Biliary Cannulation: An Update on Tools and Techniques

INTRODUCTION

Endoscopic Retrograde Cholangiopancreatography (ERCP) is a commonly performed endoscopic procedure to assess and manage biliary and pancreatic conditions. Achieving cannulation of the desired duct is a prerequisite for any successful ERCP procedure. The overwhelming majority of ERCP procedures involve deep biliary cannulation (DBC). Failed ERCP can lead to complications and the need for subsequent procedures, which may be more invasive. Many different cannulation techniques have been developed and refined over time, and this manuscript will review the current state-of-the-art of biliary cannulation.

Initial Positioning

Once the duodenoscope has been advanced to the second duodenum, the endoscopist usually attempts to achieve a “short position” of the scope by deflecting fully the lateral wheel (or ratchet) towards the right with upward deflection of the large wheel and then simultaneously torquing the scope’s shaft clockwise while withdrawing the endoscope. This transitions the endoscope to a point where the shaft is lying along the lesser curvature of the stomach. This maneuver will almost always result in the tip of the endoscope being distal to the ampulla, with the ampulla appearing to be “above” the endoscope’s tip. “Long position” (where the shaft of the endoscope lies along the greater curvature of the stomach) is often helpful in obtaining an adequate position for cannulation if a short position provides a suboptimal vantage point.

Biliary Cannulation

Biliary cannulation is the most challenging step in ERCP to master during training. It is pivotal for any successful ERCP. A retrospective study of the training of a single operator showed that biliary cannulation of a native papilla is a skill that improves during training and continues to improve after training. In this study, which only evaluated cannulation attempts in patients with native papillary anatomy and excluded those who had previously undergone a biliary sphincterotomy and counted any hands-on assistance from the attending physician as a cannulation failure, the operator achieved successful biliary cannulation of 43% at the beginning of the training and was well over 80% at the end of training. He reached >96% successful biliary...
cannulation as independent operator at the end of his first year of practice which included many referrals for failed cannulation. The study emphasized that trainees and practicing physicians should track their cannulation success rates and only count patients with native papillary anatomy, as the success rate in cannulation of patients with prior sphincterotomy is virtually 100%.

In current practice, common biliary cannulation methods include:

1. Straight biliary catheter with a guidewire and/or dye
2. Sphinctertomes with a guidewire and/or dye
3. Initial pancreatic cannulation with wire placement followed by biliary cannulation (Double wire technique)
4. Initial pancreatic cannulation with pancreatic stent placement followed by biliary cannulation (Double wire technique)
5. Precut (Needle Knife) Sphincterotomy
6. Rendezvous techniques

**Cannulation Using Contrast vs. Wire**
Guidewire cannulation refers to a set of cannulation techniques in which selective biliary or pancreatic cannulation is achieved using catheters and/or sphincterotomes and hydrophilic guidewires. The term “guidewire cannulation” implies that contrast injection is not performed during cannulation but only after deep biliary or pancreatic ductal access has been obtained as confirmed fluoroscopically. Thus, if contrast is used during cannulation the operator cannot be said to have been performing “guidewire cannulation.”

Guidewire cannulation can be performed via several different techniques. The most common approach involves gentle insertion of the tip of a catheter or sphincterotome into the ampulla, followed by gradual guidewire advancement through the working channel of the device in an attempt to access the desired duct. This technique involves direct contact between the tip of the cannulation device and the ampulla before the wire is advanced.

Another common technique involves the tip of the cannulation device being advanced near to, but not into, the ampulla, with the guidewire being advanced across a short distance into the ampulla. With this technique, the tip of the device does not contact the ampulla directly; the guidewire itself is what makes contact with the ampulla in an attempt to access the desired duct.

Guidewire cannulation has been a source of great interest in recent years and has been widely adopted. Several studies have shown a lower rate of post-ERCP pancreatitis when guidewire cannulation is used when compared to contrast-assisted cannulation techniques. The largest single study on guidewire cannulation to date is a single operator, retrospective study of 822 consecutive ERCP’s described a high success rate of deep biliary cannulation (96.7%) using dye-free, guidewire techniques. Only 11 patients (1.3%) developed post ERCP pancreatitis (all of which were mild). Eleven cases (1.3%) were complicated with a guidewire perforation; all were managed conservatively and no patients who developed guidewire perforations required any intervention beyond fluids and antibiotics.

A recent meta-analysis reviewing 7 randomized, controlled trials (including 5 non-crossover trials and 2 crossover trials) demonstrated positive findings regarding increased cannulation success rates and fewer complications when using guidewire cannulation as compared to conventional contrast guided bile duct cannulation. In the 5 non-crossover trials, there was
a significant reduction in the frequency of episodes of post-ERCP pancreatitis when guidewire cannulation was used (3.2%) as compared to contrast guided cannulation (8.7%) (Relative risk 0.38). Cannulation success rates were also higher when using guidewire cannulation (89%) versus contrast guided cannulation (78%) (Relative risk 1.19). Overall, the pooled rates of post-ERCP pancreatitis in the two crossover studies were statistically insignificant. (RR 0.97).8, 9

Although much guidewire cannulation data is encouraging, some studies have been far less enthusiastic. A multi-center, prospective study of 400 patients randomized patients to 4 groups (sphincterotome versus conventional catheter and guidewire versus non-guidewire based approaches).10 This study demonstrated that wire guided cannulation trended towards shortened cannulation and fluoroscopy times. There were no significant differences in the rates of post-ERCP pancreatitis or cannulation success.

A more recent systematic Cochrane review of 12 randomized controlled trials with 3450 participants comparing guidewire cannulation to contrast-assisted cannulation found a significantly lower incidence of post ERCP pancreatitis in guidewire cannulation groups compared to contrast assisted cannulation groups (RR 0.51, 95% CI 0.32 to 0.82). Furthermore, the guidewire cannulation group achieved a greater primary cannulation success (RR 1.07, 95% CI 1.00 to 1.15) and reduced need for precut sphincterotomy (RR 0.75, 95% CI 0.60 to 0.95) with no increase in other ERCP complications. The authors concluded that guidewire cannulation appeared to be the most appropriate first line to achieve cannulation in ERCP.11

The major concerns associated with guidewire techniques include creating a false tract (sinus) or perforation by the wire. Both of these complications can be minimized by using soft-tip guidewires. If the guidewire is advanced forcefully into a side branch pancreatic duct, post ERCP pancreatitis can ensue, although in practice this is mild in severity and rare in occurrence.5

There are different diameters of the wires that can be used. The most commonly used wires are 0.025 and 0.035” wires. It should be noted that a recent randomized prospective study (n=100) showed no difference between the two wires in regard to achieving cannulation or resulting in complications, although individual preferences among operators are often strong.12

Occasionally, during attempts to cannulate the bile duct the guidewire is advanced inadvertently into the pancreatic duct. If this occurs repeatedly, it is become increasingly common in these situations for the endoscopist to use this wire in the pancreas to their advantage via the so-called “double wire” or “two wire”

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technique. In this situation, the endoscopist will remove the sphincterotome or the cannula while leaving the guidewire in the pancreatic duct. Then the sphincterotome or the cannula can be loaded with a second wire and is advanced through the working channel to the level of the ampulla, at which point further attempts to cannulate the bile duct are commenced. The wire in the pancreatic duct can help in obtaining biliary access via several means: the angle of the PD is seen endoscopically and fluoroscopically (and can be thus avoided), the wire in the PD can help to straighten the ampulla, can allow the physician to extrapolate the presumed location of the biliary duct, and can allow placement of a PD stent if it is felt to be clinically indicated at any point during the procedure.5 (Figure 1)

Several studies have demonstrated the efficacy of double wire techniques in achieving deep biliary cannulation in adult and pediatric populations with high success and low complication rates.6, 13, 14 On the downside, a multicenter randomized study that enrolled 166 patients raised concern about a higher risk of post ERCP pancreatitis in cases with difficult biliary cannulation where the two wire technique was used compared to patients undergoing standard biliary cannulation (17% in the double wire technique vs. 8% in the standard biliary cannulation (OR 2.13; 95% CI, 0.89-5.05)(9).15 A subsequent prospective randomized controlled Japanese study (n=70 patients) recommended placement of a pancreatic stent in those who undergo cannulation via the two-wire technique.16 Overall, the two-wire technique is felt to be highly valuable and can lead to success in cases of difficult biliary cannulation, but the need for a pancreatic duct stent in these patients is unclear.

Use of Pancreatic Stent to Facilitate Biliary Cannulation

The placement of a pancreatic stent can itself serve as an aid to biliary cannulation beyond its benefits in reducing post-ERCP pancreatitis. The stent provides many of the same potential benefits of pancreatic wire in case of double wire cannulation, namely straightening the ampulla, providing information about the angle and location of the pancreatic duct, and allowing extrapolation of the angle of the bile duct. (Figure 2)

In this situation, considering placement of a pancreatic stent is very appealing since placement of a pancreatic stent itself minimizes the risk of post ERCP pancreatitis with absolute risk reduction ranges from 1 to 13 %.17, 18 With regards to the use of a pancreatic duct stent to aid biliary cannulation, one retrospective study that included 2345 ERCP cases with native papillae, 76 (4.9%) cases required a pancreatic stent placement to facilitate biliary cannulation. Among those, 71/76 (93%) patients had a successful biliary cannulation, with 60 (78.9%) patients avoiding a needle-knife sphincterotomy. Mild pancreatitis was recorded in only 4 patients (5.3%).19

Needle-Knife Sphincterotomy

Needle-knife sphincterotomy refers to performing an access sphincterotomy with a needle-knife catheter to establish biliary access. In general, needle-knife sphincterotomy is generally selected when other, less invasive means of obtaining biliary or pancreatic access have failed or if standard techniques are not felt to be feasible (i.e. impacted stone at the ampullary orifice that does not allow sphinctertome or guidewire passage. It must be stressed that needle-knife sphincterotomy is considered a high-risk procedure. Complications from needle-knife sphincterotomy include, but are not limited to, bleeding, perforation and pancreatitis - all of which can be severe.

The terms “needle-knife sphincterotomy” and “precut sphincterotomy” are sometimes used interchangeably in an erroneous manner. The term “precut sphincterotomy” may often refer to the use of a standard sphincterotome to perform a biliary sphincterotomy before deep biliary access has been obtained with a catheter and/or wire.

Contrary to what one might anticipate, limited data suggest that complications rates from needle-knife sphincterotomy may not fall as operator experiences increase. A key 2002 study reported the success and complication rates from a single endoscopist performing needle-knife sphincterotomy in 253 consecutive patients undergoing ERCP over a 7½-year interval.20 Success rates remained high throughout the entire time period but the overall complication rates and the severity of those complications remained similar throughout the study. This suggested that even in the hands of an expert, needle-knife sphincterotomy should be considered a high-risk procedure.

Modern data have, overall, been more encouraging, with a trend towards lower complication rates. The exact reason for this is unclear, but may represent the use of modern electrosurgical generators and more
understanding of how and when to perform needle-knife sphincterotomy. A 2010 study of cannulation noted that needle-knife sphincterotomy was not an independent predictor of post-ERCP pancreatitis.21

A different prospective study evaluated patients undergoing ERCP where the endoscopist was unsuccessful at achieving biliary cannulation with standard techniques after 10 minutes.22 In this study, patients were randomized to an immediate needle-knife sphincterotomy versus a second group in which cannulation was then attempted for an additional 10 minutes. The incidence of complications between the two groups was quite similar. Interestingly, the rate of pancreatitis was higher in the second group (14.9% versus 2.6%, p=0.008). This study can thus be seen to argue in defense of early needle-knife sphincterotomy in the setting of a difficult biliary cannulation when performed by an experienced operator.

Several techniques were described to perform needle-knife sphincterotomy including free-hand needle-knife (where the cut starts from the ampullary orifice and extends cephalad for variable distance—this is the most common approach), fistulotomy (where the endoscopist cuts into the ampulla above the level of the ampullary orifice), intramural incision (which involves unroofing a “false tract” created by a guidewire through a prominent papilla using a sphincterotome) and a transpancreatic sphincterotomy or also known as endoscopic transpancreatic papillary septotomy (wherein the endoscopist places the tip of the needle knife or sphincterotome in the pancreatic duct orifice and then cuts across the ampullary septum in the direction of the biliary duct).23,24

Utilization of Precut sphincterotomy is variable among endoscopists and has been reported to range from 0-38%.16 There is controversy about whether or not the reported high risk of complications is related to the technique itself or the fact that it is usually considered after prolonged attempts at cannulation, which themselves increase the risk of complications. As such, it is recommended by many authorities to have a low threshold to place a pancreatic stent prophylactically to minimize the risk of post ERCP pancreatitis if a needle-sphincterotomy is to be performed. This recommendation was validated in a randomized controlled trial which showed significantly lower incidence of post ERCP pancreatitis when a pancreatic stent was used in conjugation with needle-knife sphincterotomy (2% vs. 14%, P< 0.05).25

There are mixed results reported regarding the use of endoscopic transpancreatic papillary septotomy to facilitate biliary cannulation. One randomized trial that evaluated both the biliary cannulation rate and complications among patients who underwent either endoscopic transpancreatic papillary septotomy or traditional needle-knife sphincterotomy concluded that
endoscopic transpancreatic papillary septotomy resulted in a higher rate of successful biliary cannulation (100% vs. 77%, p< 0.01) and lower complications rate (3.5% vs. 17.7%). This technique is relatively new with few published studies to date, although most have reported encouraging results.27, 28

Failed Biliary Cannulation

Despite the variety of currently available biliary access techniques, attempts at biliary cannulation may prove unsuccessful. In these situations, physicians have multiple additional options to consider including but not limited to:

1. Repeat ERCP on a different day by the same provider.
2. Transferring the patient to another medical center for repeat ERCP by a preferably more experienced provider.
3. Endoscopic Ultrasound guided biliary drainage.
4. Percutaneous Transhepatic biliary drainage, with or without subsequent endoscopic internalization of biliary drainage.
5. Surgery (rarely).

One study that reported the results of 500 consecutive ERCPs noted a 91.8% success rate in achieving biliary cannulation. Around half of the unsuccessful ERCPs were repeated by the same endoscopist on a different day. This resulted in an 87% successful cannulation rate, endorsing the notion that simply repeating the procedure on a different day may be the best first option in the setting of a failed cannulation.29

Two studies that looked at the success rates of patients with failed biliary cannulation who were referred to another center showed the second ERCP had a success rate that was close to 96%.30, 31

Recently, EUS assisted biliary access techniques has emerged as a new technique for obtaining biliary access in patients with failed ERCP or on whom ERCP is not possible due to anatomic constraints. During this procedure, a linear echoendoscope is used to visualize the intra- or extrahepatic bile duct from either the stomach or the small bowel. Biliary access can be obtained in a transgastric or transduodenal manner with a 19-gauge needle. A guidewire is passed through the needle in an antegrade manner. In some cases transgastric or transduodenal stenting is performed over the wire and in other cases the wire is advanced across the papilla and into the duodenum where it can be used as an aid to retrograde cannulation using standard techniques. These techniques are new, not widely performed, and are still in development. A recent representative retrospective study that included 58 patients who underwent EUS assisted biliary access. The success rate was close to 98% with a 3.4% complication rate.32

Rendezvous procedures and percutaneous biliary access are occasionally required. Percutaneous biliary access is usually established by an interventional radiologist by placing a catheter or wire into the bile ducts to the ampulla to the level of the 2nd duodenum. In some cases an endoscopist can access the bile duct endoscopically following placement of a transampullary catheter or wire and place a stent (internal drainage) to allow the percutaneous catheter to be removed.

Post-Surgical Anatomy

A full discussion of ERCP in patients with post-surgical anatomy is beyond the scope of this manuscript, but a few key points are worth making. ERCP in the setting of surgically altered anatomy is becoming increasingly common. ERCP in such settings can be challenging and, in some cases, impossible. ERCP is sometimes
required in patients who have undergone antrectomy with either Billroth I or Billroth II reconstructions, bariatric procedures such as a Roux-en-Y gastric bypass, or a pancreaticoduodenectomy (Whipple procedure), to name the most common post-surgical situations encountered.

Chahal et al. described their experience performing ERCP in 51 patients who had undergone a prior pancreaticoduodenectomy. Technical success was achieved in 84% of the procedures for biliary indications, 8% for pancreatic indications, and 72% for both indications. In most of the cases a duodenoscope was used.

Single and double balloon enteroscopes allow access to the distal small bowel and may be useful in some situations where a duodenoscope is unable to reach the ampulla. One study evaluating the success of double balloon enteroscopy in patients with a history of a Billroth II gastrectomy included 32 patients. In these patients, a standard duodenoscope was able to reach the papilla in 22/32 patients (69%) and successful cannulation was achieved in 20/32 patients (63%).

A “short” (152 cm) double balloon enteroscope (DBE) was selected for use in 6 patients where cannulation had failed, and this approach allowed access to the papilla in all 6 patients; cannulation ultimately was successful in 5/6 patients (83%).

A study comparing the success rates of performing single balloon assisted ERCP versus spiral assisted ERCP in patients with Roux-en-Y anatomy was recently published. The authors found similar results (100% success or single balloon as compared to 87.5% for spiral enteroscopy). A “short” (152 cm) double balloon enteroscope (DBE) was recently made available. There are few publications that describe the use of this device to perform ERCP in patients with post-surgical anatomy.

In a representative study that reported on results of ERCPs performed on 20 post-surgical patients in 29 sessions, technical success occurred in 25/29 procedures (85%). Similarly, a different study evaluating 68 patients with post-surgical anatomy including Roux-en-Y total gastrectomy (n = 36), Billroth II gastrectomy (n = 17), and pancreaticoduodenectomy (n = 15), 103 ERCP’s were performed with the “short” DBE device. In this study, deep insertion of the device into the small bowel was successful in 100/103 procedures (97%). A cholangiogram was successfully obtained in 98/100 procedures (98%). Treatment was accomplished in all 98 procedures in which a cholangiogram could be obtained (100%). Therapeutic interventions including stone extraction (n = 47), nasobiliary drainage (n = 38), stent placement (n = 36), sphincterotomy (n = 31), choledochojunostomy dilation (n = 29), tumor biopsy (n = 10), and naso-pancreatic duct drainage (n = 1) were performed successfully with only a 4% complication rate.

CONCLUSION

Biliary cannulation is the cornerstone for any successful ERCP. It is the one of the most challenging skill to acquire during ERCP techniques. Failure to achieve biliary cannulation can result in significant morbidities and/or more invasive studies/procedures. Currently, endoscopists have at their disposal an ever-widening array of tools and techniques to allow successful biliary cannulation in almost all settings. Further developments in this realm are almost certain to be forthcoming as dedicated tools for special situations, most notably post-surgical anatomy, continue to be developed.

References


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