Left-Sided Pancreatic Cancer

Distal Pancreatectomy and its Variants: Radical Antegrade Modular Pancreatosplenectomy and Distal Pancreatectomy With Celiac Axis Resection

Steven M. Strasberg, MD and Ryan Fields, MD

Abstract: Adenocarcinoma of the body and tail of the pancreas is an aggressive malignancy, and classically there have been few survivors after surgery. Radical antegrade modular pancreasoplenectomy and distal pancreatectomy with celiac axis resection are new procedures for these tumors. Radical antegrade modular pancreatoplenectomy is designed to establish an operation with oncologic rationales both for the dissection planes used to achieve negative margins and the extent of node dissection. The extent of lymph node dissection is based on the descriptions of N1 lymph node drainage, and dissection planes are based on fascial planes of the retroperitoneum. Radical antegrade modular pancreatoplenectomy is modular, adjusting the posterior plane of dissection based on the position of the tumor on preoperative computed tomograms. It is also performed right to left to increase visibility and control blood supply early. Radical antegrade modular pancreatosplenectomy is not an extended pancreatectomy but brings the rationales of the modern Whipple procedure to left-sided tumors. In long-term results from our center in 47 patients, there was a high negative tangential margin rate of 89% and an actuarial overall 5-year survival rate of 35.5%. The actual 5-year survival in 23 patients was 30.4%. Distal pancreatectomy with celiac axis resection is a procedure for cancers that have involved the celiac axis. It is based on the fact that resection of the celiac axis may be performed without devascularizing the liver, which then receives its blood supply by the pancreaticoduodenal arcade. It is an extended pancreatectomy. Mature long term results are just becoming available. Results with distal pancreatectomy with celiac axis resection are mixed with some series reporting few or no long-term survivors, whereas others report long-term survival at approximately 20%.

Key Words: Pancreatic cancer, radical antegrade modular pancreatosplenectomy (RAMPS), distal pancreatectomy with celiac artery resection (DP-CAR)

(Cancer J 2012;18: 562-570)

An adenocarcinoma of the body and tail of the pancreas is a highly malignant tumor. Until the past decade, there were few long-term survivors after surgical resection. For instance, in 1990, it was stated that there were 5 known 5-year survivors with this disease.1 With advances in detection, staging, and treatment, especially surgical treatment, a small subset of patients with this disease is now being cured. This article will focus on radical antegrade modular pancreatosplenectomy (RAMPS) and distal pancreatectomy with celiac artery resection (DP-CAR), also called the Appleby procedure. Radical antegrade modular pancreatosplenectomy is a promising technique, which has recently been shown to have a 35% 5-year overall survival (OS). Distal pancreatectomy with celiac artery resection is an extended pancreatectomy for lesions that have spread locally to involve the celiac axis. There have been several reports of this procedure, and its evaluation is continuing.

RAMPS

History of Left-Sided Pancreatectomy and Development and Rationale of the RAMPS Procedure

The first left-sided pancreatectomies were performed in the late 19th century2 in Europe. The first in the United States was apparently performed by Briggs in St Louis in 1890.3 Until 1999, the standard operation was performed by early ligation of the splenic artery followed by mobilization of the spleen and pancreas, usually from a left-to-right direction,4 although some authors performed the mobilization right-to-left.2 Oncologic goals and the strategies to achieve them, namely, the extent of node dissection and the dissection planes used to optimize margin negativity, were not well defined, possibly because most left-sided resections before 1990 were performed for chronic pancreatitis. Radical antegrade modular pancreatosplenectomy (RAMPS) has been performed in our center since 1999.5-7 It was designed to establish an operation with oncologic rationales both for the dissection planes used to achieve negative margins and the extent of lymph node dissection. The extent of the lymph node dissection is based on the anatomic descriptions of N1 lymph node drainage from this part of the pancreas by O’Morchoe.8 The anatomic planes for the posterior margin, which is the one that is most often positive, are based on the relationship of the fascial planes of the retroperitoneum to the posterior surface of the pancreas as described by Lei et al.9 The plane of the posterior dissection is modular and depends on the position of the tumor in relation to the adrenal gland on preoperative computed tomographic (CT) scans as explained below. Radical antegrade modular pancreatosplenectomy is not an “extended” pancreatic resection. Its intention is to bring the oncologic rationales of the modern Whipple procedure, i.e., N1 lymph node dissection and dissection with the best chance of attaining negative margins, to left-sided pancreatectomies.

Anatomic Basis for the RAMPS Procedure

Position and Relations

As described by Lei et al,9 the “distal” pancreas (pancreatic body and tail) lies within the pararenal fascial space (pararenal, meaning near the kidney), that is, behind the peritoneum and in front of a distinct layer of fascia called the anterior renal fascia.
(Fig. 1). The kidney and the adrenal lie behind the anterior renal fascia in the perirenal space (perirenal, meaning around the kidney), bounded posteriorly by another layer of fascia, the posterior renal fascia. The contents of the perirenal space are contained in a fatty loose areolar tissue, whereas the connective tissue of the pararenal space is much more fibrous in nature. The 2 peritoneal layers of the mesocolon separate on the anterior surface or inferior border of the pancreas, one leaf passing upward on the retroperitoneum and one downward. This explains why the base of the mesocolon is frequently involved by pancreatic tumors.

Anteriorly, the stomach is the organ that is most commonly invaded by left-sided pancreatic cancer because the posterior parietal peritoneum overlying the pancreas is usually in contact with the visceral peritoneum covering the posterior wall of the stomach. Laterally, the spleen is frequently involved by tail lesions. The structures that share the pararenal space with the pancreas on its anteroinferior aspect include the duodenum, the splenic flexure of the colon (more laterally), and the root of the mesocolon as noted earlier. The posterior relationships of the pancreas are the most important to the surgeon because the posterior resection margin is the most common site of R1 resection. Posteriorly and superiorly pancreatic tumors invade the splenic artery, the celiac artery, the common hepatic artery, and sometimes, the origin of the left gastric artery. More posteriorly and inferiorly, the superior mesenteric artery, the aorta, and the confluence of the splenic and superior mesenteric veins may be involved. Pancreatic tumors also invade posteriorly through the anterior renal fascia to involve the adrenal and less commonly the kidney or the vasculature of these organs.

The RAMPS procedure attempts to maximize the chance of getting negative tangential margins by placing the resection plane behind the anterior renal fascia (anterior RAMPS) when the tumor has not penetrated the posterior capsule of the pancreas on preoperative CT scans, and behind the adrenal gland and Gerota fascia when it has (posterior RAMPS) (Fig. 2). In each case, the goal is to add an extra margin of safety in resecting these tumors, which can spread microscopically beyond their radiographically visible or palpable margins. In each case, the adrenal vein is the intraoperative guide to the position of the margin. In anterior RAMPS, the posterior margin is formed by identifying the adrenal vein at its junction with the left renal vein and following its anterior surface retrograde in a right-to-left direction to the left adrenal gland. The posterior margin continues out on the surface of the adrenal and Gerota fascia. In the posterior RAMPS, the adrenal vein is divided at its termination with the renal vein and elevated along with the adrenal to give the posterior margin.

**Lymph Node Drainage**

Both anatomical and pathological studies have been used to determine the propensity of a cancer to metastasize to specific lymph nodes. The anatomical approach uses dissection and injection of markers to identify the primary and secondary nodal drainage stations from particular organs. Pathological lymph node mapping studies use specimens obtained at surgery or autopsy to determine which lymph nodes are invaded in patients who have a particular tumor type. The aim of the RAMPS procedure is to perform a complete N1 lymph node dissection and not resect N2 or N3 node levels. To do so, the position of N1 nodes had to be defined, and we relied on anatomic studies of the lymphatic drainage of the body of the pancreas (Fig. 3) as summarized in a classic review by O’Morchoe.

The body and tail of the pancreas has 4 nearly equally sized quadrants. Lymphatic vessels traveling from the 4 quadrants connect to lymphatics along the superior and inferior borders of the gland. Small lymph nodes lie along the latter lymphatics. The lymphatic vessels on the superior and inferior borders of the left half of the body and tail drain to splenic nodes in the splenic hilum or gastrosplenic nodes in the gastrosplenic omentum. Lymphatic vessels coursing along the superior and inferior borders of the right half of the pancreatic body drain to the gastroduodenal and infrapancreatic nodes. These 4 sets of lymph nodes form a ring of nodes (Fig. 3). The ring of nodes drain into nodes anterior to the aorta in relation to the celiac and superior mesenteric arteries, but these nodes, which may be thought of as a string of nodes, are not exclusively an N2 node group. Lymphatics from the central part of the pancreatic body enter these nodes directly without first entering a node on the ring. Therefore, they should be considered as N1 as well as N2 nodes. Based on this information, an operation designed to remove N1 nodes should resect both sets of N1 nodes, which we have colloquially referred to as the “ring” and the “string” of nodes.

Kayahara et al performed pathological mapping of lymph nodes in cancer of the body and tail of the pancreas in 20 patients. Three node groups were involved in more than 20% of patients: nodes along the superior and inferior borders of the pancreas (nodes 11 and 18 in the Japanese system) and the gastroduodenal node (node 8 in the Japanese system) (Fig. 3). These are all resected in the RAMPS operation. Recently, Fujita et al described the results of pathological lymph node mapping in 50 patients with adenocarcinoma of the body and tail of the pancreas. They identified a group of small lymph nodes attached to the pancreas, seen only on histological slides. These nodes were involved by the cancers in approximately 75% of patients.
However, all other lymph node groups were involved very infrequently, usually in less than 10% of patients. The frequently involved small lymph nodes may correspond to the nodes that lie along the superior and inferior borders of the pancreas described in O'Morchoe's study, although those were grossly identifiable as nodes. Whether these nodes are exactly the same as those described by O'Morchoe is uncertain, but they are certainly removed by RAMPS. The results of Fujita et al are interesting, but it is unclear at present whether they apply to patients in Western countries because the incidence of cancer in nodes that could be macroscopically identified as lymph nodes grossly was so low. In addition, as we will describe, Japanese patients seem to have more well-differentiated tumors than American patients, a fact that also suggests that the disease may differ significantly in virulence in the 2 countries (United States vs Japan).

Technique of the RAMPS Procedure

Preoperative Preparation

A recent abdominal CT scan is used to decide whether to perform an anterior or posterior RAMPS. When a rim of normal pancreas remains posterior to the tumor, the anterior RAMPS is chosen (Fig. 4). When the posterior margin of the tumor contacts or seems to break through the posterior capsule of the pancreas, the posterior RAMPS is selected (Fig. 5). The tumor does not need to be seen to be touching or invading the adrenal for a posterior RAMPS to be selected. It needs only to be seen to have invaded posteriorly out of the pancreas. The principle being applied is that the space between the back of the pancreas and the front of the adrenal is too thin to reliably attain negative margins when the tumor is present in the space. Of course, in some instances, when the tumor is very far to the left in the hilum of the spleen, it is well away from the adrenal. In that case, it is the Gerota fascia and not the adrenal that needs to be removed.

The Procedure

Staging laparoscopy is performed to detect intra-abdominal metastases, which contraindicate the procedure. A left upper quadrant “J” incision or “Mercedes Benz” incision with a longer left limb is used. The abdomen is again explored for evidence of metastases. The lesser sac is entered by freeing the omentum from the colon or by opening through the gastrocolic ligament. The gastroplenic ligament is divided, taking the short gastric vessels close to the stomach to remove the gastroplenic node group. The middle colic vein traced to the superior mesenteric vein. The neck of the pancreas is elevated off the superior mesenteric and portal veins. The right gastroepiploic vein may be sacrificed if necessary to display the superior mesenteric vein. A Kocher maneuver is performed and the anterior surface of the left renal vein is exposed for several centimeters. This will be useful later in the procedure when the vein has to be identified on the left side.

The lesser omentum is opened, and the right gastric artery is divided. The proper hepatic artery is identified and followed...
proximally to display the common hepatic and gastroduodenal arteries. The gastroduodenal lymph node (node 8) is mobilized from above downward and left, attached to the superior border of the pancreas, as the common hepatic artery is displayed. The anterior surface of the portal vein is exposed by retracting the gastroduodenal artery (GDA) to the right. The neck of the pancreas is divided using a stapler. A celiac node dissection is performed, taking all the nodes from the crus of the diaphragm superiorly and posteriorly, off the celiac artery and the origins of the left gastric, hepatic, and splenic arteries. In this way, the origin of the splenic artery is exposed from a superior approach as the celiac nodes are dissected downward. The celiac ganglia are not resected.

The splenic vein is isolated at its junction with the superior mesenteric vein and divided with a vascular stapler. If tumor invasion is present at this site, a resection of the superior mesenteric vein and/or portal vein is performed and repaired primarily or with a graft. The right border of the dissection is carried downward in the sagittal plane, dividing fat and fibrous tissue until the left side of the superior mesenteric artery is identified (Fig. 6). The artery is followed on its left side, superiorly and posteriorly, down to the aorta. The left sides of both the superior mesenteric and celiac arteries should now be visible down to the point that they come off the aorta. The lymph nodes anterior to the aorta between the celiac artery and superior mesenteric artery and those anterior and to the left of the superior mesenteric artery are taken with this step.

The next step continues to develop the right border of dissection, which is now carried in the sagittal plane through the anterior renal fascia onto the renal and adrenal veins (Fig. 6). This step is facilitated by placing a finger on the anterior surface of the left renal vein behind the previously mobilized duodenum. The finger can be palpated from the left side of the dissection posterior to the superior mesenteric artery. Dividing the intervening tissue (anterior renal fascia) will expose the left renal vein. In the anterior RAMPs, the adrenal vein is identified and its anterior surface also becomes part of the posterior plane of dissection, as does the anterior surface of the adrenal gland as it is reached (Fig. 6). The dissection is continued in a postero-lateral direction onto the perinephric fat. The superior and inferior attachments of the pancreas are divided as the dissection proceeds to the left. The inferior mesenteric vein is transected. Division of the lienorenal ligament is the last step in the procedure. In the posterior RAMPs, the adrenal vein is divided at its termination into the left renal vein, and the dissection is carried to the left and posteriorly behind the adrenal gland and onto the surface of the kidney (Fig. 7). After removal from the patient, the specimen is inked at the pancreatic neck margin and on the tangential margins using different colored inks, and a frozen section of the neck of the pancreas is obtained.

These tumors may also invade several other organs or tissues in close relationship to the pancreas as described previously (stomach, duodenum, and splenic flexure of the colon). Provided that the disease is local, any of these structures may be resected as in the standard method. The view at the end of the dissection in the 2 procedures is shown in Figures 6 and 7.

**Laparoscopic Standard Distal Pancreatectomies and Laparoscopic RAMPs**

Standard distal pancreatectomy has been performed successfully by minimally invasive techniques for more than a decade and has been applied to pancreatic carcinoma in some
patients had negative tangential margins. Four of 47 patients had a positive margin at the pancreatic neck on permanent section, although the frozen section diagnosis was negative for malignancy. In all, 38 (81.0%) of 47 patients had negative margins.

**Long-Term Survival**

Mean and median follow-up times of living patients were 44.4 and 26.4 months, respectively. Eighteen patients (38.3%) are alive, and 29 patients (61.7%) have died. Eleven patients (23.4%) are alive without evidence of disease, and 7 patients (14.8%) are alive with disease. Death occurred 1.4 to 74.4 months after surgical resection. Median survival was 25.9 months (Fig. 8). Five-year OS was 35.5% (Fig. 8). Seven patients have lived longer than 5 years. The actual 5-year survival rate of the 23 patients whose surgery was performed more than 5 years before the latest follow-up (June 30, 2010) was 30.4% (7/23). Judged by short-term outcome, number of nodes, tangential margin negativity rate, and long-term survival, these single-center results are very satisfactory.

**Comparison of RAMPS With Standard Distal Pancreatectomy**

Pathologic and long-term outcomes of distal pancreatectomies in other case series are shown in Table 1. There are many problems with comparing studies. Tangential margin positivity rates are often reported, but inking of margins, which makes the margin easier to evaluate by pathologists, does not...
seem to have been done except in our study. The number of lymph nodes resected is also reported infrequently.

Two studies from Asia (one from Korea and the other from Japan) have reported survival results similar to our own. In both series, some patients were operated on using the RAMPS approach. Excluding 12 patients who had tumors that required resection of the celiac axis (modified Appleby procedure), the results of Shimada et al who used a procedure that was more radical than the posterior RAMPS are similar to ours. One problem with comparing these results to our own is that the reported grade of pancreatic carcinomas tend toward more well-differentiated tumors in Japan than in Western centers using standard distal pancreatectomy in a randomized trial. However, this goal is likely not attainable because of the disparity between the number of cases available for study and the number required for a randomized trial. The median case per year per center is 3.4 in reported case series (Table 1). To compare 2 treatments with 5-year survival of rates 20% and 35%, group sample sizes of more than 200 patients would be required (i.e., a randomized controlled trial to determine if RAMPS provides that level of superior survival outcome would require a cooperative study involving 25 or more high-volume pancreatic surgery centers over several years. Available data are insufficient to comment on the outcome of laparoscopic RAMPS.

**DP-CAR**

History of DP-CAR

In 1952, Lyon Appleby, a Canadian surgeon, presented a case of gastrectomy with en bloc resection of the celiac and common hepatic arteries in a patient with gastric adenocarcinoma. In 1960, he presented a 10-year assessment of the operation in his personal series of 19 cases. The liver maintained its arterial blood supply by retrograde flow from the GDA via the pancreaticoduodenal arcade and the superior mesenteric artery (SMA) (Fig. 9). Since then, the Western literature has used the eponymous term "Appleby procedure" to refer to any operation for cancer that involves this strategy for resection of the celiac axis and complete celiac lymph node clearance. As it has been adapted for adenocarcinoma of the pancreas, a noneponymous term for the procedure is being used more frequently. That term is radical distal (or left) pancreatectomy with resection of the celiac axis, often shortened to DP-CAR, which in Asia seems to be the preferred and customary term.

**Anatomic Basis for DP-CAR**

Distal pancreatectomy with celiac artery resection acutely occludes the celiac artery, which deprives the liver of its normal arterial blood supply by retrograde flow from the GDA via the pancreaticoduodenal arcade and the superior mesenteric artery (SMA) (Fig. 9). Since then, the Western literature has used the eponymous term "Appleby procedure" to refer to any operation for cancer that involves this strategy for resection of the celiac axis and complete celiac lymph node clearance. As it has been adapted for adenocarcinoma of the pancreas, a noneponymous term for the procedure is being used more frequently. That term is radical distal (or left) pancreatectomy with resection of the celiac axis, often shortened to DP-CAR, which in Asia seems to be the preferred and customary term.

**Table 1. Pathologic and Survival Data (Adapted from Mitchem et al)**

<table>
<thead>
<tr>
<th>First Author (Reference)</th>
<th>Mean Tumor Size (cm)</th>
<th>Percent N0/N1</th>
<th>Percent Grade W/M/P</th>
<th>Percent Margins R0/R1</th>
<th>Mean Number of Nodes Resected</th>
<th>Median Survival (Mo)</th>
<th>5-Year Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalton13</td>
<td>5.0</td>
<td>73/27</td>
<td>NS</td>
<td>R0 only</td>
<td>NS</td>
<td>10</td>
<td>NS</td>
</tr>
<tr>
<td>Johnson16</td>
<td>NS</td>
<td>29/71</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>14</td>
<td>NS</td>
</tr>
<tr>
<td>Sperti17</td>
<td>5.5</td>
<td>75/25</td>
<td>58/29/12</td>
<td>NS</td>
<td>NS</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Kayahara18</td>
<td>NS</td>
<td>64/36</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>16</td>
<td>NS</td>
</tr>
<tr>
<td>Burcharth19</td>
<td>4.3</td>
<td>39/61</td>
<td>23/23/54</td>
<td>NS</td>
<td>77/23</td>
<td>11</td>
<td>28*</td>
</tr>
<tr>
<td>Shoup50</td>
<td>4.7</td>
<td>51/49</td>
<td>0/62/38</td>
<td>NS</td>
<td>72/28</td>
<td>16</td>
<td>13†</td>
</tr>
<tr>
<td>Christein21</td>
<td>5.5</td>
<td>36/64</td>
<td>2/76/22</td>
<td>NS</td>
<td>78/22†</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Shimada22</td>
<td>NS</td>
<td>21/79</td>
<td>29w/71mp§</td>
<td>75/25</td>
<td>NS</td>
<td>22 (26)</td>
<td></td>
</tr>
<tr>
<td>Redmond23</td>
<td>4.3</td>
<td>55/45</td>
<td>NS¶</td>
<td>71/29</td>
<td>NS</td>
<td>16</td>
<td>16†</td>
</tr>
<tr>
<td>Kooby12</td>
<td>4.4</td>
<td>46/54</td>
<td>NS</td>
<td>74/26</td>
<td>13</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Kanda24</td>
<td>NS</td>
<td>49/51</td>
<td>12/76/12µ</td>
<td>74/26</td>
<td>NS</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Yamamoto25#</td>
<td>3.3</td>
<td>50/50</td>
<td>49/43/7</td>
<td>76/23</td>
<td>NS</td>
<td>NS</td>
<td>30</td>
</tr>
<tr>
<td>Fujita11</td>
<td>4.0</td>
<td>40/60</td>
<td>28w/72mp**</td>
<td>90/10</td>
<td>31†</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>Wu26</td>
<td>4.7</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Kang44#</td>
<td>4.2</td>
<td>66/44</td>
<td>18/69/12††</td>
<td>87/13</td>
<td>NS</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>Mitchem (Authors’ series)</td>
<td>4.4</td>
<td>45/55</td>
<td>2/47/49</td>
<td>81/19§§</td>
<td>18</td>
<td>26</td>
<td>36</td>
</tr>
</tbody>
</table>

*Corrected for age-related deaths.
†Authors’ estimation from survival of 2 groups.
‡Radial margins were assessed in only 62% of the patients.
§mp, moderate plus poorly differentiated tumors.
||Includes 12 patients who had Appleby procedure. None of those patients survived more than 2 years, and the median survival in them was 17 months. Median survival excluding patients who had Appleby procedure was 26 months.
††Results did not separate well-differentiated tumors from other grades.
‡‡Used RAMPS technique in some patients in series.
§§Eighty-nine percent had negative tangential margins.
source of blood flow. It also deprives the stomach of blood supply from its normal sources of blood flow. It is well known that celiac artery occlusion from atherosclerotic disease does not usually lead to hepatic infarction because of collateral circulation from the SMA through the pancreatoduodenal arcade. The inferior pancreatoduodenal artery (IPDA) arises from the right side of the SMA 2 to 3 cm from its origin. Its anterior and posterior branches (anterior and posterior inferior pancreatoduodenal arteries) communicate with the anterior and posterior branches of the GDA (anterior and posterior superior pancreatoduodenal arteries), and the whole makes up the pancreatoduodenal arterial arcade that runs within the pancreas close to the concave duodenal sweep (Fig. 9). The IPDA is often absent, in which case, the anterior and posterior inferior pancreatoduodenal arteries arise independently from the SMA. There are many variations of this arterial anatomy, the description of which is beyond the purpose of this paper. However, the critical point is that the arcade is usually sufficient to support flow to the liver when the common hepatic artery is occluded. Because of concern that the flow might be insufficient when celiac artery occlusion is abrupt, as in DP-CAR, some groups have embo-
lized the common hepatic artery with coils days or weeks before the procedure. Others have simply placed a graft between the aorta and the stump of the hepatic artery to avoid the problem of hepatic ischemia.

Gastric ischemia has been a problem in some patients in most case series. As the splenic artery is gone, there is no flow from the left gastroepiploic or short gastric arteries, and flow must come retrograde through the pancreatoduodenal arcade and into the right
gastric and right gastroepiploic arteries via the GDA.

**Results of DP-CAR**

Distal pancreatectomy with celiac artery resection was reported in 6 cases in 1997. The largest series of DP-CAR for pancreatic adenocarcinoma comes from Hokkaido University in Japan. These authors have presented their results in a series of papers. In 2007, they reported on 23 patients who underwent this operation between 1998 and 2005. No arterial reconstructions were planned; however, 3 reconstructions were necessary owing to intraoperative arterial injury requiring revascularization. All operations included en bloc resection of the celiac artery, common hepatic artery and left gastric artery, the celiac plexus and ganglions, the nerve plexus around the SMA, the crus of the diaphragm and Gerota fascia, the left adrenal gland, the retroperitoneal fat above the left renal vein, the inferior mesenteric vein, and all associated regional lymph nodes. Preoperative coil embolization of the common hepatic artery was described by this group and was performed in 19 patients (83%) to encourage collateralization of hepatic arterial blood flow via the GDA. Portal vein resection was performed in 16 patients (70%). Eight patients (35%) underwent multi-visceral resection (4 gastric resections, 3 colon resections, and 1 jejunal resection). On pathologic analysis, all patients had invasive ductal adenocarcinoma of the pancreas. None had a carcinoma arising within or in association with a mucinous cystic lesion. Following UICC guidelines, all tumors were T3 or T4. Fifteen patients (65%) had lymph node metastases. Twenty-one patients (91%) had an R0 resection. There were no postoperative deaths. The authors report a 48% postoperative morbidity rate, including 4 pancreatic fistulas, and 3 cases of ischemic gastropathy. Two patients required a second surgical procedure (one for ileus and one for intra-
peritoneal infection). The median survival after resection was 21.0 months, and the estimated 1- and 5-year OS rates were 71%
and 42%, respectively. Patterns of recurrence were not reported. These results seem very encouraging. However, there are a number of problems in evaluating the data. Importantly, the Kaplan-Meier survival curves seem immature, with only one patient having reached 5 years of survival.33 In subsequent reports from this group, 5-year survival rates of 17%34 and 25%29 have been reported in this enrolling case series, suggesting that the 5-year OS rate of 42% in the earlier report was overly optimistic. Inking of the resected specimen does not seem to have been routine. Actual invasion of the celiac and/or hepatic arteries was present in only 2 patients, but was more uniformly present in surrounding nerve plexuses. Hishinuma et al55 from the Tochigi Cancer Center in Japan reported on 7 patients who had DP-CAR in an overall series of 25 patients who underwent distal pancreatectomy for adenocarcinoma from 1987 to 2003. Portal vein resection was performed in one patient (14%). Six patients (86%) required multi-visceral organ resection. All patients had ductal adenocarcinoma of the pancreas. All tumors were T3 or T4. Four patients (57%) had lymph node metastases. Four patients (57%) had an R0 resection. There were no postoperative deaths. The authors report a 43% postoperative morbidity rate, including one pancreatic fistula. Survival rates are not determinable from such small numbers. All patients have now died, but one survived approximately 75 months and another survived approximately 45 months.

Shimada et al52 reported 12 patients who had DP-CAR as part of a series of 88 patients who had a radical distal pancreatectomy similar to the posterior RAMPS. None of the 12 patients lived more than 2 years. A number of other centers have reported series with fewer cases of DP-CAR.36–39

Evaluation of the Literature on DP-CAR

Distal pancreatectomy with celiac artery resection, unlike RAMPS, is a true "extended" pancreatectomy. At present, it is necessary to have serious reservations regarding the efficacy of this procedure. Few patients have achieved long-term survival. Our enthusiasm for new extended pancreatic procedures should be tempered by the prior collective experience of extended nodal and arterial resections for cancers of the head of the pancreas. Therefore, DP-CAR should be conducted with meticulous collection of data and detailed reporting. Of utmost importance in interpreting results of DP-CAR is documentation of pathologic evidence of celiac arterial invasion. This defines the necessity of the operation if there was no invasion of the celiac artery, was the operation necessary? Of course, preoperative and intraoperative determination of tumor invasion into the celiac artery can be difficult, if not impossible. However, it is critically important to report these data in such series. For example, Hirano and Kondo report 18 (78%) of 23 patients with perineural invasion of the nerveplexus surrounding the celiac artery (CA), CHA, splenic artery (SA), and/or SMA; but only two (9%) of these patients had intramuscular invasion of the CA or CHA. It is unclear if clearing the perineural tissues around the arteries would have been sufficient for an R0 resection, similar to the strategy commonly used to clear the SMA during a pancreaticoduodenectomy for adenocarcinoma of the head of the pancreas.

Central to the question of the necessity of arterial resection is the preoperative evaluation of patients with adenocarcinoma of the body of the pancreas. In the reported DP-CAR literature, this evaluation is not presented in much detail. It would be important to correlate preoperative radiographic findings and postoperative pathologic findings. Inking of resection specimens is important in determining whether R0 resection has been attained. As discussed earlier, it may be difficult or impossible to determine the necessity of arterial resection with a high degree of certainty preoperatively, resulting in a low rate of true arterial involvement, but a high degree of R0 resections.

Most of the reported series do not include patterns of recurrence in their analyses. It is important to determine if DP-CAR results in improved local control. This is especially relevant given the low rate reported of true arterial invasion. Might a lesser operation that includes dissection of the peripheral vessels that are dissected at surgery. As such aggressive surgical approaches are used in the modern era, detailed preoperative evaluation and postoperative pathologic analysis should be reported to address these issues. Furthermore, if patients are treated with downsizing strategies, it is important to present the total number of patients that initiated treatment, including those who progress or are unable to complete therapy. This allows for a proper determination of the effectiveness of such protocols.

REFERENCES


© 2012 Lippincott Williams & Wilkins www.journalppo.com | 569

Copyright © 2011 Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.


