Percutaneous treatment of biliary lithiasis: Indications, technical-details and complications

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Learning objectives

This study aims to illustrate techniques for the percutaneous treatment of biliary lithiasis highlighting their indications, technical-details and complications.
Background

Bile duct stone disease constitutes the major cause of nonmalignant biliary obstructions. Common bile duct (CBD) stones may occur in up to 3-14.7% of all cholecystectomy patients. Hepatolithiasis, a rare disease of the intrahepatic bile ducts, is endemic in East Asia, but it is now occasionally recognized in the West [1].

Etiology and clinical presentation of biliary lithiasis intra- or extrahepatic biliary stones can be the result of various conditions:

- passage of small gallbladder stones through the cystic into the common bile duct (CBD) (the most common cause);
- presence of a biliary stricture somewhere in the biliary tree, due to primary or secondary cholangitis, (subsequent inadequate bile drainage from that part of the biliary system, so that small stones tend to get formed above the strictures);
- intrahepatic biliary stone can be formed without an obvious cause, just because of slow or impaired bile drainage through the papilla of Vater (benign strictures of the papilla can play a role here, so if these relatively small stones do not pass the papilla, they can grow and cause biliary obstruction symptoms, such as cholangitis and jaundice);
- extrahepatic stricture (following direct iatrogenic CBD injury during laparoscopic or open cholecystectomy);
- multiple biliary duct confluence strictures (result of indirect injury, due to thermal injury of the CBD wall's vasa vasorum);
- postoperative stenosis of a biliodigestive anastomosis and other inflammatory causes;
- sometimes biliary stones originating from the gallbladder can be blocked in a smaller intrahepatic biliary duct, causing obstruction followed by cholangitis [2].

Treatment of this very common disease often involves laparoscopic and open surgery, endoscopic and percutaneous techniques. In selected cases, percutaneous treatment should be preferred and surgery used only when that fails.
Findings and procedure details

A number of modalities, including laparoscopic surgery, open surgery, and endoscopic and percutaneous techniques, are available for the treatment of bile duct stones.

- Surgical CBD exploration was the procedure of the choice for the treatment of bile duct stones a few decades ago. It has a postoperative mortality varying 1.3-4%, with 20-40% morbidity rates, and may be followed by failure of complete bile duct clearance.
- Laparoscopic choledocholithotomy, an alternative to open surgery, is generally indicated in patients with a wide CBD (>9 mm in diameter) to avoid bile duct stricture. The success rate is approximately 86-95%, with 5-18% complication rates.
- Endoscopic retrograde cholangiopancreatography (ERCP) with sphincterotomy has become the first-treatment modality for bile duct stones and disorders of the sphincter of Oddi, including functional disorders and stricture.

The current trend is to consider surgical and laparoscopic stone removal if the stones cannot be managed nonsurgically [1].

Nevertheless, endoscopic retrograde cholangiopancreatography with sphincterotomy is associated with some immediate and late complications and it can be unsuccessful, difficult or impossible because of some drawbacks.

IMMEDIATE COMPLICATIONS of ERCP

- pancreatitis (the most frequent and serious complication) [3],
- hemorrhage,
- duodenal perforation [1].

LATE COMPLICATIONS of ERCP

Biliary sphincter function is irreversibly damaged after endoscopic sphincterotomy, leading to:

- duodenobiliary reflux and chronic inflammation of the biliary system;
- recurrent biliary problems (predominantly cholangitis, sphincterotomy stenosis, and recurrent stones);
- bacterial colonization and the presence of cytotoxic components in bile and chronic inflammation, fibrosis, and reactive epithelial changes of the bile ducts [4];
• increase in the incidence of biliary tract cancer (some reports have indicated that papillary destruction may lead to malignant transformation of the choledochal epithelium) [4].

DRAWBACKS of ERCP

• duodenal diverticulum or (the biliary duct cannot be accessed);
• duodenal stenosis, ampullar stenosis;
• unusual biliary anatomy;
• previous gastrointestinal surgery (such as Billroth II reconstruction and bilioenteric anastomosis);
• presence of large and impacted stones, (larger than 15 mm in diameter);
• stones situated in the intrahepatic bile ducts;
• elderly patients in poor condition [1].

In all such cases, in which ERCP fails (for complications or contraindications) or when stones are present in intrahepatic biliary ducts, it seems preferable to use percutaneous techniques.

Several techniques have been described for the management of bile duct stones:

• extraction through the T-tube or transhepatic route tract by means of baskets or forceps;
• transhepatic or trans T-tube approaches for the expulsion of stones into the duodenum through the papilla by angiography catheters, baskets or balloon-tipped catheters that act as pushers;
• contact chemolitholysis (no longer used);
• fragmentation of the large stones stones, (using basket forceps, intracorporeal electrohydraulic lithotripsy, laser lithotripsy, extracorporeal shock-wave lithotripsy, electromagnetic lithotripsy);
• dilatation of the strictures with angioplasty balloon catheters;
• percutaneous transhepatic cholangioscope can be combined with these technique to facilitate the percutaneous stone removal [1].

PARTICULAR CIRCUMSTANCES AND MOST APPROPRIATE TREATMENT FOR EACH ONE

HEPATOLITHIASIS:

In these cases should be considered the occurrence of some complications: recurrent cholangitis, hepatic abscesses, multiple post-phlogistic strictures of intrahepatic biliary ducts, hepatic parenchymal
atrophy, secondary biliary cirrhosis, and neoplastic degeneration with onset of cholangiocarcinoma.

Goals of any treatment for intrahepatic lithiasis are stone removal and cholestasis elimination.

Even if hepatic surgery allows the achievement of these goals (with radical resection of the affected lobe and stenotic biliary segments with infected bile), it is burdened by rates of mortality and morbidity that are unacceptable if compared with the benign nature of the disease [5].

Percutaneous transhepatic cholangioscopic lithotomy (PTCSL) is less invasive than surgical approaches, and therefore can be conducted in patients with poor general conditions, difficult anatomy, and bile duct strictures.

Nd:YAG laser lithotripsy is often available for disintegrating stones that are too large to be removed using ordinary percutaneous transhepatic cholangioscopy [6].

Alternative treatments, with a percutaneous approach, represent effective therapeutic options for diffuse hepatolithiasis, for those cases who are excluded from surgical treatment (age, hepatic failure, concomitant pathologies, etc.) regardless of the extent and the severity of lithiasis [5] and in case of unilateral hepatolithiasis without complex strictures [7].

**PREVIOUS GASTROINTESTINAL SURGERY AND FAILURE OF ENDOSCOPY**

In case of:

- previous surgery such as Billroth II reconstruction and bilio-enteric-anastomosis;
- retained bile duct stones after surgery;
- incomplete extraction after endoscopy.

Papilloplasty with expulsion of the calculi using an occlusion balloon presents, several advantages over the equivalent endoscopic treatment:

- the procedure is in the direction of the bile flow (and not contrary to it, as in the case of endoscopy);

- favorable angles are achieved in which to better transmit the force necessary for the expulsion;

- kinking of the guidewires is avoided, and better positioning of the balloon is achieved in the middle (equidistant or symmetric) of the groove of the papilla to achieve better dilatation;
- the introducer catheter can be used to administer contrast material, prevent air bubbles, and avoid tract injury;

- ensured access to the bile duct so that the expulsion maneuver can be repeated as many times as necessary;

- having the bile duct with external drainage in position for several days reduces the risk of manipulation-induced cholangitis by precluding sphincter spasm and by providing an egress route for infected bile.

Maintenance of the anatomic integrity and function of the sphincter is desirable and is a great advantage compared with other treatment techniques, such as endoscopic papillotomy or surgery.

In conclusion, this is effective, non traumatic and safe technique [4].

Loehr et al reported the use of a rheolytic thrombectomy device (Angiojet system) to facilitate biliary ductal clearance in a patient with extensive intrahepatic biliary stone and debris impaction after choledochojejunostomy. The result is a low-pressure stream exposed to the vessel lumen that disrupts and removes debris by a Venturi effect. No direct mechanical manipulation is used to remove debris from the vessel lumen. The design features of the device may permit its use in cases of complex intrahepatic biliary ductal disease [8].

**SMALL STONES**

Saline solution flushed by hand or by a high-frequency pulsed water-jet generator can usually dislodge impacted stones and gather them in the major ducts. Stones and fragments are then pushed into the bowel or duodenum with the aid of an occlusion balloon or with forceful saline flushes [9].

**LARGE STONES**

Large stones need to be fragmented before they can be pushed into the digestive tract.

Fragmentation can be performed with:

- Dormia baskets or angioplasty balloon catheters;
- ESWL Extracorporeal shock wave lithotripsy (if the first-cited mechanical maneuvers are not conclusive);
- Intracorporeal lithotripsy: laser, electrohydraulic (if extracorporeal lithotripsy fails) [9].

However even the percutaneous procedures are not free from complications, in particular:
- stone extraction through the percutaneous transhepatic approach may cause parenchymal damage in the liver (nowadays the expulsion of stone into the duodenum through the papilla is preferred) [4];

- percutaneous transhepatic expulsion of the bile duct stones into the duodenum can be associated to cholangitis, biliary pleural effusion, and hemobilia (the last one often self-limiting) [1].

Moreover, percutaneous transhepatic expulsion of the bile duct stones into the duodenum sometimes may result in failure, even in experienced hands. Reasons for failure include the inability to fragment a large stone, stone impaction, and the loss of access [1].

Finally, many of the techniques that we discussed require complex and expensive equipment.
Fig. 1: A) Patient who underwent cholecystectomy, ERCP with sphincterotomy and hepaticojejunostomy referred to us for repeated episodes of cholangitis. Percutaneous transhepatic cholangiography executed via the right external biliary drainage shows multiple filling defects in the right bile ducts (multiple intrahepatic stones); only the origin of the left main duct in opacified (it is also affected by stones).

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Fig. 2: A) Patient who underwent cholecystectomy, ERCP with sphincterotomy and \epaticojejunostomy referred to us for repeated episodes of cholangitis. The stone were pushed into the bowel through biliary anastomosis with an over-the-wire Fogarty balloon (black arrows) supported by the vascular sheath (white arrow) while the guide wire (arrow head) was in place.

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Fig. 3: A) Patient who underwent cholecystectomy, ERCP with sphincterotomy and hepaticojejunostomy referred to us for repeated episodes of cholangitis. Cholangiography control after the procedure: no residual stone, free flow of contrast medium into the bowel loops

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Fig. 4: B) Patient undergoing cholecystectomy a month ago. Percutaneous transhepatic cholangiography through the T tube (white arrow) shows residual CBD stone (black arrow).

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**Fig. 5:** FIG.5 B) Patient undergoing cholecystectomy a month ago. Through the Kehr is placed hydrophilic guide wire into IV duodenum (black arrow).

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Fig. 6: B) Patient undergoing cholecystectomy a month ago. Removed the Kehr tube is positioned introducer 9 Fr. caliber with its distal end located near the CBD (black arrow). Replaced hydrophilic guide wire with an Amplatz guide, dilatation of the sphincter of Oddi with a 12 X 40 mm balloon catheter (white arrow) was performed.

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Fig. 7: B) Patient undergoing cholecystectomy a month ago. The attempts to push the gallstone into the duodenum with an over-the-wire Fogarty balloon (white arrows) were unsuccessful because of the size of the stone.

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Fig. 8: B) Patient undergoing cholecystectomy a month ago. The next step was a further expansion of the sphincter with a 16 X 40 mm balloon catheter (black arrow).

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Fig. 9: B) Patient undergoing cholecystectomy a month ago. The gallstone was then pushed into the duodenum (white arrow head) with an occlusion balloon 8.5 / 11 mm (black arrow).

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**Fig. 10:** B) Patient undergoing cholecystectomy a month ago. Cholangiographic control after the procedure demonstrates the removal of the CBD stone.

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Fig. 11: B) Patient undergoing cholecystectomy a month ago. We left in place an external biliary drainage 8 Fr (black arrow), in order to perform another cholangiographic control (it can be removed, in 10 days).

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Fig. 12: C) Residual stones in patient underwent cholecystectomy. Percutaneous transhepatic cholangiography through the drainage catheter (white arrow) already positioned in the cystic duct after cholecystectomy, shows residual CBD stone (black arrow head) and a stricture on CBD distal end (white arrow head). Once removed the drainage, was placed an Amplatz guide wire (black arrow) with the distal end in the intestinal loop.

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Fig. 13: C) Residual stones in patient underwent cholecystectomy. On Amplatz guide was performed dilatation with a 8 X 6 mm balloon catheter (white arrow) of the stenotic distal tract of the bile duct.

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**Fig. 14:** C) Residual stones in patient underwent cholecystectomy Post-procedural control showing no residual stone.

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Conclusion

The choice of the most appropriate treatment must take account of individual circumstances, local availability and complications related to each procedure and must be the result of close collaboration between IR, gastroenterologist and surgeon.
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