Original Investigation | PACIFIC COAST SURGICAL ASSOCIATION

Use the Duodenum, It’s Right There
A Retrospective Cohort Study Comparing Biliary Reconstruction Using Either the Jejunum or the Duodenum

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IMPORTANCE This is the largest series to date comparing end-to-side biliary reconstruction for all indications performed using either the duodenum or jejunum and with at least 2-year follow-up.

OBJECTIVE To demonstrate that duodenal anastomoses for biliary reconstruction are at least as safe and effective as Roux-en-Y jejunal anastomoses, with the benefits of operative simplicity and ease of postoperative endoscopic evaluation.

DESIGN, SETTING, AND PARTICIPANTS Retrospective record review with telephone survey of patients undergoing nonpalliative biliary reconstruction in the hepatopancreatobiliary surgery division of a high-volume tertiary care facility.

INTERVENTIONS Biliary reconstruction via either end-to-side Roux-en-Y jejunal anastomosis or direct duodenal anastomosis.

MAIN OUTCOMES AND MEASURES The primary end points were anastomosis-related complications (leak, cholangitis, bile gastritis, or stricture), and the secondary end points were overall complications, endoscopic or radiologic interventions, readmissions, and death.

RESULTS Ninety-six nonpalliative biliary reconstructions were performed between February 1, 2000, and November 23, 2011 for bile duct injury, cholangiocarcinoma, choledochal cysts, or benign strictures; the procedures included 59 duodenal reconstructions and 37 Roux-en-Y jejunal reconstructions. The groups were similar with regard to demographics, operative indications, postoperative length of stay, and mortality rates. However, anastomosis-related complications (leaks, cholangitis, or strictures) were fewer in the duodenal than the jejunal cohort (7 patients [12%] vs 13 [35%]; P = .009). Of patients with stricture, 5 of 9 in the jejunal cohort required percutaneous transhepatic access for management compared with only 1 of 2 in the duodenal cohort.

CONCLUSIONS AND RELEVANCE Duodenal anastomosis is a safe, simple, and often preferable method for biliary reconstruction. This anastomosis can successfully be performed to all levels of the biliary tree with low rates of leak, stricture, cholangitis, and bile gastritis. When anastomotic complications do occur, there is less need for transhepatic intervention because of easier endoscopic access.
Biliary-enteric anastomoses have a long history, dating to 1881 when Von Winicz performed the first surgical cholecystostomy. This was shortly followed by the first side-to-side choledochoduodenostomy by Riedel in 1888, the first end-to-side choledochoduodenostomy by Mayo in 1905, and the first Roux-en-Y choledochojejunostomy by Monprofit in 1908. Eventually, the Roux-en-Y biliary-enteric anastomosis became the criterion standard for reconstruction of the biliary tract. The indications for reconstruction have changed very little over the years, with injury, choledochal cysts, stricture or obstruction, and malignant neoplasms still being most common. Numerous studies have reported satisfactory outcomes with Roux-en-Y jejunal anastomoses but very little is known about the long-term results of duodenal anastomoses for biliary reconstruction.

There have been long-standing biases against using the duodenum for biliary reconstruction. The widespread adoption of this technique has been limited by claims that the duodenum does not reach, can be used only with a dilated duct, and has higher incidences of cholangitis, stricture, anastomotic leak, bile gastritis, and “sump syndrome.” However, many of these suppositions are based on priori reasoning and not on empirical evidence. In fact, findings of recent studies have suggested that using the duodenum for reconstruction may be as safe and durable as using the jejunum. Most of these studies have investigated only the outcomes of side-to-side duodenal anastomoses for palliation of malignant disease or choledochal cysts, often with limited follow-up. To date, we have been unable to find a direct comparison of end-to-side biliary reconstruction using the duodenum vs Roux-en-Y jejunal anastomosis in adults, for all indications, and with a sufficient length of follow-up.

We hypothesize that a duodenal anastomosis for biliary reconstruction is at least as safe and durable as a Roux-en-Y jejunal anastomosis, with the added benefits of ease of operation and postoperative endoscopic access. We have assembled and analyzed the largest retrospective cohort study to date, comparing the surgical outcomes of patients with biliary reconstructions for all indications using either a duodenal anastomosis or a Roux-en-Y jejunal anastomosis. We investigated both short- and long-term outcomes, the need for endoscopic and/or percutaneous access to the biliary tree, operative times, and associated hospital charges in these patient cohorts.

**Methods**

**Patient Selection**

All patients at our institution undergoing biliary reconstruction via duodenal anastomoses or Roux-en-Y jejunal anastomoses between February 1, 2000, and November 23, 2011, were identified by current procedural terminology codes 47760, 47765, 47780, 47785, 47720, 47711, and 47712. Patients were stratified into 2 cohorts based on their anastomotic type: duodenal anastomoses or Roux-en-Y jejunal anastomoses. Patients were excluded from analysis if the anastomosis was done for palliative reasons or in a side-to-side fashion or lacked 30-day postdischarge follow-up. Appropriate institutional review board approval was obtained before any record review or patient contact.

**Outcomes**

A retrospective record review of our electronic medical record system (Cerner) was undertaken to identify key data points. Complications and subsequent treatment were identified via medical record and telephone survey. Hospital charges were determined by billing data associated with the hospital stay during the time of the operation. Charlson comorbidity index scores were determined by International Classification of Diseases, Ninth Revision (ICD-9) codes present in our billing database at the time of the operation and were calculated only for cases after 2007. Postoperative complications were graded using the Clavien-Dindo classification schema and sorted dichotomously, with grade III complications the delineation between the 2 groups. Grade III or higher complications are those that require surgical, radiologic, or endoscopic intervention, require ICU management, or result in death. Bile duct injury cases were stratified into 3 groups for analysis based on time since transaction: early repair (0–72 hours), intermediate repair (72 hours to 6 weeks), and delayed repair (>6 weeks). These time periods were selected based on the likelihood of concurrent inflammation, with repairs performed at 3 days to 6 weeks being the most predisposed. Biliary strictures and cholangitis developing secondary to underlying disease (eg, recurrent cancer) and not related to surgical anastomosis were excluded from analysis.

**Telephone Survey**

Attempts were made to contact by telephone all patients without 2-year follow-up data in the electronic medical record and ask them to complete a scripted 9-question telephone survey designed to identify complications. If patients without 30-day post discharge follow-up data were contacted by telephone and completed the telephone survey, they were then included for analysis. Patients with more than 30 days of follow-up who could not be contacted by telephone were not excluded.

**Statistical Analysis**

The significance of categorical variables was determined with Fisher exact test, and that of continuous variables with Mann-Whitney rank sum test. Univariate logistical regression analysis was used to determine the significance of correlation between categorical variables. Statistical analysis was performed with MedCalc 12.3 software (MedCalc Software), and the cutoff for statistical significance was *P* < .05.

**Results**

**Baseline Characteristics**

Between February 1, 2000, and November 23, 2011, we identified 115 patients meeting inclusion criteria. Of these, 96 had appropriate follow-up data available, with 59 having end-to-side duodenal anastomoses and 37 having Roux-en-Y jejunal anastomoses.
anastomoses. All reconstructions were performed for 1 of 4 indications: benign disease (stricture, material impaction, or autoimmune disease), choledochal cyst, biliary injury, or cancer. Operations were performed by 10 surgeons, 7 of whom performed at least 3. Absorbable suture was used in all biliary reconstructions.

Basic demographic information, length of stay, hospital charges, comorbidity, operative indications, anastomotic level, preoperative interventions, and surgical confounders are compared in Table 1. All variables were similar between cohorts, except for a higher percentage of anastomoses above the biliary confluence in the jejunal group. These high anastomoses were performed with concomitant hepatectomy for cancer in all duodenal cases but were performed for a wide variety of indications in the Roux-en-Y cohort (7 cancers, 5 injuries, 2 benign strictures, and 1 choledococele). Ductal diameters were rarely recorded, but available data were similar in the duodenal and jejunal cohorts, with medians of 4.0 and 3.5 mm, respectively.

Follow-up
Ninety-six patients had at least 30 days of follow-up information available for analysis, provided by either electronic medical record (75 patients [78%]) or telephone survey (31 [32%]). In the combined cohorts we had 1-, 2-, and 3-year follow-up rates of 76% (73 patients), 51% (49 patients), and 39% (37 patients), respectively. The difference in follow-up between the cohorts at selected times was not statistically significant.

Complications
Postsurgical complications were compared between the 2 cohorts and are shown in Table 2. The jejunal cohort had a significantly higher percentage of Clavien-Dindo grade III or higher complications than the duodenal cohort (46% vs 22% [17 vs 13 patients]; P = .02). At subanalysis, we stratified the complications into either anastomotic (leak or postoperative benign stricture) or nonanastomotic (wound or hepatectomy related). The jejunal cohort had a significantly higher percentage of anastomosis-related complications than the duodenal cohort (35% vs 12% [13 vs 7 patients]; P = .01). Anastomotic complications were further subdivided into early (leak) or late (postoperative benign stricture) complications. There was no significant difference in leak rate between the groups, and the presence of a leak did not significantly prolong the hospital stay in any one cohort.

The jejunal cohort had a significantly higher number of postoperative benign strictures than the duodenal cohort (9 patients [24%] vs 2 [3%]; P = .003). A percutaneous transhepatic biliary drain (PTBD) was required in 1 of 2 duodenal stric-
... From a practical standpoint, use of the duodenum for biliary reconstruction has low morbidity, stricture rates, and risk for cholangitis or bile gastritis, while being more endoscopically accessible than the jejunum. In most situations, use of the duodenum for biliary reconstruction is not higher in our institution. Our experience suggests that duodenal anastomoses are less than 6% and morbidity rates range from 7% to 13% for duodenal and from 20% to 30% for jejunal anastomoses.

Discussion

Reconstruction of the biliary tract is often a complex and technically difficult operation. Various surgical techniques for biliary reconstruction have been used over the past century and a half. Currently, most surgeons use Roux-en-Y jejunal reconstruction as the procedure of choice because of perceived risks associated with duodenal anastomoses. We have shown that the risk is not higher in our institution. Our experience suggests that in most situations, use of the duodenum for biliary reconstruction has low morbidity, stricture rates, and risk for cholangitis or bile gastritis, while being more endoscopically accessible than the jejunum.

Published mortality rates for duodenal and Roux-en-Y jejunal anastomoses are less than 6%. Morbidity rates range from 7% to 13% for duodenal and from 20% to 30% for jejunal anastomoses.
Our 3% mortality rate was similar, with all deaths within 90 days occurring in patients with simultaneous major hepatectomy. Although our morbidity rates were higher than these published numbers, we speculate that this is more a reflection of comprehensive long-term follow-up, with a standardized complication grading system and high rates of complex associated procedures (eg, concomitant hepatectomy in 17%). Our postoperative leak rates were equivalent between cohorts, and duodenal leaks did not significantly prolong discharge compared with jejunal leaks. As expected, we had no cases of “sump syndrome” because the creation of an end-to-side anastomosis precludes the creation of the blind distal pouch seen in side-to-side anastomoses.

The widely held belief that duodenal anastomoses incur higher incidences of cholangitis has had evidence to the contrary since 1970, when a series of experiments in dogs compared biliary anastomoses using either the duodenum or colon and showed that cholangitis did not develop in either group unless there was a concomitant biliary stricture. This finding correlates with the low reported rate (0%-4%) of cholangitis associated with side-to-side choledochoduodenostomies. Our experience is similar, with no cholangitis developing in the duodenal group. However, cholangitis that was not cancer related developed in 5 patients (14%) in our jejunal cohort, all with concurrent obstruction. We do not believe this suggests that the jejunum is inherently predisposed to causing cholangitis; rather, it reflects the case complexity and high rate of stricture in our jejunal arm.

The 3% stricture rate seen in our duodenal cohort is well within the reported range of 0% to 18% in like operations. However, the 24% stricture rate seen in our jejunal cohort was significantly higher than expected. We were surprised to find that although the jejunal cohort had more anastomoses above the confluence, on regression analysis this was not a predictor of stricture development. Interestingly, anastomoses for bile duct injury were more likely to develop stricture, probably owing to small ductal diameter, potential ischemia, and/or thermal injury. Unfortunately, the paucity of ductal diameter data makes this difficult to confirm, but available measurements do show that both types of anastomoses were successful in normal-sized ducts.

With a median follow-up of 2 years in each cohort, we would expect roughly 60% of postoperative strictures to have developed, enabling accurate statistical comparison between cohorts. We speculate that the higher stricture rate is therefore most likely due to a surgical selection bias. Duodenal anastomosis has been the favored repair at our institution for more than a decade, with the jejunum relegated to reconstructions for which the duodenum is deemed unsuitable (eg, inflamed or stricture duodenum, periporal inflammation, or presence of chronic bilaoma). A common belief is that duodenal reconstructions are prone to stricture due to tension and unsuitable for high anastomoses. In our series, 38% of the reconstructions above the biliary confluence used the duodenum. We find that the duodenum will readily reach the hilum without significant tension. A full kocherization may be used to gain extra mobility, and release of the right hepatic flexure may aid in visualization.

In conclusion, duodenal anastomosis is a safe, simple, and often preferable method for biliary reconstruction. This anastomosis can successfully be performed to all levels of the biliary tree, with low rates of leaks, strictures, cholangitis, and bile gastritis. When anastomotic complications do occur, there is less need for transhepatic intervention because of easier endoscopic access.

**ARTICLE INFORMATION**

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Of all anastomoses used for biliary reconstruction, the end-to-side bile duct to duodenum and Roux-en-Y duct to jejunum have emerged as the most common. Although most surgeons use the jejunum, Rose et al from Virginia Mason Medical Center in Seattle prefer using the duodenum and have amassed a large experience with this procedure.

Their current study builds on an earlier series from the same institution that focused on patients undergoing reconstruction for bile duct injuries during cholecystectomy and concluded that the duodenum was safe to use. Although most bile duct injuries occur high on the bile duct, tension was not observed on the duodenal anastomoses. The major concern with using the duodenum was that leaks result in duodenal fistulas, which may be associated with greater morbidity than leaks from an isolated jejunal limb.

In the current study, Rose et al expand the inclusion criteria of the 2002 analysis. They found that postoperative stricture developed in 24% of the jejunal anastomoses compared with 3% of the duodenal anastomoses. Cholangitis occurred only in patients with jejunal anastomoses and stricture. Although the difference was not significant, leaks occurred in twice as many patients with jejunal anastomases.

At first glimpse, these results suggest that the duodenum may even be better than the jejunum for biliary reconstruction. However, the authors appropriately temper their comments and allude to a potential selection bias. The jejunum was