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Review Article

Updates in Endoscopic Retrograde Cholangiopancreatography

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Abstract

Endoscopic retrograde cholangiopancreatography (ERCP) is a specialised endoscopic procedure for managing pancreatic and biliary diseases. Earlier in the 1970s, ERCP was mainly used for diagnostic purposes to evaluate the biliary and pancreatic ducts and surrounding structures. But nowadays, as non-invasive imaging studies advance, it is primarily used for therapeutic purposes though it is used for therapeutic and diagnostic purposes.

Therapeutic ERCP is broadly used in conditions that lead to impairment in bile flow and leak. The requirement of the ERCP extended further for evaluation of pancreatitis of unknown aetiology, preoperative evaluation of the patient with chronic pancreatitis and evaluation of the sphincter of Oddi by manometry.

Patients should be selected with a clear-cut indication for ERCP, avoiding unnecessary or marginally indicated ERCP, especially in high-risk patients. ERCP is usually performed using a dedicated side-viewing endoscope with the patient positioned prone on a fluoroscopy table under sedation or general anaesthesia. Proper positioning of the duodenoscope is the key to cannulation of the pancreatic or common bile ducts.

Keywords: ERCP, bile duct stones, cholangitis, duodenoscope, chronic pancreatitis, minimally invasive therapeutic procedure.

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) is a specialised endoscopic procedure for managing pancreatic and biliary diseases. The common bile duct (CBD) and/or the pancreatic duct (PD) are accessed via papillary orifices or surgical anastomoses [1]. This procedure combines the use of a side-viewing endoscope, also called duodenoscope and fluoroscopy [2]. The procedure is done by injecting a contrast medium, which helps visualise the pancreatic and biliary ductal systems.

The first endoscopy was developed and performed by Phillip Bozzini in 1806 [3], and the first bile duct (BD) imaging was performed in 1920 [1]. The specialised fibreoptic duodenoscope was first described by William McCune in 1968 and credited with the first report of endoscopic cannulation of the ampulla of Vater [4]. In 1973 first biliary sphincterotomy was performed to facilitate BD stone removal, and in 1974 the first endoscopic papillary balloon dilation was performed [1-2].

Earlier in the 1970s, ERCP was mainly used for diagnostic purposes to evaluate the BD and PDs [1]. But nowadays, advancements in non-invasive imaging studies such as Magnetic resonance cholangiopancreatography (MRCP), Contrast-enhanced computer tomography (CECT) and Endoscopic ultrasonography (EUS), ERCP is not preferred by clinicians for diagnostic.

Indication and Contraindication

ERCP is an advanced endoscopic procedure that should be performed by trained endoscopists using standard techniques, and there should be a clear indication for this procedure. The indication for ERCP may be diagnostic or, more frequently, therapeutic [1,6]. Therapeutic ERCP aims to re-establish the biliary drainage to the duodenum [1]. Therapeutic ERCP is broadly used in conditions that lead to impairment in bile flow (e.g.,

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biliary or pancreatic stones and malignant or benign stricture) and bile leaks [1,6]. Urgent or emergency ERCP is indicated when establishing biliary drainage is essential with or without a proven cause of biliary obstruction, e.g., ascending cholangitis [1-2,6].

Requirement of the ERCP extended further for evaluation of pancreatitis of unknown aetiology, preoperative evaluation of the patient with chronic pancreatitis and assessment of the sphincter of Oddi by manometry in patients with suspected type II Sphincter of Oddi dysfunction [2,4]. It is also helpful in endoscopic sphincterotomy in Choledocholithiasis, sphincter of Oddi dysfunction type I, Sump syndrome, papillary stenosis, stricture therapy and facilitating stent introduction or to enable access to the PD [2,6]. ERCP-guided stent placement mainly being used for benign or malignant strictures, fistulae, postoperative bile leak, or in high-risk patients with a large stone in the BD, which is difficult to remove [2,6-7]. In re-establishing bile flow, ERCP-guided dilation of intra-biliary strictures and balloon dilation of the papilla (sphincteroplasty) offer additional value [8,9]. Though the ERCP is primarily used for therapeutic indications, there are diagnostic indications where the ERCP becomes the primary tool for diagnosing some conditions that are unclear in imaging studies. In addition to facilitation of cholangioscopy and/or pancreatoscopy, the ERCP help in tissue sampling from PD or BD and ampullectomy of adenomatous lesions of the major papilla to ensure the biliary or pancreatic drainage [1,2,6].

ERCP should be avoided or cautiously performed in a patient with a previous history of pancreatoduodenectomy, coagulation disorder or using anticoagulant/antiplatelets, recent myocardial infarction and history of contrast dye anaphylaxis [2].

Patient preparation

The clinical condition of the patients and the treatment modalities should be thoroughly discussed with the patients and their family members compassionately before doing ERCP. While obtaining informed written consent, the patients should be aware of the procedure techniques, risks and complications, advantages and disadvantages of ERCP and alternatives [2].

All the patients should undergo pre-procedure evaluation with proper clinical history, examination, and investigative assessment for a successful procedure [2,10]. Basic investigations such as full blood count and prothrombin time/international normalised ratio needs to be checked prior to the procedure. In addition to cardiovascular, respiratory assessments and basic investigations, some conditions may need further investigations, such as coagulation screening in patients with coagulopathy, chest X-ray in patients with new respiratory symptoms and 2D Echo in patients with decompensated cardiac failure. Patients using anti-platelets or anti-coagulants should be evaluated and withhold or modify their medications at adequate intervals before the procedure [2,5].

Prophylactic antibiotics should be administered to high-risk patients before or after the procedure. Patients should be fasting for 6 hours before the procedure [1,5]. On top of all these preparations, the endoscopist should review all the previous abdominal imaging findings [CT and MRCP] just before the procedure [2,10].

Techniques and difficulties

ERCP is usually performed using a dedicated side-viewing endoscope with the patient positioned prone on a fluoroscopy table under sedation or general anaesthesia [1,2]. The duodenoscope is advanced to the second part of the duodenum and aligned with the major duodenal papilla to access the BD and/or PD. The major duodenal papilla appeared as a small, pink-coloured protuberance at the junction of the horizontal and the vertical duodenal folds (T-junction) (Figure 1) [2]. Proper positioning of the duodenoscope is the key to cannulating the PD or CBD. To cannulate CBD, the scope should be positioned to view the papilla in the upper part of the video monitor, and the cannulation device should be aimed slightly tangentially to the 11 o'clock position to make the cannulation easier [5,11]. PD cannulation can be achieved by an approach more perpendicular to the duodenal wall, and the device should be pointed to the one o'clock position [11].

Figure 1: Major duodenal papilla

Once deep cannulation has been obtained by the introducing cannulation device tip into the papillary orifice, radiopaque contrast is injected under fluoroscopic visualisation to confirm cannulation and proper positioning and to describe the normal anatomy of the duct and abnormalities. The wire guide approach also helps in deep cannulation, which involves a guide wire passage under fluoroscopy into the PD or CBD before the injection of contrast. PD access with guidewires and protection with pancreatic stents facilitate biliary access [2,11].

Obtaining biliary or pancreatic access can occasionally be challenging even for an advanced endoscopist in some conditions like duodenal or ampullary distortion by tumour, intra-diverticular papilla, or postsurgical ductal anastomoses [5,10]. A periampullary diverticulum,

which occurs in approximately 7.5% of patients, is the most common abnormality associated with difficult cannulation [2]. Many techniques and devices can help access BD or PDs when the standard cannulation technique is unsuccessful [5,11]. Pre-cut sphincterotomy is an incision made with a papillotome to enter the desired duct. It is generally associated with increased complications, possibly due to prior access attempts or the pre-cut itself [1]. In some cases, needle knife fistulotomy is also used for biliary access when there is a prominent papilla and dilated BD in which the roof of the papilla is punctured directly by avoiding the papillary orifice [1,2]. The rendezvous procedure also helps as an alternative for cannulation in difficult conditions. An interventional radiologist inserts a percutaneous trans hepatic catheter before or while doing the ERCP by using Endoscopic ultrasonography (EUS). EUS helps obtain antegrade access to the BD or PD, and a wire passes through the papillary or anastomotic orifice to complete ERCP. In the modern era, advanced endoscopists use EUS combined with ERCP as it helps with drainage and debridement of intra-abdominal and retroperitoneal collections, e.g., pseudocysts walled off pancreatic and peripancreatic necroses, and postoperative collections [1,11].

Though several alternative techniques are used in difficult cannulation of ERCP, no approach is universally superior to another (Table 1). The ideal approach is determined by operator expertise and the clinical situation [1].

Table 1: Commonly used therapeutic techniques for removal of bile duct stones

Biliary sphincterotomy
Stent placement
Large (>10 mm) balloon dilation
Balloon extraction
Basket extraction
Temporary plastic (or metallic) biliary stents
Lithotripsy techniques
Mechanical lithotripsy
Intraductal cholangioscopically directed lithotripsy
Electrohydraulic lithotripsy
Holmium laser lithotripsy
Extracorporeal shock wave lithotripsy

Sphincterotomy

Sphincterotomy helps to eliminate the anatomic barrier by cutting the biliary sphincter to allow impending stone passage and facilitate stone extraction (Figure 2) [1,2]. Sphincterotomy was performed using electric cauterisation to create an incision through the musculature of the biliary portion of the sphincter of Oddi. Sphincterotomy length should be tailored to the size of the bile duct. It is preferred to do up to the level of unroofing the papilla as it will help easy access to the CBD and reduces the risk of developing papillary necrosis. If it is not dilated, there is a risk of retroperitoneal perforation during sphincterotomy for CBD. The sphincterotome is also helpful in deep cannulation in a patient who underwent partial

gastrectomy with Billroth II anastomosis, as the standard technique is unsuccessful [2].

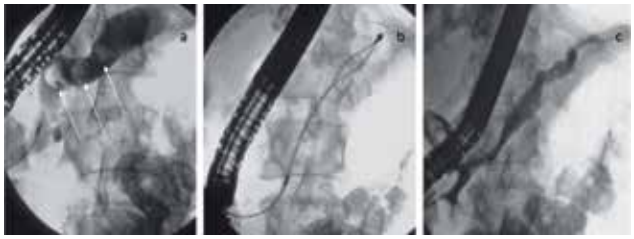

Figure 2: Fluoroscopy showing large pancreatic stones (a), basket extraction (b), and complete clearance (c)

Treating choledocholithiasis

Treatment involves sphincterotomes with an extraction basket and balloon. The baskets are used in conditions with duct dilatation and/or multiple large stones. In contrast, the balloons are used in conditions with no duct dilatation and/or single free-floating stone, and the balloons are also used when multiple small stones are present or when a large stone is being crushed [2,5,11]. In basket extraction, basket impaction within the duct is risky due to impending basket wires on the stone's surface. In these circumstances, mechanical lithotripsy helps break the stone trapped within the basket. The impaction of the basket can be prevented by extracting the distal stone first when multiple stones are present. It is also reduced by gently pulling the basket without closing it up to the periampullary level [2,11,12].

Papillary balloon dilatation (sphincteroplasty)

The special balloon performs papillary balloon dilatation under controlled pressure to dilate the ampulla. It can be performed alone or in combination with a small sphincterotomy to extract the stones (Figure 3) [9].

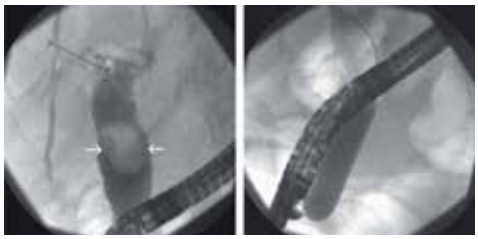

Figure 3 : Endoscopic papillary large balloon dilation to extract a very large BD stone after sphincterotomy but without requiring mechanical lithotripsy: very large stone (arrows), followed by balloon dilation to 15 mm (left to right).

There is less chance of developing post-procedure pancreatitis in combination with large balloon dilation with small sphincterotomy, and it is safer and allows stone extraction without mechanical lithotripsy [2,8-9]. This technique is preferred for patients with bleeding disorders, periampullary diverticulum, or Billroth II gastrectomy. In this procedure, the balloon inflated to 10mm for 20 to 60 seconds (Figure 4) [2,11].

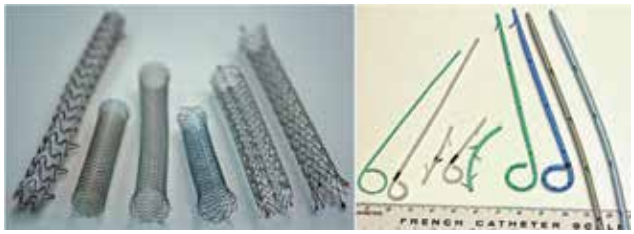

Figure 4 a): A variety of self-expanding metallic biliary stents, both covered (three on the left), and uncovered (three on the right). b) A variety of plastic stents used in the pancreatic duct for prophylactic and therapeutic purposes, ranging from 3 Fr on the left to 10 Fr on the right.

Endoscopic prosthetic stent placement

Prosthetic stent placement is an integral part of therapeutic ERCP. Stent placement is helpful in the re-establishment of biliary and pancreatic flow [1]. The stenting is primarily indicated for palliative management in malignant conditions and treatment of benign conditions such as stricture of the biliary tree, bile duct stones and bile leaks [2]. Pancreatic stents are also placed to treat recurrent pancreatitis, strictures, and duct leaks, to facilitate pancreatic stone removal, and to reduce the risk of post-ERCP pancreatitis [1,2,7,13-14].

In pancreatic or biliary malignant obstructions, the stents bridge surgery or palliation in patients with unresectable tumours with terminal disease [7,14]. Malignant conditions in which stenting is usually indicated are distal malignant biliary obstruction (often due to pancreatic cancer, cholangiocarcinoma, or external compression from lymph node metastases), hilar obstruction, may resulting from cholangiocarcinoma (Klatskin tumour), gallbladder carcinoma, hepatoma, local extension of pancreatic cancer, solid metastases, or compression from lymph nodes [1,7,13-14].

The pancreaticobiliary stents are in two categories, plastic and metallic stents (Figure 4) [1]. The metallic stents are self-expandable (Self-expandable metal stents: SEMS), have wider lumen than plastic stents (8 or 10 mm) and are variable in lengths (4–10 cm), which can be uncovered and partially or fully covered. The metal component can be stainless steel, nitinol (nickel and titanium), or Platinum (platinum core with

nitinol encasement) [1-2,7,15]. Among those metallic components, Nitinol is preferably used due to its ability to maintain the shape of the curved lumen [2]. Metal stents are cylindrical, made of interwoven alloy wires, with some stents having proximal and distal flaring to reduce migration. Biliary SEMS are deployed with through-the-scope (TTS) delivery systems. After the deployment, the stent material embeds into the tumour and normal tissue by expansible and radial pressure. Although metallic stents are only approved for malignant conditions, fully covered self-expandable metal stents (FCSEMS) are easily removable and capable of preventing tissue ingrowth, so they are increasingly used in benign conditions [1,7,16]. The choice of appropriate stent varies by clinical scenario, availability, and operator expertise [2,7,17].

Plastic stents can be in various shapes, including straight (Amsterdam), single-pigtail, and double-pigtail. One, two, or four flaps are at each end of the plastic stents to anchor the stent. Stents are available in different diameters, including 7, 8.5, 10, and 11.5 Fr, with lengths ranging between 5 and 15 cm. The plastic stents can be kept in place for a period ranging from 60 to 200 days [2,7].

Covered metal stents treat patients with unresectable tumours with an expected survival of more than 3 to 6 months [1-2,7,14]. Increased rate of stent migrations, inability to use them at the level of hilum and the possibility of stent-induced cholecystitis are considered disadvantages of the covered stents [1-2,7,14,18]. The uncovered metallic stents treat biliary obstruction caused by external compressions [2,7]. Placing covered metal stents in a patient with proximal biliary stricture should be avoided as it can cause blockage of the right or left hepatic duct [1-2,16]. It should be considered to place a plastic stent or short distal metal stent in a patient with distal biliary obstruction due to a resectable tumour [1,13]. For patients with hilar obstructions, stenting of both the right and left systems with either plastic stents or uncovered SEMS is indicated to decrease the risk of cholangitis [2,16].

There are several complications encountered in prosthetic biliary stenting. Stent occlusion and migration are the most common complications [2]. It may also cause cholecystitis, cholangitis, pancreatitis, perforation and bleeding as less common complications [2,5,19,20]. Though various stents (Plastic or metal) are indicated to treat some specific condition, a few characteristics of the stents can influence their selection and limit their usage. Limitations for using each type of stent are as follows (Table 2) [1,7,14] .

Table 2: Limitations of prosthetic stents

Plastic stents
Excessive length to diameter
Lack of conformability
Early occlusion
Risk of migration
Bacterial colonisation
Cholangitis from stent occlusion or nondrained segments
Difficulty in placement of multiple stents

Metal stents
Placement in patients with benign disease
Placement in wrong segmental ducts
Preclude resection
Tumour ingrowth
Stone formation
Reactive hyperplasia
Cholangitis – early or late
Erosion into vessels (bleeding)

Stricture dilatation

Biliary tree strictures can be benign, malignant or indeterminate. Stricture dilation can be achieved by using dilating catheters (up to 11.5 Fr) and a Gruntzig-type balloon (up to 30 Fr = 10mm, which is performed at 4 to 6 atm pressure), which is followed by stenting temporarily by the stent having a smaller diameter than the maximum diameter of the balloon [2,8,9]. The primary aim of the ERCP stricture dilation varies with the primary types of strictures. In benign stricture, dilation is used to establish the biliary drainage and treat the stricture. In malignant stricture, dilation is performed to bridge the treatment before surgery in resectable tumours or for palliative care in unresectable tumours

[1,2,9]. Indeterminate biliary strictures are one of the indications for both diagnostic and therapeutic ERCP. For the evaluation of indeterminate stricture, ERCP is used for multiple tissue sampling and cholangioscope evaluation [1,10,21].

Biliary leaks

Bile leaks most commonly result from iatrogenic injury during cholecystectomy. It may also result from pancreatic resection, hepatic resection, trauma, or necrotising pancreatitis' de novo complication [1]. ERCP and stenting is the management option. Fully covered SEMS can be used in a patient with voluminous biliary leakage with large defects in bile ducts [22-27]. The biliary stents can be kept in place for 4 to 6 weeks until the leak settles, and they can be removed by endoscopy (Figure 5) [2,25-26].

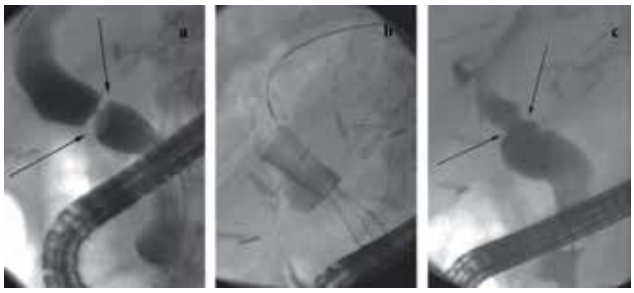

Figure 5: Anastomotic stricture after liver transplant (arrows) (a), treated with self-expanding metallic covered stent (b), with complete resolution of stricture after removal of stent (c). Source: Courtesy of Rajeev Attam, MD

Cholangioscope

Cholangioscope allows direct visualisation of the bile duct and helps in tissue sampling and directed therapy in particular conditions. Cholangioscopy can be performed by three different modalities, which are mother–daughter scope, spyglass system and slim or ultra-slim upper endoscopes [1-2,12].

The mother–daughter system is a fragile system that usually needs two operators, in which a small choledochoscope is advanced through the working channel of the duodenoscope. The spyglass system is a single-operator cholangioscope (SOC) system. In this technique, the fibreoptic bundle is advanced into the BD through a 10 Fr disposable sheath in which the fibreoptic bundle has four-way control, as for an endoscope, to steer the sheath inside the bile duct (Figure 6). This system needs adequate water irrigation to visualise biliary or PDs. This system has an additional channel for tissue sampling and introducing therapeutic devices such as stone lithotripsy probes. There are limitations in the Spyglass system as its image quality gradually reduces with subsequent usage due to the breakage of the individual fibres of the fibreoptic bundle, and replacement of the fibres is very expensive. This system has a 7%–10% risk of developing cholangitis due to prolonged water irrigation in the bile duct [1]. As the spyglass system can operate by a single person and its advantages in evaluating intraductal pathologies and therapeutic usage, it has become more popular among clinicians despite all the limitations. Placement of an ultra-slim upper endoscope directly into the bile duct is a technique that helps provide high-quality digital video images. However, the duct may be too small to accommodate the endoscope, or the scope may fall out of the ampullary opening as it is advanced due to the formation of a loop in the duodenum [1,5,10-12].

Complications

Though it is a safe and minimally invasive therapeutic procedure, it has rare complications that should be detected early and treated accordingly [5,12,19-20,27-29].

Acute pancreatitis is the most common complication in ERCP, especially associated with sphincterotomy, but it also can occur in ERCP without sphincterotomy. It ranges from 2% to 20%, depending on the patient and procedure. e.g., Sphincter of Oddi's dysfunction is associated with a 20% chance of developing pancreatitis, while CBD

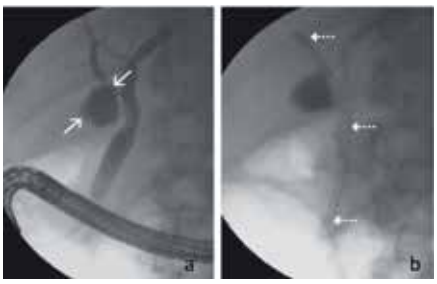

Figure 6: Cholangiograms showing a post cholecystectomy leak from an aberrant, low-insertion, right posterior sectoral duct, into which the cyst duct drained and was inadvertently injured during cholecystectomy. Leak shown by arrows (a) and 10 Fr stent placed transpapillary into right posterior sectoral duct bridging the leak (b) (arrows).

calculus is associated with less than a 5% chance [2,19-20,27,29]. The risk of developing pancreatitis can be reduced by following the strategies, including the selection of patients with absolute indication by avoiding unnecessary or marginally indicated ERCP, modifying the procedure with efficient cannulation with minimal pancreatic injection and instrumentation, considering pancreatic stenting in high-risk patients and considering pharmacological treatment in high-risk patients. (Prophylactic antibiotics, Administration of per-rectal NSAIDs, reduces the chance of developing pancreatitis by 50 %). In addition to the above strategies, aggressive fluid management significantly reduces post-ERCP pancreatitis [1,19-20].

Other rare acute complications are perforation of the duodenum or bile duct, haemorrhages, and infection, which may lead to sepsis in patients with partial obstruction of the CBD [2,18,27,29].

Haemorrhage is more commonly associated with sphincterotomy. The risk of haemorrhage is significantly high in patients with ascending cholangitis, the presence of coagulopathies and patients on anticoagulant treatment within three days [2]. As in other surgical procedures, intra-procedural haemorrhages may also lead to delayed haemorrhages in ERCP (Figure 7). Intra-procedural bleeding can be minimised by proper pre-procedural clinical and biochemical assessment to identify coagulation disorders and review previous imaging studies to identify abnormal anatomies. The bleeding can also be controlled therapeutically by injection of dilute epinephrine, application of balloon tamponade, placement of clips and placement of fully covered self-expandable metal stent [1-2,5,12].

Figure 7: Delayed haemorrhage 3 days after biliary sphincterotomy that included a protective pancreatic stent (white): (a) fresh bleeding from the cut edge of the sphincterotomy just above the pancreatic stent; (b) injection of epinephrine to control the bleeding

Perforation of the viscera is usually associated with difficult access to the ampulla of Vater and abnormal or altered anatomy [1-2,30]. Early recognition of perforation is critically important to make it possible to manage with endoscopic techniques by either closure of sphincterotomy leaks or by using standard over-the-scope clips to manage bowel perforations. Surgery is usually indicated for large perforation or failed in endoscopic intervention or delayed recognition [1-2,27,29-30].

Some long-term complications following endoscopic sphincterotomy include papillary stenosis, and cholangitis, which occur in approximately 6 to 24 % of patients [2]. In addition to these complications, nonspecific complications can occur in a patient who underwent ERCP, including aspiration, respiratory depression or arrest, cardiopulmonary complications, contrast allergy, adverse reactions to medications and cholecystitis [1-2,4,27]

Conclusion

ERCP is an advanced endoscopic procedure aimed at treating the diseases of CBD and PD. Commonly it is used to treat CBD stones, benign and malignant strictures. In addition, PD strictures and stones are also treated by ERCP. Recent advances with cholangioscope combined with ERCP allow visualising the CBD / PD lumen and taking direct biopsies. Though ERCP has complications, expert hands will reduce its occurrence.

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