# ERCP—Therapeutic Technique

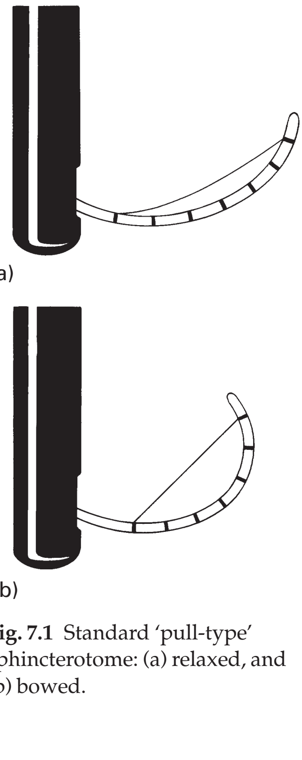
# 7

Endoscopic sphincterotomy and stone extraction was first reported in 1974. Satisfaction with the results and familiarity with the methods has led to widespread use and an expansion of indications. It has been followed by many other therapeutic techniques, including balloon dilatation of strictures, placement of stents and nasobiliary drains and increasing interest in the endoscopic management of pancreatic as well as biliary problems.

These procedures are amongst the most worthwhile that endoscopists attempt, but also the most difficult and hazardous. The indications and risks are reviewed in Chapter 8. It is essential to be properly trained and to have a volume of work sufficient to maintain and develop expertise. The therapeutic endoscopist must work in close association with surgical colleagues, forming a team approach which involves other specialists (including radiologists and pathologists). Complex procedures should be performed only in institutions with facilities adequate to deal rapidly with major complications, such as bleeding. Likewise, the importance of trained gastrointestinal (GI) nurses/assistants cannot be overemphasized. A minimum of two are required; one to ensure the patient's comfort and safety during the procedure, the other to assist the endoscopist and manage the complex equipment. The quality of this assistance can make the difference between success and failure, triumph and disaster.

## Biliary sphincterotomy

Sphincterotomy is performed with standard side-viewing duodenoscopes, appropriate sphincterotomes and an electrosurgical source. Electrosurgical units used for polypectomy are suitable; operating room electrosurgical units are unnecessarily powerful and can be hazardous if used without expert knowledge. Familiarity with a single source is probably more important than the precise specification. Most experts prefer equipment which allows the application of blended coagulation and cutting current. Regular maintenance of electrosurgery equipment and attachments is essential.



(a)

(b)

**Fig. 7.1** Standard 'pull-type' sphincterotome: (a) relaxed, and (b) bowed.

### Sphincterotomes

There are many varieties, most based on the original Demling–Classen ('pull-type') design (Fig. 7.1). The main differ-

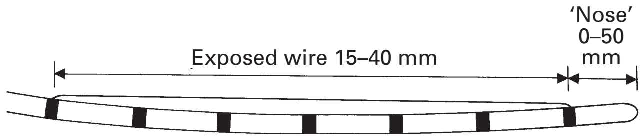



**Fig. 7.2** Length variables of sphincterotomes.

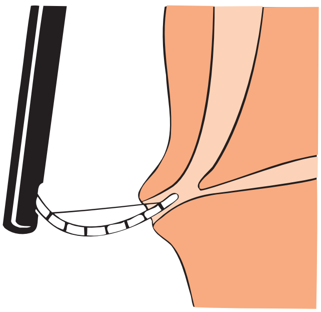


**Fig. 7.3** The sphincterotome bow is used to obtain the correct axis for bile duct cannulation.

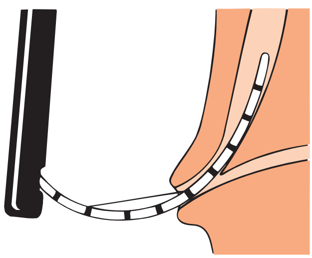


**Fig. 7.4** A long-nose sphincterotome in place.

ences are the length of the exposed diathermy wire, the length of the nose (Fig. 7.2) and the number of lumens.

A relatively short nose (5–8 mm) is convenient for cannulation. The tip can be engaged in the papilla without the wire interfering, and tension on the wire can be used to bow the tip into the correct axis (Fig. 7.3). This bowing facility is lost with sphincterotomes with longer noses (2–5 cm beyond the wire), since the diathermy wire (tensing on which causes the bow) inevitably remains inside the endoscope until deep cannulation has been achieved. The sole advantage of the long-nose sphincterotome is that cannulation is not lost while it is being withdrawn during the process of sphincterotomy (Fig. 7.4). Sphincterotomes without any protruding nose are sometimes used for pre-cutting; the diathermy wire extends into the tip of the catheter (Fig. 7.5).

The length of exposed wire in the original standard sphincterotomes was about 35 mm. Now versions are available ranging from 15 to 40 mm. Since most endoscopists perform sphincterotomies with only 5–8 mm of wire in contact with the tissues, it seems illogical to have a much longer wire, especially since it is essential to avoid touching and damaging the endoscope tip with the proximal end of the wire during the application of diathermy current. Unfortunately, a persistent problem of short-wire sphincterotomes is that most have a tendency to flip sideways, towards the 3 o'clock position (Fig. 7.6). The longer wire sphincterotomes (e.g. 35 mm) follow the natural curve of the

**Fig. 7.5** A 'pre-cut' sphincterotome.

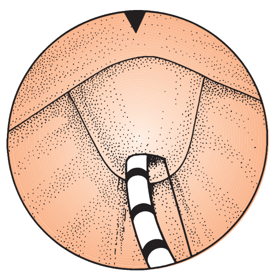


**Fig. 7.6** Bad orientation—a common problem with short-wire sphincterotomes.

endoscope and elevator, and are more likely to enter the papilla in the correct orientation (11–1 o'clock). All sphincterotomes behave better if 'trained' before use. The tip should be curled so that the wire enters and leaves the catheter along its left side (Fig. 7.7). Assistants must appreciate that sphincterotomes with short wires require less movement of the control handle to produce a bow; uninformed excessive 'tightening' will result in permanent kinking. Manufacturers are still seeking the magic formula for a '12 o'clock' sphincterotome. The diathermy wire can be monofilament or braided. It is suggested that bleeding is more commonly associated with the former, and pancreatitis with the latter. We prefer monofilament wires.

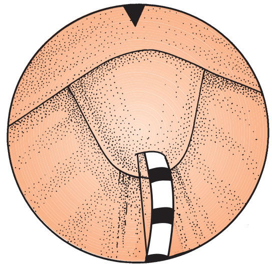


**Fig. 7.7** The correct position of the wire, which enters and leaves the *left* side of the catheter.

The original sphincterotomes had only a single lumen for the diathermy wire. Contrast injected down this lumen exits from the wire ports which is unhelpful unless deep cannulation has been achieved. Most sphincterotomes now have a second separate lumen for the injection of contrast (out of the tip) or for passage of the guidewire (Fig. 7.8). Some sphincterotomes have three lumens so that contrast can be injected without removing the guidewire.

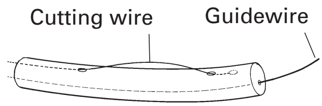



**Fig. 7.8** Double-lumen sphincterome.The channel for the guidewire (or contrast) insertion is separate from the cutting wire.

Sphincterotomes with a sigmoid shape (reverse bow) are available for patients with a Billroth II anatomy (Fig. 7.9). Unfortunately they rarely orientate as intended.

The needle-knife sphincterotome consists simply of a bare diathermy wire protruding 3–5 mm from the end of a catheter (Fig. 7.9). 'Push-type' and 'shark-fin' sphincterotomes are variants in which the wire is pushed out to form a bow (Fig. 7.9). These have little application.

## Patient preparation

Patient checks, preparation and sedation are broadly similar to those used for diagnostic ERCP. Detailed discussion of the aims, risks and alternatives must take place for the patient's consent to be truly informed. An information leaflet helps this process (see Chapter 3). Coagulation status is usually checked but the relevance of doing so has been questioned in the absence of any suggestive prior history.

Most experts give antibiotics prophylactically before therapeutic ERCP procedures, especially if there is any evidence of duct obstruction. Broad spectrum antibiotic coverage is appropriate. We use gentamicin with ampicillin (with vancomycin as a substitute in patients who are penicillin-sensitive). Other regimens are acceptable. We emphasize again the importance of well-trained assistants and of good disinfection practice. Other aspects of preparation, risks and indications are discussed in Chapters 3 and 8.

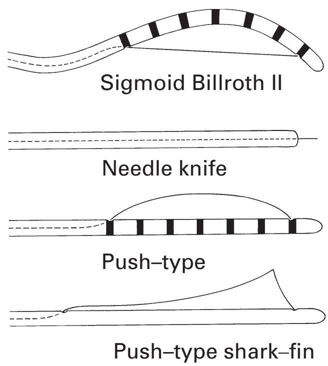



**Fig. 7.9** Specialized sphincterotomes.

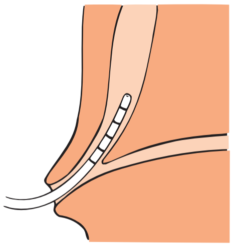
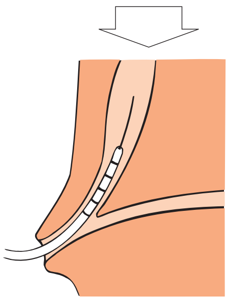
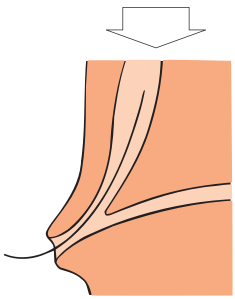


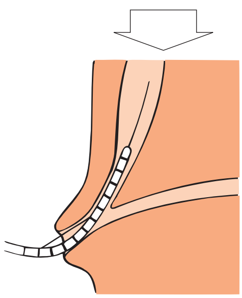
**Fig. 7.10** (a) When deep cannulation has been achieved . . .



(b) . . . the guidewire is inserted . . .



(c) . . . the catheter is removed . . .



(d) . . . and the sphincterotome is slid over the guidewire.

## Technique of biliary sphincterotomy

Most endoscopists use a standard catheter to perform cholangiography before considering and initiating sphincterotomy. When deep cannulation has been achieved (especially when it has been difficult), the catheter can be exchanged for a sphincterotome over a guidewire (Fig. 7.10).

Frequently nowadays we use a double-lumen sphincterotome for the initial cannulation, especially when the indication for sphincterotomy is strong. Deep cannulation is often easier to achieve with a sphincterotome than with a standard catheter; the tip is somewhat stiffer and the axis of approach can be changed by bowing the wire (see Chapter 6). The sphincterotome tip is inserted into the roof of the orifice, angling and bowing up slightly. Deep cannulation is usually best achieved by lifting the sphincterotome tip up with the elevator and *withdrawing* the endoscope somewhat, thus pulling the tip up into the duct axis (Fig. 7.11a–c). Attempting to achieve deep cannulation by simply pushing the sphincterotome is usually unsuccessful (and counterproductive), since the curved tip is forced around into the 'duodenal' wall of the bile duct or between mucosal folds in the sphincter itself (Fig. 7.11d). Confirmation that the sphincterotome is in the bile duct can be achieved by aspirating bile or injecting contrast. If pancreatography has been performed already, the position of the sphincterotome can be established by 'wiggling' it; the pancreatic duct will be seen to move (on fluoroscopy) if the tip is within it.

Once a sphincterotome is placed deeply in the bile duct and the indication for sphincterotomy is confirmed, it is time to check that the electrosurgical equipment is properly connected and to assess the anatomical constraints on the procedure. The size of the papilla, the size of any stone and the shape of the distal bile duct, can all determine the appropriate and safe length of incision. It is usually wise to place (or leave) a guidewire through the sphincterotome during the incision. This adds stability and prevents the embarrassment of falling out completely at a crucial moment. With standard guidewires there is some concern about leakage currents between the guidewire and the diathermy wire (particularly if a sphincterotome is reused and the channel has been damaged). We employ an insulated guidewire designed specifically for this purpose.

When everybody and everything is ready, the sphincterotome is withdrawn slowly under visual and fluoroscopic control until half of the cutting wire is visible outside the papilla. The wire should be pointing between 11 and 1 o'clock, preferably at 12 o'clock (Fig. 7.12). Sphincterotomy should not be performed if the wire cannot be placed within these limits, since perforation is more likely, especially if it swings laterally beyond the 3 o'clock position. One way to coax the wire anticlockwise is to push the endoscope tip more deeply into the duodenum whilst angling

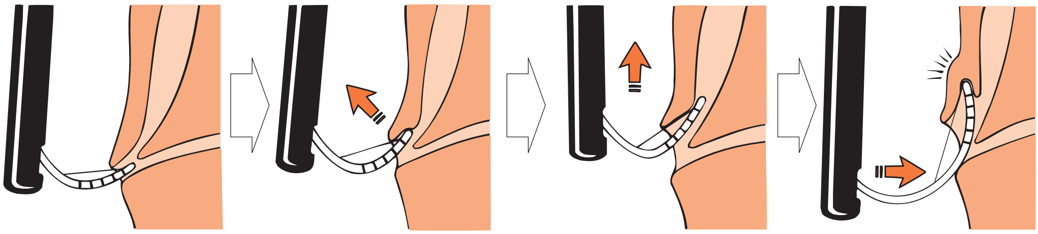


**Fig. 7.11** A sphincterotome can be used to achieve deep cannulation. (a) Insert the tip into the orifice . . . (b) . . . bow the sphincterotome to achieve the bile duct axis . . . (c) . . . and withdraw the scope. (d) Simply pushing usually does not advance the tip into the duct.

up; another is to 'lean' to the left while cutting. If good orientation cannot be achieved by manipulating the endoscope tip, it may be necessary to change to a different sphincterotome.

Experts have evolved different methods for the actual incision, but most use only slight bowing of the sphincterotome and a short (5–8 mm) length of wire in contact with the mucosa (Fig. 7.13). The principle of incision should be 'hot and slow', which is achieved by lifting the sphincterotome upwards progressively to provide the necessary pressure between the wire and tissue. The principal aim is to use the sphincterotome as a short hot wire, which is 'walked up' from the tip of the papillary orifice (Fig. 7.13). The roof of the ampulla peels open progressively and under control, to expose the distal bile duct mucosa.

Electrical settings vary with experts and electrosurgical machines. In general we use blended current at 50–60 W. However, the effectiveness and safety of sphincterotomy depends much more on the length of wire in contact with tissue (the current density) than the precise settings. The commonest error is to have too much wire inside the papilla (partially for

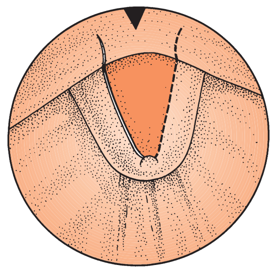


**Fig. 7.12** The correct sphincterotomy sector.

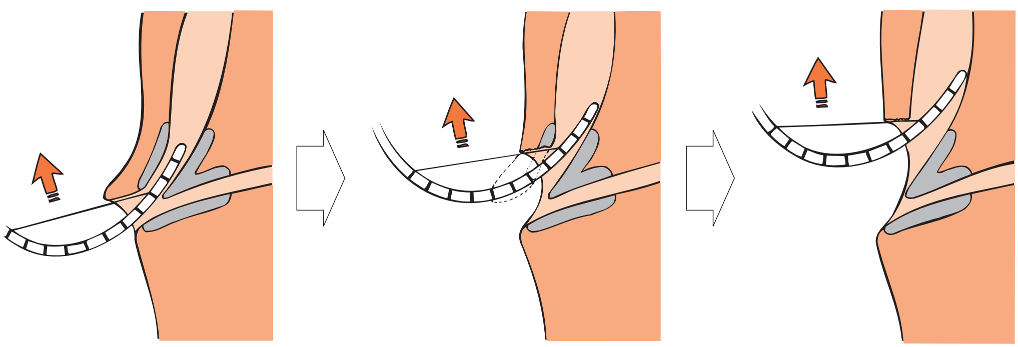


**Fig. 7.13** (a) Use an up-angle and a short wire contact . . . (b) . . . to cut the papilla in steps . . . (c) . . . and to 'walk up' the bile duct.

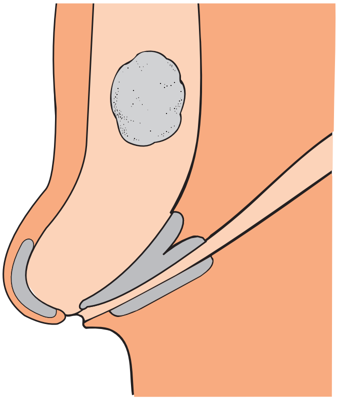


**Fig. 7.14** An easy sphincterotomy with a swollen papilla, a big duct and a 'square' termination.

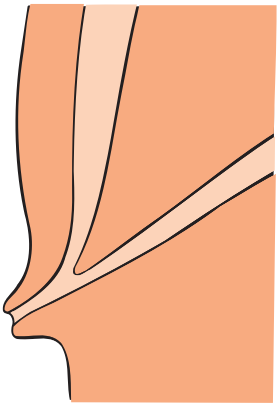


**Fig. 7.15** A more dangerous sphincterotomy with a small papilla and a small tapering duct.

fear of falling out), and to apply too much bowing tension; nothing will happen when current is applied — or only slow coagulation will result—which increases the risk of subsequent pancreatitis. There is then a temptation to increase the current settings and pressure, which will eventually and suddenly cut through the coagulated area at alarming speed with a risk of significant bleeding (the so-called 'zipper'). If nothing appears to be happening when current is applied during sphincterotomy, it is much better to reduce the length of wire in contact with the mucosa, which increases the current density and should initiate the incision.

### *Sphincterotomy size*

The size of the sphincterotomy should be tailored to the size of the bile duct and stone, and will be influenced somewhat by the shape and direction of the terminal bile duct in relation to the duodenum. The simplest, and probably safest, sphincterotomies are those performed in patients who have (or have had) a stone impacted above the orifice; the papilla is large and oedematous, and cuts easily without bleeding; the bile duct termination is often somewhat 'square' (Fig. 7.14). Sphincterotomy is more hazardous in patients with a relatively small papilla and a duct which is either not dilated or tapers distally (Fig. 7.15). Probably for this reason, the risk of perforation is significantly greater when sphincterotomy is performed for papillary stenosis.

### *When to stop cutting*

This is a crucial question, for which there is no easy answer. Some endoscopists rely on external landmarks, stating that it is safe to cut up to, but not beyond, the proximal hooding fold. Unfortunately, this fold varies in size and position, and bears little relationship to the underlying anatomy. More important is the size of the papilla itself, and whether or not any of the intramural bile duct can be seen from the duodenum. It is usually safe to cut as far as the duodenal wall; although this may produce an impressively long cut on the surface it may not reach the upper part of the biliary sphincter (Fig. 7.16). It is usually necessary to cut some more on the inside (Fig. 7.17). For this reason, measurements of sphincterotomy length are of limited relevance. Often the sphincterotome 'jumps' into the bile duct as the upper sphincter is broached, and bile flows out of the incision. *A good sign of an adequate sphincterotomy is when the partially bowed sphincterotome slides easily to and fro through the orifice.* The size of the orifice can be estimated with balloon-tipped catheters.

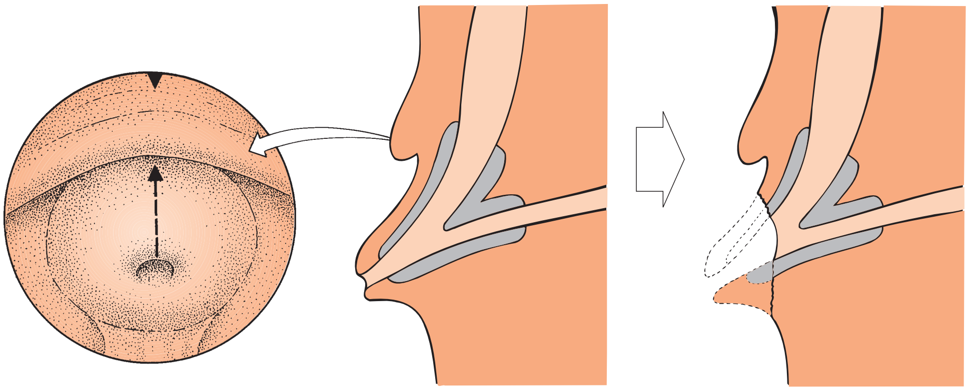


**Fig. 7.16** It is probably safe to cut down to the estimated duodenal wall —but the upper sphincter is not necessarily divided.

*Difficult sphincterotomies*

There are certain circumstances in which bile duct access and sphincterotomy may be more difficult, and where additional skills and judgement may be required.

*Peripapillary diverticula*. These are common, especially in elderly patients with duct stones. Cannulation and sphincterotomy may be extremely difficult when the papilla is actually inside the diverticulum. It can usually be found by following the longitudinal fold upwards (Fig. 7.18). The papilla is then teased out of the diverticulum by aspirating air to collapse the duodenum partially and/or by pressing firmly sideways (with a catheter or sphincterotome) to pull on the duodenal folds which flow into the diverticulum (Fig. 7.19). Sometimes it is necessary to use two accessories at the same time to hold the position while cannulating.

There is no evidence that sphincterotomy is more dangerous in the presence of a diverticulum. The direction of the bile duct is somewhat unpredictable (unless it can be seen traversing the floor of the diverticulum) but the sphincterotome, once inserted, necessarily follows the bile duct direction.

*Billroth II gastrectomy*. This turns the anatomy of the papilla 'upside down'. The diathermy wire needs to be pointing at 6 o'clock rather than 12 o'clock. Sigmoid-loop sphincterotomes designed to achieve this position do not always succeed in practice (Fig. 7.20). Our routine method is first to place a short 7 French gauge stent in the bile duct, which is easily done since cannulation is usually effected with a guidewire (see Chapter 6). A needle knife is then used to perform a cut-down sphinctero-

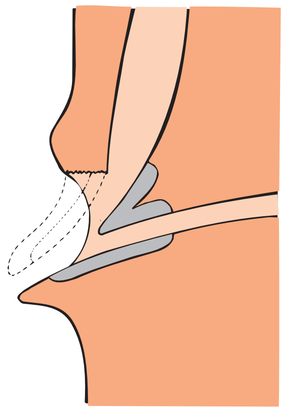


**Fig. 7.17** It is usually necessary to cut inside to ablate the biliary sphincter.

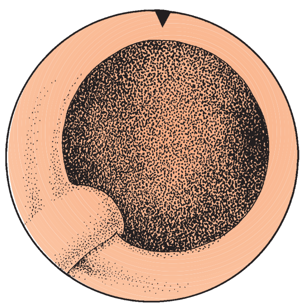


**Fig. 7.18** A papilla within the diverticulum—only the longitudinal fold shows.

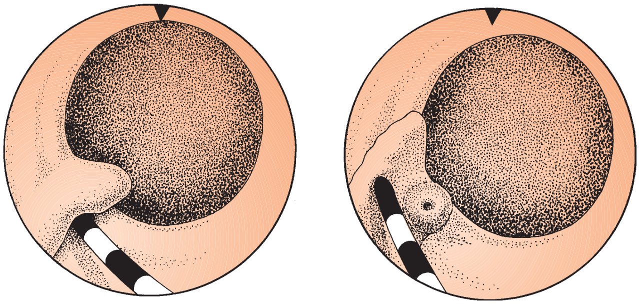


**Fig. 7.19** (a) Push with the catheter or sphincterotome to evert the papilla from the diverticulum . . . (b) . . . further pressure laterally brings the orifice into view.

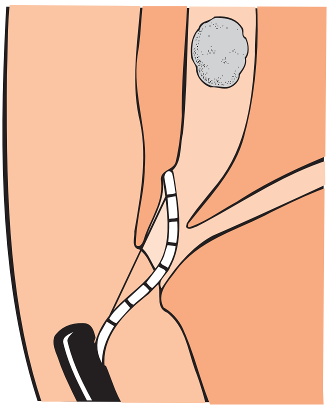


**Fig. 7.20** A sigmoid-loop sphincterotome used in Billroth II patients.

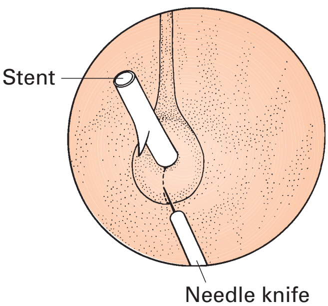



**Fig. 7.21** A needle-knife sphincterotomy over a stent in a Billroth II patient (papilla upside down).

tomy on to the stent (Fig. 7.21); the stent is then removed. Sometimes a standard (long-nose) sphincterotome can be persuaded into the correct position by deft endoscopic manoeuvring.

*Impacted stones*. These can cause the papilla to bulge into the duodenum and displace the orifice downwards (Fig. 7.22). Cannulation can be achieved with a bowed sphincterotome, 'hooking' the tip into the orifice (Fig. 7.23a). Alternatively, a needle knife can be used to incise the face of the papilla over the stone (Fig. 7.23b).

### *Pre-cutting*

Pre-cutting means starting an incision from within the common channel (or even pancreatic duct) without having achieved deep biliary cannulation. This can be done with a 'no nose' variant of the standard sphincterotome where the cutting wire extends to the tip (see Fig. 7.5), but the needle-knife sphincterotome (see Fig. 7.9) has become more popular. The bare wire is inserted into the papillary orifice and diathermy applied in short bursts with upward pressure in the 11–12 o'clock direction (Fig. 7.24). The bile duct orifice can usually be identified in the floor of this incision, either immediately or on a subsequent day (often most easily achieved by probing with the tip of a hydrophilic guidewire). A needle knife can be used also to make a direct 'drill' incision above the papilla into a dilated bile duct, or into the face of a papilla swollen by an impacted stone or choledochocele.

Pre-cutting is more dangerous than a standard sphincterotomy. It should not be used as a substitute for proper training and experience in standard techniques, and should be reserved for use by experts in high-risk patients with a strong indication for sphincterotomy when standard techniques have been

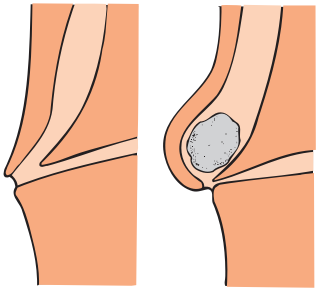


**Fig. 7.22** Compared to the normal anatomy, an impacted stone forces the orifice downwards.

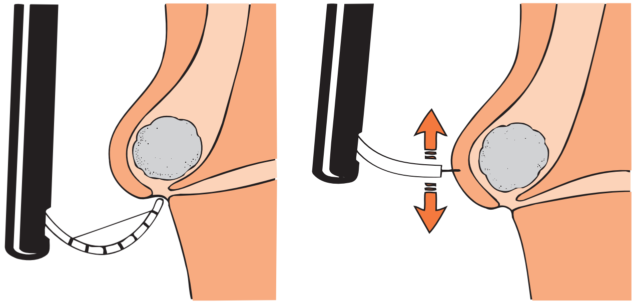


**Fig. 7.23** (a) Use a bowed sphincterotome to cannulate . . .

(b) . . . or a needle knife to incise over the stone.

exhausted. Pre-cutting cannot be recommended purely for diagnostic access to the bile duct.

*Combined endoscopic-radiological procedure*

An alternative to pre-cutting when standard sphincterotomy fails is to work over a guidewire previously positioned through the papilla (from above) by an interventional radiologist (or surgeon at cholecystectomy). The endoscopist can simply slide a double-lumen sphincterotome over the guidewire and pass it deep into the duct (Fig. 7.25). This procedure is more commonly employed for the insertion of stents and it is described in more detail on p. 160.

## Stone-extraction techniques

Although most stones (at least those <1 cm in diameter) (Plate 7.1) will pass spontaneously in the days or weeks following an adequate sphincterotomy, most experts prefer to extract them directly. This immediately clarifies the situation and reduces the risk of impaction, cholangitis and/or pancreatitis. Stones can be removed using balloon-tipped catheters or baskets.

### Balloon catheters

Balloon catheters are useful for extracting large numbers of relatively small stones and for sweeping the duct after extraction procedures to demonstrate that it is clear. Balloon diameters vary from 8 to 20 mm. The catheter shaft should be 7 French gauge (to provide some rigidity), with a central lumen for a guidewire or injection of contrast. Some balloon catheters have a third lumen which provides a useful injection port below the balloon.

The balloon catheter is advanced to the hilum of the liver.

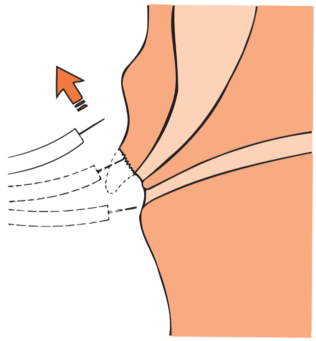


**Fig. 7.24** Pre-cutting up from the orifice with a needle knife.

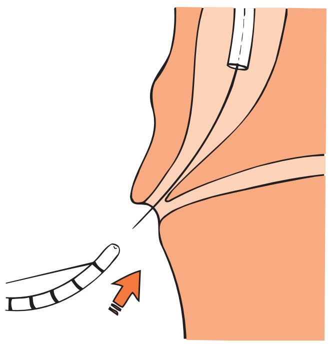


**Fig. 7.25** A combined procedure where a sphincterotome is slid over the percutaneously placed guidewire.

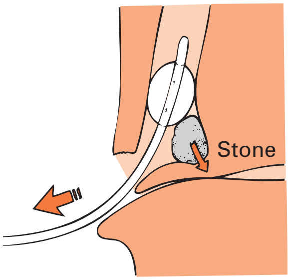



**Fig. 7.26** Difficulties may arise using a ballon for stone extraction: traction on the balloon may simply force the stone sideways against the duct wall.

This is best done over a guidewire, which makes it possible to run the balloon repeatedly down the duct without losing access. Contrast is injected and the balloon is inflated to the duct diameter, and then pulled back slowly under fluoroscopic control. It is important to check the location of the catheter tip before inflating the balloon since damage can be caused if it is inflated in a narrow duct (e.g. pancreatic duct, cystic duct or intrahepatic biliary tree). Many endoscopists prefer balloons to baskets because they cannot become impacted. Unfortunately, they are less effective for extracting larger stones, probably because the force is applied tangentially; the balloon may slip past the stone or simply force it sideways against the duct wall (Fig. 7.26). Balloons are also fragile and relatively expensive.

### Basket extraction

Basket extraction is more reliable in most cases. Standard baskets have four wires in an elongated diamond shape (Fig. 7.27). They are described by their length and maximum open dimensions, commonly 30 by 15 mm. Variants such as the three-wire and spiral baskets have not become popular. Baskets with a guidewire leader may be helpful when access is difficult.

The basket catheter is passed beyond the stone before it is fully opened, taking care not to push the stone into the intrahepatic ducts. It may be necessary to 'jiggle' the basket to trap a stone within it. The basket is then trawled down the duct in the fully or partially open position. Attempting to close the basket fully may eject the stone or, worse, impact the wires within it. Usually there is resistance when the basket and stone reach the sphinctero-tomy orifice; pulling harder simply drags the endoscope tip onto the papilla. The final stage of extraction is best done under fluo-roscopic control using a 'flip-down' manoeuvre. Holding the basket position steady at the papilla, the endoscope tip is angled sharply down and rotated to the right; this applies force in the correct biliary axis and is usually successful in extracting the stone (Fig. 7.28). When a stone cannot be extracted, it can some-times be embarrassingly difficult to release it from the basket. Try pushing the open basket high in the common hepatic duct and forcing a loop (Fig. 7.29).

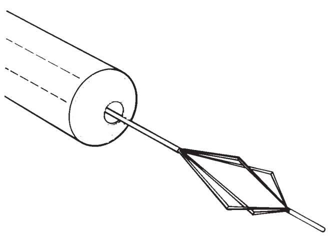


**Fig. 7.27** Standard diamond-shaped stone extraction basket.

### Difficult and big stones

Many factors (not least the experience of the endoscopist) deter-mine the success of stone extraction. Amongst the most impor-tant is stone size. A useful guide is the size of the endoscope, which measures 13–15 mm on the radiographic film (because of magnification); increasing difficulty must be expected with stones larger than the endoscope. Stones of up to 25 mm in

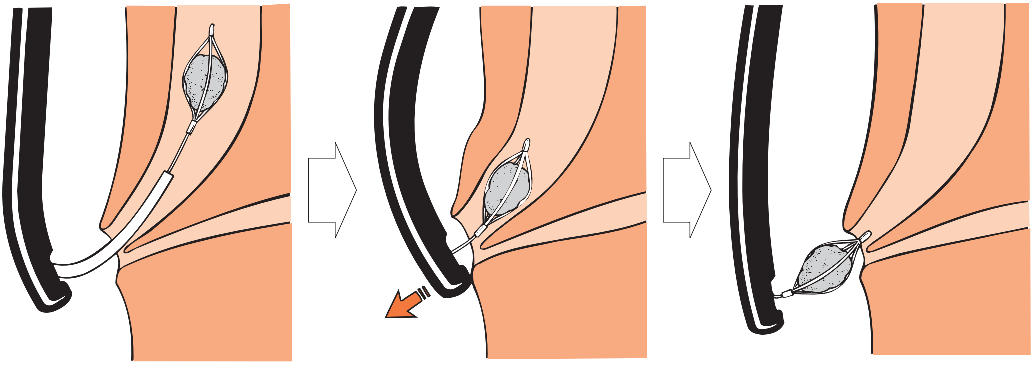


**Fig. 7.28** Stone extraction by the 'flip down' technique.

diameter can be extracted (or may even pass spontaneously) after endoscopic sphincterotomy, but the risks of bleeding and perforation increase with sphincterotomy size. Stones over 25 mm have caused gallstone ileus when released into the duodenum.

The importance of the shape of the distal bile duct has already been emphasized in relation to the safety of sphincterotomy. It is much easier to remove a large stone when the lower end of the bile duct is relatively 'square' (see Fig. 7.14) and it is foolish to attempt to pull it out intact when there is a long distal taper. Stones may be difficult to retrieve from unusual positions such as the cystic or intrahepatic ducts. A balloon catheter can usually be placed beyond such stones after careful manipulation with appropriate guidewires. Stones located above strictures can be removed only if the stricture is first dilated satisfactorily. Flat (coin-shaped) stones may be difficult to trap in a basket (or trawl in front of a balloon), and angulated stones may resist transit through the sphincterotomy. Stones which are 'sausage shaped' are the easiest to remove, partly because they are usually relatively soft, brown pigment stones. The most difficult are the large square stones which fill the bile duct lumen like a piston (Fig. 7.30). Baskets usually deform around such stones and fail to engage them—which is sometimes just as well since their size and shape make them difficult to extract through the sphincterotomy.

Mechanical lithotripsy techniques should be used when standard methods fail. In essence, the mechanical lithotriptor is simply a stronger (often larger) basket with a metal, spiral sheath. The basket wires should be strong enough to open vigorously, and designed so that the basket does not become trapped in the duct if they break. The metal sheath is sometimes difficult to manipulate into the duct directly, which has led to the development of 'three-layer' lithotriptors (Fig. 7.31). The basket is

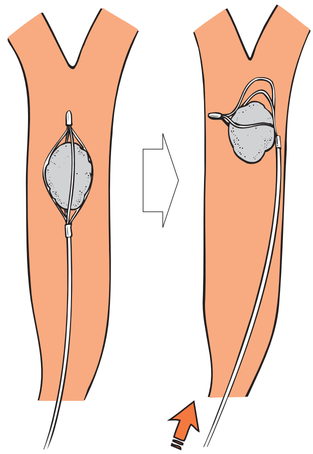


**Fig. 7.29** Releasing the stone by advancing and distorting the basket.

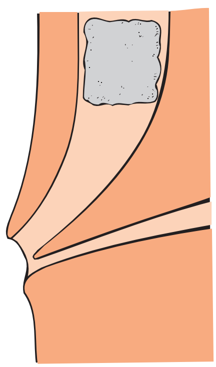


**Fig. 7.30** The 'piston'-shaped stone which is difficult to grasp and extract.

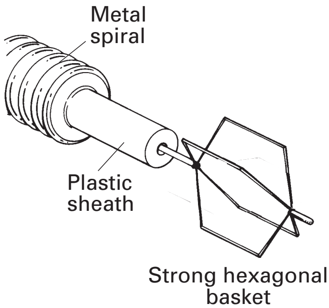



**Fig. 7.31** The 'three-layer' lithotripsy basket system.

placed deep in the duct through a standard plastic sheath, over which the metal sleeve is then passed.

Mechanical lithotripsy is used also when a stone and standard basket have become stuck in the duct. The basket handle is cut off and the endoscope is removed gently, leaving the basket in place, preferably with the plastic sleeve over it. A flexible spiral metal 'crushing sleeve' (Soehendra lithotriptor) is then advanced over the basket wires to the papilla, under fluoroscopic control, whilst pulling on the basket wires. The wire is then tightened with a reel mechanism or pliers (Fig. 7.32). Usually the stone will crush; alternatively, the basket wires will break and the stone will be released.

### Failed stone extraction

When stones cannot be removed with standard balloon and basket techniques (including mechanical lithotripsy), it is time to review other options. These involve a delay, during which stone impaction may cause cholangitis. It is therefore wise to provide temporary drainage in this context, using a nasobiliary drain or stent (see below). A nasobiliary drain is preferred if the patient is septic and when further intervention (endoscopic or surgical) is likely to take place within a few days. A stent is usually favoured when the patient's condition is stable and when there may be a significant delay before further attempts are made by specialist

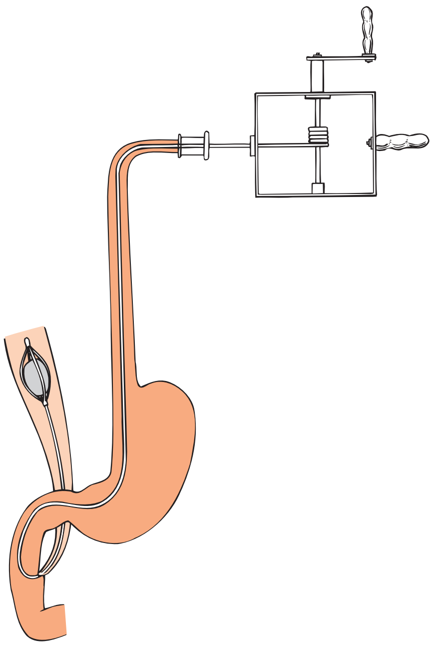


**Fig. 7.32** The reel mechanism for tightening the basket wires.

techniques (see below), particularly if these are to be at another institution.

Options for patients with big stones include *surgical intervention*, which may well be appropriate in younger and fitter patients (and certainly those with the gallbladder still in place). Large stones can be fragmented within the bile duct using *endoscopically directed shockwave*s (using pulsed lasers and electrohydraulic techniques). Because of the risk of damage to the bile duct wall, these should be employed only under direct choledochoscopic vision using a 'mother and baby' system or a percutaneous transhepatic approach. Options are discussed further in Chapter 8.

Infusion of *solvents* through nasobiliary drains has proved disappointing, largely because most of the big stones are not cholesterol rich. Solvent techniques (using mono-octanoin or methyl *tert*-butyl ether) are also time-consuming and not without hazard.

*Extracorporeal shockwave lithotripsy* (ESWL) has been used successfully, but further endoscopic manipulation is usually required to remove the fragments.

### Removing bile duct stones without sphincterotomy

Stones of less than 5 mm diameter can be extracted from the bile duct through the intact papilla using a standard basket catheter. Larger stones can be removed after balloon dilatation of the papilla (to 6 or 8 mm), with or without the addition of mechanical lithotripsy. Specialized equipment for this technique is being developed. Whether balloon dilatation is safer than sphincterotomy in the short and long term remains to be proven. When stone extraction has proved to be difficult, it may be wise to place a nasobiliary drain overnight.

## Nasobiliary drainage

Nasobiliary catheters are simply long polyethylene tubes (5 or 7 French gauge), at least twice the length of the endoscope, with multiple distal side holes. The tip is moulded to prevent it falling out. Several designs are available, including terminal pigtails, right-angle bends, mid-duct pigtails and a variety with a preformed loop in the duodenum (Fig. 7.33). The advantage of those without distal pigtails is that they can be inserted directly into the bile duct, without the need of a straightening guidewire. If a standard catheter is already in the bile duct when the decision is made to leave a nasobiliary drain, it is easiest to perform an exchange over a guidewire.

Once the distal tip has been placed in the correct position high in the biliary tree (and above any retained stone), the endoscope

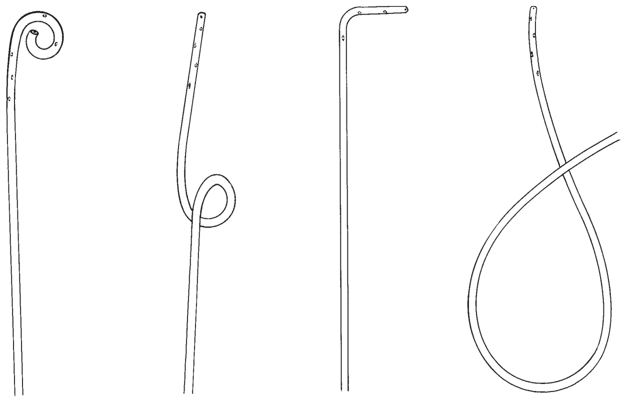



**Fig. 7.33** Designs of nasobiliary catheters.

must be removed gradually without dislodging the catheter. It is easiest for an assistant to withdraw the endoscope slowly, while the endoscopist pushes the catheter and monitors the position by fluoroscopy (Fig. 7.34).

After the endoscope has been removed, the proximal end of the drain must be rerouted from the mouth to the nose. A short plastic tube is passed through a nostril into the pharynx, grabbed by a surgical forceps (or fingers) and brought out through the mouth. The top of the biliary drain is then fed back through it; both are withdrawn at the nose until the drain lies straight in the pharynx. The drain should be strapped to the patient's face and connected to a bag with an injection/aspiration side-port.

Nasobiliary drains are usually well tolerated for several days, and have been left in place for weeks. Their essential role is to provide effective drainage; therefore, the output should be monitored and the catheter flushed (and the position checked by fluoroscopy) if there is any question of dislodgement. The drain can be used for check cholangiography, flushing and infusion of chemical solvents.

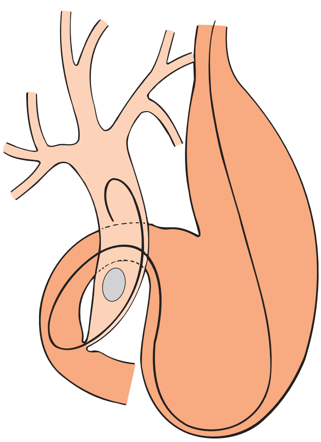


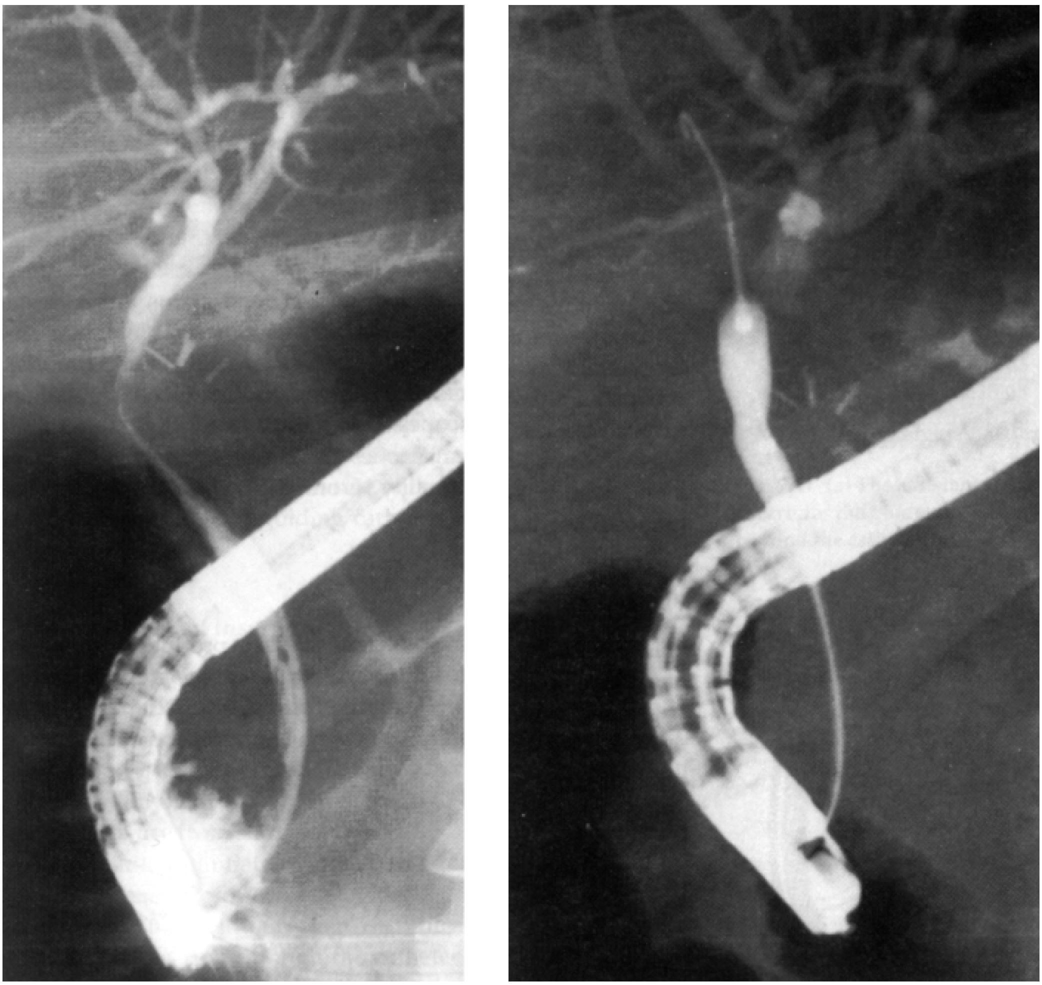
**Fig. 7.34** Nasobiliary drainage.

## Dilatation of biliary strictures

Biliary dilatation techniques were developed from those used in angioplasty. Sausage-shaped balloon catheters are slid over standard guidewires. For most purposes, it is convenient to use a balloon which is 8 mm in diameter and 2 cm long, mounted on a 7 French gauge shaft. Radiographic metal markers are incorporated (Fig. 7.35). Smaller balloons are used for tight strictures. Once placed through the stricture over a guidewire, the balloon is inflated to a predetermined pressure and the procedure is monitored under fluoroscopy for the disappearance of the 'waist' (Fig. 7.36). Dilatation may be painful and often cannot be maintained for more than 30 s. Repeated dilatations may be necessary. Most strictures recur quickly after simple dilatation; it is therefore customary to leave a stent (or stents) in place for several months.

**Fig. 7.35** A dilating balloon placed over a guidewire; the radio-opaque metal markers show up.

Dilatation of strictures which are so tight that they will not accept a balloon catheter can be achieved using 'stepped' dila-



(a) (b)

**Fig. 7.36** (a) Postoperative stricture. (b) Balloon dilatation over a guidewire.

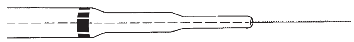


**Fig. 7.37** Tapered 'stepped' dilator for use in the bile (or pancreatic) duct over a guidewire (note metal marker).

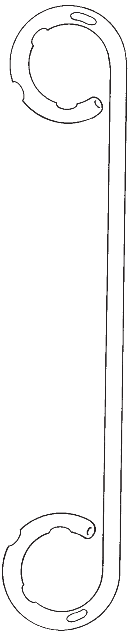


**Fig. 7.38** A pigtail stent.

tors over a guidewire (Fig. 7.37). Various sizes are available; the commonest have three steps at 5, 7 and 9 French gauge. These dilators are most commonly used in patients with malignant strictures, prior to stenting (see below).

## Biliary stenting

Endoscopic biliary stent placement is now well established, especially for palliation of malignant obstructive jaundice. Precise indications in this and other contexts are discussed in Chapter 8. Stents made of plastic (usually polyethylene) are most commonly used, but various types of expandable metal mesh stent are becoming more popular. These are discussed later.

### Patient preparation

The patient's focal problem and general status are reviewed in detail, and appropriate informed consent is obtained (see Chapter 3). The biggest specific risk of stenting is infection. This occurs mainly because of inadequate drainage, but it is essential to ensure that endoscopes and accessories are disinfected rigorously. Prophylactic antibiotics are given routinely. Stent placement requires high-quality fluoroscopy and two well-trained nurses or assistants.

### Plastic stent design

Plastic stents and introducing sets are produced by several manufacturers, with little variation in precise design. Stents of 7 French gauge can be placed through a standard diagnostic duodenoscope, and are appropriate in some contexts. How-

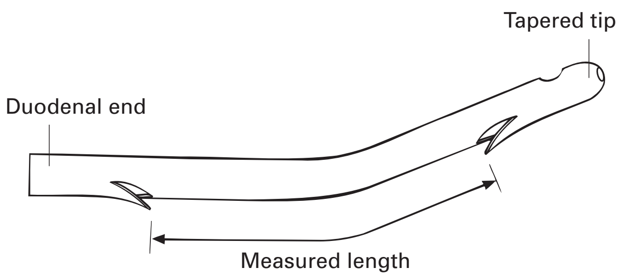



**Fig. 7.39** The anatomy of an Amsterdam-type stent.

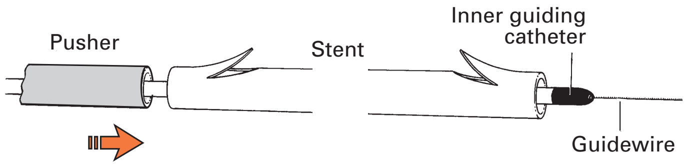



**Fig. 7.40** Standard three-layer system for stent insertion.

ever, most indications (especially malignant disease) require the use of larger stents (10–12 French gauge), for which a large-channel therapeutic duodenoscope is mandatory. The larger stents (e.g. 11.5 French gauge) are more awkward to use and have no proven advantage; most experts use 10 French gauge stents routinely. Stents with pigtails (Fig. 7.38) are still used occasionally, e.g. in patients with unremovable stones. The vast majority of stents, however, are of the 'Amsterdam' type, i.e. slightly curved with flaps near each end to prevent migration (Fig. 7.39). Stent length is traditionally measured between the flaps. Numerous variants have been produced (different plastics, side holes and flaps) without any proven advantage, as yet.

Stenting requires a long 0.035-inch diameter guidewire with a radio-opaque tip and most experts prefer hydrophilic wires. Stents of 7 French gauge are inserted directly over the wire (once it has been placed through the stricture), using a 7 French gauge pushing catheter. Larger stents require a three-layer system (Fig. 7.40). The stent is slid with a pushing tube over a 6–7 French gauge inner guiding catheter, which itself lies over the guidewire.

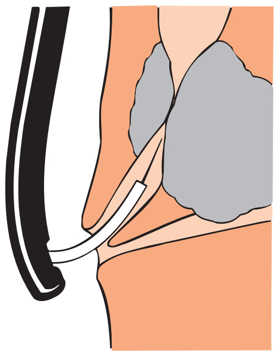
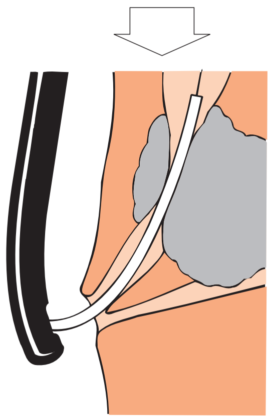


**Fig. 7.41** (a) The assistant protrudes the guidewire 2 cm beyond the catheter . . .



(b) . . . then the catheter and guidewire are advanced together to engage and pass the stricture.

### Techniques of stent insertion

Some endoscopists used to perform the initial ERCP procedure with a standard-sized duodenoscope and changed to the more cumbersome larger-channel instrument once the indication for stenting had been confirmed (usually after performing a small sphincterotomy). However, modern large-channel endoscopes are simple to use from start to finish.

Cannulation is initiated with a standard catheter or with the inner catheter of a stent set. Contrast is injected to define the anatomy but without overdistending the biliary tree. A guidewire is inserted through the catheter to engage and pass through the stricture (Fig. 7.41). Independent manipulations of the catheter and guidewire may be necessary to achieve the correct angle (Figs 7.42 & 7.43). Once the guidewire has passed through the stricture, the catheter can be slid over it and further

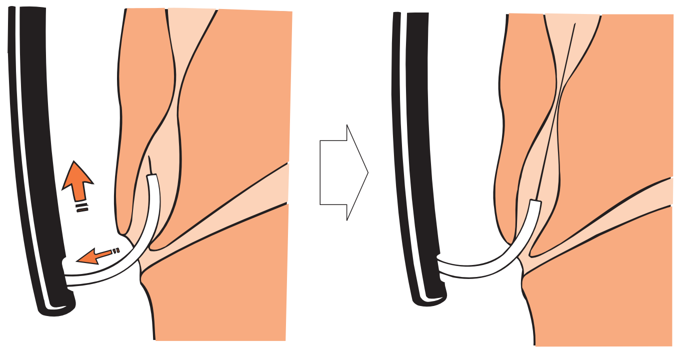


Fig. 7.42 (a) Pull back the scope and catheter . . .

(b) . . . to improve the angle for guidewire advancement.

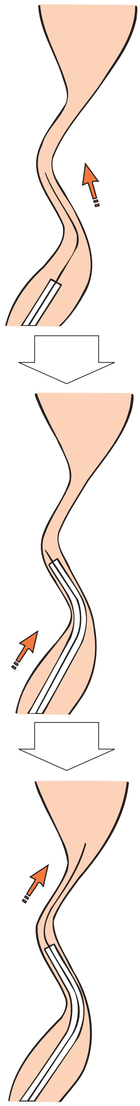


Fig. 7.43 Advance through tortuous strictures one bend at a time, first the guidewire and then the catheter.

radiographs obtained. The guidewire can be left in place whilst cytology specimens are taken. In addition, the wire can be used for placement of a sphincterotome. An alternative approach is to start the procedure with the double-lumen sphinctero-tome through which the guidewire can be threaded after cholangiography.

*Sphincterotomy before stenting?* Most endoscopists perform a *small* sphincterotomy as part of the stenting procedure. Al-though it is possible to pass stents of up to 11.5 French gauge through the intact papilla, a sphincterotomy facilitates this process and makes it possible to place more than one stent when required (e.g. in hilar lesions), and probably facilitates subse-quent stent replacement. Sphincterotomy has also been advo-cated to prevent the bile duct stent from compromising the pancreatic orifice (and causing pancreatitis); however, this risk appears to be very small, even without sphincterotomy.

*Stricture dilatation before stenting?* Benign strictures are dilated before stenting since the stent is used simply to maintain the initial dilatation. Most malignant strictures can be stented without dilatation but difficulty may be experienced in hilar lesions, perhaps particularly because less force can be applied at a distance. Under these circumstances, it is convenient to use a stepped dilator (5, 7 and 9 French gauge) over the guidewire (see Fig. 7.37).

### *Stent placement*

The correct stent length is chosen so that the top flap will be above the stricture and the bottom flap just outside the papilla (usually leaving a margin of about 1 cm for movement and tumour growth, but remember that ERCP radiographs have a magnification of about 30%). Some 'inner guide' catheters for stenting have radio-opaque markers to facilitate precise measurements (Fig. 7.44).

**Fig. 7.44** Radio-opaque markers on the stent insertion catheter.

The guidewire and inner guiding catheter (for a 10 French gauge stent or larger) should be placed well above the stricture, preferably in a main intrahepatic duct. Make sure that you are not in the cystic duct. The stent is passed over the guide catheter and into the biopsy port. The proximal flap of the stent is flattened into the biopsy channel; usually this can be done with the finger, but an introducing sleeve is provided. The 'pusher tube' is then used to guide the stent down through the endoscope. There is considerable friction in this system, so that movement of the pusher will tend also to advance the inner guide catheter (and its contained guidewire). This tendency can be minimized by attempting to 'grasp' the inner guide catheter with the endoscope elevator. Maintenance of the correct position of the guidewire and catheter in the liver should be monitored repeatedly by fluoroscopy. The assistant should inform the endoscopist as soon as the inner catheter appears out of her end of the pusher; she can then help the passage of the stent by pulling back on the inner catheter, against the pusher tube. In fact, this merely maintains the inner guide catheter and guidewire in the same position in the liver as the stent advances. Close collaboration between the endoscopist and assistant is essential.

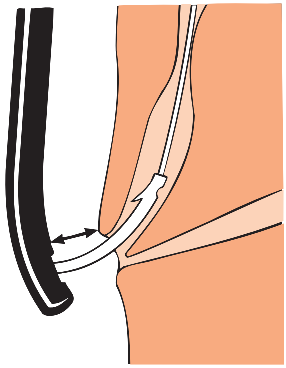


**Fig. 7.45** Good scope position, close to the papilla.

The endoscopist can feel when the tip of the stent reaches the elevator. It is important to work carefully and deliberately at this stage. The tip of the endoscope should be kept *close to the papilla*, without allowing any significant bow in the catheter (or stent) (Fig. 7.45). The position of the inner catheter and guidewire are checked again. Once everything and everyone is prepared the following steps are performed.

**1** Lower the elevator and push the stent tip 1–2 cm into the endoscopic view (Fig. 7.46).

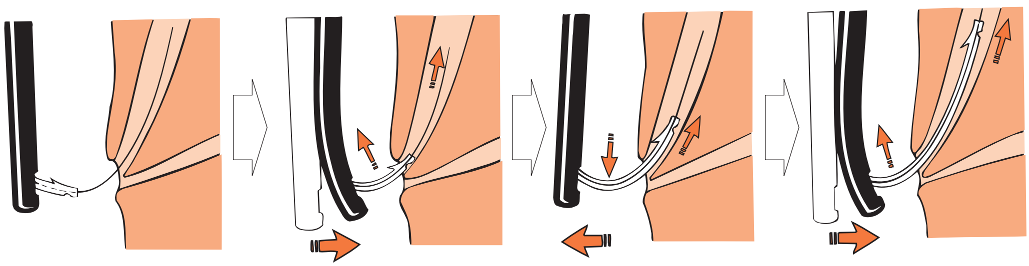


**Fig. 7.46** (a) Advance the stent tip until just visible . . . (b) . . . insert the stent tip into the bile duct by angling the scope tip up and lifting the elevator . . . (c) . . . then back off the scope slightly (angle down), drop the elevator and advance the stent slightly . . . (d) . . . then push the stent into the bile duct by angling the scope tip and lifting the elevator.

**2** Advance the stent tip into the papilla by lifting the elevator and angling the endoscope up.
**3** The assistant maintains traction on the inner catheter against the pusher tube, whilst the process is monitored on fluoroscopy.
**4** Insert the stent further in small moves, remembering that the stent cannot be withdrawn once it has been extended too far.
**5** Repeat the sequence: elevator down, stent out 1–2 cm and elevator and endoscope tip up to push the stent inwards.
**6** The assistant may need to withdraw the inner catheter slightly before the sequence is repeated (Fig. 7.46).
**7** Stop once the bottom flap abuts the papilla.
**8** If necessary, take further radiographs after removing the guidewire and injecting contrast.
**9** Remove the inner catheter and guidewire together, holding the stent in place.
**10** Watch the gratifying rush of bile as the stent and pusher separate (Plate 7.2).

*Straightening and 'jerk back' manoeuvres.* Usually there is resistance to stent passage when the tip enters the stricture. Pushing the stent simply results in a loop in the duodenum (Fig. 7.47a). If this is allowed to continue, the situation becomes irremediable and it will be necessary to remove the endoscope completely (grasping the stent in the elevator) and to start the procedure over again. To avoid this predicament, the endoscope is advanced further into the duodenum so as to straighten the stent (Fig. 7.47b). The tip of the endoscope is then angled sharply

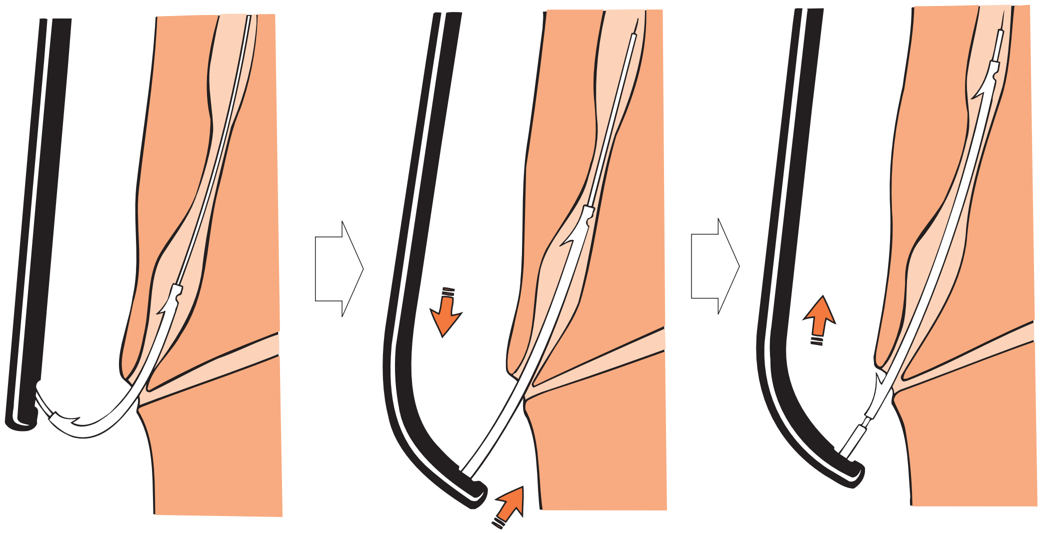


**Fig. 7.47** Getting out of loop trouble. (a) If there is too much stent in the duodenum . . .

(b) . . . advance the scope and angle it up to get the stent straight . . .

(c) . . . then pull back on the scope to force the stent inwards.

upwards, and the whole instrument withdrawn or 'jerked back' (Fig. 7.47c). This usually produces enough force in the correct axis to advance the stent through the stricture.

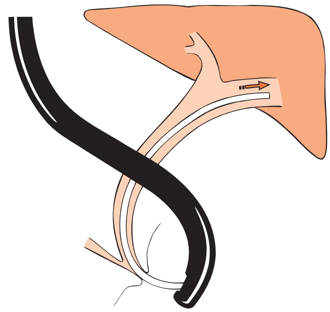


Fig. 7.48 The natural curve of the catheter takes it into the right intrahepatic duct preferentially (patient prone).

### *Bifurcation lesions (and double stenting)*

Type 1 hilar strictures (not involving the bifurcation) can be managed with a single stent. Management of type 2 and 3 lesions (involving the bifurcation or higher branches) is more difficult technically, and provides less satisfactory results. The strictures are often tortuous and sclerotic and further away from the fulcrum provided by the duodenoscope tip.

Jaundice can be relieved if about one-third of the liver can be drained. The main problem is the risk of sepsis in undrained segments. Whether or not it is necessary to attempt to drain all obstructed ducts in every case remains controversial; in fact, this is often impossible. A single stent provides good palliation of jaundice in most hilar lesions (provided an appropriate segment is selected), with an early cholangitis rate of less than 10%. When sepsis does develop, it is essential to provide drainage of the obstructed ductal system (urgently). This can be done by a second endoscopic procedure, a primary percutaneous approach or a combined endoscopic-radiological technique (see below).

### *Steering into the intrahepatic ducts*

Catheters usually enter the right intrahepatic ductal system preferentially, because of their natural curl (Fig. 7.48). It is sometimes necessary to select the left intrahepatic system; several methods may be useful in this situation. If the catheter is brought down low in the bile duct, the guidewire (which always goes straight) may be aimed towards the left side (Fig. 7.49). Another method involves the use of a catheter with a preformed bend (or side hole) near the tip (Fig. 7.50). It is also possible to use a torque-stable guidewire with a bent tip. This is placed below the stricture and rotated into the correct axis. The friction in the long catheter systems often prevents this method working optimally.

When attempting to insert two stents in different parts of the liver, it is wise to start by placing the two guidewires; it is often not possible to place a second wire once a stent has been inserted.

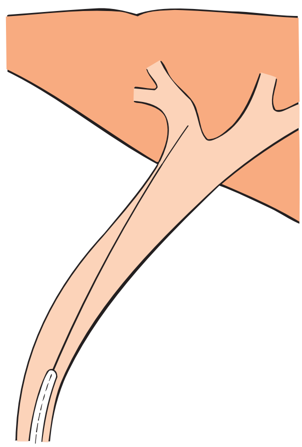


Fig. 7.49 Pulling the inner 'guiding' catheter down the duct directs the straight guidewire into the left intrahepatic duct (patient prone).

### *Failed stent insertion*

The commonest reason for failure of stenting is difficulty in deep biliary cannulation, caused by distortion of the anatomy by tumour impression or actual involvement of the papilla. Failure

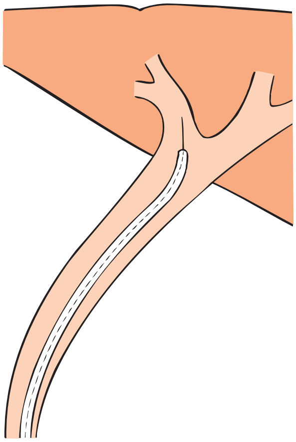


**Fig. 7.50** A preformed catheter can be used for selective entry into the left duct (patient prone).

puts the patient at risk for cholangitis, especially if contrast has been injected above the stricture. Alternative drainage techniques must be employed within days and preferably within hours (certainly once sepsis has developed). Drainage can be provided by direct percutaneous transhepatic radiological intervention or by a combined procedure.

### *Combined endoscopic-radiological stenting ('rendezvous' procedure)*

The use of a transhepatically placed guidewire has been mentioned as a method for facilitating bile duct access for sphincterotomy. Combined procedures are used for the insertion of stents when the initial cannulation fails and in patients with hilar lesions when it proves necessary to drain more than one liver segment.

In units with combined endoscopic-radiological facilities and excellent collaboration, combined procedures can often be performed immediately when the indication arises—provided that the patient's consent has been obtained beforehand. However, in most centres, combined procedures are done in stages. The first stage (after failure of endoscopic access) is to perform a standard percutaneous transhepatic drainage procedure, leaving the catheter through the stricture if possible. Radiologists usually prefer to do these procedures in their own specialized suites.

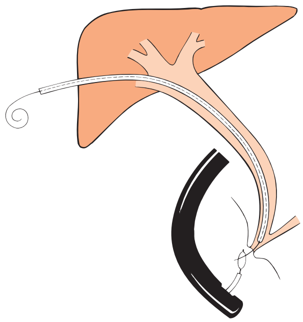


**Fig. 7.51** The combined procedure where the endoscopist catches the radiologically placed guidewire and pulls it back through the scope.

Once the patient is stable (and whilst continuing antibiotics), he is brought back to the ERCP department. The radiologist places a long standard 0.035-inch diameter guidewire through the patient's catheter into the duodenum, and the endoscopist passes the therapeutic duodenoscope opposite the papilla. The radiologist pulls the catheter back until it is only just protruding from the papilla and the guidewire is projecting 1–2 cm from it. The endoscopist grasps the tip of the wire with a snare loop and draws it back slowly through the endoscope channel (Fig. 7.51). The radiologist holds the catheter in place and helps by pushing the guidewire at the skin surface. It is important to maintain the catheter in position in order to prevent the wire traumatizing the liver. The guidewire is pulled at least 2 cm out of the endoscope, and is then used in the standard way to insert the stent using the three-layer system already described (Fig. 7.40). As the endoscopist's inner catheter advances through the papilla, it pushes the radiologist's catheter back to a position above the stricture. A significant danger with the combined procedure is advancing the stent too far, so that the tip is impacted in liver tissue and is no longer draining a duct (Fig. 7.52). One way to prevent this happening (after the radiologist has inserted a second wire) is for the endoscopist to withdraw the first guidewire until its tip is just above the stricture, and then advance it into an appropriate large duct (Fig. 7.53).

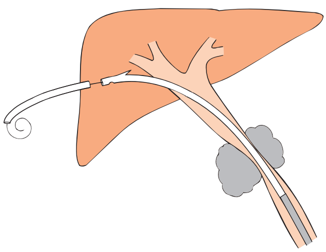


**Fig. 7.52** A danger is to advance the stent too far, so that it no longer drains . . .

Once the stent is in place, it is customary to leave the percutaneous drainage catheter in for at least one night and to do a check cholangiogram on the following day. The catheter can then be removed if the stent is functioning. Sometimes, with high lesions, there may be little room for the percutaneous catheter above the stent. This is another advantage of placing two guidewires percutaneously (through a common sleeve). One guidewire is used by the endoscopist for the stent insertion, the other subsequently by the radiologist to place a temporary external drainage tube.

A variant of the combined procedure utilizes a forward-viewing endoscope to retrieve the guidewire from the duodenum. The stent is passed through the mouth over this wire, and pushed into place with an endoscope or under radiological control using a pusher tube. These methods allow the insertion of very large stents since they do not have to be passed through the instrument channel. The techniques have not become popular because it is difficult to pass the stent through the stricture and to judge when the stent is in the optimal position.

The combined procedure stenting techniques were developed to reduce the risk of passing a large stent through the liver substance. However, these techniques are now used less frequently as endoscopists have become more skilled, and, particularly, with the development of expandable metal mesh stents which can be placed percutaneously by a radiologist through a smaller catheter.

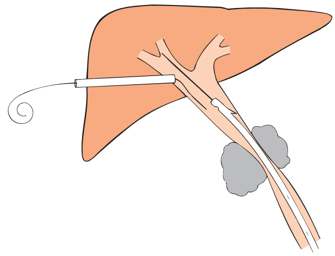


**Fig. 7.53** . . . to avoid this the endoscopist can pull the guidewire back and then place it in a large duct.

## Post-stenting care

Most stent procedures are straightforward and well tolerated. Overnight observation is wise after the first stent procedure, but may not be necessary for any subsequent elective stent exchange. Antibiotics are continued overnight and the patient is discharged on a normal diet the next morning if there are no adverse developments. Stool and urine colour should return to normal within 1 week, and improvement in liver function tests can be monitored.

### *Stent malfunction*

This is indicated by the failure of jaundice to resolve or the recurrence of obstruction. Inadequate drainage is usually followed by sepsis, which can be life-threatening. Although stent patency can be investigated by plain abdominal radiographs and scans (to check for air in the biliary tree and duct dilatation) and by dynamic isotope scans, the only way to clarify the situation completely is to repeat the ERCP procedure. Early stent dysfunction may be due to a poor position. The stent may have been placed too high with the tip impacted in a small hepatic radical, or even inadvertently in the cystic duct. Occasionally stents can be blocked by blood clots. If the stent appears to be in the correct position, patency can be checked by injecting contrast through the tip (gently so as not to increase intrahepatic pressure in the presence of sepsis).

Delayed stent dysfunction may be due to migration, usually downwards. The tip becomes impacted in the duodenal wall and can rarely cause ulceration or bleeding. Most delayed occlusion is due to the accumulation of bacterial and biliary debris, which is inevitable eventually. Stents of 10–11.5 French gauge can be expected to remain patent for 3–6 months; 7 French gauge biliary stents rarely stay patent for more than 3 months.

Life-threatening sepsis can develop rapidly after stent occlusion. Patients and their care-givers should be warned about the early symptoms (especially chills), and advised to return to specialist care immediately when these develop. Because of the potential for severe complications, consideration should be given to changing stents electively. Most experts recommend that stents should be routinely changed about every 3 months (with 10 French gauge stents) in patients with benign strictures. The value in patients with malignant disease remains to be proven, since most patients die before stent occlusion.

### *Stent removal and exchange*

The simplest way to remove a blocked (or migrated) stent is to grasp the tip in the duodenum with a snare loop or basket, and pull it out through the mouth. The duodenoscope is replaced and a new stent inserted. It is wise to note the endoscopic appearances of the papilla before withdrawing the stent, since removal may cause bleeding and an embarrassing difficulty in locating the orifice. Because of occasional problems in recannulating or re-accessing the stricture, methods have been developed for removing (then replacing) stents over a guidewire. Even when a stent is clogged with biliary material, it is usually possible to cannulate it with a wire. It can then be withdrawn through the endoscope using a small snare (Fig. 7.54) or the Soehendra extraction screw (Fig. 7.55).

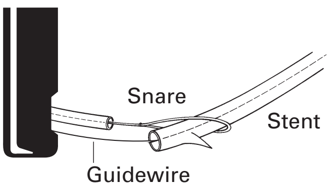



**Fig. 7.54** Removing a stent through the scope using a small snare over a guidewire.

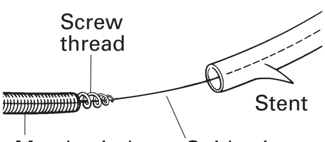



**Fig. 7.55** Using the Soehendra 'screw' stent extractor over a guidewire.

Stents which have migrated downwards and impacted the duodenal wall can be dislodged with grasping forceps. Those which have migrated upwards into the biliary system are more difficult to extract, since the tip is no longer visible within the duodenum. It is often possible to grasp the tip by fishing with a basket under fluoroscopy, or to pull the stent down again by inflating a retrieval balloon alongside or above it. If these methods fail, it is usually satisfactory to place another stent alongside the old one.

Should stent reinsertion fail, an alternative drainage procedure must be arranged immediately. The risk of life-threatening sepsis is substantial.

## Expandable metal stents

The problem of plastic stent clogging has led to the development of devices which expand to a greater diameter *in situ*. Current models are all variants on a metal mesh (Fig. 7.56). Stents are supplied compressed within the tip of a 10 French gauge delivery catheter. When released, the stents expand up to a maximum diameter of 10 mm. Most expandable metal stents shorten significantly during deployment. This field is developing so rapidly, that further details are likely to become obsolete.

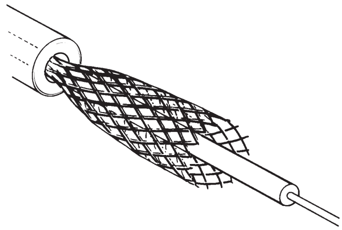
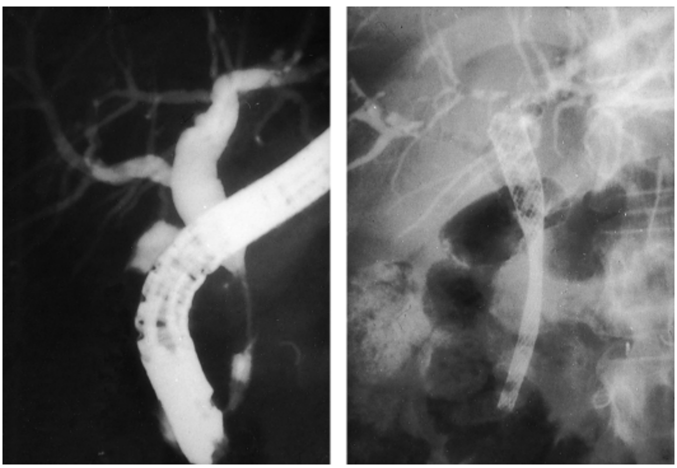


**Fig. 7.56** A metal mesh stent expanding as it is released from the compressing sleeve.

Most expandable metal stents are easier to insert than standard plastic stents, since the introducing system is 'continuous'. The device is simply inserted slowly over a guidewire and into the correct position across the stricture. It is probably wise to perform a brief dilatation (with stepped dilators), before committing yourself to stenting. It is also important to control the stent position carefully (under fluoroscopy) during deployment. Full expansion may not occur for 1 or 2 days (Fig. 7.57).

Randomized controlled trials indicate that expandable metal stents remain patent longer than standard plastic stents—but not forever. Stent malfunction is usually due to ingrowth of tumour through the mesh and appears to be more common with larger meshes. Expandable metal stents with plastic covering may overcome this problem, but there is concern that a sleeved stent may occlude duct branches (e.g. cystic ducts, intrahepatic ducts). Expandable metal stents are considerably more expensive and cannot be removed.



(a) (b)

**Fig. 7.57** (a) A bile duct tumour, and (b) a partially expanded metal stent.

### Golden rules for stenting

**1** Make sure everyone understands what is being attempted before the procedure, including the patient and GI and radiology assistants.
**2** Maintain sterility as much as possible.
**3** Do not hurry. This can lead to inadvertent withdrawal of the guidewire or to the development of loops in the duodenum—both of which often mean that the procedure has to be restarted.
**4** Make certain that the patient has adequate drainage at the end of the procedure.

Failure of drainage, either initially or after stent occlusion, places the patient at grave risk of serious sepsis. It is essential to use broad coverage parenteral antibiotics and to provide adequate drainage—by further stent insertion, nasobiliary catherization or percutaneous or surgical techniques.

## Gallbladder techniques

There are very few indications to approach the gallbladder endoscopically. However, it is technically possible to traverse the cystic duct using floppy hydrophilic wires and to place nasogallbladder drains or stents. Once the guidewire is in place, dilatation and stenting techniques are the same as for bile duct strictures.

## Pancreatic techniques

The success of endoscopic biliary treatment has encouraged endoscopists to explore their potential in patients with pancreatic diseases. The techniques are variants of those used in the biliary tree.

### Pancreatic sphincterotomy

Pancreatic sphincterotomy is performed with a standard sphincterotome or needle knife. Most experts perform a biliary sphincterotomy first in order to clarify the anatomy. The pancreatic duct is then recannulated and a cut of 5–8 mm is made in the 1 o'clock direction, over a guidewire. Pure cutting current may reduce the risk of pancreatitis. An alternative technique is to place a short (2 cm long) 5 or 7 French gauge stent into the pancreatic duct (after biliary sphincterotomy), and then to use a needle knife to perform the septotomy. There is no clear indication which technique is preferable. If a stent is used, it is removed after 1–4 weeks. The stent/needle-knife technique is preferred when performing a sphincterotomy of the minor papilla (Fig. 7.58).

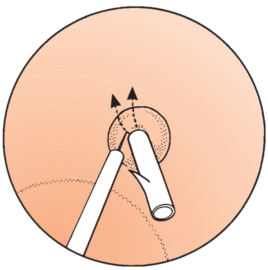


**Fig. 7.58** Needle-sphincterotomy of the minor papilla over a stent.

### Pancreatic stone extraction

Pancreatic stone extraction can often be achieved using standard baskets and balloon catheters after pancreatic sphincterotomy. Soft and small (less than 5 mm) stones located in the pancreatic head are relatively easy to remove. Other stones may require multiple procedures and adjuvant techniques such as ESWL.

### Pancreatic stricture dilatation

Stricturing of the pancreatic orifice or duct can be dilated using a small (4–6 mm diameter) balloon, or graduated stepped dilators, over a guidewire. Hydrophilic wires are particularly useful in the tortuous pancreatic duct. Stents are usually placed after dilatation.

### Pancreatic duct stenting

The techniques for placing stents in the pancreatic duct (and minor papilla) are similar to those for biliary applications. Stents selected are usually smaller (7 or 5 French gauge). Most endoscopists remove pancreatic stents after only a few weeks because they can cause duct damage, particularly at the inner tip (Fig. 7.59). To reduce this risk, the stent shape should conform to the duct configuration. Stents which have migrated into the pancreatic duct can be very difficult to remove. For this reason, many stents designed for pancreatic use have an extra external flap or a pigtail.

### Nasopancreatic drainage

Nasopancreatic drainage can be provided when necessary, particularly in the short-term management of pancreatic fistulae and after a difficult stone extraction. Commercially available drains have a straight tip with multiple side holes and a curl corresponding to the shape of the duodenum.

### Pseudocyst puncture

Pseudocysts adjacent to, and compressing, the wall of the duodenum or stomach can be drained by direct endoscopic puncture (Plate 7.3). Although this can be performed with a standard needle knife, it is wise to use a device which maintains access after the incision (e.g. a needle knife through a sleeve) and the possibility of track coagulation (using a specially designed diathermy puncture set). This is relevant since the major risk of this procedure is serious bleeding from dilated gastric vessels. Endoscopic ultrasound has been used to detect large vessels (and varices) and to confirm the exact cyst relationships.

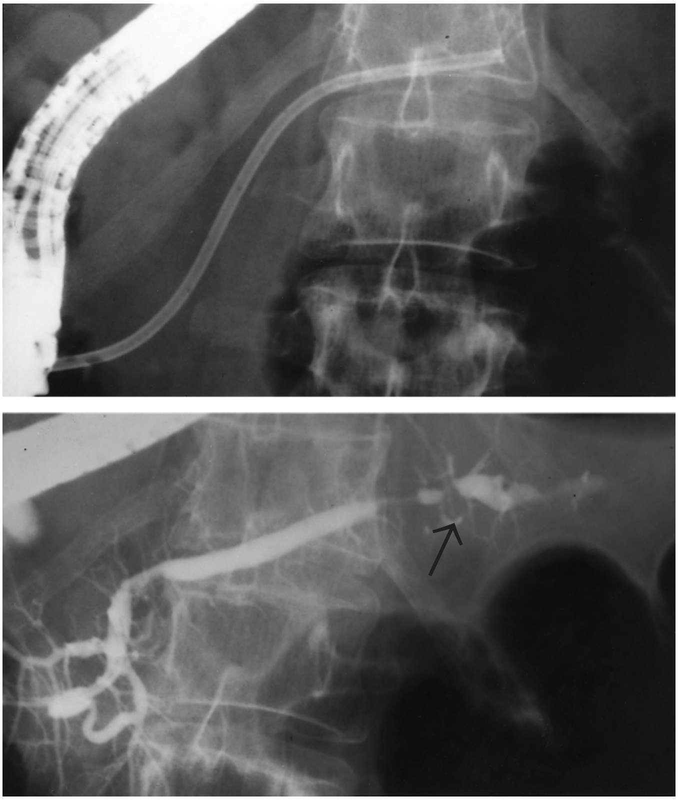


**Fig. 7.59** Pancreatic duct damage due to a stent (arrowed).

After puncturing the cyst, a nasocystic drain should be left in place for a few days for aspiration, flushing and subsequent check radiology. In some circumstances, a 10 French gauge (double pigtail) stent is placed through the orifice to maintain patency for a few weeks (Plate 7.4).

## Further reading

See further reading list in Chapter 8.