Effect of Antecolic Reconstruction on Delayed Gastric Emptying After the Pylorus-Preserving Whipple Procedure

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Hypothesis: Antecolic duodenojejunostomy prevents delayed gastric emptying (DGE) after a pylorus-preserving Whipple (ppW) procedure better than retrocolic duodenojejunostomy.

Design: A single operation team’s experience with antecolic and retrocolic duodenojejunostomy in ppW is analyzed on a prospective database using univariate and multivariate models.

Setting: Tertiary referral center that focuses on pancreatic diseases.

Patients and Interventions: One hundred consecutive patients undergoing a ppW procedure with retrocolic reconstruction between January 1, 1996, and December 31, 2001, and 100 consecutive patients undergoing a ppW procedure with antecolic reconstruction between January 1, 2002, and December 31, 2003. Characteristics such as median age, median hospital stay, sex, diagnosis, previous operations, blood loss, surgical and medical complications, American Society of Anesthesiologists risk groups, stent implantation, and especially DGE were matched for the comparison groups.

Main Outcome Measures: We compared DGE, characteristics, and perioperative variables in patients with antecolic vs retrocolic reconstruction after ppW.

Results: The DGE occurred significantly more often in patients with retrocolic reconstruction than in those with antecolic reconstruction ($P<.001$). The antecolic and retrocolic study groups were comparable in age ($P=.25$), sex ($P=.48$), and postoperative surgical ($P=.19$) and medical ($P=.054$) complications. The univariate analysis between patients with and without DGE did not show significant differences regarding diagnosis, previous operations, blood loss, surgical and medical complications, American Society of Anesthesiologists classification, or stent implantation. In the multivariate analysis, only the type of reconstruction ($P=.006$) and sex ($P=.04$) seemed to affect DGE.

Conclusion: We recommend antecolic duodenojejunostomy in patients undergoing a ppW procedure regardless of their diagnosis.

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Although the classic Whipple (cW) procedure is considered the standard surgical treatment for pancreatic and periampullary malignancies, the pylorus-preserving modification (ppW) seems to have some advantages. Several studies have shown that the ppW procedure is technically easier and quicker to perform than the cW procedure. Median operative time and median blood loss are significantly greater in the cW approach than in the ppW procedure. Furthermore, the mortality and morbidity rates are comparable between the 2 approaches, and the hospital stay after the ppW procedure seems to be shorter than after the cW procedure.

One possible disadvantage of pylorus preservation is early delay of gastric emptying. Some researchers observed a significant delay in full-regimen diet resumption for patients undergoing the ppW procedure compared with the cW procedure. Other investigators did not confirm these results and found no difference between the 2 procedures but a temporary dysfunction in both, probably due to the surgical trauma. The lack of a generally accepted definition of delayed gastric emptying (DGE) might be one reason for the different conclusions in the literature. On the other hand, the causes of DGE are still not clear and might be multifactorial. Low plasma motilin concentrations caused by resection of the duodenum, extended lymph node dissection along the hepatoduodenal ligament toward the celiac trunk (damage to vagal nerve branches), small leaks of the pan-
creaticojejunostomy, and transient pancreatitis are possible explanations for DGE in pylorus-preserving pancreas resection. Furthermore, DGE may be due to angulation or torsion of the duodenojejunostomy during the early postoperative period, in particular in retrocolic reconstruction after the ppW procedure. This confirms our own impression of having more problems with DGE in the past (Berne, Switzerland, 1996-2001 [Figure 1A]), where we performed the duodenojejunostomy in a retrocolic position, in contrast to our anastomosis performed antecolically today (Heidelberg, Germany [Figure 1B]). Because DGE is described as a complication leading to patient discomfort but also inheriting the risk of silent aspiration and aspiration pneumonias,20 we are interested in optimizing the surgical technique for pylorus-preserving pancreas resection, which is our standard technique. Moreover, we are interested in reducing the length of hospital stay and in decreasing treatments costs significantly.

However, to our knowledge, prospective randomized studies are not available to clarify the effects of antecolic and retrocolic reconstruction on DGE after ppW. In the present study, 100 patients undergoing a ppW procedure with retrocolic anastomosis are compared with 100 consecutive patients undergoing a ppW procedure with antecolic anastomosis, making this the largest retrospective analysis of a prospective database in this field.

METHODS

RETROCOLIC GROUP

Using a prospective database, we analyzed 100 consecutive patients in Berne undergoing a ppW procedure with a retrocolically performed duodenojejunostomy between January 1, 1996, and December 31, 2001. The ppW procedure performed was partially modified from the original technique.21 A functioning pylorus was preserved by dividing the right gastric artery and the right gastroepiploic vessels at their origin and by preserving the nerves of Latarjet. Thus, the entire stomach, together with the first 2 to 3 cm of the duodenum, was preserved. After resection of the pancreatic head, the first jejunal loop was transposed retrocolically through the transverse mesocolon. An end-to-side anastomosis was performed with the pancreatic remnant using interrupted sutures (Figure 1A).

The indications for operation in these patients were cancer (predominantly pancreatic cancer and entities such as periampullary carcinomas, distal bile duct cancer, and metastasis of other primary cancer; n=75), chronic pancreatitis (n=10), and benign diseases, such as cystadenoma and insulinomas of the pancreas or adenomas of the papilla of Vater (n=15). Of these 100 patients, 46 were men and 54 were women, with a median age of 65.4 years (Table 1).

ANTECOLIC GROUP

Again using a prospective database, the second group of 100 consecutive patients undergoing a ppW procedure was analyzed between January 1, 2002, and December 31, 2003, in Heidelberg. The operations were performed by the same surgical team. In contrast to the retrocolic group, the duodenjejunosotomy was performed antecolically in this group, with the previously mentioned loop coming from the hepaticojejunostomy (Figure 1B). The indications for Whipple resection in this group were comparable with those in the retrocolic group (cancer, n=70; chronic pancreatitis, n=17; and others, n=13). Of these 100 patients, 41 were men and 59 were women, with a median age of 61.0 years (Table 1).

BOTH GROUPS

General characteristics such as median age, sex, previous operations, American Society of Anesthesiologists (ASA) risk...
groups, and preoperative stent implantation to the bile duct are recorded for both groups. In malignant diseases, a standard lymphadenectomy is routinely performed. The technique used to perform a ppW procedure did not change during the analyzed periods. In both groups, 2 drainage tubes were placed at the pancreaticojejunostomy and the biliary anastomosis. No T-tubes, pancreatic stents, feeding jejunostomy tubes, or tube gastrostomies were used during the surgical procedure. Nasogastric intubation was stopped after tracheal extubation, and reintubation of the gastric tube was performed if gastric retention was clinically suspected. In addition to relying on clinical judgment, DGE was determined by whether the patient had a nasogastric tube for more than 10 days after surgery, could not proceed to a regular diet within 10 days, and had vomiting for more than 3 consecutive days after the fifth postoperative day and by whether radiographic passage with water-soluble contrast medium revealed a holdup of the contrast medium in the stomach. Nasogastric reintubation was stopped if gastric retention was less than 200 mL/d.

Generally, the patients were allowed to start drinking and eating on the first postoperative day. Parenteral nutrition after surgery was reduced and subsequently stopped when the patient could eat a sufficient amount of solid food (at least 1500 kcal/d) without vomiting. All the patients undergoing a ppW procedure received omeprazole as stress ulcer prophylaxis, and octreotide was administered routinely for 7 days starting during surgery. In both groups, the prokinetic agents metoclopramide hydrochloride and erythromycin ethylsuccinate were used in a standardized manner: the patients were routinely treated with metoclopramide after the operation until they had a balanced diet. In cases of delayed gastric intake, we also administered erythromycin on the fourth postoperative day.

A nasogastric tube was inserted if the patient vomited a volume of more than 300 mL on more than 1 occasion or had nausea or a feeling of fullness in the upper abdomen. The patients routinely received water-soluble contrast medium to exclude leakage of the duodenojejunostomy and to verify upper gastrointestinal passage. If DGE was diagnosed (see the definition earlier in this subsection), the patients were treated by further application of prokinetic agents, by nasogastric intubation, and sometimes endoscopically by gentle dilation of the duodenojejunostomy.

The postoperative course was documented prospectively regarding the diet plan, the number of days and the volume of nasogastric suction, postoperative surgical (blood loss >1000 mL vs ≤1000 mL, pancreatic fistulas, anastomotic leakage, abscess, and hematoma) and medical (cardiopulmonary disorders) complications, and the duration of hospital stay.

### Table 1. Characteristics of and Perioperative Results in Patients Who Underwent a Pylorus-Preserving Whipple Procedure With Antecolic or Retrocolic Duodenojejunostomy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Antecolic Group (n = 100)</th>
<th>Retrocolic Group (n = 100)</th>
<th>Total (N = 200)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (IQR), y</td>
<td>61 (53-71)</td>
<td>65 (53-74)</td>
<td>63 (53-73)</td>
<td>.25</td>
</tr>
<tr>
<td>Hospital stay, median (IQR), d</td>
<td>11.5 (10-14)</td>
<td>18 (14-23)</td>
<td>14 (11-19)</td>
<td>&lt;.001</td>
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<tr>
<td>Sex, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>.48</td>
</tr>
<tr>
<td>M</td>
<td>41</td>
<td>46</td>
<td>87 (43.5)</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>59</td>
<td>54</td>
<td>113 (56.5)</td>
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<tr>
<td>Diagnosis, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>.35</td>
</tr>
<tr>
<td>Cancer</td>
<td>70</td>
<td>75</td>
<td>145 (72.5)</td>
<td></td>
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<tr>
<td>Chronic pancreatitis</td>
<td>17</td>
<td>10</td>
<td>27 (13.5)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
<td>15</td>
<td>28 (14.0)</td>
<td></td>
</tr>
<tr>
<td>Previous operations, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>.001</td>
</tr>
<tr>
<td>Yes</td>
<td>51</td>
<td>28</td>
<td>79 (39.5)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>49</td>
<td>72</td>
<td>121 (60.5)</td>
<td></td>
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<tr>
<td>Blood loss, No. (%)</td>
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<td></td>
<td>&lt;.001</td>
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<tr>
<td>&gt;1000 mL</td>
<td>81</td>
<td>57</td>
<td>138 (69.0)</td>
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<tr>
<td>Missing values</td>
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<td>2</td>
<td>4 (2.0)</td>
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<td>Surgical complications, No. (%)</td>
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<td></td>
<td></td>
<td>.19</td>
</tr>
<tr>
<td>Yes</td>
<td>3</td>
<td>7</td>
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<tr>
<td>No</td>
<td>97</td>
<td>93</td>
<td>190 (95.0)</td>
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<td>Medical complications, No. (%)</td>
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<td>8</td>
<td>17</td>
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<tr>
<td>No</td>
<td>92</td>
<td>83</td>
<td>175 (87.5)</td>
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<td>ASA risk group, No. (%)</td>
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</tr>
<tr>
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<td>ASA 2</td>
<td>60</td>
<td>64</td>
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<td>ASA 3/4</td>
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<td>22</td>
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<td>Stent, No. (%)</td>
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<td>35</td>
<td>30</td>
<td>65 (32.5)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>65</td>
<td>70</td>
<td>135 (67.5)</td>
<td></td>
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</table>

### RESULTS

The overall incidence of DGE in both groups combined was 14.5%. The incidence of DGE differed significantly between the antecolic (n=5) and retrocolic (n=24) groups (P<.001 (Table 2)).

There were no significant differences between the retrocolic and antecolic groups regarding patient age (P=.25) and sex (P=.48) (Table 1). In addition, no significant differences were found between groups in terms of patients with postoperative surgical or medical complications (P=.19 or P=.05, respectively). In the retrocolic group, 7 patients developed surgical complications; in the antecolic group, 3 patients had surgical complications (anastomotic leakage, intra-abdominal abscess, bleeding, hematoma, and fistulas). For these surgical complications, which may affect gastric emptying, we did not show significant differences between the 2 groups (P=.19). Comparing the retrocolic group with the antecolic group, anastomotic leakage occurred in 2 and 0 patients, respectively; abscesses in 3 and 1 patient; bleeding in 1 and
1 patient; and pancreatic fistulas in 2 and 0 patients. The rate of repeated surgery in both groups was not significantly different in the retrocolic group (3 patients) vs the antecolic group (1 patient) (P = .62). In all patients, early relaparotomy was due to bleeding in 2 cases and to pancreatic fistulas in 3 cases; none of the patients developed DGE. No significant differences were found regarding the rate of preoperative stent implantations (P = .45). In both study groups, no postoperative in-house or 30-day mortality occurred. The ASA classification significantly differed, with higher ASA levels in the antecolic group (P = .049). The median postoperative stay differed significantly in the retrocolic group vs the antecolic group (17.5 vs 11.5 days [range, 14-25 days vs 10-14 days]; P < .001).

Comparing the previously mentioned perioperative variables in patients with and without DGE, the analysis revealed significantly more men with DGE (P = .03), a significantly longer median hospital stay in patients with DGE, and significantly more DGE in patients undergoing retrocolic vs antecolic duodenojejunostomy (24 vs 5 patients; P < .001). Statistical analysis revealed no differences in the frequency of DGE regarding the underlying disease (P = .56), although there was a tendency toward less DGE in patients with chronic pancreatitis (7.4%) compared with patients with pancreatic adenocarcinoma (15.2%) and other tumors (17.9%) (Table 2).

The overall number of resected lymph nodes after the ppW procedure for cancer did not differ significantly in patients operated on in Berne (mean, 17.0; interquartile range, 12-23 [retrocolic]) vs Heidelberg (mean, 14.6; interquartile range, 10-14 [antecolic]) (P = .35). Therefore, owing to standard lymphadenectomy and the similar numbers of resected lymph nodes in both periods, this should not have any effect on DGE in this study.

The results of the logistic regression analysis to identify variables associated with DGE are given in Table 3. Type of reconstruction (antecolic or retrocolic anastomosis) and sex affect the incidence of DGE significantly (P < .001 and P = .04, respectively).

The lack of accepted definitions for DGE makes it necessary to define DGE as a compromise between different studies and our own past study. Therefore, we chose a definition using time until the nasogastric tube could be removed and until the patient could eat regular food after surgery (10 days). For the first time in the literature, to our knowledge, 2 different study groups (antecolic vs retrocolic anastomosis) are comparable on a prospective database using the same definition of DGE and regarding equal distribution of various factors that might affect DGE.

Delayed gastric emptying due to postoperative complications, such as anastomotic leakage, seems to be an accepted concept in the literature. Nevertheless, in the present study, DGE seems to be due not only to postoperative complications: although we had significantly fewer patients with DGE after the ppW proce-

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