

The use of CT or MRI for the one-stage placement of stents in biliary obstructions

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PURPOSE

This study describes and evaluates a simple method of percutaneous intervention planning in order to treat obstructed biliary systems using computed tomography (CT) or magnetic resonance imaging (MRI).

MATERIALS AND METHODS

CT (n=18) and MRI (n=31) examinations, which were performed during the imaging work-up of 31 patients with malignant biliary obstruction, were used to plan transhepatic percutaneous biliary intervention. The appropriate intrahepatic duct, the entry point on the skin, and the puncture direction and depth were determined on axial CT or MR images. Under fluoroscopic guidance, a 21-G needle was used for puncture, and the puncture was followed by a percutaneous transhepatic cholangiography, the placement of a stent, and the placement of an external drainage catheter.

RESULTS

The biliary system was successfully accessed on the first attempt in 16 patients (51.6%). Second or third attempts were required in eight (25.8%) and two (6.4%) patients, respectively, whereas more than three attempts were necessary for the remaining five (16.3%) patients. One-stage percutaneous transhepatic biliary stent placement was performed in 29 patients (93.5%). Two (n=1) and three (n=1) interventional sessions were required in order to successfully complete stent placement in the remaining two cases. The mean fluoroscopy time for one-stage biliary stent placement was 12.6 min ± 2.6 min, and no major complications were noted.

CONCLUSION

Thorough CT/MRI-based planning is suggested prior to the interventional treatment of malignant biliary obstruction so as to reduce the number of needle passes, the duration of the procedure, the fluoroscopy time, and the number of complications.

Key words: • bile ducts • bile duct neoplasms • stents

The percutaneous interventional treatment of malignant obstructive biliary disease is a step-by-step procedure that may require two or more sessions in order to achieve its goal. Percutaneous transhepatic cholangiography (PTC) is the first step of this process, and it is usually performed by blindly puncturing the liver under fluoroscopic guidance using anatomic landmarks on the patient's skin (1–3). The present study describes and evaluates a simple and practical method for planning percutaneous biliary interventions by designing an optimal approach via the use of pictorial information from a patient's existing cross-sectional computed tomography/magnetic resonance imaging (CT/MRI) examinations as pre-procedural supplementary assistance.

Materials and methods

This study consisted of 31 consecutive patients (13 women and 18 men; mean age, 67 years; range, 56–83 years) with obstructive jaundice due to non-operable neoplasms, resulting in an indication for percutaneous external biliary drainage or stenting. The final diagnoses included cholangiocarcinoma (n=12), pancreatic carcinoma (n=9), metastatic disease at the porta hepatis (n=5), gallbladder carcinoma (n=3), hepatocellular carcinoma (n=1), and duodenal carcinoma (n=1). Histological evidence of the tumor type was established through surgical, endoscopic, or percutaneous biopsy in 19 patients. In seven additional patients, cholangiocarcinoma was diagnosed by cytology (endoscopic brushing) and imaging findings. In the remaining five patients, the diagnosis of cholangiocarcinoma was based on clinical, laboratory, and imaging findings. Patients underwent contrast-enhanced CT (n=18) and/or MRI with magnetic resonance cholangiopancreatography (MRCP) (n=31) as part of their routine clinical investigation during the 2–11 days prior to the interventional treatment.

Axial CT or MR images, which were obtained during deep expiration, were used to establish the entrance site on the patient's skin, the direction of needle insertion, and the depth of the puncture. The criteria for optimal biliary branch selection were: a) a diameter in excess of 4 mm, b) location at the "safety zone" (1), and c) an obtuse angle between the branch and the centrally located biliary system. Avoidance of the large bowel, pleura, distended gallbladder, or loculated ascites along the needle access route was a primary concern. Needle penetration into an atrophied liver segment or neoplastic tissue was also avoided. The axial plane of the selected biliary branch was determined by using the corresponding vertebral level (i.e., upper end-plate, upper costovertebral junction, lower costovertebral junction, lower end-plate, and intervertebral disk) as an anatomic landmark on the same axial image. A line was drawn across the midsagittal or midcoronal level on the determined axial plane (Figs. 1–3). Next, the distance between the midsagittal or

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Received 3 March 2008; revision requested 25 May 2008; revision received 3 September 2009; accepted 6 September 2009.

Published online 26 July 2010
DOI 10.4261/1305-3825.DIR.1758-08.2

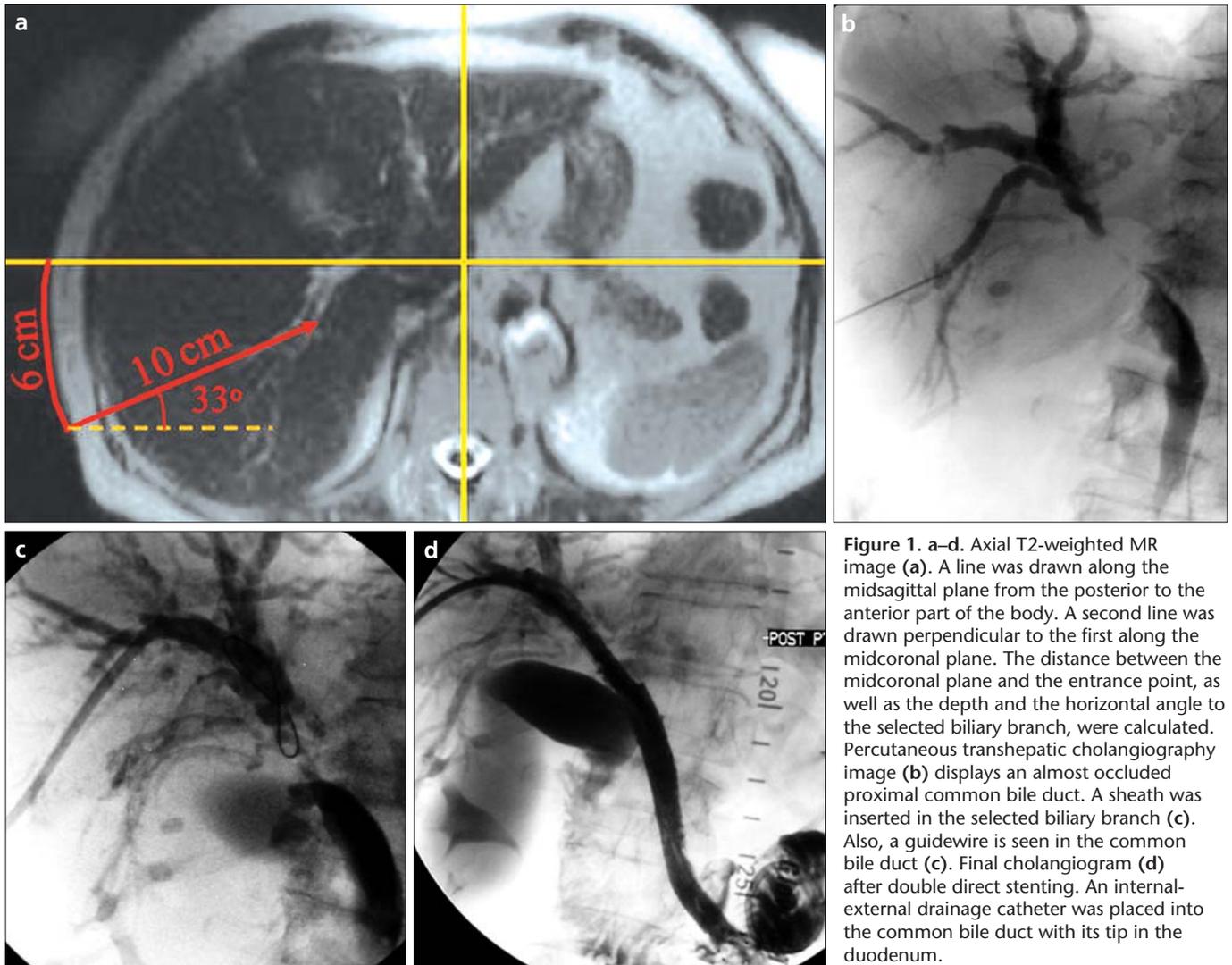


Figure 1. a–d. Axial T2-weighted MR image (a). A line was drawn along the midsagittal plane from the posterior to the anterior part of the body. A second line was drawn perpendicular to the first along the midcoronal plane. The distance between the midcoronal plane and the entrance point, as well as the depth and the horizontal angle to the selected biliary branch, were calculated. Percutaneous transhepatic cholangiography image (b) displays an almost occluded proximal common bile duct. A sheath was inserted in the selected biliary branch (c). Also, a guidewire is seen in the common bile duct (c). Final cholangiogram (d) after double direct stenting. An internal-external drainage catheter was placed into the common bile duct with its tip in the duodenum.

midcoronal level and the selected entrance site on the anterior body surface was measured. The distance between the entrance site and the selected biliary branch, as well as the horizontal angle, were also measured (Figs. 1a, 2, 3). Ultrasonography (US) evaluation was also performed in order to confirm the entry point on the patient's skin because the entry point could potentially change as a function of the depth of the patient's breath at the beginning of the intervention. A 21-G needle with a stylet was inserted under fluoroscopic guidance to the pre-calculated depth. After observing bile drainage and opacification of the biliary system, a 0.18-inch, flexible-tip, stiff, and nitinol Cope Mandril guidewire was introduced into the bile duct through the needle lumen, followed by 4-F or 5-F dilators over the wire (Figs. 1b, 1c). A stiff, 0.35-inch wire was used to replace

the 0.18-inch wire, and a 7-F sheath was then placed in order to insert the stents or balloon catheters. Obstructive masses were bypassed with the aid of hydrophilic guidewires and 4-F or 5-F, straight, hydrophilic multipurpose, or glide catheters. Finally, an 8-F pig-tail catheter (Flexima[®], Medi-Tech[®], Boston Scientific, Fremont, USA) was placed in all of the treated patients for 4–8 days for both internal and external drainage (Fig. 1d).

Results

All of the procedures were technically successful. Access to the dilated biliary tree was achieved with the first attempt in 16 patients (51.6%) (Table). Second and third attempts were necessary in eight (25.8%) and two (6.4%) patients, respectively. More than three attempts were required for the remaining five patients (16.3%). The mean

number of needle punctures in our study population was 2.13. In 13 cases (41.9%), an anterior-lateral approach using a cephalad position was used to target the bile duct with a puncture angle of 30–50° with respect to the horizontal plane. The B8 bile duct (liver segment 8) was punctured in four of these patients, the B5 bile duct was punctured in three patients, and the B5+8 bile ducts were punctured in six cases. In nine cases (29%), a B6 bile duct was punctured with a mid-axillary (n=6) or posterior-axillary (n=5) line approach, whereas in the remaining nine patients (29%), a left hepatic duct was punctured (Table).

One-stage percutaneous transhepatic biliary stent placement was performed in 29 patients (93.5%). Two (n=1) or three (n=1) interventional sessions were required for successful stent placement in the remaining two patients.

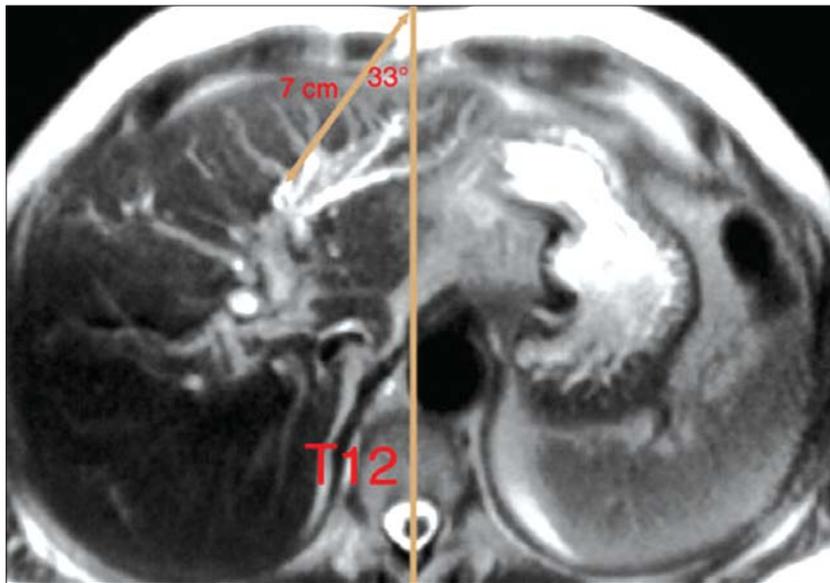


Figure 2. Axial T2-weighted MR image. T12 upper costovertebral level. A line was drawn along the midsagittal plane from the posterior to the anterior part of the body. The angle of insertion as well as the depth of the selected biliary branch was calculated. A left side approach was performed.

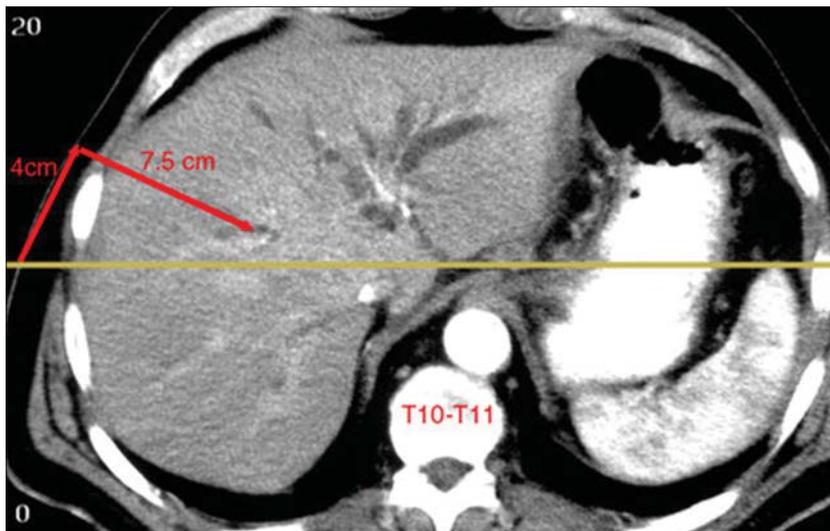


Figure 3. Axial contrast-enhanced CT image. A line was drawn along the midsagittal plane at the level of the T10–T11 intervertebral disk and then transferred at the right lateral aspect of the body. A second line was drawn perpendicular to the first line at the midcoronal level. The distance between the midcoronal plane and the entrance point, as well as the depth and the horizontal angle to the selected biliary branch, were calculated.

The fluoroscopy time for the puncture, one-stage stent placement, and biliary drainage ranged from 8.1 min to 17.4 min (mean fluoroscopy time, 12.6 min ± 2.6 min).

No life-threatening complications were noted. Transient post-interventional fever was observed in three patients (9.7%) despite the prophylactic use of antibiotics. A 4% decrease in hematocrit levels occurred in two patients (6.7%), which necessitated blood transfusions. A subdiaphragmatic abscess was diagnosed one week after the procedure in one patient and was successfully treated with a CT-guided drainage.

Discussion

PTC is considered to be indispensable to the opacification of the dilated biliary tree prior to drainage or stent placement. A blind puncture of the liver is usually performed using anatomic landmarks and fluoroscopy guidance in order to direct needle passage. A peripheral bile duct that is located at the so-called “safety zone” (1) is preferably selected to apply PTC in order to avoid large vessel injury. The success rate of fluoroscopically guided PTC has been reported to be 95%–96% with 1–6 needle passes and 99%–100% with 12–14 needle passes (1, 2). In the present study, a high success rate was achieved with a limited number of needle passes. This high success rate may be related to the pre-procedural planning that utilized pictorial information from recent cross-sectional (CT, MRI) examinations, which were performed as part of the patients’ routine clinical investigation. We hypothesize that the information that is provided by CT/MRI is important for selecting the most

Table. Distribution of the bile ducts which were selected and punctured

Number of needle punctures	Number of patients	Bile duct punctured	Number of patients
1	16 (51.6%)	B8	4 (12.9%)
2	8 (25.8%)	B5	3 (9.6%)
3	2 (6.4%)	B5+8	6 (19.3%)
More than 3	5 (16.3%)	B6	9 (29.0%)
		Main-B3	6 (19.3%)
		B2	1 (3.2%)
		Main left	2 (6.4%)
Total	31		31

suitable branch of the biliary tree and the most secure route for needle passage, which limits the number of extra needle passes. The number of passes in our study is comparable to the number that has been reported with CT-fluoroscopy (1, 3), which favors a restricted number of pass attempts. Keeping the number of needle passes as low as possible is important because the duration of the procedure, total fluoroscopy time, and incidence of complications relate to the number of needle passes (3–5). Biliary intervention techniques should aim to reduce the number of puncture attempts.

The “classical” approach of PTC utilizes needle punctures at the midaxillary line (1–3). Instead, we selected an anterior approach in a significant number of our patients in order to minimize the angle of entry into the biliary ducts and render primary stent placement easier and drainage of the biliary tree more effective. The anterior-lateral approach to the targeted bile duct at a needle angle of 30–50° was the most commonly used needle puncture approach (42%) in the present study. This type of puncture approach is consistent with other studies that have exclusively used US guidance for biliary puncture (6–8), which have mostly employed the anterior-lateral approach as opposed to the “classical” approach through the midaxillary line.

Most operators that perform biliary interventions use US as the primary imaging modality to guide the initial puncture. On the other hand, CT/MRI examinations may offer valuable information prior to intervention, wherein they provide a detailed presentation of the neoplasm location and its extent into the hepatic parenchyma, the level of obstruction, the degree of biliary distension in different parts of the liver, and the exact location and degree of gallbladder distension. In addition, the presence of loculated or free ascites, the occurrence of colonic subdiaphragmatic interposition, the position of the pleura, and post-surgical anatomic alterations can be clearly appreciated on CT/MRI examinations. This anatomic information is important for a success-

ful and uncomplicated percutaneous puncture of the biliary tree. Complications, such as pneumothorax, uncontrollable hemorrhage from a vessel or the neoplasm itself, peritoneal contamination of the disease, and rupture of the gallbladder or the bowel, may be avoided by careful selection on CT/MR images, which reveal the optimum bile duct to be punctured and the appropriate route of intervention. Cross-sectional imaging is also helpful for determining the “safety zone”, i.e. the area of the liver around the porta hepatis, where percutaneous approaches to the dilated bile ducts (with diameters of ≥ 4 mm) generally reduce the incidence of major complications (2). Although the review of CT/MRI-MRCP examinations is generally suggested (2, 4–6), we propose a pre-procedural design that is based on these cross-sectional imaging tools because important information and measurements (angle, depth, etc.) can be derived from these images. This pre-procedural information may be considered either alternative or supplementary to US imaging guidance during the procedure.

There is a general trend for one-stage stenting in cases of malignant biliary obstruction (9–11). For single-stage stenting procedures, pre-selecting the optimal biliary branch is essential. This pre-selection was based on CT/MRI imaging information in the present study, and the initially punctured bile duct was used for the stent passage and/or the drainage catheter placement in the majority of cases (29 out of 31 patients). As a consequence, the average fluoroscopy time for the one-stage stent placement or biliary drainage was 12.6 min in the present study, which is comparable to the total fluoroscopy time that has been reported for CT-fluoroscopy (3, 4). Longer fluoroscopy times are usually required for the standard “blind puncture” technique (3–8).

Pictorial information from recent CT or MRI-MRCP examinations, which are performed as part of the patient’s routine clinical investigation, can assist the pre-procedural planning of the percutaneous transhepatic treatment of

obstructive jaundice by primary/direct stent placement and/or drainage. By means of this planning, the most suitable branch of the biliary tree and the most secure route for needle passage can be selected, limiting the number of needle pass attempts and reducing the total fluoroscopy time.

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