Critical Analysis of a Large Series of Pancreaticogastrostomy After Pancreaticoduodenectomy

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Hypothesis: Pancreaticogastrostomy is a safe operation for a variety of periampullary conditions.

Design: Retrospective review of a prospectively collected database.

Setting: An academic tertiary care university hospital and a Veterans Affairs hospital.

Patients: A total of 235 consecutive patients who underwent pancreaticogastrostomy.

Main Outcome Measures: Indications for surgery, preoperative risk factors, intraoperative and postoperative variables, and factors that affect postoperative complications.

Results: The most common initial symptoms were jaundice (73.2%), weight loss (23.8%), and abdominal pain (17.0%). The 4 most common indications for surgery were pancreatic adenocarcinoma (41.3%), ampullary carcinoma (17.0%), duodenal carcinoma (7.2%), and chronic pancreatitis (7.2%). The median operating time was 6.5 hours. Median blood loss was 900 mL. The median intraoperative blood transfusion was 0 U. The median postoperative length of stay was 9 days. Postoperative mortality was 0.9%. The most common complications were pancreatic fistulae (13.6%), 1 of which was thought to cause 1 of 2 mortalities in this series. Pancreatic fistulae developing after pancreaticogastrostomy were significantly related to a low preoperative alkaline phosphatase level and surgery for nonpancreatic pathologic findings. The presence of a fistula significantly increased the postoperative length of hospital stay.

Conclusions: Pancreaticogastrostomy is a safe operation associated with low mortality and morbidity rates and a pancreatic fistula rate of 13.6%. It should be considered as a suitable alternative for management of the pancreatic remnant after pancreaticoduodenectomy.

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METHODS

PATIENT DATA

We conducted a retrospective review of a prospective database of 235 patients who underwent pancreaticogastrostomy after pancreaticoduodenectomy at Loyola University Medical Center and Hines VA Hospital between June 1, 1990, and July 31, 2005. All the patients who underwent pancreaticogastrostomy after pancreaticoduodenectomy were operated on by the same surgeon (G.V.A.), with no patients having pancreaticoduodenectomy reconstructed with pancreaticojejunostomy during this period.

Clinical and pathologic data were obtained from the surgery database, medical records, and interviews. Data obtained for each patient included demographics; preoperative laboratory values; clinical symptoms and signs; procedures, including computed tomography (CT), endoscopy, and the placement of stents; and intraoperative data, such as the use of prophylactic antibiotic agents, blood loss, operating time, and units of blood transfused. Postoperative data, including pathologic findings, mortality, morbidity, and the use of octreotide, were also analyzed. Analyses were performed using statistical software (SPSS for Windows; SPSS Inc, Chicago, Ill). The χ² or Fisher exact test was used when appropriate. Statistical significance was set at P=.05.

SURGICAL TECHNIQUE

All the patients underwent classic pancreaticoduodenectomy with distal gastrectomy. The pancreatic remnant was mobilized for 4 cm. Single layers of sutures of 3-0 silk were taken from the posterosuperior gastric wall, at least 5 cm from the cut edge of the stomach, to the anterior wall of the body of the pancreas. A gastrotomy was made, and then sutures were placed from the posteriorinferior gastric wall to the posterior body of the pancreas. Sutures entered the pancreas at least 2 cm from the cut edge and exited 1 cm from the cut edge, and when the sutures were tied, at least 1 to 2 cm of the pancreas was invaginated into the stomach without a stent. The Figure demonstrates the completed hepaticojejunostomy, gastrojejunostomy, and pancreaticogastrostomy. Two drains were placed: 1 to drain the hepaticojejunostomy on the right side and 1 to drain the pancreaticogastrostomy on the left side. All the patients received prophylactic antibiotics before surgery. Early in the series, most patients received octreotide, but in the last 123 patients, octreotide was not used. Patients began receiving erythromycin lactobionate, 250 mg intravenously every 6 hours, on day 4. The nasogastric tube was removed on day 5, and metoclopramide hydrochloride was added intravenously every 8 hours. Proton pump inhibitors were used postoperatively to prevent stress and marginal ulceration.

The patients are given a liquid diet on day 6 and, if tolerated, advanced to a postgastrectomy diet on day 7. After 2 solid meals, drainage from the left drain was measured for amylase content. If the amylase level was less than 125 U/L, the drain was removed if the volume was 200 mL/d or less. If the volume was greater than 200 mL/d, and the amylase level was normal, the patient was sent home with the drain until the drainage decreased to less than 200 mL/d, and then the drain was removed. If the fluid was amylase rich, the patient was fed, and if the volume did not change, the patient was sent home on an oral diet. If the fluid was amylase rich and the volume increased after an oral diet, then a drain study was performed by injecting dye into the drain. In 6 (19%) of 32 patients with a pancreatic leak, the drain had eroded into the pancreaticogastrostomy anastomosis and had to be pulled back. The drain placed along the biliary anastomosis was removed on day 5 if there was no bile in the drain. This was done irrespective of the volume of drainage. A pancreatic fistula was defined as amylase-rich fluid from the pancreatic drain with 3 times the serum amylase level on the first day after the patient eats a solid diet. Delayed gastric emptying was defined as a need for nasogastric suction for more than 10 days after pancreaticoduodenectomy.

Patient characteristics and preoperative risk factors are listed in Table 1. There were 145 men and 90 women (median age, 68 years; range, 21-90 years). The most common initial symptoms included jaundice (73.2%), weight loss (23.8%), and abdominal pain (17.0%). Median weight loss was 6.75 kg (range, 1.80-24.75 kg). Patients who were considered malnourished (ie, albumin level <2.5 g/dL) were given parenteral or enteral nutrition for 10 to 14 days before surgery. This occurred in fewer than 10 patients. Preoperative risk factors included hypertension, diabetes mellitus, previous cancer, chronic obstructive pulmonary disease or asthma, atrial fibrillation, coronary artery disease, peripheral vascular disease, peptic ulcer, hypothyroidism, and pancreatitis. Indications for pancreaticoduodenectomy based on pathologic findings are given in Table 2. The 4 most common indications for pancreaticoduodenectomy were pancreatic adenocarcinoma (41.3%), ampullary carcinoma (17.0%), duodenal carcinoma (7.2%), and chronic pancreatitis (7.2%). All the patients underwent preoperative CT, and 142 (60.4%) had biliary stents placed via endoscopic retrograde cholangiopancreatography or percutaneous transhepatic cholangiography.

The median operating time was 6.5 hours (range, 3.4-13.0 hours). Median blood loss was 900 mL (range, 200-7500 mL), and the median intraoperative transfusion was 0 U (range, 0-7 U). Octreotide was used after surgery in 112 patients and was not used in 123 patients. The median postoperative hospital stay was 9 days (range, 5-83 days). Thirty-day and in-hospital mortality occurred in 2 patients (0.9%) (Table 3). One patient died of a massive upper gastrointestinal hemorrhage. Aside from the 2 deaths, 191 patients underwent pancreaticoduodenectomy without mortality.

A pancreatic fistula occurred in 32 patients (13.6%) and was the most common morbidity. Most of the 32 fistulae closed with maintenance of drains and continued oral intake. In 11 (34.4%) of these 32 patients, parenteral nutrition was necessary for fistula closure. Only 1 patient had to return to surgery for closure of the fistula. An intra-abdominal abscess occurred in 14 patients (6.0%) and wound infections in 13 (5.5%). All the patients with intra-abdominal abscess were treated with either intraoperatively placed drains or new percutaneous drains by means of interventional radiology.

Hemorrhage occurred in 4 patients (1.7%). Two of the patients had hemorrhage from the gastrojejunostomy anastomosis that was controlled with endoscopic means, and the other 2 had pseudoaneurysms. One pseudoaneurysm was controlled at our institution (Loyola University Medical Center) with interventional radiology using coil embolization. The other patient died at an outside institution of massive upper gastrointestinal bleeding and is presumed to have had a pseudoaneurysm. Bile leaks occurred in 2 patients (0.9%) and were treated with percutaneous transhepatic stenting of the anastomosis, with resolution of the problem. Contained leaks from the gastrojejunostomy occurred in 3 patients (1.3%), and none required surgery. Delayed gastric emptying occurred in 14 patients (6.0%), and all resolved with conservative measures.
A second operation was required in 3 patients (1.3%). In the first patient, the surgery was for peritonitis. At exploration, it was found that the pancreatic remnant had separated completely from the stomach. In this case, the pancreatic duct was simply oversewn and the gastrotomy closed. This patient survived. The second patient had a drain included in the closure of the fascia, and when the pancreatic drain was removed, it was severed. This patient was taken back to the operating room, and the drain remnant was found in the wound just after the anterior fascia was opened; therefore, reentry into the abdomen was not necessary. The third patient who had a second surgery was the one who had surgical closure of a persistent pancreatic fistula 3 months after surgery. Of the 112 patients receiving octreotide, 12 (10.7%) developed a fistula, and this was not significant compared with the 11 (8.9%) of 123 patients who developed a fistula without octreotide administration.

Table 4 lists certain preoperative, intraoperative, and postoperative variables in relation to fistula formation. Age, duration of surgery, use of octreotide, intraoperative blood transfusion, intraoperative blood loss, preoperative biliary stenting, preoperative endoscopic retrograde cholangiopancreatography or percutaneous transhepatic cholangiography, and a preoperative albumin level of 3 g/dL had no effect on fistula formation. However, patients with elevated alkaline phosphatase levels had a significantly lower incidence of postoperative pancreatic fistula than those whose alkaline phosphatase level was not elevated. Also, patients who had pancreatic adenocarcinoma and pancreatic pathologic abnormalities had a much lower incidence of pancreatic fistula than those who had other types of pathologic abnormality. Finally, a pancreatic fistula was associated with a doubling in the median length of hospital stay.

### COMMENT

Pancreaticogastrostomy became a reality when Tripodi and Sherwin first reported successful transplantation of the pancreas into the stomach in 1934. This finding was confirmed by Person and Glenn. Waugh and Clagett at the Mayo Clinic were the first to use pancreaticogastrostomy in the clinical setting in 1946. Further impetus to the success of the operation was provided by Mackie et al in 1975. Used infrequently initially, pancreaticogastrostomy has been used much more frequently in the past 20 years. It is well known that leakage from the pancreaticojejunostomy and its consequences are the leading causes of mortality after pancreaticoduodenectomy. Data from the late 1970s and early 1980s confirm this. More recently, Yeo et al reported on 650 consecutive pancreaticoduodenectomies performed at The Johns Hopkins Hospital. They noted that 26 patients (4.0%) required repeated surgery. Of the 26 patients, 9 (34.6%) died after the second operation. In all of these patients, death could be directly related to leakage from the pancreaticojejunostomy. Several theoretical physiologic and technical advantages to performing pancreaticogastrostomy have been described. A physiologic advantage is believed to be that pancreatic enzymes are inactivated by the acidic gastric fluid. In addition, the stomach does not contain enterokinase, which is required for the conversion of trypsinogen to trypsin and the subsequent activation of other proteolytic enzymes. A lack of enzyme activation may prevent autodigestion of the anastomosis. In addition, the alkaline and pancreatic secretions may aid in preventing marginal ulceration. The proximity of the pancreas to the posterior wall of the stomach allows for potentially less tension on the anastomosis. The excellent blood supply to the stomach wall is favorable to anastomotic healing, and the thickness of the stomach wall holds sutures well. Nasogastric decompression provides for continuous emptying of the stomach and, therefore, less tension on the pancreaticogastrostomy anastomosis, a benefit not possible with a pancreaticojejunostomy anastomosis. A review of the world literature on pancreaticogastrostomy from 1946 to 1997 by Mason seems to confirm the safety of pancreaticogastrostomy. Of 813 patients who underwent pancreaticogastrostomy, 32 (4.0%) developed pancreaticocutaneous fistulae. Of these fistulae, 3 (0.4%) were thought to be the primary cause of death. In a meta-analysis of

### Table 4. Preoperative, Intraoperative, and Postoperative Variables in Patients With vs Without a Pancreatic Fistula

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No Fistula (n = 203)</th>
<th>Fistula (n = 32)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y&lt;br&gt;&lt;70</td>
<td>113 (84)</td>
<td>21 (16)</td>
<td>.29</td>
</tr>
<tr>
<td>≥70</td>
<td>90 (89)</td>
<td>11 (11)</td>
<td></td>
</tr>
<tr>
<td>Duration of surgery, h&lt;br&gt;&lt;6.5</td>
<td>110 (89)</td>
<td>13 (11)</td>
<td>.15</td>
</tr>
<tr>
<td>&gt;6.5</td>
<td>93 (83)</td>
<td>19 (17)</td>
<td></td>
</tr>
<tr>
<td>Octreotide therapy&lt;br&gt;Yes</td>
<td>94 (84)</td>
<td>18 (16)</td>
<td>.30</td>
</tr>
<tr>
<td>No</td>
<td>109 (89)</td>
<td>14 (11)</td>
<td></td>
</tr>
<tr>
<td>Intraoperative blood transfusion&lt;br&gt;Yes</td>
<td>65 (81)</td>
<td>15 (19)</td>
<td>.10</td>
</tr>
<tr>
<td>No</td>
<td>138 (89)</td>
<td>17 (11)</td>
<td></td>
</tr>
<tr>
<td>Estimated blood loss, mL&lt;br&gt;&lt;1000</td>
<td>128 (90)</td>
<td>15 (10)</td>
<td>.08</td>
</tr>
<tr>
<td>&gt;1000</td>
<td>75 (82)</td>
<td>17 (18)</td>
<td></td>
</tr>
<tr>
<td>Preoperative stent&lt;br&gt;Yes</td>
<td>127 (89)</td>
<td>15 (11)</td>
<td>.09</td>
</tr>
<tr>
<td>No</td>
<td>76 (82)</td>
<td>17 (18)</td>
<td></td>
</tr>
<tr>
<td>Preoperative ERCP or PTC&lt;br&gt;Yes</td>
<td>49 (86)</td>
<td>8 (14)</td>
<td>.92</td>
</tr>
<tr>
<td>No</td>
<td>154 (87)</td>
<td>24 (13)</td>
<td></td>
</tr>
<tr>
<td>Alkaline phosphatase, U/L&lt;br&gt;&lt;110</td>
<td>46 (74)</td>
<td>16 (26)</td>
<td>.001</td>
</tr>
<tr>
<td>&gt;110</td>
<td>157 (91)</td>
<td>16 (9)</td>
<td></td>
</tr>
<tr>
<td>Albumin, g/dL&lt;br&gt;&lt;3</td>
<td>44 (90)</td>
<td>5 (10)</td>
<td>.43</td>
</tr>
<tr>
<td>&gt;3</td>
<td>159 (85)</td>
<td>27 (15)</td>
<td></td>
</tr>
<tr>
<td>Pancreatic pathologic findings&lt;br&gt;Yes</td>
<td>135 (91)</td>
<td>13 (9)</td>
<td>.005</td>
</tr>
<tr>
<td>No</td>
<td>68 (78)</td>
<td>19 (22)</td>
<td></td>
</tr>
<tr>
<td>Hospital stay, median (range), d</td>
<td>9 (5-34)</td>
<td>18 (7-83)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; PTC, percutaneous transhepatic cholangiography.

*Data are given as number (percentage) of patients except where otherwise indicated.
pancreatic fistula after pancreaticoduodenectomy, Bartoli et al.\textsuperscript{40} also suggested that pancreaticogastrostomy was safer than pancreaticojunostomy. Yeo et al.\textsuperscript{41} published the only prospective randomized trial of pancreaticogastrostomy vs pancreaticojunostomy after pancreaticoduodenectomy. In this study, there was no difference in the mortality and morbidity whether the stomach or jejunum was anastomosed to the pancreatic remnant.

In the present study, only 2 deaths (0.9\%) occurred. One death was due to acute respiratory distress syndrome and occurred 45 days after the operation. The second death can be related to leakage from the pancreaticogastrostomy because this patient, who had a pancreaticoduodenectomy for an ampullary carcinoma, was discharged from the hospital with a drain on the ninth postoperative day. Five days after discharge, he was found unconscious by a family member and was taken by ambulance to another institution. Here, after undergoing CT, he returned to the emergency department where, according to his family members, blood rushed out of his mouth and nose, resulting in immediate death. We can only conjecture that this death was due to a pseudoaneurysm as a result of a leak from the pancreaticogastrostomy. No autopsy was performed. Late bleeding in a patient who has had pancreaticoduodenectomy, especially one who has had a leak, is often due to pseudoaneurysms. These patients should undergo immediate CT angiography, followed by conventional angiography, with embolization if a pseudoaneurysm is demonstrated.\textsuperscript{42}

Recent published large series\textsuperscript{38,43} with pancreaticojejunostomy revealed a reexploration rate of 3\% to 4\%, of which 34\% of the mortality was related directly to leakage from the pancreaticojejunostomy anastomosis. In a previous study,\textsuperscript{44} 5 (5\%) of 97 patients undergoing pancreaticojejunostomy needed reexploration, and in 3 of these 5 patients, death was due to leakage at the pancreaticojejunal anastomosis. In the same study,\textsuperscript{45} reexploration was not required in 117 patients undergoing pancreaticogastrostomy. This has also been reported by other researchers.\textsuperscript{45,46} In the present series, reexploration was required in 3 patients (1.3\%), and all 3 survived.

Previous studies have attempted to define the cause of fistula formation after pancreaticoduodenectomy. In the article by Yeo et al.,\textsuperscript{41} the surgeon’s experience and pancreaticoduodenectomy performed for nonpancreatic pathologic findings were strongly associated with pancreatic fistula formation. The soft texture of the pancreas, as seen in nonpancreatic pathologic abnormalities, was found by Lin et al.\textsuperscript{47} to be significantly associated with pancreatic fistula. In the present study, although we did not have sufficient information on the texture of the pancreatic remnant, fistula formation was significantly related to pancreaticoduodenectomy performed for nonpancreatic pathologic findings. In addition, patients with elevated alkaline phosphatase levels were found to have a significantly lower incidence of fistula after pancreaticoduodenectomy in our series. In addition, there was no correlation with fistula formation and patients having an albumin level of 3 g/dL or less. However, only 49 patients (20.9\%) had albumin levels of 3 g/dL or less. Therefore, parenteral nutrition was needed only in patients who had persistent high-volume fistulae. The development of a pancreatic fistula increases the length of the postoperative hospital stay, as seen in this study and others.\textsuperscript{48,49}

There are several reasons why delayed gastric emptying occurs in patients undergoing pancreaticoduodenectomy.\textsuperscript{50} Delayed gastric emptying occurred in only 6.0\% of patients in this series. We believe that this is due to the fact that we perform a classic pancreaticoduodenectomy that includes a distal gastrectomy. In addition, the use of metoclopramide after surgery may have also helped. Although metoclopramide increases the tone and amplitude of the antral stomach, it has an effect on the motility of the entire stomach in addition to increasing the tone of the lower esophageal sphincter. Metoclopramide is used to prevent impaired gastric motility after duodenectomy and reflux secondary to gastric stasis. Because partial pancreatectomy can have an ulcerogenic effect, proton pump inhibitors are used after surgery.

Intra-abdominal abscess occurred in 14 patients (6.0\%) and wound infections occurred in 13 (5.5\%). Intra-abdominal abscesses are mainly due to leakage from the pancreaticoenteric anastomosis.\textsuperscript{51} Leaks from the hepatocostal and gastroenteric anastomosis cause fewer intra-abdominal abscesses. Intra-abdominal abscesses are thought to be associated with increased mortality.\textsuperscript{52} This was not true in this series. All intra-abdominal abscesses were managed successfully with maintenance of intraoperatively placed drains or new percutaneous drains.

In conclusion, this study, which is the largest study of pancreaticogastrostomy in the literature, shows the safety of pancreaticogastrostomy. Mortality is low, repeated surgery is also low, and other complications of pancreatic fistulae, delayed gastric emptying, intra-abdominal abscesses, wound infections, hemorrhage, bile leaks, repeated operations, and cardiac complications are also low, further supporting the safety of pancreaticogastrostomy. Pancreaticogastrostomy remains a viable option for management of the pancreatic remnant after pancreaticoduodenectomy.

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REFERENCES

45. Delcore R, Thomas JH, Pierce GE, Hermreck AS. Pancreaticogastrostomy: a safe drain-struction has been analyzed in a prospective, randomized fashion to those we have heard from Dr Aranha today. Pancreatic reconstruction for a variety of periampullary conditions. I believe that Dr Aranha and his colleagues’ data support their conclusions that pancreaticogastrostomy is a safe alternative to pancreaticojejunoscopy. The morbidity and mortality rates in this series are commendable. Pancreatic leak occurred in 13.6% and delayed gastric emptying in only 6.0% of patients. The mean length of stay was 9 days, and only 3 patients required reoperation. There were only 2 postoperative deaths, for a mortality rate of 0.9%. Also, Dr Aranha pointed out in his presentation, pancreatic fistula was correlated with the consistency of the pancreas and is consistent with large series that one sees reported for pancreaticoduodenectomy. These results are obtainable and are comparable to results obtained in other high-volume centers employing more conventional reconstruction techniques consisting of either invagination or duct-to-mucosa pancreaticogastrostomy.

The theoretic physiologic and technical advantages espoused by proponents of pancreaticogastrostomy include lack of enzyme activation and alkaline milieu in the stomach, which may prevent marginal ulceration, the superb blood supply to the stomach, which may facilitate healing of the anastomosis, and nasogastric decompression, which may allow for lack of tension on the anastomosis, unlike a jejunal limb, which may disent with a pancreaticojejunoscopy. The merits of these advantages, I am sure, can be debated by proponents of pancreaticojejunal reconstruction, many of whom report outstanding results comparable to those we have heard from Dr Aranha today. Pancreatic reconstruction has been analyzed in a prospective, randomized fash-
tion by Yeo et al (Ann Surg, 1993;222:380-392), and in their study, the morbidity and mortality was no different in pancreaticogastrostomy vs pancreaticojejunostomy.

Dr Aranha's rich experience reported today and the surgical literature support the observation that either of these anastomotic techniques are excellent for reconstruction with comparable safety. In other words, it doesn't matter whether one does pancreaticogastrostomy or pancreaticojejunostomy. What really matters is that it is done well.

Heretofore, the durability of pancreatic anastomosis has not been a high priority, unfortunately, and this is due to the poor prognosis of many patients undergoing the operation. As the indications for pancreaticoduodenectomy have broadened and pancreatic surgeons are operating on more patients with cystic neoplasms, the prognosis is improving and patients are living for a longer period of time.

This leads me to my first question for Dr Aranha and that has to do with patency of the anastomosis and preservation of endocrine and exocrine function. The anastomosis with pancreaticogastrostomy is easily accessible endoscopically, and I wondered if Dr Aranha has any experience with assessing patency and durability of his anastomosis and preservation of endocrine and exocrine function?

Second, in my practice I reconstruct using the duct-to-mucosa technique, and should a leak concur, once it is well controlled, I am comfortable feeding the patients and then ultimately dismissing them even with the leak persisting. Presumably with a leak following pancreaticogastrostomy, there is extravasation from the stomach. Are you able to feed these patients and are you able to dismiss them from the hospital, or do you have to wait until it is completely healed?

Last, I was impressed with your low incidence of delayed gastric emptying. In the manuscript, your protocol for postoperative management included both erythromycin on day 4 and Reglan [metoclopramide hydrochloride] on day 5 when the NG [nasogastric] tube was removed. To what extent do you think that this pharmacologic regimen is responsible for your very low 6.0% incidence of delayed gastric emptying?

Dr Aranha: You asked about whether I have studied the pancreatic duct. We have not as of yet. I am in the process of getting IRB [institutional review board] approval to do such a study, but I do have quality-of-life studies that we presented recently in Durban, South Africa, at the International Surgical Society Week. We studied 88 patients who had a pancreaticogastrostomy and 44 patients with pancreaticojejunostomy. Patients who had the pancreaticogastrostomy took pancreatic enzymes for a longer period than those who had the pancreaticojejunostomy, suggesting that acid does inactivate amylase, and therefore, patients with pancreaticogastrostomy have more steatorrhea. Overall, 40% of patients with pancreaticogastrostomy were taking enzymes for more than 1 year after their Whipple procedure. However, 60% had stopped taking pancreatic enzymes.

The incidence of diabetes was 9% overall, but it was significantly lower in those with pancreaticogastrostomy than in those who have pancreaticojejunostomy. My feeling has always been that diabetes occurred because the duct became obstructed, but this has not been studied in a prospective fashion. There are other reasons for patients getting diabetes. The amount of pancreas one removes may result in a decrease of pancreatic polypeptide, and this may make the liver resistant to insulin.

Your second question was, how do we treat leaks? If I have a leak from the pancreaticogastrostomy, I will continue to feed the patient. If the amount of fluid from the drain increases, I get a drain study. Of the 23 leaks that we had, 6 patients had the pancreatic drain erode into the anastomosis. The drain was pulled back, and the leak was closed. Also, one needs to get a CT scan to make sure that there is no abscess that has to be drained. If the patient can eat and the volume does not go up, we send the patient home with the drain until the fistula closes, at which time we remove the drain. Fewer than 5 patients have had to stay in the hospital and receive total parenteral nutrition.

Finally, your question about erythromycin and Reglan as prokinetic agents. Erythromycin, as most of you know, is a motilin agonist. Motilin is concentrated in the duodenum, and therefore, loss of motilin is thought to be the reason for delayed gastric emptying that occurs more in the pylorus-preserving Whipple procedure. I think one of the reasons that we do not have the same incidence of delayed gastric emptying is because we do the classic Whipple.

Lawrence J. Koep, MD, Phoenix, Ariz: The real advantage of this drainage is access to the pancreas. We have continued to do this despite the Baltimore data, like you in many cases, whether it is papillary disease in the pancreatic duct or whether it is pancreatitis, where it is essential to be able to get access to that pancreatic duct as time goes on. The question of whether you have been able to access this so far is really critical. We have tried to do this. Early on we can do it up to about a year; we can access that pancreatic duct as time goes on. Then after that, we are having a lot of difficulty finding the pancreatic duct in the stomach because it seems like they lose it. My question is, is this something we are going to be able to do? Do you think that we will be able to access the anastomosis long term and know what is happening to the pancreatic duct and to exocrine function?

Dr Aranha: You asked if we have studied the patency of the pancreatic duct after a pancreaticogastrostomy. We have not as of yet. We did have 2 patients who had recurring attacks of pancreatitis. On these patients, we did an upper GI [gastrointestinal] endoscopy and gave them secretin, and we were able to identify the duct. I believe that over time, the gastric mucosa may grow over the end of the pancreatic duct, but I have not been able to prove this with endoscopic studies.

Your second question was in regard to patients with intraductal papillary mucinous neoplasms. In patients who have a Whipple procedure for an intraductal papillary mucinous neoplasm, a pancreaticogastrostomy is suggested in the management of pancreatic remnant because the remnant can be observed for changes by an endoscopic ultrasound. In this situation, the Johns Hopkins group also supports pancreaticogastrostomy.