CHOLEDOCHOPATHY*

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A new epoch in the diagnosis of biliary disease has recently begun with the introduction of biligrafin. It is therefore right that we should pause for a moment and review the present status of X-ray diagnosis of the biliary tract. This paper deals mainly with the intravenous method of the examination of the bile-ducts. Suggestions are made for the revision of old concepts and for a new approach to the radiological pathology of bile-duct disorders.

This analysis is based on 187 consecutive cases which were sent to us for investigation of the biliary tract by the intravenous route. Table I shows the type of cases we examined and the reasons for employing the intravenous method in these cases. Most patients were first investigated by the

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TABLE I. ANALYSIS OF THE TYPE OF CASES WHICH WERE SUBMITTED FOR EXAMINATION

Type of Examination	*Reason for Examination*	*No. of Cases*
Intravenous Cholecystcholangiography (I.V.C.C.)	1. Non-visualization on oral cholecystography	63
	2. Sensitivity to iodine	2
	3. Severe emesis	2
	4. Cholelithiasis demonstrated orally but ducts not visualized	16
	5. Jaundice	12
	6. Internal biliary fistula	7
	7. Miscellaneous	23
		125
Intravenous Cholangiography (I.V.C.)	1. Choledochopathy	62
		187

oral method and the normals were eliminated. Examinations of 125 cases were performed on non-cholecystectomized patients, while 62 of the patients had undergone cholecystectomy.

RADIOLOGICAL PATHOLOGY

The term 'post-cholecystectomy syndrome' is a loose term which does not signify a pathological entity but is nevertheless freely used by all and sundry. The cause of symptoms in a cholecystectomized patient may be entirely unrelated to the biliary tract, e.g. hiatus hernia, diverticulitis, duodenal ulcer or pancreatitis, or the symptoms may be of psychosomatic origin. They may, however, be due to pathology of the bile-ducts. When, therefore, the cholecystectomized patient presents himself with symptoms either similar to those he had before the operation, or simply referable to the upper abdomen, one wishes to exclude the presence of disease of the bile-ducts. Having excluded it, one can then follow other lines of investigation. In other words, it is not an ill-defined entity called 'post-cholecystectomy syndrome' that one wishes to exclude, but a specific entity, namely disease of the bile-ducts. It would seem to me therefore that the term choledochopathy is far more explicit than 'post-cholecystectomy syndrome', a term which I feel should be completely discarded.

Choledochopathy may have been present before cholecystectomy or may develop in the post-cholecystectomy patient *de novo*. With this in mind I shall analyse our cases according to the following classification.

Choledochopathy

1. Congenital abnormalities
2. Injuries to ducts
   - (*a*) Biliary fistula
     - (i) External biliary fistula
     - (ii) Internal biliary fistula
   - (*b*) Stricture
3. Adhesions
4. Cholangitis
5. Choledocholithiasis
6. Choledochectasis
   - (*a*) Obstructive choledochectasis
     - (i) Complete
     - (ii) Incomplete
     - (iii) Intermittent
   - (*b*) Non-obstructive choledochectasis
7. Stricture of sphincter
8. Cystic-duct stump
9. Biliary dyskinesia
10. Diverticula and cysts
11. Neoplasm.

Congenital Abnormalities of Ducts

Formerly the congenital anomalies of the bile ducts could rarely if ever be demonstrated pre-operatively. Now, however, this can be done, and the radiologist is urged to be on the look-out for an abnormal 'accessory duct' draining directly into the cystic duct or an abnormal origin of the cystic duct. Such information given to the surgeon in advance may prevent injuries to the ducts which are often followed by tragedies. Fig. 1 is a diagramatic illustration of different variants of accessory ducts according to Osler and Dow.[6] Fig. 2 shows a case which has two accessory ducts draining into the cystic duct, and the cystic duct entering the common bile-duct on the left and low down. Note the radiolucent shadows at the fundus simulating stones. This film was taken 45 minutes after the injection of biligrafin. Fig. 3 is a film of the same patient 2 hours after the injection of biligrafin, and shows the disappearance of the negative shadows, proving that they were merely due to stratification and not to stones.

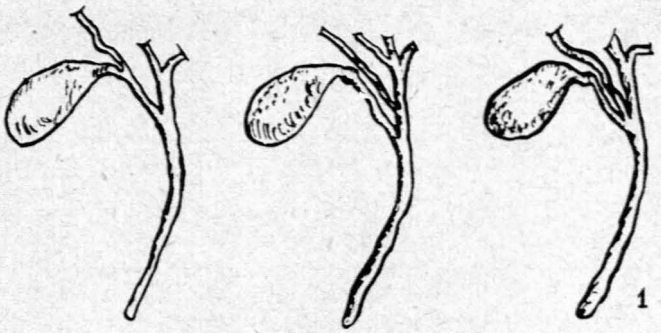

Fig. 1. Diagrammatic illustration of different variants of accessory ducts according to Osler and Dow.

Injuries to Ducts

Injuries to ducts may be seen to give rise to external biliary fistula, stricture and jaundice. Bile may escape around the T-tube and reach the surface or may form a lake around the bile-duct, and even a cyst in the liver. The cut in the duct may later close, giving rise to a stricture and obstructive jaundice. Fig. 4 is a sinogram showing the outline of a cyst in the liver, which drains into the right main hepatic duct and shows the presence of a stone in the common bile-duct. A large cyst and a complete cyst wall containing bile-stained fluid was found in the liver at operation and the stone in the bile-duct was removed.

In our 5 cases of *external biliary fistula*, the bile-ducts could not be demonstrated by the intravenous route.

Internal Biliary Fistula may be spontaneous as a result of rupture of the gall-bladder into another hollow viscus, or the result of a planned surgical procedure. We find that intravenous cholangiography more often than not fails to opacify the ducts or gall-bladder in these patients. In 2 out of 7 cases the intravenous method outlined the bile-ducts, but not the gall-bladder. Although intravenous cholecystography is seldom of assistance in these cases, air can be demonstrated in the biliary system in most cases of internal biliary fistula. The presence of air in the bile-ducts indicates in most cases that a complete obstruction is not present.

Adhesions Around the Bile-Ducts

Radiological appearances suggestive of adhesions of the bile-ducts were observed in 10 cases. Of these, 5 went to surgery and the pre-operative radiological diagnosis was confirmed. Fig. 5 demonstrates adhesions producing an hour-glass deformity with dilatation of the duct proximally, probably caused by intermittent obstruction. Fig. 15 also shows angulation of the common bile-duct due to adhesions, with proximal dilatation of the common hepatic duct. The following radiological features are suggestive of adhesions:

1. An irregular course of the duct with single or multiple angulations.

2. Dilatation of the duct proximal to the adhesions, while distally the calibre is normal.

3. Constriction of the lumen, concentric or eccentric, usually found proximal to the kink. It is probably caused

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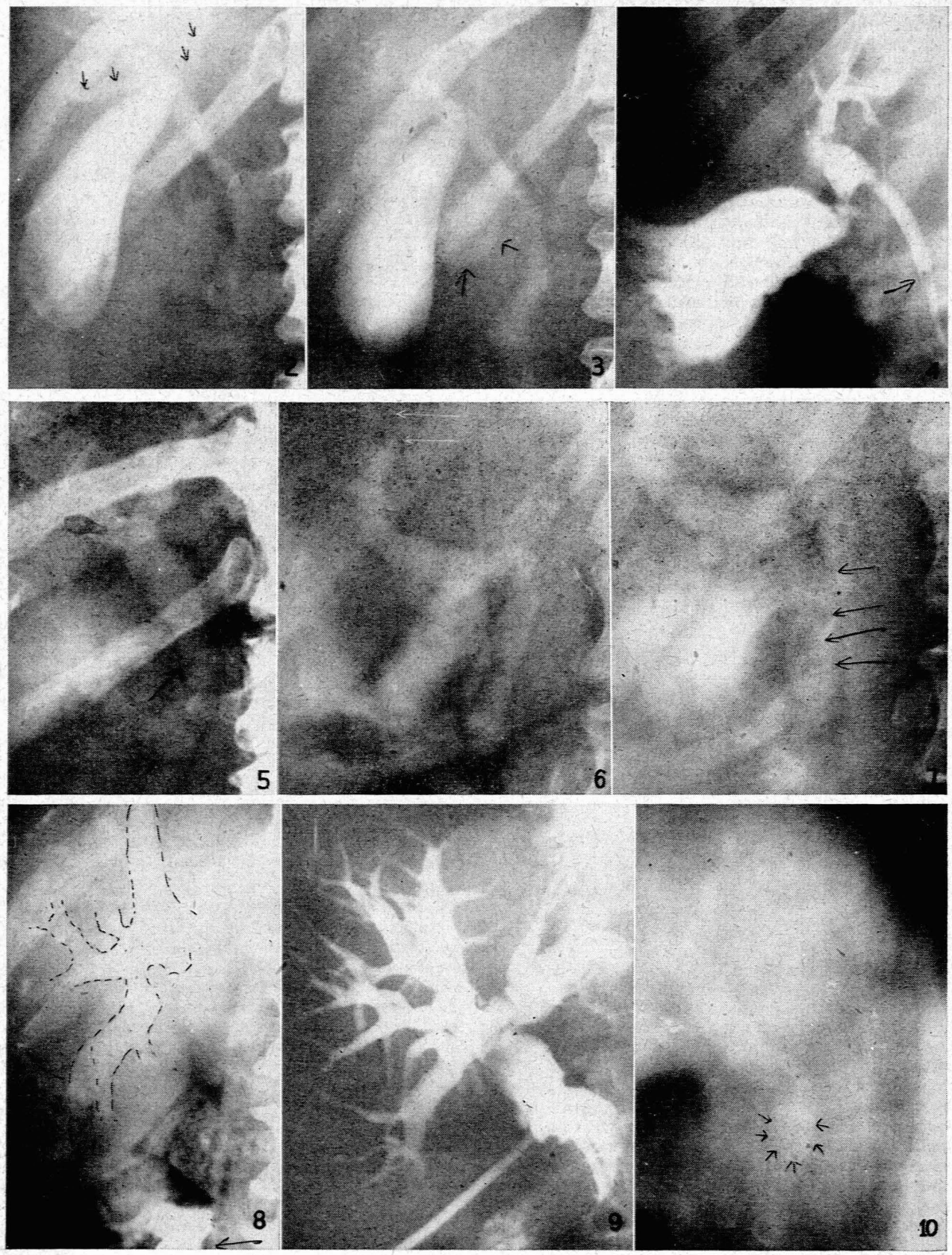
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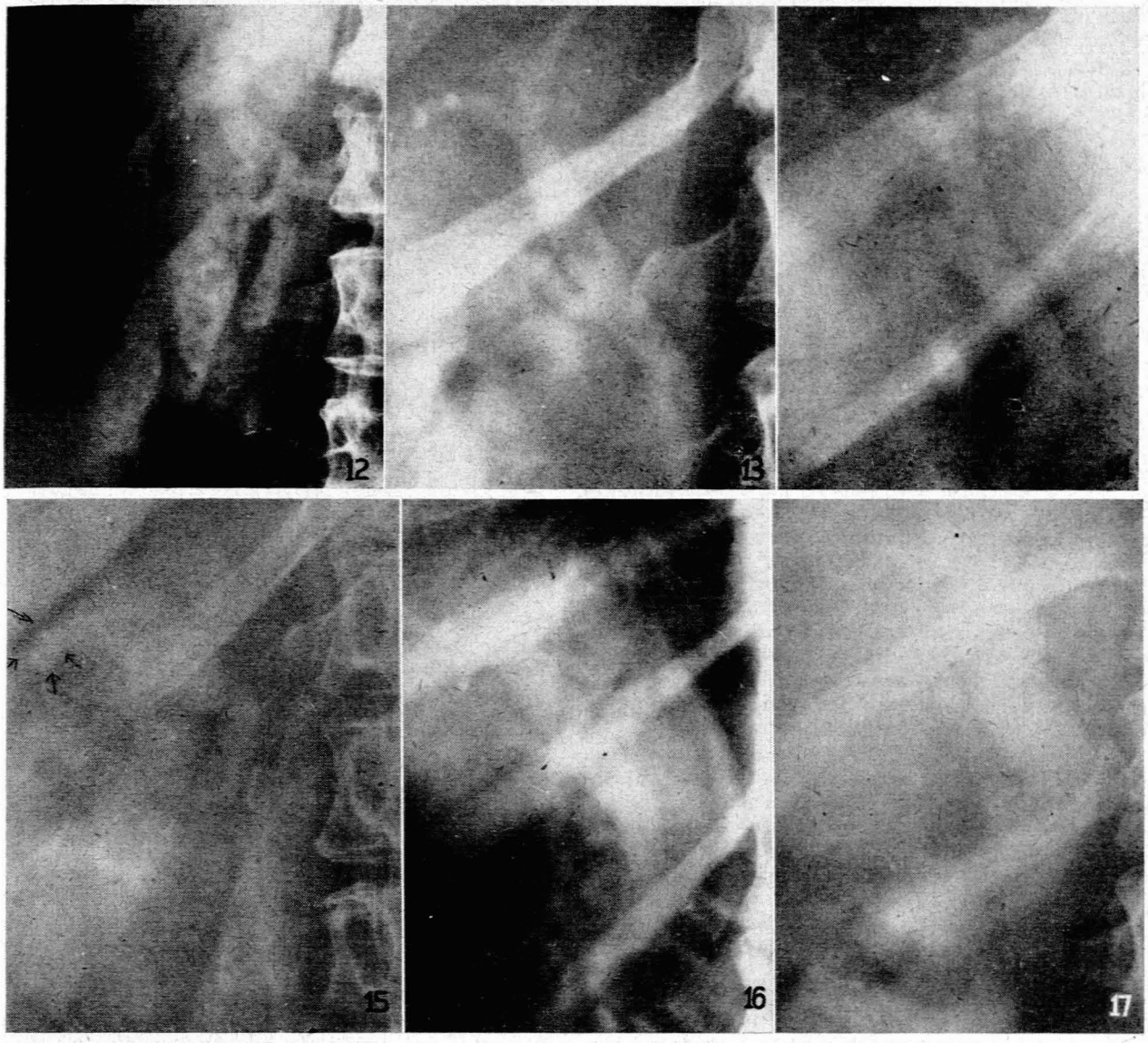

Fig. 2. Film taken 45 minutes after the injection of biligrafin, and showing two accessory ducts; the cystic duct is entering the common bile-duct along its left border. Note the radiolucent shadows at the fundus, simulating stones.
Fig. 3. Same case as Fig. 2. Film taken 2 hours after the injection of biligrafin, demonstrating the disappearance of the negative shadows which were due to stratification. Note the retrograde filling of the duodenal cap with contrast material (arrowed).
Fig. 4. Urografin introduced through an external biliary fistula leading into a cystic cavity in the liver, and draining into the right hepatic duct, which was cut at operation. A radiolucent stone is present in the common bile-duct.
Fig. 5. Adhesions producing an hour-glass constriction. Note the dilatation of the duct proximally.
Fig. 6. Film taken 45 minutes after injection of biligrafin in a non-cholecystectomized patient, showing two radiolucent stones in the left hepatic duct (arrowed) and the characteristic 'wooden club' sign.
Fig. 7. 120 minutes after the injection of biligrafin, showing 4 radiolucent faceted stones in the common bile-duct. Note the 'wooden club' appearance.
Fig. 8. Film taken 1 hour after the injection of biligrafin in a cholecystectomized patient, showing hydro-hepatosis and an abrupt arrest of the common hepatic duct. A large stone was removed from the common hepatic duct at operation. Note also the renal calculus (arrowed).
Fig. 9. Same case as Fig. 10. Post-operative cholangiogram showing marked hydro-hepatosis and choledochectasis.
Fig. 10. Tomograph showing moderate dilatation of the ducts with a large stone at its terminal portion (arrowed).
Fig. 12. Cholelithiasis with dilated ducts filled with numerous small radiolucent gall-stones.
Fig. 13. A cystic-duct remnant in an asymptomatic patient, showing normal appearances. Note the resemblance of the stump to a leaf bud.
Fig. 14. A cystic-duct remnant in an asymptomatic patient, showing the spiral-shaped tip, which is probably an anatomical variant.
Fig. 15. A cystic-duct remnant containing 4 small stones (arrowed). Note acute angulation of the common bile-duct due to adhesions, with dilatation of the common hepatic duct proximally.
Fig. 16. Dilated bile-ducts and a dilated cystic-duct remnant in an asymptomatic patient.
Fig. 17. Grossly dilated bile-ducts in a jaundiced, cholecystectomized patient. Note contrast medium in duodenum. No stone is evident radiologically. Comparison with an intravenous cholangiogram made 2 months earlier showed an increase of the duct calibre by 3 mm., suggestive of obstruction. At operation a large stone was removed from the terminal end of the common bile-duct.

by the pressure of fibrous bands and gives rise to the hour-glass constriction and dilatation of the duct above it.

4. Stasis of contrast medium in the portion of the duct proximal to the adhesions while the distal end empties readily. An erect film as an additional view may be useful.

One or more of these appearances may be found in the same case.

One feels that adhesions do not necessarily cause symptoms. The present series however, would suggest that when dilatation of the duct above adhesions is present, particularly if there is also a narrowing of the lumen, and stasis, then intermittent incomplete biliary obstruction is probably present and is responsible for the symptoms. The case is analogous to the intermittent obstruction produced by an aberrant renal artery.

Choledocholithiasis

The high incidence of choledocholithiasis in cases of cholelithiasis has been fully appreciated only during the last few decades. Baker and Koutsky[1] report that, out of 489 of their patients subjected to cholecystectomy, 199 (40·7%) had their bile-ducts explored and, of these, 107 (22%) had stones removed from the biliary passages. Best[2] found stones in the ducts to be present in 17 of 100 consecutive cases of cholecystectomy. He stated that, in 1 of every 4 cases of gall-stones in the gall-bladder, stones will be found in the common duct. The majority of these stones, he stated, come from the gall-bladder. Some may from *de novo* in the ducts; another very definite cause of recurrence of intra-duct stones is the presence of stones in the intra-hepatic ducts which later descend into the extra-hepatic ducts.

Intravenous cholangiography often demonstrates stones, both in the intra-hepatic and extra-hepatic radicles. In the majority of cases intra-duct stones are radiolucent. Fig. 6 demonstrates stones in the left hepatic duct with local dilatation of the duct. This dilatation around stones resembles a 'wooden club', and is probably due to inflammatory changes and stretching of the walls of the duct around the stones. Fig. 7 shows the same appearances at the lower end of the common bile-duct.

According to Norman,[5] intra-hepatic stones co-exist in about 8% of all cases of gall-stones. It is therefore important to have some pre-operative knowledge of the presence of such stones so that the operation will not be terminated before they are found. Fig. 8 shows hydrohepatosis demonstrated by the intravenous route and caused by an obstruction of the common hepatic duct. This patient had intermittent mild jaundice and despite his jaundice the ducts were opacified. At operation a large stone 1·5×1 inch was removed. Fig. 9 shows the post-operative cholangiogram in the same patient as in Fig. 8. Fig. 10 is a tomogram of an intravenous choledochogram with a radiolucent shadow at the lower end of the common bile-duct. This patient was explored on 3 previous occasions and the stone was not found despite the fact that the post-operative cholangiograms demonstrated it.

Many of our cases convinced us that radiological findings are in some instances far superior to surgical exploration and probing. It is possible that an impacted stone when present for some time may form a pocket similar to a diverticulum and be missed on direct probing. The frequency with which stones may be missed if only palpation is relied upon is only too well known. Fig. 13 is a drawing showing how easily stones lying in a pocket of the common bile-duct may be missed by palpation or exploration.

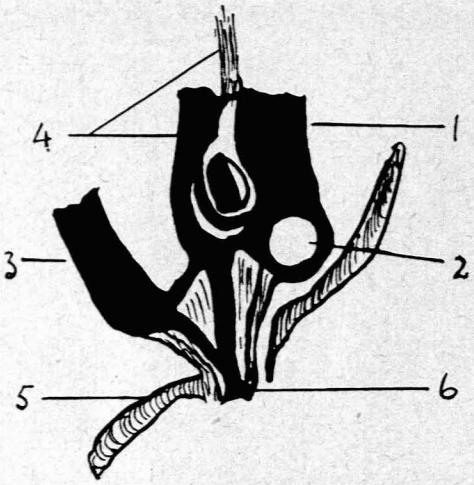

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Fig. 11. Diagrammatic illustration of the manner in which a gall-stone might evade detection by direct probing and removal with forceps when lodged in an outpouching (reproduced from Hughs and Kernutt[4]). (1) Common bile duct. (2) Stone in outpouching of duct. (3) Pancreatic duct. (4) Forceps in duct. (5) Duodenal wall. (6) Duodenal papilla.

The radiological signs suggestive of choledocholithiasis are as follows:

1. Negative shadows or filling defects (Figs. 6, 7, 10 and 12).
2. The 'wooden club' sign (Figs. 6 and 7), which is formed by the widening of the duct at the point where the stone is lodged.
3. Another sign which we have found on occasions and refer to as the 'crescent sign' is caused by the stone incompletely obstructing the duct and producing a shadow resembling a quarter moon.

The Cystic-duct Stump

Although this was a well-known entity before the advent of intravenous cholangiography, it is only recently that we started to observe its frequency, investigate its radiological appearances, and understand its clinical significance. We found a cystic-duct remnant in 29% of our cases. The presence of a cystic-duct remnant therefore would appear to be not uncommon. The normal calibre of the cystic-duct remnant is considered to be between 4 and 5 mm., and the length of the stump varied from 5 to 25 mm. The shape of the terminal end of the asymptomatic cystic-duct remnant resembles a 'leaf bud' (Fig. 13). Fig. 14 shows the spiral or beaded appearance at the tip of the stump, which is probably due either to Heister's valves or to anatomical variation in the shape of the cystic duct. It is not considered pathological.

Mere dilatation of the stump does not mean that it is responsible for symptoms. Dilatation of the stump may occur when the rest of the extra-hepatic ducts are dilated. Of our 18 cases with a cystic-duct remnant only 3 were considered pathological and proved to be responsible for symptoms (17%).

We have come across two main pathological states of the cystic duct stump, viz. (1) stone in the stump (Fig. 15) and (2) pouch formation due to inflammatory changes.

The incidence of cystic-duct stumps which were proved surgically or strongly suspected clinically to be responsible for symptoms was 17%. We are inclined to the view that the presence of a cystic-duct remnant with smooth termination

resembling a leaf bud, whether dilated or not is probably not responsible for symptoms. An out-pouching at the terminal end resembling the shape of a 'torch bulb' is considered actively pathological. One must not, however, mistake retrograde filling of the duodenal bulb or pyloric antrum with opaque medium for an out-pouching of the cystic-duct remnant.

Choledochectasis

The average width of the normal common hepatic duct is 8 mm. while that of the common bile-duct is usually 5 mm. As it is difficult to be certain where the common hepatic duct ends and the common bile-duct begins, the diameter which we measure and use as a criterion for ectasia is the maximal diameter of the extra-hepatic bile-ducts. We also measure the diameter of the terminal portion of the common bile-duct, which is an indication of the presence of normal tapering of the duct. The latter is often lost in obstructive states of the duct.

We recognize 3 degrees of dilatation. Minimal ectasia 10-11 mm., moderate ectasia 12-14 mm., and 15 mm. or over, which we call gross dilatation.

Physiological Choledochectasis. Work by recent workers such as Samuel[7], Don and Campbell[8] and others would seem to throw considerable doubt upon the conception that physiological choledochectasis occurs. In our series of 62 cholecystectomized patients, 19 (27·4%) had extra-hepatic ducts of normal widths. It would seem to us that in man physiological dilatation, if ever present, is not a constant feature. One tends to the view that choledochectasis is in most cases the result of past or present disease rather than a physiological compensatory process.

The experience recently accumulated all over the world by the use of the intravenous method has brought to the fore-front an entity which is little understood. I am referring to the problem of the dilated extra-hepatic ducts. This is a cause of much anxiety to the radiologist and surgeon. The questions which require answers are: (1) Is choledochectasis always actively pathological? (2) What are its various aetiological factors? (3) What is the correct method of handling such cases? Earlier a classification for this condition was suggested viz. obstructive and non-obstructive choledochectasis. The obstructive group is further subdivided into complete, incomplete and intermittent types. The aetiological factors associated with the obstructive type may be choledocholithiasis, stricture of the sphincter, adhesions, chronic pancreatitis, carcinoma of the ampulla of Vater, carcinoma of the head of the pancreas, or cyst of the pancreas.

Stricture of Sphincter

This probably originates in the passage of a stone through the sphincter. Such a passage may result in traumatic ulceration and infection and be followed by fibrous stricture of the sphincter. Proximal dilatation of the ducts may follow, not always accompanied by symptoms. When present, the symptoms are probably due to a severe degree of obstruction leading to stasis and infection. Complete or intermittent jaundice may follow, and stones may form as the result of stasis.

A radiological feature sometimes found in cases of complete or almost complete stricture of the sphincter is poor density of the shadow of dilated ducts, in the presence of normal liver function and normal serum bilirubin.

Wise *et al.*[8] observed that a film taken 60 minutes after the injection of biligrafin will show a 'fall off' in the density or in retention of the contrast medium in patients with an unobstructed bile-duct. In the partially obstructed ducts, however, the density of the opacified ducts is maintained even in the 2-hours film, or possibly even increased. On this basis these authors claimed to have predicted partial obstruction of the common bile-duct with a high degree of accuracy. This concept of a time and density-retention relationship over a 2-hour period is only valid in the cholecystectomized patient and depends on a normal clearance time of biligrafin by the liver.

Non-Obstructive Choledochectasis. In the last few years it has become apparent that many cases showing dilated ducts are asymptomatic, and that the mere presence of dilated ducts, although abnormal, is not actively pathological. In order to investigate what happens to the ducts of cholecystectomized patients, we have written to a number of patients who were operated on at our hospital some years earlier and asked them to submit to an intravenous cholangiographic examination. Fig. 16 demonstrates a cholangiogram of such a patient, who was operated on 4 years earlier for cholelithiasis with jaundice. At the original operation a dilated common bile-duct was explored and 18 stones removed. The patient made an uneventful recovery and at present is free of symptoms. The film demonstrates dilatation of the extra-hepatic ducts to 16 mm. and a tapering of the duct to 7 mm. There is a cystic-duct remnant 10 mm. in calibre. No stones, stricture or obstruction at the sphincter can be seen, and the contrast medium is seen to enter the duodenum in the 40-minute film. Here then is a patient with a non-obstructive choledochectasis who requires no treatment, and the danger is that the clinician or radiologist may diagnose an active abnormality where none exists. The following criteria help to differentiate the obstructive from the non-obstructive choledochectasis.

(*A*) *Obstructive Choledochectasis*

1. The presence of clinical signs and symptoms suggestive of biliary obstruction, e.g. jaundice, biliary colic, raised serum bilirubin, raised alkaline phosphatase.
2. The presence of radiological evidence of conditions often associated with obstruction, e.g. choledocholithiasis, stricture, pancreatic calculi, adhesions.
3. A delay in the appearance of contrast medium in the duodenum as shown by the 2-hour film. However, it is often difficult to be sure if some contrast medium entered the duodenum or not. Gas and faeces in the hepatic flexure often simulate shadows produced by contrast medium in the bowel.
4. Obstruction is often associated with faint density of the dye-filled duct.
5. Loss of the normal tapering of the distal portion of the common bile-duct.
6. The presence of the time and density-retention relationship in the 2-hour film.

(*B*) *Non-obstructive Choledochectasis*

Here we have dilatation of the common hepatic and common bile-ducts without the clinical or radiological findings described above. Contrast medium is clearly seen to enter freely into the duodenum approximately 45 minutes after the injection of biligrafin. In our series we came across 29 cases of non-obstructive choledochectasis.

Management of Non-obstructive Choledochectasis. Our advice depends on whether the patient has an intact gall-bladder or not. In the non-cholecystectomized patient with radiologically non-obstructive choledochectasis, one usually finds that gall-bladder disease is also present. In such cases an intravenous cholangiogram directs the surgeon's

attention to the necessity for exploration of the ducts at the time of the cholecystectomy. If this is omitted a stricture or stone may be overlooked. In the post-cholecystectomized patient with non-obstructive dilated ducts the patient should be treated conservatively in the first instance. Correlation of clinical and laboratory findings with a repeat intravenous cholangiogram following treatment would help to determine whether operation is necessary. During this period an attempt should be made to exclude other possible causes for the patient's symptoms, e.g. duodenal ulcer, hiatus hernia, diverticulitis, pancreatitis and cardiac or renal disease. A second cholangiogram may show an increase in the calibre of the ducts or may reveal stones which were invisible previously. The severity and duration of the symptoms and the absence of any satisfactory cause for them is a final deciding factor for exploration. Fig. 17 shows a grossly dilated common bile duct with a maximum calibre of 17 mm. This patient underwent cholecystectomy 11 years ago. On a recurrence of symptoms, with jaundice, in 1950 the ducts were explored and stones removed. Now, 5 years later, she complained of pains in the right hypochondrium. The first intravenous cholangiogram, 2 months before this film was taken, showed a moderately dilated common bile-duct with a maximum calibre of 14 mm. There was no evidence of any other pathological condition, e.g. stones or strictures. The contrast medium entered the duodenum 45 minutes after the injection. The physicians' decision was to treat the case conservatively. Two months later she returned for another intravenous cholangiogram. She was now jaundiced and the symptoms persisted. The second examination (Fig. 17) showed an increase in the calibre of the ducts (maximum diameter 17 mm.). We were then able to compare the films and conclude that the process was progressing both clinically and radiologically and was therefore obstructive in nature. At operation a large stone was found in the lower end of the common duct.

It is hoped that in the coming years the value of pre- and post-operative intravenous cholangiography will be fully appreciated. A pre-operative cholangiogram if performed in all cases will make it considerably easier to determine whether choledochectasis discovered at any future time requires active surgical interference or is better left alone. A pre-operative record of the state of the patient's ducts would remain for future reference and comparison.

It is a pleasure to record my gratitude to Dr. Josse Kaye, Chief Radiologist, Johannesburg General Hospital, for his encouragement, interest and guidance in preparing this paper, and to Dr. Kenneth F. Mills, Superintendent, Johannesburg General Hospital, for permission to use the hospital records and publish the case reports. To Miss M. Tompkins and Mrs. Stopforth I am very much indebted for their reproductions.

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