Percutaneous cholangiography in the management of biliary stricture

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EDITORIAL SYNOPSIS The technique of percutaneous cholangiography using a polyethylene tube threaded on to a fine needle and removing the needle as soon as the liver is entered is described, with its advantages and results. Complications are reduced to a minimum if, when a dilated biliary tree is found, operation is carried out the same day, preferably within about two hours.

The biliary tree was successfully outlined in 29 out of 39 instances in patients with strictures of the bile ducts. In none of these cases had the biliary tree been satisfactorily outlined by oral or intravenous cholangiography.

The surgical repair of biliary stricture is almost always a difficult technical problem. If the anatomy of the duct system can be demonstrated before operation, much of the uncertainty is dispelled. Percutaneous cholangiography is here described as a safe and successful technique for this purpose.

Since Huard and Do-Xuan-Hop (1937) first described cholangiography performed by percutaneous liver puncture there have been a number of reports on the procedure, its indications, complications, and limitations. The technique has been used with some success in cases of biliary stricture (Remolar, Katz, Rybak, and Pellizari, 1956; Redington, Fitzgerald, and Knight, 1957; Santos, Figueroa, and López, 1960; Kaplan, Traitz, Mitchel, and Block, 1961; Shaldon, Barber, and Young, 1962; Glenn, Evans, Mujahed, and Thorbjarnarson, 1962; Arner, Hagberg, and Seldinger, 1962; Isley and Schauble, 1962; Flemma, Schauble, Gardner, Anlyan, and Capp, 1963; Elkington and Bernstein, 1964; Weichel, 1964; Zinberg, Berk, and Plasencia, 1965). The majority of these general reports, however, deal with only small numbers of patients with biliary stricture and this condition in particular is not discussed. Because of instances of fatal intra-peritoneal haemorrhage (Nurick, Patey, and Whiteside, 1953; Darmailacq and Régner, 1954), death from bile peritonitis (Leger, Zara, and Wagnier, 1953; Stiris, 1962; Zinberg, *et al.* 1965), and from biliaemia (Arner *et al.*, 1962), the technique has yet to gain general acceptance in this country.

Early investigators used rigid metal needles of various types and a major advance was the use of a flexible catheter introduced by means of a needle,

after which the latter was removed, hence minimizing the chances of subsequent damage to the liver caused by movements. Leger *et al.* (1953) studied a small number of cases with this technique. It was later developed independently by a number of workers (Fernström and Seldinger, 1956; Wiechel, 1960; Shaldon *et al.*, 1962; Arner *et al.*, 1962) and employed in larger series. The present paper describes the application of percutaneous cholangiography as modified by Shaldon *et al.* (1962) to the investigation of patients with biliary stricture.

THE TECHNIQUE

PRINCIPLE A polyethylene tube is threaded on to a fine needle and introduced percutaneously directly into the liver. The needle is at once withdrawn leaving the polyethylene tubing *in situ*. The end of the tubing is then attached by an adaptor to a syringe. Constant suction is maintained while the tube is gradually withdrawn. Once a duct is entered, bile is aspirated into the tube and syringe. Sufficient 45% Hypaque (Winthrop) is then injected under radiological screen control to obtain optimum filling of the duct system, and films are taken in various positions to show the site and extent of any obstruction present.

PREPARATION OF THE PATIENT IN THE WARD The prothrombin time is checked and corrected, if necessary, by administration of vitamin K. The patient is tested for sensitivity to the contrast material. The abdominal skin is prepared in the ward and food and drink are withheld on the morning of the procedure. The patient is premedicated with pethidine 50 to 100 mg. and scopolamine 0.4 to 0.6 mg. 45 minutes before the time of the x-ray examination. Tetracycline cover is started the day before the examination and continued for five days.

PREPARATION OF TUBES AND NEEDLES The tubing used is thin-walled flexible polyethylene of internal diameter 1.5 mm. Short lengths are cut, each approximately 20 cm. long. A flange is made at one end of each of these tubes by rotating the tip over a small flame. The tubes, together with six flexible 20-gauge steel needles 15 cm. in length, ground with a short-bevel cutting point, and three tap adaptors, are kept pre-sterilized.

A polyethylene tube is taken and drawn, flange first, over one of the needles. While tube and needle are held in one hand, the free end is pulled out so that it is stretched and its calibre reduced until it tightly grips the end of the needle. The tube is cut off flush with the bevel of the needle, and an adaptor threaded over needle and catheter which are now ready for use.

THE PROCEDURE The investigation is performed in the x-ray department on a standard tilting screening table. Image intensification is an advantage. A general anaesthetic is used only in children or unduly nervous patients.

The examination is preferably performed by two persons, one of whom intubates the biliary tree while the other operates the image intensifier or fluorescent screen and takes the films. For an anterior injection the site chosen for insertion of the needle is 2 cm. below and 2 cm. to the right of the xiphisternum. This may be varied to avoid old operation scars. Local anaesthetic (1% lignocaine) is injected into skin, subcutaneous tissues, and down to the liver capsule with the patient holding his breath. For a lateral intercostal approach, a point in the mid-axillary line is chosen over one of the lower right intercostal spaces, below the level of the costo-phrenic angle on full inspiration as shown on preliminary screen examination.

Following a small skin incision a track is made through subcutaneous tissues and muscle using mosquito forceps. This is particularly important if there has been previous abdominal surgery, as scar tissue tends to buckle the polyethylene tube during insertion. With the patient holding the breath, the needle and polyethylene tubing are then introduced rapidly through the prepared track in a slightly cephalad direction, to a depth of approximately 10 cm. and the needle itself is then swiftly withdrawn. The patient may then breathe. The collar adaptor is then connected to a tap connector and a 20 ml. syringe containing saline. The system is flushed and the catheter slowly withdrawn as suction is applied.

When a bile duct is entered there is an immediate change of pressure in the syringe and bile, recognized by its colour, is aspirated into the tube. Occasionally the bile is white when a colourless fluid, sticky to the touch, flows up the tube. A few millilitres of bile are always drawn off for culture.

When bile is aspirated the tap adaptor is strapped to the skin and the syringe removed. Now 5 ml. of contrast material is injected by way of a further flexible polyethylene cistern. The radiologist operating the screen can see immediately whether it is flowing into the duct system. If it is, the injection is continued until the biliary tree is filled sufficiently to provide maximum information. The patient can be turned, or the table tilted, to demonstrate the anatomy of the ducts as fully as possible and the

films are taken in positions seen best to show the site and extent of the stricture. The amount of Hypaque injected varies according to the capacity of the duct system. Often 20 ml. is sufficient, but 60 ml. or more may be required if there is marked dilatation. If a blood vessel is entered, the catheter immediately fills with blood. This is of no consequence, the tube is flushed with saline and withdrawal continued.

If the tube is completely withdrawn without bile being aspirated, a second puncture is made using a fresh needle and tube, the needle being directed a little to the right of the first puncture. If this fails, yet a different direction of insertion is chosen. If the biliary system is dilated a radicle is usually successfully entered in two or three attempts. However, where the obstruction is believed to be intermittent or partial as many as 10 punctures may be made. To show a high stricture involving the origins of both left and right hepatic ducts it may be necessary occasionally to cannulate both duct systems separately.

If biliary dilatation or obstruction have been demonstrated, then operation should be performed the same day and preferably within two hours. When the diagnosis of stricture has already been made on clinical grounds the operation will probably be undertaken irrespective of the result of the percutaneous cholangiogram. The patient is taken to the operating theatre with the polyethylene tube in place, draining bile into a sterile receiver.

In patients where the clinical diagnosis of stricture is uncertain, a negative cholangiogram provides evidence against there being any biliary dilatation (or obstruction, therefore) and this should be taken into consideration with the clinical findings and biochemical results before a decision to operate is taken. When a dilated radicle has not been entered, it is safe to withdraw the cannula and observe the patient on the ward for a few days (George, Young, Walker, and Sherlock, 1965).

RESULTS

Thirty-five patients, aged 10 to 68 years, have been studied (Tables I and II). The stricture followed biliary tract surgery in 31 patients, 25 of whom had already undergone one or more explorations for repair of biliary stricture. Four patients (cases 24, 25, 32, 33) who had not undergone previous surgery gave a long history of symptoms suggestive of cholelithiasis and in every instance operation revealed stones as well as a stricture.

All patients had typical symptoms with intermittent or constant jaundice, upper abdominal pain, fever, pale stools, and dark urine. Serum bilirubin levels were elevated in the majority of cases (Tables I and II), but in 13 instances the serum bilirubin level was less than 2 mg. per 100 ml. at the time of cholangiography. The serum alkaline phosphatase was always raised. In none of the cases was it possible to demonstrate the main bile ducts satisfactorily by oral or intravenous cholangiography, although in one (case 35) the ducts contained gas and could be

TABLE I

CASES WITH SUCCESSFUL PERCUTANEOUS CHOLANGIOGRAPHY

Patient			Duration of Jaundice (mth.)	Serum Bilirubin Level (mg. per 100 ml.)	Alkaline Phosphatase Level (K.-A. units per 100 ml.)	No. of Previous Biliary Tract Operations	Findings at Percutaneous Cholangiography	Findings at Laparotomy	Operation Performed
No.	Sex	Age (yr.)							
1	F	59	6	2.8	84	4	Narrowing of choledochojunostomy; slight dilatation biliary tree	Mild stenosis of old choledochojunostomy	Dilatation of anastomosis from below via jejunum; insertion polythene splint
2	M	60	9 ^a	5	55	3	Strictures R. and L. hepatic ducts; calculi in R. main hepatic ducts	As cholangiogram	R. and L. hepatic ducts anastomosed to jejunum over Y tube splint ^a
3	F	23	2 ^a	1.1	100	2	Stricture common bile duct with calculi above	As cholangiogram	Choledochojunostomy ^a
4	F	42	3	21	22	2	Stricture at junction L. and R. hepatic ducts	As cholangiogram	R. and L. hepatic ducts anastomosed to jejunum ^a
5	M	49	1	13	46	1	Stricture common bile duct	As cholangiogram	Excision of stricture and choledochoduodenostomy
6	F	43	1	14	37	2	Stricture common hepatic duct	As cholangiogram	Choledochojunostomy ^a
7a ¹	F	50	10	8	30	2	Stricture common bile duct with stones above; cholecystoduodenostomy stenosed	As cholangiogram	Repair of common bile duct by end-to-end anastomosis over a T-tube; cholecystectomy
b		52	9 ^a	1.1	104	3	Stricture common bile duct	As cholangiogram	Choledochojunostomy ^a
8	M	62	3 ^a	1.2	25	2	Stenosis R. hepatic duct; calculi in common bile duct	Dilated common bile duct with calculi and debris; stenosed R. hepatic duct	Dilatation R. hepatic duct; irrigation of biliary tree; T-tube drainage
9	M	45	5 ^a	1.4	35	1	Stricture common bile duct with irregular walls	Calculi and debris in dilated friable common bile duct with low stricture	Excision of 3 cm. of bile duct, choledochojunostomy ^a
10	F	31	12 ^a	7	285	3	Stricture common hepatic duct with calculi above	Stenosis of old choledochojunostomy	Reconstruction of anastomosis ^a
11	M	46	2 ^a	1.2	32	3	Strictures R. main and common hepatic ducts	Stenosis of previous choledochojunostomy	Separate anastomosis of R. and L. hepatic ducts to jejunum over polythene splints
12a ¹	M	37	3	9	28	2	Stricture common hepatic duct	Stenosed choledochoduodenostomy	Choledochojunostomy ^a
b		37	3 ^a	0.5	36	3	Stricture common hepatic duct	Stenosed choledochojunostomy	Reconstruction of anastomosis over polythene splint ^a
13	F	14	36	20	44	2	Separate strictures of R. and L. hepatic ducts; debris R. hepatic duct	As cholangiogram	Excision of strictures and anastomosis of ducts to jejunum over Y-tube splint
14	M	49	12 ^a	1.2	52	2	Multiple calculi in common hepatic duct; stenosed choledochoduodenostomy	As cholangiogram	Choledochojunostomy ^a
15	F	33	24 ^a	2.1	58	2	Stricture common hepatic duct	Stenosed choledochoduodenostomy	Choledochojunostomy ^a
16	M	52	24 ^a	7	90	4	Stricture junction R. and L. hepatic ducts; slight dilatation of L. hepatic duct system only	Not operated	
17	M	16	1	28	85	1	Stricture common hepatic duct	As cholangiogram	Dilatation of stricture; cholecystectomy
18	F	53	26 ^a	0.8	100	2	Narrowing of choledochojunostomy	As cholangiogram	Dilatation of anastomosis from below via jejunum and insertion of polythene splint
19	F	49	12	22	22	1	Dilated cystic duct and gall bladder; stricture common bile duct	Occluded cholecystojunostomy	Choledochojunostomy ^a
20	F	37	132 ^a	12	85	4	Stricture common bile duct; gross dilatation of biliary tree	Debris and stones in dilated common bile duct; stenosed choledochoduodenostomy	Choledochojunostomy ^a

TABLE I *continued*

CASES WITH SUCCESSFUL PERCUTANEOUS CHOLANGIOGRAPHY									
Patient			Duration of Jaundice (mth.)	Serum Bilirubin Level (mg. per 100 ml.)	Alkaline Phosphatase Level (K.-A. units per 100 ml.)	No. of Previous Biliary Tract Operations	Findings at Percutaneous Cholangiography	Findings at Laparotomy	Operation Performed
No.	Sex	Age (yr.)							
21	F	27	5	6	42	1	Stricture common bile duct	As cholangiogram	Choledochojejunostomy ^a
22	F	68	24 ²	0.7	24	1	Stricture lower end common bile duct; stones; gross dilatation	As cholangiogram	Transduodenal sphincterotomy; irrigation of biliary tree and T-tube drainage
23	F	32	48 ²	2.6	46	2	Stricture common bile duct	As cholangiogram	Choledochojejunostomy ^a
24	F	63	6	7	130	0	Stricture lower end common bile duct; stones; gross dilatation	As cholangiogram	Cholecystectomy; sphincterotomy; T-tube drainage
25	M	25	12	10	44	0	Stricture common hepatic duct at junction of L. and R. hepatic ducts; stones	Stenosed R. and L. hepatic ducts	Dilatation of hepatic ducts. T-tube drainage
26	M	34	4 ²	0.5	40	1	Stricture common bile duct	Stenosed choledocho-duodenostomy	Cholecystectomy; choledochojejunostomy ^a
27	F	13	5	3	49	3	Gross dilatation common bile duct above stricture	Cystic common bile duct with stenosed choledochoduodenostomy	Excision of choledochus cyst; choledochojejunostomy ^a

¹Percutaneous cholangiography successfully performed on two separate occasions.

²Intermittent attacks of jaundice for period stated.

³Jejunojejunostomy also performed in these cases.

seen on plain films. This delineation was not good enough to determine the exact site and extent of the stricture.

SUCCESSFUL CASES

The findings are summarized in Table I. Cholangiograms were obtained in 27 patients and in two (cases 7 and 12) the procedure was successful on two separate occasions.

The serum bilirubin level was less than 1 mg. % in four instances and less than 2 mg. % in a further six. In the remaining 19 instances the level was between 2.1 and 28 mg. %.

Local anaesthesia was used in all cases except in two young patients (cases 13 and 27). The anterior approach was used in all but three instances (cases 22, 23, and 26) where the lateral approach was used. In 28 of the successful cholangiograms, one injection outlined the whole of the biliary tree. In one instance (case 13) the obstruction involved the junction of right and left hepatic ducts and initially only the right main duct system was outlined. To visualize the whole of the biliary tree the left main duct system was then intubated by a separate puncture, performed through the same skin incision, but with a different direction of insertion of the second needle and tube.

In 13 instances the stricture was at the site of a previous anastomosis of a major bile duct to bowel.

In nine instances the common bile duct was involved, in two the common hepatic duct, and in five the junction of right and left main hepatic ducts or these ducts individually. In addition, calculi and biliary debris were demonstrated in 10 out of 12 instances where they were subsequently found at operation.

Laparotomy was performed within two hours of the radiological procedure in all instances except one (case 16). Here, the radiographic findings were a very mild dilatation of the left hepatic duct system and a stricture at the junction of the left and right main ducts. The right main duct appeared normal in calibre. The patient had undergone four previous operations and in view of this and the minimal dilatation of the biliary system it was decided that further intervention could achieve little. After the radiological procedure had been completed he was returned to the ward and observed carefully for signs of intraperitoneal haemorrhage or bile leakage. No such signs appeared and he was allowed home after three days.

In the remaining 28 instances the operations performed were as follows (Table I):—Choledochojejunostomy was carried out in 19 instances; in 15 the common bile duct or common hepatic duct was anastomosed to a loop of jejunum and in four the hepatic ducts themselves were anastomosed separately to jejunum, using a Y-tube splint in two instances and separate polythene tube splints in one.

FIG. 1. *Stricture completely occluding the common hepatic duct at its bifurcation (case 4). The intra-hepatic biliary tree is dilated.*

Dilatation with subsequent T-tube drainage was employed in three cases when the stricture was high in the biliary tree and in two cases an existing anastomosis to bowel was dilated from below and a tube splint introduced without actual reconstruction being required. Sphincterotomy was performed in two patients and end-to-end repair of the common bile duct in two cases. In addition to these definitive procedures on the biliary stricture, cholecystectomy was performed at the same operation in four patients.

ILLUSTRATIVE CASE REPORTS

CASE 4 (TABLE 1) In November 1960, a 42-year-old

housewife underwent cholecystectomy. Three months later she developed jaundice and itching, and a further laparotomy was performed. The common bile duct could not be located because of very dense scar tissue, and she remained jaundiced. Two months later she was transferred to the Royal Free Hospital. Percutaneous cholangiography revealed a stricture completely occluding the common hepatic duct just below the junction of the right and left main ducts (Fig. 1). At operation, numerous adhesions were found, dilated right and left hepatic ducts were identified and anastomosed to a loop of jejunum. A jejuno-jejunostomy was also performed.

A percutaneous cholangiogram clearly demonstrated the biliary anatomy in a case of post-operative stricture where previous laparotomy had

FIG. 2. *Stricture of the common hepatic duct at site of previous anastomosis to bowel (case 10). A little contrast medium has entered the jejunal loop. The biliary tree is dilated and contains calculi. (We are indebted to Mr. Rodney Smith and Professor Sheila Sherlock (editors of 'Surgery of the gall-bladder and bile ducts') and to Mr. Rodney Maingot for permission to reproduce this cholangiogram.)*

been fruitless because of dense adhesions. Aided by the radiograph the surgeon was able to proceed directly to exploration of the area of the stricture in the porta hepatis and to perform an anastomosis.

CASE 10 (TABLE I) Following routine cholecystectomy in 1960, a 30-year-old housewife underwent drainage of a subhepatic abscess and, later, repair of a biliary stricture. For the past year she had suffered bouts of mild jaundice but was unwilling to have a further operation. When it was explained to her that a radiograph could show if she

was likely to benefit from further intervention, she consented to the investigation. Percutaneous cholangiography in 1962 showed a tight stricture at the site of previous anastomosis to bowel (Fig. 2). Calculi were present in the common hepatic duct. The previous anastomosis was taken down, biliary lavage performed, and a choledocho-jejunostomy constructed. The patient is well three years later.

The percutaneous cholangiogram allowed a firm decision to be made upon the advisability of surgical

FIG. 3. Stricture of the right main hepatic duct at site of its anastomosis to a loop of jejunum (case 13). Contrast medium has entered the bowel. Marked dilatation of right main biliary tree; no filling of left main duct system.

FIG. 4. The left hepatic duct and its branches have now been demonstrated by a separate intubation using a second cannula (case 13). The left main duct system is markedly dilated and there is a stricture at its lower end with small stones above it. Contrast medium has remained in the right lobe following the previous injection (Fig. 3).

exploration in a patient who had already undergone three operations and was disinclined towards further surgery. Knowing the site of the stricture and that stones also were present, it was possible to decide preoperatively the nature of the operation.

CASE 13 (TABLE I) In August 1958, an 8-year-old school-girl was found to have portal cirrhosis and oesophageal varices. In 1961, prolonged gastrointestinal bleeding was followed by laparotomy at which a choledochal cyst, 4 in. in diameter and pressing on the portal vein, was discovered. The cyst was excised as radically as possible and portocaval anastomosis performed. A month later jaundice of obstructive type necessitated further surgery and a high choledocho-jejunostomy was constructed. She was well for two years when jaundice and pruritis appeared and persisted, making further exploration unavoidable. Percutaneous cholangiography revealed a grossly dilated right main hepatic duct above a stricture at the site of anastomosis to bowel. The left main duct system did not fill (Fig. 3). The left lobe of the liver was therefore explored using a separate cannula and needle. The left main duct was shown to be equally dilated and to have a stricture at its lower end (Fig. 4). Laparotomy revealed strictures of both hepatic ducts at their junction, where they had been anastomosed to a jejunal loop. Biliary 'sludge' and debris were found in the left main ducts, as predicted from the cholangiogram. The strictures were excised, the ducts irrigated, and anastomoses to bowel reconstructed over a polythene Y-tube splint.

By use of separate cannulae it was possible to demonstrate extremely high strictures in this young patient. Because of this precise knowledge operating time was greatly reduced in a patient with chronic liver disease.

CASE 20 (TABLE I) For 11 years a 37-year-old Cypriot woman had suffered intermittent attacks of jaundice and fever. In 1952 she had undergone biliary exploration and, later, cholecystectomy. Afterwards, laparotomy had again been performed because of swinging temperatures, but no details of the operation were available. In 1953 choledocho-jejunostomy had been performed. Percutaneous cholangiography in 1964 revealed a grossly dilated biliary tree and stenosis of the previous anastomosis (Fig. 5). Choledocho-jejunostomy and jejuno-jejunostomy were performed.

The site of the biliary stricture in this patient who had undergone four previous biliary tract operations was accurately demonstrated. Gross biliary dilatation had resulted from the prolonged obstruction.

UNSUCCESSFUL CASES

In eight patients percutaneous cholangiograms could not be obtained and in two of these further attempts at cholangiography after an interval of several months were also unsuccessful (Table II). The serum bilirubin level was elevated above 2 mg. % in seven instances (range 3 to 21 mg. %) and was less than 2 mg. % in three instances. In nine instances laparotomy and operative cholangiography were performed. In one patient (case 32) surgical intervention was decided against after failure to cannulate a biliary radicle on the second occasion. The patient suffered no untoward effects.

An explanation for failure was always present. In one of the first patients studied (case 28), when a duct had not been located after three punctures the procedure was abandoned, probably too soon.

FIG. 5. Gross dilatation of the common bile and hepatic ducts after long-standing obstruction (case 20). A previous anastomosis to the duodenum has become almost totally occluded.

TABLE II

CASES WITH UNSUCCESSFUL ATTEMPTS AT PERCUTANEOUS CHOLANGIOGRAPHY

Case	Sex	Age (yr.)	Duration of Jaundice (mth.)	Serum Bilirubin (mg. per 100 ml.)	Alkaline Phosphatase Level (K.-A. units per 100 ml.)	No. of Previous Biliary Tract Operations	Findings at Laparotomy	Operation Performed	Comments (and Reasons for Failure)
28	F	65	5 ¹	1.5	32	1	Stricture common bile duct; mild dilatation of biliary tree, containing pigment stones; viscid bile	Stricture dilated; T-tube drainage	Insufficient attempts at cannulation; viscid bile
29	F	39	1	5	36	2	Stenosis of old choledochojejunostomy; stones and debris above stricture	Reconstruction of anastomosis over trans-hepatic polyethylene tube	Biliary tree undilated
30	M	58	13 yr. ¹	5	37	1	Bile ducts thickened; no identifiable stricture in main bile ducts	Sphincterotomy	Sclerosing cholangitis
31	F	10	1	21	41	2	Distended gall-bladder; common bile duct a fibrous cord from cystic duct downwards; hard, irregular liver	Cholecystectomy; choledochojejunostomy with jejuno-jejunostomy	Congenital hepatic fibrosis present
32a ²	M	47	22 yr. ¹	9	70	0	Gross distortion of biliary system which entered large cavity containing calculus and connecting with transverse colon. No recognizable common bile duct	Colon separated and sutured; stone enucleated; T-tube drainage of cavity	Sclerosing cholangitis
b		48	23 yr. ¹	12	184	1			Sclerosing cholangitis
33	F	48	1	8	64	0	Gangrenous gall-bladder connected by fistulae to duodenum and colon; multiple calculi; common bile duct normal size	Not operated Cholecystectomy; excision of fistulae; T-tube drainage of common bile duct	Sclerosing cholangitis
34	M	32	36 ¹	3	41	2	Stenosis of previous hepatojejunostomy	Dilatation of main hepatic ducts and re-anastomosis to jejunum over trans-hepatic tube	Biliary tree undilated
35a ²	F	34	6 ¹	1.6	50	8	Stenosis L. hepatic duct, with dilatation above (slight); previous choledochoduodenostomy patent	Dilatation of L. hepatic duct; gastroenterostomy, choledochojejunostomy and jejuno-jejunostomy	Slight dilatation of left hepatic duct system only
b		34	7 ¹	1.1	40	9	No obstruction to biliary tree detected	No definitive biliary operation	Biliary tree undilated

¹Intermittent attacks of jaundice for period stated.²Percutaneous cholangiography attempted on two separate occasions.

Moderate dilatation of the biliary tree was demonstrated at laparotomy. A stricture of the common bile duct was dilated up and T-tube drainage with biliary lavage instituted. The bile in this patient was extremely viscid and this might have made aspiration through a fine tube impossible. Another patient (case 31) suffered from congenital hepatic fibrosis and the extremely hard liver caused technical difficulty. At laparotomy a stricture of the common bile duct was excised and cholecystectomy and choledochojejunostomy with jejuno-jejunostomy were performed.

In six other patients (cases 29, 30, 32, 33, 34, 35) no significant dilatation of the biliary tree was present.

In case 29, stenosis of a previous choledochojejunostomy was found at laparotomy. Small calculi were present in the common hepatic duct. Choledochojejunostomy was performed using a transhepatic tube as a splint (Smith, 1964). In case 34, the findings were similar, although stones were not present; the same operative procedure was employed. In case 35 (a patient who had undergone eight previous operations), after the initial attempt at cholangiography, laparotomy revealed mild dilatation above a stricture in the left hepatic duct. This was dilated up, and choledochojejunostomy, gastro-enterostomy, and jejuno-jejunostomy then performed. Eight months later, after a recurrence of symptoms,

percutaneous cholangiography was again unsuccessful and on this occasion no stricture or biliary dilatation was detected at laparotomy. Cholangitis in the absence of obstruction was thought probable.

In three patients (cases 30, 32, 33) the operative cholangiographic and liver biopsy appearances suggested a sclerosing cholangitis. All gave a history strongly suggestive of long-standing gallstones. In case 30 (58-year-old male) biliary colic and jaundice had occurred 13 years earlier, but at cholecystectomy no calculi had been found. The common bile duct at the current operation was thickened and cord-like throughout its length, these changes extending upwards in the hepatic ducts. Operative cholangiography revealed irregular, attenuated biliary radicles. Sphincterotomy was performed. In case 32 (47-year-old male) symptoms had been present for over 20 years. Laparotomy after failed percutaneous cholangiography revealed gross distortion of the biliary system with a large cavity containing a stone, 1 in. in diameter, which was also eroding into the transverse colon. Tags of necrotic gall bladder lay adjacently. No common bile duct could be identified. Liver histology showed typical changes with heavy inflammatory infiltration of portal zones where biliary radicles were scanty or replaced by fibrous tissue. Removal of the stone, and closure of the fistula, with T-tube drainage of the cavity were employed. Following continued symptoms and jaundice, percutaneous cholangiography was again attempted one year later. As no biliary radicle could be cannulated, further operation was not performed. Case 33 (48-year-old female) had been jaundiced for only one month although symptoms suggestive of gall stones dated back 10 years. Laparotomy revealed numerous adhesions and a small gangrenous gall bladder with fistulae to the duodenum and to the colon. Multiple stones were present but the common bile duct was of normal size. Cholecystectomy and excision of fistulae were performed.

COMPLICATIONS

Haemorrhage from the puncture site in the liver was never severe enough to require transfusion. In one patient (case 20) a collection of about 500 ml. of blood was found in the peritoneal cavity at operation but active bleeding had ceased. In other cases only a little blood at the puncture site was visible at laparotomy. There was no instance of biliary peritonitis although a few millilitres of bile were present in the peritoneal cavity on six occasions. During the procedure five patients complained of some pain in the right upper quadrant of the abdomen or in the right shoulder. This was never severe and invariably settled in a short time. In case

32 the transverse colon was inadvertently punctured and in case 34 a loop of small bowel was entered. These errors became obvious immediately after injecting a few millilitres of contrast material under screen control. The catheter was withdrawn in both instances and a fresh one used for the next insertion in a different direction. There were no untoward effects, and, at subsequent laparotomy, the surgeon was unable to detect the site of puncture of these organs.

DISCUSSION

Percutaneous cholangiography should always be performed in relation to surgery, since successful cannulation of a dilated duct should be followed by surgical relief of the obstruction within a few hours if biliary leakage and peritonitis are to be avoided. For this reason the procedure should never be employed in patients considered unable to withstand operation. Although general anaesthesia has been advocated (Wiechel, 1960) this is usually reserved for unduly young or apprehensive patients. General anaesthesia is essential if the patient cannot or will not hold his breath during introduction of the needle.

The anterior approach is the best for routine use. Others employ a lateral or posterior approach (Housset and Vantsis, 1957; Wiechel, 1960; Prioton, 1960). The posterior approach is said to obviate the risk of blood or bile leaking into the peritoneal cavity since it is not trans-peritoneal (Prioton, 1960). This is a questionable advantage as the posterior or lateral sites are not readily accessible in the event of a complication. When using the anterior approach in a patient who has had previous abdominal surgery, a good track must be made through the scar tissue. Without this preparation, introduction of the soft catheter may prove impossible. In cases with extreme abdominal scarring the lateral approach may be preferable.

Intubation of a duct is achieved by slowly withdrawing and aspirating the catheter until bile is obtained. Aspiration with a needle during insertion has also been advocated (Mandl, 1953; Glenn *et al.*, 1962) but has the disadvantage that a rigid needle must be used, so enhancing the risk of producing a tear in the liver substance. Preliminary aspiration of bile has been recommended (Remolar *et al.*, 1956; Kidd, 1956; Kaplan *et al.*, 1961; Wiechel, 1964) but it is not necessary as bile and contrast medium are readily miscible (Housset and Vantsis, 1957; Wiechel, 1964). The medium may be injected under television fluoroscopic control and the cannula then manipulated until filling of biliary radicles is seen on the screen (Arner *et al.*, 1962; Glenn *et al.*,

1962). This technique may be helpful where the biliary tree is undilated (Arner *et al.*, 1962).

The two most serious complications of the procedure are intra-abdominal haemorrhage and bile peritonitis, either from leakage from the puncture site or from actual laceration of the liver. Probably the most important factor in avoiding liver injury is the use of a soft catheter after removal of the needle. This obviates the need to prevent extensive or unexpected liver movements by general anaesthesia, or by 'blocking' the ipsilateral phrenic nerves as has been suggested (Varela Fuentes, Bertoni, and Polero, 1957).

Significant haemorrhage occurred in only five patients in a series of 685 percutaneous cholangiograms reviewed by Wiechel (1964). Uncorrected hypoprothrombinaemia was present in the fatal case described by Nurick *et al.* (1953). Persistent prolongation of prothrombin time by more than two seconds should be a contraindication to the procedure. Significant haemorrhage occurred in one case in the present series. The prothrombin time was normal and chance puncture of a large vessel was probably responsible. Active bleeding had ceased by the time laparotomy was performed and it is unlikely that life would have been endangered.

In the same series of 685 patients bile peritonitis occurred in over 20 patients (Wiechel, 1964). This figure could probably have been much reduced had operation followed the same day in all cases where a cholangiogram demonstrated an obstructive lesion, and bile leaking through the puncture track therefore been avoided. In two or three reported cases where death was attributed to biliary peritonitis, operation had been delayed despite demonstration of an obstructed biliary tree by the investigation (Leger *et al.*, 1953; Zinberg *et al.*, 1965). There were no instances of bile peritonitis in the present series. The practice of leaving the polyethylene catheter in place to decompress the biliary tree while operation is awaited may also prevent biliary leakage. Broad-spectrum antibiotic cover for the procedure and routine culture of bile are of particular importance in cases of biliary stricture where leakage of potentially infected bile and consequent peritonitis or septicaemia is possible.

Small bowel and colon were each punctured on one occasion but without ill effect, and this is generally the case (George *et al.*, 1965). Careful watch should be kept on the patient where laparotomy is not undertaken. Puncture of the gall bladder has also been reported (Kidd, 1956; Varela Fuentes *et al.*, 1957; Santos *et al.*, 1960; Arner *et al.*, 1962). Provided operation is carried out in cases in which an obstructive lesion is demonstrated this should not be serious. In one patient with hepatocellular disease

reported by George *et al.* (1965), on whom operation was not performed despite gall bladder puncture, no untoward effects followed.

The success or failure of percutaneous cholangiography is governed by the degree of dilatation of the intrahepatic biliary radicles, and this in turn is related more to the duration of biliary obstruction than simply to the depth of jaundice. Absence of clinical jaundice does not preclude success, for in 10 instances cholangiograms were obtained when the serum bilirubin level was less than 2 mg. % (Table I). The serum alkaline phosphatase level, which is a more sensitive index of biliary obstruction, was, however, invariably raised. In eight of nine unsuccessful attempts at cholangiography, subsequent operative cholangiograms revealed an undilated biliary tree. In patients with biliary stricture obstruction is often intermittent or partial and the degree of biliary dilatation variable. As many as 10 attempts at puncture may be necessary before eventual success. This is more than the five attempts suggested as the maximum for the differential diagnosis of jaundice (George *et al.*, 1965). In some patients with biliary stricture the biliary tree is reduced in calibre and the bile ducts are undergoing obliterative fibrosis. Such changes were noted in three patients (cases 30, 32, 33) in whom cholangiography was unsuccessful.

The gravity of biliary stricture needs no stressing: 35 to 40% of patients who have undergone repair operations die within three or four years and with consecutive attempts at repair the chances of eventual cure become more and more remote (Maingot, 1964). Knowledge of the exact site and extent of the stricture is invaluable, especially in an operation field which is frequently scarred by previous attempts at biliary repair. Operating time is greatly reduced and the chances of further damage to other parts of the biliary tree are lessened. A decision about the nature of the reconstruction to be undertaken can often be made beforehand. A simpler operation than had been expected may be possible. Thus in two cases in the present series complete reconstruction of a previous anastomosis was avoided and a simple dilatation sufficed as no scar tissue was apparent. The procedure is perhaps of greatest value in patients with a stricture high in the biliary tree, where a knowledge of the line of direction of the main ducts is invaluable when dilators and tubes are to be passed. In other patients the demonstration of multiple pathologies such as stricture and stones (shown in ten cases) or of multiple strictures (shown in four cases) is of value.

Occasionally, when percutaneous cholangiography reveals a slightly or undilated biliary tree with little or no obstruction, operative intervention may be

avoided altogether. This is a rare occurrence, however, and only one example can be quoted from the present series. In these circumstances it is more usual to find that films cannot be obtained. When this is the case a decision about the advisability of operation must be based on the whole clinical picture and biochemical investigations. In patients with a stricture the clinical history, however, is usually fairly typical with attacks of jaundice or pain or of cholangitis. Laparotomy is then undertaken irrespective of the cholangiographic result.

SUMMARY

Percutaneous transhepatic cholangiography, by means of a flexible polyethylene catheter, successfully outlined the biliary tree in 29 out of 39 instances in patients with strictures of the bile ducts. No serious complication was encountered. Twenty-five patients had already undergone operations for biliary reconstruction and in seven cases the stricture was particularly high, involving either the junction of right and left main hepatic ducts or the ducts themselves. In no case had the biliary tree been satisfactorily outlined by oral or intravenous cholangiography. In all cases except one, operation was performed within two hours after the procedure, and the cholangiographic findings confirmed. The information obtained beforehand about the biliary anatomy was of inestimable value to the surgeon both in the planning and execution of the operation.

In nine instances where percutaneous cholangiography was unsuccessful, subsequent laparotomy revealed no significant biliary dilatation in eight, and in three of these patients there was evidence of sclerosing cholangitis.

The use of a flexible catheter, and the performance of the investigation only as a preliminary to surgical exploration have made this technique safe as well as invaluable in patients with biliary stricture.

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