26382307 DOI: 10.1055/s-0034-1392859]

93 **Amano M**, Ogura T, Onda S, Takagi W, Sano T, Okuda A, Miyano A, Masuda D, Higuchi K. Prospective clinical study of endoscopic ultrasound-guided biliary drainage using novel balloon catheter (with video). *J Gastroenterol Hepatol* 2017; **32**: 716-720 [PMID: 27420770 DOI: 10.1111/jgh.13489]

94 **Cho DH**, Lee SS, Oh D, Song TJ, Park DH, Seo DW, Lee SK, Kim MH. Long-term outcomes of a newly developed hybrid metal stent for EUS-guided biliary drainage (with videos). *Gastrointest Endosc* 2017; **85**: 1067-1075 [PMID: 27650270 DOI: 10.1016/j.gie.2016.09.010]

95 **Kim TH**, Kim SH, Oh HJ, Sohn YW, Lee SO. Endoscopic ultrasound-guided biliary drainage with placement of a fully covered metal stent for malignant biliary obstruction. *World J Gastroenterol* 2012; **18**: 2526-2532 [PMID: 22654450 DOI: 10.3748/wjg.v18.i20.2526]

96 **Uemura RS**, Khan MA, Otoch JP, Kahaleh M, Montero EF, Artifon ELA. EUS-guided Choledochoduodenostomy Versus Hepaticogastrostomy: A Systematic Review and Meta-analysis. *J Clin Gastroenterol* 2018; **52**: 123-130 [PMID: 29095426 DOI: 10.1097/MCG.0000000000000948]

97 **Huh G**, Park DH. EUS-guided transhepatic biliary drainage for next-generation ERCPists. *Gastrointest Endosc* 2022; **95**: 452-454 [PMID: 35042616 DOI: 10.1016/j.gie.2021.11.016]

98 **Canakis A**, Hathorn KE, Irani SS, Baron TH. Single session endoscopic ultrasound-guided double bypass (hepaticogastrostomy and gastrojejunostomy) for concomitant duodenal and biliary obstruction: A case series. *J Hepatobiliary Pancreat Sci* 2022; **29**: 941-949 [PMID: 34619022 DOI: 10.1002/jhbp.1055]

99 **Tyberg A**, Desai AP, Kumta NA, Brown E, Gaidhane M, Sharaiha RZ, Kahaleh M. EUS-guided biliary drainage after failed ERCP: a novel algorithm individualized based on patient anatomy. *Gastrointest Endosc* 2016; **84**: 941-946 [PMID: 27237786 DOI: 10.1016/j.gie.2016.05.035]

100 **Dhir V**, Itoi T, Khashab MA, Park DH, Yuen Bun Teoh A, Attam R, Messallam A, Varadarajulu S, Maydeo A. Multicenter comparative evaluation of endoscopic placement of expandable metal stents for malignant distal common bile duct obstruction by ERCP or EUS-guided approach. *Gastrointest Endosc* 2015; **81**: 913-923 [PMID: 25484326 DOI: 10.1016/j.gie.2014.09.054]

101 **Nakai Y**, Isayama H, Kawakami H, Ishiwatari H, Kitano M, Ito Y, Yasuda I, Kato H, Matsubara S, Irisawa A, Itoi T. Prospective multicenter study of primary EUS-guided choledochoduodenostomy using a covered metal stent. *Endosc Ultrasound* 2019; **8**: 111-117 [PMID: 30168480 DOI: 10.4103/eus.eus_17_18]

102 **Yamao K**, Kitano M, Takenaka M, Minaga K, Sakurai T, Watanabe T, Kayahara T, Yoshikawa T, Yamashita Y, Asada M, Okabe Y, Hanada K, Chiba Y, Kudo M. Outcomes of endoscopic biliary drainage in pancreatic cancer patients with an indwelling gastroduodenal stent: a multicenter cohort study in West Japan. *Gastrointest Endosc* 2018; **88**: 66-75.e2 [PMID: 29382465 DOI: 10.1016/j.gie.2018.01.021]

103 **Lyu Y**, Li T, Cheng Y, Wang B, Cao Y, Wang Y. Endoscopic ultrasound-guided vs ERCP-guided biliary drainage for malignant biliary obstruction: A up-to-date meta-analysis and systematic review. *Dig Liver Dis* 2021; **53**: 1247-1253 [PMID: 33926814 DOI: 10.1016/j.dld.2021.03.029]

104 **Patel J**, Rizk N, Kahaleh M. Role of photodynamic therapy and intraductal radiofrequency ablation in cholangiocarcinoma. *Best Pract Res Clin Gastroenterol* 2015; **29**: 309-318 [PMID: 25966430 DOI: 10.1016/j.bpg.2015.02.008]

105 **Sanders DJ**, Bomman S, Krishnamoorthi R, Kozarek RA. Endoscopic retrograde cholangiopancreatography: Current practice and future research. *World J Gastrointest Endosc* 2021; **13**: 260-274 [PMID: 34512875 DOI: 10.4253/wjge.v13.i8.260]

106 **Weismüller TJ**. Role of Intraductal RFA: A Novel Tool in the Palliative Care of Perihilar Cholangiocarcinoma. *Visc Med* 2021; **37**: 39-47 [PMID: 33718482 DOI: 10.1159/000513970]

107 **Lee DW**, Kim EY. Endoscopic Management of Pancreatobiliary Malignancies. *Dig Dis Sci* 2022; **67**: 1635-1648 [PMID: 35171406 DOI: 10.1007/s10620-022-07394-y]

108 **Talreja JP**, Kahaleh M. Photodynamic therapy for cholangiocarcinoma. *Gut Liver* 2010; **4** Suppl 1: S62-S66 [PMID: 21103297 DOI: 10.5009/gnl.2010.4.S1.S62]

109 **Talreja JP**, Degaetani M, Ellen K, Schmitt T, Gaidhane M, Kahaleh M. Photodynamic therapy in unresectable cholangiocarcinoma: not for the uncommitted. *Clin Endosc* 2013; **46**: 390-394 [PMID: 23964337 DOI: 10.5946/ce.2013.46.4.390]

110 **John ES**, Tarnasky PR, Kedia P. Ablative therapies of the biliary tree. *Transl Gastroenterol Hepatol* 2021; **6**: 63 [PMID: 34805585 DOI: 10.21037/tgh.2020.02.03]

111 **Ortner ME**, Caca K, Berr F, Liebetruth J, Mansmann U, Huster D, Voderholzer W, Schachschal G, Mössner J, Lochs H.

Successful photodynamic therapy for nonresectable cholangiocarcinoma: a randomized prospective study. *Gastroenterology* 2003; **125**: 1355-1363 [PMID: 14598251 DOI: 10.1016/j.gastro.2003.07.015]
112 **Zoepf T**, Jakobs R, Arnold JC, Apel D, Riemann JF. Palliation of nonresectable bile duct cancer: improved survival after photodynamic therapy. *Am J Gastroenterol* 2005; **100**: 2426-2430 [PMID: 16279895 DOI: 10.1111/j.1572-0241.2005.00318.x]
113 **Kahaleh M**, Mishra R, Shami VM, Northup PG, Berg CL, Bashlor P, Jones P, Ellen K, Weiss GR, Brenin CM, Kurth BE, Rich TA, Adams RB, Yeaton P. Unresectable cholangiocarcinoma: comparison of survival in biliary stenting alone versus stenting with photodynamic therapy. *Clin Gastroenterol Hepatol* 2008; **6**: 290-297 [PMID: 18255347 DOI: 10.1016/j.cgh.2007.12.004]
114 **Leggett CL**, Gorospe EC, Murad MH, Montori VM, Baron TH, Wang KK. Photodynamic therapy for unresectable cholangiocarcinoma: a comparative effectiveness systematic review and meta-analyses. *Photodiagnosis Photodyn Ther* 2012; **9**: 189-195 [PMID: 22959798 DOI: 10.1016/j.pdpdt.2012.03.002]
115 **Lu Y**, Liu L, Wu JC, Bie LK, Gong B. Efficacy and safety of photodynamic therapy for unresectable cholangiocarcinoma: A meta-analysis. *Clin Res Hepatol Gastroenterol* 2015; **39**: 718-724 [PMID: 26070572 DOI: 10.1016/j.clinre.2014.10.015]
116 **Moole H**, Tathireddy H, Dharmapuri S, Moole V, Boddireddy R, Yedama P, Uppu A, Bondalapati N, Duvvuri A. Success of photodynamic therapy in palliating patients with nonresectable cholangiocarcinoma: A systematic review and meta-analysis. *World J Gastroenterol* 2017; **23**: 1278-1288 [PMID: 28275308 DOI: 10.3748/wjg.v23.i7.1278]
117 **Lee TY**, Cheon YK, Shim CS, Cho YD. Photodynamic therapy prolongs metal stent patency in patients with unresectable hilar cholangiocarcinoma. *World J Gastroenterol* 2012; **18**: 5589-5594 [PMID: 23112552 DOI: 10.3748/wjg.v18.i39.5589]
118 **Park DH**, Lee SS, Park SE, Lee JL, Choi JH, Choi HJ, Jang JW, Kim HJ, Eum JB, Seo DW, Lee SK, Kim MH, Lee JB. Randomised phase II trial of photodynamic therapy plus oral fluoropyrimidine, S-1, versus photodynamic therapy alone for unresectable hilar cholangiocarcinoma. *Eur J Cancer* 2014; **50**: 1259-1268 [PMID: 24485665 DOI: 10.1016/j.ejca.2014.01.008]
119 **Wentrup R**, Winkelmann N, Mitroshkin A, Prager M, Voderholzer W, Schachschal G, Jürgensen C, Büning C. Photodynamic Therapy Plus Chemotherapy Compared with Photodynamic Therapy Alone in Hilar Nonresectable Cholangiocarcinoma. *Gut Liver* 2016; **10**: 470-475 [PMID: 26814610 DOI: 10.5009/gnl15175]
120 **Gonzalez-Carmona MA**, Bolch M, Jansen C, Vogt A, Sampels M, Mohr RU, van Beekum K, Mahn R, Praktiknjo M, Nattermann J, Trebicka J, Branchi V, Matthaei H, Manekeller S, Kalff JC, Strassburg CP, Weismüller TJ. Combined photodynamic therapy with systemic chemotherapy for unresectable cholangiocarcinoma. *Aliment Pharmacol Ther* 2019; **49**: 437-447 [PMID: 30637783 DOI: 10.1111/apt.15050]
121 **Canakis A**, Law R, Baron T. An updated review on ablative treatment of pancreatic cystic lesions. *Gastrointest Endosc* 2020; **91**: 520-526 [PMID: 31593694 DOI: 10.1016/j.gie.2019.09.037]
122 **ASGE Technology Committee**, Navaneethan U, Thosani N, Goodman A, Manfredi M, Pannala R, Parsi MA, Smith ZL, Sullivan SA, Banerjee S, Maple JT. Radiofrequency ablation devices. *VideoGIE* 2017; **2**: 252-259 [PMID: 29905337 DOI: 10.1016/j.vgie.2017.06.002]
123 **Inoue T**, Yoneda M. Updated evidence on the clinical impact of endoscopic radiofrequency ablation in the treatment of malignant biliary obstruction. *Dig Endosc* 2022; **34**: 345-358 [PMID: 34107114 DOI: 10.1111/den.14059]
124 **Inoue T**, Ito K, Yoneda M. Radiofrequency ablation combined with multiple biliary metal stent placement using short-type single-balloon endoscope in patients with surgically altered anatomy. *Dig Endosc* 2018; **30**: 395-396 [PMID: 29334130 DOI: 10.1111/den.13016]
125 **Inoue T**, Ibusuki M, Kitano R, Kobayashi Y, Ohashi T, Sumida Y, Nakade Y, Ito K, Yoneda M. Endoscopic Ultrasound-Guided Antegrade Radiofrequency Ablation and Metal Stenting With Hepaticoenterostomy for Malignant Biliary Obstruction: A Prospective Preliminary Study. *Clin Transl Gastroenterol* 2020; **11**: e00250 [PMID: 33108126 DOI: 10.14309/ctg.0000000000000250]
126 **Mukai S**, Itoi T. EUS-guided antegrade procedures. *Endosc Ultrasound* 2019; **8**: S7-S13 [PMID: 31897373 DOI: 10.4103/eus.eus_46_19]
127 **Steel AW**, Postgate AJ, Khorsandi S, Nicholls J, Jiao L, Vlavianos P, Habib N, Westaby D. Endoscopically applied radiofrequency ablation appears to be safe in the treatment of malignant biliary obstruction. *Gastrointest Endosc* 2011; **73**: 149-153 [PMID: 21184881 DOI: 10.1016/j.gie.2010.09.031]
128 **Sharaiha RZ**, Natov N, Glockenberg KS, Widmer J, Gaidhane M, Kahaleh M. Comparison of metal stenting with radiofrequency ablation versus stenting alone for treating malignant biliary strictures: is there an added benefit? *Dig Dis Sci* 2014; **59**: 3099-3102 [PMID: 25033929 DOI: 10.1007/s10620-014-3264-6]
129 **Figueroa-Barojas P**, Bakhru MR, Habib NA, Ellen K, Millman J, Jamal-Kabani A, Gaidhane M, Kahaleh M. Safety and efficacy of radiofrequency ablation in the management of unresectable bile duct and pancreatic cancer: a novel palliation technique. *J Oncol* 2013; **2013**: 910897 [PMID: 23690775 DOI: 10.1155/2013/910897]
130 **Isayama H**, Hamada T, Yasuda I, Itoi T, Ryozawa S, Nakai Y, Kogure H, Koike K. TOKYO criteria 2014 for transpapillary biliary stenting. *Dig Endosc* 2015; **27**: 259-264 [PMID: 25209944 DOI: 10.1111/den.12379]
131 **Kallis Y**, Phillips N, Steel A, Kaltsidis H, Vlavianos P, Habib N, Westaby D. Analysis of Endoscopic Radiofrequency Ablation of Biliary Malignant Strictures in Pancreatic Cancer Suggests Potential Survival Benefit. *Dig Dis Sci* 2015; **60**: 3449-3455 [PMID: 26038094 DOI: 10.1007/s10620-015-3731-8]
132 **Kang H**, Chung MJ, Cho IR, Jo JH, Lee HS, Park JY, Park SW, Song SY, Bang S. Efficacy and safety of palliative endobiliary radiofrequency ablation using a novel temperature-controlled catheter for malignant biliary stricture: a single-center prospective randomized phase II TRIAL. *Surg Endosc* 2021; **35**: 63-73 [PMID: 32488654 DOI: 10.1007/s00464-020-07689-z]
133 **Yang J**, Wang J, Zhou H, Zhou Y, Wang Y, Jin H, Lou Q, Zhang X. Efficacy and safety of endoscopic radiofrequency ablation for unresectable extrahepatic cholangiocarcinoma: a randomized trial. *Endoscopy* 2018; **50**: 751-760 [PMID: 29342492 DOI: 10.1055/s-0043-124870]

134 **Gao DJ**, Yang JF, Ma SR, Wu J, Wang TT, Jin HB, Xia MX, Zhang YC, Shen HZ, Ye X, Zhang XF, Hu B. Endoscopic radiofrequency ablation plus plastic stent placement versus stent placement alone for unresectable extrahepatic biliary cancer: a multicenter randomized controlled trial. *Gastrointest Endosc* 2021; **94**: 91-100.e2 [PMID: 33359435 DOI: 10.1016/j.gie.2020.12.016]

135 **Dutta AK**, Basavaraju U, Sales L, Leeds JS. Radiofrequency ablation for management of malignant biliary obstruction: a single-center experience and review of the literature. *Expert Rev Gastroenterol Hepatol* 2017; **11**: 779-784 [PMID: 28362129 DOI: 10.1080/17474124.2017.1314784]

136 **Sofi AA**, Khan MA, Das A, Sachdev M, Khuder S, Nawras A, Lee W. Radiofrequency ablation combined with biliary stent placement versus stent placement alone for malignant biliary strictures: a systematic review and meta-analysis. *Gastrointest Endosc* 2018; **87**: 944-951.e1 [PMID: 29108980 DOI: 10.1016/j.gie.2017.10.029]

137 **Zheng X**, Bo ZY, Wan W, Wu YC, Wang TT, Wu J, Gao DJ, Hu B. Endoscopic radiofrequency ablation may be preferable in the management of malignant biliary obstruction: A systematic review and meta-analysis. *J Dig Dis* 2016; **17**: 716-724 [PMID: 27768835 DOI: 10.1111/1751-2980.12429]

138 **Yang J**, Wang J, Zhou H, Wang Y, Huang H, Jin H, Lou Q, Shah RJ, Zhang X. Endoscopic radiofrequency ablation plus a novel oral 5-fluorouracil compound versus radiofrequency ablation alone for unresectable extrahepatic cholangiocarcinoma. *Gastrointest Endosc* 2020; **92**: 1204-1212.e1 [PMID: 32437711 DOI: 10.1016/j.gie.2020.04.075]

139 **Lee YN**, Jeong S, Choi HJ, Cho JH, Cheon YK, Park SW, Kim YS, Lee DH, Moon JH. The safety of newly developed automatic temperature-controlled endobiliary radiofrequency ablation system for malignant biliary strictures: A prospective multicenter study. *J Gastroenterol Hepatol* 2019; **34**: 1454-1459 [PMID: 30861593 DOI: 10.1111/jgh.14657]

140 **Laleman W**, van der Merwe S, Verbeke L, Vanbeckevoort D, Aerts R, Prenen H, Van Cutsem E, Verslype C. A new intraductal radiofrequency ablation device for inoperable biliopancreatic tumors complicated by obstructive jaundice: the IGNITE-1 study. *Endoscopy* 2017; **49**: 977-982 [PMID: 28732391 DOI: 10.1055/s-0043-113559]

141 **Strand DS**, Cosgrove ND, Patrie JT, Cox DG, Bauer TW, Adams RB, Mann JA, Sauer BG, Shami VM, Wang AY. ERCP-directed radiofrequency ablation and photodynamic therapy are associated with comparable survival in the treatment of unresectable cholangiocarcinoma. *Gastrointest Endosc* 2014; **80**: 794-804 [PMID: 24836747 DOI: 10.1016/j.gie.2014.02.1030]

142 **Schmidt A**, Bloechinger M, Weber A, Siveke J, von Delius S, Prinz C, Schmitt W, Schmid RM, Neu B. Short-term effects and adverse events of endoscopically applied radiofrequency ablation appear to be comparable with photodynamic therapy in hilar cholangiocarcinoma. *United European Gastroenterol J* 2016; **4**: 570-579 [PMID: 27536367 DOI: 10.1177/2050640615621235]

143 **Mohan BP**, Chandan S, Khan SR, Kassab LL, Ponnada S, Artifon ELA, Otoch JP, McDonough S, Adler DG. Photodynamic Therapy (PDT), Radiofrequency Ablation (RFA) With Biliary Stents in Palliative Treatment of Unresectable Extrahepatic Cholangiocarcinoma: A Systematic Review and Meta-analysis. *J Clin Gastroenterol* 2022; **56**: e153-e160 [PMID: 33780214 DOI: 10.1097/MCG.0000000000001524]

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