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Interventional Radiology Procedures in Biopsy and Drainage

Techniques in IR Series

Lee · Watkinson

Series Editors

Springer

Percutaneous Biliary Drainage and Stenting

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Clinical Features

Percutaneous transhepatic biliary drainage (PTBD) is a therapeutic procedure, which leads to the percutaneous drainage of the obstructed bile duct system.

The underlying disease is either malignancy of the bile ducts itself, or of adjacent organs or structures such as pancreas, lymphnodes, the gallbladder, or the stomach.

PTBD is also performed in benign conditions due to biliary stones or strictures, post-transplantation strictures, and after surgery (iatrogenic injuries).

Diagnostic Evaluation

Clinical

- Check for patient's history of medication, and all previously undertaken operations of the upper abdomen, especially affecting the hepatobiliary area.
- Ascites

Laboratory

- Full blood count, coagulation, hepatic and renal studies. Any imbalances should be corrected before the procedure.

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D.A. Gervais and T. Sabharwal (eds.),
Interventional Radiology Procedures in Biopsy and Drainage,
DOI: 10.1007/978-1-84800-899-1_18,

Imaging

- Pre-interventional multimodality imaging is imperative for defining the cause of the obstruction.
- The level of an associated stricture can usually be found with a simple ultrasound examination (US) of the region. US can also depict the presence of an obstructing mass, the dilated biliary system, lymph node enlargement, a hydropic gallbladder, free intraperitoneal fluid, possible vascular disorders, lobar liver atrophy, or the presence of hypervascular intrahepatic masses, i.e., hemangiomas or metastases.
- Coronal reconstruction of the CT-image corresponds the anterior-posterior fluroscopy projection and can be very helpful to better understand the anatomic background.
- High-quality multiplanar MRI combined with MRCP images provides the best information about the cause and level of obstruction. MRCP offers additional information about biliary anatomy and possible variations, GB position, presence of ascites, liver size, and colon interposition.

Indications

- Obstructive jaundice with bilirubin elevation/sepsis and ERCP failure
- ERCP not possiple, e.g., previous gastric surgery
- Inoperable patient

Alternative Therapies

- ERCP and plastic or metallic stent placement
- Open or laparoscopic surgery

Contraindications

- Massive ascites
- Incorrectable coagulopathy
- Uncooperative patient
- Progressive hepatic failure

Specific Complications

If the site of obstruction is in the distal CBD, and the patient has an incorrectable coagulopathy, or no safe hepatic access, a percutaneous cholecystostomy can be performed instead.

Patient Preparation

- Antibiotic prophylaxis is advisable before any biliary procedure. A combination of Gentamycin, Ampicillin, and Metronidaziole can be used as combination therapy or Tazocin (tazobactam/piperacillin) can be used as a solitary agent
- Infectious conditions, such as cholangitis, cholecystitis, pancreatitis, or sepsis, must be treated with IV administration of antibiotic drugs before drainage.
- It is also advisable to start patients on IV fluids before PTBD because they are almost always dehydrated and at risk for post-procedure hepatorenal failure

Anatomy

Normal Anatomy

- Right anterior and posterior sectoral ducts join to form the right main biliary duct.
- Left lobe segment 2 and 3 ducts join to form the left main biliary duct.
- Right and left main biliary ducts join to form the common hepatic duct.
- Common hepatic duct and cystic duct join to form the common bile duct (CBD).

Aberrant Anatomy

- Right anterior or posterior sectoral ducts join the left segment 2 or 3 duct or the left main bile duct.
- Left lobe ducts joining a right lobe duct or the right main bile duct.
- Right lobe aberrant ducts join the common hepatic duct.
- Cystic duct joins the common hepatic duct very low just above the papilla of Vater.

Equipment

- Fluoroscopic x-ray equipment with Ultrasound
- Catheters/Needles
  - Fine 21G Chiba needle for initial biliary puncture.
  - An 18G needle with plastic coverage for second puncture or one stick needle system with 0.018 in. guide wire and 4 Fr sheath (e.g., Neff set, Cook, Bjaerskov, Denmark).
  - Hydrophilic 0.035 in. curved guide wire for crossing the obstruction.
  - Extra stiff 0.035 in. guide wire exchanged after the papilla of Vater is crossed.
  - 8 Fr self-locking drainage catheter for external drainage.
  - 8 Fr self-locking biliary drainage catheter for internal–external drainage.
  - A 10-mm wide metallic stent carried over a 6 Fr catheter.

Pre/Peri-procedure Medications

- Adequate conscious sedation and analgesia is mandatory, because the PTBD can be very painful. In fact, some interventionalists perform PTBD under GA.
- IV fluids should be continued during drainage, as a prophylactic measure against hepatorenal failure.

Procedure

- Percutaneous transhepatic cholangiography (PTC) is the basic procedure for opacification of dilated biliary tree. It is performed under sterile conditions, with the patient in supine position. After percutaneous local anesthesia, liver is punctured duct is punctured with a fine 21–22G Chiba needle, under fluoroscopic guidance and/or ultrasound. Enter the liver in the right middle axillary line between the 9th and 11th intercostal space targeting the xiphoid, keeping the needle on a horizontal level until reaching the level of the right lateral spine margin. For the left biliary duct system, puncture the anterior abdominal wall just under the xiphoid/left costochondral junction, aiming posterior and to the right, ideally under US guidance.

Planning an Access Route

- Depending on the site of obstruction, the presence of liver atrophy or ascites, a left lobe puncture instead of the right may be decided. The presence of liver metastases or hemangiomas may alter the puncture site as well, or even make the use of real-time US guidance necessary for the initial puncture (Fig. 1).
- After opacification of the obstructed biliary system, decision must be made about the site of puncture for introduction of the drainage catheter. A bile duct, as peripheral as possible should be chosen (Fig. 2).
- In some cases, when dealing with patients with several intrahepatic stones proximal to a benign stricture, access may need to be modified by choosing a particular bile duct for the initial drainage, to provide the best access for the subsequent lithotripsy.
- For common bile duct (CBD) lesions, right-sided approach is preferred, except in cases of ascites or colon interposition. Right-sided route provides a straighter access for catheter and guide-wire manipulation and keeps the operator's hands out of the x-ray beam.
- Hilar lesions deserve special mention. These lesions are classified according to the Bismuth classification. If patients are nonsurgical candidates, Bismuth stages 2 and 3 are best palliated by PTBD and stenting. ERCP and stenting or PTBD can be used for stage 1, if surgery is not possible. Palliation of patients with stage 4 disease is difficult with any technique, but percutaneous approach is usually preferred.

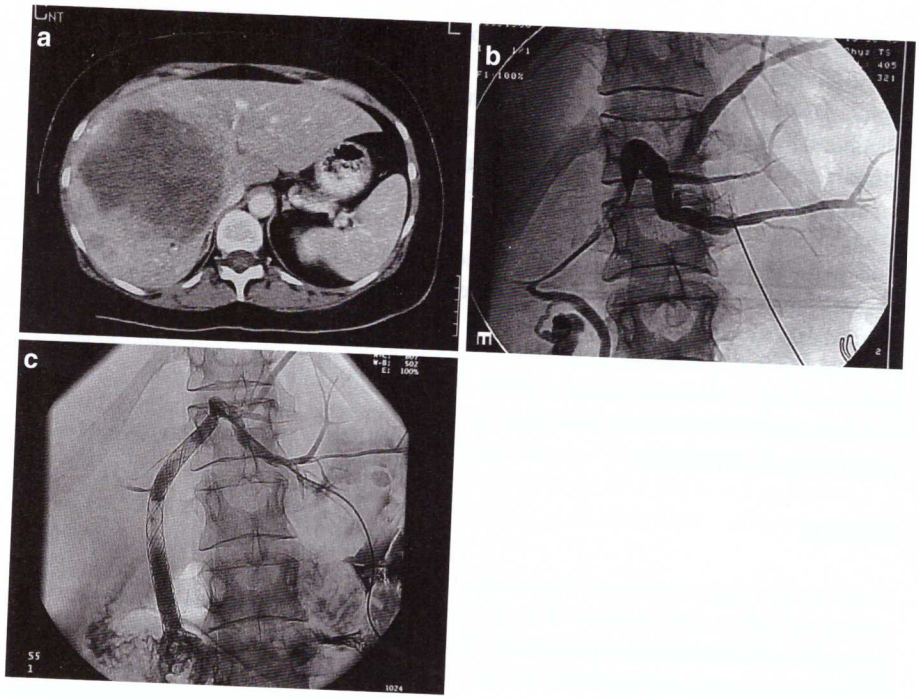

Fig. 1 (**a**) Computed tomography (CT) scan with a large liver tumor in a jaundiced patient. (**b**) Only a peripheral left liver puncture can be performed with safety. (**c**) Metallic stent in situ

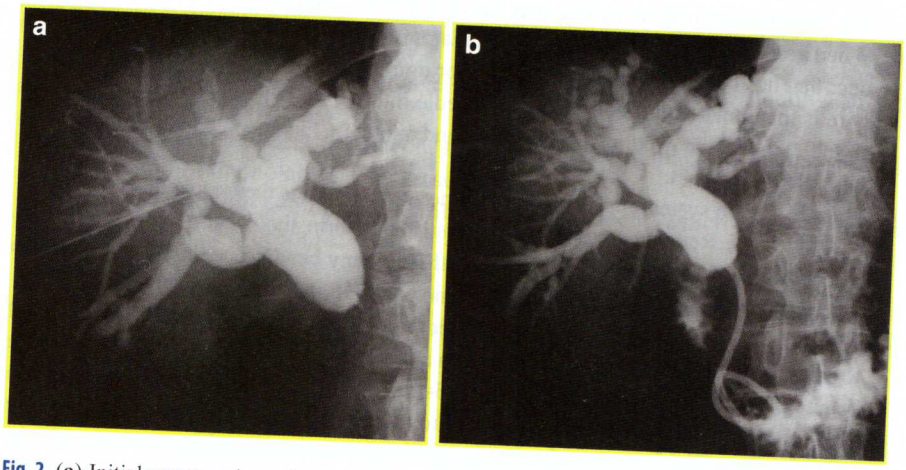

Fig. 2 (**a**) Initial puncture is performed through a dilated seventh segment bile duct. (**b**) Drainage catheter placement is performed after a more peripheral puncture of a sixth segment bile duct

- With hilar obstructions, careful evaluation of pre-procedure MRCP imaging is vital. Anatomical variations should be checked. If the right anterior or posterior sectoral ducts drain to the left main duct, then left lobe drainage may be sufficient for palliation. If the tumor is mainly involving the left ducts, then draining the right may be the best approach and vice versa. However, if draining is in only the left lobe, the left lobe should be of sufficient size to provide palliation. There is little point in draining a small left liver lobe as it will not provide relief for jaundice or pruritus. Additionally, hilar tumors tend to grow proximally along the biliary ducts so that puncturing a peripheral duct for access is vital if stenting. You ideally need 2–3 cm of stent above the obstruction for good palliation.

Performing the Procedure

Technique

There are two major techniques for introduction of a biliary catheter:

- The fine 21–22G needle technique
- The 18G needle technique
- Advantage of the fine-needle technique is that even multiple needle passages may not cause complications, so the procedure can be considered safer than using the 18G needle. However, the fine-needle technique might be difficult in inexperienced hands.
- PTC is performed initially as described above. Entry into a bile duct recognized by injection of diluted contrast material (CM) through the Chiba needle. CM injected into hepatic or portal veins flows away from the needle tip reasonably smartly. CM in the bile duct flows slowly away like wax flowing down a candle.
- When access to the bile duct is gained, a diagnostic cholangiogram is performed. If the duct that has been entered is appropriate for drainage access, then the 0.018-in. guidewire is manipulated through the Chiba needle into the bile duct. If the bile duct is not suitable, the Chiba needle is left in place and another Chiba needle is used to access a more favorable duct.
- The 4 Fr sheath system that is part of the one stick system is then tracked via the 0.018-in. guidewire. Remember to unhook the stiffener form the sheath when the duct is reached. The stiffener will not travel well through any bends. The 0.018-in. guidewire and inner plastic stylet are then removed and an 0.035-in. J-guide wire is inserted.
- A 40-cm hockey stick catheter is placed over the 0.035-in. guide wire and CM is injected to outline the exact level of the obstruction and to see if there is a nipple to suggest the course of the obstructed bile duct. A 0.035-in. Terumo guide wire is used to negotiate the obstructed segment and manipulated into the duodenum to the level of the ligament of Treitz. The Terumo guide wire is then exchanged for a superstiff guide wire.
- The percutaneous track is then dilated with 7 and 9 Fr dilators and the 8 Fr multi-sidehole pigtail catheter is placed. Note that placing a 9 Fr peel-away sheath may aid catheter placement.

- CM is injected to make sure that there are sideholes above and below the obstruction and the catheter secured.
- The only difference using the 18G needle technique is that after initial PTC, an appropriate peripheral biliary duct is chosen for puncturing with an 18G Chiba needle. Through this needle, a 0.035-in. Terumo guide wire is negotiated through the stricture, following tract dilatation and catheter placement as described above.

If opacification of multiple obstructed bile ducts occurs, the operator should try to drain as many opacified ducts as possible in order to avoid bacterial contamination and post-procedural cholangitis.

The drainage of the bile ducts is performed with a multi-sidehole pigtail catheter. The catheter is placed internally across the narrowed duct, having the external end connected to a drainage bag. The catheter is secured to the skin with sutures. Self-locking catheters are preferred in order to minimize the dislocation risk.

Endpoint

- The percutaneous catheter is placed across the stenosed/obstructed CBD, so that bile is draining through the catheter toward the bowel loops (sideholes proximal and distal to stricture).
- The drainage procedure can be extended with the placement of a permanent metallic stent, which keeps the stenosed biliary duct patent, without the need for a catheter (Fig. 1c). Metallic biliary stents have been shown to provide the best palliative treatment for non-resectable malignant obstructive jaundice, allowing longer patency rates than plastic endoprostheses. If initial transhepatic drainage is completed without causing any significant complications, especially bleeding, primary metallic stenting can follow as a single-step procedure.

The keys for shortening the total intervention time are the following:

— Careful initial transhepatic drainage, to allow primary metallic stenting, in the absence of hemobilia.
— Immediate optimal stent expansion, so that free bile drainage is guaranteed and the possibility of cholangitis decreases.
— Placement of a thin 4–5 Fr catheter after stent placement, which can be removed 1 or 2 days post-procedure.

Immediate Post-procedure Care

- The whole procedure may last 1–2 h, depending on the grade of difficulty and the cooperation of the patient.
- Catheter must be carefully fixed on the skin.
- Monitor for bleeding complications and hepatorenal syndrome.

Follow-up and Post-procedure Medications

- In general, the patient is kept in the Hospital until recovery. Usually the main post-procedural complaint is pain, especially if drainage is placed intercostally. Appropriate pain medication, which may include opiates, may be necessary.
- Blood pressure and pulse must be monitored, hematocrit must be measured, and catheter site must be checked frequently.
- Patient can eat and drink normally.
- Patient must be careful not to dislodge the catheter.
- The catheter skin entrance site must be cleaned and sterilized every 1–2 days.
- The drainage catheter should be flushed with 10-mL saline preferably every 8 h.
- At the time of catheter removal the percutaneous tract can be plugged with gelfoam pledgets delivered through a peel-away sheath. This greatly diminishes post-catheter removal pain and bile leak. Another option is to fill the catheter tract with tissue-glue (mixed with lipiodol) while slowly removing a 4–5 Fr catheter from the liver.

Results

Technical success of the percutaneous biliary drainage depends on the experience of the interventional radiologist performing the drainage. It can be as high as nearly 100%. Clinical efficacy is usually lower but still over 90%.

If metallic stenting is also performed, stent patency is an important issue. Patency depends on the cause and the site of the stenosis, but can reach 6–12 months or more.

Metallic Stenting

- Stents are used as a more permanent palliative treatment option. Initially plastic endoscopically inserted stents of 8–12 Fr size were used. Their main problems were a 30-day mortality rate of 15–24%, migration, early occlusion usually after 2–3 months, and infection. Thus, metallic stents were developed in order to overcome these complications.
- It is now proven that metallic stents offer a 30-day mortality rate of only 5%, longer patency of about 5–6 months, providing better bile flow through an 8–10-mm wide lumen and have a lower reintervention rate. Endoscopic and percutaneous placement is possible. The latter is preferred in cases of hilar tumors or if endoscopy fails.
- Technically, percutaneous metallic stenting is a relative easy procedure after internal drainage has succeeded. The stents have a delivery system of 6 Fr size, minimizing liver parenchyma damage, and enabling primary stenting more safely.

- After careful measurement of stricture length, a stent of at least 3–4 cm extra length must be chosen, so that proximal and distal overstenting with 1–2 cm in each side is possible. In this way tumor overgrowth can be avoided (proximal part) and the papilla can be kept open for better bile drainage (distal part).
- Nevertheless, stent occlusion still remains a problem due to sludge incrustation or tumoral ingrowth and overgrowth. Covered stents have been developed to overcome these complications. Nowadays, covered stents with ePTFE coverage have been clinically tried in comparison to the uncovered stents, showing relative good results regarding prevention of tumor ingrowth. Stent dysfunction tends to be significantly lower for covered stents ($P=0.046$), while tumor ingrowth occurred exclusively in bare stent. Stent migration is prohibited by side-anchoring fins. Despite the relative large stent carrying catheter size of 10 Fr, no significant difference of complication rate is noticed in relation to uncovered stents with delivery system of 6 Fr size.

Complications

Biliary drainage and metallic stenting is safe, with acceptable complication rates (10–15% minor, 4–5% major) and low procedure-related mortality between 0.8% and 3.4%. Procedure-related complications like stent misplacement or occlusion can be corrected by placement of a second stent. Severe bleeding is uncommon and should be treated conservatively with blood transfusions, or if bleeding persists, by means of arterial embolization.

- If there is significant hemobilia, check that the side holes of catheter have not migrated back to lie across a portal or hepatic vein. If this is the case the catheter needs to be advanced.
- If bleeding persists, the catheter can be upsized to tamponade the bleeding site.
- For persistent bleeding, transarterial embolization should be performed

How to Avoid Complications

Make sure that the patient receives antibiotic prophylaxis and IV fluids pre-procedure. If the patient is septic at the time of PTBD, the minimum needed to provide drainage should be performed. Do not inject too much CM and place a small pigtail catheter above the obstruction. Careful, peripheral transhepatic drainage, to allow primary metallic stenting, in the absence of hemobilia. Immediate optimal stent expansion, if necessary with the help of balloon dilatation through a 6 Fr sheath, so that free bile drainage is guarantied and possibility of cholangitis minimizes. Placement of a thin 4–5 Fr safety catheter after stent placement, which can be retrieved 1–2 days later.

Medication

Percutaneous biliary drainage is often painful. Drug therapy is aimed toward prevention and management of complications like pain, infection, or nausea.

- *Pain control*: prophylactic anti-inflammatory strong analgesia is often needed and should be given early. Patient-controlled analgesia should be established.
- *Infection control:* broad-spectrum antibiotics are recommended as transductal bacterial colonization is possible.
- *Sickness control:* antiemetics should be given.
- *Hydration*: intravenous normal saline.

Follow-up

- Biochemical tests for following bilirubin and hepatic enzymes level.
- Ultrasonographic control for imaging of biliary tree decompression.
- Cholangiographic control through the drainage catheter to check correct stent placement and expansion.

Key Points

- Review the pre-procedural imaging and plan the procedure
- Ensure that you understand the rationale for treating each patient. This will enable:
  - Correct choice of percutaneous puncture site
  - Correct choice of bile duct puncture for drainage placement
  - Avoid manipulation, which might increase the complication risk
  - Consider the possibility of immediate metallic stent placement
- Ensure adequate supportive therapy before, during, and after the procedure.
- Never start percutaneous puncture until you have personally reviewed the imaging and the bleeding parameters.
- *Stop if uncertain, especially if there is risk of arterial damage or intraperitoneal hemorrhage.*

Suggested Reading

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