Resection and palliation of pancreatic and periampullary carcinoma
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CHAPTER 5

Segmental resection and wedge excision
of the portal or superior mesenteric vein during pancreaticoduodenectomy.

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Abstract

Background: Resection of the portal/superior mesenteric vein (PV/SMV) during pancreaticoduodenectomy (PD) is disputed. Although morbidity and mortality are acceptable, survival is limited after PV/SMV resection. In this study we evaluate the effect of PV/SMV resection.

Methods: Between 1992 and 1998, 215 consecutive patients underwent PD for malignant disease. Thirty-four patients underwent a PV/SMV resection. Resection was only performed when minimal venous ingrowth was found perioperatively. Surgical techniques, peri-operative parameters, and survival were analysed.

Results: The percentage of PV/SMV resections was 16%. Extensive (segment) resections were performed in 6 patients. The median blood loss was 1.8 litres, and resection margins were microscopically tumour free in 41% of the patients. The median hospital stay was 15 days, and mortality was 0%. Median survival after PV/SMV resection for pancreatic adenocarcinoma was 14 months.

Conclusion: Limited PV/SMV resection for perioperatively encountered minimal venous ingrowth during PD can be performed safely without increased morbidity and mortality but also results in a high frequency of tumour positive resection margins.
Introduction
Pancreaticoduodenectomy (PD) is the only possibility for cure for patients with periampullary carcinoma. Radical resection is often precluded by the close anatomical relationship between the tumour in the pancreatic head, the confluence of the portal and superior mesenteric vein (PV/SMV), and the hepatic and mesenteric artery. A positive resection margin strongly correlates with limited survival\textsuperscript{1-5}, and therefore PV/SMV resection has been advocated to achieve negative resection margins\textsuperscript{6,7}. PV/SMV resection can be performed with acceptable morbidity and mortality\textsuperscript{7-12}, but the effect on survival is controversial\textsuperscript{13-15}.

In our institution PV/SMV resections are only performed when limited venous ingrowth over a short length of the vein was suspected during surgery. With extensive ingrowth of the vein, confirmed by frozen section, bypass surgery was performed. Resection was only completed when venous ingrowth limited to the small side branches of the SMV. In most patients venous ingrowth was found after transection of the pancreas. At this stage the resection was completed as this was regarded to be the point of no return. This strategy clearly results in a selection of patients who undergo PV/SMV resection during PD. The aim of this study is to investigate the effect of this strategy on morbidity, mortality and survival after PV/SMV resections during PD.

Patients and methods
Patients
From a consecutive series of 250 PDs over the period October 1992 until October 1998, 215 patients had malignant disease from which patients, who underwent a PV/SMV resection, were selected. Data were obtained from a prospective data base.

Diagnostic work-up
Standard diagnostic work-up consisted of ultrasonography (n=34) followed by computed tomography (CT) (n=25). This was a helical CT in 19/25 patients, as described previously\textsuperscript{16}. Diagnostic laparoscopy was performed in 30 patients as described previously\textsuperscript{17}. Encasement, obstruction or thrombosis of the PV/SMV were considered contraindications for surgery.

Surgical procedures
The resection of choice was a standard pylorus-preserving PD, as described previously\textsuperscript{18,19}. Reconstruction was performed with a single retro-colic jejunal-limb reconstruction. With limited venous ingrowth, detected after the transection of the pancreas, two types of PV/SMV resection were performed; a wedge excision and a segmental resection. Limited wedge excisions were performed because of limited ingrowth, generally at the point of the side branches from the vein to the pancreas not only to achieve a radical resection but sometimes because of technical reasons to prevent bleeding. Segmental resections were performed for more extensive venous ingrowth. Reconstruction after segmental resection was performed with an end-to-end anastomosis, an autologous-vein, or an artificial interposition-graft. In a previous study\textsuperscript{20} in most patients who underwent total pancreatectomy because of a tumour positive transection margin of the pancreas other resection margins were tumour positive as well. Therefore frozen sections of the pancreatic transection margin were not performed.
routinely except when there was suspicion of tumour involvement of the pancreatic margin. Resection margins of the pancreas, distal bile duct, retropancreatic tissue, portal/superior mesenteric vein and superior mesenteric artery were marked by the surgeon at the specimen and studied in detail for microscopic presence of tumour.

**Morbidity, mortality and survival**
The following intra-operative parameters were studied: total blood loss, surgery related blood transfusion (transfusions during surgery and within the first 24 hours postoperatively), operative time, postoperative complications, hospital stay, hospital mortality, and survival. Tumour characteristics, tumour size, lymph node status and resection margins were re-evaluated by a single independent pathologist with special regard to the vascular resection margins.

**Statistical analysis**
Statistical analysis was performed using the Kaplan Meier method to calculate the median actuarial survival and the survival rates, and Log Rank tests were used to compare the survivals. To eliminate the confounding factor of different tumour localisation, patients with ampullary and distal bile duct tumours were excluded from the survival analysis. Differences were considered significant at p < 0.05.

**Results**

**Patients**
In this series 34 (16%) of the patients (male/female: 15/19) with a median age of 65 years (range 46-77) and a malignant periampullary tumour underwent a PV/SMV resection. Patients presented with jaundice (n=10), fever (n=5), pain (n=9) and/or diabetes (n=6) and their median preoperative weight loss was 6 kilograms (range 0-25). The median duration of symptoms before diagnosis was 8 weeks (range 0-30).

**Surgical procedures**
All patients underwent a partial PD. A wedge excision of the PV/SMV (1-2 cm) with primary closure was performed in 28 patients and a segmental resection in 6 patients. Segmental resections were reconstructed with an end-to-end anastomosis in 4 patients and with a polytetrafluoroethylene or dacron (Sulzer Vascutec, Ltd, Inchinnan, Scotland) interposition graft in 2 patients. Median perioperative blood loss and number of blood transfusions were 1.8 litres (range 0.3-8.5) and 0 packed red blood cells (range 0-12) respectively. The median operative time was 5.5 hours (range 3.4-8.3).

**Adjuvant therapy**
Three patients received adjuvant chemoradiation in an European Organisation for Research and Treatment of Cancer study\textsuperscript{21}, and 1 patient received only radiation therapy.
Histology
A ductal adenocarcinoma was found in the pancreatic head (n=29), the papilla (n=2), and the distal bile duct (n=3). The median tumour size was 2.5 cm (range 1.5-5.0). Differentiation was poor (n=20), medium (n=12), or well (n=2). After resection, resection margins were tumour free in 14 patients (41%) and tumour positive in 20 patients (59%). Resection and dissection margins of the PV/SMV were tumour positive in 10 patients and the superior mesenteric artery in 5 patients. Tumour positive PV/SMV margins were not always located at the site of the resected wedge of the PV/SMV, but also at other parts of the 4-5 centimetre dissection plane of the PV/SMV on the pancreas. At the time of surgery these dissection margins of the PV/SMV were not suspected to be tumour positive. Other tumour positive margins included the retropancreatic tissue in 3 patients, the pancreatic neck in 9 patients and bile duct in 3 patients. In only 3 of the 34 patients the margin of the PV/SMV was the only tumour positive margin. The tumour was adjacent to the PV/SMV with an extensive desmoplastic stromal reaction but actual tumour infiltration of the resected venous wall occurred in only 1 specimen, although the dissection margins of the PV/SMV were tumour positive in 10 patients after wedge excision (n=8) or segmental resection (n=2).

Mortality/morbidity
The overall mortality, in this series (n=250) was 1.2%. Mortality after PV/VMS resection was 0%. In 14 patients (41%) one or more complications occurred including pancreatic leak, haemorrhage or intra-abdominal abscess (3 patients each), wound infection and septic shock (2 patients each) and one patient with pulmonary complications. Reoperation was performed in one patient for abdominal sepsis and in two for postoperative bleeding. Median postoperative hospital stay after PD was 15 days (range 8-69).
Follow-up and Survival
The median survival after PV/SMV resection during PD was 14.2 months (range 1.6-44.1) and as there were no censored patients at 50% of the survival time the median follow-up was equal. The 1, 2, and 3-year survival in evaluable patients were 55% (15/29), 28% (5/26), and 6% (1/26), respectively. There was no significant difference in survival after resection for pancreatic carcinoma between patients with tumour positive or tumour free resection margins (figure 1). Survival for patients with tumour positive resection margins was 14 months, compared to 11 months after resection with tumour free margins. In this series median survival after segmental resection or tangential wedge excision of the PV/SMV was not significantly different, 13 versus 15 months (figure 2). No patient survived more than 4 years.

![Survival Rate Graph](image)

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<th>Survival Rate (%)</th>
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**Figure 2.** Survival of patients after portal or mesenteric vein resection during pancreaticoduodenectomy for pancreatic carcinoma: Segmental resection or wedge excision.

Discussion
When suspected venous ingrowth is encountered during PD for periampullary carcinoma, a PV/SMV resection can be performed. At our institution, only patients with limited suspected venous ingrowth (16%) underwent PV/SMV resection during PD. In the literature, the incidence of PV/SMV resections varies widely. Japanese reports show an incidence of PV/SMV resections varying from 58-88%, whereas in western reports, 3-41% of patients undergo additional PV/SMV resections. A different patient selection and the different aggressiveness of surgery can explain this variance.
In the present series of 34 patients, there was no mortality, but morbidity was 41%, which is in accordance with results after pancreatic surgery with or without PV/SMV resection in the literature. Although PV/SMV resection did not considerably influence morbidity and mortality in the present series or in other reports, controversial findings concerning survival have been reported. Some reports demonstrate a decreasing survival for patients who underwent a PV/SMV resection during PD, and others failed to show an increase in survival compared to standard resection without vein resection. Imaizumi and colleagues reported that of the 5 patients with a 5-year survival, 2 underwent a PV/SMV resection, and suggested that PV/SMV invasion did not influence survival when all resection margins, including the PV/SMV resection margin, were tumour free.

The median survival after PV/SMV resection during PD for pancreatic carcinoma in the present series was only 14 months. In literature median survival after PV/SMV resection during PD varies greatly from 6 to 22 months. In our series only 4 patients received adjuvant radiation therapy or chemoradiotherapy. However in an other series with a survival of 22 months, most patients received adjuvant chemoradiotherapy and almost half of the patients received intraoperative radiation therapy. In our series only 38% of the patients with pancreatic adenocarcinoma had tumour free margins suggesting that PV/SMV resection for pancreatic adenocarcinoma was primarily a debulking procedure in most patients (62%). Therefore it is not surprising that the survival is nearly comparable with the median survival of 11 months of a series in which patients underwent an explorative laparotomy because they could not be resected due to venous ingrowth. Remarkably, survival benefit of tumour free resection margins could not be demonstrated in this series. After wedge or segmental resection, 50% percent of the patients with tumour positive margins had a tumour positive PV/SMV margin, but only in 3 patients (15%) the PV/SMV margin was the only tumour positive margin. This observation demonstrates that a more extensive venous resection to achieve tumour free PV/SMV margin may not have been effective in improving survival because of other distant tumour positive margins. Actual tumour infiltration into the venous wall is unusual (1/34 patients). In most specimens the tumour abutted the PV/SMV but did not actually infiltrate the venous wall. The macroscopic appearance of tumour infiltration can be explained by the desmoplastic stromal reaction, which can not macroscopically be distinguished from actual tumour infiltration. In 6 of the 34 patients the pancreatic resection margin was the only tumour positive margin. In 2 of these patients this was diagnosed during review of the original paraffin slides, and in 4 patients during the initial examination of the paraffin slides. The relatively high number of tumour positive pancreatic transection margins might be caused by the fact that frozen sections of the resection margins were not standard in this study. The fact that in 4 patients the pancreatic transection margin was the only tumour positive margin, reinforces the fact that frozen section should be performed as a standard procedure, and currently this procedure is being reinstated.

Blood loss has also been reported to influence survival. In this series blood loss was comparable with blood loss after PV/SMV resection described by others but was high compared to blood loss in series with very few or no PV/SMV resections during PD and therefore might well have contributed to the limited survival in this series compared to standard PD.
Terminology regarding definition and criteria of the extent of PV/SMV resection and venous ingrowth vary greatly and can cause confusion on this subject. Previous studies do not use a clear definition of the extent of PV/SMV resection or ingrowth. In this series limited venous ingrowth was treated with a wedge resection and more extensive venous ingrowth was treated with a segmental resection. The median survival of patients who underwent a wedge resection or segmental resection of the PV/SMV was not different. But in a previous series from our institution, 90% of all PV/SMV resections were segmental resections compared to 18% in the present series. This resulted in a median survival of 6 months after resection for pancreatic carcinoma, which is less than 14 months in the present series (p<0.05). An association between the extent of venous ingrowth and survival has also been described by others. However in our current series no apparent survival benefit was found for patients with limited PV/SMV ingrowth that underwent a wedge resection. This relation is possibly absent because of the small differences in the extent of PV/SMV ingrowth and because the tumour could already have caused micro metastases in an early stage and makes the extent of venous ingrowth irrelevant. Still the exact interpretation of data that support this mechanism is unclear.

In conclusion, tumour free resection margins are difficult to achieve in patients that undergo PV/SMV resection during PD. This is seldom exclusively caused by the PV/SMV resection margin, and actual tumour infiltration of the PV/SMV is rare. Despite the fact that wedge and segmental resections of the PV/SMV resections are technically possible without increased morbidity or mortality, they do not appear to lead to an increase in resections with tumour free margins and subsequent increased survival. These findings make PV/SMV resection a technical rather than a surgical oncologic issue.

References
PV/SMV resection


