The term ‘obstructive jaundice’ implies the partial or complete obstruction of the flow of bile and its components into the intestinal tract. Delayed flow or cholestasis may occur within the hepatic ductules and ducts (hepatic cholestasis), or there may be a mechanical cause in the extrahepatic biliary system (extrahepatic cholestasis). It is this latter group of conditions that are usually referred to as cases of obstructive jaundice.

The importance of early diagnosis and timely treatment of obstructive jaundice or cholestasis is crucial, since pathological changes (e.g. secondary biliary cirrhosis) can occur in the liver in unrelieved obstruction. The current investigation and management of obstructive jaundice is now the province of Multidisciplinary Teams (composed of surgeons, radiologists, pathologists, gastroenterologists and oncologists) and, in certain cases, is preferably undertaken in specialized centres. This contribution should be read in conjunction with Johnson, page 117.

**Investigation**

Jaundice is confirmed biochemically by an elevated serum bilirubin level (3–17 µmol/l). There is perhaps no better example of the impact that modern imaging has had on patient management than in the investigation of the jaundiced patient. The crucial question is: are the bile ducts dilated? This is because biliary obstruction leads to biliary dilatation. Initial imaging should be abdominal ultrasound.

**Ultrasound**

Ultrasound will:
- detect biliary dilatation
- may show the cause of an obstruction
- identify other information (e.g. presence of metastatic disease which may be required to direct subsequent management).

If the cause of obstruction is not apparent on the initial ultrasound examination, the anatomical level of the biliary dilatation (combined with the relevant clinical details) is helpful in deciding the likely cause and guides further investigation.

**Distal obstruction:** the vast majority of patients presenting with obstructive jaundice will either have carcinoma of the head of pancreas (Figure 1) or a common bile duct stone (Figure 2). In both pathologies, there is typically dilatation of both the intra- and extrahepatic bile ducts down to the level of the pancreas/distal common bile duct. The diagnosis may be apparent on ultrasound.
If a stone is detected in the bile duct, appropriate management follows, but if a mass is detected in the pancreas, attention focuses on whether or not this is a potentially operable tumour. If not operable (e.g. in the presence of liver metastases), then a biopsy can be arranged under ultrasound guidance for histological confirmation once the biliary obstruction has been relieved. A liver biopsy should not be performed prior to decompression, as this may result in a bile leak and subsequent biliary peritonitis. Patients with potentially operable tumours should have further staging with either CT or MRI prior to any endoscopic intervention, as this may cause difficulty in interpretation (Figure 3).

Distal obstruction may also be caused by a tumour at the ampulla or in the duodenum which can be biopsied if directly visualized at endoscopy.

**Proximal obstruction:** obstruction in the region of the porta hepatis results in proximal biliary dilatation, especially the intrahepatic ducts, with a non-dilated common bile duct distally. This is relatively unusual, but is the classical presentation of a hilar cholangiocarcinoma (Klatskin tumour, see later).

However, a similar appearance can also be seen with local infiltration from gallbladder pathology (either primary carcinoma or an inflammatory mass, Mirizzi syndrome), or from metastatic lymphadenopathy from a known or unknown primary tumour. These cases can be difficult to assess and further imaging with CT, MRI (Figure 4) or both may be required. Doppler ultrasound can delineate the relationship of a hilar cholangiocarcinoma to the vascular structures, which is important for assessing resectability.

**Dilated common bile duct only:** the ‘normal’ common bile duct diameter, is often quoted as being <6 mm. However, a ‘baggy’ common bile duct (>6 mm) is not an uncommon finding during routine ultrasound examination, particularly in patients who have had a cholecystectomy. However, it is rarely of any significance if the liver function tests are normal. In the jaundiced patient, obstructive dilatation of the common bile duct is usually associated with concomitant dilatation of the intrahepatic ducts, although there are some exceptions, which are described below.

Spontaneously resolving or fluctuating levels of jaundice are strongly suggestive of a common bile duct stone. A stone may have passed or disimpacted from the ampulla by the time of the ultrasound examination, so that the intrahepatic ducts are no longer dilated. In this situation, if a common bile duct stone is not seen on ultrasound examination, magnetic resonance cholangiopancreatography (MRCP, Figure 5) may be used to see if a stone is present.

In cases of distal obstruction and co-existing cirrhosis, the intra-hepatic ducts may not be able to dilate against the underlying parenchymal liver disease, resulting in dilatation confined to the extrahepatic ducts. Confusion over whether the derangement in liver function is related to the underlying liver disease or an element of extrahepatic obstruction may ensue. An MRCP is helpful in this situation.

**No biliary dilatation:** when no biliary dilatation is present, the cause of the jaundice is assumed to be of ‘medical’ origin. Liver metastases are often considered to be in this category, but very extensive tumour replacement of normal liver is usually required before the sheer bulk of the liver metastases cause clinical jaundice.
A more likely scenario in a jaundiced patient with liver metastases is for there to be biliary obstruction due to nodes/infiltration around the porta hepatitis, or a centrally placed liver deposit to be obstructing the ducts at their confluence near the porta hepatitis. In these patients, the ducts will be dilated, but attention may be diverted from the dilatation because of the metastases, and the opportunity for potential symptom relief through palliative stenting may be missed.

A micro- or macro-nodular heterogeneous liver, splenomegaly, ascites and varices can be detected on ultrasound and may indicate chronic liver disease as the underlying aetiology.

In many cases of ‘medical’ jaundice, not only will biliary dilatation be absent, but no other abnormality will be detected. Further imaging is rarely helpful, other than to guide a percutaneous liver biopsy for histological assessment in appropriate cases.

Ultrasound assessment may occasionally be suboptimal (e.g. obese patient) or when the head of the pancreas is obscured by bowel gas. In these cases where the findings are inconclusive, alternate imaging with either CT or MRI is appropriate.

Further imaging

CT or MRI is used after initial ultrasound assessment. The choice will depend on whether further information is needed and the availability of local expertise. Either technique can be used for tumour staging, through the use of CT is more common. MRI examination is usually limited to one area (upper abdomen), whereas CT can assess the whole body (chest, abdomen, pelvis) in appropriate cases. CT is poor at detecting gallstones (unless they are calcified), so MRCP is preferred when common bile duct stones are suspected. MRCP provides exquisite detail of both the pancreatic and bile ducts, effectively replacing the diagnostic aspect of endoscopic retrograde cholangiopancreatography (ERCP).

Tumour staging: pancreatic cancer has a very poor prognosis even after resection, though surgery is the only known cure. The role of imaging is to identify patients with a potentially curative tumour whilst aiming to avoid a futile attempt at surgery in a patient with a limited life expectancy.

Whichever imaging method is used, staging should be performed prior to any attempt at endoscopic intervention. Although the incidence of clinical pancreatitis following ERCP is low, signs of pancreatitis ‘radiologically’ on CT scanning are much more common (some inflammatory changes are seen even following an uncomplicated ERCP, Figure 3). These changes can make accurate staging impossible and even mask the tumour itself.

Furthermore, an episode of pancreatitis following ERCP can make surgery much more difficult. Although this is uncommon, the authors have encountered this scenario on several occasions in patients with potentially resectable tumours on initial staging referred from other centres. However, post-ERCP pancreatitis has made early surgical management impossible. Consequently, our policy in patients with potentially resectable tumours on staging investigations is not to use ERCP or endoscopic stenting preoperatively. When decompression is necessary, this is performed percutaneously with an external biliary drain using either ultrasound guidance, fluoroscopy or both. Endoscopic stenting is reserved for inoperable patients.

Both CT and MRI tend to underestimate the extent of disease. Most studies show that a significant minority (typically up to one-third) of patients believed to have operable tumours on staging investigation subsequently have unresectable disease at surgery. Conversely, cases thought to have inoperable disease on preoperative imaging have rarely been shown to be resectable. Indeed, it is a testament to the faith in imaging that it is difficult to prove this latter statement with reference to any recent literature, since surgeons rarely operate on patients if the imaging suggests the tumour is unresectable.

Hilar cholangiocarcinoma (Klatskin tumour) is difficult to detect, although the biliary dilatation that results is relatively easy to image. A cholangiogram either at ERCP or MRCP demonstrates the anatomy, MRCP being particularly useful at showing the proximal extent of involvement, which is used in the assessment of resectability. As noted above, metastatic carcinoma with disease at the porta hepatis can present a similar picture. A whole body CT scan (chest, abdomen, pelvis) should be performed in these patients prior to surgery to detect an alternative primary tumour or other evidence of metastatic disease.

Suspected common bile duct stones: when distal obstruction is present on ultrasound examination and common bile duct stones suspected (but not confirmed), the next step is usually ERCP. However, if there is any doubt that the obstruction may be due to tumour, staging investigations should be initially performed. Obstruction due to stone disease may resolve spontaneously. Therefore, in a well patient whose jaundice is improving, a non-invasive MRCP (to see if a stone is present) may be helpful.
Management

Bile duct stones
Once the cause of the jaundice has been confirmed as being due to common bile duct stones, then there are several options open to the clinician.

The choice of procedure will depend on:
• the clinical condition of the patient
• his age and intercurrent disease
• whether or not the patient has previously undergone cholecystectomy
• the clinical expertise available.
The options are discussed below and displayed in Figure 6.

ERCP and ES, when used in combination, have a success rate of around 90%, with a low complication rate in the hands of an experienced endoscopist. However, complications such as bleeding from damage to a branch of the superior pancreatico-duodenal artery (1–2%), perforation (1–2%), acute pancreatitis (mild: 3–5%; severe: 0.1%) can occur, as well as failure to cannulate the ampulla or inability to perform an adequate sphincterotomy. The complication and failure rate is not only operator-dependent, but may also be due to anatomical variations (e.g. peri-ampullary duodenal diverticula).

Once an adequate ES has been performed, stones may be allowed to drop out, but the duct should be cleared at the time of endoscopy. This is usually possible using a balloon catheter or Dormia basket (Figure 7), but occasionally the balloon may break and a stone in the basket may impact at the lower end of the ampulla. However, the duct can usually be cleared and this should be confirmed by a post-clearance radiograph of the duct.

If a stone is too large to pass, it may be crushed in situ using a mechanical lithotripter. However, this is often difficult to operate and can cause damage to the duct lining. In specialized units, other attempts to reduce the stone in size have included:
• perfusion with monoctanoin through a naso-biliary tube placed at the time of endoscopy
• external shockwave lithotripsy and endoscopically guided-ultrasound
• contact lithotripsy or laser.

Such techniques may involve the use of a ‘mother and baby’ scope to view the stone. This technique involves using a large ‘mother’ side-viewing duodenoscope, down which is passed a very small ‘baby’ end-viewing scope, which passes up the duct and allows visualization of the stone in the duct. Contact lithotripsy or other manipulations are then possible. However, this technique requires two very experienced endoscopists, takes a significant amount of time and is plagued by instrument failure. This and the other techniques are therefore seldom in routine use.

More commonly in cases of large or multiple irretrievable stones, a stent or ‘pigtail’ (Figure 8) catheter may be placed endoscopically to improve the passage of bile into the duodenum, relieve the jaundice and to prevent impaction of stones at the ampulla. This technique is especially useful in the elderly
able laparoscopic expertise and therefore are rarely the choice of procedure in patients presenting with obstructive jaundice. In most surgeon’s hands therefore, a patient who requests and is suitable for a laparoscopic cholecystectomy would undergo ERCP and ES preoperatively in order to clear the duct prior to surgery.

Open exploration of the common bile duct: in fit patients who are jaundiced and still have their gallbladder in situ, many surgeons will resort to definitive open cholecystectomy and a standard supraduodenal choledochotomy and duct exploration. This can be performed through a small transverse subcostal incision if this is sited correctly, i.e. medially over the confluence of the cystic duct and common bile duct. This allows all relevant pathology to be tackled in one procedure, saving the patient from multiple procedures and hospital admissions. The procedure is depicted in Figure 9.

Further drainage procedures are indicated in cases where the bile duct is:

- very dilated
- contains multiple stones
- drains poorly
- has a stone that is impacted at the lower end and all efforts to remove it have failed
- is difficult to totally clear for any reason.

Drainage procedures are especially useful in the elderly and include a choledocho-duodenostomy or transduodenal sphincteroplasty. The former procedure, which involves anastomosing the duodenum to the opened duct, is safe as long as the duct is dilated. However, if the duct is small or a stone is impacted at the lower end, then a transduodenal sphincteroplasty is more appropriate. This involves opening the duodenum opposite the ampulla, cannulating and then cutting into the ampulla in the line of the duct, opening the duct, removing any impacted stone, and suturing the mucosa of the duct and the duodenum together to keep the lower end patent. The duodenotomy is then closed.

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Laparoscopic exploration of the common bile duct during laparoscopic cholecystectomy: selective peroperative cholangiography will occasionally demonstrate the presence of unexpected common duct stones. Cholangiography is therefore strongly indicated in all patients who have:

- been jaundiced
- abnormal liver function tests
- a dilated common bile duct on ultrasound (>7–8 mm)
- a history of acute pancreatitis of gallstone aetiology.

Direct laparoscopic choledochotomy may be undertaken with incision of the common bile duct, extraction of calculi and insertion of a T-tube. Alternatively, when the stone is small and the cystic duct lumen negotiable, a Fogarty catheter or stone basket may be passed under fluoroscopic control down into the bile duct, where the stone can be either extracted or pushed through the ampulla. This method requires the stones to lie in the bile duct distal to the entry of the cystic duct.

These techniques are time-consuming and require consider-

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8 Drainage with pigtail stent for large retained stones (arrows) as visualized by ERCP.

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9 Procedure for open exploration of the common bile duct

- Careful identification of the anatomy of Calot’s triangle
- Routine cholecystectomy and cholangiography
- A supra-duodenal longitudinal choledochotomy
- Extraction of calculi with Fogarty balloon or Desjardins forceps
- Confirmation of clearance of the duct of calculi with choledochoscopy and/or cholangiography
- Avoidance of forceful papillary dilatation
- Insertion of a T-tube for decompression of the biliary tree and on-table radiological confirmation of the absence of residual stones. Avoidance of removal of the latex T-tube within 10 days of operation in order to avoid bile leaking into the peritoneal cavity.
Malignant stricture (Figure 10)

In patients who have a malignant cause for their jaundice, the initial decision is to ascertain the resectable potential of any lesion. This will depend on the nature, site, extent or spread of the malignant lesion as well as the age and co-morbidity of the patient. Radiological signs of irresectability include:

- liver or peritoneal metastases
- ascites
- enlarged lymph nodes
- a lesion that involves the vessels (especially the superior mesenteric vein and portal vein, Figure 11).

All patients’ cases should be discussed at a Multidisciplinary Team meeting and a management strategy proposed for each individual case depending on the radiological staging of the case and the age and co-morbidity of the patient. Histological confirmation of malignancy may not be possible in all patients preoperatively for fear of cellular spread, but this should be sought in all patients who do not undergo definitive resectional surgery, both for prognostic reasons and if chemotherapy is to be considered.

Non-resectable cases: the most common clinical situation encountered is that of an elderly, frail patient with co-morbidity and an unresectable neoplasm. The insertion of a biliary stent is required in these cases. There are different forms of stent in current use and different approaches for insertion.

**Route of insertion** – endoscopic stenting is preferred to percutaneous transhepatic stenting, especially for lower bile duct or pancreatic lesions. However, due to angulation at the site of the tumour, this approach is not always successful and in these cases (and in patients with proximal lesions), a percutaneous transhepatic approach is adopted Figure 12).

**Type of stent** – following negotiation of the malignant structure with a guide wire, it is usually possible to place a biliary stent through the lesion by passing this over the guide wire. If there is any chance that future surgery may be possible, a plastic stent is inserted, either endoscopically or transhepatically. However, if resection is not an option, then an expandable metal or Wall stent is increasingly favoured.

In cases in which it is not possible to pass a transhepatic stent (because of oedema or other technical reasons), it is crucial to leave an external percutaneous catheter *in situ*, otherwise the...
patient is left with an obstructed system and a perforation in the biliary system and is liable to develop biliary peritonitis or an infected system. In patients where such an external drain is left in situ, the volume of bile must be recorded and, if copious, may need to be replaced with intravenous saline and potassium. Some patients may benefit by replacing the bile down a nasogastric tube. The bile draining externally should be cultured at regular intervals to ensure no infection ensues.

Complications of stenting are shown in Figure 13.

Potentially resectable cases: a more uncommon scenario is that of a younger, generally fit patient with a potentially resectable neoplasm as indicated by appropriate investigation. If a patient has been deemed as such by the Multidisciplinary Team, the treatment will depend on the site of the lesion. In broad terms, such a tumour may be considered to be either distal or proximal.

Distal lesions are tumours found in the distal common bile duct (cholangiocarcinomas, see Anthony, page iii), ampullary carcinomas or carcinomas in the pancreatic head or adjacent duodenum. The elective treatment is a standard pancreatocoduodenectomy (Whipple's procedure, see Cameron/Thomas, page 122). In certain situations (e.g. distal cholangiocarcinoma of the bile duct or certain ampullary carcinomas), a pylorus-preserving procedure may be appropriate. However, most surgeons would deem this inappropriate for carcinoma of the duodenum or pancreatic head, where greater clearance is required.

If, at operation, the neoplasm is unexpectedly found to be unresectable, the patient may benefit from a palliative choledochojunostomy and gastrojejunostomy (often termed a triple bypass due to the addition of an entero-enteroostomy). A cholecystojunostomy is less favoured due to the potential obstruction of the cystic duct by the expanding neoplasm, especially when the cystic duct insertion is low in the common bile duct.

With modern, precise investigation, the requirement for palliative biliary bypass for the above neoplasms is infrequent. When this is required, however, one must obtain tissue for histological examination, usually by means of a transduodenal biopsy or biopsy of an unexpected metastases. The use of adjuvant chemotherapy, (usually within the confines of clinical trials) will depend on the histological findings and oncology input.

Proximal lesions — for lesions sited proximally in the ducts system (including the Klatskin tumour involving the confluence of the hepatic ducts), if deemed operable, surgery should be undertaken in a specialized unit where liver surgery is undertaken regularly. Multidisciplinary facilities must be available and special equipment (e.g. ultrasonic dissectors, argon coagulator and laser) should be available for concomitant liver lobe resection when necessary. Central liver split procedures may be required with subsequent hepatodochojunostomy, and this can be performed with minimal blood loss and morbidity.

In patients who may be unexpectedly irresectable, a bypass procedure may be possible, utilizing an hepatodochojunostomy with a Roux-en-Y loop of jejunum being anastomosed to the left hepatic duct once it has been lowered from the liver plate, or anastomosis of the Roux loop to the segment III duct of the liver. This procedure requires an experienced hepatobiliary surgeon.

Benign stricture (Figure 14)

The most common cause of benign biliary stricture is damage to the common duct or its blood supply at the time of surgery (Figure 15). The best treatment is immediate reconstruction by an experienced biliary surgeon when such damage is identified at the time of surgery.

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
However, in delayed strictures, options include endoscopic balloon dilatation (bilioplasty), stenting or surgical reconstruction. Dilatation, although of value, does not often provide good long-term results, even when repeated on multiple occasions. Stenting is frequently complicated by sludging and cholangitis, requiring multiple admissions and subsequent control with antibiotics and stent replacement.

In cases where a metal Wall stent has been used, a plastic stent may be inserted through the blocked lumen of the metal stent, but the results are not entirely satisfactory. Surgical bypass (hepatodochojjunostomy) in the hands of an experienced hepatobiliary surgeon is therefore the preferred definitive treatment. Hence, it is wise not to insert a metal stent if reconstruction is to be considered, as these stents cannot be removed.

**Postoperative care**

Postoperative care of the jaundiced patient is a crucial part of their management. This must include:

**Monitoring (at time of surgery and in early postoperative period) of:**
- fluid balance
- urine output
- drainage fluid with replacement with saline
- sepsis
- pain control.

**Postoperative imaging when appropriate:** e.g. T-tube cholangiography, ultrasound scanning, etc.

**Appropriate follow-up**

**Benign disease** – patients with benign strictures should be followed up for life, looking for any evidence or risk of recurrent stricturing, sepsis or secondary choledocholithiasis. Patients with simple stone disease that has been dealt with definitively may be discharged.

**Malignant disease** – depending on the age of the patient and the nature of the treatment, careful consideration should be given to the appropriateness of attending surgical clinics indefinitely.

An alternative may be for a close liaison with the primary health care team and an open surgical ward admission policy. The involvement of a support team, Macmillan Nurses and Hospice care are invaluable and therefore only those younger patients who have undergone potentially curative procedures may need to be followed up in the surgical clinic. Oncological follow-up will depend on whether the patient has received chemotherapy or is involved in a prospective trial.

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**FURTHER READING**
