J Gastrointest Surg (2008) 12:2183–2190
DOI 10.1007/s11605-008-0621-9

Pancreaticoduodenectomy with Vascular Resection for Local Advanced Pancreatic Head Cancer: A Single Center Retrospective Study

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Received: 20 May 2008 / Accepted: 15 July 2008 / Published online: 6 August 2008

Abstract
Introduction Pancreaticoduodenectomy with vascular resection remains a controversial approach for patients with local advanced pancreatic head cancer for the lack of evidences of survival and quality of life benefits. The aim of this study was to evaluate whether patients of pancreatic head cancer benefit on quality of life, survival, and treatment cost from pancreaticoduodenectomy with vascular resection compared with palliative therapy.
Materials and Methods Two hundred fourteen patients of pancreatic head cancer whose pancreatic head could not be dissected free from adjacent vascular were involved in this study. Eighty of these patients underwent pancreaticoduodenectomy with vascular resection, whereas other patients underwent palliative therapy.
Results Pancreaticoduodenectomy with artery resection offered worse outcomes on almost all aspects of quality of life and survival compared with palliative therapy. Pancreaticoduodenectomy with vein resection offered better 5-year survival compared with palliative therapy, whereas palliative therapy offered better quality of life after surgery.
Conclusion Pancreaticoduodenectomy with artery resection is nonsensical on treatment of pancreatic head cancer with artery adhesion/invasion. As for patients with vein adhesion/invasion, pancreaticoduodenectomy with vein resection should be performed cautiously. When actual vein invasion is very possible to have taken place, the choice of treatment strategy should be considered carefully by the pancreatic surgeons.

Keywords Pancreatic neoplasms · Neoplasm invasiveness · Pancreatectomy · Palliative care · Drug therapy · Brachytherapy

Introduction

Pancreatic cancer is lethal and is one of the leading causes of cancer death worldwide with rising incidence.[1] Despite of the advancement in its diagnosis and staging, little progress has been made in overall survival. The 5-year survival rate of patients is less than 5%, and the median survival is less than 1 year for the last three decades.[2–4]

Treatment of pancreatic cancer includes multiple modalities, but surgical resection offers the only potential chance for cure.[5] The first successful regional resection for a periampullary tumor was performed by Kausch in 1909 and was popularized by Whipple.[6] From 1980s, pancreaticoduodenectomy (PD) was performed extensively in large hospitals.[7,8] Unfortunately, because of the late diagnosis of the disease, 80–90% of patients are precluded from surgical resection for locally advanced or disseminated disease.[9] In patients with locally advanced disease, tumor adherence or invasion into adjacent structures, particularly the celiac and superior mesenteric vasculature, makes complete resection very difficult. To deal with vascular barriers, pancreatic surgeons performed en bloc resection with vein resection

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(portal vein, superior mesenteric vein, and superior mesenteric-portal vein confluence; Fortner type I operation) and artery resection (hepatic artery, superior mesenteric artery, and celiac artery; Fortner type II operation).[10] However, the extent of resection of pancreatic cancer is still under discussion.

In recent years at the Union Hospital, Wuhan, some patients of pancreatic head cancer with vascular adhesion/invasion being estimated to resectable were treated with PD with vein resection (VR) and/or artery resection (AR), and the others were treated with palliative therapy including surgical bypass, I125 brachytherapy, coeliac plexus block, and chemotherapy. We report herein the quality of life (QOL), the survival, and the economic outcomes of radical resection comparing with palliative therapy.

Materials and Methods

Patients

Nine hundred twenty-six patients with cancer of the pancreatic head were treated in Pancreatic Center, Union Hospital, Wuhan from January 1996 to December 2005. Excluding patients with disseminated disease (identified by preoperative imaging studies or surgical findings), severe medical comorbidities (oxygen-dependent obstructive pulmonary disease, unstable coronary artery disease, other malignancies, etc.), and Karnofsky Performance Status <40, 214 patients (23.1%) whose pancreatic head and uncinate process could not be dissected free from adjacent vascular were involved in this study. The details of these 214 patients were listed in Table 1. To determine the impact of vascular resection on postoperative complications, 247 patients of local advanced pancreatic head cancer who underwent PD without vascular resection formed the control group (PD group).

Table 1 Demographic Characteristics of 214 Patients of Pancreatic Head Cancer with Blood Vessel Adhesion/Invasion

	VR group (n=61)	VP group (n=89)	AR group (n=19)	AP group (n=45)
Age (median year, range)	52 (28–72)	53 (31–84)	46 (36–70)	58 (30–76)
Male (n, %)	38 (62.3)	50 (56.2)	15 (78.9)	32 (71.1)
Jaundice (n, %)	49 (80.3)	67 (75.3)	16 (84.2)	38 (84.4)
Abdominal pain (n, %)	32 (52.5)	43 (48.3)	11 (57.9)	27 (60.0)
Weight loss (n, %)	51 (83.6)	72 (80.9)	15 (78.9)	35 (77.7)

Preoperative Workup

Preoperative workup included history and physical examination, routine laboratory testing, chest radiography, electrocardiography, contrast-enhanced computed tomography (CT; 100%), magnetic resonance imaging (MRI/MRA/MRCP; 72.8%), and angiography (21.5%). Preoperative angiography was abandoned in 2000 with increasing accuracy of MRA and better vessel imaging of CT.

Treatment Strategy

Patients whose pancreatic head and uncinate process could not be dissected free from adjacent vascular undergoing radical resection or non-radical resection therapy depended on the extent of vascular adhesion/invasion according to preoperative imaging studies (mainly CT) and operative findings. Between January 1996 and June 2002, PD with VR was performed in patients whose portal vein (PV)/superior mesenteric vein (SMV)/superior mesenteric-portal vein confluence (SMPV) was adhered/invaded but not totally occluded, and PD with AR was performed in patients whose celiac axis (CA)/hepatic artery (HA)/superior mesenteric artery (SMA) was adhered/invaded but not stenosed. Between July 2002 and December 2005, with our preliminary findings that vascular resection (especially AR) played a little role in longer overall survival but worse QOL, the indication of vascular resection was limited. For vein invasion/adhesion, complete encircling of involved veins was also considered as a contraindication. PD with VR was only performed when tumor formed a convexity against the vein or tumor partially encircled the vein but the length of the involved vein was less then 5 cm. For artery invasion/adhesion, performance of AR was mainly according to the judgment of surgeons. AR was performed only when preoperative imaging studies or surgical findings indicated that actual invasion of artery have not taken place. Besides stenosis of the artery, fixation of surrounded lymph nodes, stiffness of surrounded lymphatic tissue and nerve plexus, and more than 5 cm of the length of the involved artery were also considered as the contraindications of PD with AR. Thus, part of the patients that were estimated to be resectable according to previous criteria were treated with palliative therapy. During these 10 years, 61 patients underwent PD with independent VR (without AR; VR group) and 19 patients underwent PD with AR (with or without VR; AR group). After surgery, patients were treated with systemic chemotherapy of gemcitabine (1,000 mg/m^2 on days 1, 8, and 15; every 4 weeks for one cycle) from 1999. Chemotherapies were started 4 weeks after radical resection except for postponed for sustained bone marrow suppression, and 36/80 patients completed all six cycles.

Palliative therapy was performed on 134 patients with vascular adhesion/invasion (89 with vein adhesion/invasion but not artery adhesion/invasion, VP group; 45 with artery adhesion/invasion with or without vein adhesion/invasion, AP group) who were not treated with radical resection. The unresectability of these patients, which was suggested by preoperative imaging, was confirmed by exploratory operation. Part of these patients were treated with biliary bypass (n=96) or gastric bypass (n=51) for treatment or prevention of jaundice or intestinal obstruction. Brachytherapy of I125 interstitial implantation and coeliac plexus block with alcohol were performed in all these patients. In addition, systemic chemotherapy of gemcitabine was performed. Chemotherapy was started 4 weeks after palliative surgery, except if postponed for sustained bone marrow suppression, and 70/134 patients completed all six cycles. Besides, biopsies were done in some of the patients for final diagnosis.

Assessment of Quality of Life

QOL assessment was initiated prior to surgery and completed at the 6-month follow-up. Patients were given questionnaires of the European Organisation for Research and Treatment of Cancer (EORTC) QLQ-C30, which were used to assess QOL in this study, before surgery (baseline) and 3 and 6 months after surgery (including PD with vascular resection, surgical bypass, I125 interstitial implantation, and coeliac plexus block).[11] The EORTC QLQ-C30 is a patient-based questionnaire that includes a total of 30 items and is composed of five functional scales (physical, role, cognitive, emotional, and social), three symptom scales (fatigue, pain, and nausea/vomiting), five single items assessing cancer symptoms (insomnia, dyspnea, appetite loss, constipation, and diarrhea), a global health assessment, and a question about perceived financial difficulties. Following the scoring instructions given by the EORTC Quality of Life Study group, the raw EORTC QLQ-C30 scores were linearly transformed to 0–100 scales before statistical analyses were performed. A higher score on functional scales and global health assessment represent a better level of functioning and QOL, whereas high scores on symptom scales and other single items represent more symptomatology. A mean change between 0 and 10 on the transformed scales was regarded as not clinically important; changes ≥10 were regarded as clinically significant, as previously described.[12]

Data Collection of Survival and Treatment Costs

Survival data were generated monthly by direct contact when patients underwent chemotherapy in Union Hospital, Wuhan and then every 3 month by telephone interview with the patient or his or her family until death or the end of data collection for this study (December 2007). The total treatment costs including charges of chemotherapy were calculated from office copies of payment receipts of patients from the treasurer's office, Union Hospital, Wuhan. Costs for treatment of complaints that were not concerned in pancreatic cancer (e.g. coronary heart disease, odontalgia, etc.) were excluded.

Statistical Analysis

All data analyses were performed using Statistical Package for the Social Sciences (SPSS) version 11.0 software. Analysis of variance was used to compare outcomes of patients treated with different strategies. All differences were considered significant at two-sided $P<0.05$. Data of QOL were analyzed for the subscales at each of the assessment points. The change in scores from baseline to each of the two given time points was calculated by subtracting the baseline score for each patient from the subsequent scores for the same patient. Treatment costs were described in terms of US Dollars with the exchange rate of 8.27 RMB yuan against 1 US dollar. Data of QOL and treatment costs were analyzed with analysis of variance (ANOVA)-Student–Newman–Keuls (SNK) test. Overall survival was demonstrated using the method of Kaplan and Meier, and log-rank test was used to evaluate differences between survival curves. One-, 2-, 3-, and 5-year survival were estimated by life tables.

Results

Pathological Findings

Surgical pathology demonstrated that the main pathological diagnosis of pancreatic head cancer was adenocarcinoma originating from pancreatic duct and bile duct and then was acinic cell carcinoma. Diagnoses of other carcinomas were rare. Actual vascular invasion was confirmed in 42 of 61 patients of VR group and 15 of 19 patients of AR group (Table 2).

Postoperative Course

Morbidity of postoperative complications, reoperation rate, and hospital stay of patients were shown in Table 3. Patients undergoing resection (VR group, AR group, and PD group) suffered a higher complication rate. Although VR was associated with thrombosis of PV and SMV, the overall complications of PD with VR were comparable with that of PD without VR (PD group). Compared with PD without AR (VR group and PD group), PD with AR demonstrated a higher complication rate. In addition, the

Table 2 Pathological Findings in All Four Groups

	VR group (n=61)	VP group (n=78)	AR group (n=19)	AP group (n=39)
Adenocarcinoma (n, %)	56 (91.8)	70 (90.0)	18 (94.7)	36 (92.3)
Acinic cell carcinoma (n, %)	3 (4.9)	3 (3.8)	1 (5.2)	2 (5.1)
Other carcinoma (n, %)	2 (3.3)	5 (6.4)	0 (0)	1 (2.6)
Actual blood vessels invasion (n, %)	42 (68.9)		15 (78.9)	

postoperative bleeding, which was the main complication associated with AR, increased the reoperation rate of PD with AR. Like postoperative complications, the median length of postoperative hospital stay after resection was longer than after palliation. Besides, results showed that AR prolonged the hospital stay of patients undergoing PD.

Quality of Life

Thirty-six of 61 patients in VR group, 78 of 89 patients in VP group, 12 of 19 patients in AR group, and 31 of 45 patients in AP group completed questionnaires of baseline and 3 month after surgery, 30 of 61 patients in VR group, 61 of 89 patients in VP group, five of 19 patients in AR group and 26 of 45 patients in AP group completed all three questionnaires. The changes in scores compared with baseline in representative aspects of QOL were shown in Fig. 1. Increased scores from baseline in Fig. 1a–c means improvement of global health status, physical functioning, and emotional functioning, while increased scores from baseline in Fig. 1d–f means worsening of pain, diarrhea, and economical impact.

Three months after surgery, VP and AP group demonstrated better global health status change than VR and AR group, respectively, although neither of the four groups showed clinical significance compared with baseline. In aspects of functional scales, patients undergoing palliative therapy (VP and AP group) worsened less in physical function, but patients undergoing radical resection (VR and AR group) obtained better emotional function. With respect to symptom scales and single items, patients undergoing palliative therapy benefited more than those undergoing radical resection in relief of pain and diarrhea. When compared with patients without artery adhesion/invasion (VR and VP group), patients with artery adhesion/invasion (AR and AP group) obtained comparable changes in scores in most items.

Six months after surgery, the differences of score changes in most items between VR and VP group leveled out, whereas the differences between AR and AP group widened. Patients in VR group improved in QOL but that in AR group worsened when compared 3 months after surgery.

In addition, according to the result of perceived financial difficulties, the treatment cost exercised severe adverse impact on economy in all groups.

Survival

Two hundred five of the 214 patients completed the follow-up until death, five of 214 patients (two in VR group and three in VP group) completed the follow-up at the end of data collection for this study, and four of 214 patients (one in VR group, two in VP group, and one in AP group) lost to follow-up were censored at the time of last contact. None of the 214 patients in this study died within 30 days of surgery, whereas one patient in AR group died 34 days after surgery for arterial thrombus formation. The median survival time for the VR, VP, AR, and AP group was 13, 12, 7, and 9 months, respectively. The estimated 1-, 2-, 3-

Table 3 Postoperative Course of Patients

	VR group (n=61)	VP group (n=78)	AR group (n=19)	AP group (n=39)	PD group (n=247)
Overall complications (n, %)	14 (22.9)	5 (6.4)	7 (36.8)	3 (7.7)	58 (23.5)
Wound infection (n, %)	2 (3.3)	2 (2.6)	0 (0)	1 (2.6)	8 (3.2)
Postoperative bleeding (n, %)	0 (0)	0 (0)	3 (15.8)	0 (0)	2 (0.8)
Intra-abdominal abscess (n, %)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.4)
Thrombosis (n, %)	2 (3.3)	0 (0)	1 (5.3)	0 (0)	0 (0)
Pancreatic fistula (n, %)	10 (16.4)	0 (0)	4 (21.1)	0 (0)	41 (16.6)
Biliary leak (n, %)	2 (3.3)	1 (1.3)	0 (0)	0 (0)	7 (2.8)
Colo-jejunal fistula (n, %)	0 (0)	1 (1.3)	0 (0)	1 (2.6)	1 (0.4)
Delayed gastric emptying (n, %)	0 (0)	1 (1.3)	1 (5.3)	1 (2.6)	4 (1.6)
Reoperation (n, %)	1 (1.6)	0 (0)	3 (15.8)	0 (0)	5 (2.0)
Postoperative hospital stay (days)	16±5	12±2	18±7	12±2	15±4

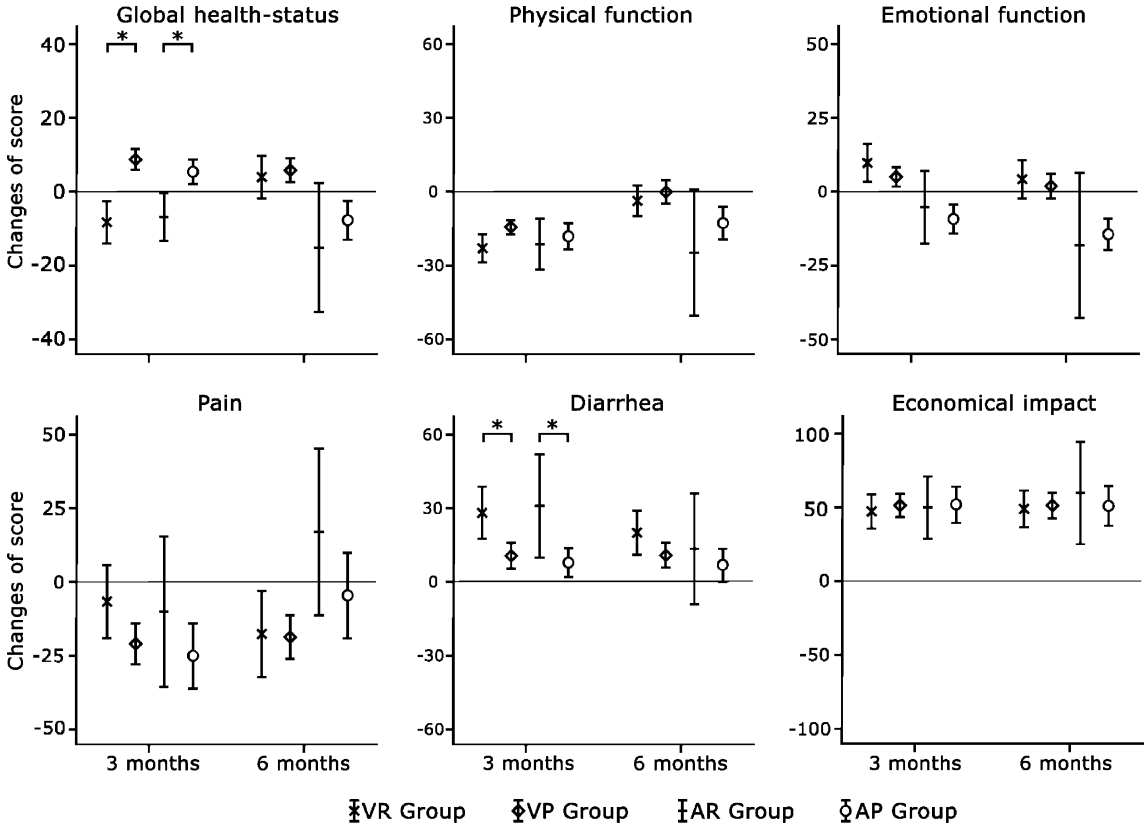

Figure 1 Changes in QLQ-C30 scores compared with baseline scores. Zero represents baseline. *Error bars* represent 95% confidence intervals of means of numerical changes in scores from baseline. *Error bars with positive values* represent improvement of functioning or worsen of symptoms. *Error bars with negative values* represent worsen of functioning or improvement of symptoms. *$P<0.05$.

and 5-year survival of all groups obtained with life tables were listed in Table 4. Survival analysis using the method of Kaplan and Meier among the four groups were displayed in Fig. 2. the difference between AR and AP group was statistically significant (log rank, $P=0.008$). Although there was no statistical significance in overall survival between VR group and VP group (log rank, $P=0.103$), the estimated 5-year survival of VR group were much higher than that of VP group.

To evaluate whether patients with actual invasion of veins benefit on survival from PD with VR, the survival of these patients was compared with that of patients undergoing palliation. Results showed that these patients acquired comparable survival with those undergoing palliation. None of these patients survived more than 5 years.

Treatment Costs

The treatment costs of the four groups were 15.8±2.8 thousands dollars (VR group), 14.1±4.3 thousands dollars (VP group), 17.2±6.7 thousands dollars (AR group), and 13.7±2.8 thousands dollars (AP group), respectively. There was no statistical significance among the four groups according to ANOVA-SNK test.

Discussion

More than three decades ago, PD was associated with a high perioperative mortality up to 25%; thus, few PD were performed for the treatment of pancreatic diseases. In recent

Table 4 One, 2, 3 and 5-Year Survival in All Four Groups

	1-year survival (M±SE)	2-year survival (M±SE)	3-year survival (M±SE)	5-year survival (M±SE)
VR Group	56%±6%	24%±6%	19%±5%	13%±4%
VP Group	52%±5%	23%±4%	11%±3%	1%±1%
AR Group	16%±8%	0%		
AP Group	40%±7%		10%±5%	0%

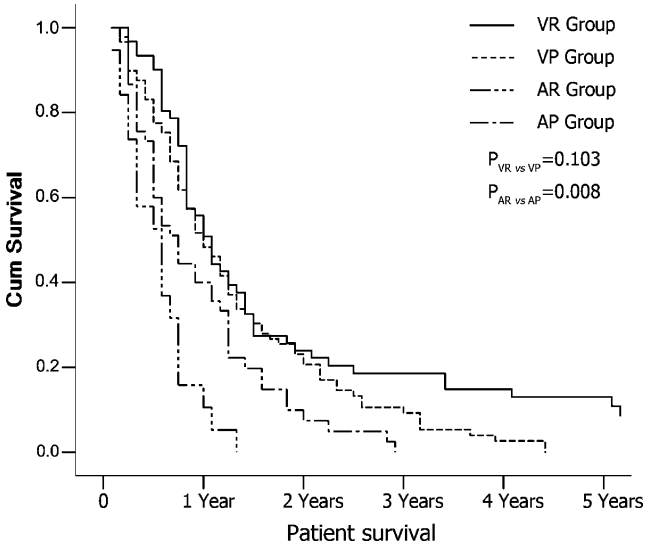

Figure 2 Kaplan–Meier survival curve for all four study groups.

years, with advances in surgical technique and perioperative care, the perioperative mortality had decreased to below 5% in high-volume centers. Thus, PD was performed frequently by surgeons.[7,8] Despite of this fact, only a small percentage of patients with pancreatic cancer were considered for PD because of the high morbidity of locally advanced and disseminated disease.

Because radical resection remains the only potential curative treatment for carcinoma of the pancreas, many surgeons sought to perform more radical resections to broaden indications of PD. To deal with vascular adhesion/invasion, which is frequently a limiting factor for radical resection, surgeons attempted to perform PD with infiltrated vascular resection. The first VR was reported by Moore in 1951, then Fortner further defined the concept of en bloc pancreatectomy in 1973.[10,13] Fortner reasoned that tumor infiltration to adjacent vessels, which was regarded as a contraindication of PD, could be overcome by en bloc resection of involved veins (type 1 resection) and arteries (type 2 resection). In recent years, experiences performing this radical procedure with VR increased. It has been reported to be performed with acceptable perioperative mortality comparably to PD without VR from many centers, but PD with VR remains a controversial approach because of the lack of evidence of survival and QOL benefit.[14–22] As for artery adhesion/invasion, it is regarded as a contraindication of PD by almost all surgeons because of high perioperative mortality and morbidity of complications.[23,24]

Our study reached an identical conclusion with previous studies on AR that it made no sense on patients with arteries adhesion/invasion. Most of patients undergoing PD with AR benefited neither on QOL nor on long-term survival. Although the perioperative mortality could be as low as 0% with increase of surgeon experience and advance in perioperative care, the morbidity of complications of PD with AR was much higher than non-radical resection therapy. More importantly, the estimated 1-year survival of patients undergoing PD with AR was only 16%±8%. The benefit of long-term survival for vascular resection with PD may be due to adherence to vasculature without actual invasion. Dismayingly, pathology of surgical specimens confirmed actual artery invasion in 78.9% patients in AR group. The high incidence of actual invasion may be due to the fact that arteries are surrounded by lymphatic tissue and nerve plexus, and tumor spread within these tissues is almost certain in case of actual artery invasion. In addition, the radical surgery procedure should also play a negative impact role in patients when actual invasion have taken place. Thus, artery adhesion/invasion was considered as a contraindication of PD in most cases in our hospital since July 2002.

Although experiences of PD with VR have been reported by many surgeons, there remains no consensus on its indications. In our institution, the judgment of resectability was mainly based on the degree of vein invasion.[25,26] We took up a relative radical position on PD with VR before June 2002, whereas PD with VR was performed more selectively after July 2002. The reasons were that (1) little obvious benefit on survival but damage in QOL was obtained from this radical resection according to experience from 1995 in our center and (2) only patients without actual vein invasion benefited on survival from PD with VR (Fig. 3), but actual vein invasion took place in more than two thirds of the patients estimated as "resectable" (Table 2). Therefore, many patients that can be estimated to resectable with radical position were treated with palliative therapy. In

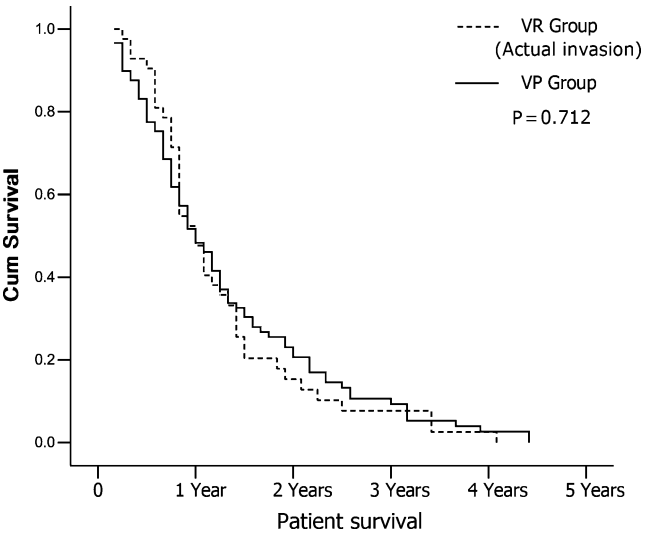

Figure 3 Kaplan–Meier survival curve for patients with actual invasion of veins in VR group and all patients in VP group.

review of all patients with vein adhesion/invasion of 10 years in our center, palliative therapy offered comparable 1- and 2-year survival with advances in chemotherapy, but PD with VR offered better 5-year survival. In spite of this, it must be pointed out that, besides treatment strategy, there are other important factors contributing to patient survival. Patients in VP group were mainly estimated unresectable, whereas patients in VR group were all estimated respectable; thus, VP group should be worse than VR group in tumor grade, tumor size, etc. Considering these factors, the difference of the effect on patient survival between PD with VR and palliative therapy should be smaller than shown. Thus, randomized controlled trial is needed for further study on the comprehensive evaluation of different treatment strategies.

QOL is another criterion for treatment strategy of pancreatic cancer. QOL of patients undergoing palliative therapy increased to preoperative levels more quickly than that of patients undergoing PD with VR after surgery. Six months after surgery, patients undergoing PD with VR and palliative therapy scored comparably in most items. With respect to pain assessment, patients undergoing palliative therapy scored better than patients undergoing PD with VR 3 months after surgery, which confirmed the favorable effect of coeliac plexus block. With respect to diarrhea assessment, for the skeletonization of common hepatic artery, celiac axis, and superior mesenteric artery in PD with VR and the coeliac plexus block in palliative therapy, postoperative diarrhea developed in both group but that of VR group were more serious than VP group. Six months after surgery, a few patients in VR group still suffered severe diarrhea. Based on the assessment of financial difficulties, the treatment costs of pancreatic cancer were big burden for Chinese patients and played severe adverse impact on economy, and the impact of both treatment strategies were equal. Considering the difference of the morbidity of postoperative complication and the length of hospital stay between patients undergoing resection and palliation, we tentatively put forward that PD procedure plays an important role in the deterioration of postoperative QOL. However, although results showed that the morbidity of postoperative complication and the length of hospital were comparable between patients undergoing PD with VR and PD only, this study has a limitation on the evaluation of the impact of VR procedure on postoperative QOL for the lack of the QOL assessment of patients undergoing PD only.

Conclusion

Our results showed that, in most cases, patients can benefit neither on QOL nor on long-term survival from PD with AR; thus, PD with AR should be performed in exceptional circumstances only. As for patients with vein adhesion/invasion, systematic palliative therapy offered better QOL and comparable 1- and 2-year survival, whereas PD with VR offered better 5-year survival. However, for the differences of tumor grade, tumor size, etc. of the PD group and VP groups, the benefit of PD with VR on survival is ambiguous. Thus PD with VR should be performed restrainedly. Because no preoperative examinations can distinguish actual invasion form inflammatory infiltration to date, surgeons must evaluate the possibility of actual vein invasion according to their experiences. When preoperative imaging studies or surgical findings indicate that actual vein invasion is very possible to have taken place, the choice of treatment strategies should be considered carefully by the pancreatic surgeons.

References

1. Parkin DM, Bray F, Ferlay J, Pisani P. Global cancer statistics, 2002. CA Cancer J Clin 2005;55:74–108.
2. Jemal A, Murray T, Ward E, Samuels A, Tiwari RC, Ghafoor A, et al. Cancer statistics, 2005. CA Cancer J Clin 2005;55:10–30.
3. Makowiec F, Post S, Saeger HD, Senninger N, Becker H, Betzler M, et al. Current practice patterns in pancreatic surgery: Results of a multi-institutional analysis of seven large surgical departments in Germany with 1454 pancreatic head resections, 1999 to 2004 (German advanced surgical treatment study group). J Gastrointest Surg 2005;9:1080–1086. (discussion 1086–1087). doi:10.1016/j.gassur.2005.07.020.
4. Yeo CJ, Cameron JL. Pancreatic cancer. Curr Probl Surg 1999;36:59–152.
5. Warshaw AL, Fernandez-del Castillo C. Pancreatic carcinoma. N Engl J Med 1992;326:455–465.
6. Whipple AO, Parsons WB, Mullins CR. Treatment of carcinoma of the ampulla of vater. Ann Surg 1935;102:763–779. doi:10.1097/00000658-193510000-00023.
7. Cameron JL, Pitt HA, Yeo CJ, Lillemoe KD, Kaufman HS, Coleman J. One hundred and forty-five consecutive pancreaticoduodenectomies without mortality. Ann Surg 1993;217:430–5. (discussion 435–438)doi:10.1097/00000658-199305010-00002.
8. Trede M, Schwall G, Saeger HD. Survival after pancreatoduodenectomy. 118 consecutive resections without an operative mortality. Ann Surg 1990;211:447–458. doi:10.1097/00000658-199004000-00011.
9. Sener SF, Fremgen A, Menck HR, Winchester DP. Pancreatic cancer. A report of treatment and survival trends for 100,313 patients diagnosed from 1985–1995, using the national cancer database. J Am Coll Surg 1999;189:1–7. doi:10.1016/S1072-7515(99)00075-7.
10. Fortner JG. Regional resection and pancreatic carcinoma. Surgery 1973;73:799–800.
11. Sprangers MA, Cull A, Bjordal K, Groenvold M, Aaronson NK. The european organization for research and treatment of cancer. Approach to quality of life assessment: Guidelines for developing questionnaire modules. Eortc study group on quality of life. Qual Life Res 1993;2:287–295. doi:10.1007/BF00434800.
12. Osoba D, Rodrigues G, Myles J, Zee B, Pater J. Interpreting the significance of changes in health-related quality-of-life scores. J Clin Oncol 1998;16:139–144.

13. Moore GE, Sako Y, Thomas LB. Radical pancreatoduodenectomy with resection and reanastomosis of the superior mesenteric vein. Surgery 1951;30:550–553.
14. Al-Haddad M, Martin JK, Nguyen J, Pungpapong S, Raimondo M, Woodward T, et al. Vascular resection and reconstruction for pancreatic malignancy: A single center survival study. J Gastrointest Surg 2007;11:1168–1174. doi:10.1007/s11605-007-0216-x.
15. Bachellier P, Nakano H, Oussoultzoglou PD, Weber JC, Boudjema K, Wolf PD, et al. Is pancreaticoduodenectomy with mesentericoportal venous resection safe and worthwhile? Am J Surg 2001;182:120–129. doi:10.1016/S0002-9610(01)00686-9.
16. Carrere N, Sauvanet A, Goere D, Kianmanesh R, Vullierme MP, Couvelard A, et al. Pancreaticoduodenectomy with mesentericoportal vein resection for adenocarcinoma of the pancreatic head. World J Surg 2006;30:1526–1535. doi:10.1007/s00268-005-0784-4.
17. Fuhrman GM, Leach SD, Staley CA, Cusack JC, Charnsangavej C, Cleary KR, et al. Rationale for en bloc vein resection in the treatment of pancreatic adenocarcinoma adherent to the superior mesenteric-portal vein confluence. Pancreatic tumor study group. Ann Surg 1996;223:154–162. doi:10.1097/00000658-199602000-00007.
18. Harrison LE, Klimstra DS, Brennan MF. Isolated portal vein involvement in pancreatic adenocarcinoma. A contraindication for resection? Ann Surg 1996;224:342–347. (discussion 347–349). doi:10.1097/00000658-199609000-00010.
19. Hartel M, Wente MN, Di Sebastiano P, Friess H, Buchler MW. The role of extended resection in pancreatic adenocarcinoma: Is there good evidence-based justification? Pancreatology 2004;4:561–566. doi:10.1159/000082181.
20. Leach SD, Lee JE, Charnsangavej C, Cleary KR, Lowy AM, Fenoglio CJ, et al. Survival following pancreaticoduodenectomy with resection of the superior mesenteric-portal vein confluence for adenocarcinoma of the pancreatic head. Br J Surg 1998;85:611–617. doi:10.1046/j.1365-2168.1998.00641.x.
21. Reddy SK, Tyler DS, Pappas TN, Clary BM. Extended resection for pancreatic adenocarcinoma. Oncologist 2007;12:654–663. doi:10.1634/theoncologist.12-6-654.
22. Tseng JF, Raut CP, Lee JE, Pisters PW, Vauthey JN, Abdalla EK, et al. Pancreaticoduodenectomy with vascular resection: Margin status and survival duration. J Gastrointest Surg 2004;8:935–949. (discussion 949–950)doi:10.1016/j.gassur.2004.09.046.
23. Ghaneh P, Costello E, Neoptolemos JP. Biology and management of pancreatic cancer. Gut 2007;56:1134–1152. doi:10.1136/gut.2006.103333.
24. Tempero M, Arnoletti JP, Ben-Josef E, Bhargava P, Casper ES, Kim P, et al. Pancreatic adenocarcinoma. Clinical practice guidelines in oncology. J Natl Compr Canc Netw 2007;5:998–1033.
25. Nakao A, Harada A, Nonami T, Kaneko T, Inoue S, Takagi H. Clinical significance of portal invasion by pancreatic head carcinoma. Surgery 1995;117:50–55. doi:10.1016/S0039-6060(05)80229-6.
26. Loyer EM, David CL, Dubrow RA, Evans DB, Charnsangavej C. Vascular involvement in pancreatic adenocarcinoma. Reassessment by thin-section ct. Abdom Imaging 1996;21:202–206. doi:10.1007/s002619900046.