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# Endoscopic Ultrasound-Guided Cholangiodrainage

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## Abstract

Endoscopic ultrasound (EUS)-guided cholangiodrainage (EUCD) following the initial steps as puncture of an extra- or intrahepatic segment of the retained biliary tree and cholangiography is a substantial and indispensable part in the spectrum of interventional EUS. Besides transluminal EUS-guided drainage of the pancreatic duct (EUPD) and endoscopic necrosectomy, it belongs to the greatest advances in interventional EUS which has been further elaborated in recent years. In addition, EUCD has been considered a reasonable therapeutic alternative over the years as a well-established percutaneous transhepatic cholangiodrainage (PTCD), since it allows permanent internal drainage of the retained bile duct or its branches to the upper gastrointestinal tract via an extra-anatomic prosthetic bypass implanted transluminally by image (EUS)-guided, real-time EUS and thus it avoids persistent disturbance of the patient's physical integrity as in PTCD. It requires extensive endoscopic expertise, experience in interventional EUS as well as interdisciplinary understanding and overview for the mostly late-stage malignant tumor disease. However, it is still an experimental clinical procedure which needs further careful evaluation of its indication, clinical courses and outcome in well-selected cases with currently exclusively malignant tumor growth.

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Endoscopic retrograde cholangiography (ERC) has been established as the standard method in the treatment of biliary obstruction caused by stones or tumor lesions. Selective transpapillary cannulation and drainage of the bile duct can be achieved in almost 90–95% of clinical cases. The successful drainage depends on the expertise of the investigator, the anatomic specifics around the papilla of Vater (papilla) and the biliary tree as well as the endoscopic techniques, tools and devices which are used to cannulate the papilla and to get through stenoses [1, 2]. In case of an obstruction at or within the bile duct, transpapillary endoscopic placement of plastic stents or metal prostheses is considered the most effective therapeutic modality in a palliative approach to posthepatic jaundice [3]. In patients who formerly underwent surgical intervention (such as BII gastric resection or hepaticojejunostomy with Roux-en-Y reconstruction, kephal pancreatoduodenectomy, gastroenteroanastomosis) or who were diagnosed with tumor-induced gastric outlet syndrome or locally advanced malignant infiltration of the papilla, a primary internal endoscopic drainage is not possible in the majority of cases.

In such patients, in particular in those with incurable malignancy, percutaneous transhepatic cholangiodrainage (PTCD) is used or the biliary tree is surgically anastomosed with a Roux-en-Y jejunal loop (as the most commonly used type of biliodigestive anastomosis). Both approaches are associated with a higher morbidity and mortality when compared with ERC. In addition, a permanent external/internal drainage of the biliary tree cannot be achieved in each case using PTCD-based access [4–7]. Furthermore, a sole external drainage can cause a temporary or even permanent loss of bile and the subjective impression of an ‘altered physical integrity’, which is a substantial psychological problem in patients with incurable malignancy and limited life expectancy: For example, by the visible external drainage of the bile and the daily rinsing, the patient is repeatedly confronted with the incurable character and the hopelessness of the disease. This might be a remarkable problem even during the initial phase of the ongoing palliative treatment [8].

In patients with advanced and incurable malignant tumor growth as well as obstructive tumor-induced jaundice, the primary aim in the palliative therapeutic concept is a sufficient, permanent and possibly internal drainage of the biliary tree with a low complication rate and no need for a reintervention until death. Endoscopic ultrasound (EUS)-guided cholangiodrainage (EUCD) may fulfill these requirements [9–18]. Because of the anatomic adjacency of the pancreatobiliary system to the stomach and duodenum, longitudinal EUS is a suitable tool which allows puncture of the intra- and extrahepatic segments of the biliary tree and thus the subsequent placement of a transluminal cholangiography, which can be considered the basic prediction for an EUS-guided internal drainage with good prospects. Currently, three various techniques can be subdivided: (1) If the papilla can be reached but the catheter cannot be introduced into the papilla, an EUS-ERC rendezvous maneuver is preferred [11–13, 19, 20]. (2) If the papilla cannot be reached because of former surgical interventions and an obstructive jaundice due to malignant tumor growth, EUS-guided choledochoduodenostomy is preferentially chosen [13, 16, 18]. (3) In case of tumor lesions at or within the hepatic hilus, EUS-guided hepaticogastrostomy (or hepaticojejunostomy after former gastrectomy) is primarily used [11, 13, 17].

In recent years it has been shown several times, but in only small case series, that EUCD can provide a success rate of 75–100% and a low complication rate (0–18%) [9–18] (table 1). Controlled randomized studies comparing EUCD with PTCD or surgical intervention are lacking.

The present overview describes the various technical aspects of EUCD, values critically the currently available and relevant publications on the subject and compares them with own clinical experiences and also provides suggestions for an adequate approach according to the various indications.

## **Procedural Aspects**

### *Approach, Material and Technique in General*

The technical prediction for EUCD is a longitudinal EUS endoscope of big caliber (Aloka-Olympus GF-UCT140, Olympus, Hamburg, Germany; Pentax-Hitachi EG 3830 UT, Pentax, Hamburg, Germany). The investigation is performed under fluoroscopy control in the ERCP unit. This provides the option to carry out a rendezvous technique during the same procedure (table 2). The patients lie primarily on the left body side or on the abdomen as done for ERCP. Analgesedation is similarly administered as done for ERCP using midazolam/disoprivan/pethidine under permanent cardiopulmonary monitoring by a second physician. The biliary tree is

**Table 1.** Reported results of the transluminal EUCD – chronological order

Author	Cases n	Stent type	Drainage success	Complications	Clinical long-term success
Burmester 2003	4	plastic stent	75%	1 peritonitis	no data
Bories 2007	11	7 plastic stents 3 SEMS	90%	18% (1 bilioma, 1 cholangitis)	90% (2 reinterventions)
Püspök 2005	6	5 plastic stents 1 SEMS	100%	16% (1 cholecystitis)	no data
Will 2007	10	4 plastic stents 5 SEMS	90%	12.5% (1 bleeding, 1 cholangitis)	80%
Kahaleh 2006	23	11 Plastic stents 10 SEMS	91%	17% (1 bleeding, 2 pneumoperitoneum, 1 biliary leakage)	78%
Tarantino 2008	9	7 plastic stents 1 metal stent	100%	0%	100% (1 reintervention)
Yamaha 2008	5	plastic stent	100%	1 pneumoperitoneum	100%
Yasutaka 2009	5	plastic stent	80%	0%	80%
Hara 2009	10	plastic stent	100%	1 pneumoperitoneum 1 peritonitis	100%
Itoi 2008	4	plastic stent	100%	1 focal peritonitis	100%
Will DDW 2009	35	19 SEMS 6 plastic stents	80% (n = 28/35)	3 cholangitis 1 hemobilia 1 peritonitis (death) 2 stent dislocations (metal)	71% (n = 25/35)

**Table 2.** Technical predictions for EUCD

Longitudinal echoendoscope  
 (Aloka-Olympus GF-UCT140, Olympus, Hamburg, Germany;  
 Pentax-Hitachi EG 3830 UT, Pentax, Hamburg, Germany)  
 Fluoroscopy unit  
 Therapeutic duodenoscope  
 Patient monitoring (SO<sub>2</sub>, RR, heart rate) – by a second physician  
 19-G needle (Wilson-Cook, Mediglobe, Olympus)  
 Needle-knife catheter (Olympus, Germany; Wilson-Cook, Müncchengladbach, Germany)  
 0.035-Fr guidewire (Boston Scientific, Ratingen, Germany; Wilson-Cook, Germany)  
 5- to 9-Fr bougies (Olympus, Germany)  
 6- to 8-mm biliary dilatation balloons (Boston Scientific, Germany; Endoflex, Voerde, Germany)  
 8.5- to 10-Fr plastic prostheses (Amsterdam/Pigtail)  
 6- to 8-mm covered metal stents (Boston Scientific, Germany)

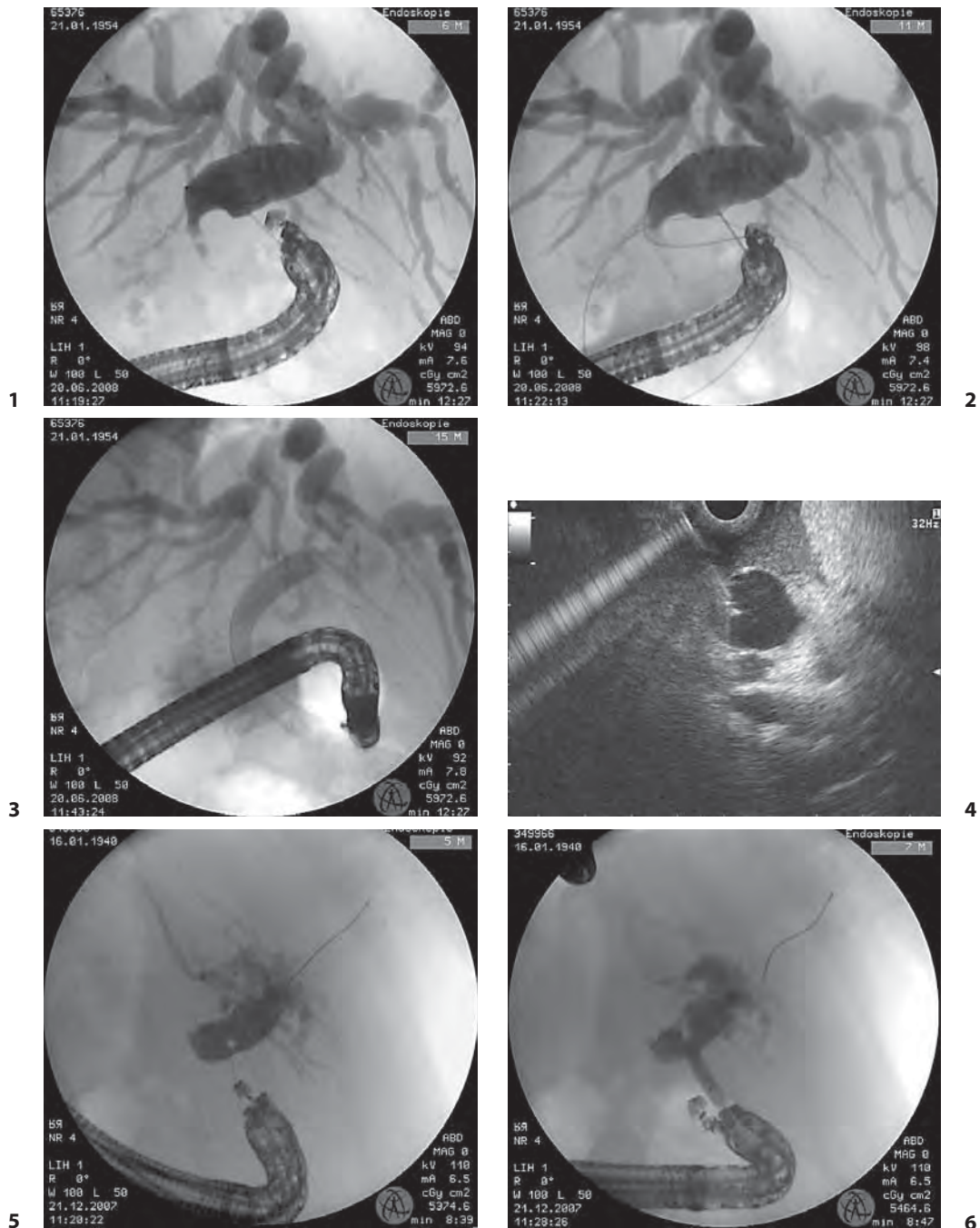
approached under focused endosonographic view by a puncture using a 19-G needle or a needle-knife catheter. The authors favor the 19-G needle since it can be faster placed into the biliary tree while the needle-knife catheter cannot be precisely visualized during the slow introduction step of the needle and the sonographic artifacts during electrocoagulation. However, the catheter is advantageous for the guidewire system since the tip of the Terumo wire cannot be sheared as possible (potential problem) in case of a sharp 19-G needle. If the biliary tree has been successfully punctured, bile is withdrawn for microbiologic investigation to initiate antibiotic treatment according to the antibiogram and results of an antibiotic resistance test if required. Independently from this, each EUCD has to be performed under peri-interventional antibiotic prophylaxis as it is well established (e.g., cefuroxime intravenously). Via the needle and catheter placed in the biliary tree, contrast media is applied to: (a) reveal the anatomy of the biliary duct and the type of biliary obstruction (proximally, distally, with flow of the contrast media into the jejunum or not), and (b) determine the next step of the approach.

In this moment, anatomy of the bile duct can be much better imaged by relocating the patient on the back. Via the 19-G needle, a 450-cm long, 0.035-inch guidewire (e.g., J wire; Boston Scientific, Ratingen, Germany) is introduced. The manipulation of the wire can be difficult through the 19-G needle, in particular, in rendezvous procedures (passage of the wire through the papilla or anastomosis) since, as already mentioned above, the tip of the Terumo wire can possibly be sheared at the sharp needle tip. If this happens, the wire cannot be moved any longer and further manipulations become impossible leading to the consequence that needle and guidewire need to be removed. To circumvent this potential problem, the bile duct should be tangentially punctured, which allows to avoid a 'zigzag' of the wire behind the needle. In case of a transgastric or transjejunal puncture of the biliary tree of the left hepatic lobe, it is recommendable to puncture in the direction to the hepatic hilus to guarantee a sufficient infeed of the wire. If the wire has to be relocated in case of an ongoing rendezvous maneuver, the puncture needle should be removed after initial infeed of the wire followed by the introduction of a 5-Fr bougie via the guidewire. By such a soft bougie, it can be attempted to overcome the malignant stenosis and to achieve the passage of the wire through the papilla. If this has been achieved, echoendoscopy can be substituted by a therapeutic duodenoscopy. Via the wire in situ, which is held by the duodenoscopy and led out of the mouth of the papilla, conventional transpapillary drainage can be performed (fig. 1–3).

The transgastric or transduodenal position of the wire will be kept as long as the stenosis has not been passed by the prosthesis during implantation. This allows getting through very solid/dense stenoses near the hepatic hilus by countermoving the wire. Subsequently, the wire is pulled back by the duodenoscopy. If the papilla can be reached but the wire cannot be passed through the papilla after former successful EUS-guided transgastric or transduodenal puncture of a(the) extra- (and/or) intrahepatic segment(s) of the biliary tree, the option of a rendezvous maneuver has to be abandoned and it can be intended to perform hepaticogastrostomy, hepaticojejunostomy or choledochoduodenostomy/choledochogastrostomy.

#### *EUS-Guided Choledochoduodenostomy/Choledochogastrostomy*

In patients with no previous surgical intervention and distal occlusion of the bile duct due to malignant tumor growth as well as extended caliber of the intra- and extrahepatic biliary tree, a primary transduodenal or transgastric antegrade drainage of the biliary tree should be attempted if the papilla cannot be reached or the wire cannot be passed through the papilla. This provides the advantage that, compared with a hepaticogastrostomy, there is an untouched anatomy of the



**Fig. 1.** Transduodenal EUS-guided puncture of the bile duct and subsequent cholangiography in stenosis of the papilla due to malignant tumor growth. **Fig. 2.** Infeed of the wire via the 19-G needle with passage of the wire through the papilla to prepare the rendezvous maneuver. **Fig. 3.** Substitution of the echoendoscope by a duodenoscope, holding and leading the wire out of the mouth of the papilla as well as transpapillary placement of a covered Wallstent. **Fig. 4.** EUS-guided choledochogastrostomy in a locally advanced pancreatic carcinoma: 1. Transgastric puncture of the bile duct using a 19-G needle. **Fig. 5.** EUS-guided choledochogastrostomy: 2. Placement of a guidewire within the intrahepatic segments of the biliary tree. **Fig. 6.** EUS-guided choledochogastrostomy: 3. After dilatation with 5-Fr bougies – balloon dilatation of the puncture site.

intrahepatic biliary tree as well as 'normal' physiology characterized by an antegrade flow of the bile. However, the prediction is that the common bile duct can be precisely imaged through the wall of the duodenal bulb or the antrum.

The echoendoscope is placed at the wall of the duodenal bulb or antrum at the site of the small curvature leading to a puncture direction exactly toward the hepatic hilus. It needs to be taken care of the fact that the endoscope is fixed with a stable position in situ to avoid an alteration of the subsequent interventional steps by a dislocation of the endoscope. Within the hepatoduodenal ligament, the three leading structures – portal vein, hepatic artery and common bile duct – can be easily identified also using color-coded Duplex ultrasonography for reliable differentiation of the anatomic structures. While a puncture of the middle segment of the common bile duct can be achieved transduodenally, the proximal segment of the extrahepatic bile duct can be rather accessed via a transhepatic puncture through the wall of the antrum and through the caudate lobe (fig. 4).

After successful puncture of the bile duct using a 19-G needle, alternatively using a needle-knife catheter, the puncture distance is held by placement of a 0.035-inch guidewire (fig. 5). Via this wire, endoscopic choledochostomy is created using a sequential dilatation (initially with 5-Fr and subsequently with 7-Fr bougies) or via a wire-guided cystostome as it is used for the treatment of pseudocysts. After enlargement of the puncture site up to the width of the 5-Fr bougie, alternatively, a dilatation balloon specifically designed for the biliary tree (4 mm are adequate) can be used (fig. 6).

The width of the choledochoduodenostomy/choledochogastrostomy should be chosen according to the size of the prosthesis which is to be implanted. The authors favor a covered metal prosthesis (fig. 7). Prior to this step, preparation of the former puncture site by dilating it up to 7 Fr is sufficient. If plastic prosthesis is used, the puncture site should be predilated up to 8.5 Fr or even 9 Fr. The use of a dilatation balloon may increase the risk of provoking a pneumoperitoneum, however, implantation of the prosthesis can be thus facilitated.

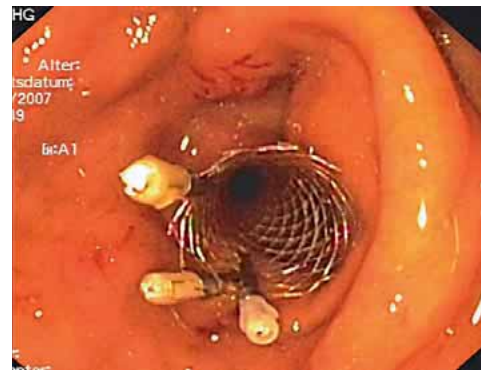
Transintestinal intervention via a wire in place to achieve a sufficient drainage of the biliary tree requires simultaneous fluoroscopic and endoscopic controls of the correct wire position in situ. In particular, it has to be strictly taken care of the requirement that the wire has to be held in a straight position while introducing it and that the echoendoscope is placed near the neostium. If loops of the wire form, the wire has to be straightened. Trying to correct the extraintestinal formation of such wire loops (between duodenum and bile duct) often causes dislocation of the wire leading to the consequence that the procedure has to be restarted.

If the prosthesis cannot be implanted into the bile duct after dilatation of the former puncture site using bougies or a balloon, dilatation or distension of the puncture site should be repeated. Via the wire placed in situ along the puncture site, each device of the equipment can be changed which underlines the necessity that an adequate wire position in situ is essential and should be steadily followed with great attention. The length of the prosthesis in a transgastric or transduodenal approach is recommended to be sufficient with 6–8 cm. Covered metal prostheses provide the advantage of a bigger lumen (10 mm) and of an immediate occlusion of the enteral and biliary access site but hold the risk of a peritoneal dislocation by lacking flaps. The authors try to avoid dislocation of the metal stent by a mucosal fixation of the stents using hemoclips (fig. 8).

How far the risk of a pneumoperitoneum or biliary ascites can be lowered cannot be stated currently. The transduodenal approach including the antegrade biliary fistula provides the advantage that it can also be used in patients with ascites since it is associated with a retrograde access site.



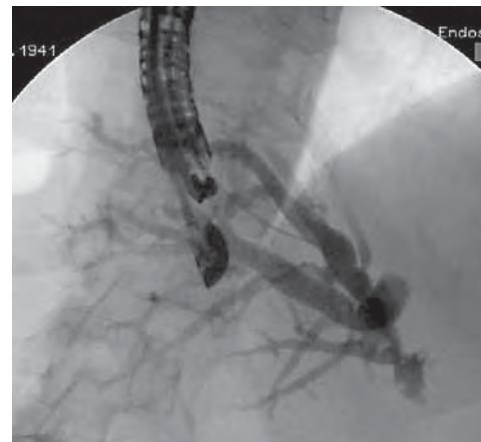
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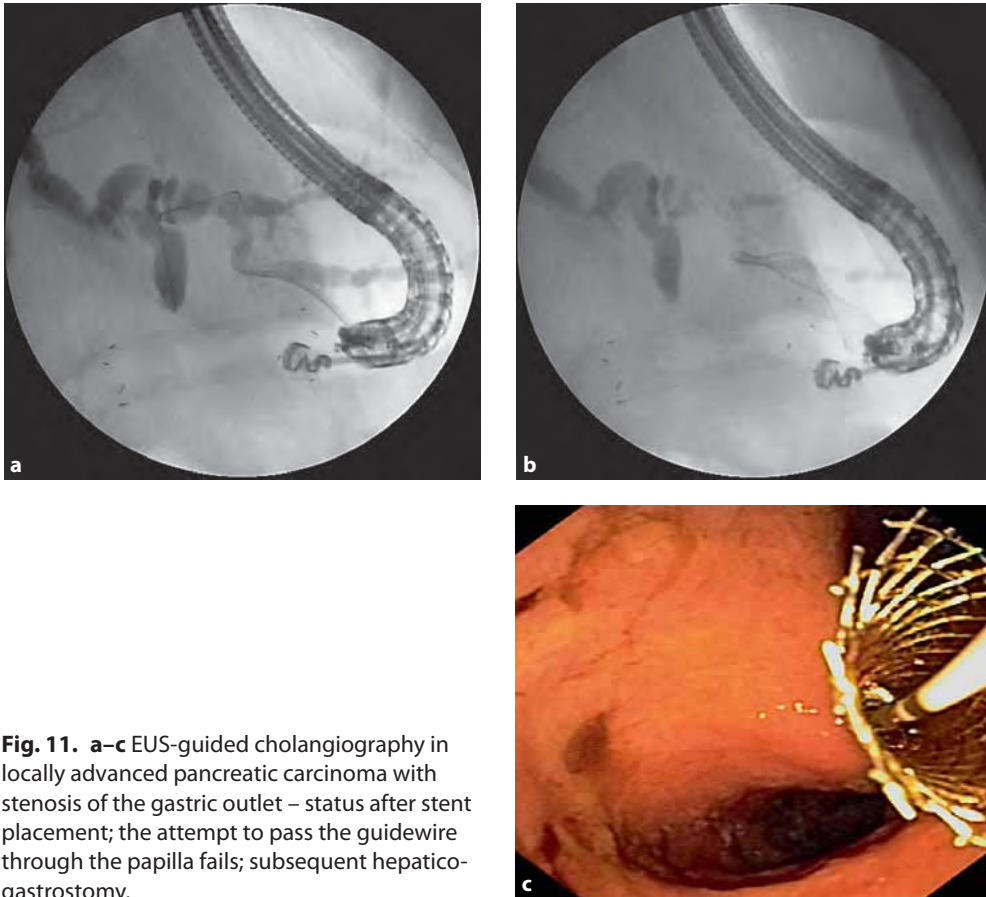
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**Fig. 7.** EUS-guided choledochogastrostomy: 4. Implantation of a covered Wallstent. **Fig. 8.** EUS-guided choledochogastrostomy: 5. Fixation of the metal prosthesis at the wall of the antrum to avoid dislocation. **Fig. 9.** EUS-guided hepaticogastrostomy in recurrent tumor growth after hemihepatectomy because of gallbladder carcinoma: 1. EUS-guided transhepatic puncture of the enlarged biliary duct within the left hepatic lobe. **Fig. 10.** EUS-guided hepaticogastrostomy in recurrent tumor growth after hemihepatectomy because of gallbladder carcinoma: 2. Cholangiography with retention of bile within the biliary tree before hepaticojejunostomy.

#### *EUS-Guided Hepaticogastrostomy/Hepaticojejunostomy*

In patients with former surgical intervention(s) (such as gastrectomy, BII-gastric resection, pancreaticoduodenectomy, hepaticojejunostomy) and in case of biliary obstruction due to malignant tumor growth including an enlarged intrahepatic segment of the biliary tree or in patients with complete obstruction of the bile duct in whom an antegrade EUCD cannot be achieved, hepaticogastrostomy/hepaticojejunostomy should be aimed for. Contrarily to choledochogastrostomy/choledochoduodenostomy, the biliary tree is drained retrogradely via the transhepatic route.

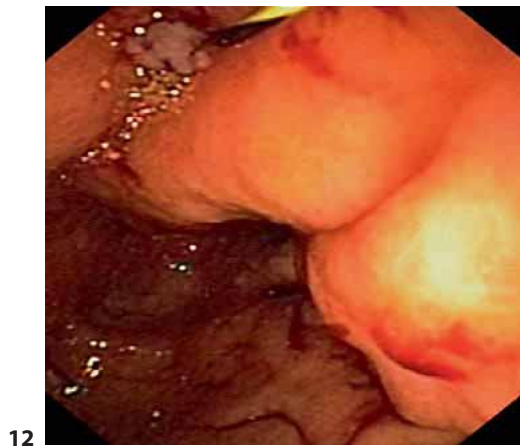
While passing the aboral segment of the esophagus and the cardia, the left hepatic lobe should be transluminally identified and thus the enlarged intrahepatic ducts of the biliary tree of the third and second hepatic segment can be followed toward the hepatic hilus by a continuous right turn and infeed of the endoscope. If the anatomy of the intrahepatic biliary ducts of the left hepatic lobe has been revealed, the optimal route to approach these ducts should be selected.



**Fig. 11. a–c** EUS-guided cholangiography in locally advanced pancreatic carcinoma with stenosis of the gastric outlet – status after stent placement; the attempt to pass the guidewire through the papilla fails; subsequent hepaticogastrostomy.

Optimal conditions are: (1) stable (adherent position of the stomach/jejunum at the left hepatic lobe – be aware of possible ascites [!]); (2) stable, possibly straight position of the echoendoscope to avoid dislocation of the bougies and stents; (3) tangential puncture of a large branch of the bile duct, with no further small branches ending in this large branch in the direction to the hepatic lobe to ensure an optimal infeed of the guidewire, and (4) short distance through the liver parenchyma to limit the resistance for dilatation using bougies/balloon. If these requirements for a successful drainage are given, a puncture using a 19-G needle is performed very similar as done for duodenocholedochostomy (fig. 9). After obligatory sampling of bile for microbiological investigation, cholangiography follows (fig. 10, 11a–c).

Also under these circumstances, it appears to be reasonable to investigate the patient lying on his back to reveal and image more appropriately anatomy of the biliary tree and pathology of its obstruction, in particular, near the hepatic hilus. Simultaneously, the route to approach the bile duct or its branches should be investigated to determine the length and type of prosthesis which is needed. In case of placement of covered metal prostheses, the specific aspect that the mouths of the biliary duct branches are not ‘overstented’ to disfavor an appropriate drainage needs to be taken care of. If this problem cannot be satisfyingly ruled out, plastic prostheses should be preferred.



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**Fig. 12.** Endoscopic view after introduction of the guidewire through a 19-G needle. **Fig. 13.** Dilatation using 5-Fr bougie via the wire in position. **Fig. 14, 15.** Endoscopic and radiological finding of a balloon dilatation to create a hepaticojejunostomy in case of locally advanced gallbladder carcinoma and status after gastric resection according to the BII procedure (cf. fig. 16, 17). **Fig. 16, 17.** Transjejunal EUS-guided placement of two covered Wallstents to drain biliary tree of the right hepatic lobe in locally advanced gallbladder carcinoma (status after former gastric resection according to the BII procedure which does not allow to reach papilla).

A 0.035-inch wire should be infeed through the 19-G-puncture needle into the biliary tree. Wire position may not be corrected by retrograde pulling too often to avoid shearing of the tip of the Terumo wire. After substitution of the needle by a 5-Fr bougie, the wire position can be corrected with no further serious problems (fig. 12, 13).

During dilatation using bougies, formation of wire loops within the gastric lumen but, in particular, perigastrically should be avoided. Therefore, all manipulations should be controlled using fluoroscopy. During the EUS-guided puncture, the stomach is held close to the left hepatic lobe by the endoscope. After infeeding the wire, further maneuvers are endoscopically controlled but giving up the holding position and purpose of the echoendoscope leading to the generation of an empty space between liver and stomach. Primarily, there is a straight position of the wire through this space, however, during the bougie change including intermittent infeed of the wire, a wire loop can form which can be difficult to be straightened. If this is impossible, the placement of the prosthesis cannot be achieved. In case of much ascites leading to a great distance between stomach and liver, this proximal transhepatic approach should not be favored.

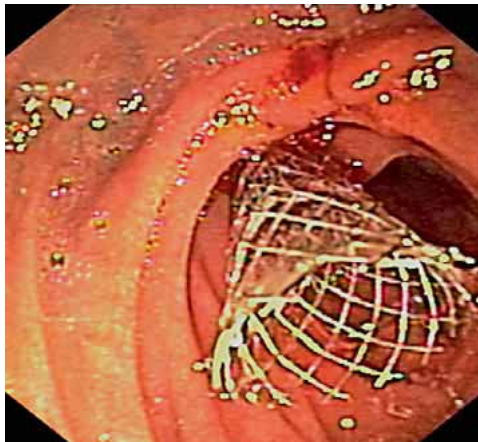
After sequential dilatation using bougies up to 7 Fr, placement of a covered Wallstent can be achieved. In case of plastic prostheses of 8.5 Fr in size, sometimes it is recommendable to dilate the access site up to the width provided by a 9-Fr bougie. In case of a dense liver or problems in infeeding the bougies, a dilating balloon of 4 mm in size can be helpful to enlarge the access channel (fig. 14, 15).

Peritoneal dislocation of the transgastric or transjejunal drainage can only rarely occur because of the holding flaps and the pigtail in plastic prostheses, while in metal prostheses, this might happen as has been described and observed in treated patients of the reporting department. To avoid such dislocation during the release of the prosthesis, again, the maneuver should be controlled by fluoroscopy and endoscopic view (fig. 16, 17). A delayed stent dislocation can be avoided by prophylactic placement of clips (fig. 18, 19).

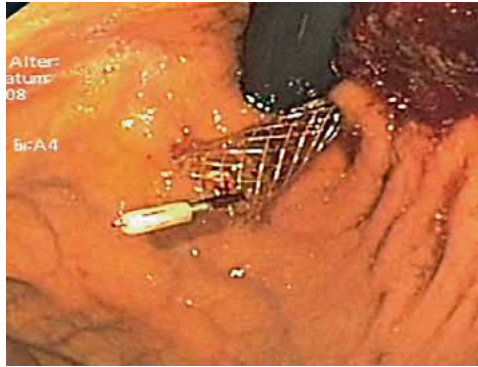
#### *EUS-Guided Transhepatic Internal Drainage with No Rendezvous*

In case of a specific anatomy, in which papilla cannot be reached or in case of malignancy-induced anastomotic stenosis after former hepaticojejunostomy, it can be attempted, very similar to a PTCD with internal placement of a metal stent, to get through this stenosis using an EUS-guided internal drainage. If this can be achieved, orthograde biliary drainage can be sustained. As a possible route to the biliary duct, the transgastric approach is recommended. The initial steps are identical with those mentioned above. After getting through the central or distal stenosis of the bile duct, the length of the stenosis is measured and the transhepatic route to implant the metal prosthesis can be prepared. In contrast to hepaticogastrostomy, metal prosthesis is completely introduced into the biliary tree to get through the stenosis and it is internally released leading to a regular bile flow as usual. The transgastric access site is clipped after removal of the devices, or a second metal prosthesis can be implanted (fig. 20, 21). The advantage of the method is that the physiological bile flow can be sustained and that a peritoneal dislocation of the metal prosthesis is impossible.

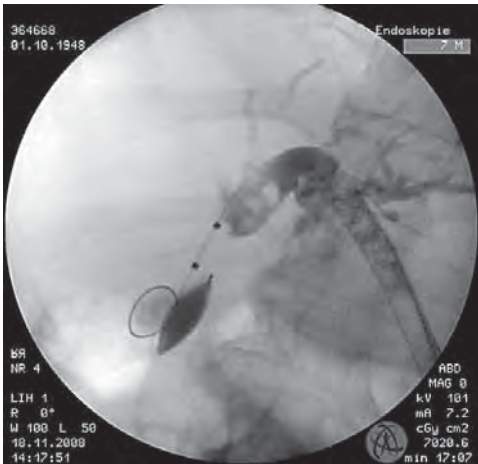
In table 3, the suggested methods of EUCD are listed and were associated with the appropriate indications reflecting personal experiences and reports from the literature.



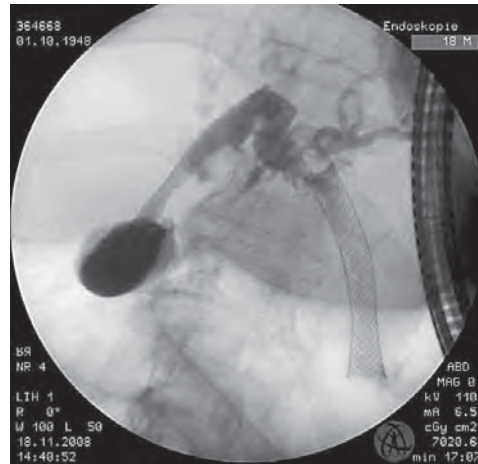
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**Fig. 18, 19.** Endoscopic finding of a transjejunal hepaticojejunostomy with no clips for fixation and a transgastric hepaticojejunostomy with a clip for fixation to avoid dislocation. **Fig. 20, 21.** Status after former hemihepatectomy in case of a Klatskin's tumor showing recurrent tumor growth; EUS-guided cholangiography: tumor stenosis and cholangiolithiasis; 1. Creation of a hepaticogastrostomy; 2. Stone extraction; 3. Open up the tumor stenosis with a metal stent.

## Postinterventional Care

Patients after EUCD should be equally treated as patients who have undergone ERC with drainage. Peri-interventional prophylaxis with antibiotic has already been mentioned above, however it is recommended to continue it initially as calculated therapy for 7–10 days, which needs to be optimized if necessary after bile has been microbiologically investigated.

Patients stay 'n.p.o.' through the whole day of intervention, undergo infusion and administration of analgesics if necessary. The first obligatory control of the stent patency and position should be undertaken on the first postinterventional day with percutaneous abdominal ultrasound and analysis of appropriate laboratory parameters. Using abdominal ultrasound, aerobilia should be detected as evidence for effective drainage (fig. 22, 23). The stent should be completely imaged according to its total length, in particular, the segment protruding into the intestinal

**Table 3.** Indications correlating to the methods of EUCD

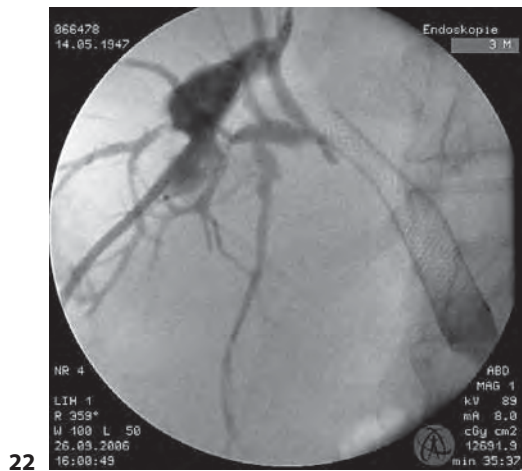
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1. Rendezvous technique with ERC – transduodenal, transgastric puncture  
Normal anatomy of the gastrointestinal tract, papilla can be reached  
After EUS-guided puncture of the biliary tree and passing the wire out of the papilla conventional ERC with transpapillary drainage
  2. Choledochoduodenostomy/choledochogastrostomy  
Normal anatomy of the stomach/bulb; papilla cannot be catheterized  
Failure of rendezvous technique  
Duodenal stenosis because of malignant tumor growth  
Distal tumor stenosis of the bile duct  
Status after gastroenteroanastomosis
  3. Hepaticogastrostomy/hepaticojejunostomy  
Status after gastrectomy, status after Bill gastric resection  
Status after hepaticojejunostomy  
Status after pancreaticoduodenectomy  
Normal anatomy – obturated common bile duct  
Proximal tumor stenosis
  4. Transhepatic EUS-guided drainage of the biliary tree  
Papilla cannot be reached  
Malignancy-induced stenosis of the bile duct or at its intrahepatic segments/branches  
Malignancy-induced stenosis at the hepaticojejunostomy.
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lumen should be precisely measured. In patients with complaints, dispositioning of the stent needs to be taken into account, which can lead to the generation of a biliary peritonitis (fig. 24, 25). A postinterventional pneumoperitoneum is frequently reported but is classified to be harmless if the drainage function is satisfying.

Since all patients undergo EUCD because of a malignant incurable disease and drainage was placed under palliative intention, reinterventions are rather rare because of the long-lasting patency of metal stents. In case of stent occlusion, it can be attempted to change the stent via the neostium as it is handled in ERC or the same EUCD procedure is performed again.

### **Treatment Results and Outcome**

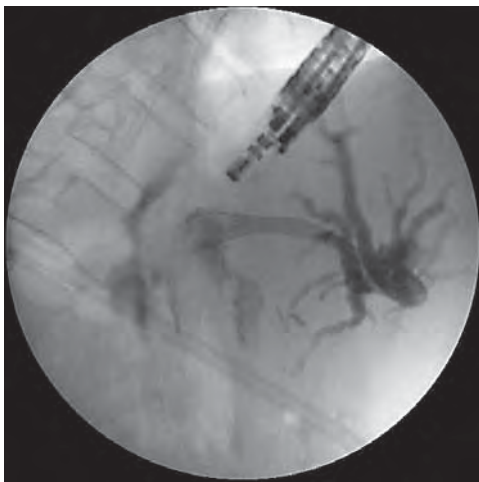
EUCD is considered a novel therapeutic alternative of internal biliary drainage in patients with obstructive malignant jaundice and unsuccessful ERC or PTCD. In the literature, three technical options of EUCD have been described – rendezvous technique, hepaticogastrostomy/hepaticojejunostomy, and choledochogastrostomy/choledochobulbostomy. Until today, approximately 100 patients have been reported correcting the total number of those who underwent EUCD but were listed and described twice [9–18]. While in approximately 27 cases, successful drainage could be achieved by the rendezvous technique, the remaining cases underwent direct EUS-guided biliary drainage. Transhepatic retrograde biliary drainage via the left hepatic lobe and extrahepatic antegrade biliary drainage of the bile duct were achieved with a plastic stent in two thirds of cases whereas in the residual one third, a covered metal stent was used. While there is a success rate of almost 100% in EUS-guided cholangiography, this rate is slightly lower (mean, 91%) ranging from 75 to 100% in EUCD. However, a clinical long-term success rate has not been provided by all studies but if reported it ranges from 80 to 100% (mean, 90%). Thus, feasibility



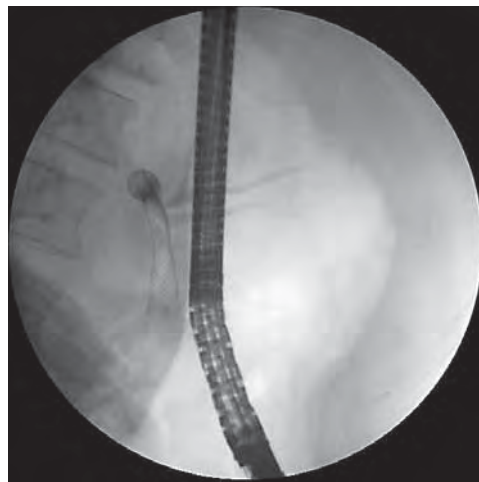
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**Fig. 22, 23.** Hepaticogastrostomy with metal stent in situ; ultrasound control of the function (aerobilia, intraluminal length of the stents – be aware of possible dislocation). **Fig. 24, 25.** After stent release, stent dislocation occurs; endoscopic transgastric stent removal; placement of a PTCD.

of EUS-guided biliary drainage has been demonstrated, in contrast, there are only preliminary data on the clinical safety of the technique. EUCD has been performed in several high-volume endoscopy centers. Complication rates range from 0 to 25% (mean, 15.7%). The spectrum of potential complications comprises pneumoperitoneum, cholangitis, stent migration and biliary leakage with peritonitis [11, 13, 16–18].

Currently, EUCD still needs to be considered an experimental procedure which has to be performed by experienced interventional endosonographers and endoscopic clinicians in large gastroenterological centers [10, 14, 16, 17]. There is a number of open questions which finally need to be assessed: (1) Should EUCD only be used in patients with obstructive jaundice and malignancy, or can it also be used in patients with benign diseases? (2) When is EUCD reasonable in the therapeutic algorithm (primarily after unsuccessful ERC/PTCD or always before PTCD)? (3) Which type of biliary drainage is the safest if the EUS-guided rendezvous technique

cannot be achieved (hepaticogastrostomy/hepaticojejunostomy; choledochogastrostomy/choledochobulbostomy)? (4) How can the access to the biliary tree be achieved (FNP with needle and atraumatic access via guidewire, bougies/balloon dilatation or more traumatically using high-frequency diathermia)? (5) Which stent can be favored (covered metal/plastic stent – straight or curved)? (6) Should a change of the stents be aimed for, and, if yes, in what time intervals?

The currently established advantage of EUCD with regard to patient comfort and morbidity in comparison to PTCD needs to be investigated in a randomized study. A general recommendation to perform EUCD in case of unsuccessful ERC can, at present, still not be given.

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