Duodenal-Preserving Resection of the Head of the Pancreas and Pancreatic Head Resection With Second-Portion Duodenectomy for Benign Lesions, Low-Grade Malignancies, and Early Carcinoma Involving the Periampullary Region

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Hypothesis: Duodenal-preserving resection of the head of the pancreas (DPRHP) and pancreas head resection with segmental duodenectomy (PHRSD) can be alternatives to standard pancreaticoduodenectomy for benign periampullary lesions.

Design: Retrospective analysis of patients requiring surgery for benign and borderline malignant tumors of the periampullary region.

Setting: Tertiary care referral center.

Patients: Duodenal-preserving resection of the head of the pancreas (n=8) and PHRSD (n=7) were performed in 15 patients with a preoperative diagnosis of benign and borderline malignant tumors of the periampullary region (11 pancreas head lesions [2 intraductal papillary mucinous tumors, 4 serous cystadenomas, 2 insulinomas, 1 epidermal cyst, 1 metastatic renal cell carcinoma, 1 nonfunctioning islet cell tumor/parapapillary] and 4 duodenal lesions [3 adenomas and 1 adenocarcinoma]).

Main Outcome Measures: Surgical factors (operation time and blood loss), postoperative complication, postoperative pancreatic insufficiency (e.g., development of diabetes mellitus and steatorrhea or elevated stool elastase values), weight change, and recurrence of disease.

Results: No differences were noted in the mean operation time and estimated blood loss between the 2 procedures. Major postoperative complication constituted the following: bile duct stricture (n=1) in DPRHP and delayed gastric emptying (n=1) and postoperative bleeding (n=1) in PHRSD. Newly developed diabetes mellitus occurred in 1 patient. Exocrine pancreatic insufficiency (steatorrhea) was observed in 1 patient after PHRSD. Patients with early duodenal carcinoma and intraductal papillary mucinous tumors with a borderline malignancy are still alive without evidence of recurrence. There was no hospital or long-term mortality.

Conclusions: Duodenal-preserving resection of the head of the pancreas is recommended first for a benign or low-grade, early malignant pancreatic head lesion; PHRSD can be an option for a lesion of the ampullary-parapapillary duodenal area as well as the pancreatic head. Duodenal-preserving resection of the head of the pancreas can be converted to PHRSD if ischemia of the second portion of the duodenum occurs. We found benign periampullary lesions could be conservatively treated with DPRHP and PHRSD, which could substitute for classic pancreaticoduodenectomy.

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guidelines for vessel preservation during DPRHP. However, preserving a PDA is a difficult and time-consuming procedure. To overcome the technical difficulties associated with preserving vasculature during DPRHP, a pancreatic head resection with a second-portion duodenectomy (PHRSD) was introduced. In this procedure, unlike DPRHP, the duodenum can be mobilized by the Kocher maneuver, which leads to easy handling and vessel identification. In addition, surgeons do not need to be stressed about preserving the PDAs. We applied these 2 surgical procedures to benign or low-grade malignant lesions of the pancreatic head and para-papillary area duodenum. In this article, we retrospectively analyzed clinical outcomes of patients to determine the feasibility of both surgical procedures and to establish the surgical indications of the procedures.

**METHODS**

**PATIENTS**

The DPRHP and PHRSD were performed in 15 patients (8 patients underwent DPRHP and 7 patients underwent PHRSD) for preoperatively diagnosed benign periampullary lesions between December 1, 1995, and September 30, 2001, at the Department of Surgery, Seoul National University Hospital, Seoul, South Korea. Table 1 lists the patient’s demographics, preoperative reports, location of the tumor, and final diagnosis classified by operations.

### INdications

These procedures were considered for the benign lesions or tumors with low-grade malignant potential. In principle, these procedures were applied in consideration of the size, location(s), and the extent of disease.

**Cystic Neoplasm of the Pancreatic Head**

Duodenal-preserving resection of the head of the pancreas was considered unless there was any evidence of invasiveness or solid component or vessel preservation was precluded by their large size.

**Intraductal Papillary Mucinous Tumor**

Duodenal-preserving resection of the head of the pancreas was considered and attempted if the lesion was localized at the head and involved only the branches of the main duct. If the main duct was likely involved and dilated or if an invasive intraductal papillary mucinous tumor (IPMT) was suspected, the case was ineligible.

**Endocrine Tumor or Nonfunctioning Islet Cell Tumor**

An endocrine tumor (e.g., insulinoma) with a relatively large size (>2 cm) located close to the main pancreatic duct was considered a candidate for DPRHP instead of enucleation. A nonfunctioning islet cell tumor was a candidate for this procedure also.

**Ampullary or Nonpancreatic Periampullary Tumor**

Pancreas head resection with segmental duodenectomy was attempted if gross endoscopic and biopsy findings revealed a benign adenoma.

**Converting DPRHP to PHRSD**

During the surgical procedure, DPRHP was converted to PHRSD if ischemia of the second portion of the duodenum was observed.

**SURGICAL PROCEDURES**

Duodenal-Preserving Resection of the Head of the Pancreas

Figure 1 shows the principal steps of the operative procedure. After abdominal exploration, the lesser sac was entered and the anterior aspect of the pancreatic head was fully exposed. The Kocher maneuver was not performed to preserve the integrity of the mesoduodenal vessels. The neck of the pancreas was transected along the midline of the superior mesenteric vein and portal vein. With preserving the right gastroepiploic artery, the anterosuperior pancreaticoduodenal artery was identified and divided. The origin of the posterior superior pan-

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### Table 1. Diagnosis, Preoperative Complaints, Location of Tumor According to Operation

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Diagnosis</th>
<th>Location</th>
<th>Preoperative Complaint</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPRHP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/M/56</td>
<td>Serous cystadenoma</td>
<td>Pancreatic head</td>
<td>None</td>
</tr>
<tr>
<td>2/F/50</td>
<td>Serous cystadenoma</td>
<td>Pancreatic head</td>
<td>None</td>
</tr>
<tr>
<td>3/F/33</td>
<td>Serous cystadenoma</td>
<td>Pancreatic head</td>
<td>None</td>
</tr>
<tr>
<td>4/M/52</td>
<td>IPMT</td>
<td>Pancreatic head</td>
<td>None</td>
</tr>
<tr>
<td>5/M/57</td>
<td>IPMT</td>
<td>Uncinate process</td>
<td>Epigastric pain</td>
</tr>
<tr>
<td>6/F/56</td>
<td>Insulinoma</td>
<td>Pancreatic head</td>
<td>LOC</td>
</tr>
<tr>
<td>7/M/26</td>
<td>Insulinoma</td>
<td>Pancreatic head</td>
<td>LOC</td>
</tr>
<tr>
<td>8/F/62</td>
<td>Epidermal cyst</td>
<td>Pancreatic head</td>
<td>None</td>
</tr>
<tr>
<td>PHRSD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/F/47</td>
<td>Tubulovillous adenoma</td>
<td>2 cm Below the AOV</td>
<td>Epigastric pain</td>
</tr>
<tr>
<td>2/F/51</td>
<td>Tubulovillous adenoma</td>
<td>AOV</td>
<td>None</td>
</tr>
<tr>
<td>3/F/51</td>
<td>Villous adenoma</td>
<td>Just below the AOV</td>
<td>Epigastric pain</td>
</tr>
<tr>
<td>4/M/58</td>
<td>Serous cystadenoma</td>
<td>Pancreatic head</td>
<td>Abdominal pain</td>
</tr>
<tr>
<td>5/M/34</td>
<td>Nonfunctioning islet cell tumor</td>
<td>Pancreatic head</td>
<td>None</td>
</tr>
<tr>
<td>6/M/66</td>
<td>Adenocarcinoma</td>
<td>2 cm Anterosuperior to AOV</td>
<td>None</td>
</tr>
<tr>
<td>7/F/56</td>
<td>Metastatic renal cell carcinoma</td>
<td>Uncinate process</td>
<td>None</td>
</tr>
</tbody>
</table>

Abbreviations: AOV, ampulla of Vater; DPRHP, duodenal-preserving resection of the head of the pancreas; IPMT, intraductal papillary mucinous tumor of the pancreas; LOC, loss of consciousness; PHRSD, pancreatic head resection with second-portion duodenectomy.
creaticoduodenal artery (PSPDA) was identified and the attached pancreatic tissues were separated downward, preserving the vessels. Leaving both the PSPDA and common bile duct (CBD) intact, the pancreatic tissues surrounding the CBD and intervening between the PSPDA and the CBD were carefully dissected. The pancreatic head facing the third portion of the duodenum was retracted upward and the pancreatic branches of the anterior inferior pancreaticoduodenal artery were ligated while the duodenal branches were preserved. The terminal portions of the CBD and the pancreatic duct were exposed as dissection approached the papilla. Then the pancreatic duct was divided at its confluence with the CBD. Finally, the pancreatic head was completely removed from the tightly attached parapapillary area of the second portion of the duodenum. The thinned wall of the medial part of the suprapapillary duodenal wall was reinforced with a 3-0 polyglactin (Vicryl) suture if needed. The distal pancreas was anastomosed to the posterior wall of the stomach and pancreatic tube was inserted and passed out through the anterior wall of the stomach for diversion. Cholecystectomy with T-tube choledochostomy was performed.

Pancreas Head Resection With Segmental Duodenectomy

Figure 2 shows the schema of PHRSD. Originally, PHRSD was introduced to overcome the technical difficulty of vascular preservation. For this reason, meticulous dissection for preservation of vasculature in DPRHP was unnecessary in this procedure. The preservation of only 2 vessels—the anterior inferior pancreaticoduodenal artery and the gastroduodenal artery—was needed for the blood supply to the remaining first and third portion of the duodenum, respectively.8,11

The pancreatic head was fully mobilized using the Kocher maneuver to examine the size and the extent of the tumor. The superior pancreaticoduodenal arteries were ligated and divided at their roots with preservation of the gastroduodenal and the gastroepiploic arteries. After tunneling of the pancreatic neck was performed, the exposure of the anterior inferior pancreaticoduodenal artery was performed with the dissection between the inferior portion of the pancreatic head and the third portion of the duodenum. At the point of transition to the anterior superior pancreaticoduodenal artery (between the second and third portion of the duodenum), the anterior inferior pancreaticoduodenal artery was ligated and divided. Then the pancreatic head including an intrapancreatic portion of the CBD and the second portion of the duodenum were resected en bloc. The distal end of the resected CBD was anastomosed to the first portion of the duodenum with an interrupted 4-0 polyglactin (Vicryl) suture and a T tube was inserted for biliary diversion and stenting. The end-to-end duodenoduodenostomy was performed and finally the pancreatogastrostomy was performed in the same manner as the DPRHP.

CLINICAL DATA ANALYSIS

Clinical data were obtained from the patients’ medical records (surgical reports, pathologic reports, postoperative data, hospital course, and outpatient medical records) and telephone interviews. The surgical factors (including operation time, estimated blood loss, and transfusion), postoperative complications, and early outcomes were analyzed. The postoperative long-term outcomes (endocrine and exocrine function, recurrence, and weight change) were also evaluated. The median follow-up period was 13 months (range, 7-89 months) postoperatively.

RESULTS

The postoperative pathologic diagnosis of DPRHP comprised serous cystadenoma of the pancreas head (n=3), IPMT (n=2), insulinoma (n=2), and an epidermal cyst of the pancreas head (n=1). Except for epidermal cyst, preoperative diagnoses were well matched to the postoperative pathologic diagnoses.

In PHRSD, there were 4 duodenal lesions and 3 pancreatic head lesions. The PHRSD was applied to the duodenal lesions (tubulovillous adenoma of the ampulla of Vater [n=2], villous adenoma of the ampulla of Vater [n=1], and
adenocarcinoma of the duodenum \( n=1 \)) and performed successfully. The pancreatic head lesions were serous cystadenoma of the pancreatic head \( n=1 \), nonfunctioning islet cell tumor of the pancreatic head \( n=1 \), and metastatic renal cell carcinoma of the pancreatic head \( n=1 \). Initially, the patients with serous cystadenoma and nonfunctioning islet cell tumor of the pancreatic head were candidates for DPRHP; however, they were converted to PHRSD because the ischemic sign of the duodenal second portion was observed during the surgical procedure. The final diagnosis of a patient having early duodenal cancer was proved to be a “villous adenoma” on the preoperative endoscopic biopsy specimen. On the postoperative pathologic report, it was shown to be a “well-differentiated adenocarcinoma, confined to the mucosa.” The patient with a “metastatic renal cell carcinoma” had a history of a radical nephrectomy for renal cell carcinoma 8 years prior to the operation. The preoperative radiological diagnosis was a “nonfunctioning islet cell tumor of the pancreas.”

SURGICAL FACTORS

The mean surgical times for DPRHP and PHRSD were 366 minutes (range, 260-455 minute) and 392 minutes (range, 375-475), respectively. The mean estimated blood loss from the operation field was 450 mL for DPRHP and 557 mL for PHRSD. One unit of packed red blood cells was transfused during PHRSD to a patient with metastatic renal cell carcinoma.

POSTOPERATIVE COMPLICATIONS

AND HOSPITAL COURSE

There were 6 cases (40%) of postoperative complications irrespective of the type of surgical procedure.

Table 2. Postoperative Complications and Its Management

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Complication</th>
<th>No. of Patients</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPRHP</td>
<td>Bile duct stricture</td>
<td>1</td>
<td>Balloon dilatation</td>
</tr>
<tr>
<td></td>
<td>Fluid collection</td>
<td>1</td>
<td>PCD</td>
</tr>
<tr>
<td>PHRSD</td>
<td>DGE</td>
<td>1</td>
<td>NPO and L tube</td>
</tr>
<tr>
<td></td>
<td>Pancreatic leakage</td>
<td>2</td>
<td>PCD</td>
</tr>
<tr>
<td></td>
<td>Postoperative bleeding</td>
<td>1</td>
<td>Exploration</td>
</tr>
</tbody>
</table>

Abbreviations: DGE, delayed gastric emptying; DPRHP, duodenal-preserving resection of the head of the pancreas; NPO, nothing by mouth; PCD, percutaneous drainage; PHRSD, pancreatic head resection with second portion duodenectomy.

Table 2). Minor pancreatic leakages were detected in 2 patients who recovered well with conservative management with percutaneous drainage and short-period fasting. In 1 patient with IPMT who underwent DPRHP, obstructive jaundice due to a focal bile duct stricture developed a few days after hospital discharge. A T tube was inserted in situ and the patient’s condition was managed successfully by an interventional balloon dilatation through the T-tube tract. The patient has been healthy with normal liver function for 3 years.

Delayed gastric emptying (DGE) was defined as nasogastric drainage for more than 10 days, or a reinsertion of a nasogastric tube because of vomiting, or a failure to tolerate a semisolid diet 14 days after surgery. In 1 patient who underwent PHRSD and who had a serous cystadenoma of the pancreatic head, DGE developed, and was managed conservatively for 20 days with a complete recovery. No DGE was observed in the DPRHP group.

Major postoperative bleeding presenting gastrointestinal tract bleeding occurred in 1 patient after hos-
The stool elastase level was measured.

Steatorrhea. As an objective parameter for pancreatic exocrine function, the stool elastase level was measured.

Five patients reported postoperative steatorrhea with intermittently abdominal cramping pain in the early posthospital days. One of the aforementioned patients is still suffering from postprandial diarrhea and severe steatorrhea. As an objective parameter for pancreatic exocrine function, the stool elastase level was measured. Among the 15 patients, 5 patients had less than the lower limit for stool elastase level (reference range, 72-432 ng/dL). One patient with a serious cystadenoma of the pancreas and another patient with early duodenal cancer lost more than 10% of their preoperative body weight during the postoperative 3 months. Symptoms of cholangitis, which might occur due to choledochoduodenostomy, were not observed in any patients after PHRSD.

Beger et al described DPRHP, which was developed and indicated for chronic pancreatitis. They removed the pancreatic head subtotally while leaving a small part of the head of the pancreas close to the duodenal wall. In contrast to this procedure, we performed a total pancreatic head resection while preserving the whole length of the CBD without the Kocher maneuver. The authors’ procedure might be difficult for chronic pancreatitis.

Isaji and Kawarada and Nakao described PHRSD as a simpler and safer method for a complete resection of the pancreatic head than DPRHP because in PHRSD, vessel preservation is not as stressful as in DPRHP. In addition, the duodenum can be mobilized by the Kocher maneuver, which facilitates the palpation of the lesion of the pancreatic head and vasculature and makes it simple to identify and dissect the peripancreatic structures.

However, in our experience, the operation time in the 2 procedures was similar. The gastroduodenal artery and the anterior inferior pancreaticoduodenal artery were preserved to prevent ischemia of the first and the third portion of the duodenum. It is worth spending additional time preserving the gastroduodenal artery so as to retain good viability of the first and proximal second portion of the duodenum. For reconstruction, DPRHP requires 1 anastomosis (pancreaticogastrectomy), whereas PHRSD requires at least 3 anastomoses (pancreateoco chicteric, choledochoduodenostomy, and duodeno duodenal anastomosis). It is believed that DPRHP requires a good deal of time to preserve the vessels whereas PHRSD takes time to complete a multiple anastomoses.

All benign pancreatic head diseases can be treated with DPRHP. Other pancreatic lesions (such as IPMT) with a potential involvement of the main pancreatic duct or ampullary/parapapillary duodenal tumor with a benign or low-grade malignant potential are candidates for a PHRSD. For a benign lesion of the pancreatic head, DPRHP can be attempted first, after which it can be converted to PHRSD if the duodenal blood supply is preserved. In our series, 2 patients were converted to PHRSD from DPRHP during the operation owing to vascular compromise of the duodenum.

Buchler et al demonstrated a significant difference between duodenal preservation and pylorus-preserving pancreaticoduodenectomy (PPPD) when glucose tolerance, insulin secretion, and resultant postoperative weight gain were looked at. In their report, though it was different in the volume of the resected pancreas (PPPD, 40%-60%; DPRHP, 30%-40%), the major difference between the surgical procedure was, in fact, the preservation of the duodenum, and this would appear to be the crucial factor for intact or unchanged glucose tolerance after DPRHP. Even though it was not the same as DPRHP, PHRSD could...
preserve upper gastrointestinal tract including the third portion of duodenum and the proximal jejunum for a longer time than PPPD could. It is believed that the preserved relatively short segment may play a significant role in absorbing the iron, calcium, fat, folic acid, and so on. Therefore, both procedures are thought to be superior to PPPD with regard to postoperative nutritional support. Our result would appear to reveal that weight loss is a serious long-term problem after PHRSD. However, 3-month follow-up period would not appear to be long enough to permit a comparison between the procedures with regard to weight loss.

After a Whipple operation, the percentage of patients who become diabetic amounts to 20% to 40%.13 Bittner et al14 performed a prospective study to evaluate the endocrine pancreatic function following DPRHP. In most patients, DPRHP did not lead to an impairment of glucose tolerance. In this study, 2 patients with preoperative diabetes mellitus who had a serious cystadenoma of the pancreas and early duodenal cancer showed no change in their blood glucose levels after the operation. One patient who had a villotubular adenoma of the ampulla of Vater became diabetic after PHRSD; this patient’s diabetes mellitus is under control because the patient is taking oral hypoglycemic drugs.

Only 1 biliary complication from DPRHP was experienced. This patient had a stricture of the distal CBD, which was successfully managed by dilatation and temporary stenting. A focal ischemia or a sealed-off microperforation might be the cause of the stricture, which appears to be a procedure (DPRHP)-related complication. A biliary stricture, as a late complication, is also a potential complication of PHRSD because the choledochoduodenostomy stoma is usually small (owing to the normal caliber of the CBD) and reflux of duodenal content is expected.9,10

Delayed gastric emptying has been described as one of the leading causes of postoperative morbidity after PPPD, and it causes a prolongation of nasogastric intubation and delays the beginning of oral intake and the patient’s recovery. Many factors have been implicated in the pathogenesis of pancreaticoduodenectomy, including gastric dysmotility secondary to an anastomotic leak or perianastomotic abscess, gastric atony after resection of the duodenal pacemaker and disruption of gastroduodenal neuroconnections, ischemic injury to the antrpyloric muscle mechanism, and gastric dysmotility in response to a reduction of circulating levels of motilin.15,16 Muller et al15 compared DGE after PPPD and DPRHP. In contrast to the PPPD, they found no DGE after DPRHP. Even though no meaningful conclusion can be made owing to too few instances (8 cases) of these surgical procedures in our series, we also found no DGE after DPRHP.

One case of DGE that occurred in the PHRSD group was probably caused by an intra-abdominal complication (anastomotic leak or perianastomotic abscess) that gave rise to gastric dysmotility, because the duodenal pacemaker, located 0.5 to 1 cm distally from the pylorus, could be preserved and antropyloric muscular ischemia could not occur in PHRSD. In addition, reduction of the circulating level of motilin after duodenal resection is not thought to be a major cause of gastric dysmotility in PHRSD. Murakami et al17 reported that pancreatic fibrosis enhances DGE in PPPD with a pancreaticogastrostomy, probably due to the effect of pancreatitis and increased gastric fluid production. We performed pancreaticogastrostomy, and we think it can be an attributable cause of DGE in this study.

Among the 5 patients who had postoperative steatorrhea, 1 patient with PHRSD had steatorrhea at this time; the others recovered within 3 months postoperatively. Although we were unable to prove the statistical significance of the study because of the small number of cases, it appears that there was no difference in the outcome between the 2 operations.

Intraductal papillary mucinous tumor of the pancreas shows (1) a tendency toward intraductal spread, (2) dysplasia varying in severity and epithelial atypia within the same tumor, and (3) slower development, which means (4) a better prognosis.18 Histologically, the tumor includes a spectrum of changes ranging from low- to high-grade dysplasia and from adenoma to infiltrating carcinoma. Intraductal papillary mucinous tumor of the pancreas has a high rate of malignant degeneration; however, the respectability rate and survival after resection are almost 90%, which suggest early surgical resection is warranted. The oncologically correct approach to treatment should be to proceed with a pancreatic resection until a resection margin free of epithelial atypia is achieved. In some of the literature, even total pancreatectomy is recommended when a resection margin cannot be achieved.19-22 However, it is proposed that carcinoma occurs frequently in the main pancreatic duct type than in the branch type23 and the extent of resection of the IPMT with mild to moderate dysplasia at the resection margin remains uncertain.21 We agree that standard Whipple operation or PPPD is too invasive for patients with IPMT of borderline malignancy in pancreas head and DPRHP can completely eradicate the lesions.24 Two IPMTs in our series that were side branch duct type on preoperative computed tomographic scan, had a free resection margin on intraoperative frozen section but turned out to be IPMT with moderate dysplasia on the postoperative pathological report. Although there is the possibility of recurrence in remnant pancreas, both patients are under observation and show no sign of developing symptoms and recurrence in the median follow-up period of 34 months.

Theoretically, because DPRHP and PHRSD are less extensive surgery than standard pancreaticoduodenectomy, operation time should be shorter and blood loss should be less, there should be fewer complications and the hospital stay should be shorter. Although our results did not satisfy these conditions, more cases and experience would improve our surgical skills and thus produce better clinical outcomes.

Duodenal-preserving resection of the head of the pancreas is technically difficult owing to the high level of vascular preservation; PHRSD is complicated because of the multiple anastomoses. The 2 operations had a similar aspect of early and late complications. Indications for doing DPRHP should be limited to benign pancreatic le-

CONCLUSIONS
sions and those for PHRSD should include benign or low-grade malignant ampullary and parapapillary duodenal lesions as well as benign pancreatic head lesions. Duodenal-preserving resection of the head of the pancreas can be converted to PHRSD if ischemia of the second portion duodenum occurs. We concluded that both DPRHP and PHRSD can be alternatives to a conventional pancreaticoduodenectomy in the aspect of organ preservation, postoperative morbidity, and nutritional support.

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REFERENCES