Biliary bypass redux: lessons for the therapeutic endoscopist from the archives of surgery

With the advent of lumen-apposing self-expandable metal stents (LAMS) and 1-step biliary drainage systems (DEUS) we have entered a new era of therapeutic endoscopy, in which novel endoscopic anastomosis creation has taken on a multitude of forms. Although many of these procedures represent significant advances in the potential for endoscopists to solve clinical problems, they simultaneously represent recapitulations of procedures that have been performed and perfected by surgeons over many decades. Operative biliary bypass has been the historical criterion standard for palliation of malignant biliary obstruction, and it has been considered both effective and durable. Reviewing the history of GI surgery, and the lessons learned therefrom, we might be able to avoid the pitfalls and improve the outcomes of procedures that are now being performed endoscopically. In this review, we focus on the history of surgical procedures used for the purpose of bypassing biliary obstruction. Endoscopic counterparts of these procedures involve the creation of a new extraanatomic bypass facilitated by the insertion of an anastomotic device, such as an LAMS. Of course, EUS can be used to gain access to an obstructed biliary tree for guidewire passage across the obstruction, and subsequent recanalization of the biliary tree with a stent, but these types of anatomy-preserving procedures are not the primary focus of this discussion.

Biliary bypass surgery has been performed to reroute the flow of bile in patients with both benign and malignant disorders of the extrahepatic biliary tract or pancreas.[1,2] The surgical options for these diverse conditions depend on both the specific pancreaticobiliary pathologic condition involved and the length and quality of expected patient survival, especially in individuals with malignant conditions. However, because survival remains difficult to predict, management should generally be tailored to ensure the best quality of life.[2-4]

The surgical options for biliary bypass can use either the intrahepatic bile ducts (IHBD), the common bile duct (CBD), or the gallbladder as a conduit for biliary flow; anastomoses can be created to the stomach, to the duodenum, or to a jejunal Roux limb, leading to 7 major permutations for patients with native anatomy: hepaticogastrostomy (HG), cholecystogastrostomy (CCG), choledochoduodenostomy (CDD), cholecystoduodenostomy (CCD), choledochojejunostomy (CDJ), Roux-en-Y hepaticoenterostomy (RYE), and Roux-en-Y cholecystojejunostomy (RYC), the choice of which is frequently determined by the surgeon's preference and the extent of disease. All of these types of biliary-enteric bypasses have been demonstrated to be efficacious in retrospective series.[5] Table 1 characterizes the advantages, disadvantages, and endoscopic feasibility of each approach.

Numerous technical factors need to be considered in the performance of biliary bypass operations, some of which are not pertinent to endoscopic variants of these procedures. Direct bilioenteric anastomosis to the jejunum, and the creation of a Roux-en-Y limb as a conduit for biliopancreatic secretions, are not endoscopically feasible, except in patients who already have surgically altered anatomy. These jejunal anastomoses, technically easier to perform, are intended to reduce the likelihood of recurrent jaundice by placing the anastomosis at a distance from the tumor[6-10] and to reduce the likelihood that intestinal contents will reflux into the biliary tract.[8,11] But the concept that using the jejunum rather than the duodenum as a conduit for biliary bypass in patients with cancer will reduce the risk of delayed biliary obstruction by tumor growth may be more hypothetical than real; among more than 2400 patients undergoing CDD for unresectable cancer, recurrent obstruction occurred in an average of only 6.6% of patients (0%-7%), which compared favorably with a recurrence rate of 7.4% (6%-20%) in patients undergoing CDJ and 10.1% (6%-21%) in patients undergoing cholecystoenterostomy.[12] Using the duodenum (eg, in CDD) offers the theoretic advantage of being more physiologic, returning bile to the duodenum, maintaining alkaline secretions, neutralizing gastric acid, and maintaining normal feedback mechanisms of GI secretion—factors that may result in a lower rate of ulcer formation, as compared with Roux-en-Y reconstructions.[13-15] This option is obviously not helpful if neoplastic obstruction of the duodenum develops distal to the CDD bypass. Hepaticoenterostomy is reserved for cases in which either the extent of bile duct involvement precludes choledochoenterostomy or the cystic duct/common duct confluence is compromised, precluding cholecystoenterostomy.[5]

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TABLE 1. Advantages, disadvantages, and endoscopic feasibility of various biliary-enteric anastomoses

Anastomosis	Advantage	Disadvantage	Endoscopic feasibility
Bile duct conduct	More reliable long-term conduit	Bile stasis; sump syndrome	Yes
Gallbladder conduit	Easier to perform	Dependent on cystic duct patency	Yes
Anastomosis to the stomach (cholecystogastrostomy, hepaticogastrostomy)	–	Gastric acid hypersecretion secondary to gastrin release and bile gastritis	Yes
Anastomosis to the duodenum (cholecystoduodenostomy, choledochoduodenostomy)	More physiologic; returns bile to the duodenum, maintains alkaline secretions, neutralizes gastric acid and maintains normal feedback mechanisms of GI secretion	Bile stasis; sump syndrome	Yes
Anastomosis to the jejunum	Recurrent jaundice less likely	Less physiologic; ulcer formation possible	No
Roux-en-Y limb	Reflux of intestinal contents into the biliary tract less likely	–	No

The creation of a cholecystoenteric anastomosis was first suggested more than 140 years ago by Johann Nepomuk Ritter van Nussbaum.[16] It was not until 10 years later however, in 1880, that the first cholecystoenteric anastomosis was performed, by Alexander van Winiarter.[16] Choledochoduodenostomy was first described in 1892 by Reide.[17] Surgical anastomosis of the gallbladder directly to the stomach is now rarely performed, both because of the technical difficulty of anastomosing a thin-walled gallbladder to a thick-walled stomach and because of bile gastritis and adverse events resulting from gastric acid hypersecretion caused by gastrin release.[11]

Ideally, a bilioenteric anastomosis should improve biliary drainage, prevent stasis, and avoid the consequences of back-pressure (the sump syndrome). The latter is due to reflux of intestinal contents into the biliary tree in patients with a CDD, which tend to collect in the cul-de-sac of the residual intrapancreatic portion of the CBD. The clinical manifestations include cholangitis, hepatic abscess formation, and acute pancreatitis. The prevalence of sump syndrome is reported between 0% and 9.6%[18-20] and may be a technical adverse event of inadequate stomal size and unfavorable anastomotic configuration.[21] The vascular anatomy of the bile duct and the potential for postoperative biliary strictures resulting from anastomotic ischemia have led to the general recommendation that the biliary enteric anastomosis should be performed as high within the biliary tree as possible.[6] However, to reduce the incidence of sump syndrome, the anastomosis should also be located at the lowest possible point of the CBD, which is thought to reduce stasis and cholangitis.[22,23] Creating an adequate stoma measuring at least 2.5 cm in diameter is also believed to reduce the chances that sump syndrome will develop. These recommendations are based on postoperative contrast studies,[24] where it was proposed that the more barium that refluxed up through the anastomosis the better. Despite the reflux of duodenal contents into the CBD, no increased incidence of cholangitis has been reported in the absence of obstruction.[25,26] Stasis may also be a determining factor for the development of choledochitis,[27] a risk factor for malignancy, which is reported to occur in as many as 5% to 8% of patients with choledochoenteral anastomosis.[28] The long-term risks of sump syndrome and recurrent obstruction with CCD are unknown. Larger LAMS (currently available in the United States only in 10-mm or 15-mm diameters) could theoretically reduce the risk of sump syndrome, a condition that can generally be prevented with biliary sphincterotomy when the distal bile duct is unobstructed.[29] Besides, dedicated biliary LAMS, more specific for gallbladder and CBD drainage, are needed.

Another consideration is the risk of delayed biliary obstruction by local tumor progression. Whether to use the gallbladder as a conduit for bypassing a malignant distal biliary obstruction remains controversial, given the potential for malignant obstruction of the cystic duct. Patency of the cystic duct and communication with the CBD must be established before such a procedure can proceed, and the junction of the cystic duct with the common hepatic duct should be at least 1 cm above the proximal extent of the tumor.[30] Tarnasky et al[30] reported that among 101 potential candidates for this approach, ERCP revealed an obstructed cystic duct in 51 patients and cystic duct takeoff within 1 cm of the biliary stricture in 28 patients. As a result, only 22% of the candidates were suitable for cholecystojejunostomy (CCJ). However, proponents of using the CBD rather than the gallbladder (and hence the cystic duct) believe that cholecystoenterostomies are not reliable long-term conduits and that mechanical or functional biliary obstruction will inevitably develop, with resultant cholangitis or recurrent jaundice.[31-36] Most of the published reports comparing the gallbladder and the