Techniques and Outcomes of ERCP in Patients with Billroth II Anatomy

ERCP in patients with Billroth II can be challenging even in experienced hands because of altered anatomy. The challenges include afferent limb intubation, reaching the duodenal papilla, and selective cannulation. In general, side-viewing endoscope is preferred but it is mostly operator dependent and when the afferent limb is long, colonoscope or single or double-balloon enteroscope can be useful. Similarly, the choice of sphincterotomy technique depends on the individual endoscopist’s preference. The risk of complications like perforation, bleeding, cholangitis, and pancreatitis can be higher with ERCP in Billroth II patients when compared to native anatomy.

INTRODUCTION

Billroth II reconstruction is performed when more extended distal gastrectomy is required, and it preserves jejunal continuity not duodenal continuity. The procedure involves anastomosing the remnant stomach to the proximal jejunum in an end-to-side fashion. The afferent limb is from the duodenum and an efferent limb extends distally. The common indications for Billroth II procedure are to treat malignant tumor in the distal lower two-thirds of the stomach, complications of peptic ulcer disease (perforation, bleeding, and duodenal stricture), neuroendocrine ulcer disease, and management of devascularization injuries of the stomach secondary to trauma. The choice of reconstruction depends on the remnant anatomy available for reconstruction and from the previous studies, Roux-en-Y reconstruction appears to be well tolerated with better quality of life when compared to Billroth II. Endoscopic retrograde cholangiopancreatography (ERCP) is technically difficult in patients with Billroth II as the papilla can only be reached through the afferent limb and the papillae of vater appears upside-down compared with its orientation in native anatomy. In this review article, we will discuss the technical challenges of ERCP in Billroth II using different types of endoscopes, complications, and outcomes of ERCP as patients with this anatomic reconstruction are still encountered in clinical practice.
Billroth II Anatomy
The Billroth II anastomosis is constructed after the proximal stomach is transected at the antrum and the duodenum is divided distal to the pyloric ring. Billroth II gastrojejunoanastomosis anastomosis can be of two types, anastomosis involving the entire gastric division edge (polya) or part of the entire gastric division edge (Hofmeister). In the polya technique, the gastrojejunal anastomosis includes the entire length of the gastric resection line, whereas in the Hofmeister technique, the half of the gastric resection line closest to the lesser curvature is sutured, and the lower half closest to the greater curvature is anastomosed to the proximal jejunum. The anisoperistaltic anastomosis (afferent loop on the lesser curvature) helps the biliopancreatic secretions that reach the lesser curvature to empty along the greater curvature of the stomach and prevents biliary reflux. An infracolic anastomosis prevents the jejunal loop from narrowing as it traverses the mesocolon. Retrocolic position when compared to precolic decreases delayed gastric emptying. A precolic gastroenterostomy is necessary when the lesser cavity is inaccessible among patients undergoing palliative gastrectomy.

The common indications for Billroth II reconstruction include gastric cancer (lesions in the lower two-thirds of the stomach), leiomyoma, complications of ulcer disease (gastric outlet obstruction, bleeding, perforation), and devascularization injury to stomach. The perioperative outcomes among patients with gastric cancer are similar in both Roux-en-Y and Billroth II groups in terms of morbidity, mortality, and nutritional impairment. The rate of anastomatic inflammation and biliary reflux is higher with Billroth II when compared to Roux-en-Y group. Roux-en-Y has a higher rate of delayed gastric emptying when compared to Billroth II.

Technical Challenges of ERCP in Billroth II Anatomy
The inability to reach the papilla is one of the most common causes for the failure of ERCP in patients with altered anatomy. The various factors that contribute to the difficult access to the papilla include the length of the afferent limb, limbing of the duodenoscope in the remnant stomach, excess angulation of the afferent limb, and the presence of braun anastomosis. Braun anastomosis is creating an enteroenterostomy between the afferent and efferent limbs to divert food to the efferent limb to prevent bile reflux. While some authors report differences in the papillary access failure rates using the duodenoscope (31.8%) and forward-viewing endoscopes (8.65%), others showed similar papillary access failure rates with different endoscopes. In situations where the afferent limb could not be intubated or advancing within the afferent limb is challenging, the use of a front-viewing endoscope, changing the position to supine or prone position, and manual compression in the epigastric region can help reduce the limbing of the endoscope.

Selective cannulation of the bile duct can be challenging in patients with Billroth II anatomy because of the inverted orientation of the papilla and, by extension, the pancreatic duct and the common bile duct (CBD). The elevator on the side-viewing duodenoscope allows precise manipulation during the cannulation step of the ERCP and the success rate of cannulation is higher when the side-viewing endoscope is used when compared with the forward-viewing endoscope. A transparent cap can, to some extent, overcome the lack of an elevator on the forward-viewing endoscope as it enhances the stability of the endoscope and provides a higher degree of anatomic alignment between the catheter and the desired duct during selective cannulation. In terms of the endoscopic view, the position of the working channel is very important. The position of the working channels is different for each of the endoscopes. Selective cannulation can be attempted by matching the orientation of the position where the catheter emerges on the endoscopic view and the position of the papilla, although in practice this can be difficult, especially with a forward viewing instrument.

Sphincterotomy
In patients with Billroth II reconstructions, because of the reversed anatomy, a biliary sphincterotomy should be undertaken in the direction of 5 o’clock instead of 11 o’clock. The choice of the sphincterotomy technique depends on the individual endoscopist’s preference. The
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various methods of performing sphincterotomy in patients with Billroth II include standard sphincterotomy, reverse sphincterotomy (Billroth II sphincterotome) and needle-knife sphincterotome guided by biliary endoprosthesis. Wire-guided standard sphincterotomy (PreCurved Double Lumen Sphincterotome, Cook Medical, Limerick, Ireland) endoscopic sphincterotomy (EST) is performed using a side-viewing or forward-viewing endoscope, a guidewire is first inserted in the bile duct and then a standard sphincterotome was used to perform the EST. Wire-guided BII sphincterotome (Billroth II Sphincterotome, Cook Medical, Limercik, Ireland) EST using a side-viewing or forward-viewing endoscope is performed by using a Billroth II sphincterotome after cannulation of the bile duct with a guide wire. Needle-knife (Huibregtse Triple Lumen Needle Knife, Cook Medical, Limerick, Ireland) EST guided by biliary endoprosthesis using a side-viewing or forward-viewing endoscope is performed in three steps (cannulation of the bile duct using a guide wire, insertion of a biliary stent, and the biliary stent is used as a guidance while cutting the papilla with a needle knife).

When the cutting scores were compared by the three different techniques (standard sphincterotome, Billroth II sphincterotome and needle-knife sphincterotome), the needle knife was significantly superior to the others and Billroth II sphincterotome had significantly shorter time consumption when (continued on page 54)
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Abdelhafez et al. showed the efficacy of endoscopic sphincterotomy using standard sphincterotome, BII sphincterotome, and needle knife guided by endoprosthesis were 2.2±3.0, 6.3±2.8, 8.9±1.5 (blinded videotypes rated by an ERCP expert using mean and standard deviation on a scale of 0-10) respectively. The study did not find any significant difference in the efficacy of the endoscopic sphincterotomy using forward or side-viewing endoscopes. Also, the mean and standard deviation for the duration (seconds) of different endoscopic sphincterotomy techniques using standard sphincterotome, B II sphincterotome, and needle knife guided by endoprosthesis showed 249.8±105.9, 163.5±80.7, and 243.4±37.8 respectively. There was no significant difference between the duration of different endoscopic sphincterotomy techniques using forward or side-viewing endoscopes.

Endoscopic transpapillary balloon dilation (EPBD) can be safe and effective in Billroth II patients for the removal of large CBD stones without ES but some authors recommend ES before EPBD to prevent pancreatitis and ES can guide the ballooning direction for the effective removal of bile duct stone.

**ERCP Procedure**

ERCP procedures in patients who have undergone previous Billroth II gastrectomy patients are generally approached initially with a side-viewing

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**Figure 2a.** Endoscopic image of inverted papilla in a Billroth II patient. Note pus at ampulla consistent with cholangitis.

**Figure 2b.** After cannulation of the bile duct with an inverted rotatable sphincterotome, the cutting wire is oriented to the opposite of normal positioning.

**Figure 2c.** Biliary sphincterotomy is performed with the inverted sphincterotome.

**Figure 2d.** A large stone is removed from the bile duct after sphincterotomy using a stone retrieval basket.
duodenoscope. In most patients, the ampulla can be reached with this device. If this is not the case, the duodenoscope can be changed to a forward-viewing gastroscope or an adult or pediatric colonoscope. The afferent limb is usually located in the lesser curvature of the stomach, but in practice identifying the afferent limb is often a matter of trial and error. If there is no evidence of bile on the intubated limb and if the endoscope is in the left abdominal quadrant toward the pelvis on the fluoroscopic image, the other limb should be accessed. In situations where the afferent limb is tight with sharp angulations, a catheter and a soft angled guidewire can be advanced to the duodenal stump under fluoroscopic guidance to determine if it is feasible to proceed with the duodenoscope. Fluoroscopy often provides critical clues as to which limb has been intubated, as the endoscope should still arc towards the right upper quadrant.

Cannulation can be performed using standard straight ERCP catheters (ERCP-1-HKB, Cook Endoscopy, Winston Salem, North Carolina, USA) or bendable catheters (Swing Tip, Olympus Medical, Tokyo, Japan). In patients with Billroth II, some find straight catheters to be more useful as the direction for cannulation is at the 5 o’clock position and steerable catheters can guide to the papilla. Other practitioners simply start with a sphincterotome as these can often be rotated to accommodate the inverted ampulla and simplify cannulation.

Technical success is defined by access to the papilla and cannulation of the desired duct (biliary or pancreatic). Clinical success is achieved by extraction of the stone from the bile duct, stent placement for benign or malignant stricture, and achieving biliary or pancreatic drainage.

Types of Endoscopes
The choice of the endoscope for ERCP in patients with Billroth II gastrectomy depends on the operator preference. The forward-viewing endoscope allows to enter the afferent limb easily and safely because of the advantage to see the lumen en face. The disadvantages with the forward-viewing endoscope are its shorter working length, which may create problems reaching the papilla (especially in patients with a long afferent limb) and the lack of elevator. The cap assisted forward-viewing endoscope can aid in better identification of the afferent limb by allowing better maneuvering around acute angulations. The cap provides a fixed distance between the jejunal wall and tip of the endoscope and allows easier cannulation of the papilla. On the other hand, the side-viewing endoscope has the advantage of having a long working length and an elevator. However, with the side-viewing endoscope it is not always possible to see the lumen en face which makes it challenging to enter the afferent loop and increases the risk of small bowel perforation.

The anterior oblique-viewing endoscope has the advantage of both forward-viewing and side-viewing endoscope by providing both good visibility and the presence of elevator helps in the cannulation of the desired duct. This device is not in widespread use.

When the efferent limb is too long to reach the afferent limb, a colonoscope or a single-balloon or double-balloon enteroscope (DBE) with a wide working channel can be useful. A colonoscope can often reach the ampulla in patients with Billroth II anatomy. A balloon-assisted enteroscope can help to overcome sometimes the sharp angulation of the gastrojejunal anastomosis and can advance deep into the small intestine when compared to side-viewing or standard forward-viewing endoscopes. The disadvantages of balloon-assisted enteroscopy include difficulty in obtaining an en face view of the papilla, the fact that they can be technically demanding to operate and requires expertise, and the need for specialized equipment.

Risk Factors for ERCP and Complications
Looping during scope insertion can be a risk factor for perforation during ERCP in patients with Billroth II anatomy. Perforation can occur via the tip or the shaft of the endoscope. The shape of endoscope insertion upon reaching the target site in patients with Billroth II reconstruction can be J type or looped (L) type. J type is a simple scope configuration that makes it easy to reach the ampulla, while L type scope insertion forms a loop and makes it challenging to reach the ampulla. In patients with Billroth II reconstruction, loop-shaped insertion of the endoscope upon reaching the ampulla is strongly associated with perforation. Intestinal adhesions from Billroth II reconstruction can
reconstruction can also lead to perforation during ERCP and it is unclear if antecolic or retrocolic gastrojejunostomy is more strongly associated with intestinal adhesions.\textsuperscript{32}

Surgically altered anatomy is a risk factor for perforation while performing ERCP. Previous studies showed that the overall rate of perforation during ERCP with normal anatomy, Roux-en-Y and Billroth II were 0.35\%, 2.0-11.1\%, and 5.6-7.7\% respectively, illustrating the increased risk in these patients.\textsuperscript{26,33-36} Perforations usually occur when the afferent limb is entered near the duodenojejunal flexure resulting in tear of the jejunal wall, rather than direct perforation by the tip of the scope.\textsuperscript{26}

Perforations can also occur after sphincterotomy, which is estimated to occur in 1.5-5\% patients with Billroth II anatomy.\textsuperscript{37} The rate of perforation with sphincterotomy is higher with Billroth II anatomy because of the inverted position and there is often a paucity of information regarding the direction of cutting, and length of the sphincterotomy.\textsuperscript{26}

Perforations are more common at the acute angled site of the afferent limb.\textsuperscript{38} Perforations after sphincterotomy can be intraperitoneal or retroperitoneal. Most retroperitoneal perforations can be managed conservatively by bowel rest, nasogastric biliary decompression, and antibiotics.

When the rates of complications are compared using different endoscopes, more adverse events have been reported with the use of side-viewing endoscope, although most favor this device in the context of Billroth II ERCP. Park et al. showed that the rate of bowel perforation vs. post-ERCP pancreatitis using side-viewing, forward-viewing, balloon-assisted, oblique-viewing, and dual-lumen endoscope in Billroth II anatomy were 3.6\% vs. 1.8\%, 1.7\% vs. 4.1\%, 4.1\% vs. 3.0\%, 1.2\% vs. 1.8\%, and 3.1\% vs. 1.6 \% respectively.\textsuperscript{31} Similarly, bleeding with side-viewing, forward-viewing, and oblique-viewing endoscope occurred in 1.9\%, 1.4\%, and 0.6\% respectively.\textsuperscript{31}

The rates of bowel perforation vs. post-ERCP pancreatitis in patients with Billroth II anatomy who underwent endoscopic sphincterotomy, EST+EPBD, and EPLBD have been reported to be 3.5\% vs. 1.2\%, 1.3\% vs. 3.7\%, 2.0\% vs. 6.5\%, 1.8\% vs. 2.3\% respectively.\textsuperscript{31} Similarly, bleeding with EST, EST+EPBD, and EPLBD were reported to be 1.7\%, 1.3\%, and 1.8\% respectively.\textsuperscript{31} Published outcomes following ERCP in Billroth II patients are shown in Table 1. practicalgastro.com/uploads/adler-table-1.pdf

**CONCLUSION**

ERCP in Billroth II can be technically challenging but safe in experienced hands. In general, side-viewing endoscope with or without endoscopic sphincterotomy can aid in the successful cannulation and lead to both technical and clinical success. However, the choice of endoscope sometimes depends on the endoscopists preference, the patient’s specific surgical anatomy, and the indication for the procedure. Single or double balloon enteroscope can be useful when the afferent limb is too long to reach and careful planning prior to the procedure can reduce the risk of complications. Prompt recognition of adverse events like perforation, cholangitis, pancreatitis, and bleeding can lead to effective management and improve the outcomes of ERCP in Billroth II patients. 

**References**


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