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Pictorial Review

Percutaneous biliary interventions through the gallbladder and the cystic duct: What radiologists need to know

A. Hatzidakis [a], P. Venetucci [b], M. Krokidis [c,*], V. Iaccarino [b]

[a] Department of Medical Imaging, University Hospital of Heraklion, Heraklion, Greece
[b] Department of Cardiovascular and Interventional Radiology, University Hospital "Federico II", Naples, Italy
[c] Department of Radiology, Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK

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Percutaneous cholecystostomy is an established drainage procedure for the management of high-risk patients with acute cholecystitis. However, percutaneous image-guided access to the gallbladder may not be limited to the simple placement of a drain, but may also be used as an alternative approach to the biliary tree through the catheterization of the cystic duct, for a variety of other more complicated conditions. Percutaneous transcholecystic interventions may be performed in both malignant and benign disease. In the case of malignant jaundice, the transcholecystic route may be used when the liver parenchyma is occupied by metastatic lesions and transhepatic access is not possible. In benign conditions, access through the gallbladder may offer a solution if the biliary tree is not dilated. The transcholecystic access may then be route of insertion of large sheaths, internal drainage catheters, lithotripsy devices, stone retrieval baskets, and stents. The purpose of this review is to illustrate the techniques and to discuss the indications, complications, and technical difficulties of this alternative access to the biliary tree.

Introduction

Image-guided percutaneous gallbladder drainage was introduced into clinical practice in the early 1980s,[1–3] however, it was not until the 1990s that the majority of radiologists became more familiar with the technique and the first case reports were published.[4–10] Since then, the method has been widely used and offers a valid solution in selected patients with an acutely inflamed and obstructed gallbladder.[11–17]

Percutaneous transcholecystic access to the biliary tree may be performed after image-guided puncture of the gallbladder and subsequent catheterization of the cystic duct and the common bile duct (CBD), with a guide wire.[12,17–19] The procedure may be used in a variety of malignant and benign conditions.[20–22] The purpose of this review is to illustrate the main percutaneous transcholecystic access techniques and to discuss the indications, complications, and technical difficulties of this alternative access to the biliary tree.

Indications

Indications for percutaneous transcholecystic access to the biliary tree are mainly conditions of obstruction of the

* Guarantor and correspondent: M.E. Krokidis, Department of Radiology, Cambridge University Hospitals NHS Trust, Hills Road, Cambridge CB2 0QQ, UK. Tel.: +44 1223 348920; fax: +44 1223 217847.
E-mail address: mkrokidis@hotmail.com (M. Krokidis).

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CBD (benign or malignant) that are either not associated with dilated ducts or where the transhepatic approach is not feasible due to diffuse liver disease (cysts or metastases). Further indications may be the necessity of stent placement in the cystic duct and failed endoscopic sphincterotomy or stone removal in patients with acute pancreatitis.[4,5,11,12,22] Several reports have been published describing catheterization through the cystic duct and the placement of an external biliary drain or alternatively catheterization of the obstruction of the CBD and the placement an internal drain.[16,17,23–25] Yasumoto et al.[18] described lack of intrahepatic duct dilatation and history of gastrectomy as the main indications for transcholecystic access and stent deployment in the CBD. The indications for interventions through the gallbladder and the cystic duct are listed in Table 1.[12,16,17,21–25]

Techniques

Two access routes are described for percutaneous cholecystostomy: the transhepatic and the transperitoneal.[26] No significant difference in complication rates is reported between the two access routes.[14,15] The main reported benefits of the transhepatic route are reduction in the risk of bile leakage, greater catheter support, and quicker maturation of the tract.[15,19,27] Disadvantages, such as higher rate of bleeding, pneumothorax, and fistula formation, have also been reported.[28] The transperitoneal route is preferred for patients with bleeding disorders or those with diffuse liver disease.

Premedication and sedation may be used. Most of the authors use 1–2 mg midazolam and 50–100 μg fentanyl intravenously. Fasting for 6 h is required if sedation is administered.

Ultrasound-guided puncture and the Seldinger technique are used by the majority of operators. There might be a risk of minor bile leakage with the Seldinger technique during the needle–dilator–catheter exchange manoeuvres.[11,19,27] The kit that is most commonly used has a 22 G access needle, through which a 0.018″ wire is introduced. When the wire is within the gallbladder the system is upsized to 0.035″ with the use of a coaxial introducer (Fig 1). Another approach may be with the use of CT guidance, which reduces the risk of pneumothorax, and with a CT cholangiogram the precise anatomy of the cystic duct may be delineated. Once access to the gallbladder is obtained, an 8.5 F drainage locking pigtail catheter is advanced over the 0.035″ wire and left *in situ* for a few days. In this way, the gallbladder is decompressed and wire manipulation and catheterization of the cystic duct is more feasible. In the series of Yasumoto et al.,[18] stent deployment in the CBD was performed after a mean time of 10.4 days (range 5–21 days). Tract maturation is also important to avoid bile leak. If the transhepatic route is used, the tract is matured within 2 weeks of the initial access. For access via the transperitoneal route, at least 3 weeks are required; tract fistulography may be performed prior to any manoeuvres to confirm the presence of a mature and stable fistula.[15]

To access the cystic duct, fluoroscopy and real-time fluoroscopic imaging are required. A cholangiogram is initially performed preferably with diluted contrast medium, in order to confirm the CT findings. The drainage catheter is then exchanged over a stiff wire to a 6 or 7 F sheath, preferably with a Britetip. The use of a second safety guide wire as a "buddy wire" outside the sheath is recommended in case access is lost due to the lack of support from the gallbladder, which may occur even with a mature tract. The "buddy-wire" technique requires that two wires are inserted through the sheath and the sheath is then retracted and re-inserted over one of the two wires so that the second wire remains within the gallbladder as a separate access. The sheath may also be secured with a stitch to the skin to increase support during catheter–wire manipulations.

A short 4 or 5 F angled catheter (Fig 1) may be introduced through the sheath, and a stiff hydrophilic wire may be used to navigate the tortuous cystic duct. After crossing the cystic duct, the catheter is advanced to the CBD. Depending on the underlying disease, the CBD may also be crossed with the

Table 1
Indications for interventions through the gallbladder and the cystic duct.[11,15–20]

1. Benign or malignant CBD disease in a patient with an already existing cholecystostomy
2. Benign or malignant CBD disease in a patient with contraindication for transhepatic puncture
3. Benign or malignant CBD disease in a patient after failed or contraindicated endoscopic retrograde cholangiopancreatography/ percutaneous transhepatic cholangiography, including acute pancreatitis
4. Malignant jaundice due to obstruction of the distal CBD, presenting as acute cholecystitis
5. Acute cholecystitis due to cystic duct malignant infiltration, for decompression and cystic duct stenting
6. Acute cholecystitis due to cystic duct obstruction, caused by an occluded metallic stent of the CBD, for decompression and cystic duct stenting

CBD, common bile duct.

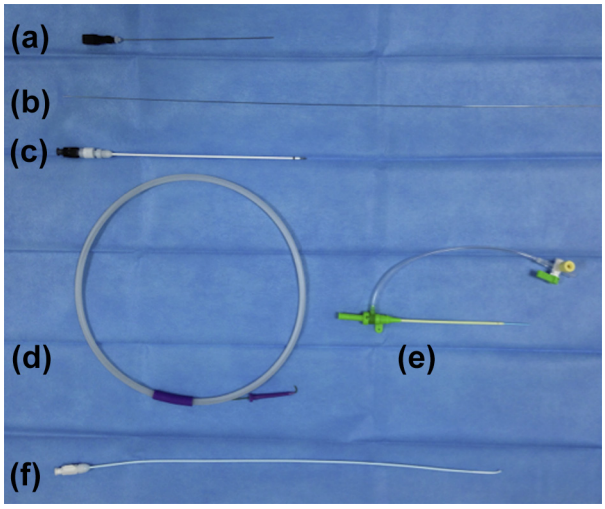

Figure 1 Access kit for transcholecystic interventions: (a) 22 G needle, (b) 0.018″ wire, (c) coaxial access system, (d) 0.035″ stiff wire, (e) 6 F brite tip sheath, (f) 4 F biliary manipulation catheter.

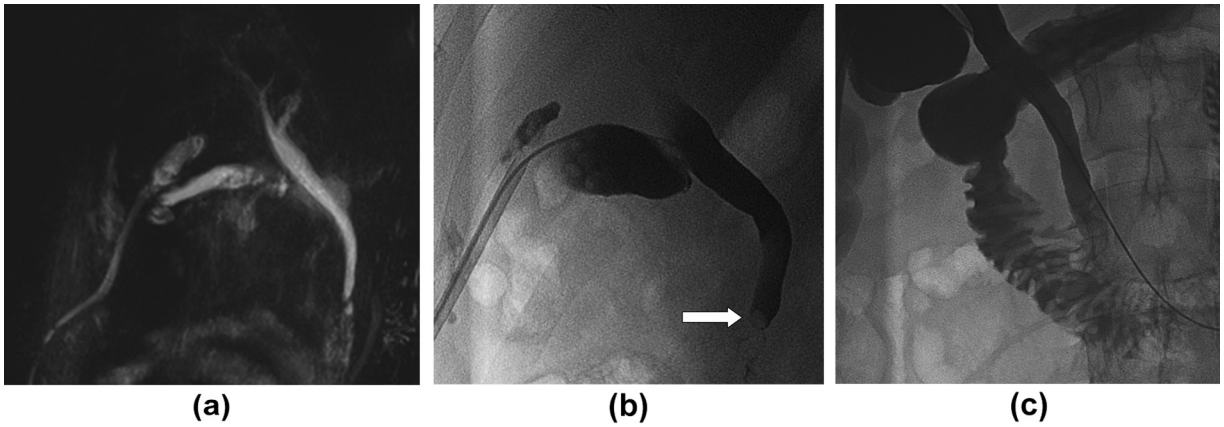

Figure 2 (a) A 68-year-old male high-surgical risk patient due to a recent aorto-coronary bypass was admitted in septic status with a gallbladder abscess with pericholecystic expansion. The abscess was drained with a 12 F pigtail catheter. Follow-up 2 days later with MR cholangiography shows the catheter in a peri-cholecystic location. The presence of stones and evidence of inflammation of the papilla was also revealed. (b) Three weeks later, the patient was stable and a 10 F introducer sheath was positioned in the peri-cholecystic cavity. Guide wire introduction within the gallbladder was possible. The CBD was catheterized via the transcystic route and the presence of a distal CBD stone that was obstructing the papilla was confirmed (arrow). (c) The sphincter was dilated with a 10 mm balloon and the stone is then pushed easily towards the duodenum. Finally, a biliary transcholecystic drain was left *in situ*. Laparoscopic cholecystectomy was performed at a later stage.

same guide wire–catheter combination and access to the duodenum may be obtained. In cases of a tight CBD occlusion, further guide wire support may be required and a larger and stiffer catheter may be used.[17,18]

After crossing the papilla of Vater, the hydrophilic guide wire needs to be exchanged with a super-stiff one, which straightens the tortuous cystic duct and provides the necessary support for insertion of a longer sheath.[18] Through the longer sheath or over the super-stiff wire, metallic stents or special lithotripsy baskets can then be advanced easily in most cases (Figs 2–9).

Procedure limitations

The main limitations of percutaneous transcholecystic access to the biliary tree are due to anatomical reasons that may decrease the technical success of interventions through the gallbladder and the cystic duct. These are malignant infiltration or occlusion from a stone of the cystic duct/CBD junction; very tortuous cystic duct; cystic duct of small calibre (<2 mm), which would increase the difficulty of advancing a metallic stent or a balloon catheter; the presence of Heister valves, which may be challenging to

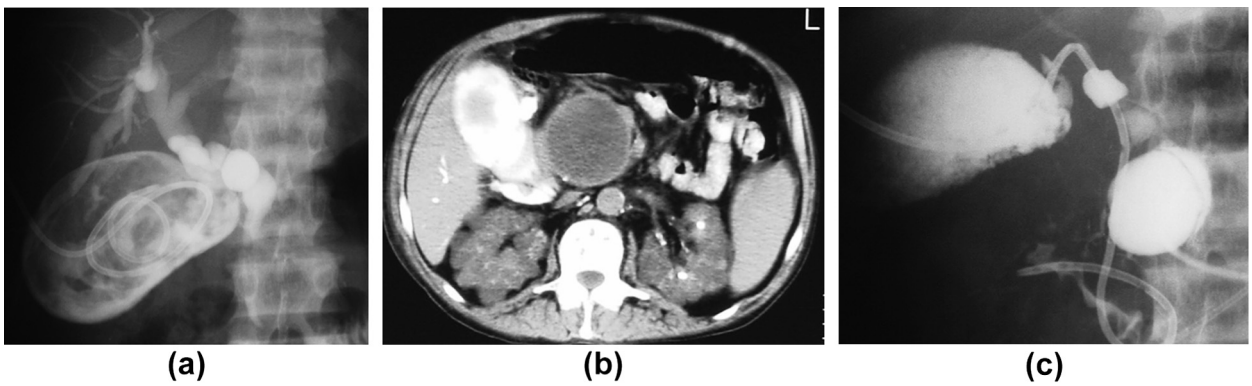

Figure 3 (a) A 70-year-old male high-surgical risk diabetic haemodialysis patient presented with acute acalculous cholecystitis. Percutaneous cholecystostomy was performed with excellent clinical outcome. Cholangiography 2 days later reveals gallbladder sludge and marked dilatation of the intrahepatic bile ducts due to external compression on the distal CBD. (b) CT with injection of diluted contrast medium through the cholecystostomy catheter reveals the presence of a large pancreatic head pseudocyst responsible for the CBD obstruction. The patient denied history of pancreatitis. (c) Percutaneous CT-guided drainage of the pseudocyst was performed during the same session. Subsequently, placement of an internal biliary draining catheter was performed in order to decompress the dilated biliary tree. Three months later the pseudocyst was fully drained without re-filling through the pancreatic ducts and no CBD compression was noticed. The biliary catheter was replaced with a simple cholecystostomy pigtail catheter, which remained closed for 1 week. During that period the patient remained symptom free and both catheters were retrieved.

cross with a guide wire; and finally, elevated mobility of the gallbladder due to lack of support from the surrounding organs.[18,21] Catheterization of the cystic duct can be technically difficult as it is tortuous and the spiral valves of Heister are present. In the early years van Sonnenberg et al.,[5] successfully catheterized the cystic duct in only two of the five patients in whom the procedure was attempted. In a more recent study, Miyayama et al.,[16] failed to pass through a cystic duct that was infiltrated with tumour, and therefore, cholecysto-choledochostomy was the only possible way to the CBD.[16] After this experience, the same group used a microcatheter in the three subsequent cases in order to pass through the infiltrated cystic duct via transcholecystic access.[12] Krokidis et al.,[17] advanced a hydrophilic wire through the spiral valves and towards the CBD in the first attempt assuming that the cystic duct was not

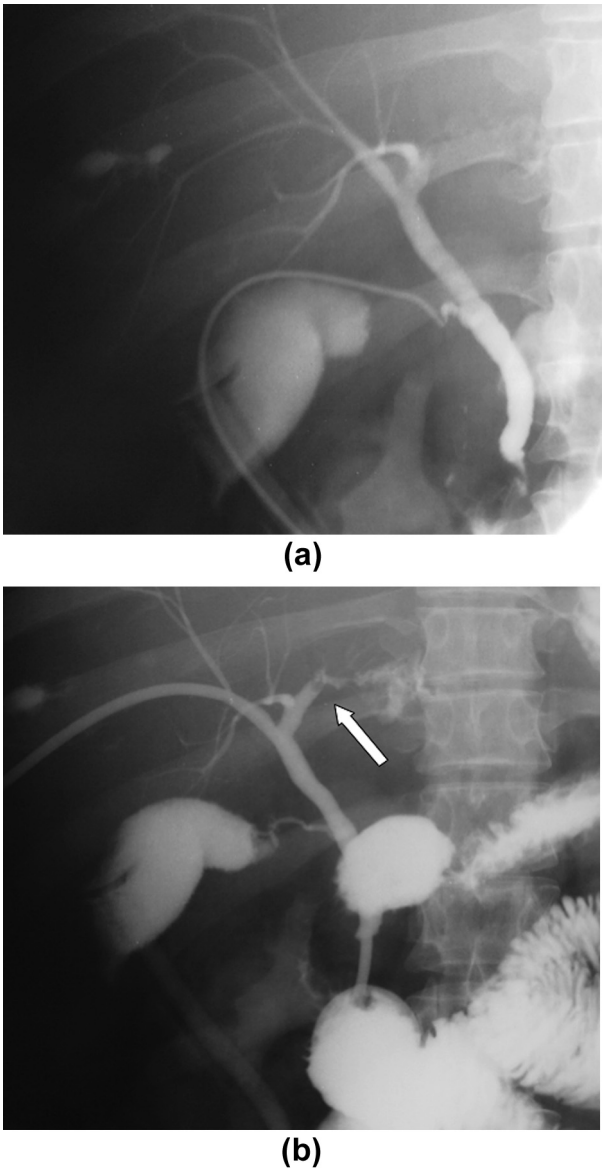

Figure 4 (a) A 30-year-old male patient with a body mass index >30, was admitted after a car accident with stable liver trauma and multiple bilomas. Several surgical draining catheters were placed. Through the cholecystostomy catheter, a diagnostic catheter was advanced in the cystic duct and cholangiography revealed contrast medium extravasation in the right liver lobe. The left bile duct system was not adequately opacified. (b) After percutaneous transhepatic biliary drainage, an 8 F biliary catheter was placed. Cholangiography detected complete transection of the left main bile duct (arrow). Cholecystostomy catheter was retrieved 2 weeks later after tract maturation.

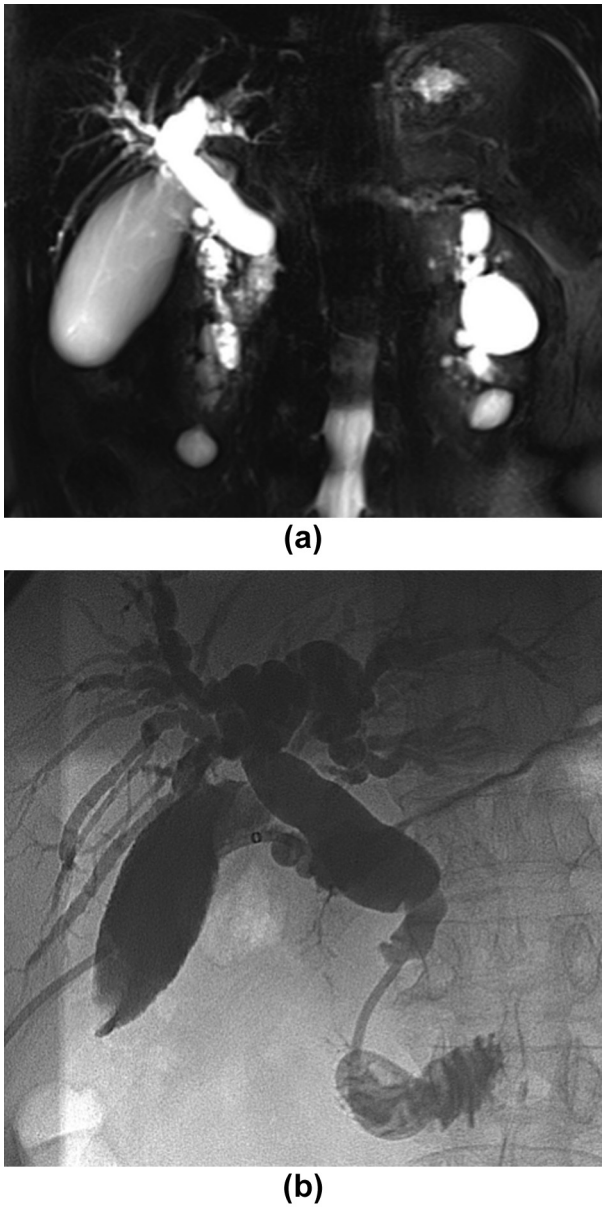

Figure 5 (a) A 75-year-old male patient, in poor general condition, with jaundice and coagulopathy. MR cholangiography shows distal occlusion of the distal CBD, dilatation of the entire biliary tree and enlarged hydropic gallbladder in anterior deflection. The findings suggested pancreatic head tumour. (b) An operable pancreatic mass was confirmed and biliary drainage was requested before pancreatectomy and biliodigestive anastomosis. Due to patient's coagulopathy percutaneous cholecystostomy with subsequent transcystic CBD drainage was performed. The patient was then operated without postoperative complication.

infiltrated with tumour.[17] They experienced some difficulty in passing through the malignant stricture in the infiltrated papilla.

A highly mobile gallbladder is usually the result of a very low transperitoneal puncture,[27] a rather long and tortuous transperitoneal tract, or an immature cholecystostomy tract.[15] In order to avoid a highly mobile gallbladder, percutaneous placement of anchors can be introduced prior to initial drainage.[29,30]

Technical problems

Technical problems are usually related to long, non-mature, or tortuous cholecystostomy tracts; thin or tortuous cystic ducts with tight valves of Heister; poor support of the introduced catheter and wire; and difficult anatomical configuration. Solutions to these problems vary and include allowing a longer period to enable tract maturation,[15] use of special anchoring devices of the gallbladder,[27,29,30] and repeated sessions in case of failure. New access from a different angle may be used if no other solution is feasible.

In cases of significant wire bulking due to acute angulation or tight stenosis of the CBD or of periampullary diverticula, the "rendezvous" procedure may be considered, as previously described.[31] Stents may be difficult to advance through cystic ducts. This issue needs to be taken into consideration when the type of stent is selected and stents with a low-profile (6 F) carrying a catheter need to be the first-line approach, unless a covered stent needs to be deployed in the distal CBD.[17] Other technical issues may be related to the proximal margin of the stent. The landing zone needs to be in a healthy segment of the CBD; therefore, only low strictures may be stented via the cystic duct.

Technical success and complications

The technical success rate of percutaneous cholecystostomy for acute cholecystitis is very high, and was reported to be >85% in a recent review article comprising 53 published studies including 1918 patients.[32]

The largest series in the literature for metallic stent deployment through the cystic duct provides information on 15 patients with malignant obstruction of the distal

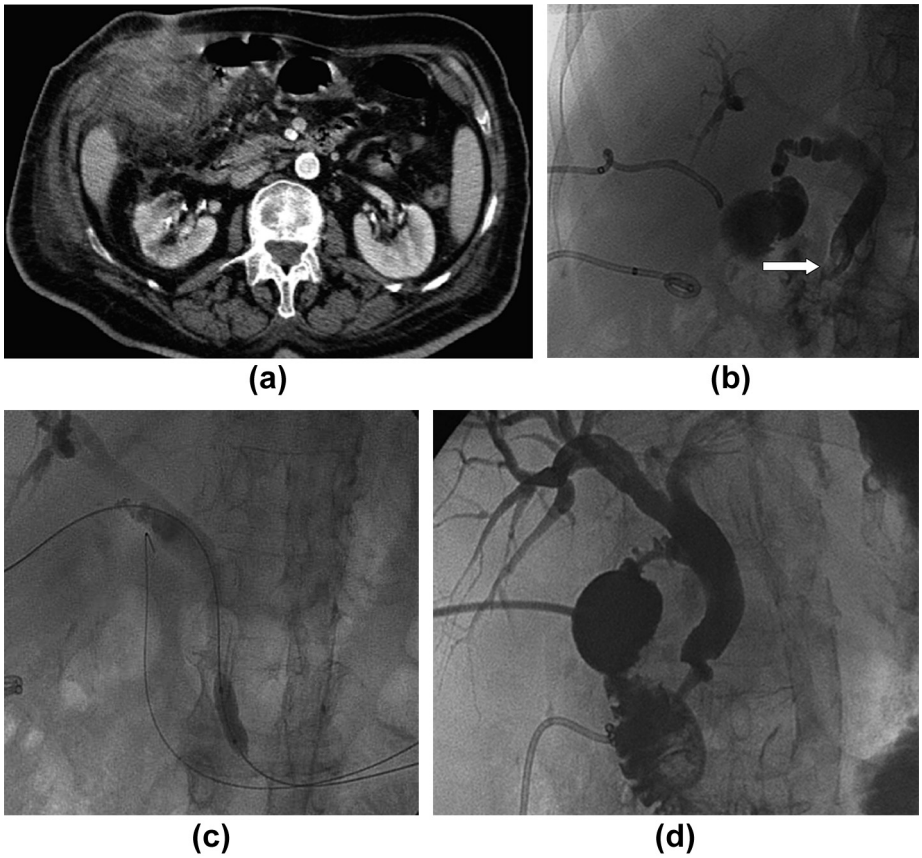

Figure 6 (a) An 83-year-old woman with severe ischaemic heart disease and recurrent episodes of septicaemia was admitted with acute right upper abdominal pain and a cholecysto-cutaneous fistula. The fistula was caused 1 year earlier due to a surgical cholecystostomy catheter placed for acute cholecystitis. CT revealed inflammation of the gallbladder and the surrounding area. (b) A percutaneous cholecystostomy catheter was advanced through the cutaneous fistula and another subhepatic drainage catheter was placed, with good clinical outcome. One week later, the gallbladder catheter was slightly displaced. Cholangiography revealed free passage of the cystic duct and presence of a stone in the distal CBD (arrow). (c) Transcholecystic 10 mm × 2 cm balloon insertion; the papilla of Vater was dilated and the stone was pushed into the duodenum. (d) The final result was considered successful and all the drainage catheters were removed.

Figure 7 An 85-year-old male patient with dementia, in poor general condition, was admitted with symptoms of acute cholecystitis, cholangitis, and jaundice. Ultrasonography revealed biliary tree dilatation with signs of gallbladder inflammation and distal CBD stones. Percutaneous cholecystostomy was performed with good clinical result. Cholangiography showed a patent cystic duct and confirmed the CBD stones. Internalization of the drain without external bag was decided, in order to avoid catheter displacement. Two weeks later patient underwent successful endoscopic stone removal and the drainage catheter was removed.

CBD.[18] A 100% technical success rate was reported with a clinical success rate of 93% (14/15). Stent patency is no different than that of any other biliary stent series and is reported as 297 days (range 7–982 days). Early stent occlusion was due to sludge formation and was treated with the deployment of a second stent.

Complications after percutaneous cholecystostomy occur in 3–13% of cases and are usually minor.[27] The main complaint from patients during the procedure is pain, which can be controlled by intravenous administration of analgesics.[18] A common minor complication is catheter migration, which occurs in approximately 8.6% of the cases.[28] Major complications, such as bile peritonitis, significant haemorrhage, and haemo- or pneumothorax affect <5% of patients.[27,28] In high surgical risk patients with acute cholecystitis, a high (15–25%) rate of mortality is reported, due to the extensive co-morbidities, the poor general condition of the patient, and advanced underlying disease.[27,32] Procedure-related mortality is very low at <0.4%.[32] There are no reported complications caused by the catheterization of the cystic duct. Nevertheless, perforation of the cystic duct and haemobilia are possible adverse effects. These complications are usually self-limiting and need no further action.

Conclusion

In conclusion, the transcholecystic approach of the biliary tree is safe and technically feasible. After negotiation of the cystic duct, various interventional techniques, such as biliary stenting and lithotripsy are possible with high success and low complication rates. These procedures can be added to the percutaneous image-guided armamentarium and can be considered as valid alternative treatment options for patients with advanced malignant or benign biliary disease.

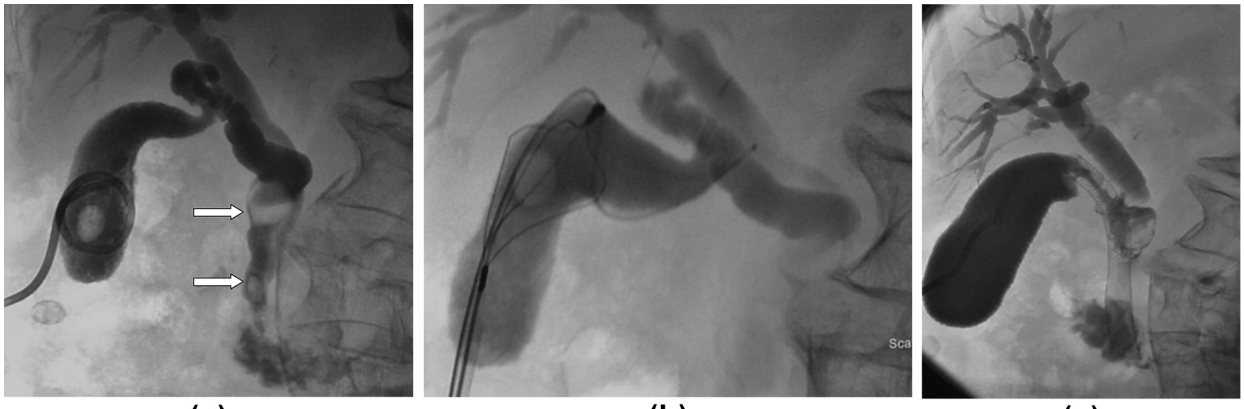

Figure 8 (a) An 80-year-old female patient with severe respiratory insufficiency and Alzheimer's disease was admitted with symptoms of acute cholecystitis. Ultrasonography revealed biliary tree dilatation with signs of gallbladder inflammation and presence of gallbladder lithiasis and several distal CBD stones. Percutaneous cholecystostomy was performed with good clinical result. Cholangiography showed one relative small gallbladder stone, a patent cystic duct, one large and one small CBD stone (arrows). (b) Percutaneous removal of the gallbladder stone was performed with help of an endoscopic basket. Subsequently, internalization of the drain was decided, in order to avoid catheter displacement. (c) Surgical or endoscopic treatment was not feasible is this case. Also percutaneous lithotripsy of the large CBD stone was considered challenging. Two weeks later, the patient underwent placement of a metallic stent through the cystic duct and the CBD with the distal end into the duodenum; the stones were pushed away from the papilla of Vater. Subsequently, the cholecystostomy catheter was removed. The patient died 1 year later from another cause.

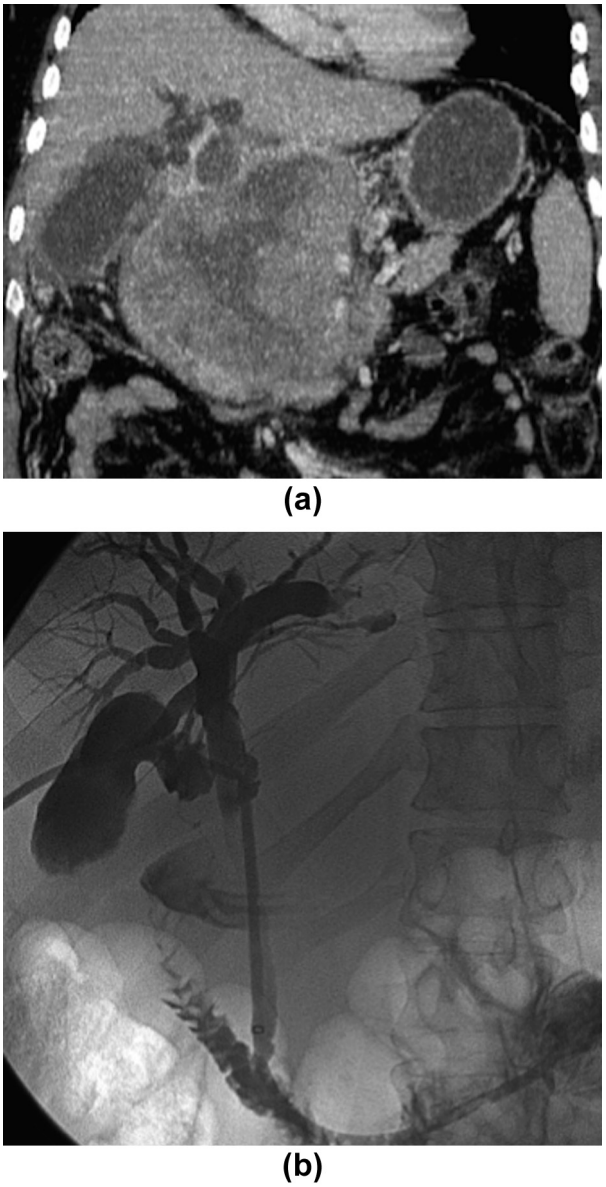

Figure 9 (a) A 62-year-old male patient in poor clinical condition was admitted with jaundice. A very large pancreatic head tumour was detected at CT with obstruction of the intra- and extrahepatic biliary ducts. Due to coagulopathy, percutaneous drainage of the hydropic gallbladder was decided. (b) Two weeks after the initial drainage, the catheter was exchanged with a long internal biliary drain that was advanced through the cystic duct, and because the duodenum was compressed by the mass the catheter was further advanced within the proximal jejunum. The patient underwent surgery 2 weeks later.

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