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Original Research Article

Endoscopic Ultrasonography-Guided Biliary Drainage: Experience of a Moroccan Center

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Abstract

Background: Endoscopic ultrasound-guided biliary drainage (EUS-BD) is a relatively new therapeutic modality in the arsenal of endoscopists for attaining satisfactory biliary drainage when traditional ERC fails. The aim of our study is to describe the first Moroccan experience with EUS-BD in patients with malignant biliary obstruction after a failed or inaccessible ERCP. ***Methods:*** This is a retrospective study conducted at Ibn Sina Hospital, from Mars 2018 to July 2022, which include 27 patients with an inoperable or metastatic malignant biliary obstruction who underwent endoscopic ultrasonography-guided biliary drainage (EUS-BD) in case of endoscopic retrograde cholangiopancreatography (ERCP) failure. ***Results:*** From a total of 288 patients with malignant biliary obstruction,27 underwent EUS-BD (9,3%), 15 EUS-guided hepaticogastrostomy (55,5%) and 12 EUS-guided choledocoduodenostomy (44,4%) were performed. The mean age was 62.5 years (age range: 23-74 years), a male predominance of 59% was noted, cholestatic jaundice was present in 100% of patients and associated with pruritus in 92.59% of cases. The mean level of Total Bilirubin was 190 mg/l. The causes of biliary obstruction were: an inoperable pancreatic head mass in 13 patients(48,1%), a cholangiocarcinoma in 7 patients (25.9%), an ampullary mass in 4 patients(14,8%), a gallbladder cancer with hepatic and duodenal invasion in one patient (3,7%), a gastric antropyloric adenocarcinoma with pancreatic head invasion in one patient (3,7%) and Duodenal adenocarcinoma in one patient (3,7%).The leading causes of failed ERCP were secondary to tumor infiltration of the duodenal wall and critical duodenal stenosis in 11 cases (40,7%), in 9 cases due to a difficult cannulation (33.3%) and in 7 cases due to a failure to pass the stricture by ERCP (25.9%). In EUS-HG The technical and the clinical success rates were 86.6% (13/15) and 84.6% (11/13), respectively, the complication rate was 13.3% (2/15) including one case of stent migration complicated with bile leak and one case of cholangitis. In EUS-CD The technical and the clinical success rates were 91.6% (11/12) and 81.8% (9/11)), respectively, the complication rate was 16.6% (2/12) including two cases of cholangitis. The technical and the clinical success rates in all EUS-BD were 85.1% (24/27) and 83.3% (20/24), respectively. The complication rate was 14.8% (4/27). Conclusion: EUS-BD appears to be an effective and safe therapeutic option for biliary decompression in cases where ERCP fails.

Keywords: EUS-BD, EUS-CD, EUS-HG, malignant biliary obstruction.

INTRODUCTION

Endoscopic retrograde cholangiography (ERCP) with stent placement is the procedure of choice for relief of biliary obstruction, the success rate of ERCP is 90 % [1-3]. Failure of ERCP can be attributed to surgically altered anatomy, duodenal obstruction, gastric outlet obstruction, in situ enteral stents, periampullary diverticula, or periampullary tumor infiltration [4]. Conventionally, such patients undergo percutaneous transhepatic biliary drainage (PTBD) or Surgical biliary bypass. However, PTBD is more commonly preferred to surgery, it is associated with high substantial morbidity rates of up to 23% in the form of catheter dislodgement, recurrent infection, acute cholangitis, pneumothorax, and cosmetic problems (due to external drainage) [5]. This may lead to poor outcomes and decline in quality of life [6, 7].

Endoscopic ultrasound-guided biliary drainage (EUS-BD) is an alternative to failed ERCP, first published by Giovannini and colleagues [9] in 2001. Subsequently, several groups described the efficacy of EUS-BD with a pooled technical success rate of 91.5% and a pooled clinical success rate of 87% [12], suggesting it is an effective alternative in place of PTBD or biliary bypass surgery.

The aim of our study is to describe the first Moroccan experience with EUS-BD in patients with malignant biliary obstruction after a failed or inaccessible ERCP.

PATIENTS AND METHODS

Patients:

This study is a retrospective study conducted at Ibn Sina Hospital, from Mars 2018 to July 2022, which include 27 patients with an inoperable or metastatic malignant biliary obstruction who underwent endoscopic ultrasonography-guided biliary drainage (EUS-BD) in case of endoscopic retrograde cholangiopancreatography (ERCP) failure.

Methods:

All the procedures were performed in the prone position with intubation, EUS was performed using the Pentax linear echoendoscope with an experienced endoscopist, following which, the patients were admitted for at least 2 days and monitored for potential complications such as fever, abdominal pain, pneumoperitoneum, bleeding, and peritonitis.

EUS-BD techniques

EUS-guided hepaticogastrostomy

15 patients underwent EUS-guided hepaticogastrostomy (EUS-HG) this approach was typically preferred in cases where the papilla is not endoscopically accessible due to gastric outlet obstruction, to an obstructing duodenal tumor, or in patients with surgically altered anatomy. Dilatation of intrahepatic ducts is necessary to perform this approach.

With the tip of the echoendoscope positioned along the lesser curvature of the stomach, the dilated left hepatic duct (segment III) can be correctly visualized. Transgastric needle (19-gauge) insertion into the left hepatic duct and contrast injection clearly show the biliary tree under fluoroscopy. The next step is to exchange the needle over a guidewire (0.035 inch) for a 6.Fr cystotome used to create the fistula between the stomach and the left hepatic duct with a cutting current. When necessary, a 6-mm dilation balloon was used to dilate the track. Finally, an 8-cm partially covered self-expandable metal stent (PCSEMS) was deployed under fluoroscopic and endoscopic guidance into the track created between the left hepatic duct and the stomach (Figure 1).

EUS-guided choledocoduodenostomy

12 patients Underwent EUS-guided choledochoduodenostomy (EUS CD). It is usually performed in case of failure of selective cannulation of the common biliary duct because of ampullary neoplasm, neoplastic infiltration from pancreatic cancer, or when the access to the papilla is prevented by benign (peptic stenosis) or malignant duodenal stenosis. The tip of the echoendoscope is advanced to the duodenal bulb or, when feasible, to the antrum wall where the dilated common biliary duct (CBD) is closer to the wall, the access to the bile duct is achieved with a 19-gauge needle, an aspiration of bile followed by contrast injection clearly show the biliary tree under fluoroscopy. The next step is to exchange the needle over a 0.035 inch guidewire for a 6.Fr cystotome used to create the fistula between the CBD and duodenal bulb.6 cm fully covered self-expandable metal stent (FCSEMS)was then positioned over the under fluoroscopic and endoscopic guidance (Figure 2).

Outcome Parameters

The outcome parameters included technical and clinical success.

- Technical success was defined as the successful deployment of the stent into the biliary system.
- Clinical success was defined as greater than 50% reduction in the bilirubin value after 2 weeks from the procedure, when compared with the preprocedural value.

All complications during the procedures and follow-up were recorded. Patients were monitored during and after the procedure for complications such as fever, bleeding, biliary peritonitis, and pneumoperitoneum.

RESULTS

From a total of 288 patients with malignant biliary obstruction, 27 underwent EUS-BD (9,3%), 15 EUS-guided hepaticogastrostomy (55,5%) and 12 EUS-guided choledocoduodenostomy (44,4%) were performed. The mean age was 62.5 years (age range: 23-74 years), a male predominance of 59% was noted, cholestatic jaundice was present in 100% of patients and associated with pruritus in 92.59% of cases. The mean level of Total Biturbin was 190 mg/l.

The causes of biliary obstruction were: an inoperable pancreatic head mass in 13 patients(48,1%), a cholangiocarcinoma in 7 patients (25.9%), an ampullary mass in 4 patients(14,8%), a gallbladder cancer with hepatic and duodenal invasion in one patient (3,7%), a gastric antropyloric adenocarcinoma with pancreatic head invasion in one patient (3,7%) and Duodenal adenocarcinoma in one patient (3,7%).

The leading causes of failed ERCP were secondary to tumor infiltration of the duodenal wall and critical duodenal stenosis in 11 cases (40,7%), in 9 cases due to a difficult cannulation (33.3%) and in 7 cases due to a failure to pass the stricture by ERCP (25.9%).

In EUS-HG The technical and the clinical success rates were 86.6% (13/15) and 84.6% (11/13), respectively, the complication rate was 13.3% (2/15) including one case of stent migration complicated with bile leak and one case of cholangitis.

In EUS-CD The technical and the clinical success rates were 91.6% (11/12) and 81.8% (9/11)), respectively, the complication rate was 16.6% (2/12) including two cases of cholangitis.

The technical and the clinical success rates in all EUS-BD were 85.1% (24/27) and 83.3% (20/24), respectively. The complication rate was 14.8% (4/27).

The summary of all cases is shown in Table 1 and 2.

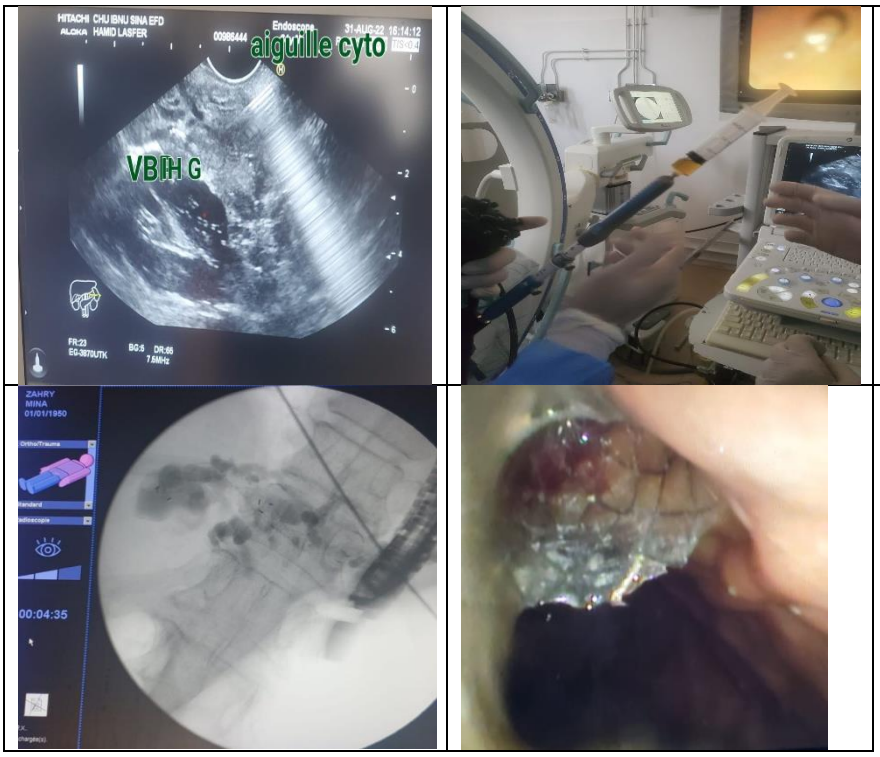

Figure 1: EUS-guided hepaticogastrostomy

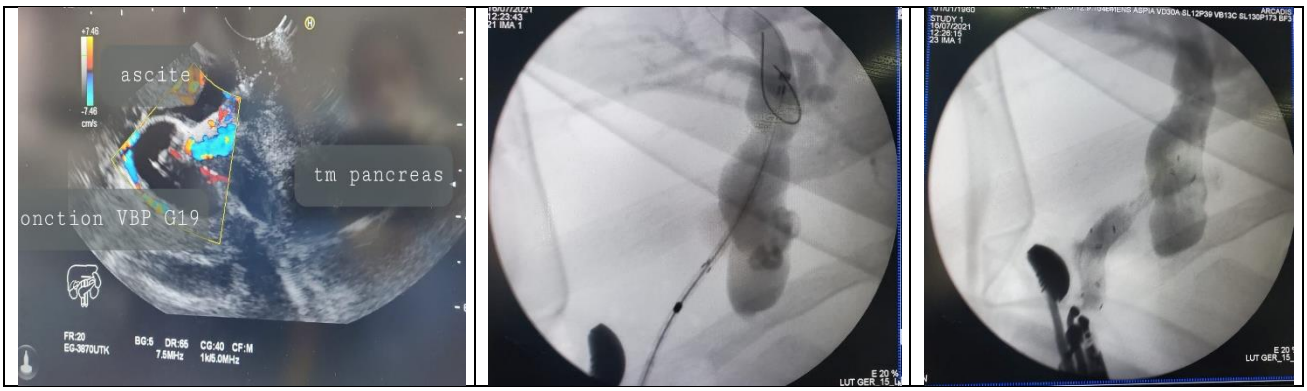

Figure 2: EUS-guided choledocoduodenostomy

Table 1: Summary of cases that underwent EUS-BD

case	Age	Sex	Diagnosis	Indication of EUS-BD	Procedure	Stent	Technical success	Clinical success	complications
1	65	M	Cholangiocarcinoma	ERCP failure to pass the stricture	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
2	55	M	Inoperable pancreatic head mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
3	74	F	Inoperable pancreatic head mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
4	67	M	Inoperable pancreatic head mass	difficult cannulation	EUS CD	FCSEMS, 6cm	Yes	Yes	None
5	69	M	gallbladder cancer with hepaticand duodenal invasion	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	No	cholangitis
6	72	F	Ampullary Mass	difficult cannulation	EUS-CD	FCSEMS, 6cm	Yes	Yes	None
7	59	M	Inoperable pancreatic head mass	difficult cannulation	EUS CD	FCSEMS, 6cm	No	No	None
8	63	F	Inoperable pancreatic head mass	ERCP failure to pass the stricture	EUS CD	FCSEMS, 6cm	Yes	Yes	None
9	23	M	Inoperable pancreatic head mass	difficult cannulation	EUS CD	FCSEMS, 6cm	Yes	Yes	None
10	54	F	Cholangiocarcinoma	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
11	62	M	gastric antropyloric adenocarcinoma with pancreatic head invas ion	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	No	No	None
12		M	Cholangiocarcinoma	ERCP failure to pass the stricture	EUS CD	FCSEMS, 6cm	Yes	No	cholangitis
13		F	Ampullary Mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
14		F	Inoperable pancreatic head mass	difficult cannulation	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
15		M	Inoperable pancreatic head mass	difficult cannulation	EUS CD	FCSEMS, 6cm	Yes	Yes	None
16		M	Cholangiocarcinoma	ERCP failure to pass the stricture	EUS CD	FCSEMS, 6cm	Yes	No	cholangitis
17		M	Cholangiocarcinoma	difficult cannulation	EUS CD	FCSEMS, 6cm	Yes	Yes	None
18		F	Ampullary Mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
19		F	Inoperable pancreatic head mass	ERCP failure to pass the stricture	EUS CD	FCSEMS, 6cm	Yes	Yes	None
20		F	Inoperable pancreatic head mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
21		M	Inoperable pancreatic head mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
22		M	Cholangiocarcinoma	ERCP failure to pass the stricture	EUS-HG	PCSEMS, 8cm	No	No	None
23		M	Duodenal adenocarcinoma	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	No	Stent migration+ Bile leak
24		F	Inoperable pancreatic head mass	difficult cannulation	EUS-HG	PCSEMS, 8cm	Yes	Yes	None
25		F	Inoperable pancreatic head mass	ERCP failure to pass the stricture	EUS CD	FCSEMS, 6cm	Yes	Yes	None
26		M	Cholangiocarcinoma	difficult cannulation	EUS CD	FCSEMS, 6cm	Yes	Yes	None
27		M	Ampullary Mass	Duodenal stenosis	EUS-HG	PCSEMS, 8cm	Yes	No	None

BD: biliary drainage; CD: choledocoduodenostomy; EUS: endoscopic ultrasoun; HG: hepaticogastrostomy; PCSEMS: partially covered self-expandable metallic stent; ERCP: endoscopic retrograde cholangiopancreatography;

Table 2: Technical success, clinical success and complications rates of EUS-BD

	EUS-HG	EUS CD	Total
Technical success	86.6% (13/15)	91.6%(11/12)	85.1%
Clinical success	84.6% (11/13)	81.8%(9/11)	83.3%
Complications	13.3%	16.6%	14.8%
CD: choledocoduodenostomy; EUS: endoscopic ultrasoun; BD: biliary drainage; HG: hepaticogastrostomy;			

DISCUSSION

Endoscopic retrograde cholangiography (ERCP) with stent placement is the procedure of choice for relief of biliary obstruction. The success rate of ERCP is 90 % [1–3], Failure of ERCP can be attributed to surgically altered anatomy, duodenal obstruction, gastric outlet obstruction, in situ enteral stents, periampullary diverticula, or periampullary tumor infiltration [4]. Conventionally, such patients undergo percutaneous transhepatic biliary drainage (PTBD). However, PTBD is associated with substantial morbidity in the form of catheter dislodgement, recurrent infection, acute cholangitis, pneumothorax, and cosmetic problems (due to external drainage) [5]. This may lead to poor outcomes and decline in quality of life [6, 7].

Endoscopic ultrasound-guided biliary drainage (EUS-BD) is a relatively new therapeutic modality in the arsenal of endoscopists for attaining satisfactory biliary drainage when traditional ERC fails. Wiersema and colleagues [8] described the first EUS-guided cholangiopancreatography in 1996 on patients who had failed ERCP. The world's first EUS-guided biliary drainage was published by Giovannini and colleagues [9] in 2001. Subsequently, several groups described the efficacy of EUS-BD, suggesting it is an effective alternative in place of PTBD or biliary bypass surgery. EUS-BD can be performed by two major approaches: extrahepatic (EH) and intrahepatic (IH).

In the EH approach, the common bile duct is accessed mainly through the duodenum or through the gastric antrum. Biliary drainage can be achieved by either transluminal stent placement (choledochoduodenostomy) or transpapillary stent placement via the rendezvous technique [10], this approach is usually performed in case of failure of selective cannulation of the common biliary duct because of ampullary neoplasm, neoplastic infiltration from pancreatic cancer, or when the access to the papilla is prevented by benign (peptic stenosis) or malignant duodenal stenosis.

On the other hand, when the IH approach is used the left lobe of the liver is accessed from the gastric wall and rarely from the distal esophagus or jejunum. Using this approach, biliary drainage can be attained by either transluminal stent placement (hepaticogastrostomy) or transpapillary stent placement via rendezvous technique or antegrade technique [10]. Such approach is typically preferred in cases where the papilla is not endoscopically accessible due to gastric outlet obstruction, to an obstructing proximal duodenal tumor, or in patients with surgically altered anatomy. Dilatation of intrahepatic ducts is compulsory to perform this approach. Cancer infiltration of the gastric wall within the planned path of approach to the biliary ducts or massive ascites and coagulopathy are contraindications to this type of approach.

The choice of approach is still under debate and is mainly based on anatomical factors, indication of the procedure, and the endoscopist's experience. Ascites or nondilated intrahepatic left biliary ducts are conditions for an extrahepatic approach.

Artifon *et al*., [10] compared the outcomes of EUS-HG and EUS-CD in a prospective randomized trial of 49 patients with distal malignant biliary obstruction. The technical success rate was 96% versus 91% with a clinical success rate of 91% versus 77% and similar procedural time. The overall adverse event rates were 16.3% (20% for the HG group and 12.5% for the CD group). These data show no significant differences between the two techniques.

These data have been confirmed by Khashab *et al*., [27] in an international multicenter comparative trial with 121 patients who underwent EUS-BD (CD: 60, HG: 61). However, CD was found to be associated with shorter hospital stay, improved stent patency, and fewer procedural and stent-related complications [27].

Based on the meta-analysis of EUS-guided biliary drainage done in 1437 patients from 23 studies, a pooled technical success rate of 91.5% was reported, a pooled clinical success rate of 87% [12], Other studies have shown clinical success in the range of 84%–97% [13, 14, 16-22]. In the majority of studies [13-23] clinical success has been closely related to technical success, indicating the importance of a successful procedure, In our study the technical and the clinical success rates were 86.6% (13/15) and 84.6% (11/13), our results match those of previous studies.

Outcomes and complications in EUS-BD have been well documented in sever large studies, EUS-BD has a similar profile of adverse events to ERCP. In a meta-analysis, an overall pooled rate of adverse events was 17.9%, the commonest being biliary leak and infection. The pooled rate of biliary leaks was 4%, and the pooled rate of infection and stent migration was 3.8%

[12]. The complication rate of our study was 16.6%, our results correspond with the data of the literature.

Comparative studies between EUS-BD and other techniques are primarily available for distal malignant obstruction. In a recent systemic review and meta-analysis of EUS-BD versus ERCP, 9 studies involving 634 patients were included. There were no significant differences between the technical and clinical success of EUS-BD and ERCP-BD. EUS-BD was associated with significantly less reintervention versus ERCP-BD and regarding adverse events, the rates were similar for EUS-BD and ERCP-BD. There were no significant differences in the types of adverse events (stent occlusion, stent migration, stent dysfunction, and duration of stent patency) between the 2 techniques. EUS-BD was associated with lower reintervention rates compared with ERCP-BD, with comparable safety and efficacy outcomes [11].

There are no prospective studies evaluating the role of EUS-BD as a primary drainage technique in comparison to ERCP. The ERCP related complications like pancreatitis in difficult cannulation might suggest the role of EUS-BD as a good primary alternative in these setting or in patients with altered anatomy or malignant obstruction. However, the use of advanced ERCP techniques in a tertiary-care center usually provides high technical success rate so that EUS-BD is required in a very limited number of cases (only 0.6% of native papilla ERCPs according to the authors) [26].

There is level 1 evidence for EUS-BD in the distal biliary malignant block. A recent systematic review and meta-analysis by Sharaiha and colleagues [25] included 9 studies comparing the efficacy and safety of EUS-BD and PTBD: 3 randomized controlled trials (RCTs) and 6 retrospective studies. EUS-BD and PTBD showed equivalent technical success. However, EUS-BD was associated with better clinical success, fewer postprocedure adverse events, and lower reintervention rates, No significant differences were observed for the duration of hospital stay between EUS-BD and PTBD, but EUS-BD was more cost-effective.

Our study's limitations are the relatively small number of cases and their retrospective assessment.

CONCLUSION

EUS-BD appears to be an effective and safe therapeutic option for biliary decompression in cases where ERCP fails. However, it requires a high level of technical skills and should be performed only in tertiary centers by experienced endoscopists. Randomized controlled trials evaluating the efficacy of this procedure in comparison with other therapeutic modalities are required.

REFERENCES

1. Varadarajulu, S., Kilgore, M. L., Wilcox, C. M., & Eloubeidi, M. A. (2006). Relationship among hospital ERCP volume, length of stay, and technical outcomes. *Gastrointestinal endoscopy*, *64*(3), 338-347.
2. Ang, T. L., Teo, E. K., & Fock, K. M. (2007). EUS-guided transduodenal biliary drainage in unresectable pancreatic cancer with obstructive jaundice. *Jop*, *8*(4), 438-443.
3. Burmester, E., Niehaus, J., Leinweber, T., & Huetteroth, T. (2003). EUS-cholangio-drainage of the bile duct: report of 4 cases. *Gastrointestinal endoscopy*, *57*(2), 246-251.
4. Püspök, A., Lomoschitz, F., Dejaco, C., Hejna, M., Sautner, T., & Gangl, A. (2005). Endoscopic ultrasound guided therapy of benign and malignant biliary obstruction: a case series. *Official journal of the American College of Gastroenterology| ACG*, *100*(8), 1743-1747.
5. Beissert, M., Wittenberg, G., Sandstede, J., Beer, M., Tschammler, A., Burghardt, W., ... & Hahn, D. (2002). Metallic stents and plastic endoprostheses in percutaneous treatment of biliary obstruction. *Zeitschrift für Gastroenterologie*, *40*(07), 503-510.
6. Winick, A. B., Waybill, P. N., & Venbrux, A. C. (2001). Complications of percutaneous transhepatic biliary interventions. *Techniques in vascular and interventional radiology*, *4*(3), 200-206.
7. Oh, H. C., Lee, S. K., Lee, T. Y., Kwon, S., Lee, S. S., Seo, D. W., & Kim, M. H. (2007). Analysis of percutaneous transhepatic cholangioscopy-related complications and the risk factors for those complications. *Endoscopy*, *39*(08), 731-736.
8. Wiersema, M. J., Sandusky, D., Carr, R., Wiersema, L. M., Erdel, W. C., & Frederick, P. K. (1996). Endosonography-guided cholangiopancreatography. *Gastrointestinal Endoscopy*, *43*(2), 102-106.
9. Giovannini, M., Moutardier, V., Pesenti, C., Bories, E., Lelong, B., & Delpero, J. R. (2001). Endoscopic ultrasound-guided bilioduodenal anastomosis: a new technique for biliary drainage. *Endoscopy*, *33*(10), 898-900.
10. Artifon, E. L., Ferreira, F. C., Otoch, J. P., Rasslan, S., Itoi, T., & Perez-Miranda, M. (2012). EUS-guided biliary drainage: a review article. *JOP. Journal of the Pancreas*, *13*(1), 7-17.
11. Lyu, Y., Li, T., Cheng, Y., Wang, B., Cao, Y., & Wang, Y. (2021). Endoscopic ultrasound-guided vs ERCP-guided biliary drainage for malignant biliary obstruction: a up-to-date meta-analysis and systematic review. *Digestive and Liver Disease*, *53*(10), 1247-1253.
12. Dhindsa, B. S., Mashiana, H. S., Dhaliwal, A., Mohan, B. P., Jayaraj, M., Sayles, H., ... & Adler, D. G. (2020). EUS-guided biliary drainage: A systematic review and meta-analysis. *Endoscopic Ultrasound*, *9*(2), 101-109.
13. Park, J. K., Woo, Y. S., Noh, D. H., Yang, J. I., Bae, S. Y., Yun, H. S., ... & Lee, K. H. (2018). Efficacy

of EUS-guided and ERCP-guided biliary drainage for malignant biliary obstruction: prospective randomized controlled study. *Gastrointestinal Endoscopy*, *88*(2), 277-282.

14. Tsuchiya, T., Teoh, A. Y. B., Itoi, T., Yamao, K., Hara, K., Nakai, Y., ... & Kitano, M. (2018). Long-term outcomes of EUS-guided choledochoduodenostomy using a lumen-apposing metal stent for malignant distal biliary obstruction: a prospective multicenter study. *Gastrointestinal endoscopy*, *87*(4), 1138-1146.
15. Kahaleh, M., Perez-Miranda, M., Artifon, E. L., Sharaiha, R. Z., Kedia, P., Peñas, I., ... & Giovannini, M. (2016). International collaborative study on EUS-guided gallbladder drainage: Are we ready for prime time?. *Digestive and liver disease*, *48*(9), 1054-1057.
16. Will, U., Fueldner, F., Kern, C., & Meyer, F. (2014). EUS-guided bile duct drainage (EUBD) in 95 patients. *Ultraschall in der Medizin-European Journal of Ultrasound*, 276-283.
17. Dhir, V., Itoi, T., Khashab, M. A., Park, D. H., Teoh, A. Y. B., Attam, R., ... & Maydeo, A. (2015). Multicenter comparative evaluation of endoscopic placement of expandable metal stents for malignant distal common bile duct obstruction by ERCP or EUS-guided approach. *Gastrointestinal endoscopy*, *81*(4), 913-923.
18. Weilert, F. (2014). Prospective evaluation of simplified algorithm for EUS-guided intra-hepatic biliary access and anterograde interventions for failed ERCP. *Surgical endoscopy*, *28*, 3193-3199.
19. Dhir, V., Artifon, E. L., Gupta, K., Vila, J. J., Maselli, R., Frazao, M., & Maydeo, A. (2014). Multicenter study on endoscopic ultrasound-guided expandable biliary metal stent placement: Choice of access route, direction of stent insertion, and drainage route. *Digestive Endoscopy*, *26*(3), 430-435.
20. Park, D. H., Jeong, S. U., Lee, B. U., Lee, S. S., Seo, D. W., Lee, S. K., & Kim, M. H. (2013). Prospective evaluation of a treatment algorithm with enhanced guidewire manipulation protocol for EUS-guided biliary drainage after failed ERCP (with video). *Gastrointestinal Endoscopy*, *78*(1), 91-101.
21. Prachayakul, V., & Aswakul, P. (2013). A novel technique for endoscopic ultrasound-guided biliary drainage. *World Journal of Gastroenterology: WJG*, *19*(29), 4758-4763.
22. Vila, J. J., Pérez-Miranda, M., Vazquez-Sequeiros, E., Abadia, M. A. S., Pérez-Millán, A., González-Huix, F., ... & Armengol-Miró, J. R. (2012). Initial experience with EUS-guided cholangiopancreatography for biliary and pancreatic duct drainage: a Spanish national survey. *Gastrointestinal endoscopy*, *76*(6), 1133-1141.
23. Kim, T. H., Kim, S. H., Oh, H. J., Sohn, Y. W., & Lee, S. O. (2012). Endoscopic ultrasound-guided biliary drainage with placement of a fully covered metal stent for malignant biliary obstruction. *World journal of gastroenterology: WJG*, *18*(20), 2526-2532.
24. Shah, J. N., Marson, F., Weilert, F., Bhat, Y. M., Nguyen-Tang, T., Shaw, R. E., & Binmoeller, K. F. (2012). Single-operator, single-session EUS-guided anterograde cholangiopancreatography in failed ERCP or inaccessible papilla. *Gastrointestinal Endoscopy*, *75*(1), 56-64.
25. Sharaiha, R. Z., Khan, M. A., Kamal, F., Tyberg, A., Tombazzi, C. R., Ali, B., ... & Kahaleh, M. (2017). Efficacy and safety of EUS-guided biliary drainage in comparison with percutaneous biliary drainage when ERCP fails: a systematic review and meta-analysis. *Gastrointestinal endoscopy*, *85*(5), 904-914.
26. Holt, B. A., Hawes, R., Hasan, M., Canipe, A., Tharian, B., Navaneethan, U., & Varadarajulu, S. (2016). Biliary drainage: role of EUS guidance. *Gastrointestinal Endoscopy*, *83*(1), 160-165. DOI: 10.1016/j.gie.2015.06.019
27. Khashab, M. A., Messallam, A. A., Penas, I., Nakai, Y., Modayil, R. J., De la Serna, C., ... & Park, D. H. (2016). International multicenter comparative trial of transluminal EUS-guided biliary drainage via hepatogastrostomy vs. choledochoduodenostomy approaches. *Endoscopy International Open*, *4*(02), E175-E181. DOI: 10.1055/s-0041-109083