A Safe Technique for Radical Antegrade Modular Pancreatodoesplenectomy with Venous Resection for Pancreatic Cancer

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Pancreatic resections for pancreatic cancer involving the portal vein (PV) or the superior mesenteric vein (SMV) are performed with an en-bloc resection of the PV-SMV axis. The superior mesenteric artery (SMA) first approach is recommended for these cases. In this surgical technique, the retroportal lamina along the SMA is resected before the venous resection is performed to leave the tumoral specimen attached exclusively to the area of vascular invasion on the mesenterico-portal (MP) axis. This procedure allows the venous resection and reconstruction to be performed safely and with limited venous clamping time. Most studies have focused on major venous resections during pancreaticoduodenectomy. Pancreatoduodenectomy with PV resection is under-reported and represents 0% to 4% of the cases in major series. Pancreatoduodenectomy with PV resection requires an appropriate surgical technique to be performed safely. Unlike pancreaticoduodenectomy, the venous resection and reconstruction during pancreatosplenectomy can be difficult because of the distance between the 2 venous stumps, and it may require prolonged clamping of the venous axis. The oncologic principles of radical antegrade modular pancreatosplenectomy (RAMPS) for pancreatic cancer, established by Strasberg and colleagues and Mitchem and associates, should be respected. We report our technique for safely performing RAMPS with an en-bloc MP axis resection.

METHODS

Study patients

Between January 2008 and December 2012, 52 patients underwent RAMPS for adenocarcinoma of the pancreas.

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left gastric artery, and the celiac trunk on the left border is performed. The splenic artery, which has been previously ligated, is divided to allow for mobilization of the upper border of the left pancreas. The splenopancreatic block is tilted on the right side and the SMA is skeletonized on its left border up to its origin on the aorta. The retroportal lamina is removed entirely, and the right border is not dissected to preserve the right nerve plexus to avoid long lasting postoperative diarrhea. The uncinate attachments of the left border of the MP axis are divided. The specimen is then attached only to the MP axis. At this stage of the procedure, the length of tumoral venous invasion should be carefully evaluated. If the length is up to 3 cm, then the vascular axis is clamped above and below the zone of invasion, and a direct termino-terminal anastomosis is performed using 6/0 nonabsorbable suture (Fig. 2, Video 2). If the length of tumoral venous invasion is longer than 3 cm, an autologous venous graft is necessary (Fig. 3). In our experience, the left renal vein represents an ideal graft because its diameter is similar to the MP axis and its easy accessibility. The left renal vein is clamped proximally at its origin on the caval vein and clamped distally immediately before the insertion of the left adrenal vein, and harvested. The MP axis is clamped above and below the zone of invasion, the specimen is removed, and the vascular reconstruction is achieved by interposing the left renal vein graft between the PV and SMV using 2 termino-terminal anastomoses using 6/0 nonabsorbable suture (Fig. 3).

**Pathologic analysis**

All specimens were analyzed with a standardized pathologic protocol using multicolor inking of the resection margins.13,14 In the operating room, the surgeon identified 3 margins: the PV-SMV margin; the SMA margin; and the posterior margin. Three colors were used for inking. The resection was considered curative (R0) if no tumor cells were identified in any of the resection margins.

**Definition of pancreatic fistula**

The diagnosis of pancreatic fistula was established according to the definition of the International Study Group on Pancreatic Fistula (ISGPF).15 Pancreatic fistula was defined as any measurable drainage output from an intraoperatively placed drain (or percutaneous drain placed on or after postoperative day 3) with an amylase content greater than 3 times the upper limit of the normal serum amylase level according to the ISGPF.15

**RESULTS**

There were 3 male and 7 female patients, and the median age was 62 years (range 51 to 77 years). All patients had a pancreatic adenocarcinoma. One patient underwent 6 cycles of neoadjuvant chemotherapy (cisplatin combined with gemcitabine). The tumors were all located at the

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**Abbreviations and Acronyms**

- **MP** = mesenterico-portal
- **PV** = portal vein
- **RAMPS** = radical antegrade modular pancreatosplenectomy
- **SMA** = superior mesenteric artery
- **SMV** = superior mesenteric vein

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**Figure 1.** Preoperative CT scan showing a tumor at the pancreatic neck with involvement of the splenic vessels (A). The contact with the superior mesenteric vein (B) is highlighted by the white arrow.
pancreatic neck, and the median diameter was 46.5 mm (range 10 to 80 mm). One patient underwent an additional en-bloc resection of the transverse colon and the left adrenal gland. The median operative time was 424 minutes (range 235 to 580 minutes). The median time of the PV clamping was 20 minutes (range 15 to 25 minutes). One patient required an intraoperative blood transfusion of 6 units of packed red blood cells. The median length of vein resected, as measured before the specimen fixation, was 30 mm (range 20 to 40 mm). A venous graft from the left renal vein was required in 1 patient. Radical (R0) resection was achieved in 90% of
the cases. One patient underwent an R1 resection because of microscopic residual disease at the pancreatic transection margin. This patient had an intraoperative frozen section of that margin that was considered free from residual disease by the pathologist, but microscopic disease was found on the final pathologic examination. The patient underwent postoperative radio-chemotherapy. The histopathologic data showed venous wall invasion in 8 patients (80%). The median number of lymph nodes removed was 17 (range 13 to 95). Seven of 10 patients (70%) had positive lymph nodes. The postoperative mortality was zero. The overall postoperative morbidity was 40% because 4 cases of pancreatic fistula were graded A in 2 patients and B in 2 patients; these patients underwent percutaneous radiologic drainage. None of the patients required relaparotomy or experienced postoperative portal vein thrombosis. The median hospital stay was 19.5 days (range 11 to 42 days). Mean follow-up was 19.1 ± 10.1 months (range 7 to 42 months; median 18 months). Overall survival rates of the patients were 85.3% and 20.7% at 1 year and at 3 years, respectively. Median survival was 20.5 months, and 1-year disease-free survival was 42%.

DISCUSSION

The described surgical technique allowed for RAMPS with an en-bloc MP axis resection for pancreatic cancer without mortality and with a high rate of curative R0 resections.

Long-term survival in cases of pancreatic cancer is related not only to the tumor stage and disease aggressiveness but also to a margin free R0 resection.16 The SMA first approach, which has been proposed for pancreaticoduodenectomy, allows complete resection of the retroportal lamina; this results in a wider “arterial margin” achievable without SMA resection.4-8 According to our technique, the combination of the SMA first approach and the RAMPS procedure11 allowed for a high rate of R0 resections even for pancreatic cancer requiring pancreateo-splenectomy with PV resection. To maximize the oncologic benefits of the described technique, we advocate the systematic use of preoperative neoadjuvant chemotherapy in patients with borderline resectable pancreatic adenocarcinoma. This strategy will allow for a further increase in the R0 resection rate and a lower rate of node positivity.17

From a technical point of view, the optimal oncologic plane of modern pancreatic surgery for right-sided and left-sided pancreatic resections should be the SMA instead of the PV/SMV, which was previously accepted.18,19 The vein is simply a technical issue. Our technique may allow for avoiding a total pancreatectomy in some patients with large pancreatic tumors (>4 cm) located in neck of the pancreas with infiltration of the splenic vein and SMV.20 Formal evidence that the RAMPS procedure is associated with a better survival than standard pancreateo-splenectomy is missing because of the absence of randomized studies. In this series, RAMPS obtained a high percentage (90%) of R0 resections.

The “artery first approach” for pancreaticoduodenectomy, to “clear” the SMA margin before performing venous resection allows for suspension of the specimen on the vein to be resected to facilitate vascular anastomosis and reduce venous clamping time.4-8 In this series, all patients had MP-axis involvement, and the classical anterior-to-posterior approach on the left of the PV-SMV would have required performing the venous resection/reconstruction before the retroportal lamina. Such an approach is feasible but technically more challenging and time consuming. Resection of the retroportal lamina after the venous anastomosis is performed may induce bleeding from the anastomosis (because of excessive tension of the vein during the further dissection to remove the specimen) or a less complete clearance of the SMA margin.

To avoid the risk of postoperative stenosis, we did not perform lateral MP axis resections, particularly in cases of left-sided pancreatic resections, which have a higher risk of pancreatic fistula than cases of pancreaticoduodenectomy. Venous or bovine pericardial patches are acceptable alternatives to segmental PV resections, but in most cases, such reconstructions are more difficult and time consuming than a direct termino-terminal venous anastomosis.

Venous resections during pancreateo-splenectomy are more difficult to perform. In duodenopancreatectomy, venous resection almost never requires an interposition graft; in cases of pancreateo-splenectomy, the 2 stumps of the veins may be too far apart to be reanastomosed directly without tension, even if there is complete mobilization of the right colon and of the root of the mesentery because of the persistence of the head of the pancreas. Mobilization of the PV and of the SMV above and below the zone of invasion should be extensive, and the middle colic vein should be systematically divided. In cases of persistent tension and/or extensive vein resection (>3 cm), an interposition graft is necessary.21

REFERENCES


