Investigation and management of obstructive jaundice

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Abstract

Obstructive jaundice is a medical emergency. Local guidelines should be in place and widely publicized to facilitate timely investigation and management and avoid complications. Management must involve a multidisciplinary team that can offer a full range of investigative techniques (cross-sectional imaging, percutaneous procedures, endoscopic retrograde cholangiopancreatography).

Keywords obstructive jaundice; cholestasis; gallstones; choleangiocarcinoma; Klatskin tumour; pancreatic cancer; bile duct stones; biliary stricture; cholecystectomy

Jaundice can be defined as an increase in the concentration of bilirubin in serum leading to the clinical manifestation of yellowing of the skin and sclera (icterus). This may be secondary to partial or complete obstruction of the outflow of bile and its components from the liver into the alimentary tract (cholestasis). Cholestasis may occur within the liver in the hepatic ductules (hepatic cholestasis) or in the extrahepatic bile duct system due to mechanical obstruction (extrahepatic cholestasis or obstructive jaundice).

Obstructive jaundice is not a definitive diagnosis and early investigation to find the cause of cholestasis is of great importance because pathological changes (e.g. secondary biliary cirrhosis) can occur if obstruction is unrelieved.

This contribution discusses the initial investigative process, potential diagnoses and therapeutic alternatives that may be encountered.

Classification

Pre-hepatic jaundice is due to increased bilirubin load on the hepatocytes (usually due to haemolysis). The increase in serum bilirubin is mainly unconjugated and the concentrations of transaminases and alkaline phosphatase are normal.

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Hepatic jaundice is failure of excretion of bile from the hepatocytes. Conjugated serum biliubin is raised. Transaminases are raised, dependent on the cause (e.g. viral or drug-induced).

Cholestatic jaundice is caused by failure of formation of bile or of bile transport. This may occur at any point from the hepatocyte to the ampulla of Vater. Serum conjugated bilirubin is elevated and alkaline phosphatase is increased. Cholestatic jaundice may be intra- or extra-hepatic (*vide infra*).

Investigations

Careful history-taking, clinical examination and investigations point to the cause of jaundice (Table 1). Serum biochemistry confirms the diagnosis of jaundice with an elevated serum bilirubin, usually ≥40 μmol/l when detectable clinically. An obstructive pattern is recognizable in the other liver function tests i.e. a high alkaline phosphatase and only mild increase in the concentration of transaminases (Table 1).

Having diagnosed a cholestatic picture, the priority is to establish whether there is biliary dilation, which differentiates extrahepatic cholestatic jaundice, or obstructive jaundice from intrahepatic causes. This is most easily assessed by ultrasonography.

Imaging

Ultrasound:

- shows the size of the bile ducts
- defines the level of the obstruction
- identifies the cause (in some cases)
- gives other information related to the disease (e.g. hepatic metastases, gallstones, hepatic parenchymal change).

The level of biliary obstruction will help to guide further investigation (Figure 1) if the cause of the obstruction is not apparent.

Distal obstruction – dilation of the intra- and extrahepatic bile ducts is present; most patients will have a gallstone in the common bile duct (see below) or carcinoma of the head of pancreas (see below). Both diagnoses may be apparent on ultrasound, but often the distal bile duct is poorly seen with ultrasound due to overlying bowel gas.

Distal obstruction may also be caused by a duodenal or ampullary lesion. These can be investigated by duodenoscopy and biopsied if directly seen.

Proximal obstruction – proximal biliary dilation usually results from obstruction at the porta hepatis and is recognized by dilation of the intrahepatic ducts without enlargement of the distal common bile duct. This is an uncommon finding, but is the classical appearance of a hilar cholangiocarcinoma (Klatskin tumour). Other disease processes may simulate this appearance. Local infiltration of a gallbladder tumour, severe inflammation in the gallbladder causing compression of the extrahepatic biliary tree (Mirizzi syndrome) or metastatic malignant disease in and around the porta hepatis may give rise to hilar biliary obstruction. Further cross-sectional imaging is required to elucidate the cause.

Dilated common bile duct only – isolated dilation of the common bile duct may be present with abnormal liver function in certain special cases.

Presentation of jaundice

	Stones in common bile duct	Malignancy	Drug-induced cholestasis	Acute viral hepatitis
History	Dyspepsia, biliary colic	Nil	Drug history (present and last 6/12 months)	Transfusions, injections, contacts
Pain	Colic, epigastric to back (episodic), none	Epigastric to back (constant), none	None	Discomfort in right upper quadrant, none
Weight loss	Slight±	Remorseless, none	Slight±	Slight±
Pruritis	±	+	+	Transient
Investigations				
Bilirubin (serum; mmol/l)	50–150	Steady rise to >200	Variable	Variable
Urobilinogen (urine)	+	–	–early	–early (+late)
Alkaline phosphatase (serum; × normal)	>3×	>3×	>3×	<3×
Aspartate aminotransferase (serum; × normal)	<5×	<5×	>5×	>10×
White cell count (differential)	↑/Normal (↑polymorphs)	↑/Normal	Normal	↓(↑lymphocytes)
Ultrasound	Gallstones ± dilated ducts	Dilated ducts ± mass/ stricture	Normal	Splenomegaly

Table 1

A common bile duct stone may cause intermittent jaundice and dilation of the bile duct due to a 'ball valve' effect. Fluctuating liver function tests may be observed; if they are resolving, a stone may have been passed or become disimpacted at the ampulla of Vater. The resultant pressure changes in the bile duct will be intermittent and not sufficient to cause intrahepatic dilation. Magnetic resonance cholangiopancreatography (MRCP) is indicated if a stone is not visible on ultrasound.

In hepatic parenchymal disease (e.g. cirrhosis), fibrosis may prevent the intrahepatic bile ducts dilating, resulting in dilation confined to the extrahepatic bile ducts. The question then is whether the derangement of liver function is related to the liver disease or extrahepatic disease; MRCP may be helpful.

The 'normal' common bile duct is often quoted as <7 mm in diameter. Mild dilation of the bile duct (<10 mm) may be insignificant if liver function tests are normal. Patients may be described as having a 'baggy' bile duct particularly post-cholecystectomy. The important factor is derangement of liver function. MRCP is usually required to exclude stones in the common bile duct (Figure 2).

Biliary dilation is absent – the cause of jaundice is assumed to be other than extrahepatic cholestasis.

Metastatic hepatic disease is in this category, but the tumour required to cause clinical jaundice is extensive and other causes should be sought.

The jaundiced patient with liver metastases may have biliary obstruction due to infiltration and obstruction of the bile ducts at or near the porta hepatis. The intrahepatic ducts are dilated but attention may be drawn to the metastases, missing the opportunity to palliate symptoms by relieving the obstruction.

Other signs of liver disease may be apparent on ultrasound. The echo-texture of the liver, splenomegaly, ascites, and signs

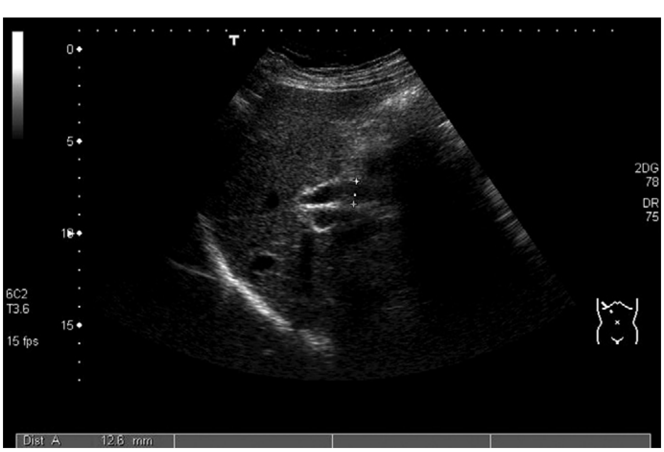


Figure 1 Ultrasound showing dilation of the common bile duct (marked by cursors).

Figure 2 MRCP showing stone in the common bile duct (arrow).

of portal hypertension may be present, indicating chronic underlying liver disease as the possible cause.

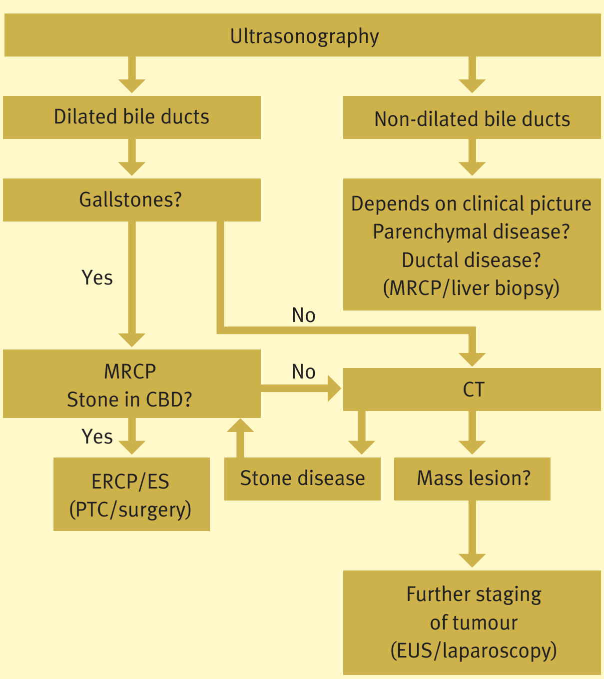
Further imaging is unlikely to be helpful in the absence of biliary dilation or other abnormality on ultrasound, and investigation should focus on the medical causes of jaundice. Ultrasound assessment may be suboptimal in some cases (e.g. obesity) and further imaging with CT or MRCP is appropriate.

Biliary stenting to relieve obstruction and a biopsy for histological confirmation may be undertaken if metastatic disease is present. Liver biopsy Is contraindicated if there is an obstruction of the bile duct due to the risk of a bile leak and subsequent biliary peritonitis. A biopsy of the primary lesion is therefore often taken during placement of a biliary stent.

Figure 3 shows an imaging algorithm for assessing jaundice.

Further imaging: spiral CT and MRI has revolutionized the management of obstructive jaundice. After initial ultrasound, cross-sectional imaging is used to gain further information for staging (see below) or if more specific assessment is required. The choice depends on indications, local availability and expertise. Either can be used for tumour staging, but identifying non-calcified gallstones (the majority) on CT is difficult, so MRCP is preferred if stones in the common bile duct are suspected. MRCP gives exquisite assessment of the pancreatic duct and bile ducts without the risks inherent in endoscopic retrograde cholangiopancreatography (ERCP), rendering diagnostic ERCP virtually obsolete.

Assessment of jaundice



MRCP: Magnetic resonance cholangiopancreatography; ERCP: Endoscopic retrograde cholangiopancreatography; ES: Endoscopic sphincteropapillotomy. PTC: Percutaneous transhepatic cholangiography; EUS: Endoscopic ultrasound; CBD: Common bile duct.

Figure 3

Staging

Pancreatic cancer retains a very poor prognosis even after surgery. Surgery is the only hope of cure, but long-term survival is only about 10–15%. The role of imaging is to identify potentially resectable tumours and to exclude those patients from surgery who either have unresectable disease or else would have an inevitably poor prognosis, thus avoiding the morbidity associated with an unsuccessful attempt at surgery and shortening an already poor life expectancy. Obstructive jaundice tends to be a late feature of the disease and up to 80% of cases presenting with jaundice will be unresectable.

Staging CT or MRI must precede endoscopic intervention. The rate of acute pancreatitis demonstrated on CT after ERCP is ten times higher than its rate of clinical manifestation. Even an uncomplicated ERCP can cause inflammatory changes, rendering interpretation of resectability (and even diagnosis) impossible. All cases of suspected pancreatic malignancy should be discussed with a specialist centre and the multidisciplinary team (surgeons, gastroenterologists, radiologists) before intervention.

Preoperative drainage of the biliary tree: the authors favour surgery without preoperative drainage of the biliary tree but, if preoperative drainage is required due to severe jaundice or surgical delay, the preferred technique is percutaneous. Decompression is achieved by placement of a short metal stent under ultrasound guidance, fluoroscopy or a combined procedure. Occasionally, an external drain may be placed, although the rate of infective complications is higher for this technique. Though uncommon, the authors have encountered tumours that were initially staged as resectable, but have been rendered inoperable due to endoscopic intervention. Other surgical units practise preoperative drainage by ERCP and stents, but management must be based on local expertise and results.

Contrast-enhanced multislice CT is the radiological investigation of choice in most UK centres for assessment of biliary malignancies. Contrast agents (p.o., i.v.) are used and imaging done in unenhanced, venous and arterial phases. CT and MRI tend to overestimate resectability rates, underestimating the extent of the disease (Figure 4).

Staging laparoscopy has been reported to exclude a further 10% of potentially resectable patients from open surgery. Various strategies have been employed, from laparoscopic examination of the abdominal cavity to more radical dissection attempting to mimic resectional surgery. The addition of laparoscopic ultrasound to image the relationship of the tumour to the superior mesenteric artery, mesentery vein and portal vein may increase sensitivity for unresectability. The additional rate of exclusion from surgery with this technique depends on the quality of the cross-sectional imaging.

Endoscopic ultrasound can further evaluate relationships to vascular structures. It may help define benign lesions mimicking cancer (e.g. sclerosing pancreatitis) if there is diagnostic doubt. Endoscopic ultrasound enables the aspiration of cysts and biopsy of solid lesions, but is operator-dependent and not widely available.

Figure 4 CT showing tumour encasement of coeliac axis branches by pancreatic cancer (arrow).

Hilar cholangiocarcinoma (Klatskin tumour) is often difficult to detect on CT, although the biliary dilation it causes is often easily visible. This appearance on imaging can also be attributed to metastatic disease at the porta hepatis, so a CT of the chest, abdomen and pelvis is essential to look for primary malignancy and to assess resectability of the hilar lesion. Staging laparoscopy may help to detect intra-peritoneal spread.

Suspected common bile duct stones: if distal bile duct obstruction is confirmed on ultrasound, and a duct stone suspected (but not confirmed), an assessment of the degree of suspicion for malignancy must be made. If doubt exists, MRCP should be done to confirm a stone before proceeding to ERCP (Figure 2). Common bile duct stones may pass spontaneously and the liver function tests improve. Staging CT should be done to exclude a neoplasm if MRCP does not show stone disease and hyperbilirubinaemia persists.

Management

Bile duct stones

Several options are available after investigations have revealed bile duct stones; selection depends on:

- physical condition
- comorbidity and medical history
- previous attempts at intervention
- if the patient has had a cholecystectomy
- availability of equipment/theatre/anaesthetist/expertise of interventionist
- patient preference.

ERCP ± sphincterotomy: ERCP has a success rate of about 90% and a low complication rate in experienced hands, but risks such as bleeding from damage to a branch of the superior pancreaticoduodenal artery (1–2%), perforation (1–2%), acute pancreatitis (2–5%; severe 0.1%) are inherent to the procedure. Technical problems such as failure to cannulate/identify the ampulla of Vater and anatomical anomalies (e.g. duodenal diverticulum) can cause difficulties.

After identification and cannulation of the ampulla of Vater, a cholangiogram is done to confirm anatomy and the stone. An adequate sphincterotomy is undertaken and the duct cleared using a balloon catheter or Dormia basket. Confirmation of duct clearance should be established with a radiograph.

If the stones are too large to clear, they can be crushed *in situ* using a mechanical lithotripter. These can be difficult to operate and can cause damage to the duct lining. Other techniques (e.g. chemical dissolution, extracorporeal shockwave lithotripsy, contact lithotripsy, laser under direct vision) have been attempted. These techniques are time consuming, require a high level of expertise and are not available outside specialist centres.

Placement of an endoscopic 'pigtail' stent can be achieved if multiple stones are present or stones are too large for extraction. This relieves obstruction and prevents impaction of stones at the ampulla of Vater. Stent insertion may be considered as a bridge to surgery in the fit patient, or potentially a long-term solution for the elderly, unfit individual. Stents will become blocked, necessitating a repeat procedure and stent change, and there is the risk of recurrent cholangitis and secondary biliary cirrhosis. Fitness should be carefully considered before discounting surgery, particularly with the advent of laparoscopic exploration of the bile duct.

ERCP may be considered the definitive treatment for some unfit patients, but most will proceed to cholecystectomy to remove remaining gallstones and prevent further complications.

Laparoscopic exploration of the common bile duct may be done through the cystic duct or common duct via a choledochotomy. Similar balloon catheters and Dormia baskets as those used for endoscopic removal of stones are employed under fluoroscopic guidance to remove common duct stones. Choledochoscopy and lithotripsy can also be done for larger stones.

This technique requires considerable laparoscopic expertise and is time consuming, so it is rarely the first-line treatment for common bile duct stones; these are usually removed at ERCP preoperatively and a laparoscopic cholecystectomy done electively. Laparoscopic exploration can be an alternative to open exploration if ERCP has failed or is not possible.

Open exploration of the common bile duct is done through a subcostal incision sited over the confluence of the cystic and common bile ducts (i.e. midline to midclavicular line). For fit individuals, this offers the advantage of a single intervention to deal with common duct stones and removal of the gallbladder, but may risk increased morbidity compared with the laparoscopic approach.

Technique – open exploration of the common bile duct involves:

- a small transverse incision
- dissection of Calot's triangle to define anatomy
- cholecystectomy
- transcystic exploration or supraduodenal longitudinal choledochotomy
- extraction of calculi by Fogarty balloon trawl, Desjardins forceps or Dormia basket
- confirmation of duct clearance superiorly and inferiorly by choledochoscopy and/or cholangiography.

In the case of choledochotomy, a T-tube is usually inserted to confirm clearance of the duct by a postoperative cholangiogram after at least five days. The T-tube is removed after two weeks, when an epithelialized tract has formed to avoid bile leak into the peritoneal cavity.

Most surgeons avoid exploration of a non-dilated common bile duct due to the risk of stricture formation.

Removal of common bile duct calculi may prove difficult by any of the above methods, for example:

- impacted stone when all efforts to remove it have failed
- multiple large stones
- inaccessible duct (e.g. previous surgery, unfit patient).

Surgical or percutaneous drainage procedures may be useful. Choledochoduodenostomy may be done by anastamosis of a dilated common bile duct to the duodenum. Alternatively, particularly in a non-dilated duct, a transduodenal sphincteroplasty is undertaken by first carrying out an open sphincterotomy and stone extraction, then suturing the mucosa of the duct and duodenum together to keep the lower end patent; these procedures are rarely undertaken.

Percutaneous stenting may be done in an unfit patient with common bile duct stones that cannot be removed by ERCP.

Malignant strictures

If there is a possible malignant cause for obstructive jaundice, the priority in a fit patient is to stage the disease process and assess the potential resectability. Several factors are crucial:

- nature of the primary lesion
- site, spread and extent, as well as local anatomical relationships of the lesion
- liver or peritoneal disease
- ascites
- lymphadenopathy
- fitness, comorbidity and preference of the patient.

Histological proof of malignancy is often not obtained before resection because of the risk of cancer seeding through percutaneous intervention preoperatively. If palliative treatment is considered, a definitive diagnosis is desirable for prognostic reasons and when contemplating chemotherapy or radiotherapy.

After initial staging and discussion with the multidisciplinary team, patients with a malignant cause of obstructive jaundice can be divided into two categories: non-resectable and potentially resectable.

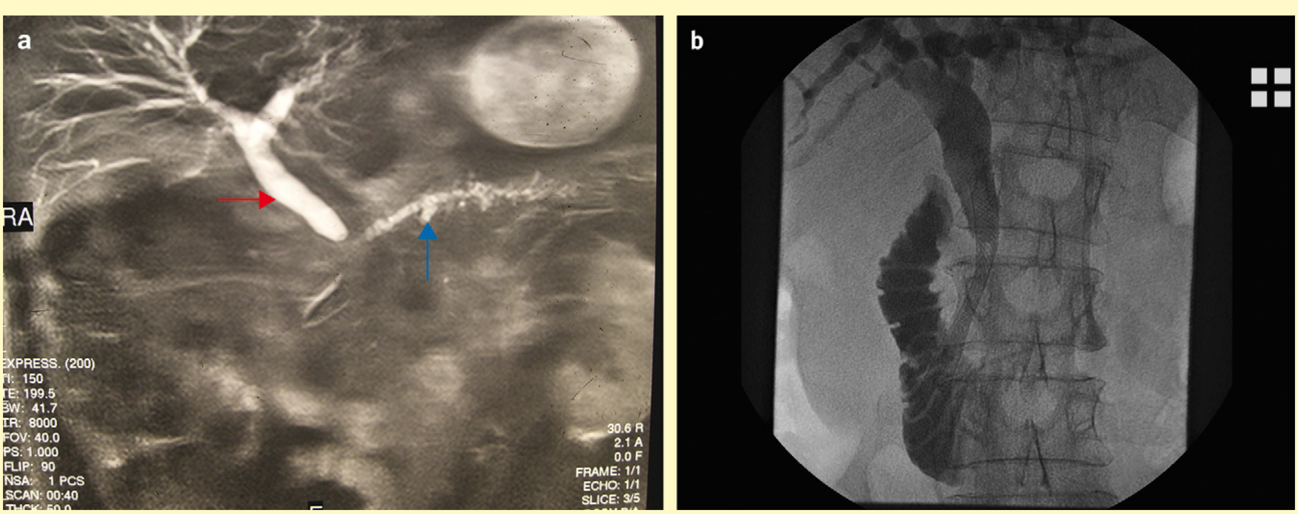
Unresectable cases are determined by the anatomy of the lesion, the fitness, comorbidity, and preference of the patient (e.g. the elderly, unfit patient who presents late with advanced disease). The insertion of a biliary stent is required in most cases to alleviate jaundice and palliate symptoms. There are various options to consider.

Choice of stent will depend on local expertise. Access to the biliary system by ERCP may be limited by the tumour because of local anatomical distortion or technical difficulties, so a percutaneous transhepatic or combined endoscopic approach may be necessary. The authors' favoured technique is percutaneous expanding metallic stenting which, although initially more expensive (the stent), requires fewer repeat interventions to maintain patency compared with endoscopic plastic stents.

A guidewire is passed radiologically through the malignant lesion; the stent is inserted over the guidewire under fluoroscopic guidance (Figures 5 and 6). An external drain is placed if the lesion cannot be traversed by a guidewire (e.g. due to oedema or technical reasons). This is important because, during attempted stent placement, infection may have been introduced into the obstructed system causing sepsis if left undrained, or alternatively a biliary leak may ensue, causing biliary peritonitis.

Access to the obstructed biliary tree may be a problem after failure of endoscopic stenting if infection is introduced and drainage is not achieved; percutaneous decompression of the biliary tree is urgently required.

The complications of stenting are shown in Table 2.



a MRCP showing 'double duct dilation' with pancreatic cancer. The common bile duct is shown by the red arrow and the pancreatic duct is shown by the blue arrow. **b** Same patient after percutaneous transhepatic cholangiography and insertion of Wall stent.

Figure 5

Figure 6 Percutaneous transhepatic cholangiography and bilobar stent of Klatskin tumour.

Potentially resectable cases should be undertaken only in a specialized unit serving large populations and undertaking the procedures regularly. Treatment depends on site of the obstructing malignancy and can be divided into distal or proximal lesions.

Distal lesions are tumours found in or around the distal common bile duct and include cholangiocarcinomas, ampullary carcinomas or carcinomas in the pancreatic head or adjacent duodenum. Whipple described the classic pancreaticoduodenectomy in 1935 and it remains the standard operation for most of these lesions). A pylorus-preserving procedure may be done in certain situations where adequate cancer clearance is possible (duodenal third part tumour, distal cholangiocarcinoma of the bile duct).

With the increased sensitivity of helical CT and the addition of staging laparoscopy, the unexpected finding of an unresectable tumour at operation is uncommon. The need for palliative surgical bypass has been largely superseded by percutaneous or endoscopic stenting. In a few cases, there will be unsuspected metastatic disease or vessel involvement by the tumour, and a gastrojejunostomy and/or choledochojejunostomy can be carried out with palliative intent. Histological proof of malignancy (usually by a frozen section) should be sought beforehand. Cholecystojejunostomy is not recommended because the cystic duct can be obstructed as disease progresses up the bile duct, particularly if there is a low insertion into the common duct.

Proximal lesions – high ductal lesions (including the Klatskin tumour involving the confluence of the hepatic ducts) may require extensive resection of the liver as well as resection of the entire extrahepatic biliary tree. Previously, excessive haemorrhage and liver failure would have deemed many of these tumours unresectable, but ultrasonic dissectors, argon coagulators and tissue glues (along with detailed understanding of liver anatomy) have facilitated tumour clearance (Figures 7 and 8).

A palliative bypass procedure is usually attempted if the tumour is unexpectedly unresectable. This involves finding a duct to form a enteric–biliary bypass above the tumour, often utilizing the left hepatic or segment III duct to form a hepaticojejunostomy.

An algorithm for the management of malignant strictures and masses is shown in Figure 9.

Complications of stenting

Immediate
- Sepsis
- Haemorrhage
- Acute pancreatitis
- Perforation and bile leak (peritonitis)

Late
- Recurrent jaundice due to:
  - Displacement
  - Sludging
  - Overgrowth by neoplasm
- Erosion into adjacent viscus

Table 2

Benign strictures

The commonest cause of benign biliary stricture is iatrogenic injury of the common bile duct during cholecystectomy; other causes are shown in Table 3.

The treatment is immediate surgical repair if an injury is identified at the time of cholecystectomy. Injuries are recognized at the time of surgery in only one-third of cases. If this is not possible, a large-calibre drain is placed in the subhepatic space and transfer arranged to a specialist centre for repair. Obstruction of the biliary tree may result from complete transection of the common hepatic duct or common bile duct with the surgical clips occluding the proximal ducts. Alternatively, devascularization of the common bile duct due to excessive dissection or thermal injury to the duct from injudicious use of diathermy may lead to stricture formation with delayed presentation.

Balloon dilation, stenting (endoscopic or radiological) or surgical reconstruction may be considered. Balloon dilation is complicated by restenosis and long-term results are poor.

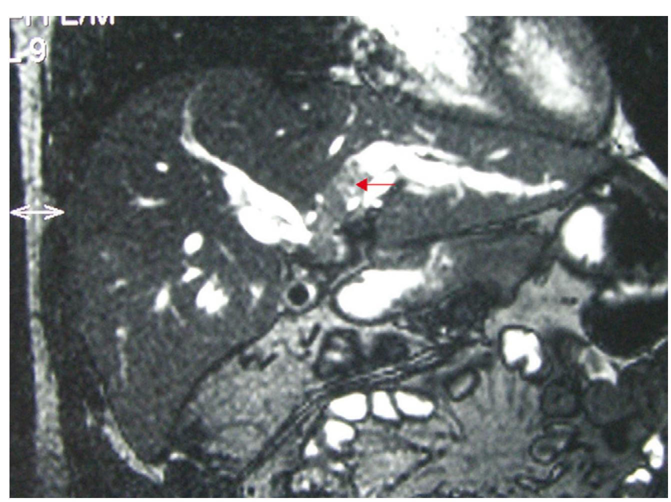


Figure 7 MRCP showing cholangiocarcinoma extending within the left-sided bile duct (arrow).

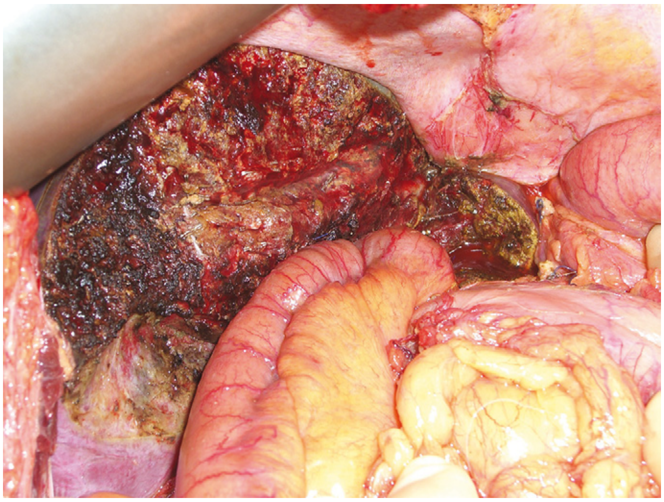
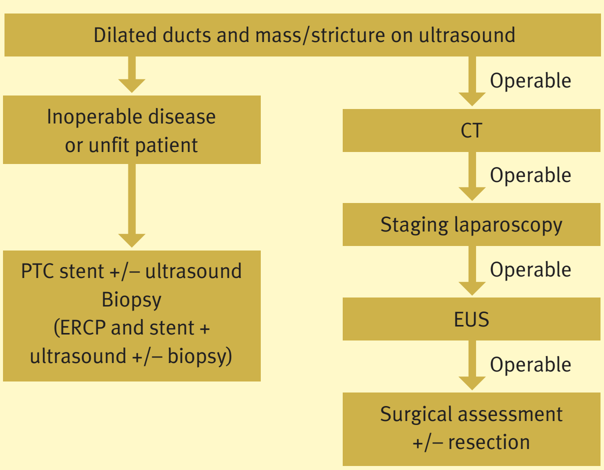


Figure 8 Intraoperative image of patient in Figure 7 after left hemihepatectomy and biliary reconstruction.

Stent placement in the biliary tree may be plagued by repeated blockage due to sludging or grit formation and also offers a nidus for infection and cholangitis. Surgical bypass by hepaticojejunostomy is the preferred definitive treatment in the fit patient. Chronic cholestasis predisposes to a high risk of secondary biliary cirrhosis; long-term monitoring of liver function should be undertaken to screen for this eventuality.

Management of a malignant stricture or mass



ERCP: Endoscopic retrograde cholangiopancreatography; PTC: Percutaneous transhepatic cholangiography; EUS: Endoscopic ultrasound.

Figure 9

Causes of benign biliary stricture

Trauma
Iatrogenic injury (cholecystectomy)

Infective
Parasitic infections (e.g. Echinococcus (hydatid disease), Ascaris (roundworm), Clonorchis (liver flukes))
Recurrent Oriental cholangiohepatitis (pyogenic cholangitis)—*Escherichia coli*
HIV cholangiopathy

Inflammatory
Pancreatitis acute/chronic
Sclerosing pancreatitis
Primary sclerosing cholangitis
Inflammatory pseudotumour
Gallstone-related (Mirizzi's syndrome)

Table 3

Post-interventional care

The monitoring of the following is crucial to successful outcome:
- fluid balance
- urine output and renal function
- drainage fluid output and appropriate replacement
- sepsis
- pain control.

Follow-up

Benign disease: as stated above, chronic cholestasis runs the risk of secondary biliary cirrhosis, and life-long follow-up may be appropriate after correction of a benign stricture due to the risk of recurrent stricture formation and sepsis. Patients with common bile duct calculi who have undergone definitive treatment may be discharged.

Malignant disease: the value of regular follow-up has been questioned due to the poor prognosis (even after resection); there are no treatments that offer a survival advantage in recurrent disease. Symptomatic patients may benefit from palliative intervention or chemotherapy and many surgeons offer follow-up.

An alternative strategy is fostering close links with the Primary Care Team and allowing an open appointment policy in the surgical clinic. Specialist nursing support can provide the patient with a 'safety net', and Macmillan nursing and hospice care are invaluable. ◆