

Pancreaticoduodenal Resection

Surgical Experience and Evaluation of Risk Factors in 103 Patients

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From an institutional review of 103 pancreaticoduodenal resections (PDRs) performed during the period 1968–1981, risk factors and selection criteria of this procedure were evaluated. A total of 43.7% of the patients were operated on for benign lesions, mainly right-sided chronic pancreatitis (35%); 56.3% of the interventions were performed for malignant disease, mainly carcinoma of the periampullary region. Despite the absence of any selection, the hospital mortality in 103 consecutive PDRs only reached 10.6% for the whole group (11/103 patients) and 8.3% for the elective group (8/96 patients). Mortality was significantly influenced by age barrier over 65 years ($p < 0.0001$) and by urgent degree of surgery ($p < 0.03$). All three patients with renal insufficiency had a fatal outcome after PDR. A total of 19.4% of the patients (20/103 patients) developed a surgical complication. The most important complication was pancreatic fistula (15/103 patients, 14.5%) responsible for all digestive-related fatal outcomes (six patients). Surgical treatment of pancreatic fistula (10 patients) is compromised by a high morbidity and a high mortality rate (50%). Postoperative morbidity as well as the incidence of the pancreatic fistula were significantly influenced by the age of the patients over 65 years ($p < 0.01$ and < 0.001 , respectively), and by the serum bilirubin level over 6 mg/dl ($p < 0.002$). The poor quality of the pancreatic tissue ($p < 0.03$) and the urgent degree of the intervention ($p < 0.03$) also raised the incidence of pancreatic leakage. Morbidity rate was more important in the malignant disease group ($p < 0.05$). Corrected 5-year actuarial survival after PDR is excellent for ampullary cancer, moderate for chronic pancreatitis, and extremely poor for pancreatic and bile duct carcinoma. The decision to perform PDR should be taken after evaluation of the aforementioned risk factors: the emergency, age, serum bilirubin, quality of pancreatic tissue and renal insufficiency, underlying disease, and psycho-social status of the patient.

SINCE THE INITIAL REPORTS from Whipple and Brunschwig, pancreaticoduodenal resection (PDR) was applied with variable frequency because of the significant morbidity and mortality rate.^{1–3} Increasing technical skill has lowered the postoperative mortality to below 10%.^{2,4} This paper evaluates surgical complications and risk factors of PDR in a series of 103 consecutive unselected

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patients treated at the University Hospital St-Luc, Louvain-en-Woluwe, Belgium. From this review, the authors tried to deduce some criteria allowing a more careful patient selection and thereby a reduced morbidity and mortality rate.

Materials and Methods

From January 1967 to May 1981, 103 PDRs were performed for benign and malignant diseases of the periampullary region and head of the pancreas (Table 1). All hospital records were reviewed in order to obtain a correct pathologic classification. There were 66 men and 37 women with a mean age of 52.6 years ranging from 18 to 78 years. Twenty-five patients (24.3%) had already undergone surgery, mostly for symptoms referable to diseases of the ampullary region: biliary diversion (12 patients), explorative laparotomy (three patients), cholecystectomy (three patients), cholecystectomy and duodenopapillectomy (two patients), cholecystectomy and transduodenal sphincterotomy (one patient), duodeno-jejunoscopy (one patient), oversewing of a traumatic pancreatic defect (one patient), and drainage of a pancreatic pseudocyst (one patient). Four patients had a previous partial gastrectomy. Seven patients were submitted to an endoscopic sphincterotomy.

Ninety-four patients underwent an elective intervention. Seven patients had an emergency PDR performed because of a hemorrhagic shock (four patients), an acute necrotizing pancreatitis (two patients), and a pancreatic trauma (one patient). Five of them had a benign lesion.

Forty-five patients (43.7%) presented with a benign disease, mainly a symptomatic right-sided chronic pancreatitis. Thirty-six of these patients (75%) were men. The mean age was 45.1 ± 11.4 SD years, ranging from 18 to

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66 years. A malignant lesion, mainly a pancreatic or ampullary carcinoma, was present in 56.3% (58 patients). The mean age of this group was higher (58.4 ± 9 SD years), ranging from 34 to 78 years. Men outnumbered women (55%:45%).

Preoperative visceral angiography was only performed on patients with advanced cancers showing an embedding of the porto-mesenteric axis by the tumor on abdominal scanning. Pancreaticoduodenal resection was performed using the technique described by Waugh-Child. The end-to-side pancreaticojejunostomy, performed in all but three patients, is done with absorbable sutures and is protected by wrapping of the greater omentum. The pancreatic duct is always splinted. Ligation (two cases) and obstruction (one case) of the pancreatic duct by rapid hardening amino acids occurred because of the poor quality of the pancreatic remnant. A large hemigastrectomy is performed in order to prevent anastomotic ulceration.

All malignant diseases were treated by *en bloc* resection of the primary cancer with wide tissue margins and regional lymphatic drainage. About one-half of the patients of the malignant disease group (28/58 patients) had regional lymph node involvement. Two patients presented with an invaded transection margin at definitive pathologic examination. Pancreatectomy, however, was not completed because of regional lymph node invasion.

Resection of the porto-mesenteric axis was necessary in one patient of the benign disease group (1/45 patients, 2.2%) and in nine patients of the malignant disease group (9/58 patients, 15.5%). The vascular resection was never responsible for any morbidity or mortality.

Two patients underwent simultaneously a total gastrectomy and a PDR for a gastric carcinoma invading the pancreatic head. This same combined procedure was used for an enormous peptic ulceration of the gastric stump in a patient with a Zollinger-Ellison syndrome treated previously by partial gastrectomy.

Postoperative morbidity and mortality of PDR were evaluated in relation to patient age, serum bilirubin level, renal insufficiency, histological type of the resected specimen, previous pancreaticobiliary surgery, timing of intervention, and quality of the pancreatic tissue.

Surgical mortality is defined as any death occurring during hospital stay. All leakage or collection with amylase-positive dosage is considered a pancreatic fistula.

Postoperative pulmonary complications (six patients) and temporary gastric outlet obstruction (six patients) are not included in the morbidity rates. The former occurred mainly in younger patients with a chronic alcoholic pancreatitis; the latter in gastroenterostomies performed on younger residents.

All patients are followed up for at least 2 years or until their death. At closure of the study, 51 patients were alive; 52 already died. All 51 reviewed patients underwent clin-

TABLE 1. Indication of Whipple Procedure

	Number	Per cent
Benign lesion		
Chronic pancreatitis	36	35
Endocrine tumor	3	
Aneurysm of pancreatic arteries	2	8.7
Trauma	2	
Acute necrotizing pancreas	2	
Malignant lesion		
Peri-ampullary	24	23.3
Head pancreas	25	24.3
Common bile duct	5	4.8
Gallbladder	1	
Duodenum	1	3.9
Gastric	2	
Total	103	100

ical, biochemical, and ultrasound and scanning examinations.

Chi square, Fischer's, and Student's t-test are used when appropriate. Wherever it is stated that groups are not significantly different, the *p* value always exceeds 0.05. Survival of the different patient groups was calculated using the actuarial method following Mantel-Haenszel.

Results

Overall hospital mortality of the series was 10.6% (11/103 patients). Three patients died 2 months after PDR of complications directly related to the surgical technique. The deaths were due six times to a complicated pancreatic fistulization; twice to septicemia in the absence of an abdominal complication; twice to a cardiac disease (myocardial infarction and atrioventricular block); and once to worsening of a preoperative underscored renal insufficiency (Table 2).

Age over 65 years significantly raised mortality and morbidity of PDR ($p < 0.0001$, and $p < 0.001$, respectively, Table 3). Preoperative serum bilirubin levels exceeding 6 mg/dl significantly enhanced morbidity ($p < 0.01$) but did not influence mortality (NS). All three patients with a renal insufficiency had a complicated lethal postoperative outcome. Morbidity rate was more important in the malignant disease group ($p < 0.05$). Previous pancreaticobiliary surgery did not significantly in-

TABLE 2. Hospital Mortality in 103 Pancreaticoduodenal Resections (PDR) ($n = 11$; 10.6%)

	Number
Urgent PDR	3/7 (42.8%)
Pancreatic fistula	3
Elective PDR	8/96 (8.3%)
Pancreatic fistula	3
Cardiac disease	2
Septicemia	2
Renal failure	1

TABLE 3. Factors Influencing Mortality and Morbidity in 103 Pancreaticoduodenal Resections

	Morbidity		Mortality	
	N	%	N	%
Urgent surgery	3/7	42.8	3/7	43
Elective surgery	21/96	NS	8/96	$p < 0.03$
Age <65 years	14/86	16.3	4/86	4.7
>65 years	10/17	$p < 0.001$	7/17	$p < 0.0001$
		58.8		41.2
Benign disease	6/45	13.4	4/45	8.8
Malignant disease	18/58	$p < 0.05$	7/58	NS
		31		12
Serum bilirubin level <6 mg/dl	12/74	16.2	6/74	8.5
>6 mg/dl	12/29	$p < 0.01$	5/29	NS
		41.4		17.2
Renal insufficiency (n = 3)	3/3	100	3/3	100

fluence morbidity or mortality (NS). The pathologic aspect of the resected specimen did not, however, influence mortality (NS).

Twenty patients (19.4%) presented a surgical complication during the early postoperative period (Table 4). Reoperation was necessary 19 times in 15 patients (14.5%). Pancreatic fistula (15/103 patients, 14.5%) was the most common and important complication of PDR responsible for six of the 11 postoperative deaths.

Three minor pancreatic leaks healed out spontaneously after local wound care. Two patients died of a complicated chronic pancreatic fistula 1 and 2 months after emergency PDR was performed for an acute necrotizing pancreatitis caused once by an endoscopic sphincterotomy and once by a chronic renal insufficiency.

Surgical treatment of the fistula was applied in 10 patients because of either an uncontrollable bleeding (three patients) or an infection (seven patients). Total pancreatectomy was successful in three patients but could not prevent fatal outcome in two others. Three patients underwent a drainage-lavage of the pancreatic area; two of them died of a septicemia. A procedure involving ob-

struction of the pancreatic duct by rapidly hardening amino acids was applied without success in one patient; this patient died of a septic complication of the pancreatic leak. One patient underwent a wide parietal excision because of an extensive wall digestion by the chronic pancreatic fistula. It should be stressed that surgical reintervention for a pancreatic leak in 10 patients was complicated by four colonic fistulae and by four fatal septic complications. The colonic complications were managed twice by simple drainage, once by ileocolonic bypass, and once by a right hemicolectomy.

Closure of the pancreatic duct by ligation (two patients) or by rapidly hardening amino acids (two patients), applied as a preventive (three patients) or therapeutic act (one patient) was followed in every case by pancreatic leaking. Two patients finally underwent a total pancreatectomy; two died of a septic complication.

More precise analysis of the pancreatic leaks (Table 5) showed that this complication was more frequent and always fatal in the emergency PDR group ($p < 0.03$). A fibrotic pancreas is less prone to fistula formation than a normal friable gland ($p < 0.03$). Serum bilirubin level exceeding 6 mg/dl and age over 65 years also significantly influenced incidence of pancreatic leakage ($p < 0.002$ and $p < 0.001$, respectively). An isolated biliary fistula was only seen once in this series and it healed spontaneously. One patient had to be reoperated because of intra-abdominal bleeding.

Early postoperative gastrointestinal (GI) tract bleeding was caused twice by an anastomotic ulceration and three times by an erosive gastritis. One of these latter cases responded well to truncular vagotomy and pyloroplasty. Upper GI hemorrhages were lethal in three patients presenting a renal insufficiency; two of them also had a pancreatic fistula. One patient developed an anastomotic ulceration some years after PDR was performed for chronic pancreatitis; he was cured by a transthoracic truncular vagotomy. Exocrine and endocrine pancreatic function, weight evolution, and activity of the patients were carefully registered. A steatorrhea was seen in all patients. Three patients (one 5 years after PDR for ampullary carcinoma and two after PDR for chronic pancreatitis) developed malnutrition because of alcohol addiction leading to cirrhosis.

Endocrine pancreatic function was seldom disturbed or aggravated. In the benign disease group, two of the reviewed patients (8%) aggravated their diabetes; two patients of the malignant disease group needed more (oral) antidiabetics (10%); one patient became insulin-dependent (5%).

Eighty per cent of the patients maintained their preoperative weight. The initial weight before the beginning of the disease was not reached, however. Long-term functional results of PDR were outstanding in the group of

TABLE 4. Surgical Complications in 20 Patients after Pancreaticoduodenal Resection (19.4%)

	Number
Pancreatic fistula	15
Biliary fistula	1
Hemorrhage	
Intraabdominal	1
Gastrointestinal	5
Stress bleeding	3
Anastomotic ulcer	2

ampullary cancers reflecting the normal function of the pancreatic remnant.

In both groups of patients, about two-thirds had a "normal" home activity; however, the majority of them were unemployed and were declared invalid by the health insurance, probably because of the bad reputation of the Whipple resection.

The corrected 5-year actuarial survival curves for the groups are shown in Fig. 1.

The best results were achieved in the ampullary cancers ($50 \pm 13\%$ SD). These results were even better if there was absence of lymph node invasion ($60 \pm 15\%$ SD versus $23 \pm 18\%$ SD if lymph node invasion) and if the tumor was limited to the duodenal wall ($76 \pm 15\%$ SD versus 0% if invasion and environmental structures, $p < 0.01$).

Bad results were obtained in bile duct and pancreatic carcinomas as only one single survival was noted after 4 years. These results were not better when resected lymph nodes were free of invasion. The 5-year corrected actuarial survival in the chronic pancreatitis group only reached $33 \pm 17\%$ SD years.

Discussion

Pancreaticoduodenal resection is a widely used technique in the treatment of periampullary, duodenal, and cephalic pancreatic diseases.

Despite the absence of any selection, the hospital mortality in this group of 103 consecutive PDRs only reached 10.8% for the whole group and 8.3% for the elective operated group. Postoperative morbidity and mortality will only be lowered by adequate patient selection. The mortality rate is significantly raised by age over 65 years and

TABLE 5. Factors Influencing Pancreatic Fistula in 103 Pancreaticoduodenal Resections

Significance	Factors	
*NS	Benign disease 5/45 (11.1%)	Malignant disease 10/58 (17.2%)
* $p < 0.03$ †F = NS	Urgent 3/7 (42.8%)	Elective intervention 12/96 (12.5%)
* $p < 0.03$	Fibrotic pancreatic tissue 3/48 (6.25%)	Normal pancreatic tissue 12/55 (21.8%)
* $p < 0.002$	Bilirubin < 6 mg/dl 5/74 (6.75%)	Bilirubin > 6 mg/dl 10/29 (34.5%)
* $p < 0.001$ †F < 0.01	Age < 65 years 8/86 (9.4%)	Age > 65 years 7/17 (41.2%)

* Chi square test.

† F = Fischer exact test.

by emergency degree of surgery. All three patients presenting a renal insufficiency had a fatal postoperative outcome. Bilirubinemia did not influence mortality as five patients with a normal bilirubin level died of unrelated abdominal causes such as extra-abdominal sepsis (two patients), cardiac disorder (two patients), and glomerulonephritis (one patient). The morbidity rate is significantly raised by age, by serum bilirubin elevation over 6 mg/dl, and by the quality of the pancreatic tissue remnant. These data reflect the dominating role of pancreatic leakage in postoperative morbidity, as they all aggravate this complication (Tables 3–5). Pancreatic leakage is rare in the chronic pancreatitis group. This can be explained by the safety of the pancreaticojejunal anastomosis performed with a fibrotic gland in a young, non-jaundiced patient, by the decreased exocrine production of the gland,

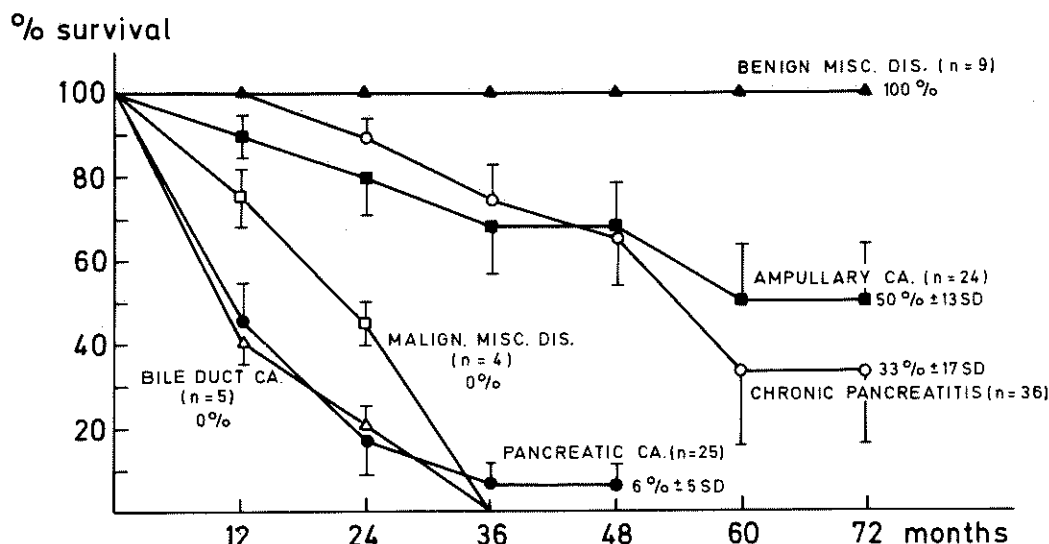


FIG. 1. Corrected 5-year actuarial survival after pancreaticoduodenal resection.

and by the larger diameter of the pancreatic duct.⁵ Previous pancreaticobiliary surgery had no influence on morbidity and mortality. All these data comply with other reports.^{3,6-8} Management of pancreatic leakage consists of a total pancreatectomy or a drainage-lavage of the pancreatic area. Both methods are difficult and will be compromised by a high infection rate. Therefore, re-intervention should be limited to hemorrhagic or to persistent, local, or systemic septic complications. Because of the high mortality of treatment of pancreatic leakage (50% in our series), more attention should be given to the prevention of this complication.⁵

The benefit of decompressing the liver in severely jaundiced patients has been shown by several authors.^{6,7,9,10} Some perform a classical two-stage surgery; others prefer the percutaneous transhepatic bile drainage. Percutaneous transhepatic bile drainage may be an easy method to obtain a rapid normalization or lowering of serum bilirubin levels to improve hepatic function, coagulation, nutritional status (and thereby wound healing), and last but not least to confirm the diagnosis.^{9,10} Biliary infection may nevertheless serve as a warning for a too deliberate use of the method. If performed, a closed drainage system with permanent decontamination is mandatory.¹¹ Endoscopic retrograde cholangiopancreatography (ERCP) and sphincterotomy should be omitted because of their serious, although rare, surgical complications.¹² In this series, one patient died after an emergency PDR for a massive hemorrhage after endoscopic sphincterotomy.

Normal or friable pancreatic tissue is predisposed to leakage. In these circumstances some authors close the divided pancreatic remnant and simply ligate or obstruct the duct. These methods, however, predispose fistula formation.⁵ The latter procedure may even deteriorate the remaining endocrine tissue. Others propagate total pancreatectomy as this procedure eliminates the pancreaticojejunoanastomosis; this technique also allows removal of eventual multicentric pancreatic cancers. Morbidity and mortality increased, however, in comparison with the classical Whipple procedure and no major improvement of 5-year survivals is obtained.^{2,4,8,9}

The authors aim to perform a pancreaticojejunoanastomosis in nearly every case. The duct is always splinted by a silastic tube in order to omit obstruction during performance of the anastomosis. The anastomosis will be wrapped by the greater omentum. This structure, carefully preserved during the beginning of the operation, will separate the pancreaticojejunal and the gastrojejunal anastomosis. A pancreatic leak will thereby remain isolated, so disruption of neighboring anastomoses will be omitted. Penrose drainage inserted near the pancreaticojejunal anastomosis will adequately drain the left pancreatic area. It is our impression, although not yet statistically proved,

that the incidence of complicated pancreatic fistula could be reduced markedly.

Biliary fistula is uncommon after PDR (one patient in our series). The biliodigestive anastomosis may be stented in case of a thin caliber of the bile duct by a Kehr drainage inserted cephalad from the suture line.

Upper GI bleeding after PDR becomes rare since prophylactic administration of cimetidine and antacids. A large hemigastrectomy will prevent anastomotic ulceration and precludes the systematic use of truncular vagotomy in PDR. All three lethal GI hemorrhages occurred after emergency PDR in patients presenting a renal insufficiency (three cases), a very high serum bilirubin level (two cases), and a complicated pancreatic fistula (two cases).

The decision to perform a PDR should be taken after the evaluation of the aforementioned risk factors. Presence of more than one factor in the same patient precludes PDR.

The surgical act should also be correlated to the underlying disease. Pancreaticoduodenal resection is indeed a very satisfactory procedure in ampullary cancers but discouraging in pancreatic and bile duct carcinoma.^{1-3,7,9,13,14} The difference in prognosis between ampullary and pancreatic cancers lies in the patterns of the lymph node involvement. Pancreatic carcinomas more often involve multiple and distant lymph node groups not removed by this technique.¹⁴

An exact tissue diagnosis as by perioperative transduodenal needle aspiration cytology¹⁵ and an extensive perioperative staging is imperative before an extensive resectional procedure is undertaken.^{3,9,16,17} *En bloc* resection of the primary cancer with wide tissue margins and with the regional lymphatic drainage is necessary.^{13,18} Indemnity of the resection margin should always be kept in mind.⁸

More extensive procedures as PDR and regional pancreatectomy have to be reserved to the low-risk patient with a less advanced cancer of the periampullary region or with an invasive ampullary cancer.^{13,18,19} Palliative bypass surgery is more appropriate in the high-risk patient and in the cases of advanced pancreatic carcinoma. About one-half of the patients in these series underwent PDR for benign disease, mainly a right-sided chronic pancreatitis because of invalidating pain associated with biliary and/or GI obstruction but also because of the often unclear pre- and perioperative differential diagnosis with a malignant lesion. This last condition was present in eight of the 36 resected patients (22%). The operative mortality in this group was very low (5.5%) reflecting the low incidence of pancreatic fistula. The less favorable 5-year corrected actuarial survival of this group is in accordance with the late mortality that can be expected in the non-

operative treatment of the severe chronic pancreatitis and seems to be independent of the surgical procedure itself.¹⁹ Further alcohol and drug abuse often leads to cachexia, pulmonary, and/or cardiovascular complications.

Excessive fat loss is the most significant absorptive derangement produced by pancreatic resection present in all patients of these series.²⁰ Alcohol intake, causing hepatic and further pancreatic cirrhosis, will lead to malnutrition. The exocrine pancreatic insufficiency could be controlled in nearly all cases by dietetic measures and administration of substitution pancreatic enzymes and fat soluble vitamins.

Endocrine pancreatic insufficiency is not a major problem after PDR.²⁰ Twelve per cent of the reviewed patients presented an aggravation or disturbance of the carbohydrate absorption. The decision to perform PDR needs an exact evaluation of the attitude of the patient towards a well-regulated life necessary to face all different dietetic restrictions after PDR. The ability to gain weight after resection is minimal; however, most patients maintain their preoperative weight. The best long-term results for the whole series are obtained in PDR performed for ampullary cancers reflecting an almost normal exocrine and endocrine function of the pancreatic remnant.

Our experience shows PDR can be performed with an acceptably low mortality and morbidity. Careful patient selection has to be based on evaluation of the different mentioned risk factors, the underlying disease, and the psycho-social status of the patient. The long-term survival rates are excellent to good for benign and ampullary lesions, moderate for chronic pancreatitis, but poor for pancreatic and bile duct carcinomas.

References

1. Gudjonsson B, Livstone EM, Spiro HM. Cancer of the pancreas. *Cancer* 1978; 42:2494-2506.
2. Levin B, Remine WH, Hermann RE, et al. Cancer of the pancreas. *Am J Surg* 1978; 135:185-191.
3. Shapiro TM. Adenocarcinoma of the pancreas. *Ann Surg* 1974; 182:715-721.
4. Edis AJ, Kiernan PD, Taylor WF. Attempted curative resection of ductal carcinoma of the pancreas. *Mayo Clin Proc* 1980; 55:531-536.
5. Papachristou DN, Fortner JG. Pancreatic fistula complicating pancreatotomy for malignant disease. *Br J Surg* 1974; 182:715-721.
6. Braasch JW, Gray BN. Considerations that lower pancreaticoduodenectomy mortality. *Am J Surg* 1977; 133:480-484.
7. Cohen JR, Kuchta N, Geller N, et al. Pancreatoduodenectomy. *Ann Surg* 1982; 195:608-617.
8. Forrest JF, Longmire WP. Carcinoma of the pancreas and periampullary region. *Ann Surg* 1979; 189:129-138.
9. Cooperman AM, Herter FP, Marbde CA, et al. Pancreatoduodenal resection and total pancreatectomy—an institutional review. *Surgery* 1981; 90:707-712.
10. Denning DA, Ellison EC, Carey LC. Preoperative percutaneous transhepatic biliary decompression lowers operative morbidity in patients with obstructive jaundice. *Am J Surg* 1981; 141:61-65.
11. Clouse ME, Evans D, Costello P, et al. Percutaneous transhepatic biliary drainage. *Ann Surg* 1983; 198:25-29.
12. Fekete F, Laigneau P, Lortat-Jacob JL. Les accidents chirurgicaux de cholango-wirsungographie rétrograde. *Chirurgie* 1977; 103:658-668.
13. Marchal H, Hureau J. Les Tumeurs Oddiennes. Monographie Association Française Chirurgie. Paris: Ed Masson, 1978.
14. Cubilla AL, Fortner J, Fitzgerald PJ. Lymphnode involvement in carcinoma of the head of the pancreas. *Cancer* 1978; 41:880-887.
15. Ihse I, Toregard BM, Akerman M. Intraoperative fine needle aspiration cytology in pancreatic lesions. *Ann Surg* 1979; 190:732-734.
16. Fortner JG. Surgical principles of pancreatic cancer. *Cancer* 1981; 47:1712-1718.
17. Holyoke ED. New surgical approaches to pancreatic cancer. *Cancer* 1981; 47:1719-1723.
18. Solassol CL. Les Pancréatectomies Régionales. In Maillet P, ed. Les Cancers du Pancréas. Paris: Association Française de Chirurgie, 1981:100-107.
19. Gall FP, Muhe E, Gebhardt C. Results of partial and total pancreaticoduodenectomy in 117 patients with chronic pancreatitis. *World J Surg* 1981; 5:269-275.
20. Griffen WO. Metabolic consequences of pancreatectomy. In Buchwald H, Varco RL, eds. *Metabolic Surgery*. New York: Grune & Stratton, 1978:111-124.