

tions, there was no significant difference in survival between those requiring PD and those not requiring PD. Thus, to achieve R0 resection is an important objective, irrespective of whether or not PD is performed.

Ajisaka et al. [5] and Shchepotin et al. [11] reported that the 5-year survival rates of patients undergoing PD were 35% and 17%, respectively. In a study of 26 patients undergoing PD combined with right hemicolectomy, Yonemura et al. [10] reported that the 5-year survival rate of 13 patients with tumors infiltrating the pancreatic head was 55%. In our series, the 5-year survival rate for such patients was 34.3%. In PD patients without incurable factors, the 5-year survival rate was higher, at 47%, and 4 patients have survived for more than 5 years. Careful application of the PD procedure can achieve improved survival outcome. Kodama et al. [13] and Habu et al. [14] mentioned that a small amount of peritoneal dissemination and limited liver metastasis, respectively, were not contraindications for PD. However, most patients in the present series who had incurable factors died of the disease soon after operation. Incurable factors, such as pN3, positive lavage cytology, peritoneal dissemination, and visceral metastasis, should be regarded as a contraindication for PD.

In summary, the results after PD for patients with advanced gastric cancer with tumors invading the pancreatic head were acceptable from the aspects of morbidity, mortality, and survival benefit. If an R0 resection can be achieved by PD in such patients, this procedure should be performed. Patients with incurable factors should not be considered for PD. The combination of PD and total gastrectomy should be considered with caution.

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Delayed Gastric Emptying after Distal Gastrectomy for Gastric Cancer

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ABSTRACT

Background/Aims: Gastric surgery may potentiate delayed gastric emptying. The aims of the study were to determine the frequency and causes of delayed gastric emptying in patients who had undergone distal gastrectomy for gastric carcinoma and to assess which factors predispose to its development.

Methodology: 209 patients, who had undergone gastrectomy, were evaluated.

Results: Delayed gastric emptying occurred in 4.3% of patients receiving a Billroth-I, and 15.5% of patients receiving a Roux-Y reconstruction ($p=0.01$). The patients who had these consecutive symp-

toms following Roux-Y operation were all clinically diagnosed as having Roux stasis syndrome. The delayed gastric emptying after Roux-Y operation was more frequent in patients receiving extensive lymph node dissection than those receiving conventional dissection ($p<0.05$). The symptoms spontaneously subsided, and postoperative body weight loss was not significant.

Conclusions: In spite of the strong association between delayed gastric emptying and the Roux-Y procedure, it enables a relatively early return to oral intake.

KEY WORDS:

Gastric cancer;
Reconstruction;
Stomach;
Roux-en-Y;
Stasis;
Gastrointestinal surgery

INTRODUCTION

Roux-Y reconstruction of gastrojejunal continuity is an established means of draining the gastric remnant after distal gastrectomy. The main advantage of the Roux-Y operation is that it prevents bile and pancreatic juice from reaching the gastric mucosa, but the gastrojejunostomy may cause the delayed gastric emptying of both solids and liquids, and delayed gastric emptying is part of the so-called Roux-en-Y stasis (Roux stasis) syndrome. This syndrome was described by Mathias *et al.* (1) in 1985, and it was diagnosed based on clinical criteria, which included epigastric fullness, epigastric pain, nausea, and vomiting of food. In the more severe form of the syndrome, weight loss and gastric bezoars may develop. The prevalence of the syndrome has ranged from 10% to 30% (2,3), but the factors leading to its development are not well known. Roux-Y reconstructions have recently been frequently used after gastrectomy for gastric malignant disease, and thus the incidence of delayed gastric emptying has been tending to increase. Once it occurs, patient's QOL is reduced and the hospital stay is prolonged.

The aims of the present study were to determine the frequency of the delayed gastric emptying retrospectively, including the Roux stasis syndrome, in patients who had undergone distal gastrectomy for gastric malignant disease and to identify predisposing factors.

METHODOLOGY

A total of 209 adult patients (134 men and 75 women) with gastric adenocarcinoma underwent dis-

tal gastrectomy during a 3-year period from 1999 through 2001. Mean patient age was 63 ± 12 years (range: 29 to 85 years). According to the 13th edition of the Japanese classification of gastric carcinoma (4), 129 patients (61%) had stage I disease, 21 (10%) had stage II disease, 29 (14%) had stage III disease, and 28 (13%) had stage IV disease. Billroth-I reconstruction was performed in 116 patients (56%), Billroth-II reconstruction in 9 patients (4%), and Roux-en-Y reconstruction after gastrectomy in 84 patients (40%). Fourteen patients were excluded because of major surgical postoperative complications (anastomotic leakage; 4, abdominal abscess; 6, pancreatic fistula; 2, severe pancreatitis, and ileus; 2). Among 209 patients, 18 were diagnosed with delayed gastric emptying based on the criterion that postoperative oral feeding was prohibited because of postprandial pain, nausea, or vomiting and the postoperative hospital stay was more than 25 days. Abdominal X-ray, upper GI series, and endoscopic examinations were performed to rule out other causes that might produce similar clinical symptoms, such as remnant gastritis, anastomotic stricture, and intestinal obstruction.

Endotracheal anesthesia and a standard midline laparotomy incision were used for all patients in our institution. The gastroduodenostomy and gastrojejunostomy were performed end-to-end by the Albert-Lembert suture method. The jejunal anastomosis was placed 20cm distal to the gastrojejunal anastomosis in the Roux-en-Y reconstruction and was performed end-to-side by the Albert-Lembert suture method. Main trunk vagal nerve entering the celiac axis was preserved in 28 patients (13%), and vagotomy was per-

TABLE 1 Occurrence of Delayed Gastric Emptying after Distal Gastrectomy

	Roux-en-Y reconstruction	Billroth-I reconstruction
Delayed gastric emptying	13 (15.5%)*	5 (4.3%)
No delayed gastric emptying	71 (84.5%)	111 (95.7%)

* $p=0.01$, compared to Billroth I reconstruction. Values in parentheses are percentages.

formed in the other 181 patients (87%) for subtotal gastrectomy and lymph node dissection.

Gastric tumors located in the lower third or the lower two thirds of the stomach were treated by distal or subtotal gastrectomy. Although D1-2 lymphadenectomy as defined in the 13th edition of the Japanese classification (4) was the standard dissection, D1 meant dissecting para-gastric nodes (#1, 3, 4, 5, and 6), and D2 dissecting the nodes along the left gastric artery (#7), the nodes along the common hepatic artery (#8), and the nodes around the celiac artery (#9) in addition to D1 lymphadenectomy. D3 lymphadenectomy meant dissecting the hepatoduodenal nodes (#12b/p), retropancreatic nodes (#13), those along the superior mesenteric vein (#14v), and para-aortic nodes between the level of the celiac axis and the inferior mesenteric artery (#16a2/b1) in addition of standard D2 lymphadenectomy. D0 or D1 lymph node dissection was performed in 63 patients (30%) in the present study, D2 dissection in 111 patients (53%), and D3 dissection in 29 patients (14%).

The following were evaluated: operative details, methods of reconstructions after gastrectomy, stage, extent of lymph node dissection, truncal vagotomy, operation time, operative blood loss, postoperative course, interval between operation and cessation of oral feeding because of the symptoms of delayed gastric emptying, length of hospital stay, patient backgrounds (diabetic gastroparesis, preoperative pylorus stenosis), and body weight loss between before the operation and a month after discharge.

Roux-Y stasis syndrome was diagnosed mainly on the basis of clinical criteria (1,5), which included food vomiting and presence of two of the three following conditions at the time of follow-up after distal gastrec-

tomy with Roux-en-Y reconstruction: postprandial pain, postprandial nausea, and absence of bile vomiting. Although anastomotic stricture and intestinal obstruction were excluded as causes of the Roux-Y stasis syndrome by endoscopic examinations or upper GI series, anastomotic ulceration was included.

Student's t test and the χ^2 test were used for univariate analyses where appropriate to assess differences between groups. Multivariate analyses were performed by using a Cox hazards model. P values <0.05 were considered to indicate statistical significance. All data are expressed as means \pm standard error of the mean (SEM).

RESULTS

In 1999, 55 patients (76%) underwent Billroth-I reconstruction and 17 patients (24%) underwent Roux-en-Y reconstruction after distal gastrectomy, in 2000, 38 patients (59%) underwent Billroth-I and 26 patients (41%) underwent Roux-en-Y, and in 2001, 23 patients (36%) underwent Billroth-I and 41 patients (64%) had the Roux-en-Y. A total of 116 patients (58%) underwent Billroth-I reconstruction following gastric cancer resection and 84 patients (42%) underwent Roux-en-Y reconstruction. The rate of Roux-Y reconstruction increased from 24% to 64%. Operation time was 274 ± 71 minutes, and intraoperative blood loss was 535 ± 375 grams in the 84 patients with Roux-en-Y reconstruction.

Postoperatively delayed gastric emptying occurred in 5 patients (4.3%) after Billroth-I reconstruction, and 13 patients (15.5%) after Roux-en-Y reconstruction ($p=0.01$) (Table 1). The postoperative hospital stay of the 5 patients with delayed gastric emptying after Billroth-I reconstruction was 36.4 ± 12.1 days, and the postoperative day (POD) when oral feeding was stopped because of the symptoms of obstruction was 16.6 ± 6.2 (Table 2). According to the clinical criteria, the 13 patients (8 men and 5 women, mean age was 61 ± 12 years old) with Roux-en-Y delayed gastric emptying all met the clinical criteria for Roux-Y stasis syndrome (Tables 2 and 3). Six (46%) of these 13 patients who had delayed emptying symptoms after Roux-en-Y reconstruction had stage I disease according to the 13th edition of Japanese classification of

TABLE 2 Clinical Features of Patients with Delayed Gastric Emptying after Distal Gastrectomy

	Roux-en-Y reconstruction (n=13)	Billroth-I reconstruction (n=5)
Postoperative hospital stay (days)	42.5 ± 11.8 (25-64)	36.4 ± 12.1 (25-54)
Postoperative day when oral feeding was stopped (day)	$9.9 \pm 2.8^*$ (5-15)	16.6 ± 6.2 (10-26)
Postoperative day when oral feeding was restarted (day)	26.0 ± 9.5 (14-46)	25.6 ± 9.6 (17-41)
Met the clinical criteria for R-Y stasis syndrome (number of patients)	13	-
Upper gastrointestinal series findings (number of patients)	Congestion at residual stomach: 8/9	Congestion at residual stomach: 3/3
Endoscopic findings (number of patients)	Anastomotic edema: 6/8 Anastomotic ulceration: 3/8 Bile reflux in stomach: 0/8	Anastomotic edema: 3/3 Anastomotic ulceration: 0/3 Bile reflux in stomach: 0/3

* $p=0.07$, compared to Billroth-I reconstruction. Values in parentheses are ranges.

gastric carcinoma (4), and 7 (54%) had stage II, III, and IV disease. D0 or D1 lymphadenectomy was performed in 2 patients (15%), D2 lymphadenectomy in 5 patients (38%), and D3 lymph node dissection in 6 patients (46%). The operation time was 285±74 minutes, and the operative blood loss was 517±386mL (Table 3). Delayed gastric emptying prolonged the postoperative hospital stay to 42.5±11.8 days. Oral feeding was stopped because of obstructive symptoms on 9.9±2.8 POD (Table 2), and restarted on 26.0±9.5 POD. Upper gastrointestinal series (performed in 9 cases), endoscopy (performed in 8 cases), or both showed that 6 patients had jejunal-mucosal edema at the anastomosis, and 3 of the 13 patients who had the delayed gastric emptying after a Roux-Y operation had ulceration on the proximal side of the anastomosis (Table 2). Moreover, no patients had bile reflux in the stomach remnant. Among the 5 patients who had delayed gastric emptying following the Billroth-I operation, postoperative endoscopy (performed in 3 patients) showed that 3 patients had anastomotic edema and none had anastomotic ulceration (Table 2). All 13 patients after Roux-Y gastrectomy were able to restart oral feeding by 46 POD, and they were discharged from hospital without their symptoms. They did not have significant postoperative body weight loss a month after discharge, compared with the group without delayed gastric emptying following a Roux-en-Y operation (Table 3).

The analysis to identify factors predisposing to delayed gastric emptying after Roux-en-Y reconstruction revealed that delayed gastric emptying was more common in the D3 lymph node dissection group than in the D0-2 dissection group ($p=0.004$) by univariate and multivariate analysis (Tables 3 and 4). Patient gender, age, stage, truncal vagotomy by sectioning the main nerves entering the celiac axis, operation time, intraoperative blood loss, and preoperative status were not significantly associated with the development of delayed gastric emptying. The postoperative hospital stay of the patients with delayed gastric emptying was much longer than that of the patients who did not have delayed emptying (Table 3). Moreover, when the 3 cases with anastomotic ulceration were excluded from the 13 cases with delayed gastric emptying after Roux-en-Y reconstruction, the remaining 10 patients were considered to have developed "Roux stasis syndrome". Comparison of these 10 patients with the other 71 cases revealed that postoperative delayed emptying was also more common in the D3 lymph node dissection group than in the D0-2 dissection group ($p=0.027$).

DISCUSSION

Gastric surgery may potentiate or induce delayed gastric emptying and result in chronic gastroparesis (6). Since the changes in gastric emptying following the various forms of vagotomy, drainage procedures, gastric resection, and the several methods of gastrointestinal reconstruction have been discussed previously, further discussion is unnecessary other than to emphasize the increased postoperative risk of delayed

TABLE 3 Characteristics of Patients with Delayed Gastric Emptying after Distal Gastrectomy with Roux-en-Y Reconstruction

	Delayed gastric emptying (n=13)	No delayed gastric emptying (n=71)
Sex (male/female)	8/5	50/21
Age (years)	61±12	63±11
Stage (I/II-IV)	6/7	26/45
Operation time (min)	285±74	268±67
Operative blood loss (mL)	517±386	510±356
Truncal vagotomy (-/+*)	2/11	11/60
Lymph node dissection (D0-2/D3)	7/6*	62/9
Diabetes	2	5
Preoperative pyloric stenosis	0	3
Postoperatively hospital stay (days)	42.5±11.8**	19.9±5.3
Body weight loss*** (kg)	7.3±4.2	5.6±2.3

* $p=0.004$; ** $p<0.05$, compared to "No delayed gastric emptying"; *** Body weight loss between before the operation and one month after discharge;#Vagotomy -: gastrectomy without truncal vagotomy; vagotomy +: gastrectomy with truncal vagotomy.

TABLE 4 Delayed Gastric Emptying Factors after Roux-en-Y Gastrectomy on Multivariate Analysis

Parameters	P value	Hazard ratio	95% Confidence interval
Stage (I vs. II-IV)	0.051	9.60	0.989-93.183
Vagotomy (- vs. +*)	0.688	0.68	0.105-4.412
Lymph node dissection (D0-2 vs. 3)	0.004	0.03	0.002-0.313
Diabetes (- vs. +**)	0.403	2.5	0.292-21.403

P values were calculated using a Cox hazard model; *Vagotomy -: gastrectomy without truncal vagotomy; vagotomy +: gastrectomy with truncal vagotomy; **Diabetes -: had not diabetes; diabetes +: had diabetes.

gastric emptying in predisposed persons. Patients with obstructive ulcer disease have been reported to be at increased risk of postoperative gastric atony (7). The prevalence of delayed gastric emptying after gastrectomy has been reported to range from 5% to 30% (2,3,5,8). Delayed gastric emptying has also been reported to continue to affect a considerable number of patients (24%) after gastric surgery and be particularly common in patients with diabetes, malnutrition, and gastric or pancreatic cancer (8). In this study, Roux-en-Y reconstruction after gastric cancer resection caused significantly more delayed gastric emptying than Billroth-I reconstruction. The clinical features of patients showing delayed emptying, such as postoperative hospital stay, the days when oral feeding was stopped and restarted, and upper GI series findings did not differ according to whether a Billroth-I or Roux-en-Y operation had been performed. Other factors may cause delayed gastric emptying after Roux-en-Y operations.

The Roux-en-Y operation is reported to be superior to either Billroth I or II reconstruction for preventing bile reflux into gastric remnant and gastritis (9,10) and to prevent carcinoma of the remnant stomach (11). Moreover, Roux-en-Y reconstruction is supposed to cause anastomotic leakage rarely, compared to Billroth-I reconstruction. From these points of view, we

frequently have used Roux-en-Y reconstruction after subtotal distal gastrectomy in recent years. However, the gastrojejunostomy may cause delayed gastric emptying of both solids and liquids. Mathias *et al.* (1) called attention to the characteristic clinical syndrome of abdominal pain, nausea, and vomiting made worse by eating after a Roux-en-Y operation. Many investigators proposed that the Roux-en-Y limb acted as a functional obstruction and caused the clinical symptoms (R-Y stasis syndrome) of abdominal pain, nausea, and vomiting, especially after eating (1,2,3,5). In the majority of patients, symptoms subside with time. Van der Mijle and coworkers (12) further characterized this syndrome in a larger group of patients who had undergone Roux-en-Y gastrojejunostomy. Gastric emptying and Roux limb transit were studied by a radionuclide test, and motility disorders of the Roux limb were further evaluated by manometry. The results suggested that the Roux-Y stasis syndrome had a shared origin, with some patients experiencing delayed gastric emptying related to vagotomy and others having disorders in Roux limb transit secondary to motility abnormalities.

Two major hypotheses have been proposed to explain the cause of the Roux stasis syndrome (5). According to the first hypothesis, the gastric remnant produces acid that passes into the Roux-Y limb and disturbs its motility. The acid is probably poorly buffered by alkaline secretions in the proximal part of the Roux-Y limb. The second hypothesis is that the Roux-Y limb itself causes functional obstruction of the gastric outlet. A long limb clearly is a barrier against reflux, but Gustavsson *et al.* (5) reported that there is a risk of Roux-Y stasis syndrome when the limb is made too long. In addition, Miedema and Kelly (13) found that separation of the Roux limb from the duodenal pacemaker (14) by jejunal transection allowed ectopic pacemakers to arise in the Roux limb and drive contractions orad. However, some investigators found normal motor activity in the Roux limb of patients who underwent reconstruction after gastrectomy (15). Moreover, though concomitant vagal denervation of the distal stomach by truncal or selective vagotomy may interfere with the antropyloric pump mechanism and slow gastric emptying of solids, our study showed that truncal vagotomy is not significantly associated with the development of the Roux-Y delayed gastric emptying.

Delayed gastric emptying occurring in the early postoperative period is generally thought to spontaneously resolve within 6 weeks of the operation, and the temptation to reoperate on a nonobstructive stomach should be avoided (6,8). Various prokinetic agents have been tested as means of enhancing gastric emptying of solids after Roux-en-Y reconstruction, including bethanechol chloride (16), metoclopramide (8,17), cisapride (18), ondansetron (19) (the potent 5-hydroxytryptamine-3 receptor antagonist), and erythromycin lactobionate (20), as a motilin agonist, could be useful agents in stasis patients, but the long-term results are still unknown. In our study, the delayed gastric emptying that occurred in the early postoperative period spontaneously resolved within 46 days of the operation without use of any therapeutic agents. The uncut Roux-en-Y gastrojejunostomy has been reported to be an attractive alternative to distal gastrectomy because ectopic pacemaker potentials and potential motor abnormalities in the Roux limb have been found to be suppressed, at least in a dog model (12,13,21). Evidence to document the clinical efficacy of the uncut Roux-en-Y gastrojejunostomy, however, is lacking.

Our data showed that the Roux-en-Y operation delayed gastric emptying and that the Roux stasis syndrome, after excluding the cases with anastomotic ulceration, occurred significantly more frequently in the extended D3 lymph node dissection group than in the conventional D0-2 dissection group. Distal gastrectomy with extended lymphadenectomy, such as D3 dissection, actually requires truncal vagotomy and may interrupt lymph flows, especially around the celiac axis and abdominal aorta. Although our study showed that truncal vagotomy is not significantly associated with the development of Roux-Y delayed emptying, the interruption of lymph flow may cause edema of the intestine and mesentery, and the edema may affect the Roux limb and anastomosis. Although Roux-en-Y reconstruction following distal gastrectomy with extended lymphadenectomy may cause delayed gastric emptying and prolong postoperative hospital stay, the symptoms subsided spontaneously within 7 weeks of the operation, and postoperative body weight loss was not significant. In spite of the strong association between delayed gastric emptying and the Roux-en-Y operations for gastric cancer, it enables a relatively early return to oral intake.

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Original article

Risk factors for pancreas-related abscess after total gastrectomy

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Abstract

Background. European clinical trials of gastrectomy have shown that pancreas-related complications are the major cause of mortality. The aim of this study was to determine the risk factors for pancreas-related abscess after gastrectomy and to evaluate the effects of the abscess on postoperative mortality.

Methods. Between 1992 and 1999, 663 consecutive patients with gastric carcinoma underwent total gastrectomy. Data from these patients were analyzed, to identify the predictors of pancreas-related abscess caused by pancreatic juice leakage, by a multiple logistic regression model.

Results. On multivariate analysis, increasing age ($P = 0.018$) and body mass index ($P = 0.006$) were independent preoperative risk factors. Dissection along the distal splenic artery was an intraoperative risk factor. The hazard ratios were increased 9.13-fold ($P = 0.000$) with a pancreas-preserving operation and 16.72-fold ($P = 0.000$) by distal pancreatectomy. Patients with the abscess had a higher postoperative mortality rate ($P = 0.008$), and a higher re-operation rate ($P < 0.001$) than patients without the abscess.

Conclusion. Pancreas-related abscess is more likely to occur in older, obese patients undergoing node dissection along the distal splenic artery. Abscess formation is associated with a higher mortality and re-operation rate. Spleen preservation should be evaluated in Japan.

Key words Gastric cancer · Morbidity

Introduction

The most frequent major complication after gastrectomy with extended dissection is pancreatic juice leakage [1], because recently, the incidence of anastomotic

leakage has decreased remarkably [2]. Pancreatic juice leakage is often followed by contamination, resulting in a peripancreatic abscess. Secondary hemorrhage from major arteries damaged by contamination can be fatal. European clinical trials of gastrectomy have shown that pancreas-related complications are a major cause of mortality [3,4].

The prediction and early detection of pancreas-related complications may be helpful. The aim of this study was to determine risk factors for pancreas-related abscess after gastrectomy, caused by pancreatic juice leakage, and to evaluate the effects of the abscess on postoperative mortality.

Patients and methods

Six hundred and sixty-three consecutive patients with gastric carcinoma underwent total gastrectomy, between 1992 and 1999, at the National Cancer Center Hospital, Tokyo. Data for these patients were analyzed to identify the predictors of pancreas-related abscess caused by pancreatic juice leakage, using a multivariate logistic regression model.

The diagnosis of a pancreas-related abscess was made when purulent fluid containing turbid necrotic debris drained from the peripancreatic area for more than 7 days. The abscess cavity was assessed by computed tomography (CT) scan and contrast study through drains. We recorded an abscess regardless of its cavity size. When we found anastomotic leakage radiologically on initial diagnosis of the abscess, we excluded these patients from the pancreas-related abscess group.

The preoperative and perioperative data were collected from the patients' records and stored on our gastric surgical database.

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Operative techniques

Total gastrectomy with Roux-en-Y esophagojejunostomy was performed in 623 patients (94.0%), as the standard operation. Forty patients (6.0%) underwent jejunal interposition. Pouch formations were added in 7 patients (1.1%). The extent of nodal dissection along the distal splenic artery and splenic hilum varied, including no dissection of these nodes. Distal pancreatectomy or the Maruyama pancreas-preserving method [5] was usually performed for advanced tumor (T2, T3, and T4). The splenic arteries were sacrificed distally to the dorsal pancreatic arteries, in all patients, when we performed pancreas-preserving total gastrectomy. At least one drainage tube was applied in the left subphrenic space in all patients. In most cases, the amylase level of the drainage fluid was determined on the first postoperative day. All patients received antibiotic prophylaxis for the same period.

Statistical methods

Univariate analyses were performed in order to predict those preoperative and perioperative variables that were associated with a pancreas-related abscess. Fischer's exact test and the Mann-Whitney test were used as appropriate.

To develop a model for predicting postoperative pancreas-related abscess in terms of pre- and perioperative variables, three preoperative and six perioperative variables were entered in multiple logistic regression analysis. All the statistical procedures were performed with the SPSS 11.5 statistical package (SPSS Japan, Tokyo, Japan). The limit for statistical significance was $P < 0.05$.

Results

The overall incidence of pancreas-related abscess was 11.5%. The median amylase level of the drainage fluid on the first postoperative day was 1942 I/l (range, 22–387 000) U/l overall, and it was 1682 (22–303 800) U/l in patients without abscess and 6590 (96–387 000) U/l in patients with abscess.

The male-to-female ratio was 2.5:1, and the mean age was 59.9 ± 11.6 years. The proportion of patients with early gastric cancer (T1) was 21.1%. Operation with curative intent was performed in 82.5% of the patients. Nodal dissection along the distal splenic artery was performed in 68.0% of the patients and D2 dissection or more was carried out in 67.6% of the patients. The median operation time was 263 min (90–580 min). Median blood loss was 567 ml (250–4457 ml).

Univariate analysis identified several preoperative patient-related factors as having a high association with pancreas-related abscess. The preoperative demographic data are shown in Table 1, for patients with and without the abscess. Increasing age ($P = 0.004$) and increasing body mass index ($P = 0.008$) had a strong association with postoperative pancreas-related abscess.

Perioperative data are also presented in Table 1. Univariate analysis showed that depth of tumor invasion ($P = 0.007$), operation time ($P = 0.024$), extent of dissection ($P = 0.000$), and dissection along the distal splenic artery ($P = 0.000$) were all associated with a greater incidence of abscess formation. The method of dissection along the distal splenic artery was categorized into one of five variations.

Multivariate analysis identified three independent factors as predictors of postoperative pancreas-related abscess formation (Table 2). Increasing age and increasing body mass index increased the risk of the abscess by 1.4- and 1.1-fold, respectively.

Dissection of nodes along the distal splenic artery and in the splenic hilum was an intraoperative risk factor. If the relative risk for the abscess was set at 1 for patients with neither splenectomy nor pancreatectomy, the hazard ratios were 9.1 for pancreas-preserving operation and 16.7 for distal pancreatectomy.

The postoperative outcomes of the patients with and without pancreas-related abscess were compared (Table 3). The patients with the abscess had a higher postoperative mortality rate. Patients with pancreas-related abscess had 7.6-fold increased mortality compared to patients without the abscess. The re-operation rate for patients with pancreas-related abscess was 32-fold greater than that for patients without the abscess.

Discussion

Increasing body mass index increases the risks of pancreas-related abscess. The literature also reports fat volume as being a risk factor in increasing postoperative complications [6,7]. Nodal dissection along the distal pancreas and in the splenic hilum in obese patients is a difficult task, even in the hands of experienced surgeons specializing in the treatment of gastric carcinoma.

Patients in the West usually have a higher body mass index than those in Japan [8]. The observed high morbidity rates in Western randomized trials for D2 dissection may be related to the greater obesity of these patients.

Increasing age also increases the risk of abscess formation. Patients in the West receiving gastrectomies are usually older than those in Japan, as well as having a

Table 1. Univariate analysis of variables associated with pancreas-related abscess

	No abscess (n = 587)	Abscess (n = 76)	P value; patients with vs without abscess	
Preoperative variables				
Sex				
Male	413 (87.1%)	61 (12.9%)	0.080	
Female	174 (92.1%)	15 (7.9%)		
Age (years)	59.5 (22–91) ^a	62.8 (44–84) ^a	0.004	
Body mass index (kg/m ²)	21.7 (12.2–37.7) ^a	22.6 (15.0–31.5) ^a	0.008	
Perioperative variables				
Depth of tumor invasion				
Early (T1)	133 (95.0%)	7 (5.0%)	0.007	
Advanced (T2, T3, T4)	454 (86.8%)	69 (13.2%)		
Curability of operation				
Curative (R0)	480 (87.8%)	67 (12.2%)	0.200	
Noncurative (R ≥ 1)	107 (92.2%)	9 (7.8%)		
Operation time (min)	260 (90–580) ^a	286 (140–540) ^a	0.024	
Blood loss (ml)	565 (25–3776) ^a	587.5 (70–4457) ^a	0.123	
Extent of dissection				
D0, D1	207 (96.3%)	8 (3.7%)	0.000	
D2, D3	380 (84.8%)	68 (15.2%)		
Dissection methods for nodes along the distal splenic artery				
	Splenectomy	Distal pancreatectomy	Dissection along distal splenic artery	
1.	No	No	No	155 (98.1%)
2.	Yes	No	No	49 (90.7%)
3.	No	No	Yes	10 (83.3%)
4.	Yes	No	Yes	309 (86.3%)
5.	Yes	Yes	Yes	64 (79.0%)
				3 (1.9%)
				5 (9.3%)
				2 (16.7%)
				49 (13.7%)
				17 (21.0%)

Splenectomy (yes), pancreatectomy (no), dissection along distal splenic artery (yes) indicates pancreas-preserving total gastrectomy method

^aMedian values, with ranges in parentheses

Table 2. Multivariate predictors of pancreas-related abscess

Variables	P value	Odds ratio	95% Confidence interval of odds ratio	
Preoperative variables				
Age (continuous)	0.018	1.414	1.060–1.886	
Body mass index (continuous)	0.006	1.126	1.035–1.225	
Perioperative variables				
Dissection methods for nodes along the distal splenic artery				
	Splenectomy	Distal pancreatectomy	Dissection along distal splenic artery	
1.	No	No	No	1
2.	Yes	No	No	0.012
3.	No	No	Yes	0.011
4.	Yes	No	Yes	0.000
5.	Yes	Yes	Yes	0.000
				6.601
				11.973
				9.130
				16.724
				1.505–28.953
				1.760–81.468
				2.791–29.864
				4.675–59.823

Table 3. Relationship of postoperative events to pancreas-related abscess

Variables	No abscess (n = 587)	Abscess (n = 76)	P value
Re-operation	4 (0.7%)	17 (22.4%)	< 0.001
Operation-related death	4 (0.7%)	4 (5.3%)	0.008

higher body mass index [9,10]. The observed high morbidity rates in Western trials were related to the age distribution [11], similar to our findings here.

Our study shows that the dissection of nodes alongside the distal splenic artery and nodes in the splenic hilum is an intraoperative risk factor. Distal pancreatectomy with splenectomy had the highest odds ratio. However, even when we performed pancreas-preserving total gastrectomy to avoid pancreas-related complications, there was still a considerably higher odds ratio of abscess formation. Pancreas-preserving splenectomy is part of the standard operation in specialized centers in Japan. Splenectomy without dissection along the distal splenic artery also had a high risk of abscess formation.

Japanese retrospective studies have shown that 20%–30% of patients with advanced cancer in the proximal stomach have nodal metastasis in the splenic hilum, and that gastrectomy with resection of these nodes can yield a 5-year survival of 20%–25% [12]. Consequently, in Japan, dissection of nodes in these areas is performed routinely.

Although mortality rates from gastrectomy complicated by pancreas-related abscess are lower in Japan than those reported in Western series [3,4], pancreas-related abscess formation remains a strong factor in the mortality and morbidity rates in both Japanese and Western centers.

Evaluation of the role of splenectomy for proximal gastric cancer is important. Spleen preservation, avoiding thorough nodal dissection in the splenic hilum as well as in the distal splenic artery, as described by groups in the United Kingdom [13,14], should be evaluated in Japan. The Japan Clinical Oncology Group have recently started a randomized controlled trial to evaluate the effect of splenectomy on postoperative morbidity and longterm cancer-free survival [15].

Conclusions

Pancreas-related abscess after gastrectomy is more likely to occur in older, obese patients undergoing node dissection along the distal splenic artery. Because the abscesses are associated with high mortality and reoperation rates, the role and oncologic value of splenec-

tomy has to be considered more carefully. This now forms the basis of a nationwide trial.

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From a new Editor-in-Chief

An international forum for discussion of gastric cancer is needed, particularly now

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Gastric cancer may or may not be changing. According to the estimate by the International Agency for Research on Cancer, the worldwide incidence of gastric cancer in 2002 was 933,937, of which no less than 56% of cases were from East Asia (China, Japan, and Korea) alone. Interestingly, gastric cancer in this high-incidence area is not, or only very slowly, undergoing the phenomenon of “proximal shift” of tumors, which today is a definite trend in gastric cancer in the West. The difference between East and West in terms of tumor biology as well as treatment modality seems to be becoming greater over the years. Now many physicians and

researchers in both hemispheres are wondering if they are fighting against the same disease that the other side is.

In such a situation, the role of the International Gastric Cancer Association (IGCA) is particularly important. It provides opportunities for worldwide specialists to meet and discuss the disease. Our journal, *Gastric Cancer*, should also be a forum for global discussion as the only international journal specialized in this malignancy.

Since its first publication in 1998, *Gastric Cancer* has maintained some unique features as the joint official journal of IGCA and the Japanese Gastric Cancer Association (JGCA). The editorial board consists of the same number of members from both associations, and any submitted manuscript is reviewed by a team composed of referees from both associations. Even the position of Editor-in-Chief has been shared; Professor J. Rüdiger Siewert from IGCA and Dr. Oichiro Kobori from JGCA formed a good partnership to develop a high-quality peer-review system.

Now I have succeeded Dr. Kobori to undertake the JGCA's part as an Editor-in-Chief. My task is clear: to further expand the journal's scope as a forum for global discussion and to enhance the journal's status in the field of oncology.

Both Professor Siewert and I are surgeons. Approximately 80% of the JGCA and IGCA members are also surgeons. However, our journal is not a surgical journal. Our editorial board has prominent medical oncologists and scientists to welcome any category of papers related to gastric cancer. Our goal is comprehensive understanding and consequent conquest of gastric cancer.

In 2004, a total of 1,450 English papers having the keyword “stomach neoplasms” were published, according to the PubMed database. Of these, 513 papers (35.4%) were from Japanese institutions or had at least one Japanese author. Considering the high incidence of

the disease in Japan, this high proportion is understandable. *Gastric Cancer* is a quarterly journal, and we published 41 papers in 2004. This accounted only for 2.8% of the above-mentioned 1,450, and I would aim at doubling this within 3 years. Of all 268 papers published in volumes 1 to 7 of *Gastric Cancer*, 207 (77.2%) were from Japanese institutions. Although this high proportion is due largely to the fact that the membership ratio of JGCA to IGCA is 6 to 1, I hope we will receive more papers from outside Japan to make our journal a truly international forum.

As a gastric surgeon, I have visited 22 countries either for giving lectures or live demonstrations of surgery. As a host at the National Cancer Center Hospital, Tokyo, I have received visitors from an additional 21 countries and had intensive discussions with all of them. I believe I am part of a global network of gastric cancer specialists, on a personal level, and I intend to make full use of that network to increase the value of the journal.

Dear colleagues: Please do not hesitate. You have good reasons to write papers for *Gastric Cancer*:

1. Your paper will be sent directly to 6,000 worldwide specialists of gastric cancer.
2. The abstract of your paper is immediately listed in Medline and PubMed.
3. The PDF file of your paper is uploaded on the Springer website and can be downloaded through their 4,500 worldwide access sites in addition to downloading by our 6,000 subscribers.
4. Your paper may be selected for the Nishi Award of the JGCA (the best three papers each year) and you will be awarded US\$2,000.

I am looking forward to your participation in this international forum for gastric cancer.

Takeshi Sano
Editor-in-Chief

Identification of risk factors for the development of complications following extended and superextended lymphadenectomies for gastric cancer

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Background: Extended lymphadenectomy for gastric carcinoma has been associated with high mortality and morbidity rates in several multicentre randomized trials.

Methods: Using data from 523 patients registered for a prospective randomized trial comparing extended (D2) and superextended (D3) lymphadenectomies, risk factors for overall complications and major surgical complications (anastomotic leakage, intra-abdominal abscess and pancreatic fistula) were identified by multivariate logistic regression analysis.

Results: Mortality and morbidity rates were 0.8 per cent (four of 523) and 24.5 per cent (128 of 523) respectively. Pancreatectomy (relative risk 5.62 (95 per cent confidence interval (c.i.) 1.94 to 16.27)) and prolonged operating time (relative risk 2.65 (95 per cent confidence interval 1.34 to 5.23)) were the most important risk factors for overall complications. A body mass index of 25 kg/m² or above, pancreatectomy and age greater than 65 years were significant predictors of major surgical complications.

Conclusion: Pancreatectomy should be reserved for patients with stage T4 disease. Age and obesity should be considered when planning surgery.

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Introduction

Despite a declining incidence in Western Europe¹ and the USA², gastric carcinoma remains the second commonest cause of cancer death worldwide, with over 600 000 deaths per year³. Given the poor outcome of irresectable disease treated by other therapeutic modalities in phase II and III trials^{4,5}, the curative treatment of gastric carcinoma remains primarily surgical. Although the presence of distant metastases usually precludes curative surgery, this does not necessarily apply to disease in the regional lymph nodes, which can be dissected *en bloc* with the primary lesion^{6,7}. This type of resection may allow cure, provided that metastases are within the margins of dissection. Removal of a wider range of lymph nodes by extended lymph node dissection might increase the

chance of cure, but is inappropriate if the cancer has spread systemically.

In Japan, gastrectomy plus extended systematic lymphadenectomy (D2 resection) has long been the standard treatment, even for superficial cancers⁸. Success with D2 resection has led to the evolution of a superextended lymphadenectomy (D3 resection) and several feasibility studies evaluating dissection of para-aortic lymph nodes have been performed⁹⁻¹². A randomized trial (Japan Clinical Oncology Group (JCOG) 9501) was launched in 1995, primarily to explore the potential survival benefit of D3 over D2 dissection¹³. This trial has provided the opportunity to evaluate prospectively collected data on gastric cancer surgery in Japan. The present study represents a detailed analysis of risk factors for overall and surgical complications following D2 and D3 resections.

Patients and methods

Between June 1995 and April 2001, 523 patients registered in the JCOG 9501 study were allocated randomly to either D2 (263 patients) or D3 (D2 plus para-aortic lymph node dissection; 260 patients) resection. Eligibility criteria and the method of randomization have already been reported in detail¹³. In brief, patients aged less than 75 years of age with histologically proven and resectable primary gastric carcinoma with an estimated depth of SS (penetrating the muscle layer), SE (penetrating the serosa) or SI (invasion to an adjacent organ) were recruited after giving informed consent. Patients found positive for free cancer cells by cytological examination of peritoneal washes and those with Borrmann type 4 tumours (linitis plastica type) were excluded. Twelve institutions participated in the trial initially and 12 other institutions were added to increase patient recruitment.

After laparotomy, cytological examination of peritoneal washes was performed, followed by gross examination of the abdominal cavity and the primary lesion. Only patients who were negative for free cancer cells in the abdominal cavity and without evidence of gross para-aortic lymph node spread, peritoneal carcinomatosis or other distant metastasis were eligible to participate. The patients were allocated randomly to either D2 or D3 resection by the minimization method of balancing the groups according to T stage (T2 *versus* T3/T4), gross appearance (Borrmann types 1 and 2 *versus* Borrmann types 3 and 5) and institution. The surgeons were notified immediately of the allocation results and completed the operation accordingly.

Patients underwent appropriate gastrectomy with systematic lymphadenectomy as allocated. Perigastric lymph nodes (nodal stations 1, 3, 4, 5 and 6 according to the Japanese Classification of Gastric Cancer¹⁴) and nodes at the base of the left gastric artery (7), along the common hepatic artery (8) and at the base of the splenic artery (11) were resected routinely. Lymph nodes along the hepatoduodenal ligament and behind the pancreatic head (12 and 13) were resected when the primary lesion was located in the lower third of the stomach. Lymph nodes along the left side of the cardia (2), within the splenogastric ligament (4sa) and at the splenic hilum (10) were resected with the spleen when total or proximal gastrectomy was performed. Concurrent resection of the pancreatic tail was not routine during either D2 or D3 resection and was reserved for patients with direct invasion to the pancreas. In patients randomized to superextended lymphadenectomy, para-aortic lymph nodes from the level of the coeliac trunk down to the root of the inferior mesenteric artery (16a2 and 16b1) were dissected. The mode of reconstruction following resection was not specified.

All information on complications was extracted from the case-report forms for the trial. Anastomotic leakage, intra-abdominal abscess and pancreatic fistula were considered to be major surgical complications. Anastomotic leakage was defined as dehiscence confirmed by radiographic examination using contrast medium. Pancreatic fistula was diagnosed if there was prolonged purulent discharge containing pancreatic juice from the drainage tube.

Factors that might affect the risk of overall and major surgical complications were evaluated by univariate analysis using cross-tabulations. Variables analysed included extent of lymphadenectomy, splenectomy, pancreatectomy, type of gastrectomy, pathological (p) T category (pT2 and pT3 *versus* pT4), sex, age, body mass index (BMI), operating time, amount of blood loss and need for autologous blood transfusion. Operating time and blood loss were divided into tertiles for analysis. Two factors associated with surgical experience were also evaluated: institutions that enrolled over 20 patients *versus* those with fewer patients and first and second halves of the trial (1995–1998 *versus* 1999–2001). The χ^2 test was used to assess differences in proportions. The independent contribution of various factors was assessed by multivariate logistic regression analysis, with mutual adjustment of potential risk factors for complications. All factors analysed in the univariate analysis were included as variables in the multivariate analysis. Two-sided *P* values are presented. Statistical analysis was performed using SAS[®] version 8.12 (SAS Institute, Tokyo, Japan).

Results

Total gastrectomy was performed in 199 (38.0 per cent) of 523 patients and proximal gastrectomy in four;

Table 1 Complications

Severe abdominal complications	
Pancreatic fistula	30
Abdominal abscess	29
Anastomotic leakage	11
Other complications	
Pneumonia	16
Anastomotic stenosis	14
Bowel obstruction/ileus	16
Lymphorrhoea	10
Thoracic effusion requiring thoracic drainage	7
Severe feeding problem requiring prolonged hyperalimentation	6
Wound abscess	5
Postoperative bleeding	3
Severe diarrhoea	3
Urinary tract infection	3
Catheter-induced sepsis	3
Pulmonary embolism	2
Cardiac failure	1
Cholecystitis requiring percutaneous drainage	1

the remaining patients underwent distal gastrectomy. Splenectomy was performed in 191 patients (36.5 per cent) and distal pancreatectomy in 22 (4.2 per cent). There was no significant difference in the type of gastrectomy and incidence of combined resection between the two groups. Details of patient demographics and tumour stages have been reported previously¹³.

There were four hospital deaths (0.8 per cent), two in each group. Two patients suffered from rapid disease progression and died 3 and 5 months after

surgery without being discharged from hospital. One patient died from pneumonia at 46 days and another died from massive bleeding from the gastroduodenal artery 24 days after operation. Complications were identified in 128 patients (24.5 per cent) and major surgical complications in 49 patients (9.4 per cent) (Table 1).

The results of univariate analyses of risk factors for overall postoperative complications are summarized in Table 2. Only pancreatic resection ($P = 0.001$) and

Table 2 Univariate and multivariate analysis of risk factors for overall complications

	No. registered	No. with complications	Univariate analysis		Multivariate analysis	
			Relative risk	P	Relative risk	P
Extent of lymphadenectomy						
D2	263	55	1		1	
D3	260	73	1.48 (0.99, 2.21)	0.057	0.93 (0.58, 1.51)	0.776
Splenectomy						
No	332	64	1		1	
Yes	191	64	2.11 (1.41, 3.17)	<0.001	2.05 (0.52, 8.01)	0.304
Pancreatectomy						
No	501	115	1		1	
Yes	22	13	4.85 (2.02, 11.63)	<0.001	5.62 (1.94, 16.27)	0.001
Extent of gastrectomy						
Distal	320	62	1		1	
Total or proximal	203	66	2.01 (1.34, 3.00)	<0.001	0.84 (0.22, 3.27)	0.804
Invasion to adjacent organs						
T2, T3	501	123	1		1	
T4	22	5	0.90 (0.33, 2.50)	0.846	0.37 (0.11, 1.24)	0.107
Sex						
M	358	94	1		1	
F	165	34	0.73 (0.47, 1.14)	0.163	0.73 (0.45, 1.19)	0.207
Age (years)						
< 56	160	33	1		1	
56-65	207	48	1.16 (0.70, 1.92)	0.557	1.26 (0.73, 2.17)	0.403
> 65	156	47	1.66 (0.99, 2.77)	0.053	1.63 (0.92, 2.89)	0.092
Body mass index						
< 25	446	101	1		1	
≥ 25	77	27	1.85 (1.10, 3.10)	0.019	1.75 (0.99, 3.08)	0.054
Operating time (min)						
< 240	167	23	1		1	
240-297	179	43	1.98 (1.13, 3.46)	0.016	1.77 (0.96, 3.25)	0.068
> 297	177	62	3.38 (1.97, 5.78)	<0.001	2.65 (1.34, 5.23)	0.005
Blood loss (ml)						
< 395	174	27	1		1	
395-710	174	42	1.73 (1.01, 2.97)	0.045	1.05 (0.58, 1.90)	0.886
> 710	175	59	2.77 (1.65, 4.64)	<0.001	1.11 (0.58, 2.12)	0.754
Blood transfusion						
Yes	408	87	1		1	
No	115	41	2.04 (1.31, 3.20)	0.002	1.53 (0.92, 2.56)	0.102
Case volume*						
< 20	147	41	1		1	
≥ 20	376	87	0.78 (0.51, 1.20)	0.256	0.83 (0.51, 1.34)	0.437
Period						
1995-1998	295	75	1		1	
1999-2001	228	53	0.9 (0.58, 1.33)	0.566	0.87 (0.56, 1.35)	0.539

Values in parentheses are 95 per cent confidence intervals. *No. of patients registered.

Table 3 Univariate and multivariate analysis of risk factors for major surgical complications

	No.	No. with major complications	Univariate analysis		Multivariate analysis	
			Relative risk	P	Relative risk	P
Extent of lymphadenectomy						
D2	263	23	1		1	
D3	260	26	1.16 (0.64, 2.09)	0.623	0.67 (0.32, 1.39)	0.279
Splenectomy						
No	332	20	1		1	
Yes	191	29	2.79 (1.53, 5.09)	<0.001	1.08 (0.15, 7.56)	0.941
Pancreatectomy						
No	501	43	1		1	
Yes	22	6	3.99 (1.49, 10.74)	0.003	6.90 (1.86, 25.58)	0.004
Extent of gastrectomy						
Distal	320	19	1		1	
Total or proximal	203	30	2.74 (1.50, 5.03)	<0.001	2.15 (0.31, 15.20)	0.442
Invasion to adjacent organs						
T2, T3	501	47	1		1	
T4	22	2	0.97 (0.22, 4.26)	0.964	0.37 (0.067, 2.01)	0.246
Sex						
M	358	38	1		1	
F	165	11	0.60 (0.30, 1.21)	0.150	0.57 (0.26, 1.27)	0.169
Age (years)						
< 56	160	7	1		1	
56-65	207	20	2.34 (0.96, 5.67)	0.061	3.06 (1.15, 8.20)	0.026
> 65	156	22	3.59 (1.49, 8.66)	0.005	4.04 (1.48, 11.02)	0.006
Body mass index						
< 25	446	34	1		1	
≥ 25	77	15	2.93 (1.51, 5.69)	0.001	3.32 (1.54, 7.12)	0.002
Operating time (min)						
< 240	167	8	1		1	
240-297	179	14	1.69 (0.69, 4.13)	0.252	1.60 (0.60, 4.27)	0.350
≥ 297	177	27	3.58 (1.58, 8.12)	0.002	2.96 (1.03, 8.55)	0.045
Blood loss (ml)						
< 395	174	10	1		1	
395-710	174	11	1.11 (0.46, 2.68)	0.822	0.47 (0.17, 1.30)	0.145
> 710	175	28	3.12 (1.47, 6.65)	0.003	0.86 (0.32, 2.31)	0.767
Blood transfusion						
Yes	408	29	1		1	
No	115	20	2.75 (1.49, 5.08)	<0.001	1.99 (0.97, 4.08)	0.061
Case volume*						
< 20	147	16	1		1	
≥ 20	376	33	0.79 (0.42, 1.48)	0.457	0.76 (0.36, 1.67)	0.454
Period						
1995-1998	295	30	1		1	
1999-2001	228	19	0.80 (0.44, 1.47)	0.475	0.83 (0.43, 1.61)	0.575

Values in parentheses are 95 per cent confidence intervals. *No. of patients registered.

prolonged operating time (patients in the upper tertile for whom the operating time was more than 297 min; $P = 0.005$) were identified as significant independent risk factors for overall complications (Table 2). A BMI of 25 or more was close to significance ($P = 0.054$).

The results of univariate analyses of risk factors for major surgical complications are summarized in Table 3. Multivariate analysis identified BMI ($P = 0.002$), pancreatic resection ($P = 0.004$), age (56-65 years, $P = 0.026$; over 65 years, $P = 0.006$) and operating time

over 297 min ($P = 0.045$) as significant independent risk factors for major surgical complications (Table 3).

Discussion

Gastrectomy plus extended systemic lymphadenectomy (D2 resection) is the standard procedure for gastric carcinoma in Japan. This approach has resulted in superior stage-by-stage survival than that observed in most Western countries and has led to cure for a

proportion of patients with nodal disease beyond the perigastric region, although this has not been confirmed in Western randomized trials^{15,16}. Although long-term follow-up revealed significantly better disease-free survival for the D2 group in the subset with node-positive cancer¹⁷, this difference did not extend to all patients in the trial, in part owing to the unacceptably high mortality rate associated with D2 resection⁸. JCOG 9501, a Japanese multi-institutional prospective randomized trial comparing D2 with more extended resection, has superior quality control of surgical procedures and reliability of data¹³ than retrospective Japanese studies and Western prospective trials.

The most significant risk factor for both surgical and overall complications in the present study was pancreatic resection, although it should be noted that this was performed in only 4.2 per cent of patients, compared with 30.3 and 15.2 per cent in the UK Medical Research Council (MRC) and Dutch trials respectively^{15,16}. The rate of pancreatectomy was lower in the present series because a pancreas-preserving technique^{18,19} was generally used, whereas distal pancreatectomy and splenectomy were integral parts of D2 dissection in the Dutch trial unless cancer was located in the distal stomach. The low morbidity rate in the present study may well be related to pancreas preservation^{18,19}. The success of this approach has also been reported in a multicentre phase II trial of D2 dissection in Northern Italy²⁰.

Splenectomy, on the other hand, was not an independent determinant of risk, possibly because it was never performed with distal gastrectomy in the present series. In the Dutch randomized trial a high mortality rate after distal gastrectomy was attributed in part to necrosis of the remnant stomach as a result of splenectomy and division of the short gastric arteries²¹. The survival benefit of splenectomy performed solely to facilitate dissection of lymph nodes close to the splenic hilum has been questioned, however, and a randomized trial to explore this issue is ongoing²².

Age was not an independent risk factor for overall complications in this study, in contrast to the Dutch trial in which age over 65 years was a significant risk factor for hospital death and overall complications²¹. This discrepancy may be attributed to the fact that only patients aged 75 years or less were eligible for inclusion in the JCOG 9501¹³, whereas other trials have included older patients^{15,16}. Japanese patients were, on average, 8 years younger than Dutch patients²³; consequently the proportion of patients over 65 years of age was 29.8 per cent in the present series as opposed to 51.3 per cent in the Dutch trial¹⁶. This age distribution

may account for the very low incidence of perioperative cardiovascular events in the present series, another factor that may have influenced the low morbidity and mortality rates.

Extended lymph node dissection may be hampered by excess bodyweight^{24–26} and in the present study BMI was a significant risk factor for major surgical complications. Caucasians in general have a higher BMI than Japanese and the incidence of morbid obesity is significant among patients in the USA and Europe. Only 14.7 per cent of the present patients had a BMI of 25 kg/m² or greater, whereas one-third of the US population is obese (BMI over 27 kg/m²)²⁷. These data suggest that the patients' physique favours Japanese patients when major gastric cancer surgery is performed.

The extent of lymph node dissection (D2 versus D3), surgical volume and the period in which the operation was performed had no impact, suggesting that there were no learning curve issues. Although D2 resection has long been a standard procedure in Japan, all surgeons in the trial were experts from specialized centres who had sufficient experience with D3 resection through numerous other studies. Of the variables reflecting difficulties encountered during surgery, prolonged operating time was identified as a significant independent risk factor for both overall and major surgical complications. However, amount of blood loss and blood transfusion were significant only in univariate analysis; this may be attributable to multicollinearity, as these two factors are closely related.

Gastrectomy with extended lymphadenectomy is feasible and safe in Japan, provided that older patients with comorbidity are excluded and pancreatectomy is reserved for lesions with direct invasion to the pancreas. Obese patients should be treated with caution, however, as they have a significant risk of developing major surgical complications. Hopefully, with careful patient selection, appropriate surgical expertise and pancreas and spleen preservation⁸ where possible, equally good results, rarely achieved previously^{20,28}, will be realized in the West.

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