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Ultrasound and fluoroscopy guided percutaneous transhepatic biliary drainage in patients with nondilated bile ducts

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Abstract

Background: The purpose of this study is to demonstrate the feasibility, safety, and success of percutaneous transhepatic biliary drainage (PTBD) using a combination of ultrasound and fluoroscopy guidance in patients with nondilated bile ducts.
Methods: Between January 2005 and July 2007, 50 patients with nondilated bile ducts underwent ultrasound-and-fluoroscopy guided PTBD. The underlying disease processes were divided into biliary obstruction ($n = 38$) and bile leakage ($n = 12$). We used ultrasound guidance when puncturing a bile duct and during cholangiography. We punctured along the course of the targeted bile duct or portal vein when the bile duct was not visualized, which we termed the ''parallel technique.'' This method made it possible for us to cannulate the peripheral bile duct successfully, even when its course was not visualized well by sonography. We then installed a drainage catheter under fluoroscopy guidance. The technical success and complications of the procedure were evaluated.
Results: Neither significant complications nor technical failures were observed. There were only four minor complications: transient hemobilia ($n = 3$) and fever ($n = 1$).
Conclusions: Ultrasound-and-fluoroscopy guided PTBD in patients with nondilated bile ducts is a safe, feasible, and efficient procedure for the palliation of biliary obstruction and leakage.

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Percutaneous transhepatic biliary drainage (PTBD) is an effective and almost universally successful nonsurgical procedure for the palliation of cholestasis in both malignant and benign biliary obstruction [1–3]. However, when applied to patients without bile duct dilatation, this procedure has technical difficulties. There are inevitable cases that require PTBD in the absence of dilated bile ducts [4–7], and some studies have shown that fluoroscopy guided PTBD can be applied to patients with nondilated bile ducts with a similar success rate and rate of complication incidence as with patients with bile duct dilatation [4, 7, 8].

Fluoroscopy guided PTBD as used in the studies mentioned above has some risks, including puncture of the central bile duct to obtain a cholangiogram or application of the blinded puncture of the peripheral bile duct to avoid puncturing the central bile duct. The number of studies that show the superiority of PTBD under ultrasound guidance, in terms of the advantages of puncturing the bile duct by observing the duct in real time, is on the increase [2, 9–12]. In the past, it was frequently difficult to use ultrasound for cases of a nondilated bile duct. However, the resolution for ultrasound has markedly improved. Therefore, ultrasound guidance would help to raise the success rate and decrease complications of PTBD in patients with nondilated intrahepatic bile ducts.

The purpose of this study is to show the feasibility, safety, and success rate of PTBD in patients with nondilated bile ducts using a combination of sonography and fluoroscopic guidance.

Materials and methods

Between January 2005 and July 2007, 555 patients underwent 888 PTBD or reinsertion of a biliary drainage catheter at our institution. Ultrasound-and-fluoroscopy guided PTBD was performed on 50 patients (33 men and 17 women; 34–87 years old; mean age 64.9 years) with nondilated intrahepatic bile ducts. As this study was retrospective, the institutional review board of our hospital waived its approval and the need for informed consent from the patients.

On CT, ductal dilatation was defined as visualization of the peripheral bile ducts. On sonography, ductal dilatation was diagnosed by either identification of the peripheral ducts measuring more than 2 mm in diameter or by visualization of ducts that were larger than the adjacent portal vein [4].

The underlying disease processes were divided into biliary obstruction and bile leakage. PTBDs were performed on 38 patients with biliary obstruction and 12 patients with bile leakage. The causes of biliary obstruction were a bile duct stone ($n = 24$), bile duct carcinoma ($n = 3$), carcinoma of the pancreas ($n = 2$), gallbladder carcinoma ($n = 1$), metastasis to the porta hepatis ($n = 4$), and benign bile duct stricture of various causes ($n = 4$). The causes of bile leakage were leakage at choledochojejunostomy ($n = 4$), leakage at the cholecystectomy site ($n = 3$), retraction of a preexistent biliary drainage catheter ($n = 2$), trauma ($n = 1$), and iatrogenic bile duct injury with a bile leak ($n = 1$).

We used a Advantx AFM (GE Medical Systems, Milwaukee, WI, USA) unit and Advantx LCA (GE Medical Systems, Milwaukee, WI, USA) unit for fluoroscopy guidance, and used Medison SA-6000C (Medison Co., Seoul, Korea) and Acuson Sequoia 512 (Siemens. Medical Solutions, Mountain View, CA, USA) for ultrasound guidance.

The procedures were always performed on a patient under local anesthesia with application of a mild sedative protocol. Prophylactic treatment with antibiotics was started before the procedures. After draping the operation field, we decided the most approachable puncture site under ultrasound guidance. The ultrasound monitor displayed the longest course of the targeted peripheral bile duct and the accompanying portal vein, and we punctured along the course of the targeted bile duct (Fig. 1) or portal vein even when the bile duct was not visualized. This method made it possible for us to cannulate the peripheral bile duct successfully, even when its course was not visualized well on the display monitor, because this new technique, which we term the "parallel technique" increases the possibility of the puncture needle meeting the targeted bile duct running parallel with the portal vein (Fig. 2**B**).

We used ultrasound until the Chiba needle punctured the targeted peripheral bile duct as in the method proposed by Kim et al. [13]. After puncturing the targeted duct and confirming bile juice flow from the Chiba needle, cholangiography was performed by injecting contrast material gently under fluoroscopic guidance. Although there was no visualized peripheral bile duct to puncture, we punctured along a portal vein running parallel with the bile duct as described above. Then we pulled back the puncture needle, slowly injecting the contrast medium under fluoroscopic guidance, and could obtain a cholangiogram successfully in most cases (Fig. 2**C**). After a cholangiogram was obtained, a guidewire was inserted toward the liver hilum and into the common bile duct. The needle was then removed, and a thin-walled sheath was inserted over the guidewire. The wire was replaced by a 0.035-inch Radifocus guidewire (Terumo Medical, Tokyo, Japan). Finally, along the guidewire, a drainage catheter was placed with its tip in the common duct.

Upon failure to obtain a cholangiogram by puncturing the bile duct under ultrasound guidance, we attempted to puncture the bile duct up to five more times without a Chiba needle extracted from the liver capsule. In some cases, when an appropriate angle between the punctured bile duct and the needle was not achievable, we only obtained a cholangiogram and punctured another site with another Chiba needle under fluoroscopy guidance. Procedures were considered as successful when the bile duct was punctured under ultrasound guidance, contrast medium was injected, and a pigtail catheter was inserted into the bile duct using a guidewire under fluoroscopy guidance.

We performed a radiological review and medical record review of all the patients, and checked the success rate of the procedure and existence of complications. The complications were classified into major complications and minor complications with reference to the Society of Cardiovascular and Interventional Radiology guidelines [14]. Major complications include admission to a hospital for therapy (for outpatient procedures), an unplanned increase in the level of care, prolonged hospitalization, permanent adverse sequelae, or death, and minor complications include nominal therapy or a short hospital stay for observation as needed, exclusive of sequelae.

Results

For all 50 patients with nondilated bile ducts, the ultrasound and fluoroscopy guided PTBDs were successful. For four cases the procedure was performed in two steps, that is, a preceding ultrasound guided cholangiogram and additional puncture under fluoroscopy guidance as described above, as an appropriate angle was not achievable. In 43 cases, a right approach was adopted and for the other seven cases, a left approach was adopted.

Only four patients suffered procedure-related complications. There were four minor complications: three cases of transient hemobilia and one case of fever. There were no major complications or procedure-related deaths.

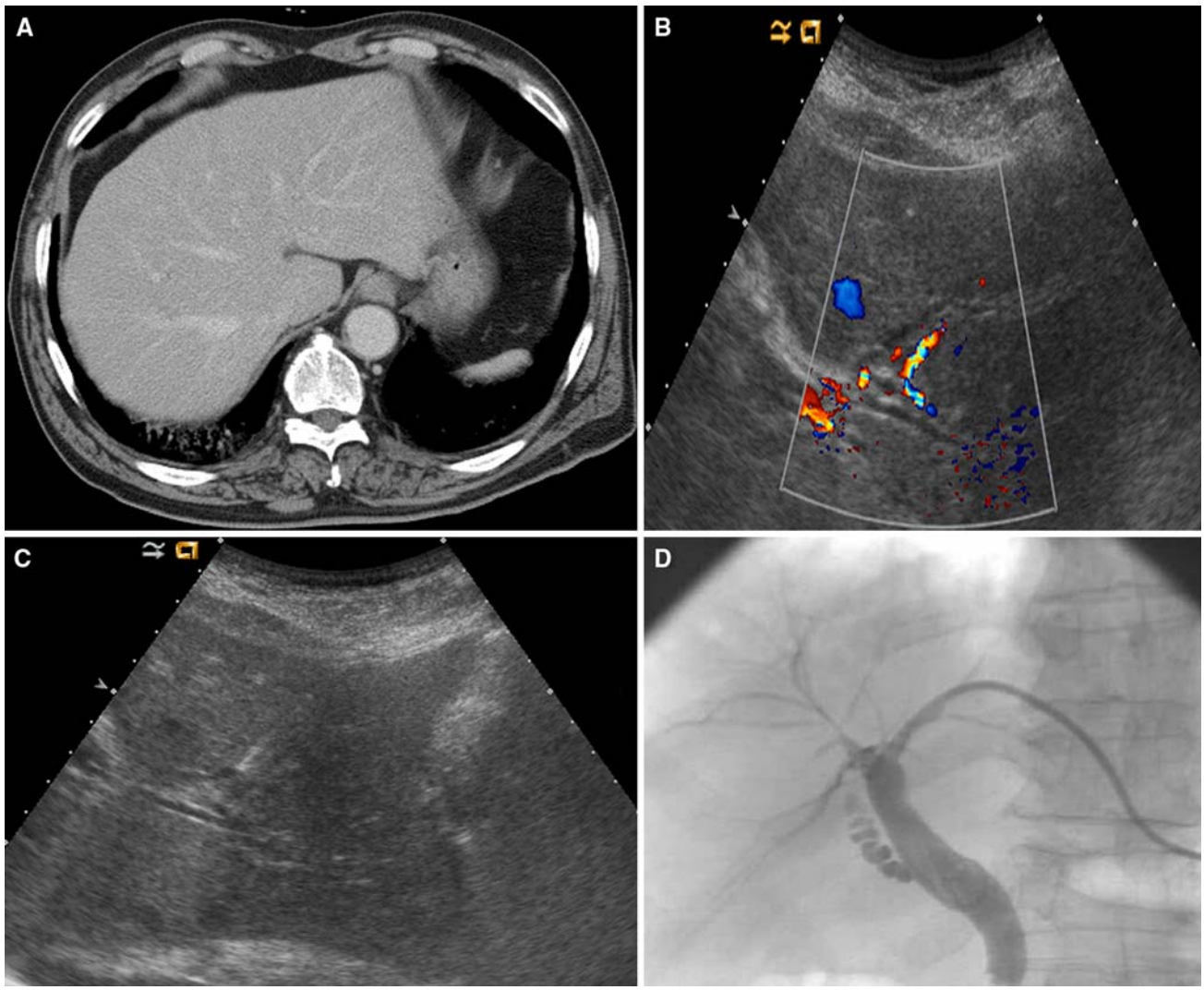

Fig. 1.. A 78-year-old man with jaundice and fever who was diagnosed with acute cholangitis due to a common bile duct stone. **A** Initial computed tomography does not show bile duct dilatation. **B** Ultrasonography reveals an intrahepatic bile duct just anterior to and parallel with the portal vein. **C** Ultrasonography reveals the puncture needle nearly parallel with portal triad. The needle tip is placed in the targeted intrahepatic bile duct. **D** A fluoroscopic image shows the 8.5-French biliary drainage catheter in place.

Discussion

Percutaneous transhepatic biliary drainage is a therapeutic procedure that includes the sterile cannulation of a peripheral biliary radicle after percutaneous puncture followed by imaging-guided wire and catheter manipulation. The indications for the procedure include decompression of an obstructed biliary tree, dilation of biliary strictures, and removal of bile duct stones [1–3].

Most PTBDs are performed when the intrahepatic bile duct is dilated, but even when not dilated, PTBD should be performed in cases including a suspected obstruction of the bile duct in transplanted livers, bile leakage, primary biliary cirrhosis, and primary sclerosing cholangitis, and a previous gastrointestinal operation such as a Roux-en-Y gastrojejunostomy [4, 6, 7]. The pressure of the biliary tree can be high even in cases of biliary stone disease without dilatation of the bile duct [15]. It is thought that this results as infection of the bile duct before dilatation may limit the ability of the duct to distend. Therefore, if fever or any symptoms or signs of septic condition are present in biliary stone disease patients without dilatation of the bile duct, biliary drainage should be performed. Since our institution does not perform emergency Endoscopic Retrograde Cholangiopancreatography (ERCP), several such cases were included in this study group.

Funaki et al. [4] performed percutaneous bile drainage by injecting and catheterizing the peripheral bile ducts in 96 patients after liver transplantation or iatrogenic benign bile duct strictures in the absence of bile duct dilatation. These investigators had a 90% success rate and no

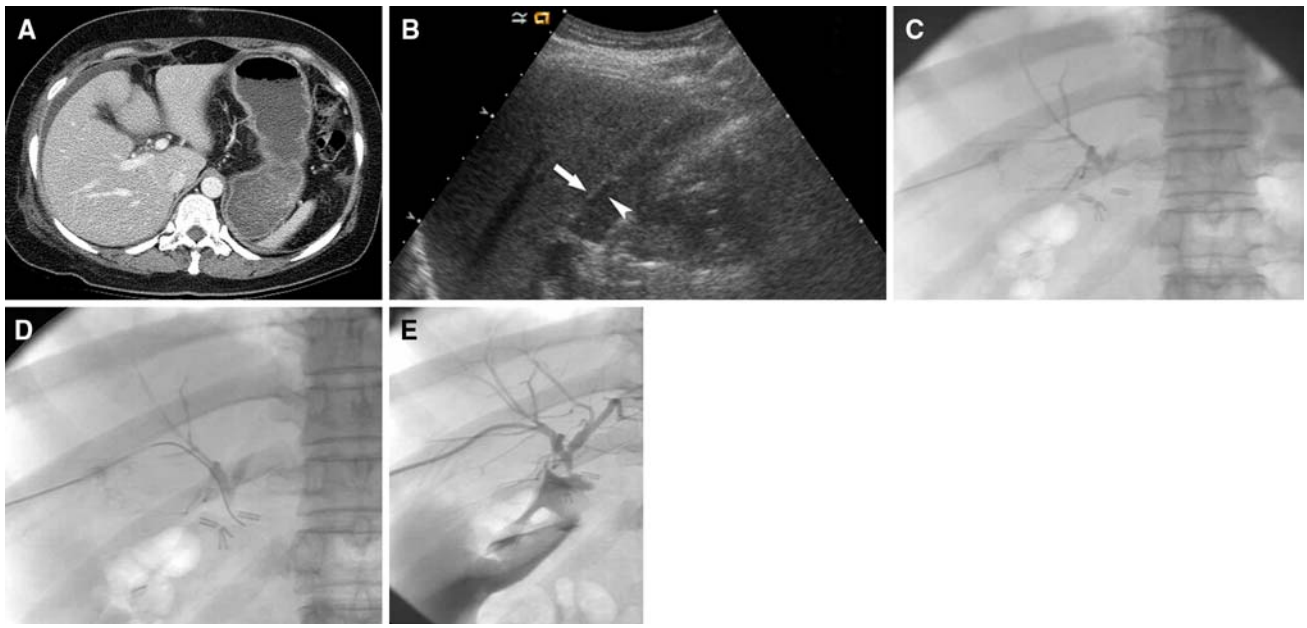

Fig. 2.. A 45-year-old woman with an intraperitoneal bile leak after a laparoscopic cholecystectomy. **A** Computed tomography does not show bile duct dilatation. There is some fluid collection in the right-perihepatic space. **B** Ultrasonography performed during the procedure does not show the presence of a dilated bile duct, and shows the echogenic line of the puncture needle (*arrow*) which is placed just anterior to and parallel with the targeted portal vein (*arrowhead*). **C** A percutaneous transhepatic cholangiogram shows a nondilated bile duct. A small amount of contrast material is seen in the periductal area due to contrast injection when pulling back the puncture needle, because the bile duct was not visible and we performed percutaneous drainage using the "parallel technique." **D** A fluoroscopic image shows the 0.018-inch guidewire passing through peripheral bile duct. E. Fluoroscopic image reveals a 7.0-French drainage catheter installed as the 8.5-French drainage catheter did not pass thorough the nondilated bile duct. A cholangiogram obtained through the drainage catheter discloses bile leak at the cholecystectomy site.

immediate mortality was observed. They used up to ten punctures of the liver capsule and up to 50 passes through the liver to puncture a peripheral bile duct. The aim was to avoid hilar structures and reduce or eliminate the risk of hemorrhage and bile leaks. However, a peripheral bile duct puncture is largely an accidental event and undoubtedly, it requires many passes through the liver during the procedure to obtain such a high success rate in the absence of intrahepatic bile duct dilatation.

Cozzi et al. [6] performed percutaneous cholangiography for the treatment of postsurgical biliary leaks in 17 patients with nondilated intrahepatic bile ducts close to the hilum using the Chiba needle, where the target ducts are larger. These investigators limited the risk related to performing this maneuver near large vascular trunks by using a small-sized needle. After diagnostic transhepatic cholangiography, PTBD was attempted in each patient. Lee et al. [7] also performed PTBD in 14 patients suffering from postsurgical biliary leaks, with the two-step approach, that is, cholangiography with cannulation of the central bile duct followed by catheterization of a peripheral bile duct. Although these investigators used a small sized needle, there was still more risk of hemorrhage than puncturing a peripheral bile duct.

We used ultrasound to visualize the peripheral bile duct to be punctured. This reduced the risks of puncturing the central bile duct and blinded puncture of a peripheral bile duct. Even though it is difficult to localize a nondilated bile duct using ultrasound and in some cases, visualization fails, the increase of ultrasound resolution helped to define a peripheral bile duct using ultrasound for most of the cases. In the case of failure of visualization of some peripheral bile ducts, we punctured along the course of the portal vein running parallel with a bile duct. This technique increases the possibility of the puncture needle meeting the targeted bile duct running parallel with the portal vein, and provides an appropriate angle to insert a drainage catheter. Therefore, we could obtain cholangiograms and insert drainage catheters successfully with this technique in most cases.

In some cases, the angle between the bile duct and puncture needle was not appropriate for drainage catheter installation. The problem was solved by puncturing another peripheral bile duct using an additional Chiba needle under fluoroscopy guidance. We did not use needle guidance as the fixed angle (30°) of the needle made it more difficult to select the bile duct. Using this "parallel technique" with ultrasound and fluoroscopy guidance, successful bile drainage could be accomplished with no major complications.

This study has some limitations. First, the study could not estimate the accurate number of punctures and

procedure time in each case because it is a retrospective study. Second, the results can differ with the dexterity of an operator, which is a common limitation of all ultrasound-guided procedures, but it is thought that if sufficient experience for the visualization of the peripheral portal triad and needle is obtained, the techniques stated above can be performed safely without much difficulty. Third, this study presented only the findings for ultrasound-and-fluoroscopy guided PTBD; it was not a prospective study showing a comparison with fluoroscopy guided PTBD. A prospective comparative analysis is required with a large number of patients.

In conclusion, ultrasound-and-fluoroscopy guided PTBD in patients with nondilated bile ducts is a safe and feasible method and may reduce the risks of puncturing the central bile duct and reduce the risk of a blinded peripheral duct puncture.

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