



**Open Access**

# Training in Endoscopy: Endoscopic Retrograde Cholangiopancreatography

Jaihwon Kim

Department of Internal Medicine, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seongnam, Korea

Endoscopic retrograde cholangiopancreatography (ERCP) is a key endoscopy skill used to diagnose and treat pancreaticobiliary diseases. However, its diagnostic use is decreasing in favor of other less invasive methods such as magnetic resonance cholangiopancreatography and endoscopic ultrasound. Alternatively, its use has become more important in the therapeutic area. ERCP trainees must know the anatomy and physiology of the pancreaticobiliary system, several key basic skills, and complications of a successful procedure. This article briefly introduces basic ERCP knowledge, techniques, numbers necessary to achieve competency, and complications for new ERCP operators. **Clin Endosc 2017;50:334-339**

**Key Words:** Endoscopy; Cholangiopancreatography, endoscopic retrograde; Biliary tract; Pancreas

## INTRODUCTION

Since endoscopic retrograde cholangiopancreatography (ERCP) introduction in 1968,<sup>1</sup> it has been an essential endoscopic technique for the diagnosis and treatment of pancreaticobiliary diseases. Techniques, indications, and delicate accessories of ERCP have evolved over time, and it is currently performed in many medical centers.

ERCP is an advanced endoscopic technique that is challenging for trainees for several reasons such as the use of side view endoscope, procedural complexity, and risk of complications. As a result, proficiency in using an upper gastrointestinal endoscope is imperative and a precise understanding of the pancreaticobiliary anatomy and physiology is essential. For these reasons, a recent study in the United States has shown

that only 23% of the fellows who completed ERCP training have experience completing >180 cases yearly,<sup>2</sup> meaning that appropriate ERCP training is very difficult in real practice.

In Korea, the education and training guidelines for the board of gastrointestinal endoscopy were published in 2011 by the Korean Society of Gastrointestinal Endoscopy (KSGE),<sup>3</sup> and ERCP training has been also recommended as an optional item. However, there were no established Korean training guidelines for ERCP. Therefore, both trainers and trainees have difficulty with education and learning. In this background, the Korean Pancreatobiliary Association (KPBA) recently published ERCP educational guidelines for fellows.<sup>4</sup> In this article, introductory ERCP training based on the recent KPBA guidelines will be discussed.

## CONSIDERATIONS AT EACH ERCP STAGE

The KPBA guidelines suggested three step considerations: before, during, and after ERCP procedures.

### Before the ERCP procedure

Prior knowledge of the anatomy and physiology associated with pancreaticobiliary diseases, medications for sedative

Received: May 3, 2017 Revised: May 14, 2017

Accepted: May 14, 2017

Correspondence: Jaihwon Kim

Department of Internal Medicine, Seoul National University Bundang Hospital, Seoul National University College of Medicine, 82 Gumi-ro, 173 Beon-gil, Bundang-gu, Seongnam 13620, Korea

Tel: +82-31-787-7075, Fax: +82-31-787-4290, E-mail: drjaihwon@snu.ac.kr

© This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

endoscopy, proper antibiotic usage, informed consent, gastric endoscopy skill, and ERCP indications and contraindications.

### During the ERCP procedure

Basic skills required for beginners, procedure types by difficulty level, and knowledge of radiation exposure.

### After the ERCP procedure

The ability to prevent and manage procedure-related complications and report the results properly after the procedure.

## ANATOMY AND PHYSIOLOGY OF THE PANCREAS AND BILIARY TRACT

The most common biliary indications of ERCP are common bile duct (CBD) stones, benign and malignant biliary stenosis, and bile leak. Pancreatic diseases include anomalies such as pancreas divisum, annular pancreas, acute and chronic pancreatitis, benign and malignant pancreatic stenosis, and pancreatic duct rupture.

Anatomical and physiological knowledge is very important for ERCP success. The American Society for Gastrointestinal Endoscopy (ASGE) emphasizes the need to learn the general anatomy and physiological knowledge of the bile duct and pancreas prior to the ERCP procedure.<sup>5</sup> Therefore, it is necessary to interpret normal anatomical findings and understand the anatomical variations of the biliary duct, pancreatic duct, and papilla. It is also emphasized that endoscopists must understand pathological conditions such as bile duct stones, benign and malignant stenosis of the biliary and pancreatic duct, choledochal cysts, annular pancreas, and pancreatic duct rupture, which can be observed in the pancreatic and biliary duct.

The American Gastroenterological Association (AGA) encourages trainees to master physiological characteristics such as bile component and bile flow regulation, gallbladder and bile duct movement regulation, and anatomical knowledge and exocrine and endocrine function of the pancreas.<sup>6</sup>

During the ERCP procedure, fluoroscopic images of the biliary and pancreatic ducts frequently require rapid interpretation. Therefore, ERCP should be performed by an operator with strong knowledge of normal and abnormal fluoroscopic images. An operator must know the three-dimensional anatomy and normal variations of the biliary and pancreatic ducts to be able to interpret images regardless of a center's equipment. They must also have knowledge of various pathological situations that are indications of ERCP and be able to read images of common diseases well.

Physiological knowledge is not necessary for the ERCP

procedure itself but is necessary for managing and treating patients before and after the ERCP procedure. This physiological knowledge will be achieved during training of the general digestive system before ERCP training; in addition, operators must acquire important physiological knowledge of the bile duct and the pancreatic disease for training ERCP.

In addition to the physiological items required by the ASGE and AGA, operators in Asian countries including Korea must also gain knowledge about primary choledocholithiasis and intrahepatic stones.

## INDICATIONS FOR ERCP

Because ERCP procedures are difficult and can cause serious complications, it is necessary to clearly understand their purpose and indications. Although it is difficult to definitively specify the indications for ERCP procedures, endoscopists who practice ERCP must objectively assess its purpose and indications. Therefore, ERCP should be performed only for appropriate indications<sup>7-9</sup> and should not be routinely used before cholecystectomy. It should also not be performed in cases of abdominal pain without evidence of pancreatic duct closure or to provide routine decompression of malignant biliary obstructions preoperatively. Table 1 shows the ERCP indications suggested by the ASGE.<sup>10</sup>

## BASIC ERCP SKILLS

### Insertion of duodenoscope

To perform the procedure, the duodenoscope should be inserted safely into the second portion of the duodenum. Therefore, it is important that the operator understands the duodenal architecture and how to insert the scope into the esophagus, stomach, and duodenum. Because the duodenoscope is a side view scope and the tip is somewhat stiff, trainees may experience insertion difficulty. When the scope is inserted into the esophagus, the vocal cords are not located at the front of the visual field rather obliquely upward of the visual field. The scope should then be inserted into the vocal cords.

When the pyloric ring is passed, the position of the pylorus is checked and placed at the 6 o'clock position without its placement in the front of the field of view. The endoscopist then gently pushes the scope to insert it into the descending portion. The endoscope is then shortened using the pulling method to naturally allow the distal end of the endoscope to approach the descending portion of the duodenum. Upon shortening, the endoscope appears as an L shape on the contrast. If there is difficulty approaching the papilla through this

shortening method, due to duodenal axis deformity or duodenal diverticulum, the endoscope can be pushed to maintain the long axis and approach the papilla.

Although insertion of the duodenoscope is the most basic component of the ERCP procedure, duodenal perforation may occur during the insertion and pulling procedure.

**Selective cannulation**

After the endoscope insertion into the duodenum, the operator should be trained to enable selective cannulation of the biliary or pancreatic duct through the papilla. Successful catheter insertion into the biliary or pancreatic duct through the papilla is the most basic step in further treatment, so the operator must be aware of the selective cannulation method. With a normal papilla, the 11 o'clock direction of the endoscopic view shows the bile duct, while the 1 o'clock to 5 o'clock

direction of the endoscopic view shows the pancreatic duct.

After training, the KPBA guidelines state that the ERCP trainee's success rate should be >80%.<sup>4</sup> The ERCP trainees should also be trained in rescue methods such as fistulotomy using a needle knife or precut sphincterotomy if standard cannulation fails. Because these procedures are more likely to cause complications, they should be performed after sufficient guidance from a trained specialist. The rescue procedure should not be used primarily and not be used in more than 10%–15% of total ERCP procedures.

**Sphincterotomy**

Sphincterotomy is also a most basic procedure of ERCP. Trainees should be familiar with adaptation of the papillotomy and its implementation. It is also necessary to understand complications such as hemorrhage or perforation after

**Table 1.** General Indications of ERCP by ASGE Guidelines

A. The jaundiced patient suspected of having biliary obstruction (appropriate therapeutic maneuvers should be performed during the procedure).
B. The patient without jaundice who's clinical and biochemical or imaging data suggest pancreatic duct or biliary tract disease.
C. Evaluation of signs or symptoms suggesting pancreatic malignancy when results of direct imaging (e.g., EUS, US, CT, MRI) are equivocal or normal.
D. Evaluation of pancreatitis of unknown etiology.
E. Preoperative evaluation of the patient with chronic pancreatitis and/or pseudocyst.
F. Evaluation of the sphincter of Oddi by manometry. Empirical biliary sphincterotomy without sphincter of Oddi manometry is not recommended in patients with suspected type III sphincter of Oddi dysfunction.
G. Endoscopic sphincterotomy: <ol style="list-style-type: none"> <li>1. Choledocholithiasis.</li> <li>2. Papillary stenosis or sphincter of Oddi dysfunction.</li> <li>3. To facilitate placement of biliary stents or dilation of biliary strictures.</li> <li>4. Sump syndrome.</li> <li>5. Choledochocele involving the major papilla.</li> <li>6. Ampullary carcinoma in patients who are not candidates for surgery.</li> <li>7. Facilitate access to the pancreatic duct.</li> </ol>
H. Stent placement across benign or malignant strictures, fistulae, postoperative bile leak, or in high-risk patients with large unremovable common bile duct stones.
I. Dilation of ductal strictures.
J. Balloon dilation of the papilla.
K. Nasobiliary drain placement.
L. Pancreatic pseudocyst drainage in appropriate cases.
M. Tissue sampling from pancreatic or bile ducts.
N. Ampullectomy of adenomatous neoplasms of the major papilla.
O. Therapy of disorders of the biliary and pancreatic ducts.
P. Facilitation of cholangioscopy and/or pancreatoscopy.

ERCP, endoscopic retrograde cholangiopancreatography; ASGE, American society for gastrointestinal endoscopy; EUS, endoscopic ultrasound; US, ultrasound; CT, computed tomography; MRI, magnetic resonance imaging. Adapted from American Society for Gastrointestinal Endoscopy.<sup>10</sup>

sphincterotomy. Sphincterotomy is usually performed using a pull-type sphincterotome after guidewire insertion into the bile duct. However, it must be careful not to perform sphincterotomy too fast. Since the catheter is sometimes inserted into the pancreatic duct, pancreatic sphincterotomy including its indications and complications should be understood as well.

### Balloon dilatation

Balloon dilatation is mainly used to enlarge the papillary orifice for removal of large CBD stones. Because procedure-related complications such as pancreatitis, hemorrhage, and perforation may occur, it is advisable that the operator selects the proper target and gradually expands the duct during the procedure. It can also be used to expand the stenosis of the bile or pancreatic duct. The balloon diameter should not be larger than that of the proximal portion of the stenosis. ERCP trainees should be aware of the exact indications for this procedure and avoid stretching for long stenotic lesions because of insufficient study results.

### Bile duct stone removal

The removal of CBD stones is a major indication for ERCP and one of the most commonly performed procedures. KPBA guidelines state that the CBD stone removal and bile duct drainage success rate should be  $\geq 85\%$ .<sup>4</sup> Balloons and baskets are mainly used to remove stones, while techniques such as mechanical lithotripsy, electrohydraulic lithotripsy, or laser lithotripsy may be necessary. Electrohydraulic or laser lithotripsy should be performed in a highly skilled and well-equipped situation. It is important that the operator be aware of the risk of stones trapped in the basket and be trained to perform mechanical lithotripsy.

### Stent insertion

ERCP trainees should be aware of the importance of proper drainage after contrast media is injected into the proximal portion of the occlusion and familiar with stenting indications and types. Current stent types include plastic and metal. Operators should be aware of stent types, lengths, diameters, and characteristics. Causes of bile duct obstruction include malignant obstruction, large CBD stones that are difficult to remove, benign strictures due to chronic pancreatitis, or bile duct injury after surgery. Bile duct obstruction caused by these conditions is a common indication for drainage, especially in the presence of jaundice or cholangitis due to bile duct obstruction. KPBA guidelines recommend a successful biliary stent insertion rate  $\geq 80\%$ .<sup>4</sup> In addition to therapeutic stent insertion, special circumstances such as pancreatic stent insertion for the prevention of post-procedure pancreatitis should be recognized.

**Table 2.** Recommended Adequate Numbers of ERCP Experience in Each Skills in a Prospective Study

Skills of ERCP	Adequate numbers of ERCP before achievement
Cholangiography	160
Pancreatography	140
Deep cannulation of the pancreatic duct	160
Stone extraction	120
Stent insertion	60
Overall competence	180–200

ERCP, endoscopic retrograde cholangiopancreatography. Adapted from Jowell et al.<sup>11</sup>

## MINIMAL PROCEDURE NUMBERS NEEDED TO ACHIEVE ERCP COMPETENCY

How many ERCP cases do trainees need to perform to achieve competency? The KSGE education and training guidelines for the board of gastrointestinal endoscopy suggest  $>30$  ERCP cases ( $>10$  therapeutic procedures) as an optional criteria for gastroenterology fellows because of the short length of the training course in Korea, with limited opportunities for ERCP training.<sup>3</sup> However, the Gastroenterology Core Curriculum by the ASGE published in 1996 indicated that fellows had to complete 100 ERCP procedures, including 25 therapeutic cases (20 sphincterotomies and five stent placements).<sup>5</sup> A prospective study evaluated the number of supervised ERCP procedures that physicians must complete to achieve procedural competence.<sup>11</sup> This findings of the study show that competency may be achieved after the completion of the following numbers of procedures: 160 cholangiographies, 140 pancreatographies, 160 deep cannulations of the pancreatic duct, 120 stone extractions, and 60 stent insertions (Table 2).<sup>11</sup> The authors concluded that fellows achieved overall competence after completing 180–200 ERCP procedures. The subsequent ASGE guidelines for advanced endoscopic training stated that most fellows must perform at least 180 procedures to achieve ERCP competency, with at least half of these cases being therapeutic.<sup>12</sup>

## COMPLICATIONS

### Pancreatitis

Post-ERCP pancreatitis, the most common ERCP complication, is known to occur in 1%–7% of patients except for those with sphincter of Oddi dysfunction or pancreatic duct treatment.<sup>13</sup> The incidence of pancreatitis after ERCP varies

by endoscopist experience and procedural difficulty. Risk factors of post-ERCP pancreatitis are divided into two categories: patient and technique. Patient-related factors include younger age, suspected sphincter of Oddi dysfunction, history of previous post-ERCP pancreatitis, and normal serum bilirubin. Women may be at increased risk, but it is difficult to determine the confounding effect of sphincter of Oddi dysfunction, a condition that occurs almost exclusively in women. Technique-related factors include papillary trauma by repetitive cannulation, acinarization of the pancreas by contrast injection, and pancreatic sphincterotomy. To reduce the incidence of post-ERCP pancreatitis, guidewire or hybrid technique using minimal contrast in combination with wire probes, pancreatic duct stent in specific situations such as biliary sphincterotomy for sphincter of Oddi dysfunction, suspected sphincter of Oddi dysfunction with normal manometry, pancreatic sphincterotomy, precut sphincterotomy, balloon dilation of the biliary sphincter, and endoscopic ampullectomy can be used after pancreatic wire-assisted biliary cannulation, probably after difficult cannulation, and even after unselected ERCP in patients with “virgin papilla,” excluding those with pancreas divisum or cancer.<sup>14</sup>

### Perforation

Perforation due to ERCP is known to occur in approximately 0.1%–0.6% of cases, and in patients with normal anatomical structure, a perforation rate of <1% is expected.<sup>13</sup> Perforation by a simple guidewire does not usually require surgery and can usually be managed conservatively (fasting, fluid, and antibiotics), and perforation of the biliary or pancreatic duct can be treated with a stent. In contrast, esophageal and gastric perforation require surgery. Both conservative management and surgery are considered in cases of small perforations of the posterior duodenal wall.<sup>15</sup>

### Bleeding

Bleeding during ERCP is common and does not represent an adverse outcome. As a result, post-ERCP bleeding is defined as immediate hemorrhage requiring endoscopy or another intervention, while delayed hemorrhage is defined as hemoglobin reduction or hemorrhage requiring transfusion within 10 days after the procedure. Post-ERCP hemorrhage is observed in approximately 1% of cases, but most cases are mild hemorrhage. Bleeding risk after major sphincterotomy is known to occur in up to 2% of cases.<sup>13</sup> Methods to prevent hemorrhage after sphincterotomy are balloon dilatations of sphincters, correction of any coagulopathies, withholding of anticoagulant medications for as many as 3 days afterward, and use of a meticulous endoscopic technique. For the treatment of significant hemorrhage, several endoscopic

treatments such as injection of dilute epinephrine, balloon tamponade, and thermal therapy can be used. In cases of refractory bleeding, angiographic therapy is rarely used.<sup>14</sup>

## CONCLUSIONS

ERCP is an important endoscopic technique that is used for the diagnosis and treatment of pancreatobiliary disorders, but it remains challenging and complicated. Trainees should be aware of the anatomy and physiology of pancreatobiliary system and know basic ERCP skills and complications. A trainee must continuously learn and practice this technique to become an experienced ERCP endoscopist.

### Conflicts of Interest

The author has no financial conflicts of interest.

## REFERENCES

- McCune WS, Shorb PE, Moscovitz H. Endoscopic cannulation of the ampulla of Vater: a preliminary report. *Ann Surg* 1968;167:752-756.
- Shahidi N, Ou G, Telford J, Enns R. When trainees reach competency in performing ERCP: a systematic review. *Gastrointest Endosc* 2015;81:1337-1342.
- Lee KM, Choi SR, Jang BI, et al. Education and training guidelines for the board of the Korean society of gastrointestinal endoscopy. *Korean J Gastrointest Endosc* 2011;42:207-214.
- Kim J, Park ET, Son BK, et al. ERCP educational guidelines for fellows. *Korean J Pancreas Biliary Tract* 2017;22:1-13.
- Chutkan RK, Ahmad AS, Cohen J, et al. ERCP core curriculum. *Gastrointest Endosc* 2006;63:361-376.
- American Association for the Study of Liver Diseases; American College of Gastroenterology; American Gastroenterological Association; American Society for Gastrointestinal Endoscopy. Training the gastroenterologist of the future: the gastroenterology core curriculum. *Gastroenterology* 2003;124:1055-1104.
- Carr-Locke DL. Overview of the role of ERCP in the management of diseases of the biliary tract and the pancreas. *Gastrointest Endosc* 2002;56(6 Suppl):S157-S160.
- Hawes RH. Diagnostic and therapeutic uses of ERCP in pancreatic and biliary tract malignancies. *Gastrointest Endosc* 2002;56(6 Suppl):S201-S205.
- Adler DG, Baron TH, Davila RE, et al. ASGE guideline: the role of ERCP in diseases of the biliary tract and the pancreas. *Gastrointest Endosc* 2005;62:1-8.
- Appropriate use of gastrointestinal endoscopy. American Society for Gastrointestinal Endoscopy. *Gastrointest Endosc* 2000;52:831-837.
- Jowell PS, Baillie J, Branch MS, Affronti J, Browning CL, Bute BP. Quantitative assessment of procedural competence. A prospective study of training in endoscopic retrograde cholangiopancreatography. *Ann Intern Med* 1996;125:983-989.
- Baron TH, Petersen BT, Mergener K, et al. Quality indicators for endoscopic retrograde cholangiopancreatography. *Gastrointest Endosc* 2006;63(4 Suppl):S29-S34.
- Cotton PB, Lehman G, Vennes J, et al. Endoscopic sphincterotomy complications and their management: an attempt at consensus. *Gastrointest Endosc* 1991;37:383-393.
- Kahaleh M, Freeman M. Prevention and management of post-endo-

scopic retrograde cholangiopancreatography complications. Clin Endosc 2012;45:305-312.

15. Kwon CI, Song SH, Hahm KB, Ko KH. Unusual complications related

to endoscopic retrograde cholangiopancreatography and its endoscopic treatment. Clin Endosc 2013;46:251-259.