Progress report

Cholangiography in the jaundiced patient

The differentiation between intrahepatic or 'medical' and extrahepatic or 'surgical' jaundice remains problematical in many patients. A diagnosis based only on the history, physical examination, laboratory tests, and non-invasive radiological studies may well be in error. Traditionally, an exploratory laparotomy was performed in patients whose condition showed no spontaneous resolution during a protracted period of observation. This meant considerable delay before the relief of surgical obstruction in some, whereas others with 'medical' jaundice would be subjected to the increased morbidity and mortality of laparotomy. A number of techniques have been developed which permit direct cholangiography when the intravenous technique is inadequate. All procedures have their pros and cons and each institution must select those which they regard as most suitable in view of the facilities and resources available, as well as the experience of the cholangiographer. Whichever technique or combination of techniques is chosen, the situation should be virtually eliminated whereby either 'surgical' jaundice is prolonged because of a lack of diagnosis, or where a patient with intrahepatic cholestasis is subjected to an unnecessary laparotomy.

Transhepatic cholangiography

Percutaneous transperitoneal
Sheathed needle technique

The percutaneous injection of contrast into the gallbladder was described before the use of oral or intravenous cholangiography. The forerunner of most current techniques was the intrahepatic injection of lipiodol by a Vietnamese and a French physician in Hanoi in 1937. Major advances include the use of a water-soluble contrast medium and of roentgen television control. The procedure has gained wide acceptance and is one of those most commonly used in the preoperative demonstration of biliary obstruction.

Vitamin K injections may be required to reduce the patient's prothrombin time to within three seconds of control, and the platelet count must exceed 40,000 mm⁻³. Until recently, emphasis has been laid on the restriction of the use of percutaneous transhepatic cholangiography to the immediate preoperative period. In this way, the danger from haemorrhage, bile leak, and septicaemia which may complicate the procedure is minimised and the potential benefit to the surgeon of knowing preoperatively precise anatomical details of the obstruction justifies the risks incurred.

The needle is usually inserted via an anterior approach from just to the right of the xiphisternum and advanced towards the right main hepatic duct. The steel needle is then withdrawn leaving an outer flexible polyethylene sheath in situ. This sheath is slowly withdrawn until bile can be aspirated...
through it. If dilated bile ducts have been entered, the biliary tree is de-
compressed before radio-opaque contrast is injected\(^8,12,13,14\). Aspirated
bile should be sent for bacteriological culture, which may influence subsequent
choice of antibiotics. Occasionally prolonged percutaneous drainage via
the polyethylene tube is useful in patients considered to be too ill for immediate
laparotomy, in whom simple drainage of bile may dramatically improve
both their general condition and the prognosis of subsequent definitive
surgery\(^12,15,16,17\).

Though Wiechel (1964)\(^14\) reported a 100\% success rate for percutaneous
cholangiography in patients with large duct obstruction, in most other series
those in whom bile ducts were not visualised consisted of from 20\%\(^13,18\) to
50\%\(^19\) of patients in whom a surgical cause of cholestasis was present.
Success with percutaneous cholangiography in patients with 'surgical'
cholestasis is generally greatest for malignant strictures, intermediate for
calculus obstruction, and least for postoperative strictures, possibly reflecting
the degree to which intrahepatic bile ducts are dilated\(^20,21,22\). Drake and
Beal (1965)\(^11\) in a collective study of 559 patients found that 25\% of those
in whom percutaneous cholangiography had failed were later shown to have
a surgical lesion. Hines et al. (1972)\(^23\) reviewed 1629 procedures recorded
in the literature and found an overall success rate of 74\%. As a generalisation
one can therefore say that the chances of success with sheathed-needle
percutaneous cholangiography are 75\% and that the probability of there
being no surgical cause of cholestasis in a patient in whom the method
failed is similarly 75\%.

**Chiba technique**

Certain modifications of the Hanoi technique were described by Belgian
workers in 1960\(^24\) but their adoption in English-speaking countries followed
popularisation in the Orient. The present vogue is to employ the technique
used in Chiba University and described by Okuda et al. (1974)\(^25\). In the
Chiba technique the liver is approached through the mid-axillary line as
described by Wiechel (1964)\(^14\). With the patient lying supine, the operator's
hands do not preclude continuous fluoroscopic monitoring. The 'skinny'
needle used is made of stainless steel, has an outer diameter of 0.7 mm, does
not have an outer sheath, and is extremely flexible so that the patient may
breathe normally while it lies *in situ*. The needle is advanced parallel to the
table top as far as the spine bisecting a sagittal line between the dome of the
diaphragm and the duodenal cap which is usually identifiable as an air
bubble, though a duodenal tube may be used for this purpose\(^22\). Alternatively,
recent advances in ultrasonography\(^25\) permit precise localisation of the liver
hilus and its surface markings beforehand. Contrast is injected continuously
as the needle is withdrawn. With experience it is not difficult to recognise
the differing patterns of centrifugal flow in portal veins, midline drainage of
hepatic veins, and centripetal flow in bile ducts, in which the contrast lingers
much longer than in the blood vessels. A linear pool of contrast occupies
the tract vacated by the needle. This extravasated material can be seen later
within the lymphatic channels which drain medially *via* the liver hilus\(^26\).
Up to six insertions of the needle are usually permitted before the procedure
is deemed a failure.

The advantages of the Chiba technique are potentially several. Its relative
safety has meant that percutaneous cholangiography need no longer be
Cholangiography is confined to the immediate preoperative period. In the presence of 'surgical' hepatobiliary disease the technique has proved successful in 91% 22, 90% 28, 100% 27, and 95% 29 of patients.

Failure to opacify the biliary system after an adequate attempt with the Chiba technique thus casts sufficient doubt on the diagnosis of 'surgical' obstruction to prevent the patient undergoing laparotomy until further evidence is obtained. An additional advantage of this percutaneous method is that cholangiography was successful in 67.5% 22, 85% 28, 60% 27, and 25% 29 of patients in whom 'surgical' disease was not present, being in general a much higher proportion than for the sheathed-needle technique. However, failure may occur in the presence of biliary disease, especially when there is non-diffuse dilatation of intrahepatic bile ducts in sclerosing cholangitis 24, 30, 31 as has also been noted for the sheathed needle 10, 32 and transjugular 33 techniques.

**Complications of Percutaneous Cholangiography**

Hines *et al.* (1975) 23 found an overall complication rate of 5% in 1629 reported procedures and a total of four associated deaths. The commonest complications are intraperitoneal haemorrhage 5, 14, 10, 19, sepsicaemia 34, 30, 35, 38, and leakage of bile into the peritoneum 5, 12, 19, 37, 33 which Seldinger (1966) 9 found in 2.6% of 1218 procedures he reviewed. Redman and Joseph (1975) 38 reported common bile duct obstruction and pancreatitis complicating haemobilia in a patient after percutaneous cholangiography. Prioton (1960) 39 proposed extraperitoneal puncture of the liver through a posterior approach so as to avoid intraperitoneal bleeding and bile leak. However there were serious complications, including one fatality, in only 12 procedures, and a more accessible site of liver entry is preferred by surgeons, lest oversewing it becomes necessary 10. Because of the extreme narrowness of the Chiba needle, together with the fact that the whole width of the right lobe of the liver is traversed before any major ducts or vessels are penetrated, the risk of intraperitoneal leakage is theoretically diminished, and the risk of bile-blood fistula 40 is small. Nevertheless, in the series by Okuda *et al.* 22, Redecker *et al.* 27 and Elias *et al.* 29 the complication rate is not significantly different from that found by Hines *et al.* 23 for the sheathed-needle technique. This may be due to the greater delay before surgical intervention in the three series with the Chiba needle. It is important to realise that septicaemia, which occurs more commonly in the presence of benign disease than when there is a malignant obstruction of the bile ducts 34, may occur after percutaneous cholangiography with the Chiba technique 22, 29. Antibiotics are therefore given prophylactically before each procedure. The main disadvantage of the Chiba technique in our hands, though not others' 27, is that aspiration of bile is usually not possible. Contrast is injected into a biliary system which may already be under increased pressure and harbouring infectious organisms. In these circumstances, if the patient is not proceeding to early laparotomy, the biliary tree may be decompressed via a slightly wider bore sheathed needle 9. In general, it is still advisable that percutaneous cholangiography should be followed by early laparotomy, since in this way the major complications, even if they do occur, can be effectively treated.

**Transjugular**

In 1967 Hanafie and Weiner 41 described a technique for cholangiography in
jaundiced patients which avoided transperitoneal puncture of the liver and so eliminated the risk of haemorrhage and bile leak into the peritoneum. A Teflon catheter designed for trans-septal heart catheterisation was advanced over a guide-wire from the right internal jugular vein into the hepatic vein. Cardiac monitoring is necessary since arrhythmias may occur. After removing the guide-wire and ensuring that the catheter lies within a central vein an 18-gauge needle of thick-walled steel is inserted through the catheter and thrust 1 to 2 cm into the liver parenchyma. Weiner and Hanafee (1970) reported an overall success rate of 75% for duct visualisation in 56 patients including 88% for obstructed bile ducts. Rosch et al. (1973) succeeded in 29 of 31 patients (93%) with dilated ducts but in only one of 22 patients (4.5%) with non-dilated ducts. The transjugular approach was used for both cholangiography and liver biopsy in a number of patients.

If peripheral hepatic veins are punctured there is a danger of perforating the liver surface with intraperitoneal leakage of bile. Temporary biliary-venous communication is inevitable if cholangiography succeeds, though no established fistulas were seen. In one series of 55 patients in whom transjugular cholangiography was attempted, proving successful in 42, febrile reactions were noted in 22 patients, being severe in eight with fatal Gram negative septicaemia in one. Kadell and Weiner (1973) report 13 cases of Gram negative septicaemia after the procedure including one fatality. Though the use of prophylactic antibiotics tended to reduce the incidence and severity of complications, Kadell and Weiner (1973) conclude that the procedure is contraindicated in anyone with a history of prior cholangitis, unless antibiotics more effective than ampicillin become available. Since transjugular hepatic venography, even without attempted cholangiography, is a complex procedure and potentially fatal, this approach to cholangiography should not be contemplated except when its major advantages apply, as in the presence of deficient haemostasis or ascites, and in these circumstances it is rarely urgent. Endoscopic retrograde cholangiography (ERCP) at which one acquires expertise in the more routine investigation of cholestasis would therefore appear the method of choice in the presence of marked ascites and haemorrhagic diathesis.

OPEN 'MINILAPAROTOMY'

A diagnostic procedure has been recommended which involves opening the peritoneum through a 4 to 5 cm midline sub-xiphoid incision under local anaesthesia. The liver and adjacent structures can be directly inspected. For cholangiography a 20 gauge Teflon catheter is inserted 15 cm into the liver substance and radiocontrast injected during its withdrawal. Cholangiography was successful in all 59 patients with obstructed ducts and in 21 of 30 without obstruction. Stein (1975) reported successful cholangiography in 20 of 23 patients and visual or biopsy diagnosis in the remaining three patients. In addition to cholangiography and needle liver biopsy, the 'minilap' allows manometry and venography of the portal system via a gastroepiploic vein.

In their early experience Strack et al. (1971) encountered intraperitoneal haemorrhage and bile leak requiring emergency laparotomy, but neither of these complications occurred later in their study when the puncture site on the liver surface was routinely sutured. Chills and fever may occur soon after this procedure as after other methods of transhepatic cholangiography.
In the series of Del Guercio et al. (1974)\textsuperscript{47}, 48\% of patients did not need to proceed to a second operation, and many of the remainder would have been referred for definitive surgery much later if this diagnostic approach had not been available. It was computed that of the $1546.00 hospital bill incurred by patients up to the time of diagnosis, the interval between the time when minilaparotomy became indicated and when it was actually performed accounted for an average of $984.00 per patient\textsuperscript{47}. This argues not so much in favour of minilaps \textit{per se}, but of a generally aggressive approach to the diagnosis of cholestatic jaundice. Though the diagnostic yield of minilaparotomy is extremely high, the almost comparable rates of success for percutaneous needle liver biopsy and percutaneous transhepatic cholangiography without peritoneal incision, diminish its attractiveness as a routine procedure for the investigation of 'difficult' jaundice.

**LAPAROSCOPIC**

Laparoscopy obviates the sampling error inherent in blind percutaneous needle liver biopsy and permits direction of both biopsy and cholangiography needles towards areas of maximum interest. The difficulty in obtaining cholangiograms when intrahepatic bile ducts are non-dilated can be overcome by injection directly into the gallbladder as first done 'blindly' in 1921\textsuperscript{4} and under laparoscopic control in 1942\textsuperscript{48}. However, intrahepatic ducts are not seen when there is no obstruction to the outflow of contrast through the sphincter of Oddi. A needle is inserted so as to transverse the right lobe of the liver before puncturing the hepatic surface of the gallbladder\textsuperscript{49,50}. Tamponade of the puncture site by the liver was thought to prevent bile extravasation as occurred in many instances after direct puncture of the fundus of the gallbladder\textsuperscript{51}. Control of both bile leaks and bleeding from the peritoneal liver surface can be achieved under direct vision. There appears to be a marked geographical variation in the frequency with which laparoscopy is employed, so much so, that, on the mainland of Europe, some employ ERCP only if laparoscopy is contraindicated or has failed\textsuperscript{52,53}.

**Endoscopic retrograde cholangio-pancreatography (ERCP)**

ERCP first reported by McCune et al. (1968)\textsuperscript{54} and popularised in Japan\textsuperscript{55} was the subject of a previous Progress Report in 1972\textsuperscript{56}. It has established itself as an extremely useful tool for visualising the bile ducts in difficult cases of jaundice\textsuperscript{57,58,59,60,61}. It is not contraindicated in the presence of ascites, coagulation defects, hydatid liver disease, or liver abscess, nor is its success diminished by sclerosis of the intrahepatic biliary tree. In experienced hands the bile ducts are visualised in from 70 to 90\% of procedures with additional useful information being obtained from upper gastrointestinal endoscopy, biopsy, pancreatography, and cytology\textsuperscript{62,63}. Opacification of the intrahepatic tree is frequently good and may help in the diagnosis and preoperative planning\textsuperscript{30,64,65,66,67,68}. Attainment of proficiency requires considerable practice, published rates of success often omitting the learning phase\textsuperscript{69}. In a recent survey of 10 435 attempts at ERCP in the USA Bilbao et al. (1976)\textsuperscript{70} found that for those who had performed 200 or more procedures there was a 15\% failure rate in cannulation and a 3-5\% complication rate after successful studies, whereas in less experienced hands the failure
rate was 62\% and the complication rate 15\%. This argues strongly for attachment of beginners to more experienced cholangiographers so that the patient is spared the long, unsuccessful or often complicated examination to which he may otherwise be subjected.

Complications of ERCP have recently been reviewed\textsuperscript{70,71}. The incidence of pancreatitis after ERCP correlated closely with the degree of filling of the pancreas and with previous pancreatic abnormality\textsuperscript{70}. Hyperamylasaemia is extremely common after otherwise uncomplicated ERCP\textsuperscript{72} but significant pancreatitis occurs much less frequently and is probably better indicated by elevation of the renal amylase : creatinine clearance ratio\textsuperscript{73}. The pancreatitis is usually mild but fatalities have occurred\textsuperscript{70,74,75}. Excessive pressure of injection, the filling of pseudocysts, and parenchymal opacification should be avoided, and an interval of six weeks allowed to elapse before ERCP after an episode of acute pancreatitis. A mass in the head of the pancreas may result from attempted cannulation and may present the surgeon with appearances of a neoplasm\textsuperscript{76}. Kasugai et al. (1974)\textsuperscript{77} described manometric monitoring of the injection pressure, but the technique is not widely used. Sepsis almost never occurs unless contrast has been injected into diseased and obstructed ducts\textsuperscript{70,71}. The cannula is not sterile and organisms such as \textit{Pseudomonas} can frequently be cultured from endoscopy equipment unless they are washed with 2\% glutaraldehyde\textsuperscript{78,79,80}. There is no evidence that incorporating an antibiotic into the injected contrast as suggested by Kasugai et al. (1974)\textsuperscript{77} is of benefit, but antibiotics should be administered immediately after the procedure if contrast has entered poorly draining ducts. Information regarding the effectiveness of antibiotics in the treatment of biliary sepsis is inadequate\textsuperscript{81}. It has been shown for aminoglycosides such as gentamicin that their concentration in normal bile is less than in serum\textsuperscript{82}. Ampicillin, though well concentrated in normal bile, is absent or much reduced in bile in the presence of biliary obstruction\textsuperscript{83}, unlike tetracycline, which was present in obstructed bile\textsuperscript{84}. Clindamycin in its most active form was highly concentrated within the liver in patients with biliary obstruction though virtually absent from the bile\textsuperscript{85}. The significance of these observations to clinical usage is not established. Until more information becomes available, because of the mixed organisms involved when cholangitis and septicaemia follow ERCP, parenteral administration of combinations of potent antibiotics to cover a wide range of organisms is indicated. Complications of routine medications occur\textsuperscript{70,71}. Diazepam thrombophlebitis is troublesome. Because of the altered pharmacodynamics of drugs in patients with liver disease\textsuperscript{86}, dosages must be tailored to avoid hepatic precoma and respiratory depression in susceptible patients. Spasmolytics should be avoided in the glaucomatous and elderly.

\textbf{Ancillary tests}

The finding on a radioactive colloid \textit{liver scan} of a filling defect at the hilum of the liver suggests a diagnosis of extrahepatic biliary obstruction but is not specific\textsuperscript{87,88}. \textit{Dynamic isotope studies} with recently developed isotopic compounds such as \textit{\textsuperscript{123}I} or \textit{\textsuperscript{99}Te} are useful in measuring the completeness of obstruction. By means of Grey-scale \textit{ultrasonography}, recently the subject of comprehensive reviews\textsuperscript{91,25}, differentiation between intra- and extrahepatic causes of cholestasis was correctly predicted in 97\% of 104 patients\textsuperscript{92}.
The EMI body scanner enables identification of dilated bile ducts by computerised tomographic scanning but its use for this purpose currently is prohibitively expensive. Percutaneous needle liver biopsy may be extremely valuable. In a series of 125 patients with large bile duct obstruction the needle liver biopsy showed changes compatible with this diagnosis in 83%, and, though the histological changes were misleading in six patients, in 17 others the biopsy was of particular value, causing the clinicians to alter their diagnosis. When cholangiography demonstrates a probably malignant stricture arteriography gives information regarding its extensiveness. A good case can be made for routine operative cholangiography in biliary tract surgery, since a 4% incidence of missed common bile duct stones is common even in the absence of any indication of common duct pathology. Another common pitfall thus avoided is the attributing to hepatitis of high common hepatic duct obstruction by cholangiocarcinoma because of the collapsed extrahepatic biliary system.

Neonatal Cholestasis

In the newborn infant with cholestatic jaundice radiological visualisation of the bile ducts is usually not possible, though percutaneous transhepatic cholangiography has been successful in an infant with congenital biliary atresia and in an 8 month old child in whom a patent biliary tree was shown. In these children extrahepatic biliary atresia must be differentiated from neonatal hepatitis. A useful indication may be obtained by following the fate of $^{131}$I Rose-Bengal after intravenous injection of a 40 $\mu$Ci dose. Urine and stool must be collected separately for 48-96 hours, necessitating bladder catheterisation in females. Counting with a scintillation probe over the gallbladder before and after intravenous cholecystokinin is no longer recommended, but administration of cholestyramine to prevent any enterohepatic recycling of the Rose-Bengal is useful. The finding of less than 10% of the radioactivity in the stool of an infant receiving cholestyramine is practically diagnostic of extrahepatic biliary obstruction.

Conclusion

Though local practice will reflect the previously acquired expertise of the operators, it seems reasonable to employ a minimum of percutaneous transhepatic cholangiography, and, ideally, this in combination with ERCP for preoperative cholangiography in patients with cholestatic jaundice. Few cases will defy both techniques. The morbidity is well known and if properly anticipated can be reduced to a minimum by judicious use of antibacterial agents and early surgical intervention when appropriate. Grey-scale ultrasonography by indicating the diameter of the bile ducts enables one to select percutaneous transhepatic cholangiography for dilated ducts and ERCP for non-dilated ducts with an almost 100% success rate for the former and only slightly less for the latter in experienced hands.

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