Percutaneous Biliary interventions in benign and malignant strictures: What the radiologist needs to know regarding the current practice and recent advances

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Learning objectives

The main topics covered in this presentation will be:

- Normal biliary anatomy and common variants and their impact on treatment decisions
- State of the art management of malignant biliary obstruction
- State of the art management of benign biliary strictures
- Recent advances in interventional management of biliary strictures
- After reviewing the exhibit, the viewer will be familiar with current percutaneous techniques for management of malignant and benign biliary disease as well as recent advances. The viewer will also have an understanding of normal biliary anatomy, common variants, and the impact of anatomy on percutaneous interventions and decision making.

Background

- Malignant biliary obstruction is not uncommon, particularly in the later stages of certain cancers, especially pancreatic and cholangio carcinomas. Biliary obstruction can result in significant deterioration of quality of life and worsen hepatic failure.
- Endoscopic management is usually the initial approach. However, endoscopic therapy is often precluded due to surgically altered anatomy or the location and size of tumor. In these cases, percutaneous interventions play an important, and often life saving, role.
- Percutaneous interventions also play an important role in the management of benign strictures related to pancreatitis, biliary calculi, surgical anastamoses, and sclerosing cholangitis.
- Percutaneous interventions are especially critical in patients with surgically altered anatomy such as prior Bilroth or other Roux-en-Y procedures where the biliary enteric anstamosis is often not accessible endoscopically.

Imaging findings OR Procedure details

Imaging the Biliary Tree

Percutaneous Transhepatic Cholangiography (PTC):

- Original method of obtaining detailed images of biliary anatomy.
• **Advantages:**
  • It provides exquisite detail of the biliary anatomy and pathology.
  • It provides opportunity for intervention.
• **Disadvantages:**
  • It is an invasive procedure with a relatively high risk of complications even in experienced hands.
  • It has largely been replaced as a primary diagnostic tool by less invasive techniques.

**Endoscopic retrograde cholangiopancreatography (ERCP):**

• **One of the most frequently used methods for imaging the biliary tree.**
  • This is frequently the initial procedure performed in jaundiced patients.
• **Advantages:**
  • It provides an avenue for intervention at the same time as diagnosis.
• **Disadvantages:**
  • Lower success rate in patients with postoperative anatomy or with hilar or large duodenal and pancreatic head masses.
  • Invasive procedure and with serious associated complications.

**Ultrasound (US) and Conventional Computed Tomography (CT):**

• Frequently used to assess the biliary tree.
• They provide excellent imaging of the liver and surrounding tissues. They are not as useful as other modalities in delineating the ductal anatomy of the liver.
• Ultrasound excels at identifying the presence of biliary dilatation as well as level and cause of obstruction.
• Can also reveal intraductal tumor.

**Magnetic Resonance cholangiography (MRCP):**

• New noninvasive method of delineating the biliary tree.
• It provides detailed information similar to that provided by ERCP and PTC.
• MRCP is limited by the usual constraints of MR imaging.
• MRCP is a purely diagnostic procedure.

**Intravenous inverse contrast enhanced CT cholangiography (IVICE CTC):**

• The patient is given IV contrast to enhance the liver parenchyma, making the biliary tract less attenuated.
• The images are usually displayed in an inverse contrast manner using minimum intensity projection.
Cholangiographic contrast enhanced CT cholangiography (CCE CTC):

- The patient is administered an oral cholangiographic contrast agent (Telepaque; Nycomed Amersham, Princeton, NJ) which is expressed in the biliary tract, and thus enhances it.

Transhepatic contrast enhanced CT cholangiogram (THCE CTC):

- Diluted contrast (1:4 to 1:6) is administered directly into the biliary tract through a preexisting, invasively placed, biliary indwelling catheter (T-tube or biliary drainage catheter).

Biliary Anatomy

- An accurate knowledge of the biliary ductal anatomy is critical for interpretation of PTC images, for determining the best technical approach for biliary interventions, and for avoiding procedural complications.
- "Normal" biliary anatomy is present in only 57% of patients. Complications can be prevented if we are aware of possible anatomic variants before the procedure.

Couinaud Classification on page 13

- Liver anatomy is typically described according to the Couinaud classification.
- The caudate lobe, segment I, lies between the fissure for the ligamentum venosum and the inferior vena cava. The remainder of the liver is divided into the right and left lobes by the middle hepatic vein.
- The right lobe consists of segments V-VIII. Segments VII and VIII are superior and are divided from the inferior right hepatic segments, V and VI, by the horizontal portion of the right portal vein. The anterior segments, V and VII are divided from the posterior segments, VI and VII, by an oblique plane containing the right hepatic vein.
- The left lobe consists of segments II-IV, and is divided into the lateral segments, II and II, and the medial segment, IV, by the umbilical fissure and falciform ligament.

Ductal Anatomy

Type I biliary ductal anatomy (Typical/normal 57%) on page 14

Right Hepatic Duct

- Drains right lobe of liver (segments 5,6,7,8)
• Formed by two main tributaries, anterior and posterior. The posterior duct is oriented horizontally. Anterior duct is oriented vertically.
• RHD is normally short and can have many variations

**Left Hepatic Duct**

• Drains left lobe of liver (segments 2,3,4)
• Anterior to portal vein
• Formed by two main inferior and superior, horizontally oriented tributaries
• The duct draining the caudate lobe usually joins the origin of the left or right hepatic duct.

**Common Hepatic Duct/Common Bile Duct**

• CHD is formed by confluence of right and left hepatic ducts.
• Cystic duct joins CHD along right lateral margin to form CBD and then enters the duodenum via the Ampulla of Vater.

**Type 2 Biliary Ductal Anatomy (12%) on page 14**

• 11% of patients will have a “triple” confluence, where the right anterior, right posterior and left hepatic duct meet at the hilum to form the common hepatic duct.
• This is important when treating hilar lesions.
• Patient may need three drainage catheters or three stents for successful treatment.

**Type 3A Biliary Ductal Anatomy (16%) on page 28**

• Drainage of the posterior right hepatic duct into the left hepatic duct before its confluence with the right anterior duct is the most commonly seen variant and is present in up to 20% of the population.
• Performing CBD interventions through these ducts becomes difficult due to sharp angulation of the duct as it drains into the left hepatic duct.
• Access of the anterior ducts are preferable in the presence of this variant.

**Type 3B Biliary Ductal Anatomy (6%) on page 15**

• Posterior RHD drains directly to CHD, below the hepatic hilum
• This variant anatomy is important for laparoscopic cholecystectomy. The right posterior segmental duct may drain extrahepatically to CHD and could be inadvertently ligated. It is liable for iatrogenic injury leading to post laparoscopic cholecystectomy bile leak.

**Type 3C Biliary Ductal Anatomy (2%) on page 15**

• Posterior RHD drains to cystic duct (Duct of Luschka)
• Important for laparoscopic cholecystectomy. Right posterior segmental duct or part of right posterior segment of liver is draining extrahepatically to cystic duct. Common cause of post cholecystectomy bile leak. The duct may not be opacified during routine PTC, and an effort may need to be made to identify the duct if suspected clinically.

**Type 4 Biliary Ductal Anatomy (1%)** on page 16

• The right hepatic duct drains into the cystic duct. This is an uncommon variant.

**Type 5 Biliary Ductal Anatomy (6%)** on page 17

• Accessory right duct is present.
• Subdivided into types 5A and 5B according to the drainage pattern of duct.
• Type 5A: Drains to the CHD.
• Type 5B: Drains to the RHD.

**Type 6 Biliary Ductal Anatomy (1%)** on page 18

• The left lobe segments II and III drain individually into the RHD or CHD.

**Type 7 biliary ductal anatomy (1%)**

• Type 7 is an unclassified or complex variation.

**Unusual Anatomic Variants**

• Aberrant ducts are the sole drainage for a given hepatic segment.
• Direct drainage of the right posterior duct into the right (5%) or left (1%) common hepatic duct, known as the aberrant hepatic duct.
• Accessory ducts are in addition to the normal drainage for a hepatic segment.
• Accessory ducts are seen in 2% of patients. May originate from or run in adjacent to either the right or left ductal system. May be a solitary finding or in association with other variant anatomy.

**Common Anatomic Variants of the Cystic Duct**

• Low cystic duct insertion, characterized by insertion of the cystic duct in the lower 1/3 of the extra hepatic bile duct is present in 9%
• Medial cystic duct insertion where the cystic duct inserts into the medial or left aspect of the CBD is present in 10-20%
• A parallel course of the cystic and CBD, defined as a parallel course of the ducts for >2cm is present in 2-25% of the population and can lead to Mirizzi’s Syndrome.
Percutaneous Management of Malignant Biliary Obstruction

At our institution PTC is usually reserved for patients with surgically altered anatomy, or those in whom ERCP has failed. In these patients, PTC provides a reliable method for accessing the biliary tree for diagnosis and intervention.

**Indications for Biliary Drainage**

- Pruritus due to biliary obstruction.
- Cholangitis.
- Normalization of bilirubin prior to chemotherapy.
- Postoperative bile leaks.
- Delivering local treatment for primary bile duct cancer.
- Brachytherapy
- Photodynamic therapy.
- Hyperbilirubinemia and dilated bile ducts, per se, are not indications for drainage.

**Preprocedure Imaging**

- Ultrasound excels at identifying the presence of biliary dilatation as well as level and cause of obstruction. It can also reveal the intraductal tumor.
- Contrast enhanced CT scan of the abdomen demonstrates biliary dilatation, level and cause of obstruction, and relevant landmarks, as well as metastases and other liver lesions that one might want to avoid during the drainage procedure. It can also show hepatic atrophy, portal vein occlusion and ascites.
- MRCP provides detailed images of the biliary anatomy and also determine the presence of biliary dilatation and level of obstruction.
- At our institution, we prefer CT scan of the abdomen (preferably contrast enhanced) prior to intervention in all elective or semi-elective cases. US alone is not as helpful in guiding intervention.

**Intraprocedural Issues**

- Most procedures are performed under conscious sedation. However, PTC can be a painful procedure, and some patients will require anesthesia to safely perform the procedure.
- Right side approach is technically easier and keeps the operator's hand away from the x-ray beam. It is less comfortable for long term catheters as it often requires an intercostal approach.
- Left side approach is preferred in certain circumstances like, presence of ascites and colonic interposition between abdominal wall and right lobe of liver (Chilaiditi's syndrome).
• In patients with prior surgical resection, detailed review of CT is required to assess approach prior to procedure.

PTC Approach

• **Right** on page 19
• **Left** on page 18

Determine Level of Obstruction

• Determining the overall anatomy of the liver and the probable level of obstruction are the two most critical factors in determining approach.
• Many non-resectable cancer patients can be treated in a single sitting. PTC is performed, a metallic stent placed, and no external access left in place.
• In patients with resectable tumor, an internal/external biliary drainage catheter is placed across the obstruction and left in place. The catheter has two functions:
  • It drains the bile and lowers bilirubin level.
  • It acts as a guide for the surgeon during resection.

CBD Obstruction

• Either a left or right sided approach may be used in these patients. Right sided approach is the author’s preference.
• A single stent, and/or drainage catheter is sufficient in these patients.
• Metallic stents are used only for inoperable patients. Since these stents become embedded in the bile duct epithelium, they cannot be removed and their presence can hinder surgical procedures.
• If patient is an operable candidate than, either an internal/external biliary drain or an internal plastic stent can be placed across the biliary obstruction.
• Covered stents have been used, but to date there is no benefit over bare metal stents and the cost is substantially higher.
• **Case 1** on page 20
• **Case 2** on page 21

**Bismuth Classification** on page 21

• CHD and Hilar obstructions are classified according to the Bismuth classification system
• Type I: limited to the CHD, > 2cm from the confluence.
• Type II: CHD, <2cm from the confluence, involves the confluence.
• Type IIIa: Type II + involvement of the right hepatic duct.
• Type IIIb: Type II + involvement of the left hepatic duct.
• Type IV: Type II + involvement of both right and left hepatic ducts OR multifocal involvement.
• Type V: Stricture at the junction of the cystic duct and CBD.
Bismuth Type I

- Right and left hepatic ducts communicate freely.
- A single internal/external biliary drainage catheter or metallic stent can be placed across the obstruction.

Bismuth Type II

- Complete biliary drainage is not possible with one drainage catheter or stent.
- This needs separate drainage catheters or 'T' configuration stents or kissing stents in 'Y' configuration in right and left ducts across the obstruction.
- 'Y' configuration stents are preferred over the 'T' configuration because patency rates are higher with 'Y' configuration and they can be recanalized more easily if they become occluded.
  - Case 3a on page 21
  - Case 3b on page 22

Bismuth Type III and IV

- May need multiple drainage catheters or stents across the biliary obstruction, which needs to be modified based on the cholangiographic findings.
  - Case 4 on page 22

Recurrent Obstruction After Stent Placement

- Overall mean patency for bare metallic stents is 5.8 months.
- If the stents are occluded, they can be managed endoscopically. If endoscopy is not feasible then it can be managed by percutaneous approach.
- The occluded stent can be dilated or new stents may be placed.
- If rapid occlusion is an issue, internal/external biliary drainage catheters may be placed.
  - Case 5a on page 23, 5b on page 23

Percutaneous Management of Benign Biliary Obstruction

- Bile duct injury (BDI) during cholecystectomy or CBD exploration accounts for 95% of all benign biliary strictures.
- Ductal and periductal inflammatory conditions like chronic pancreatitis, sclerosing cholangitis and necrotizing cholangitis account for most of the remaining benign strictures.
- Benign stenosis of a hepaticojejunostomy anastamosis (Whipple, liver transplant, etc.) is also frequently seen at our institution.
- Stone disease may be present either primarily, or in addition to a stricture and may also be managed percutaneously.
Anastamotic Strictures

- Often seen post hepaticojejunostomy, these strictures are managed by PTC with balloon angioplasty of the stenosis. An internal/external drain is placed across the anastamosis and left in place for 2-6 months.
- Catheter exchange is repeated every 6-8 weeks with repeat angioplasty as needed. The stricture heals over time to the size of the drainage catheter allowing for removal.
- Although, these strictures may recur, results are good, and less traumatic than repeat surgery.
- Metallic stent placement is not recommended as the long term patency is poor.

Strasberg Classification of Bile Duct Injuries on page 24

Management of Bile Duct Injuries

- Strasberg Type A injuries: leaks from ducts of Luschka in the liver bed are self limiting and result in small bilomas resolve spontaneously. Cystic duct leaks can be managed endoscopically in 88-100% of cases.
- Minor injuries including small leaks and minor strictures are managed by endoscopic or percutaneous means.
- Major injuries like complete transection or occlusion of major biliary ducts ultimately need surgical reconstruction. PTC/PTBD are often used as an intermediate step to define anatomy and decompress the ducts before surgery.
- If the duct is totally occluded, an external drain is the only option.
- If surgical reconstruction is planned, it is useful to place the tip of the external drain immediately above the obstruction. This helps the surgeon to identify the obstructed duct during the surgery.
- If the obstructed duct can be traversed, a internal/external biliary drainage catheter can be placed and ideally advanced to the duodenum.
- If the common duct is completely transected, a biliary drainage catheter can be advanced across the transected duct and into the subhepatic space. The catheter is then left to external drainage. This drains both the bile ducts and the biloma, and provides a guide for reconstructive surgery.

- Case 6 on page 24
- Case 7 on page 25
- Case 8 on page 25
- Case 9a on page 26, 9b on page 26
- Case 10a on page 27, 10b on page 28, 10c on page 28

Advances in Percutaneous Management of Biliary Disease
Retrievable Biliary Stent Grafts

- The poor long-term patency of metallic stents in the biliary system and their inability to be removed limit their widespread application in the treatment of benign biliary disease.
- The goal of a retrievable stent-graft in the treatment of benign biliary strictures is based on the idea of achieving long-term biliary patency without a drainage catheter.
- Recently, there have been several reports regarding the use of retrievable stent grafts for benign biliary strictures.
- The retrievable stent-graft has two main components.
- The outer tubular lining is constructed from a polytetrafluoroethylene (PTFE) material.
- An inner supporting nitinol stent.
- In experienced hands, retrievable stents have a 100% technical success rate in stent placement and retrieval, a primary patency rate of 90.6%, and a secondary patency rate and clinical success rate of 97%.

Cutting Balloons

- Cutting balloons may improve the technical success rate of cholangioplasty by resolving lesions that are refractory to conventional or high pressure balloons.
- The cutting balloon is a noncompliant balloon with four atherotomes (microsurgical blades) mounted longitudinally on its outer. The atherotomes are 2 cm in length and 0.127 mm in height/depth for all balloon sizes. The cutting balloon has a diameter of 5 to 8 mm and a shaft length of 50 to 135 cm.
- Once it is in place across the biliary stenotic lesion, it is inflated slowly and maintained for 5 minutes to apply the atherotomes with even opposition to the target lesion.
- Its nominal full-inflation pressure (full deployment of atherotomes) and burst pressure is 6 and 10 atm, respectively, for all balloon sizes.
- The cutting balloon is designed so that, when it is inflated, the atherotomes score the wall, creating four initiation sites for crack propagation.
- In some cases the cutting balloon is deflated and rotated less than 90° and re-inflated at the same site for another 5 minutes (rotational cutting technique).
- Utilizing a rotational cutting technique, in theory, allows the formation of eight initiation sites for crack propagation.
- The cutting balloon is sized no more than 10% of the estimated true diameter of the main biliary duct.
- The cutting balloon should be deflated slowly to retract the atherotomes into their groove/housing along the balloon to reduce the risk of injury to patient and operator during cutting balloon removal.
- Subsequently, conventional balloon dilation is performed.
• The maximum conventional balloon diameter is 20 to 25% larger than the estimated true diameter of the main biliary duct.
• The size of the conventional balloon is always equal to or larger than the diameter of the initial cutting balloon.
• The conventional balloon is kept inflated across the biliary stricture for 5 to 10 minutes.
• Cutting balloons seem to raise the technical success rate in benign biliary strictures close to 100% with no significant increase in major complications.
• However, it is unknown whether the increased technical success rate of cutting balloons will translate into an improved long-term patency rate, which is what really counts.
• Since long-term patency has not been proven and, considering the added expense of cutting balloons, it is not unreasonable to utilize them solely for lesions that are refractory to conventional balloons and not for all comers.

Cholangioscopy

• Direct visualization of the biliary tract can be extremely helpful.
• While retrograde endoscopic techniques may seem like the only option to accomplish this, endoscopy of the bile ducts or gall bladder via percutaneous tracts or T-tube tracts is not only relatively easy but is also safe and efficacious.
• There are two primary indications for biliary and gall bladder endoscopy
  • Removal of calculi
  • Diagnosis of indeterminate masses or strictures.
• Biliary stones may need to be treated percutaneously if the stones are inaccessible to retrograde endoscopy
• This occurs when postsurgical changes prevent retrograde access to the bile ducts, or, if stones are lodged high in the intrahepatic ducts.
• In these cases, cholangioscopy allows better directional control of baskets and graspers, providing a three dimensional orientation instead of the two dimensional orientation that fluoroscopy provides.
• This allows precise placement of baskets around stones therefore, increasing procedural efficiency.
• Cholangioscopy allows treatment of large stones that cannot be safely extracted by simple fluoroscopic basketing. This is accomplished through the use of laser or electrohydrolitic lithotripsy (EHL) probes.
• Direct visualization allows precise placement of the probe on the stone, and allows better distinction between stone fragments, blood clots, or air bubbles, which may be indistinguishable on contrast cholangiography.
• Cholangioscopy allows visualization of stones that may be totally missed by cholangiography. A duct can be so impacted with stones that no contrast will be forced into the duct on cholangiography. In one study of patients with primary sclerosing cholangitis, stones were not detectable on cholangiography in 7 of 23 (30%).
Direct visualization by cholangioscopy provides diagnostic clues regarding indeterminate biliary masses or strictures, that fluoroscopy cannot provide, such as color, texture, and deformability. This will help distinguish soft masses such as a small villous adenoma or polyp from a stone.

Cholangioscopy allows biopsies to be obtained using a grasping or cup-type forceps under direct visual guidance from the most abnormal appearing structure.

Careful selection of access routes is critical to ensuring successful cholangioscopy and to minimize complications.

Tract dilation to accommodate the access sheath of the cholangioscope should be delayed for several weeks after the initial drainage procedure. This allows clearance of infected material plus allows the tract to mature.

Allowing time for tract maturation decreases the chances of bleeding complications.

Overall complications occur in about 20% of cases, with major complications occurring in around 8%.

Most complications are bleeding or infection and the majority relate to tract dilation, with a minority being due to the cholangioscopy itself.

Successful stone removal can be achieved in about 90 to 95% of cases.

Successful diagnosis of indeterminate strictures can be accomplished through a combination of visual inspection and endoscopic-guided biopsy. For intraluminal masses the accuracy of endoscopic biopsy is close to 100% but for peri-ductal metastatic lesions or mural strictures (as with primary sclerosing cholangitis) diagnostic accuracy is significantly lower.
**Fig. 1:** Couinaud Subsegmental Anatomy

**Fig. 2:** Type I biliary ductal anatomy (Typical/normal 57%)
Fig. 3: Type 2 Biliary Ductal Anatomy (12%)

Fig. 4: Type 3B Biliary Ductal Anatomy (6%)
Fig. 5: Type 3C Biliary Ductal Anatomy (2%)
Fig. 6: Type 4 Biliary Ductal Anatomy (1%)
**Fig. 7:** Type 5 Biliary Ductal Anatomy (6%)

**Fig. 8:** Type 6 Biliary Ductal Anatomy (1%)
Fig. 9: Approach for left sided PTC
Fig. 10: Approach for right sided PTC

Fig. 11: Case 1: 65 year old female patient with adenocarcinoma of head of pancreas with liver metastasis. CBD Obstruction mild proximal dilatation A. Metal stent placed and
choledochoplasty performed B. Multiple filling defect in CHD due to clots C. Safety drain was placed across the stent until clots resolve D. It was removed later.

**Fig. 12:** Case 2: 69 year old male patient with Non Hodgkin's Lymphoma compressing the distal CBD. A. Initially, an internal/external biliary drain was placed across the stenosis. B. Later on plastic (Amsterdam)stent was placed across the stenosis. C. Placement of metallic stent was avoided since lymphoma usually responds to chemotherapy and the CBD obstruction was expected to resolve after treatment.

**Fig. 13:** Bismuth Classification
**Fig. 14:** Case 3a: A. An endoscopically placed plastic "Amsterdam" stent preferentially drains the right duct, and blocking the initial access. B. The plastic stent was pushed into the bowel with a Fogarty balloon, uncovering a stenosis at the bifurcation of the CHD.

**Fig. 15:** Case 3b: C. Same patient with bare metallic stents placed across the stenosis resulting in free drainage of contrast from both the right and left hepatic ducts. D. No external drain is needed.
Fig. 16: Case 4: 58 year old female patient with Bismuth Type III biliary ductal obstruction caused by Klatskin's tumor. A. There is obstruction of the CHD, right and left hepatic ducts and right secondary confluence with two internal/external drains across the obstruction. B. Subsequently two kissing bare metal stents were deployed in ‘Y’ configuration.

Fig. 17: Case 5a: After initial access, a catheter and guide wire are used to recanalize the occluded stent. Staying within the lumen of the stent is critical for future intervention.
**Fig. 18:** Case 5b: The lumen of the stent is balloon dilated, and a new, slightly longer stent was placed within the existing stent. No external drainage is needed.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Cystic duct leak or leak from duct of Luschka.</td>
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<tr>
<td>B</td>
<td>Occlusion of a part of biliary tree, usually an aberrant right hepatic duct.</td>
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<tr>
<td>C</td>
<td>Transection without ligation of an aberrant right hepatic duct.</td>
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<tr>
<td>D</td>
<td>Lateral injury to the major bile duct.</td>
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<td>E1</td>
<td>CHD stricture with a stump &gt;2cm</td>
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<tr>
<td>E2</td>
<td>CHD stricture with a stump &lt;2cm</td>
</tr>
<tr>
<td>E3</td>
<td>Hilar stricture with no CHD stump, but preserved hepatic ductal confluence.</td>
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<tr>
<td>E4</td>
<td>Hilar stricture with no communication of the right and left hepatic ducts.</td>
</tr>
<tr>
<td>E5</td>
<td>Involvement of aberrant right segmental hepatic duct with or without CHD stricture</td>
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**Fig. 19:** Strasberg Classification of Bile Duct Injuries

**Fig. 20:** Case 6: 58 year old male patient with clipping of CBD and CHD injury during laparoscopic cholecystectomy. A. Multiple surgical clips in the region of CBD and
extravasation of contrast on cholangiogram. B. Since the clipped CBD could not be crossed, an external drain was placed with its tip immediately proximal to the obstruction.

**Fig. 21:** Case 7: 54 year old female patient with ampullary injury during surgery. A. Cholangiogram showing severe stricture of distal CBD. B. Balloon dilatation was performed, C. And an internal/external biliary drain was placed across it. D. After 4 months follow up cholangiogram showing only mild residual stenosis.
Fig. 22: Case 8: 49 year old male patient with early carcinoma of gall bladder, status post cholecystectomy and peripancreatic and porta hepatis lymph node dissection. A. There is long segment stricture of the CBD due to tumor invasion. B. There is also contrast extravasation from CHD due to injury during surgery. Internal external drain was placed across the biliary leak and stricture. C. Subsequently, a covered stent was placed across the malignant stricture and leaking CHD.

Fig. 23: Case 9a: -Patient with large biloma and suspected leak after laparoscopic cholecystectomy. -Two view from initial cholangiogram show extravasation of contrast from cystic duct remnant.
Fig. 24: Case 9b: -Two months following placement of internal external drainage catheter to divert bile flow. The leak has resolved and the catheter was therefore removed. - Embolization of the cystic duct remnant with coils, gel foam and Amplatzer plugs have all been described.
**Fig. 25:** Case 10a: Patient with small stone in distal CBD. Could not be removed endoscopically.

**Fig. 26:** Case 10b: -A Fogarty balloon is inflated above the stone and used to push the stone into the small bowel -Stone baskets may also be used to crush the stone.

**Fig. 27:** Case 10c: Final images show no residual stone.
**Fig. 28:** Type 3A Biliary Ductal Anatomy (16%)
Conclusion

- Percutaneous biliary interventions play an important and integral role in diagnosis and treatment of benign and malignant biliary strictures, and is a cornerstone in any algorithm for management of these cases.
- After reviewing the exhibit, the viewer will be familiar with the different radiological signs as well as the current percutaneous interventions of benign and malignant biliary strictures. The viewer will be acquainted with the recent advances in biliary interventions.

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References


