

elicited the fact of a deficient coagulability of the blood. It then occurred to me that the adoption of a form of treatment capable of exalting this deficient coagulability would control the symptoms. To this end I administered one of the salts of calcium. In almost all cases complete relief has followed this form of treatment not only of the headache but of many of the associated symptoms. It is, however, important to estimate the coagulability of the blood before beginning treatment because, as a general rule (to which there is an occasional exception), unless there be a deficient coagulability of the blood, no benefit from the administration of a salt of calcium need be expected. The following embodies the principles of the treatment:—

**A. Medicinal.**—1. The administration of one of the salts of calcium. Of the two which have been used the lactate of calcium is to be preferred to the chloride, because the latter is unpalatable, often nauseating, and occasionally not absorbed, whilst the lactate is much less open to any of these objections. The following has proved a satisfactory mixture: 15 grains of lactate of calcium, half a minim of tincture of capsicum, and one ounce of chloroform water; to be taken three times a day before meals. If more convenient one may prescribe as a powder 15 grains of lactate of calcium, which should be dissolved in one-third of a tumbler of water and taken before meals. If the lactate of calcium be not available, the chloride may be administered: 15 grains of chloride of calcium and one ounce of camphor water; to be taken three times a day before meals (if nauseating it may be given after meals). (Calcium lactate may be combined with the bitters, with iron, with strychnine, &c., but may not be combined with the alkalies or their carbonates.) 2. Regulation of the bowels. Constipation is a common accompaniment and must be controlled. Mild aperients, such as salines or liquid extract of cascara, are usually sufficient.

**B. Dietetic.**—The ingestion of one or two pints of milk a day is advisable though not essential. The patient should be counselled against eating oysters, crabs, strawberries, &c., which seem to contain certain lymphagocytic agents. It is best to avoid malt liquors and wines. The medicinal treatment of the constipation should be supplemented by a suitable dietary. Such a regimen in chronic cases is almost invariably successful.

In a number of cases, usually of the less severe type, considerable relief is felt in from a half to one and a half hours after the exhibition of the calcium salts. In others the relief comes during the first 24 hours of treatment, whilst in almost all the headaches disappear after the fourth day. Very occasionally a severe chronic headache of long duration is but little affected in less than ten days' treatment. It is advisable to continue the administration of one of the salts of calcium for a period of three weeks in the milder types of the lymphatic headache and for six weeks in the severer types.<sup>3</sup> For the relief of the occasional lymphatic headache, which is very commonly met with, the exhibition of half a drachm of calcium lactate is usually successful in from half an hour to one hour.

It is convenient to set forth in tabular form certain clinical data and the results of the various blood examinations in 14 cases of lymphatic headache. (See Table III.) In addition to the 14 cases tabulated I have treated 34 more, making 48 in all. The following is a synopsis of the 48 cases:—

1. All definitely conformed to the lymphatic type of headache above described, and of these, 40 obtained complete relief and eight considerable, though not complete, relief.

2. In four cases neuralgia occurred, two facial and two of the nerves of the lower extremities. In all relief was coincident with the disappearance of the headache and the oedema.

3. In 23 cases there was pain after food. Of these, 16 found complete and seven partial relief. Further, the rapidity with which this result was obtained appears to me to be a strong evidence in favour of the above-mentioned theory as to the causation of the gastric pain.

4. In 22 cases dyspnoea occurred. 12 were completely relieved, nine partially, and one not at all. Shortness of breath has proved the most intractable of all symptoms.

5. Oedema of the eyes or of the extremities occurred in 21 cases, and of these 17 were completely and quickly relieved.

<sup>3</sup> No ill effects have been observed as a result of the immediate administration by mouth of a single large dose of a salt of calcium or as a result of the daily administration of small doses over a long period.

Puffiness of the eyes is readily controlled but oedema of the feet usually requires several weeks' treatment.

6. Chilblains occurred in six cases and urticaria in two. All eight cases obtained complete relief of pain and swelling. A glossy erythema sometimes persisted for a considerable period after the chilblain had disappeared but it caused no discomfort whatever.

7. In the majority of cases some anæmia was apparent, though usually not pronounced. In about 25 per cent. of the above cases there was slight or severe chlorosis and of the latter there were several in whom the anæmia was greatly lessened or controlled during treatment *vide* Case 3, Table III.). The evidence, however, is insufficient to speak positively on this point.

8. Languor was practically always an accompaniment of this condition and one of the most astonishing results was the almost invariable improvement in mental and physical tone which followed the control of the morbid process conducive to serous hæmorrhage.

9. Relapses occurred in eight cases, as a rule apparently due to the return to a careless mode of living or to dietetic indiscretion. The symptoms in all the cases were a second time easily controlled by treatment.

#### CONCLUSION.

That we have in the salts of calcium a therapeutically rational and effectual means of relieving headaches which are due to a deficient coagulability of the blood.

*Possible further applications.*—1. In the treatment of those neuralgias accompanied by a deficient coagulability of the blood. Four cases have been treated with success. 2. In the treatment of migraine. In two typical cases the paroxysms have practically ceased during treatment with calcium lactate.

*Note on the relief of headaches and the oedema of chronic nephritis.*—Six cases of chronic nephritis have been treated according to the principles enunciated above. In five the headaches and the oedema were greatly lessened by the administration of a salt of calcium. One case obtained only partial relief. The details of this investigation will appear in another communication.

I wish to acknowledge my indebtedness to the honorary and resident staff of the City of London Hospital for Diseases of the Chest for allowing me to investigate cases which were under their care at the hospital.

## REMARKS UPON THE SURGERY OF THE COMMON BILE-DUCT.<sup>1</sup>

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THE subject that I have chosen for the address which, by your courtesy, I have the honour to deliver to-night is "The Surgery of the Common Bile-Duct." Experience in this branch of surgery has been rapidly accumulating and a brief survey of the work which has already been done is not undesirable. An occasion of this kind affords a definite stimulus to a scrutiny of one's own work and gives an incentive and an opportunity both for comparison with that of others and for a review of the whole subject.

The common bile-duct is rather more than three inches in length; it extends from the junction of the cystic and common hepatic ducts downwards and to the right in the free edge of the gastro-hepatic omentum to its termination in the second portion of the duodenum where it bears a relationship to the opening of the canal of Wirsung, the duct of the pancreas. As a rule, three portions of the duct are described: (1) the supra-duodenal portion; (2) the retro-duodenal portion, or the pancreatic portion; and (3) the trans-duodenal portion. 1. The supra-duodenal portion varies from one and a quarter to one and a half inches in length. It lies in the free edge of the gastro-hepatic omentum, having the hepatic artery to the left and the portal vein behind. It is the widest part of

<sup>1</sup> An address delivered before the Nottingham Medico-Chirurgical Society on Oct. 18th, 1905.

the duct, which in its whole course is funnel-shaped, gradually narrowing from its origin to its termination. The point of chief surgical importance is the fact that along this portion of the duct three or four lymphatic glands lie. These in their enlargement may come to resemble stones; indeed, they cannot always be distinguished from stones by touch alone. 2. The retro-duodenal portion is from an inch to one and a quarter inches in length. It is in close relationship with the pancreas, lying either in a groove in the gland or actually traversing its substance. Helly in 40 cases found that the duct lay in a groove in 15 cases and was embedded in the gland in 25. Bunker in 58 cases found that in 55 the duct was embedded, in three only was it partially uncovered by the pancreas. 3. The trans-duodenal portion, about from half to three-quarters of an inch in length, consists of that portion of the duct which lies within the wall of the duodenum. In order to open the lumen of this portion of the duct from within the duodenum the wall of the bowel has therefore to be cut *into* but not *through*. The common duct at its termination in the duodenum is associated with the termination of the duct of Wirsung in a manner that is liable to variation. The two ducts are surrounded by a circular band of muscular fibres described as the "sphincter of Oddi." Letulle and Nattan-Larrier described four varieties in the mode of ending of the common bile-duct and of the pancreatic duct in the duodenum. First type: Two cases in 21. There is a complete absence of any projection or raising up of the mucosa. A longitudinal furrow from two to three millimetres long, with prominent lips, surrounding a circular or oval opening, is seen. This opening is the termination of the common duct. The canal of Wirsung opens into the common duct at a variable distance from the intestine. Second type: Six cases in 21; it forms the "perfect model of the ampulla of Vater." At the opening into the intestine there is a slight projection on the surface of the mucosa from seven to 12 millimetres in length. The opening is circular or elongated vertically and at its largest measures three millimetres in length. The two ducts terminate in a cavity more or less circular the measurements of which are in a vertical direction from four to six millimetres and in the transverse from six to seven millimetres. Before opening into the ampulla both ducts are narrowed for a few millimetres. As a rule the common duct lies near to the duodenum in this type and can be felt as a vertical ridge beneath the mucosa. Third type: Eight cases in 21. This form is characterised by the presence of a very slight elevation on the surface of the duodenum, by a shallow fossa or gutter situated immediately below the point of opening of the ducts, and by the non-confluence of the two ducts before their termination. There is, therefore, no ampulla. The extent of the gutter or trough which surrounds the lower parts of the ducts at their terminations varies very greatly in different cases. The two ducts lie together at their termination like the two barrels of a gun; the pancreatic duct may be below and behind or below and in front of the common duct. Fourth type: four cases in 21. In this form there is a prominent papillary projection on the summit of which the two ducts open side by side, separated by a vertical partition; there is no ampulla. In some cases the opening of the canal of Wirsung may be crescent-shaped, the opening of the common duct lying in the hollow of the crescent. It will be seen that from the surgical point of view it is a matter of the greatest importance to recognise these varieties of form; the obstruction of the lower part of the duct in the first variety would involve an implication of the pancreas; the obstruction of the orifice of the ampulla in the second variety would convert the common duct and the canal of Wirsung into a single channel, whereas in the third and fourth forms the ducts are strictly separate. The conditions in which surgical interference with the common duct is called for are: (1) rupture of the duct; (2) calculus and in inflammatory conditions caused by other agents; (3) stricture; (4) new growth; and (5) pressure upon the duct from without.

#### 1.—RUPTURE OF THE COMMON BILE-DUCT.

Rupture of the common bile-duct may be the result of injury or of disease.

(a) *Traumatic rupture* of the common duct is always subcutaneous; so far as I am aware no case has been recorded as the result of a penetrating wound. Traumatic subcutaneous rupture probably occurs more frequently than the recorded cases would lead one to believe. The number of

the cases in which a laceration or rupture of the duct has been discovered either during an operation or upon post-mortem examination is small, but cases similar in all the details of their clinical history to these have recovered after the abdomen has been aspirated and large quantities of bile or deeply bile-stained fluid have been evacuated. A rupture of the duct in these instances, though, of course, not certain, was at the least extremely probable. The bile-duct may be torn at any part of its course and the rent may be small or the duct may be completely severed. The laceration, when small in size, may involve the anterior or the posterior wall; a large tear or a complete division of the duct is the condition generally found. As soon as the duct is torn bile escapes into the peritoneal cavity and before long sets up a responsive peritonitis. The result is that in the earliest days a very copious deposit of lymph is found in all the parts in the neighbourhood of the duct. The under surface of the liver is plastered with thick layers of lymph, the intestines, the duodenum, and the stomach especially, are all coated over with lymph, which can be peeled off in thick strips. The bile escaping from the duct may run free in the peritoneal cavity or its passage may be checked by barriers of lymph; an encysted swelling then results. It is interesting to note that this abundant deposit of lymph occurs only, or at least chiefly, after a traumatic rupture of the common duct. When the hepatic duct or the gall-bladder is torn lymph is formed in most cases but neither so rapidly nor so freely as when the common duct is involved. The reason for this may be found in the different condition of the bile as regards the presence of micro-organisms. Gilbert and Lippmann<sup>2</sup> investigated the condition, so far as concerned micro-organisms, of the bile in the extra-hepatic ducts in animals. The middle and lower thirds of the common duct were found to contain both aerobic (including the bacillus coli communis) and anaerobic organisms but, in the cystic duct and gall-bladder, only anaerobic organisms were found. The numbers of these organisms diminished gradually towards the upper part of the hepatic duct. It seemed clear that the infection of the bile passages proceeded upwards from the intestine. Bile poured out therefore from either the hepatic duct or the gall-bladder would prove less irritating to the peritoneum than that escaping from the common duct and would call forth a less vigorous response from it. This abundant deposit of lymph prevents the resorption of bile by the peritoneum. But for this the bile would be rapidly absorbed and give rise to symptoms of toxæmia. In a series of experiments upon dogs Erhardt ligatured the common duct immediately above the duodenum and, from the ligature, slit the duct upwards to the hepatic duct. The animals died within from two to six days from deep jaundice and profound symptoms of toxæmia. No evidences of peritonitis were present. The bile absorbed rapidly by the peritoneum caused death from poisoning, the harmful constituents of the bile being, according to Biedl and Kraus, the bile-acid salts. In Erhardt's experiments it was found that if at the time of the operation a culture of the bacillus coli was introduced into the peritoneum a plastic peritonitis resulted. Bile was therefore absorbed far more slowly, jaundice was slight and slow in appearing, and the animals survived for 14 days or longer. It would appear, therefore, that in rupture of any part of the bile passages two dangers are to be apprehended—one from the absorption of the bile-the acid salts of which are poisonous, the other from infection by organisms escaping through the distal torn end and coming from the duodenum. These organisms, in so far as they excite a fibrinous peritonitis, are helpful rather than harmful. It is interesting to note that suppurative peritonitis, either general or local, has not been observed in any case so far recorded. Infection with organisms (probably the bacillus coli) is therefore slight. The deposit of lymph upon and around the common duct may cause the complete sealing up of the rent, so that when an operation is performed no further escape of bile is perceived and the source of that which has already escaped may be difficult to discover. In Battle's case, for example, the laceration was hard to find post mortem on account of this coating of the parts with lymph. In one case of rupture of some part of the bile passages Routier opened the abdomen, drained away all the deeply bile-stained fluid, and found the under surface of the liver and gall-bladder and all the region of the ducts firmly surrounded by thick deposits of lymph. No bile could be seen to issue from any point. After

<sup>2</sup> Mémoires de la Société de Biologie, vol. xxxi.

thoroughly drying the peritoneum with swabs Routier closed the abdomen completely and the child made a perfect recovery. The detailed history in this case shows unquestionably that a rupture of the bile passages had occurred and affords a proof seemingly conclusive that the secure healing of a duct may be accomplished through the agency of the lymph. A case is recorded by Thompson of Edinburgh in his work on "Diseases on the Liver" in which the bile passages at some part would seem to have been ruptured. After the usual course of symptoms the abdomen was tapped and 16 pints of bile were withdrawn. At the post-mortem examination no lesion of the bile passages or of the liver was discoverable. There was a new "false membrane" covering the ducts and lymph was deposited everywhere.

*Symptoms.*—The symptoms and signs caused by a rupture of the common bile-duct are jaundice, the absence of bile in the stools, the gradual distension of the abdomen by fluid, and wasting. In two cases out of the total number of 12 recorded death occurred from shock or collapse when no symptoms of any kind other than these had had time to develop. The patients were almost all young children, only four being over 20 years of age and five being under six years of age. The accident was generally due to the patient being run over, or kicked, or struck in the abdomen. Jaundice is a variable symptom; it may come on within the first few days or its appearance may be delayed for a fortnight. In at least one case, that of Hahn, it was never present. In Porter's case and in Stierlin's jaundice disappeared after the abdomen had been tapped and a large quantity of bile evacuated. The jaundice is never profound; in most of the records it is stated that the jaundice was "slight" or that the skin was "lemon coloured." The colouring of the skin is due to the absorption of bile by the peritoneum. As soon as lymph is poured out the absorption ceases or is reduced considerably, and the jaundice then remains stationary or fades slowly away.

Bile is absent from the fæces in all cases of rupture of the common duct. All the bile passing down the duct escapes at the point of rupture. Though these statements are accurate in so far as they concern the cases in which the presence of a laceration of the duct has been verified by operation or by post-mortem examination, it cannot be open to doubt that in some cases a rent in the duct has been closed by the deposit of lymph and the patency of the canal restored. The case of Routier, quoted above, is possibly one exemplary instance of this. In the records of the 12 verified cases it is noticed that the stools were "clay-coloured," "pale grey," or "acholic" in nine, in one no record was made, and in two death occurred from shock too early to admit of any observations upon this point. During the time that jaundice is present there may be bile in the urine, though this is not necessarily the case. The bile, though unable to reach the intestine, does not necessarily become absorbed by the peritoneum to an extent sufficient to cause either jaundice or staining of the urine.

The gradual distension of the abdomen by fluid is a constant feature in all cases. In 10 of the 12 cases (two patients dying from shock) a slow accumulation of fluid in the abdomen was observed. The fluid when aspirated was found always to be bile or fluid deeply bile-stained. The bile escaping into the peritoneum may flow over the whole cavity and fill every part of it, as does the fluid in a case of ascites. Or if the sero-fibrinous peritonitis be rapidly set up barriers of lymph may confine the fluid to a limited area of the abdomen, the rest being free. A local swelling, generally in the right hypochondrium, then results. In one case (Drysdale's) the fluid filled the right side of the abdomen and the greater part of the pelvis and the wall of lymph was so firm and so complete that the recorder speaks of a "cyst," into which the common duct opened at the point of rupture.

A rapid loss of flesh is noted as having occurred in most of the cases and in some the emaciation is spoken of as being "extreme." The temperature is generally normal, increasingly worse as the abdomen enlarges.

So far as the differential diagnosis is concerned, it would seem that an accurate discrimination between rupture of the hepatic or common ducts and rupture of the gall-bladder should be possible. When either of these ducts is torn the whole of the bile escapes into the peritoneal cavity and the stools are colourless; if the gall-bladder be torn bile can still flow unhindered along the ducts into the intestine and the colour of the stools is normal or, owing to the escape of a part of the bile through the gall-bladder, is only slightly paler than is natural.

*Treatment.*—In all the cases so far recorded no treatment has been adopted in the days immediately following the accident. It is only when the abdomen has become greatly distended by fluid that aspiration or incision has been contemplated. In one case, that recorded by Rose, no less a period than nine months elapsed between the receipt of the injury and the operation. If the circumstances were such that a diagnosis could be made early and operation undertaken promptly the results would be more satisfactory than they are, but the injury received is rarely such as to do damage to other parts than the common duct, the shock and collapse pass off rapidly, and the general and local conditions improve so decidedly that no question of surgical treatment arises. It is only when jaundice, fæcal acholia, and, above all, the general distension of the abdomen, are recognised that the diagnosis is assured. If early operation could be performed then end-to-end suture, or partial suture with drainage, as in choledochotomy, might be performed. In some of the cases, Porter's and Stierlin's, the distal end of the common duct could not be found even after the most careful search; in Stierlin's case, indeed, the distal end could not be discovered even at the post mortem examination. In such circumstances ligature of the proximal end of the duct and cholecystenterostomy might be performed, or the proximal end of the duct might be implanted into the duodenum. In those cases in which the conditions are so serious that the simplest and speediest operation is alone permissible the bile must be emptied out as thoroughly as possible and a large drainage-tube be introduced. Courvoisier suggested that when the common duct was completely ruptured tubes might be passed into each torn end and left hanging out from the abdominal incision. When adhesions around the tubes had shut them off from the general peritoneal cavity the tubes could be removed and the bile might then find its way from the upper to the lower opening and the biliary fistula gradually close.

(b) *Pathological rupture of the common bile-duct* occurs generally as the result of the presence of a foreign body. Inflammation, softening and distension of the walls, and finally ulceration are set up and the duct at last gives way. The rupture of the duct may occur into the general peritoneal cavity; or into a localised mass of protective adhesions, an abscess then resulting; or the outer surface of the duct before rupture occurs may have become strongly adherent to a neighbouring viscus into which the perforation takes place, with the formation of a fistula.

Including the cases collected by Courvoisier there are 11 instances of perforation of the common bile-duct into the general peritoneal cavity; in six cases stones were present, in three ascariæ, and in two no foreign body could be found. In all the clinical course was rapid and death occurred from acute peritonitis; in one case there was profuse hæmorrhage, possibly from ulceration into the portal vein. An interesting example of rupture of the common duct into the peritoneal cavity, causing death from peritonitis, is recorded by Janeway.<sup>3</sup> In some cases the perforation of the duct is subacute, an abscess being slowly developed. The spreading of this gives rise occasionally to a subphrenic abscess, or the local abscess may rupture and cause a diffuse septic peritonitis, or the abscess may open secondarily into the colon<sup>4</sup> or upon the abdominal wall, an external biliary fistula being formed.<sup>5</sup>

When the common duct has become adherent to a hollow viscus or the perforation has occurred from the third portion of the duct a fistula results. I have operated upon fistulæ connecting the common duct and the gall-bladder and the common duct and the duodenum. A choledcho-duodenal fistula may connect the second or the third part of the duct with the bowel. The "wide-mouthed opening" of the common duct into the duodenum seen in cases of longstanding obstruction of the duct by a calculus is in reality the opening of a fistula through which the stone has ulcerated into the bowel.

## 2.—STONE IN THE COMMON DUCT.

A stone lodged in the common duct causes an obstruction which is either *complete* or *incomplete*; complete when the stone has just entered the duct which it fits tightly preventing any drop of bile from passing it, incomplete when the stone has been in the duct for some weeks or months when secondary changes in the duct such as softening and

<sup>3</sup> New York Medical Journal, 1877, p. 531.

<sup>4</sup> Bristowe: Transactions of the Pathological Society of London, London, 1858, vol. ix., p. 285.

<sup>5</sup> Morris: New York Medical Record, Jan. 1st, 1887, p. 22.

dilatation have occurred and when, therefore, the stone no longer fits the duct tightly but lies loosely within it, permitting the escape of bile by its side. In other words, an acute obstruction of the duct is complete and a chronic obstruction is incomplete. In the majority of cases of calculous occlusion of the duct there are more stones than one. Courvoisier in 149 cases found that there was a single calculus in 95, that there were two calculi in 36, and that there were 12 stones or more in 18 cases. The experience of most surgeons, however, is different from this. When choledochotomy is performed a solitary stone is found in only about 1 case in 4. Courvoisier in 123 cases found that the position of the stone or stones blocking the duct was as follows: in 17 cases at the commencement of the duct; in 19 cases in the middle of the duct; in 20 cases near the duodenum (retro-duodenal portion); in 41 cases at the ampulla; and in 26 cases the whole length of the duct was blocked. Vautrin in 47 cases found that calculi were present in the part of the common duct above the duodenum in 27 cases; in the duct in contact with the duodenum in 18 cases; and in the ampulla in two cases. In some rare cases the whole of the common duct, from end to end, the hepatic duct, and all the intrahepatic ducts may be filled with stones very tightly packed together or with a sort of thick tenacious mucus containing gall-stones innumerable.

*Acute occlusion of the common duct* from within is rare, except as a transient condition. When a gall-stone escapes into the common duct from the cystic duct it passes at once downwards into the funnel-shaped duct as far as it can before it is arrested. The larger a stone is the sooner will progress be checked; the smaller a stone the further will it pass. When a part of the duct is reached the lumen of which is so narrow that the stone cannot pass it is arrested. It then fills the duct and blocks its lumen absolutely, allowing no drop of bile to escape by its side. The common duct is then as securely blocked as if tied with a string. But this condition of things does not long endure. Slowly but surely certain changes occur, the result of inflammation in the duct, softening of its walls, and the secretion-pressure of the bile, which have the effect of giving rise to a dilatation of the duct, so that a stone which at first fitted tightly now fits loosely. The stone forms, as Fenger first pointed out, a sort of "ball-valve" in the duct. A complete occlusion of the duct is, therefore, in cases of stones, only an acute temporary condition. As the result of inevitable changes in the duct the obstruction becomes only a partial, incomplete one. In cases of stricture, simple or malignant, or of compression of the duct from without by enlarged glands or by the head of the pancreas involved in a carcinomatous growth, the complete obstruction of the duct may be permanent. A stricture of the duct may cause its absolute obliteration for a space of an inch or more; in such a state the occlusion is complete and permanent. In all cases where the block in the duct is complete the bile pent up behind the obstruction becomes gradually absorbed and the hepatic ducts and all the biliary ducts behind the occlusion become filled with clear sticky mucus. The ducts are everywhere dilated.

The chief, and often the only, symptom of complete closure of the common duct is jaundice, deep and unchanging. In the earliest stages when the obstruction is developing pain may be present but it is rarely or never severe and it disappears speedily. Jaundice in cases of obstruction by stone appears rapidly and attains its maximum within a few days; in cases of obstruction of the duct due to stricture, simple or malignant, or to compression by growth from without, the jaundice comes insidiously, deepens little by little, never lessens, but progresses always to its maximum intensity without any periods of remission. It is in these cases of complete obstruction of the duct that the diagnosis is difficult and at times even impossible. If time elapses without any onset of rigors or of variation in the jaundice, the likelihood of a stone being present is small; the obstruction then is probably due to malignant disease in or around the duct.

The condition of the gall-bladder in these cases affords a great help in achieving an accurate diagnosis. This point was first fully investigated by Courvoisier. He found in 187 cases of obstruction of the common duct that in 100 the obstruction was due to causes other than stone, and in 87 to the impaction of a stone. Of the 100 cases in which the obstruction was due to causes other than stone, in 92 there was dilatation of the gall-bladder and in eight cases there was a normal gall-bladder and an atrophy of the gall-bladder. Of 87

cases in which the obstruction was due to stone, in 70 cases the gall-bladder was atrophied and in 17 cases the gall-bladder was dilated. All these cases were collected from the literature. Of the cases that came to operation and were recorded by Courvoisier, 35 in number, in 18 the obstruction was due to causes other than stone, and in 16 of these there was dilatation of the gall-bladder, in 17 the obstruction was due to stone, and in 13 of these the gall-bladder was contracted. These observations of Courvoisier were formulated by him in the following statement, which is now generally referred to as "Courvoisier's Law." "*In cases of chronic jaundice due to blocking of the common duct, a contraction of the gall-bladder signifies that the obstruction is due to stone; a dilatation of the gall-bladder, that the obstruction is due to causes other than stone.*" The validity of this law has been closely investigated and its truth has been affirmed by almost every writer. Ecklin in 172 cases of common duct obstruction due to calculus found that 28, or 16 per cent., had dilatation of the gall-bladder and 144, or 84 per cent., had contraction of the gall-bladder. In 139 cases of obstruction due to other causes 121, or 87 per cent., had dilatation of the gall-bladder.

A further examination of the question has been made by Dr. A. Cabot of Boston who collected the records of the Massachusetts Hospital. There were 86 cases of obstruction of the common duct. Of these 57 were due to obstruction by stone; in 47 the gall-bladder was atrophied, in eight it was normal, and in two enlarged. 29 cases were due to causes other than stone; in 27 the gall-bladder was distended, in one the gall-bladder was empty, and in one contracted around three stones. Only four cases therefore in this series did not fall in with Courvoisier's law. Cabot writes: "With the exception of these four cases, which constitute only 5 per cent. of the total number examined, every record of the Massachusetts Hospital series in which definite statements are to be found concerning the points at issue goes to confirm Courvoisier's law." The explanation given by Courvoisier of the occurrence of sclerosis of the gall-bladder in cases of stone was that the presence of calculi in the gall-bladder and their passage or attempted passage down the ducts had caused irritation and inflammation in and around the bile passage. Cholecystitis and peritonitis were the result and had determined the cicatricial cramping and compression of the gall-bladder.

If persistent and unvarying jaundice is associated with enlargement of the gall-bladder, and inflammatory troubles, rigors, sweatings, elevation of temperature, and rapidity of pulse are also in evidence, then it is probable that there is a stone in the common duct and that cholangitis and cholecystitis are secondary to it, for infection of the bile passages, though not impossible in cases of malignant disease, occurs far less frequently than when the obstruction is calculous. The presence of enlargement of the liver, especially of an irregular character, or of ascites will support a diagnosis of carcinoma.

*Incomplete occlusion of the common duct; chronic calculous obstruction.*—In the great majority of cases of obstruction of the common duct by stone the block is only a partial and intermittent one. At the first the occlusion, as I have pointed out, is complete, but after a time the stone is loosened and comes to act as a ball-valve. It then floats in the duct, upwards and downwards. At times it is pressed onwards, in part, perhaps, by the force of the bile behind it, in part also by the muscular contraction of the walls of the duct. As it passes further downwards it comes to a part of the duct whose lumen is not large enough to permit the further descent of the calculus. The stone is arrested there, gripped firmly, and for a time the block in the duct again becomes complete. Soon, however, the stone is floated upwards into the wider duct and bile escapes past it into the lower part of the duct to flow into the duodenum. The occlusion is then incomplete and remains so until the stone again attempts to pass downwards and is again arrested. The description given by Fenger of the "ball-valve" action of the stone is thus seen to be completely justified, for at times the passage of bile is absolutely stopped by the stone and at other times the bile can flow past the stone unhindered. The fact that the stone lies freely moveable in a dilated duct is always realised by the surgeon in the operation of choledochotomy, for it is difficult to fix the stone owing to the ease with which it slips away from the grasp of the fingers.

The symptoms of stone in the common duct are sometimes trivial and inconspicuous and, indeed, are at times entirely



absent. I have twice found during the performance of cholecystotomy that stones were present in the common duct when symptoms were wholly lacking. If the stone is small or fits loosely in the duct there may be neither obstruction nor cholangitis and the stone, therefore, may never attract clinical recognition. The symptoms are due in part to the intermittent mechanical impediment in the duct and in part to the cholangitis which the stones excite.

Pain is present only at times. It comes, as a rule, in attacks which vary much in severity. The pain is dull and aching with, especially in the beginning of the attack, spasmodic outbursts. As a rule the pain is accompanied by a rigor; the temperature runs rapidly up to 102°, 103°, or 104° F; there are shivering and collapse, followed by sweating, and in the succeeding hours it is noticed that the jaundice, which is persistent, has deepened much in tinge. In the intervals between such attacks as these the patient suffers little or not at all. There is neither pain nor tenderness over the liver and the jaundice grows gradually paler. Jaundice, which was described by Courvoisier as the "cardinal symptom" of common duct obstruction, never disappears, though in very old-standing cases the patients may say that they are free from jaundice when there is still an obvious tinge of yellow in the conjunctivæ and in the skin. In one patient, a woman, who had suffered from these ague-like paroxysms for nine years, the skin was said to be "sallow" normally and the suggestion that she was jaundiced to a slight degree met with no confirmation. It was only after the removal of one large and several smaller stones from the common duct that the patient became convinced, as her skin gradually whitened, that the sallowness was due to jaundice, from which she had never been free through all the nine years. Many patients noticed that the jaundice varies during the course of the day, being lighter in the morning and becoming deeper towards night.

The temperature angle in a case of common duct obstruction by a stone is quite characteristic. With each attack of pain there is a rapid elevation of temperature when the rigor occurs. As the rigor passes off the temperature remains until the next seizure of pain occurs, when the temperature mounts to 103° or 104° to fall again at once. This rapid elevation and sudden fall of the temperature in each "attack" when the temperature is normal in the intervals causes the chart of a case of this kind to be perfectly characteristic. I suggested for it some time ago a name which seems quite appropriate and which has been since widely adopted—the name "steeple chart."

Courvoisier, in his analysis of recorded cases, found fever in 25 per cent. of the cases of occlusion from stone and in only 10 per cent. of the cases of occlusion due to other causes. The former estimate seems to me to be considerably below the truth. If a case of common-duct obstruction be observed for a period of two or three weeks there will, with few exceptions, be found some abrupt elevation of temperature coinciding with the pain, and attacks of shivering and subsequent sweating, not perhaps of sufficient gravity to be considered as rigors, will occur. During an attack, and for some hours after, there may be a slight enlargement of the liver and the liver everywhere is tender to the touch. In chronic obstruction of the common duct the liver is always enlarged in the earlier stages; its increase in size may indeed be considerable. The liver may reach to the umbilicus or even descend beyond it. In each attack, when a rigor and an elevation of temperature followed by a deepening of the jaundice occur, an increase in the size of the liver may be observed and the organ on handling is found to be tender. In the latter stages the liver decreases slowly in size and at the last may be even smaller than the normal. According to Mongour the shrinkage of the liver is the most important sign of the degeneration of the hepatic cells. The condition of the stools and of the urine varies from time to time. As a rule, some bile passes always into the intestine so that the motions are a deep buff in colour. After an attack there is obvious evidence both in the fæces and in the urine that less bile is getting access to the duodenum. The variations are, however, much more readily recognised in the stools than in the urine. The persistent presence of urobilin in the urine is held by many observers to indicate the onset and the continuance of a process damaging to the hepatic cells. In many cases an enlargement of the spleen is noticed, more especially after an attack and for some days subsequently. The gastric disturbances noticed in cases of gall-stone impaction vary within very wide limits. There may be nothing more than a

sense of uneasiness in the epigastrium and distension after food for which there is often a distaste, or, on the other hand, there may be severe vomiting during, and subsequent to, the attack and a feeling of profound nausea. Itching of the skin is almost constant as in all forms of jaundice and a crop of boils may at times break out.

One of the most marked and characteristic symptoms of obstruction of the common duct by stone is loss of weight. A loss of two, three, or four stones is not infrequently recorded. The loss is both rapid and considerable and after a successful operation is very speedily regained. This loss of weight was ascribed by Fenger to "intermittent, frequent, ptomaine intoxication—that is, bile absorption—as well as to disturbed digestion." It is most important that this symptom should be recognised as a frequent and striking manifestation of stone in the common duct, for the haggard, wasted, often emaciated, appearance of the patient may strongly suggest a diagnosis of malignant disease. It is more than likely that some measure of responsibility for this symptom may rest with the pancreas, the secretion of which may be profoundly modified both in quality and in quantity by an extension of the inflammation from the common duct to the canal of Wirsung into the substance of the pancreas. Chronic pancreatitis is by no means an uncommon event in long-standing obstruction of the common duct, wherever the obstruction may be.

The characteristic signs and symptoms of stone in the common duct, therefore, are:—

*Jaundice.*—The jaundice is persistent but variable. It never wholly disappears, though in the interval between the attacks of pain may be so slight as to be almost unnoticeable. The colour becomes deeper after each attack of pain and gradually fades away in the intervals. In some patients a variation in the depth of tinge is noticed in the course of the day. When the jaundice deepens there is an increase in the amount of bile in the urine and a diminution in the amount in the stools. The jaundice in common-duct obstruction may be said to "ebb and flow."

*Pain.*—Pain may be constant and slight but is liable to characteristic exacerbations. In the attacks the pain comes on suddenly, rapidly attains a maximum, when it is colicky in character, and then perhaps quite suddenly it disappears. Pain may radiate across the epigastrium and be associated with attacks, so called, of "indigestion."

*Fever.*—The elevations of temperature are characteristic and give rise when recorded to a "steeple chart." There is a sudden elevation at the time of the onset of pain; there are a rigor, shivering followed by sweating, and a speedy return of the temperature to the normal, where it remains until the next attack. The paroxysms of pain, fever, and jaundice are ague-like in character and may occur with remarkable regularity.

During and after an attack there are tenderness and enlargement of the liver and probably also of the spleen. Itching of the skin is always present and at times is the most distressing feature in the case, rendering rest and sleep impossible. The cause of the attacks is probably to be found in a renewed attempt on the part of the duct to expel the stone. From the dilated portion of the duct the stone is made to enter the narrower portion below and a spasmodic muscular contraction is set up. In this way fresh damage is done to the duct, tension is increased, infection occurs, a cholangitis or an increase of an inflammatory condition already in existence takes place and the mucosa throughout the ducts swells and narrows the lumen. The obstruction, in fact, becomes for the time mechanically complete and partly for this reason and partly because of the renewed attack of cholangitis the jaundice deepens.

In the most severe forms of infection suppuration may arise in the duct. It is certain that infection is present in all cases attended by the symptoms just enumerated; it is equally certain that the infection rarely gives rise to suppuration. When a stone is removed from the common duct, even when jaundice is marked and long enduring, it is in my experience very rare to find pus in the ducts, however severe the clinical manifestations may have been. Some authors—Kehr and others—talk of foetid pus as being not uncommonly found behind a stone in the common duct. In my experience it is almost unknown. A suppurative cholangitis, therefore, is a rare complication of impacted stone. It is also a most serious—often, indeed, a lethal—one. The suppuration may extend not only along the whole length of the common duct but also may involve the cystic duct and the gall-bladder (giving rise to empyema) and the

hepatic ducts. In some cases an abscess or abscesses may develop in the liver by direct extension of the infection along the ducts, giving rise to the condition known as biliary abscess.

A gall-stone may remain in the common duct for years. In one of my patients the symptoms had been present for nine years and a case of 17 years' duration is recorded by Körte. One of the consequences of so long enduring an inflammation in the duct is that the head of the pancreas may be involved by infection of Wirsung's duct or, perhaps, by direct or by lymphatic infection. Chronic pancreatitis, as was pointed out by Riedel, is a not infrequent complication of gall-stones impacted in the common duct. Opie has shown that in all probability many cases of acute pancreatitis are due to the impaction of a stone of small size in the ampulla of Vater, the result being that the common duct and the duct of Wirsung are converted into a single channel; retrojection of bile along the duct of the pancreas then occurs. In such a case the symptoms come on with marked suddenness. They are epigastric pain and tenderness, followed by distension, vomiting, and collapse. The diagnosis most often made is one of intestinal obstruction. In acute pancreatitis with fat necrosis there is no increased leucocytosis; in acute infective cholangitis there is a marked leucocytosis. There are many other causes in addition to calculus which set up inflammatory changes in the duct but a consideration of these, though of great interest and importance, must be omitted here.

### 3. STRICTURE OF THE COMMON DUCT.

This may be congenital or acquired; the former condition would seem to be the more frequent.

(a) *Congenital stenosis* of the common duct is a part of the disease which has been described as "congenital obliteration of the bile-ducts." It is probable that, as Rolleston has suggested, the disease is primarily started during foetal life "by poisons derived from the mother and conveyed to the liver of the foetus and that a mixed cirrhosis and cholangitis are set up." The result on the ducts is that an obliterative cicatricial process is started. The stenosis is perhaps found more commonly at the lower end of the common duct than elsewhere. Above the narrowed part the duct may dilate and form a cyst. In one case, the specimen of which is in the Museum of Guy's Hospital, three and a half pints of bile were aspirated from the cyst and Oxley<sup>6</sup> records a case of a cyst containing 36 ounces of bile occurring in a child six weeks old.

The existence of this congenital obliteration or stenosis of the ducts in foetal life and in early infancy is now well recognised. It is not so generally known that a condition, probably the same, certainly closely allied to it, is found in young adults. In them jaundice may first appear at any time between the ages of 10 and 25; the jaundice gradually deepens, there is no pain, nor are there, as a rule, any rigors or other evidences of infection. A tumour, cystic in character, may be recognised below the costal margin on the right side. On opening the abdomen a stricture of the common duct, generally near its lower end, has been found and cholecystenterostomy, or choledoch-enterostomy, or choledochotomy with drainage have been performed. An admirable history of such a case is given by Swain.<sup>7</sup> Other cases are recorded by Astby,<sup>8</sup> by Körte,<sup>9</sup> by Konitzky,<sup>10</sup> by Seyffert,<sup>11</sup> and by Rostowzew.<sup>12</sup> In none of these cases was there any history of cholelithiasis. The stenosis came on insidiously and was probably the result of a continuation into adult life of a process begun in early infancy or in foetal life. There would be an analogy then in the condition found in the pylorus described as "congenital, hypertrophic stenosis," which is believed to have a definite relationship with a similar condition which first attracts attention in young adults. Most of the cases proved fatal after operation. A successful operation for the similar condition is recorded by Treves.<sup>13</sup> The patient, aged 19 years, had been jaundiced since the age of three years. At the operation the lower end of the common bile-duct was found to be obliterated or absent. Cholecystenterostomy proved successful.

(b) *Acquired stenosis of the common duct.*—Acquired stricture of the common duct results, as a rule, from the healing of an ulcer which has been caused by the pressure or the constant fretting of a stone. In other cases the cause may be an ulceration due to typhoid fever or possibly to syphilis. A stone which has been long delayed in the duct may pass onwards into the duodenum, and a stricture then slowly develops. As a rule, a stone is found in the strictured duct above the obstruction. Hoffman, Merbach, Wyeth, and others have described a similar condition in the hepatic duct; in the cystic duct it is seen quite commonly. Pye-Smith<sup>14</sup> has described a case of cicatricial contraction of the common duct in a woman aged 26 years; a small stone lay immediately above the stricture. Johnson<sup>15</sup> records a remarkable case of stricture of the upper part of the common duct in a woman aged 38 years. The symptoms after being present for over a year disappeared, to return a year later shortly before her death. Phillips<sup>16</sup> records a case of "cartilaginous" stricture in the common duct. In neither of these cases were gall-stones found. Körte<sup>17</sup> records the case of a man, 40 years of age, who had suffered for five months from jaundice, rigors, and remittent fever. On opening the abdomen the gall-bladder was found to be dilated and stones were present in the cystic duct. The hepatic and common ducts were dilated. The common duct was opened and found to contain a stone behind a very narrow stricture. The stricture was excised and an end-to-end anastomosis was made between the cut ends. A drainage-tube was placed in the hepatic duct and cholecystenterostomy was performed. The patient died on the twelfth day from hæmorrhage from an ulcer on the lesser curvature of the stomach; a large vessel was found eroded. Pennato<sup>18</sup> gives notes of one case of stenosis of the common duct near its termination due to fibrous inflammatory thickening. There was an enormous distension of all the ducts behind the obstruction.

I have operated upon one case of this kind. The patient was a man, aged 63 years, who had the typical symptoms of a stone in the common duct and who had suffered from his disease for nearly four years. I found the upper part of the common duct greatly dilated, at least one and a half inches in diameter. In the dilated portion a small stone and much black sand were found. The common duct at the junction of its first and second portions rapidly narrowed like a wine-glass to its stem. I performed a plastic operation upon the duct and drained the hepatic duct. For nine weeks bile was discharged from a fistula but at the end of that time the wound became dry and the patient has since (for over nine months) been perfectly well.

A cicatricial contraction in a duodenal ulcer may cause a narrowing of the duct. I have met with only one such case. The scar in the duodenum felt like a stone fixed in the ampulla. I opened the duodenum to remove the stone, when a hard cicatricial nodule was found. There was no suspicion as to its malignancy. I therefore united the wound in the bowel to the gall-bladder (cholecystenterostomy), affording a complete relief to the symptoms. The patient remains well four and a half years after the operation. A case of excision of a simple stricture of the common duct is recorded by Kehr. In one case, in addition to that mentioned above, Körte excised a stricture of the common duct which he supposed was cicatricial. On microscopical examination it was found that the condition was carcinomatous. There can be no doubt that a stricture which, to the naked eye, appears merely fibrous may be undoubtedly carcinomatous; cases in support of this statement are related by Krokiewicz, Körte, and others.

### 4. CARCINOMA OF THE COMMON BILE-DUCT.

Cancer of the bile-ducts is rare; the common duct is affected far more frequently than the hepatic or cystic ducts. It is not improbable that the disease is more common than the records seem to show, for the resemblance in certain cases to a simple fibroid thickening of the duct is very close. It is well known that in a very large proportion of cases of carcinoma of the gall-bladder the condition is associated with, and its onset determined by, gall-stones. The dependence of cancer of the common bile-duct upon the prolonged irritation of stones is far less clear. In 40 cases

<sup>6</sup> THE LANCET, Dec. 8th, 1883, p. 988.

<sup>7</sup> THE LANCET, March 23rd, 1895, p. 743.

<sup>8</sup> Medical Chronicle, October, 1898, p. 28.

<sup>9</sup> Beiträge zur Chirurgie den Gallenwege, p. 227.

<sup>10</sup> Inaugural Dissertation, Marburg 1888.

<sup>11</sup> Inaugural Dissertation, Greifswald, 1888.

<sup>12</sup> Deutsche Medicinische Wochenschrift, 1902, p. 739.

<sup>13</sup> Practitioner, January, 1899, p. 18.

<sup>14</sup> Transactions of the Pathological Society, vol. xxiv., p. 250.

<sup>15</sup> Brit. Med. Jour., 1880, vol. ii., p. 200.

<sup>16</sup> THE LANCET, Nov. 5th, 1887, p. 916.

<sup>17</sup> Beiträge zur Chirurgie den Gallenwege, p. 341.

<sup>18</sup> La Clinica Moderna Italiana, 1901, No. 6.

collected by Devic and Gallavardin<sup>19</sup> gall-stones were found nine times, three times in the duct and six times in the gall-bladder. Rolleston in 80 cases found that gall-stones were referred to in 62 cases; in 23 it was noted that they were present, in 39 that they were absent. The growth may affect any portion of the duct, but though there is no point of predilection the ends of the duct seem to be more commonly attacked than the central portion. In 57 cases mentioned by Rolleston the upper end, the junction of hepatic, cystic, and common ducts was affected 25 times, the middle part 11, and the lower end 21 times.

The growth appears in two characteristic forms which may be described as the *projecting* and the *infiltrating*. In the first it is small in size and projects as a firm, white nodule into the lumen of the duct. When during an operation the duct is gripped between the fingers the impression that the lump is a calculus is very strong. The projecting mass may undergo ulceration and bleeding be caused thereby. In the second form the growth infiltrates the duct, converting it for a part, or for the whole, of its length into a rigid thickened tube. The stricture thus formed, especially when localised, may readily be mistaken for a cicatricial mass, the result of the healing of an ulcer. The infiltrating form is seen more commonly at the upper end of the duct, the growth spreading upwards into the cystic and hepatic ducts. The growth, as a rule, is small, but Brenner records an instance in which the tumour formed was as large as a hen's egg and Rolleston one of the size of an orange. The growth does not spread easily to surrounding parts, a few glands may be enlarged, and deposits at times are seen in the liver, but metastases rarely occur. In a very few cases the growth is palpable on examination of the abdomen. Behind the growth, of either form, all the ducts are dilated; this is a constant feature. The gall-bladder is dilated also. Devic and Gallavardin in 18 cases of growth in the common duct found the gall-bladder distended in 17 and in 14 cases of cancer at the confluence of the three ducts seven times. In one half the cases the gall-bladder is easily palpable.

The growth begins insidiously and increases steadily. The symptom to which it first gives rise is jaundice, which begins almost imperceptibly, deepens by the slowest degrees, and never recedes. As the colour deepens less bile is noticed in the stools and bile appears in the urine. There is progressive, unceasing emaciation, week by week strength is lost, and the body-weight decreases. In all recorded cases the very striking cachectic appearance of the patient is mentioned. Ascites may rarely appear from pressure upon, or involvement of, the portal vein. Splenic enlargement is infrequent. In some cases the conditions may be complicated by the presence of a stone in the duct. The symptoms then are anomalous. In only one recorded case, that of Stokes, has there been intermittent fever. Death may be due to gradual exhaustion, to hæmorrhage, to rupture of the gall-bladder, or to the onset of an acute infection in the duct.

*Treatment.*—Carcinoma of the common duct is generally unsuspected. Only one case, so far as I am aware, has been positively diagnosed. The treatment that is necessary will depend upon the position and extent of the growth. If the growth be limited, of the "projecting" type, the part of the duct in which it lies should be removed. A cylinder, one inch or more, must be cut away and if enlarged glands are found they also must be removed. After the removal of the growth an end-to-end approximation may be made, if need be, when the duodenum has been "mobilised" after the method of Kocher. Drainage should be provided for, the circular suture being incomplete at one part where a tube is introduced. If end-to-end anastomosis cannot be performed the distal end of the severed duct may be closed by ligature and the proximal end anastomosed with the duodenum. Or both ends may be closed and cholecystenterostomy performed.

If the growth be extensive, of the "infiltrating" type, resection of the duct may still be possible, but suture of the divided ends, then so far separated, is out of the question. Ligature of the ends and cholecystenterostomy may be performed. If the growth is irremovable a palliative operation—cholecystenterostomy—may give relief to the most urgent and most troublesome symptom, jaundice.

Dr. W. J. Mayo<sup>20</sup> makes some very practical remarks upon cases of operative defect of the common bile-duct. He

records two cases in which growths were removed from the common duct—in one end-to-end anastomosis was performed and in the other choledochoduodenostomy—and two cases in which a part of the duct was removed together with the cystic duct and the gall-bladder. Brenner reports<sup>21</sup> two cases operated upon by Jordan of Heidelberg. In both the cancer was unrecognised at the operation; both patients died and the condition of cancer of the duct was discovered post mortem. Kehr records one case of choledochectomy for cancer. I have only once had to deal with cancer of the common duct by operation. The growth involved the common hepatic, cystic, and common bile-ducts. The growth with the gall-bladder was removed and the distal end of the common duct, rendered mobile by freeing the duodenum, was sutured to the proximal cut end of the hepatic duct and drainage was instituted.

##### 5.—PRESSURE UPON THE DUCT FROM WITHOUT.

There are numerous conditions which cause blocking of the common duct by compressing it from the outside or by causing kinking. These conditions are: (a) chronic inflammatory enlargement of the head of the pancreas; (b) tumours of the pancreas (cysts, carcinoma, calculus); (c) ulcer or carcinoma of the stomach or duodenum; (d) peritonitis which results in adhesions around the duct; (e) enlargements of the lymphatic glands along the duct due to tubercle, lymphadenoma, or carcinoma; (f) stone in the cystic duct, causing compression of the duct; (g) tumours growing from the kidney, adrenals, retroperitoneal tissues, or elsewhere; (h) aneurysms of the larger vessels, aorta, superior mesenteric, hepatic; and (i) hepatoptosis, or nephroptosis causing kinking of the duct. The mere enumeration of these conditions is sufficient to show that any detailed consideration of them would carry one far beyond the scope of this paper. Most of the conditions cause an interference with the common duct only as a matter of secondary significance, and they do not call, therefore, for any surgical interference with the duct itself.

##### OPERATIONS UPON THE COMMON DUCT.

The operations practised upon the common duct are: (1) choledochotomy; (2) choledochostomy; (3) choledochectomy; (4) choledochoplasty; and (5) choledochenterostomy. In all operations upon the common duct it will be found of great advantage to place a sandbag under the patient's back, behind the liver, to make a free opening into the abdomen by Bevan's incision, or by Mayo Robson's incision (a curtailed Bevan's incision), and, if possible, to lift up the lower edge of the right lobe of the liver, to turn it upwards and outwards through the incision, and in this way to put the ducts on the stretch and to bring them near to the surface. As soon as the abdomen has been opened and the exact condition of things discovered gauze swabs must be packed in the wound to cover and to protect all the parts in the immediate neighbourhood of the operation area. A large swab is passed backwards into the upper part of the kidney pouch, a second downwards towards the pelvis on to the transverse colon, and a third inwards to the middle line over the gastro-hepatic omentum. Over these large swabs smaller ones are placed which are changed from time to time as they are soiled. The larger ones remain throughout the operation.

1. *Choledochotomy.*—The common duct may be opened in its first, second, or third portion.

(a) *In its first portion* the duct is exposed by freeing the adhesions around it and rotating the liver in the manner already described. The stone is then located and is gripped between the finger and thumb of the left hand. With the stone so held a suture is introduced into the duct on each side of it, the needle being passed into the lumen of the duct and picking up the duct walls at two or three points. The stone acts the part of a "darning ball" (the ball thrust into a stocking that is being darned), making the introduction of the needle easy. The two sutures are of catgut and are left long. The duct is held up by traction upon them and incised on to the stone. The edges of the duct may be seized then with long fine vulsellum forceps. The stone is extracted and any other stones that are easily felt are taken away also. The finger is then passed into the duct, an additional glove-finger being put on. The finger should be passed upwards to the bifurcation of the hepatic duct and downwards to the ampulla. It is with the finger alone that calculi can be detected; a spoon or a probe is quite useless. When all the

<sup>19</sup> Revue de Médecine, July, 1901, p. 575.

<sup>20</sup> Annals of Surgery, July, 1905, p. 90.

<sup>21</sup> Virchow's Archiv, 1899, vol. clviii., p. 253.

stones are abstracted pieces of gauze are passed into the duct and will bring away with them some fine sand. If there is much thick muddy sand in the duct it may be necessary to wash it out with saline solution introduced by a syringe which gives good pressure. During all these manipulations care must be taken to prevent the soiling of parts by the constant packing with, and changing of, the swabs. When the duct is clear it may be closed with a suture or may be drained. If the gall-bladder is healthy and the cystic duct patent the duct should be closed by a continuous suture. The removal of the gall-bladder if the cystic duct is patent is, in my opinion, most inadvisable in cases of stone in the common duct. The two stitches, which have been already introduced as retractors, are tied, the upper ends and the lower ends of one to the corresponding ends of the other; after tightening the ends are left long till a continuous suture is passed over them. The gall-bladder is then opened and drained.

In many cases of common duct stone the gall-bladder is small, shrunken, and buried in adhesions. It is useless, therefore, for purposes of drainage. In such circumstances a tube must be introduced into the common duct and passed upwards to the hepatic duct. When so introduced it is fixed by a single catgut stitch and the wound in the duct is closed up to the tube by one or two interrupted sutures of catgut; the gall-bladder, if the patient's condition permits, should then be removed. In many cases I have removed the gall-bladder first and then have slit up the stump of the cystic duct into the common duct at its origin, where a tube is introduced after the removal of the stones. In either case, whether the duct is directly drained or not, a split rubber tube is passed down by the side of the duct and beyond it into the upper part of the kidney pouch.

The operation of choledochotomy in a simple case where the gall-bladder, though containing stones, is reasonably healthy and adhesions are few and easily separable, offers no difficulties whatever and can be completed within half an hour. But in many cases adhesions are numerous, of old standing, and therefore tough, and in some cases fistulous tracks may exist between the gall-bladder and the duodenum or the colon. The conditions in the gall-bladder may have undergone what Mr. J. Rutherford Morison aptly calls the "natural cure," the stones may be securely isolated in the gall-bladder or imbedded in the liver, and the cystic duct may be closed. A patient with such a condition has suffered perhaps for a great many years. She is therefore old and not improbably is feeble in health. If a stone in the common duct be causing urgent symptoms its removal alone may be as much as the patient can bear. The "cured" condition of things in the gall-bladder must then be ignored, for to deal with them would involve the performance of cholecystectomy, partial hepatectomy, or the closing of fistulous openings in the bowel. If the stone in the common duct is removed and the duct cleared of sand or other stones and drained the patient, after recovery from the operation, suffers no further troubles.

It is for such cases—for cases where, owing to the patient's age or general condition or to the local conditions present, nothing more than the common duct operation is possible, that I have adopted the method I have elsewhere described as "rotation of the common duct." By this method the adhesions are ignored and the stone is yet easily removed. As soon as the condition of things is seen the left hand of the surgeon is passed transversely inwards in front of the pylorus and above the stomach, along the gastro-hepatic omentum. When the hand is well placed the thumb is passed downwards to the common duct, so that the gall-bladder remnant buried in adhesions then lies in the cleft between the thumb and first finger and the tip of the thumb is against the stone. The hand is now rotated, the fingers are flexed, and the hand and wrists are bent over to the patient's left. The stone in the duct is thus brought well up into the wound and is easily seen. Behind and around it swabs are placed, a stitch, or two stitches, introduced, the duct is incised, the stone is removed, a tube is placed in, fixed with a stitch, and the operation is complete. Rotation of the duct avoids the necessity of the free separation of adhesions and converts what might be an exceedingly formidable and prolonged operation into a simple, speedy, and therefore far safer one.

There are cases in which when the stone or stones have been removed from the duct an immovable one is felt in the ampulla. This must then be removed through the duodenum in the manner to be mentioned presently. The wound in the duct may well be left open until the ampulla is incised and

a piece of gauze passed from the one opening to the other will bring away with it much fine sand.

(b) *In its second portion (retro duodenal choledochotomy).*—The retro-duodenal portion of the duct may be reached from behind by a procedure similar to that employed by Kocher in the "mobilising of the duodenum" as a preliminary to the performance of gastro-duodenostomy. This method was suggested at the German Surgical Congress in 1898 by Haasler. It had been found necessary three times in 13 operations for stone in the common duct. Oscar Bloch of Copenhagen has described a similar operation to this. In the very great majority of cases a stone which appears to be fixed in this portion of the duct can be moved upwards into the first portion. The operation is therefore very rarely necessary.

(c) *In its third portion (trans-duodenal choledochotomy).*—When the duodenum is opened the calculus may be found in the lower part of the duct or in the ampulla. If in the latter the ampulla is incised and the stone is extracted (McBurney's operation); if in the former the posterior wall of the duodenum over the duct is incised (Kocher's operation). The earlier steps in both methods are the same. The duodenum is exposed and if deeply placed or not easily accessible it may be freed by a vertical incision in the peritoneum to its right side. The stone is fixed by grasping it between the thumb and the fingers of the left hand. The duodenum is then opened by a vertical incision about one inch or a little more in length. The edges of this incision are grasped with fine vulsella and held apart. The greatest care is taken to prevent any leakage from the duodenum. The fluid therein is mopped up at once by swabs which are instantly discarded. As soon as the duodenum is well opened the stone is readily felt or, if in the ampulla, may be seen. If in the ampulla the edges of the opening are enlarged and the stone is taken away. If in the duct the walls of the duodenum are incised over the stone or the duct is slit up on a director passed into the ampullary orifice and the stone dislodged. In both cases a further search for other stones is necessary, the finger being passed upwards into the duct, which readily admits it. If the duct has had to be divided freely the incision may be closed by suture or the opening left patent, the operation being then known as choledochoduodenostomy.

2. *Choledochostomy* is performed when the common duct is dilated so as to form a cyst. In most cases the swelling has been mistaken for the gall-bladder. (For records of cases see "Gallstones and their Surgical Treatment," second edition, pp. 418 *et seq.*)

3. *Choledochectomy* is performed in cases of malignant disease or when in the removal of the stone the duct has been torn across. Cases are recorded by Doyen, Mayo, and myself. The ends of the duct may be approximated, or the distal end closed, and the proximal implanted into the duodenum, or both ends may be closed and cholecystenterostomy performed, or the defect in the duct may be repaired by a flap taken from the stomach.

4. *Choledochoplasty.*—I have once performed a plastic operation upon the common duct in a case of simple stricture of the duct, slitting the duct up longitudinally and stitching it transversely; an opening was left for drainage. The result has been very good. Kehr has repaired a defect in the common duct by turning a seromuscular flap upwards from the stomach.

5. *Choledochoduodenostomy* is performed when there is an impermeable stricture of the common duct which is greatly dilated behind the obstruction. A number of cases have been recorded since Riedel first performed the operation in 1888. Kocher's method of choledochoduodenostomy between the third portion of the duct and the second portion of the duodenum has already been mentioned.

In cases where the common duct is drained it is desirable to keep in the tubes for at least a fortnight. An examination of a post-mortem specimen of common duct obstruction by stone will show the evidences of cholangitis which may extend upwards to the minute ducts in the liver. To give time for these ducts to rid themselves of infection is important. It is my custom in all these cases to administer urotropine to the patient immediately after the operation and for a few days before it if opportunity permits. In a case which I published in THE LANCET<sup>22</sup> the excretion of urotropine in the bile was proved by the rapid disappearance of typhoid organisms which were present therein when this drug was administered in ten-grain doses thrice daily.

Leeds.