

BRIEF ARTICLES

## Surgical palliation of unresectable pancreatic head cancer in elderly patients

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median overall survival were also significantly longer in Group A ( $P = 0.001$  and  $P < 0.001$ , respectively).

**CONCLUSION:** Surgical palliation does not increase the morbidity or mortality rates, but it does increase the survival rate and improve the quality of life in elderly patients with unresectable pancreatic head cancer.

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**Key words:** Adenocarcinoma; Elderly; Palliative surgery; Pancreas neoplasms

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### Abstract

**AIM:** To determine if surgical biliary bypass would provide improved quality of residual life and safe palliation in elderly patients with unresectable pancreatic head cancer.

**METHODS:** Nineteen patients, 65 years of age or older, were managed with surgical biliary bypass (Group A). These patients were compared with 19 patients under 65 years of age who were managed with surgical biliary bypass (Group B). In addition, the results for group A were compared with those obtained from 17 patients, 65 years of age or older (Group C), who received percutaneous transhepatic biliary drainage to evaluate the quality of residual life.

**RESULTS:** Five patients (26.0%) in Group A had complications, including one intraabdominal abscess, one pulmonary atelectasis, and three wound infections. One death (5.3%) occurred on postoperative day 3. With respect to morbidity, mortality, and postoperative hospitalization, no statistically significant difference was noted between Groups A and B. The number of readmissions and the rate of recurrent jaundice were lower in Group A than in Group C, to a statistically significant degree ( $P = 0.019$ ,  $P = 0.029$ , respectively). The median hospital-free survival period and the

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### INTRODUCTION

Pancreatic adenocarcinoma is the fourth most frequent neoplasm of the gastrointestinal tract in Korea and it has increased in incidence over the past 15 years (data from the 2002 Annual Report of the Korea Central Cancer Registry). Its incidence increases with age: people older than 65 years represent the section of the population with the highest risk of developing pancreatic adenocarcinoma<sup>[1]</sup>. In the year 2000, the world-wide incidence of pancreatic adenocarcinoma was 21 6367 cases; 60% of patients were over 65 years of age<sup>[2]</sup>.

The tumor is located in the pancreatic head and uncinate process in 70% of cases<sup>[3]</sup>. Surgical resection and biliary-enteric reconstruction usually provides adequate biliary drainage, but only 10% to 20% of patients can be treated surgically with an intent to cure<sup>[4,5]</sup>. Under other circumstances, the only option is appropriate

palliation to relieve jaundice, pruritis, pain, and duodenal obstruction<sup>16,71</sup>. However, there is controversy over how to provide optimal palliative treatment. In the 1980s, because of the high morbidity and mortality of surgical procedures, obstructive jaundice was mainly managed by endoscopic biliary stenting or percutaneous transhepatic biliary drainage (PTBD). However, more recent studies show a significant decrease in the perioperative mortality and morbidity associated with bypass surgery<sup>18,91</sup>. Therefore, the surgeons' dilemma of "non-surgical or surgical palliation" remains, especially in treating elderly patients.

We performed a retrospective study to determine if surgical biliary bypass would provide improved quality of residual life and safe palliation in elderly patients with unresectable pancreatic head cancer.

## MATERIALS AND METHODS

We reviewed the clinical records of 55 patients with unresectable pancreatic head cancer who underwent palliative treatment at our hospital between January, 2001 and January, 2006. Patients excluded from the study comprised those who had already undergone palliative resection, had already developed gastric outlet obstruction, had no obstructive jaundice at the time of diagnosis, or had histology other than adenocarcinoma. There were 19 patients, 65 years of age or older, who were managed with surgical biliary bypass (Group A), these patients were compared with 19 patients under the age of 65 who were managed using surgical biliary bypass (Group B), to determine if surgical biliary bypass could be performed safely in elderly patients. In addition, the results of patients in Group A were also compared with those obtained from 17 patients, aged 65 or older (Group C), who received only PTBD with or without stenting as definitive palliation for unresectable pancreatic head cancer. The purpose of this comparison was to evaluate the quality of residual life in the two groups, and the following parameters were considered: recurrence of jaundice, gastric outlet obstruction, the number of readmissions, median survival, and median hospital-free survival. Hospital-free survival, in which patients are able to spend their daily life at home or away from the hospital until the final readmission, may be related to quality of life. Diagnostic methods included contrast-enhanced computed tomography, ultrasonography, and magnetic resonance imaging. All patients underwent endoscopy to rule out gastroduodenal obstruction. Contraindication to palliative surgery included the presence of distant metastases on preoperative assessment, concomitant risk factors, or patients' choice. Demographics, perioperative and postoperative data were collected from hospital records and analyzed.

All patients underwent diagnostic or therapeutic PTBD before bypass surgery, and operations were performed without delay to lower the bilirubin level. Surgical biliary bypass included cholecystectomy and biliary-enteric bypass (hepaticojejunostomy

or choledochojejunostomy). If the blood supply to the proximal bile duct was not sufficient, hepaticojejunostomy was performed. Gastrojejunostomy was performed in patients at high risk for duodenal obstruction during the survival period (such as in cases with duodenal invasion). The previously inserted PTBD catheter was used for postoperative external biliary drainage. It was removed when the biliary-enteric bypass healed without bile leakage.

PTBD was performed by a radiologist with experience in interventional biliary procedures. Ultrasound was used to locate and access the ducts. A 21-gauge Chiba needle was inserted percutaneously under local anesthesia with 1% lidocaine, and advanced horizontally into the right or left intrahepatic duct. After placement of a guide wire across the obstructing lesion, sequential dilation of the track was performed. An 8.5F pigtail catheter was positioned with its tip in the distal bile duct. If the catheter was not manipulated past the obstruction, the catheter was left above the obstruction and placed for external drainage. One to two weeks later, biliary stenting was performed by using a plastic stent (BONASTENT™ Biliary; Standard Sci-Tech Inc., Seoul, Korea), if possible, to allow for internal drainage in patients who did not have biliary bypass surgery. Cholangiography was performed immediately after placement of the catheter to confirm that the pigtail catheter was in the correct position within the bile duct.

Statistics were performed using the SPSS for Windows Statistical Software Package (Version 15.0, SPSS Inc. Chicago, IL, USA). All results are presented as mean  $\pm$  SD or as median with range. Inter-group differences were compared using the  $\chi^2$  test and Fisher's exact test, and differences between means were compared using the Mann-Whitney *U* test. Two-tailed *P* values less than 0.05 were considered statistically significant.

## RESULTS

### **Surgical palliation: Old versus young**

Sex ratio, surgical risks as assessed according to the American Society of Anesthesiologists (ASA), and TNM staging according to the American Joint Committee on Cancer (AJCC) 2002 classification were similar between the two groups, A and B. One patient in Group A and 4 in Group B underwent biliary bypass only. The mean preoperative bilirubin level was higher in Group B ( $11.2 \pm 7.9$  vs  $14.5 \pm 6.5$  mg/dL), but not to a statistically significant degree (Table 1). The mean minimal postoperative bilirubin level was significantly lower in Group A ( $0.9 \pm 0.5$  vs  $1.5 \pm 0.6$ ). Five patients (26.0%) in Group A had complications including one intraabdominal abscess, one pulmonary atelectasis, and 3 wound infections. In Group B, there was one case of pulmonary atelectasis with pleural effusion. The morbidity rate was higher in group A, but not to a statistically significant degree. One death (5.3%) occurred in Group A after 3 d. The patient presented with upper gastrointestinal bleeding after one day and

Table 1 Patient characteristics and clinical outcomes of Groups A, B and C

	Group A	Group B	Group C
Patient characteristics			
Number of patients	19	19	17
Mean age	71.6 ± 4.8	55.6 ± 6.8	74.4 ± 5.8
Male/Female	7/12	13/6	11/6
ASA			
I	6	8	5
II	9	8	9
III	4	3	3
Stage			
III	16	13	16
IV	3	6	1
Biliary and gastric bypass	18	15	14.5 ± 6.5
Mean preoperative bilirubin level (mg/dL)	11.2 ± 7.9	14.5 ± 6.5	
Clinical outcomes			
Mean postoperative bilirubin level (mg/dL)	0.9 ± 0.5	1.5 ± 0.6 <sup>b</sup>	2.2 ± 2.7
Early complications	5 (26%)	1 (5.3%)	1 (5.9%)
30 d mortality	1 (5.3%)	0 (0.0%)	4 (26.7%) <sup>a</sup>
Recurrent jaundice	0 (0.0%)	2 (10.5%)	2 (11.8%)
Gastric outlet obstruction	0 (0.0%)	1 (5.3%)	14 (range, 2-43) <sup>a</sup>
Median postoperative hospital stay (days)	19 (range, 3-73)	20 (range, 13-70)	20 <sup>a</sup>
Number of readmissions	9	22	120 (range, 0-230) <sup>b</sup>
Median survival (days)	290 (range, 3-723)	213 (range, 70-510)	150 (range, 2-240) <sup>b</sup>

ASA: American Society of Anesthesiologists. <sup>a</sup> $P < 0.05$ , <sup>b</sup> $P < 0.01$  vs Group A.

underwent reoperation, but died of multiple organ failure. There were no cases of recurrent jaundice or gastric obstruction in Group A, but 7 patients required 9 readmissions due to fever, pain, poor oral intake, or other reasons. In group B, recurrent jaundice developed in 2 patients (10.5%), gastric outlet obstruction developed in one patient (5.3%). Six patients required 22 readmissions. Median postoperative hospitalization was shorter in Group A (19 d, range 3-73 d), but there was no statistically significant difference between the two groups. Median overall survival in the two groups was not significantly different (Table 1).

### **Surgical palliation versus non-surgical palliation in old age**

Seventeen patients 65 years of age or older underwent PTBD for palliation of pancreatic head cancer. The radiologic findings in these patients included tumor invasion of the superior mesenteric vein or portal vein in 3 patients, superior mesenteric artery in 5 patients, both in 7 patients, hepatic artery in one patient, and hepatic metastases in one patient. Patient age, sex ratio, surgical risk (ASA), and TNM staging were similar between the two groups. The mean preoperative bilirubin level was higher in Group C (11.2 ± 7.9 vs 14.5 ± 8.7 mg/dL), but not to a statistically significant degree (Table 1). In Group A, successful biliary drainage was observed in 18 of 19 patients (94.7%). Successful biliary drainage was observed in 15 of 17 patients (88.2%) in Group C. There was no statistically significant difference between the two groups. Successful bile drainage was defined as a reduction in the bilirubin level (total bilirubin < 2.0 mg/dL) and improvement in symptoms. The difference in morbidity and mortality rates were not statistically significant

between the two groups. One of the 17 patients in Group C (5.9%) had an early complication due to dislodgment of the catheter. One death (5.9%) occurred in Group C after 2 d because of massive hemobilia. Nine patients in Group C required 20 readmissions due to cholangitis, recurrent jaundice, pain, or other reasons. Recurrent jaundice developed in 4 patients (26.7%), and gastric outlet obstruction developed in 2 patients (11.8%). Three of these patients underwent reinsertion of the PTBD, one patient underwent endoscopic endoprosthesis, and 2 patients underwent duodenal stent placement. The number of readmissions, and rate of recurrent jaundice were higher in Group C to a statistically significant degree ( $P = 0.019$ ,  $P = 0.029$ , respectively). Median postoperative hospitalization was shorter in Group C (14 d, range 2-43 d). The median hospital-free survival period was significantly longer ( $P = 0.001$ ), and median overall survival was significantly longer ( $P < 0.001$ ) in Group A compared to Group C.

### **DISCUSSION**

The risk of developing pancreatic cancer dramatically increases with age, with a median age of 72 years at the time of diagnosis<sup>[10]</sup>. Thus, the epidemiology of the disease combined with the growth of the elderly population is leading to an increasing number of cases. Even if most patients with pancreatic head cancer are not candidates for radical surgical resection, because of early metastatic spread or extensive local tumor involvement, palliation of obstructive symptoms and pain remains a core component in the management of this disease. Di Carlo *et al*<sup>[11]</sup> reported there was no significant difference in the frequency of locally advanced or metastatic disease

in elderly patients (over 70 years) compared with those under 70 years. However, to our knowledge there are few reports on the use of surgical biliary bypass to manage unresectable pancreatic head cancer in old age<sup>[12,13]</sup>. Although endoscopic stenting of the bile duct or PTBD can relieve biliary obstruction, surgical bypass is done in many cases because of patient or physician preference, an inability to access the bile duct, or failure of non-surgical palliation<sup>[14]</sup>. Surgical bypass can also be performed when a pancreatic head cancer proves to be unresectable during an operation intended to cure the tumor. Significant advances have been made in non-operative palliation for perampullary cancer. Percutaneous or endoscopic palliation of obstructive jaundice can provide biliary decompression with lower early morbidity compared to open biliary bypass surgery<sup>[15-18]</sup>. However, these techniques have had disappointing outcomes with regard to recurrent jaundice. Several studies have compared PTBD with endoscopic endoprosthesis in malignant biliary obstruction. The endoscopic approach proved to be safer and more effective compared with PTBD<sup>[19,20]</sup>. However, the long-term complications of both these procedures make them less desirable than surgical bypass in those patients who are expected to survive more than a few months<sup>[21]</sup>.

It may be a common conception that elderly patients are more susceptible to an increased mortality, morbidity and longer hospitalization than their younger counterparts. Interestingly, reluctance to advise an operation is often unrelated to the presence of comorbidities or impaired functional status<sup>[22]</sup>.

In recent studies, the morbidity of palliative double bypass surgery (biliary-enteric reconstruction, gastrojejunostomy) has ranged between 4.8% and 28%, and mortality has ranged between 1% and 9%<sup>[6,7,23,24]</sup>. Nuzzo *et al.*<sup>[12]</sup> reported that the morbidity and mortality rates for surgical palliation in elderly patients (> 70 years) with perampullary cancer were comparable to those of younger patients ( $\leq$  70 years), with no statistically significant difference found between the 2 groups. In our study, postoperative morbidity and mortality rates in elderly patients were 26% (5 patients) and 5.3% (one patient), respectively. These figures are comparable to rates reported in other series. Also, there was no significant difference between elderly patients and younger patients in terms of mortality and morbidity rates. Median postoperative hospitalization was 19 d in elderly patients (range, 3-73 d), and there was no statistically significant difference between elderly patients and younger patients in this regard.

To evaluate the efficacy of palliative bypass surgery for the treatment of unresectable pancreatic head cancer in elderly patients, the results were compared against those obtained from patients 65 years of age or older who received PTBD. More frequent recurrent jaundice, readmission, and shorter hospital-free survival were noted in the non-surgical palliation group. Overall, the quality of life, assessed by relief of biliary obstructive symptoms, the number of readmissions, and hospital-free survival, was better after surgical biliary bypass than non-surgical

palliation. Survival was improved after surgical bypass. The reasons behind this are not clear, but factors that may contribute include relief of biliary obstruction, low rate of recurrent jaundice, and prevention of gastric obstruction. These may help to improve both the nutritional state of the patients and their general well-being. Therefore, older age alone should not be a contraindication to surgical palliation of unresectable pancreatic head cancer, although elderly patients may require more intensive postoperative care. However, our results must be interpreted with caution because of the selection bias inherent in this study. Actually, surgical palliation was performed in patients who did not have metastatic disease on the preoperative imaging studies. Also stenosis of the biliary duct might be higher in the non-surgical palliation group. Thus, long-term survival and a good quality of survival could be achieved in patients who underwent surgical palliation.

In conclusion, surgical palliation does not increase the morbidity and mortality rates, but it does increase the survival rate and improve the quality of life in elderly patients with unresectable pancreatic head cancer. Further clinical observations and prospective, controlled studies are needed to elucidate the long-term effects of this procedure.

## COMMENTS

### Background

Even if most patients with pancreatic head cancer are not candidates for radical surgical resection, because of early metastatic spread or extensive local tumor involvement, palliation of obstructive symptoms and pain remains a core component in the management of this disease. There are few reports on the use of surgical biliary bypass to manage unresectable pancreatic head cancer in old age.

### Research frontiers

Significant advances have been made in non-operative palliation for perampullary cancer. Percutaneous or endoscopic palliation of obstructive jaundice can provide biliary decompression with lower early morbidity compared to open biliary bypass surgery. However, these techniques have had disappointing outcomes with regard to recurrent jaundice. We performed a retrospective study to determine if surgical biliary bypass would provide improved quality of residual life and safe palliation in elderly patients with unresectable pancreatic head cancer.

### Innovations and breakthroughs

There was no significant difference between elderly patients and younger patients in terms of mortality and morbidity rates. The quality of life, assessed by relief of biliary obstructive symptoms, the number of readmissions, and hospital-free survival, was better after surgical biliary bypass than non-surgical palliation. Survival was improved after surgical bypass.

### Applications

Surgical palliation does not increase the morbidity and mortality rates, but it does increase the survival rate, and improve the quality of life in elderly patients with unresectable pancreatic head cancer.

### Peer review

The authors found that surgical palliation does not increase the morbidity and mortality rates, but it does increase the survival rate and improve the quality of life in elderly patients with unresectable pancreatic head cancer. This is an important study.

## REFERENCES

- 1 Casadei R, Zanini N, Morselli-Labate AM, Calculli L, Pezzilli R, Pote O, Grottola T, Ricci C, Minni F. Prognostic factors in perampullary and pancreatic tumor resection in elderly patients. *World J Surg* 2006; **30**: 1992-2001; discussion

- 2002-2003
- 2 **Shore S**, Vimalachandran D, Raraty MG, Ghaneh P. Cancer in the elderly: pancreatic cancer. *Surg Oncol* 2004; **13**: 201-210
  - 3 **Reznek RH**, Stephens DH. The staging of pancreatic adenocarcinoma. *Clin Radiol* 1993; **47**: 373-381
  - 4 **Singh SM**, Longmire WP Jr, Reber HA. Surgical palliation for pancreatic cancer. The UCLA experience. *Ann Surg* 1990; **212**: 132-139
  - 5 **Sarr MG**, Cameron JL. Surgical palliation of unresectable carcinoma of the pancreas. *World J Surg* 1984; **8**: 906-918
  - 6 **Sohn TA**, Lillemoe KD, Cameron JL, Huang JJ, Pitt HA, Yeo CJ. Surgical palliation of unresectable periampullary adenocarcinoma in the 1990s. *J Am Coll Surg* 1999; **188**: 658-666; discussion 666-669
  - 7 **van Wagenveld BA**, Coene PP, van Gulik TM, Rauws EA, Obertop H, Gouma DJ. Outcome of palliative biliary and gastric bypass surgery for pancreatic head carcinoma in 126 patients. *Br J Surg* 1997; **84**: 1402-1406
  - 8 **Lillemoe KD**, Sauter PK, Pitt HA, Yeo CJ, Cameron JL. Current status of surgical palliation of periampullary carcinoma. *Surg Gynecol Obstet* 1993; **176**: 1-10
  - 9 **Gouma DJ**, van Geenen R, van Gulik T, de Wit LT, Obertop H. Surgical palliative treatment in bilio-pancreatic malignancy. *Ann Oncol* 1999; **10** Suppl 4: 269-272
  - 10 **Petrowsky H**, Clavien PA. Should we deny surgery for malignant hepato-pancreatico-biliary tumors to elderly patients? *World J Surg* 2005; **29**: 1093-1100
  - 11 **Di Carlo V**, Balzano G, Zerbi A, Villa E. Pancreatic cancer resection in elderly patients. *Br J Surg* 1998; **85**: 607-610
  - 12 **Nuzzo G**, Clemente G, Greco F, Ionta R, Cadeddu F. Is the chronologic age a contra-indication for surgical palliation of unresectable periampullary neoplasms? *J Surg Oncol* 2004; **88**: 206-209
  - 13 **Miniello S**, Testini M, Piccinni G, D'Abbicco D, Amoruso M, Cristallo G, Bonomo GM. [The role of palliation in periampullary tumors in the elderly] *Ann Ital Chir* 2003; **74**: 251-254
  - 14 **Urbach DR**, Bell CM, Swanstrom LL, Hansen PD. Cohort study of surgical bypass to the gallbladder or bile duct for the palliation of jaundice due to pancreatic cancer. *Ann Surg* 2003; **237**: 86-93
  - 15 **Shepherd HA**, Royle G, Ross AP, Diba A, Arthur M, Colin-Jones D. Endoscopic biliary endoprosthesis in the palliation of malignant obstruction of the distal common bile duct: a randomized trial. *Br J Surg* 1988; **75**: 1166-1168
  - 16 **Smith AC**, Dowsett JF, Russell RC, Hatfield AR, Cotton PB. Randomised trial of endoscopic stenting versus surgical bypass in malignant low bileduct obstruction. *Lancet* 1994; **344**: 1655-1660
  - 17 **van den Bosch RP**, van der Schelling GP, Klinkenbijl JH, Mulder PG, van Blankenstein M, Jeekel J. Guidelines for the application of surgery and endoprosthesis in the palliation of obstructive jaundice in advanced cancer of the pancreas. *Ann Surg* 1994; **219**: 18-24
  - 18 **Bornman PC**, Harries-Jones EP, Tobias R, Van Stiegmans G, Terblanche J. Prospective controlled trial of transhepatic biliary endoprosthesis versus bypass surgery for incurable carcinoma of head of pancreas. *Lancet* 1986; **1**: 69-71
  - 19 **Speer AG**, Cotton PB, Russell RC, Mason RR, Hatfield AR, Leung JW, MacRae KD, Houghton J, Lennon CA. Randomised trial of endoscopic versus percutaneous stent insertion in malignant obstructive jaundice. *Lancet* 1987; **2**: 57-62
  - 20 **Cotton PB**. Endoscopic methods for relief of malignant obstructive jaundice. *World J Surg* 1984; **8**: 854-861
  - 21 **Taylor MC**, McLeod RS, Langer B. Biliary stenting versus bypass surgery for the palliation of malignant distal bile duct obstruction: a meta-analysis. *Liver Transpl* 2000; **6**: 302-308
  - 22 **Samet J**, Hunt WC, Key C, Humble CG, Goodwin JS. Choice of cancer therapy varies with age of patient. *JAMA* 1986; **255**: 3385-3390
  - 23 **Bakkevold KE**, Kambestad B. Morbidity and mortality after radical and palliative pancreatic cancer surgery. Risk factors influencing the short-term results. *Ann Surg* 1993; **217**: 356-368
  - 24 **Lesurtel M**, Dehni N, Tiret E, Parc R, Paye F. Palliative surgery for unresectable pancreatic and periampullary cancer: a reappraisal. *J Gastrointest Surg* 2006; **10**: 286-291

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