

Nonsurgical, Percutaneous Transhepatic Cholangiography— Diagnostic Significance in Medical Problems of the Liver

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Percutaneous transhepatic cholangiography has been carried out from the right flank on 314 patients with hepatobiliary disease, using a very thin needle. Practically no complication has been encountered in 80 cases with medical problems of the liver. In contrast, such complications as bile leakage, bleeding, shock, fever, and blood pressure drop were experienced in patients with biliary obstruction and stones, though less frequently than reported. The intrahepatic bile ducts were visualized in 67.5% of the patients with no to minimal dilatation, and this high success rate is accounted for by the policy of injecting contrast medium instead of suctioning bile in search of an intrahepatic duct. This technique has proved of value in the diagnosis of intrahepatic cholestasis, inflammation or infection of the bile ducts, space-occupying lesions of the liver, and in elucidating the cause of biliary colics. It sometimes provides unexpected information. It may also serve the same purpose as portography and hepatic arteriography, since these vessel systems run together with the bile duct.

Percutaneous transhepatic cholangiography (PTC) which was first carried out by Huard and Do-Xuan-Hop (1) in 1937, is now regarded as a most reliable technic in the diagnosis of biliary obstruction. However, because of the frequent complications that follow the procedure, it is performed by or in close cooperation with a surgical team, having an operating table set for laparotomy. Since 1962 when Arner (2), Glenn (3), and their associates first uti-

lized an image amplifier to facilitate direct observations, it has become possible to visualize even nondilated intrahepatic bile ducts under certain conditions. A number of approaches have since been described (2-8), but we have found the procedure modified by Ohto and Tsuchiya (9, 10), which uses a long, thin needle across the entire thickness of the right lobe, to be the most suitable for nonsurgical patients and to have the least complications.

We have used their technique in more than 300 patients with various hepatobiliary diseases during the past three years, and found it to be highly diagnostic not only in surgical jaundices but also in certain nonsurgical conditions of the liver. In 67.5% of the patients with nondilated bile ducts, the intrahepatic ducts were visualized, providing information otherwise unob-

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tainable. Even if the bile duct was not entered and the procedure was marked as "failure," the fact that repeated trials failed proved of significance in differentiating intrahepatic from extrahepatic cholestasis. Because of the minimal risk, this procedure may be considered seriously in certain liver disorders beside its established indications.

MATERIALS AND METHODS

The subjects for study consisted of 314 patients, of the ages of 17 to 71, on whom PTC was carried out by our medical teams for the suspected hepatobiliary or pancreatic diseases during the period from March 1970 to March 1973. The so-called Chiba needle was used; it is 15 cm in length, 0.7 mm in outer diameter, 0.5 mm in inner diameter, and has a bevel angle of 30 degrees. A radiopaque duodenal tube was employed in some patients for anatomical orientation. It was made by connecting a 13-cm piece of silicone tube with a metal olive at the end, to a 120-cm piece of radiopaque Lehman cardiac catheter. As contrast medium, undiluted 60% meglumine isothalamate (Conray, Daiichi Co.) or 60% sodium and meglumine diatrizoate (Urografin, Schering) was used. Roentgen television sets of the Toshiba or Hitachi series have been satisfactory for this procedure.

Procedure

The general principle of the technique is to introduce the needle from the flank toward an area slightly above the junction of the right and the left hepatic bile ducts, avoiding the gallbladder, and to seek a bile duct by injecting contrast medium instead of suctioning bile. The 7th interspace in the right flank is used as the site of puncture, but if the direction of the needle seems to cut across the pleura at the costophrenic angle, the 8th interspace is chosen.

The needle is inserted always parallel with the plane of the table. The site of puncture is 10 to 13 cm from the table, with the patient supine. According to the anatomical measurements in Japanese (10, 11), the distance of 12 cm is used for subjects with a chest thickness of 19.5 cm or more, and 11 cm for those with thinner chests, small adjustments being made in subjects with much larger or smaller thicknesses. When the duodenal tube has been passed for reference, its vertex is used as the landmark and aim is made at a midpoint on a vertical line drawn from the tube vertex to the diaphragm level. When the tube has not been passed, aim is made from the 7th interspace at a point along the right vertebral column, 1.5 to 2 vertebral body thicknesses from the vertebro-diaphragmatic junction, or 1 to 1.5 vertebral body thicknesses below the junction if the 8th interspace is punctured.

The patient is placed supine on the fluoroscopic table, made to hold the head with the right arm and hand, and the point of puncture and direction are marked on the chest wall. A lead marker may also be used on the skin. Local anesthesia is made with 1% procaine hydrochloride along the course of the needle as far as the peritoneum. While the patient holds the breath halfway between inspiration and expiration, the needle fitted with a stylet is inserted along the marked direction as deep as the vertebral column or a few centimeters short of it. The stylet is removed, the needle is connected to a syringe containing contrast medium, and it is slowly withdrawn while a mild pressure is applied onto the plunger. When the needle is in a blood vessel, the medium runs fleetingly; if in the parenchyma, it stays, and it flows slowly and hepatofugally when a bile duct is entered. For the visualization of dilated bile ducts, suction may be used instead of pressure, and 40 to 60 ml of bile is withdrawn through a connecting tube, to be replaced by similar amounts of contrast medium. For nondilated ducts, the first trial may be unsuccessful. Then the needle is withdrawn and reinserted 3 to 5 mm above the first site in the same interspace, the next trial being 3 to 5 mm below, and so on, and 4 to 6 trials may be made altogether. The direction of the needle is always parallel to the table plane. When a bile duct is entered, several exposures are taken while the contrast medium is being injected; then the needle is removed. Several more projections are made with the patient supine, prone, erect, and at angles if necessary. A wide adhesive tape is placed tight around the right lower chest to immobilize the flank. If there is no sign of complication and the blood pressure is stable, hypotonic duodenography is carried out in addition.

Pretreatment

Prophylactic antibiotics are given starting 2 days before and stopping 3 days after the procedure. One hour prior to puncture, 50 to 100 mg of pentobarbital calcium and 5 mg of diazepam are given. Intravenous feeding of 5% glucose

Table 1. Disease Groups, Number of Patients and Success Rates of Percutaneous Transhepatic Cholangiography

Group	No. of patients	No. of successes	Success rate(%)
Malignancy of the liver, bile duct, and pancreas	95	95	100
Cholelithiasis	121	104	85.9
Other surgical diseases	18	15	83.3
Nonsurgical diseases	80	54	67.5
TOTAL	314	268	85.3

TRANSHEPATIC CHOLANGIOGRAPHY

mixed with hemostatic preparations is started shortly before the procedure, and the needle is left in the vein during the entire period in case of need. It is removed if there is no sign of complication or drop of blood pressure.

Indications and Contraindications

This procedure may be indicated also for the study of extrahepatic biliary obstruction and in related surgical conditions: 1) to differentiate intrahepatic and extrahepatic cholestasis, 2) to study the changes in intrahepatic biliary tract, 3) to demonstrate space-occupying lesions, 4) to demonstrate the cause of biliary colics, 5) to demonstrate stones and parasites in the intra- and extrahepatic bile ducts, 6) to study the Vater's papilla in combination with hypotonic duodenography, the best approach to demonstrate the so-called sclerosing papillitis, 7) to study the lower portion of the choledochus which reflects pancreas head lesions, and so on. It is to be remembered that intravenous cholecystocholangiography is not satisfactory for the study of the lower choledochus and that hepatoma arises in more than 40% of the cirrhotic livers in Japan. As will be discussed later, hepatic lymphatics and portal branches may be studied by this procedure, and for that reason, a few patients who do not fall into these categories have also been included in this study.

The contraindications for the procedure are 1) bleeding tendency, 2) sensitivity to iodine and contrast medium, 3) high fever, or continuous fever around 38° C, 4) poor general conditions, 5) extreme jaundice, 6) ascites, 7) moderate to severe anemia, and 8) immediately after an attack of severe pain.

Normal Size of the Bile Duct.

The calibers of the major bile ducts in normal cholangiograms have been measured to be 4 to 7 mm for the left hepatic duct, 3 to 6 mm for the right hepatic, 4 to 8 mm for the common hepatic, and 5 to 9 mm for the choledochus. The calibers of smaller ducts diminish as they approach the periphery. Any measurements above or below these normal ranges have been considered abnormal.

Diagnosis

Final diagnosis has been made by a combination of autopsy, operation, laparoscopy, biopsy histology, clinical and radiologic findings, and from the clinical course.

RESULTS

Disease Groups and Rate of Success

The patients may be divided into four major disease groups: 1) malignancies of the liver, bile

Table 2. Success Rate of Percutaneous Transhepatic Cholangiography in Nonsurgical Hepatobiliary Diseases

Disease	No. of patients	No. of successes	%
Intrahepatic cholestasis	20	13	65.5
Acute hepatitis	11	6	54.4
Chronic hepatitis	1	1	100
Cirrhosis of the liver	13	8	61.5
Postcholecystectomy syndrome	18	13	72.3
Chronic pancreatitis	4	2	50.0
Cholangitis	3	3	100
Clonorchiasis	2	2	100
Miliary liver abscess	1	1	100
Hepatobronchial fistula	1	1	100
Insufficiency of papilla of Vater	1	1	100
Dubin-Johnson syndrome	1	1	100
Normal liver	4	2	50
TOTAL	80	54	67.5

duct, and pancreas, 2) gallstone diseases, 3) other biliary tract diseases of surgical nature, and 4) nonsurgical hepatobiliary diseases (Table 1). Group 1 consisted of 19 cases of bile duct carcinoma in the porta hepatis area, 37 cases of common duct carcinoma, 26 cases of pancreas or papillary carcinoma, 4 cases of primary carcinoma of the liver, 4 cases of metastatic carcinoma of the liver, and 5 cases of gallbladder carcinoma—totalling 95 cases. The procedure was successful in all with a 100% success rate. However, severe complications were more frequent in this group than in other groups.

Of the 121 cases of gallstones, or Group 2, 54 had stones in the common duct, 34 in the gallbladder, 28 in the bladder and the common

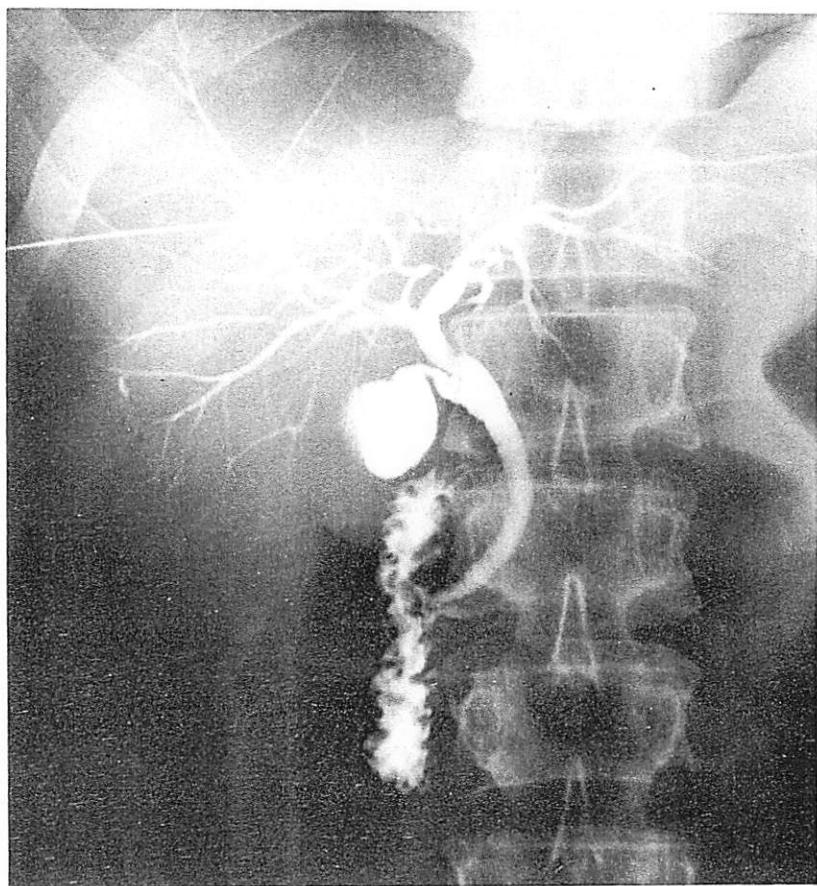


Fig 1. A typical normal cholangiogram obtained by PTC in a patient with intrahepatic cholestasis (Case 1). The caliber of the entire biliary tract is normal. A linear deposit of contrast medium is seen along the wake of needle withdrawal in search of a bile duct.

duct, 3 in the common duct and intrahepatic ducts, one in the bladder and intrahepatic ducts, and one in the intrahepatic ducts only. The rate of success of this procedure was 83.3% or 104 cases out of 121.

Other surgical conditions of the bile duct system (Group 3) included 10 cases of cholecystitis, 4 cases of stenosis of the common duct due to stenosing papillitis and other undetermined causes, 3 cases of internal fistula, and one case of idiopathic choledochus dilatation—totalling 18 cases. The rate of success was 83.3%.

Group 4, or the nonsurgical hepatobiliary

diseases, included 80 patients consisting of 11 cases of acute hepatitis of a noncholestatic type, 20 cases of hepatitis of an intrahepatic cholestatic type, 13 cases of cirrhosis of the liver, 18 cases of postcholecystectomy syndrome, 4 cases of chronic pancreatitis, 3 cases of cholangitis, 2 cases of clonorchiasis, one case each of chronic hepatitis, miliary abscesses of the liver, hepatobronchial fistula (which was discovered by this procedure) (12), insufficiency of the papilla of Vater, Dubin-Johnson syndrome, and 4 cases with normal liver. In 54 out of 80, the intrahepatic bile ducts were visualized to such an ex-

tent that the films were of diagnostic significance (Table 2).

Diagnostic Significance

Beside the surgical conditions for which this procedure is indicated, it also proved of diagnostic significance in a number of medical problems. Most importantly, it helped distinguish intrahepatic cholestasis from extrahepatic biliary obstruction (Case 1). In several cases of common duct stones, recurrent jaundice without pain favored the diagnosis of benign recurrent intrahepatic cholestasis, but PTC readily demonstrated stones (Case 2). In one case of primary biliary cirrhosis, histology was not diagnostic, and PTC provided the most decisive information (Case 3). In a patient who had an unexplained high alkaline phosphatase level with otherwise normal liver tests, PTC demonstrated liver flukes in the intrahepatic ducts, and a repeated PTC after one course of Stibunal therapy proved it to be unsuccessful. In another patient in whom the same disease was suspected, the cholangiogram provided information on the approximate number of flukes or the severity of clonorchiasis (Case 4). In a number of patients with postcholecystectomy syndrome, this procedure helped in determining whether there were stones, residual or newly formed, or whether the complaints were of a dyskinetic nature. In one patient with high fever and leukocytosis of unknown cause, PTC demonstrated miliary abscesses scattered throughout the liver (Case 5). In a patient with similar clinical findings, PTC disclosed an incidental, unusual transit of the contrast medium from the center of the right liver into bronchi through lymphatic channels, as described elsewhere (12). He later developed purulent pulmonary complications. In a cirrhotic patient, PTC disclosed an abnormally located, wide semicircular bile duct, suggesting a complicating carcinoma (Case 6). In another patient with cirrhosis, the lower half of the right liver was missing on the scintigram, and primary carcinoma arising in that area was

strongly suspected. PTC demonstrated a markedly shrunk right liver with the gallbladder displaced cephalad (Case 7). Extremely small calibers of the intrahepatic bile ducts and common duct were seen in a case of Dubin-Johnson syndrome. The gallbladder was also proportionately small. This unusual diminished size of the entire bile duct system has not been described in literature, and may be secondary to a scanty flow of bile (Case 8).

The intrahepatic bile ducts were visualized in 67.5% of the total of 80 patients with non-surgical problems. Even if the intrahepatic ducts were not entered, the difficulty in hitting bile ducts during repeated trial runs indicated the fact that they were not dilated. In the patients with dilated intrahepatic bile ducts, this procedure never failed to visualize them. In the majority of patients, this procedure contributed directly or indirectly to the correct diagnosis.

The following are the illustrative cases.

Case 1. FM, a 69-year-old woman, was admitted because of jaundice, pruritus, and acholic stools. Blood chemistry included 108 units (King-Armstrong) of alkaline phosphatase and 15.8 mg/100 ml of total bilirubin, suggesting cholestasis. Needle biopsy of the liver revealed many bile thrombi and minimal hepatocyte changes. Considering her age, extrahepatic obstruction was strongly suspected. PTC, which was preferred to exploratory laparotomy, disclosed an entirely normal cholangiogram (Figure 1), and the diagnosis of intrahepatic cholestasis was made. She responded to the subsequent corticosteroid therapy remarkably.

Case 2. FH, a 45-year-old farmer, was referred to us with the tentative diagnosis of intrahepatic cholestasis because of icterus, pruritus, and high alkaline phosphatase. He had had a similar episode of jaundice with epigastric discomfort 4 months earlier, responded to prednisolone, and had been discharged from hospital for 2 months. There was no history of pain to suggest gallstone disease. PTC revealed a small stone in the lower common duct and irregularly dilated intrahepatic bile ducts, indicating

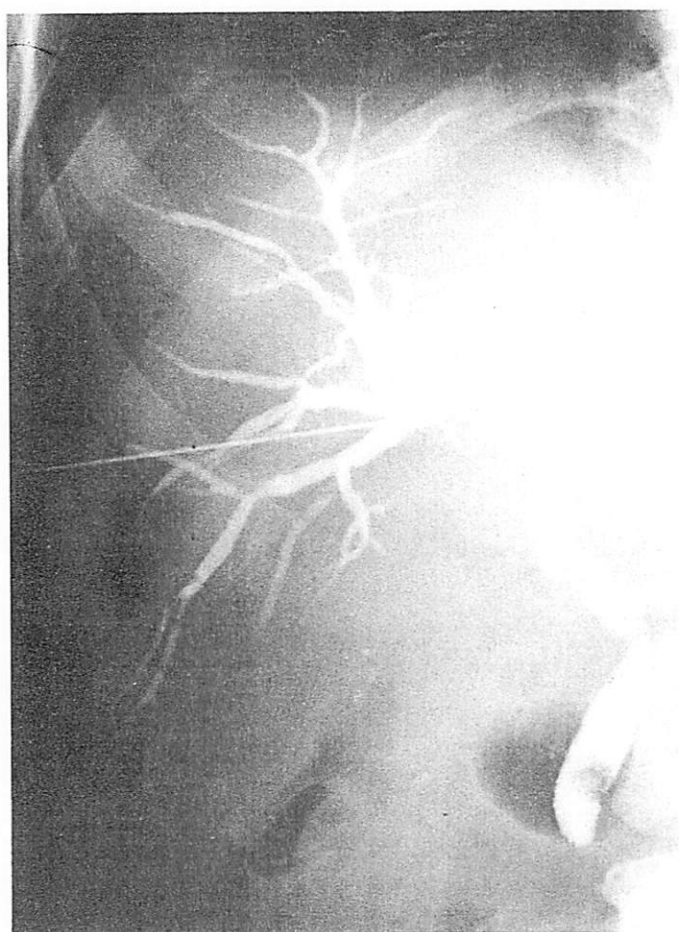


Fig 2. A choledochus stone is apparent to correct the previous diagnosis of recurrent intrahepatic cholestasis in this patient who had several episodes of jaundice without pain (Case 2). The intrahepatic bile ducts are mildly and irregularly dilated, suggesting chronic cholangitis.

chronic inflammatory processes (Figure 2). Subsequent operation and liver biopsy confirmed the diagnosis of chronic cholangitis.

Case 3. IM, a 46-year-old female, was admitted because of easy fatigability, pruritus, and jaundice. She had noted increasing skin darkness and yellow spots on the upper eye-lids for about 2 years. Blood chemistry, together with positive mitochondrial antibody, suggested primary biliary cirrhosis, but the specimen obtained by needle biopsy was not large enough to be diagnostic. In view of the rarity of this disease in Japan and to rule out any lesion along

the extrahepatic bile duct, PTC was carried out. A normal bile duct system was disclosed and the diagnosis was confirmed (Figure 3).

Case 4. ZO, a 43-year-old farmer, was referred to us because of general malaise, anemia, and abdominal distress. He had had an "inflamed gallbladder" and a parasitic disease 4 years previously for which he had not sought treatment. Physical examination revealed an enlarged liver, and blood chemistry showed a high alkaline phosphatase level and a moderate increase in γ -globulin. Feces and duodenal aspirate contained numerous ova of *Clonorchis*

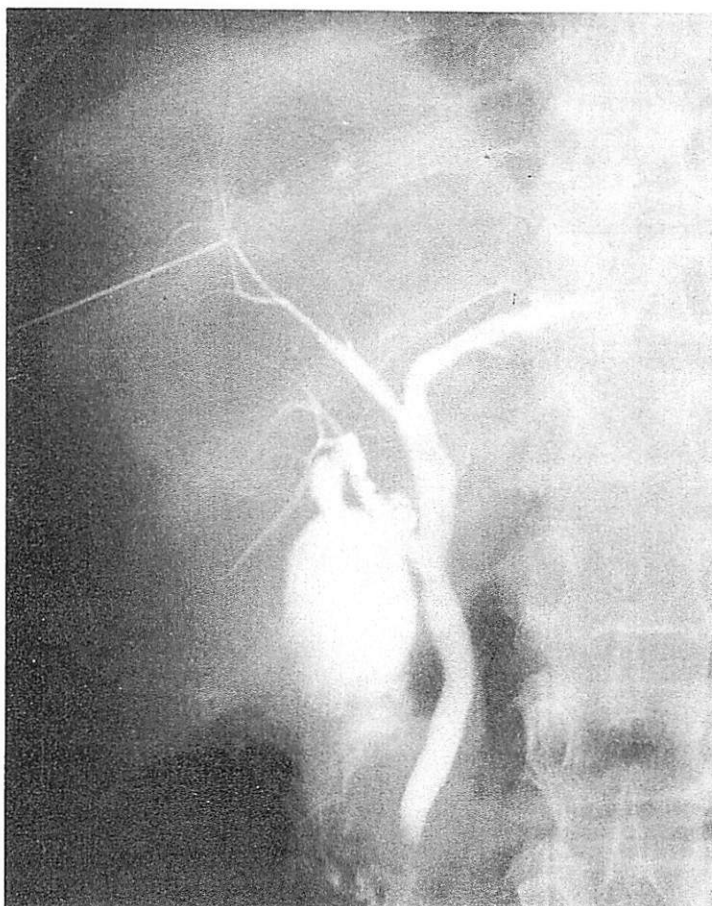


Fig 3. Primary biliary cirrhosis of the liver (Case 3). There is no evidence of dilatation of bile ducts or extrahepatic biliary stenosis. The cholangiogram also suggests that the cirrhotic processes are not too advanced. There is an anomalous connection between the cystic duct and intrahepatic bile ducts.

sinensis. PTC disclosed an unusual picture of markedly dilated biliary tract with more than 200 small filling defects, which obviously represented individual liver flukes (Figure 4).

Case 5. MO, a 65-year-old female, was admitted because of jaundice, fever, and pruritus. She had had dull epigastric pain for 10 days prior to admission. Her liver was palpable two finger breadths, and the laboratory study showed leukocytosis, neutrophilia, accelerated sedimentation rate, hyperbilirubinemia, and elevated alkaline phosphatase. Obstructive jaundice with cholangitis was suspected, and PTC disclosed, besides stones in the gallbladder

and the choledochus, multiple small stains throughout the liver (Figure 5). She succumbed 3 weeks later, and autopsy demonstrated milary abscesses scattered throughout the liver. Thus, the multiple stains on the cholangiogram which had not been interpreted with certainty at the time, represented individual abscesses.

Case 6. TS, a 49-year-old male, entered the hospital because of hepatomegaly and mild jaundice. On admission, a firm liver with a smooth surface was felt two finger breadths below the costal margin. Laboratory study showed increased γ -globulin and alkaline phosphatase. Gamma scanning demonstrated



Fig 4. Clonorchiasis (Case 4). The entire biliary tract is dilated, and many small filling defects are seen toward the periphery of the intrahepatic ducts, representing individual liver flukes. The number of flukes suggests a heavy infestation.

an enlarged liver with generally poor uptake of the colloid. Blind needle biopsy disclosed *Schistosoma japonicum* ova in the portal area and advanced fibrosis. The main problem was to determine whether or not there was complicating liver cell carcinoma, a rather frequent occurrence in Japan. PTC disclosed abnormal intrahepatic bile ducts including a semicircular deposit of the contrast medium in the right lower lateral region, suggesting a neoplastic growth (Figure 6). Subsequent laparoscopy and biopsy confirmed the diagnosis of primary liver cell carcinoma.

Case 7. TN, a 56-year-old alcoholic male,

was admitted because of abdominal distension and epigastric distress. He had had a history of ill-informed liver disease. On admission, the liver and spleen could not be palpated because of ascites. Laboratory data were not diagnostic except for moderately increased γ -globulin. Liver scanning revealed a small right liver mass with almost complete disappearance of the lower portion of the right lobe, and an enlarged spleen. Celiac angiography disclosed winding intrahepatic arteries typical of cirrhosis, but no vessels were seen in the right lower portion. Superior mesenteric arteriography was not successful. Thus, it was not

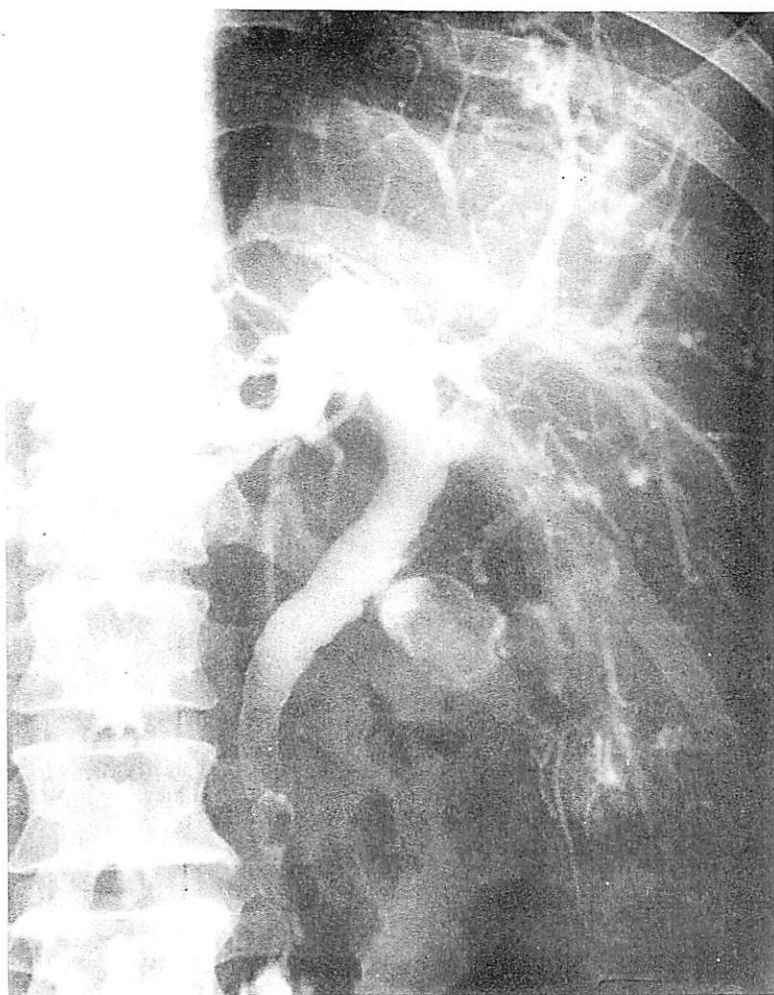


Fig 5. The film of a woman with hepatomegaly and fever (Case 5). One bladder stone and another in the common duct are obvious. There are many small round stains throughout the right liver which were found at autopsy to be multiple small abscesses.

clear whether the right lower area was supplied from the superior mesenteric, a most common variation of the liver arteries, or that the defect on the scan in fact represented a neoplasia. PTC disclosed an extremely small liver with approximation of the major bile ducts in the right lobe; the gallbladder was displaced to point cephalad as a result of shrinkage of the right liver (Figure 7). The intrahepatic bile ducts draining the inferolateral portion were seen coursing more or less in parallel with those from the superolateral portion. These changes

are characteristic of the cirrhotic process. Other biliary tract alterations included branching of small bile ducts with large angles, a sudden change in the course of the duct, and widening of the caliber instead of narrowing as it goes more peripherally. Subsequent laparoscopy and biopsy demonstrated advanced cirrhosis of the liver.

Case 8. YN, a 20-year-old male, was referred to us because of jaundice of unknown etiology. He had had mild icterus without pruritus for 2 months prior to admission, but there had been

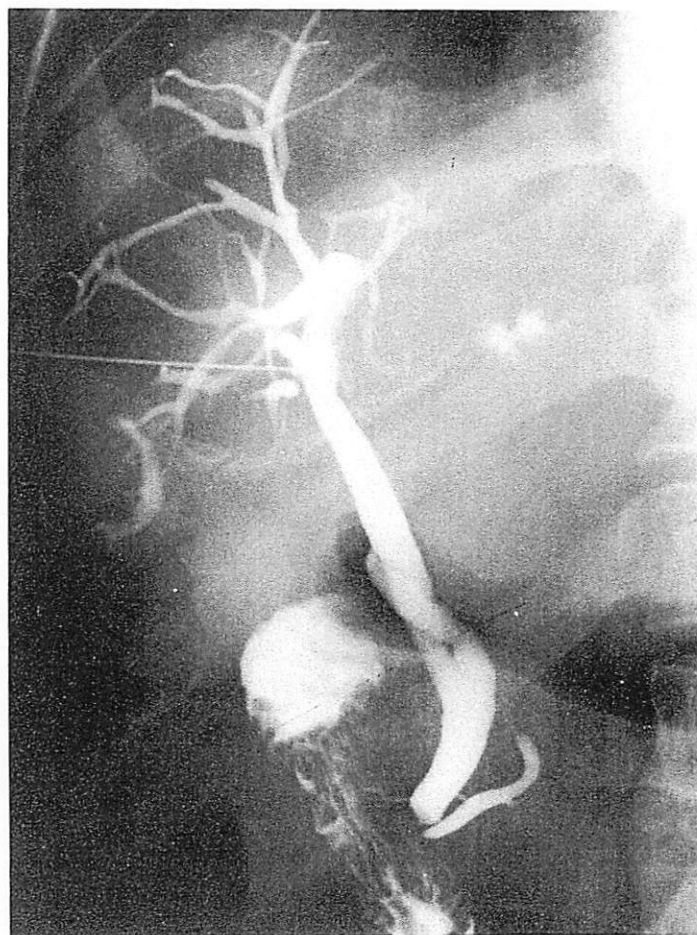


Fig 6. Primary carcinoma of the liver arising on the basis of cirrhosis (Case 6). Beside irregular dilatation of the intrahepatic bile ducts, there is a semicircular, wide deposit of contrast medium in the right lower liver, suggesting a neoplasia. The pancreatic duct is also visualized. The small pool of contrast medium to the left indicates the site of trial injection.

no history of past jaundice. Laboratory tests were unremarkable except for the total bilirubin of 2.9 mg/100 ml, of which 2.0 mg was the direct type. PTC disclosed extremely small intra- and extrahepatic bile ducts, and a proportionally small gallbladder (Figure 8). The picture of the entire biliary tract system looked like that of a child, placed in an adult abdomen. The caliber of the major ducts was measured to be less than one-half the normal average. Subsequent studies including serum bromsulfalein analysis, laparoscopy, and needle biopsy estab-

lished the diagnosis of Dubin-Johnson syndrome.

Complications.

Table 3 lists the complications that occurred during or shortly after the procedure. Pain of varying degrees, which is not listed, has been encountered in about 1 of 7 patients. Pain was often evoked in the epigastric region when the needle was advanced as far as the vertebral column. If the removal of bile was not adequate in patients with obstructive jaundice or stones,

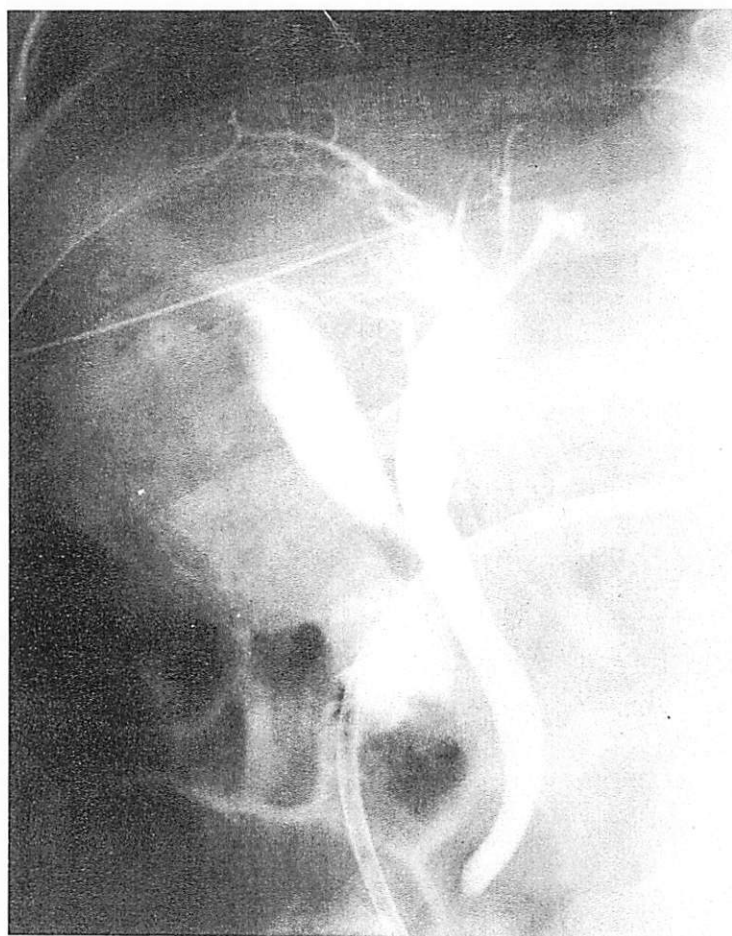


Fig 7. In this patient with cirrhosis (Case 7), the right lower half of the liver was missing or cold on the scintigram, and hepatoma was suspected. The cholangiogram revealed an unusually small, shrunk right lobe, with a displaced gallbladder to point cephalad. The bundle of streaks running toward the porta hepatitis represents lymphatic channels.

pain was often experienced, probably due to an increasing intraductal pressure after the introduction of contrast medium. Such pain has to be differentiated from that which ensues bile leakage. Injection of contrast medium into liver parenchyma, particularly along the portal tract, caused pain, the severity and duration of which depended on amount of medium and the speed of drainage. The pain sometimes radiated to the right shoulder, but did not last long and was usually alleviated with analgesics. It is to be noted that parenchymal injection of contrast medium often provided additional information

on the hepatic lymphatics (Figure 9) which are enlarged and run fast in cirrhotic livers.

Sudden rise of temperature developed with chills 1 to 2 hours after PTC in 11 patients, of whom 8 had stones, 2 had bile duct carcinoma, and 1 had pancreas head carcinoma. Blood culture was positive for *E coli* in only one patient, but chills and fever were most likely caused by the entry of infected bile into the vein. The fever was controlled with antibiotics in 3 to 7 days. A slight temperature rise was not infrequent in obstructive jaundice. All six patients in whom blood pressure dropped more than 25 mmHg

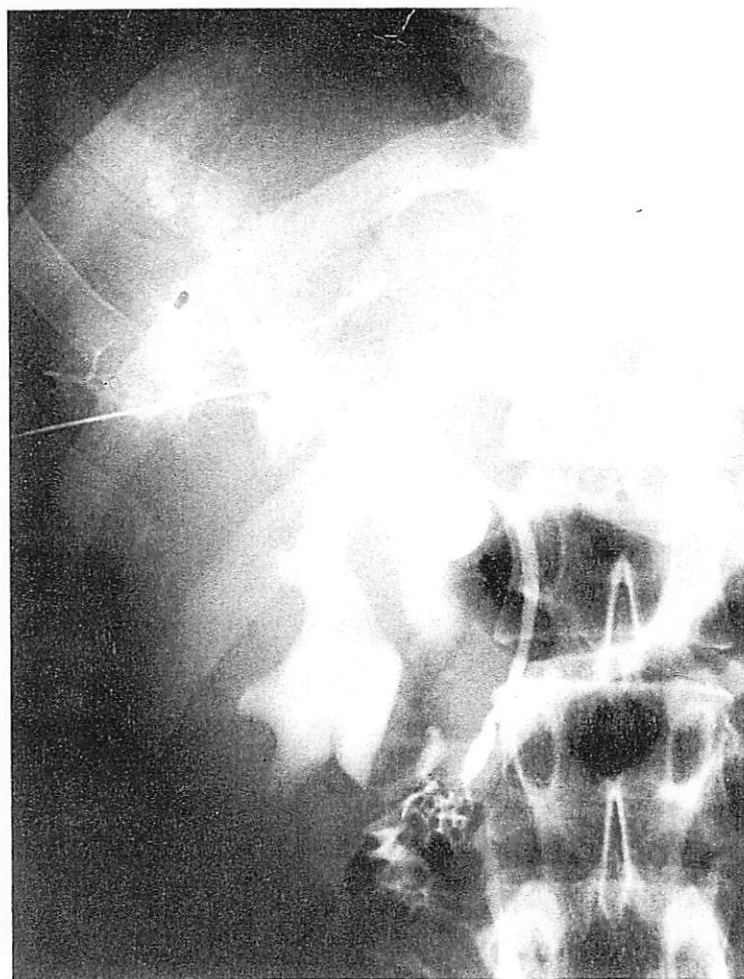


Fig 8. Dubin-Johnson syndrome (Case 8). The common hepatic duct, choledochus and gallbladder are extremely small and proportionately small. The lead circle is the guide mark on the skin. The irregular streaks radiating from the parenchymal deposit of contrast medium represent portal vein branches.

had obstructive jaundice, and it occurred during the procedure in 2 patients and shortly after it in 4. The gallbladder was punctured in 1 patient who later complained of abdominal pain, but the symptoms subsided without surgery. When bile leaked from a dilated duct near the liver surface or from an extrahepatic duct by bad aim, it was soon followed by upper abdominal pain of increasing severity. The only patient who required surgery had had a bile duct carcinoma, and about 8 hours after the procedure, he developed signs of peritonitis. Bleeding was sus-

pected in 2 patients when there was continuous right upper quadrant distress, and a drop in hematocrit was noted. Following blood transfusions, the bleeding seemed to have ceased with improvement of the general conditions, and no laparotomy was required. The cause of bleeding was thought to be the patient's inability to hold breath at the time of puncture or to maintain quiet, calm breathing during the procedure. Therefore, caution has to be exerted when a patient with pulmonary disease is studied. Two patients, one with miliary liver abscesses and

TRANSHEPATIC CHOLANGIOGRAPHY

Table 3. Complications of Percutaneous Transhepatic Cholangiography

Complication	No. of patients	Frequency (% of total*)	Among nonsurgical cases †	
			No.	%
Fever **	11	3.50	0	0
Drop of blood pressure (> 25 mmHg)	6	1.91	0	0
Bile leakage	3	0.95	0	0
Biliary peritonitis	2	0.64	0	0
Bleeding	2	0.64	0	0
Cough ††	1	0.32	1	1.25
TOTAL	25	7.96	1	1.25

* 314 cases

† 80 cases

** Above 38.0° C

†† Due to preexisting hepatobronchial fistulae.

the other with advanced bile duct carcinoma, died 2 to 3 weeks after the procedure, but the death could not be ascribed to this examination.

It is to be emphasized that all these complications were encountered in patients with surgical problems, particularly with dilated bile ducts and/or gallstones, and it never occurred in patients with nonsurgical hepatobiliary diseases. The only complication experienced in patients categorized in the "nonsurgical" group was a cough and spitting of contrast medium during the injection. It occurred in a patient with hepatomegaly and fever, and the cholangiogram thus obtained demonstrated an already established hepatobronchial communications. Several weeks later, he developed purulent pulmonary complications (12). Since no large abscess was found, he was placed in the nonsurgical group.

DISCUSSION

There have been a number of reports on PTC including a few recent excellent re-

views (7, 13), and its indications have so far been limited to the conditions in which the biliary tract is expected to be dilated. In most of the past studies, the roentgenologic examination was carried out under strict surgical conditions with a scheduled surgery to follow, because of the frequent complications and the nature of the disease. The reported complications include bile leakage, biliary peritonitis, internal bleeding into either the abdominal cavity or a major bile duct, shock presumably due to passage of bile into blood or a so-called bile-blood fistula (14), fever, infection, pneumothorax, induction of colicky pain, puncture of the gallbladder and other organs (6, 15-17), etc. There were about 10 deaths in literature up to 1970 which were directly attributable to this procedure (2, 5, 6, 16-21). The analysis of 1218 attempts collected by Seldinger (7) from 44 publications revealed 32 cases (2.6%) of biliary peritonitis, but its incidence was 0.64 or one-fourth as frequent in our series of 314 cases. Other complications were also much less frequent in our experience compared with the previous investigators.

The major merits of the technique used in this study are: 1) entry from the lateral chest wall, which provides a better protection afforded by the thickness of the liver tissue against bile leakage, 2) use of a thinnest possible needle without a fitting-over catheter, and 3) search for intrahepatic bile ducts by injecting contrast medium instead of suctioning bile. If the needle is inserted from the flank with the patient supine, its position and direction are readily followed in a lighted room, and the TV monitor effect is taken full advantage of, compared with the approaches from the anterior surface. Also, the chances of puncturing the gallbladder are minimal. A number of investigators use a thin, soft catheter fitting over the needle for the purpose of drainage (2-4, 6-8), but it inevitably makes the hole in the liver surface larger, and risk of bile leakage may be even greater in patients with increased intraductal pressures. The other advantage of the use of a thin needle is that it

Fig 9. A hepatic lymphogram obtained in a patient with cirrhosis. Beside the bunch of increased lymphatic channels going to the porta and thenceforth into the Cisterna chyli, two thick lymphatics are running caudad to give off many branches to the left, a finding compatible with increased lymphatic flow.



has a better chance of hitting nondilated intrahepatic bile ducts while an exploratory injection of contrast medium is continued. The suction method seldom succeeds in visualizing nondilated bile ducts. Duodenal intubation has a dual advantage; its position in the first duodenal portion gives an approximate orientation of the gallbladder, and subsequent hypotonic duodenography through it often provides films showing both the lower common duct and the duodenal mucosa for the diagnosis of lesions in the pancreas head and around the papilla of Vater.

It is noteworthy that in 67.5% of the 80

patients with nonsurgical hepatobiliary problems, the visualization of the biliary tract was achieved by this technic. Also remarkable was the fact that in 13 out of 20 patients with intrahepatic cholestasis, the very condition in which differential diagnosis is imperative for the avoidance of harmful surgery (22), this procedure proved successful and highly diagnostic. Even if it fails, the failure itself is meaningful, because it suggests the absence of bile duct dilatation. In the early reports in which the conventional fluoroscopy was employed, PTC was never successful in patients without obstructive jaundice. With the TV monitor, Glenn et al (3)

had success in 2 of 4 patients with nondilated bile ducts, Arner et al (2) in 18 out of 35, Hines et al (23) in 7 of 23, and most of other investigators (4, 20, 24) had no luck in their small numbers of patients.

Other than for the diagnosis of intrahepatic cholestasis and differentiation of nonsurgical from surgical jaundice, this technique may be indicated for the elucidation of the cause of biliary colics, as in postcholecystectomy syndrome and the so-called dyskinesia, and for the demonstration of intrahepatic stones, malformations, inflammation along the biliary tract, and the location and extent of neoplastic invasion. It may be carried out as a substitute for portography with much less risk, and further, intrahepatic portal branches are visualized during trial injections and may be studied on the film taken for that purpose (25). Though less desirable, it may also substitute for celiac angiography in various hepatobiliary diseases including space-occupying lesions, since the artery, portal vein, and bile duct run together in the portal tract. Several other fortuitous indications have been described in the text. In one patient with unexplained alkaline phosphatemia, PTC demonstrated *Clonorchis sinensis* infection of moderate severity. Instillation of Stibunal into the intrahepatic bile duct at a repeat PTC failed to reduce the fecal egg count, suggesting ineffectiveness of this compound which has long been the major drug for this parasite (26). An additional feature of transhepatic cholangiography is the feasibility of hepatic lymphography that has not yet been emphasized but may yield information of some significance, as in cirrhosis.

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