

Predictors of operative morbidity and mortality in gastric cancer surgery

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Background: The aim of this study was to identify factors that predict morbidity and mortality in gastric cancer surgery.

Methods: Data on 719 consecutive patients who underwent operations for gastric cancer at Seoul National University Hospital between January and December 2002 were reviewed.

Results: Overall morbidity and mortality rates were 17.4 per cent (125 patients) and 0.6 per cent (four patients) respectively, and the rates of surgical and non-surgical complications were 14.7 per cent (106 patients) and 3.3 per cent (24 patients). Morbidity rates were higher in patients aged over 50 years (odds ratio (OR) 1.04 (95 per cent confidence interval (c.i.) 1.02 to 1.06)), when the gastric tumour was resected with another organ (36 per cent for combined resection *versus* 15.4 per cent for gastrectomy only; OR 3.25 (95 per cent c.i. 1.76 to 6.03)) and when gastrojejunostomy was used for reconstruction after subtotal gastrectomy (17.0 per cent for Billroth II *versus* 9.5 per cent for Billroth I; OR 2.00 (95 per cent c.i. 1.05 to 3.79)). Only three patients (2.8 per cent) with a surgical complication underwent reoperation, two for adhesive obstruction and one for intra-abdominal bleeding.

Conclusion: Age, combined resection and Billroth II reconstruction after radical subtotal gastrectomy were independently associated with the development of complications after gastric cancer surgery.

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Introduction

Surgery is the only proven effective treatment for gastric cancer. Lymph node level two (D2) dissection is the standard procedure for gastric cancer in Korea. Morbidity and mortality rates of 43–46 and 10–13 per cent respectively after D2 gastrectomy have been reported in multicentre trials in the Western world^{1,2}. Although rates were significantly higher after D2 than D1 resection, no survival benefit was shown for the D2 procedure^{3,4}. Major complications of gastric cancer surgery include anastomotic leakage or stenosis, bleeding, abscess, wound dehiscence, pancreatitis and functional problems. High morbidity and mortality rates have been reported for those requiring extensive gastric resection and in the elderly^{5–7}.

Operative techniques, anaesthesiology, postoperative care, and interventional radiology associated with gastric cancer surgery have improved considerably in recent years. The aim of the present study was to document the frequency and nature of operative morbidity and mortality

after gastric cancer surgery with respect to the extent of resection and the type of reconstruction, and identify factors predictive of complications and death.

Patients and methods

A prospectively collected database of 719 consecutive patients who underwent operation for gastric cancer at Seoul National University Hospital between January 2002 and December 2002 was reviewed. Variables analysed included sex, age, body mass index (BMI), American Society of Anesthesiologists (ASA) grade, extent of resection and type of reconstruction. Surgical and non-surgical complications were documented.

Radical subtotal gastrectomy with gastroduodenostomy (Billroth I) and gastrojejunostomy (Billroth II) were the main operations used. Roux-en-Y oesophagojejunostomy with or without a Paulino pouch was performed after total gastrectomy. A D2 lymph node dissection with curative

intent was performed in all patients. When the tumour was located in the lower third of the stomach the double-stapling Billroth I method was used, but if the tumour extended to the upper part of the stomach, was close to the pylorus or there was a scar at the duodenal bulb, Billroth II gastrojejunostomy was used. A Billroth II anastomosis was generally preferred when tumour invasion extended beyond the subserosa.

Operative mortality included all hospital deaths. Ileus was defined as postoperative absence of bowel motility demonstrated by gaseous distension without an air–fluid level on simple radiography. Intestinal obstruction was defined as mechanical obstruction with an air–fluid level and an obstructing point shown by computed tomography (CT). Bleeding was defined by the need for postoperative transfusion. A fluid collection was defined by the presence of septic fluid in the abdominal cavity causing fever higher than 38°C and proven by CT. Wound infection included the presence of serous fluid or pus at the incision, leading to delayed suture removal or a need for wound re-suture.

Statistical analysis

The χ^2 test, Fisher's exact test and independent *t* test, and a binary logistic regression model were used for statistical analysis. $P < 0.050$ (two sided) was regarded as significant. SPSS® version 11.0 (SPSS, Chicago, Illinois, USA) was used for data analysis.

Results

The clinicopathological characteristics of the 719 patients are summarized in Table 1. Overall morbidity rate was

17.4 per cent (125 patients) and the mean(s.d.) postoperative stay was 12.8(8.1) days. Surgical complications are listed according to operation type in Table 2. Non-surgical complications, including pneumonia, pleural effusion, urinary problem, cardiac arrhythmia, liver function test abnormality, thyroid crisis, laryngeal oedema and fever of unknown origin, occurred in 24 patients (3.3 per cent). The BMI and ASA grades of these 24 patients were higher than those of 594 patients with no complications, although the difference was not significant (mean(s.d.) BMI 24.3(2.5) versus 23.4(3.0), $P = 0.118$; ASA grade 1.9(0.8) versus 1.6(0.6), $P = 0.070$).

Univariate analysis showed that age, sex, extent of resection (combined or not) and type of reconstruction after radical subtotal gastrectomy were significantly associated with operative morbidity (Table 3). Multiple

Table 1 Patient characteristics

	No. of patients (<i>n</i> = 719)
Sex ratio (M:F)	493:226
Mean(s.d.) age (years)	57.3 (12.3)
Early gastric cancer	307 (42.7)
Tumour stage	
I	380 (52.9)
II	115 (16.0)
III	98 (13.6)
IV	126 (17.5)
Location	
Lower	365 (50.8)
Middle	210 (29.2)
Upper	96 (13.4)
Entire	48 (6.7)

Values in parentheses are percentages unless indicated otherwise.

Table 2 Surgical complications according to operation type

	Curative resection (R0/R1) (<i>n</i> = 646)					Palliative resection (R2) or no resection (<i>n</i> = 73)				
	BI (<i>n</i> = 179)	BII (<i>n</i> = 224)	TG (<i>n</i> = 145)	Combined (<i>n</i> = 73)	PG or PPG (<i>n</i> = 25)	STG (<i>n</i> = 12)	TG (<i>n</i> = 7)	Combined (<i>n</i> = 10)	Bypass or open biopsy (<i>n</i> = 44)	Total
Ileus (paralysis)		4	4	2						10
Intestinal obstruction		2	1	1	2		1			7
Anastomotic leakage				1				1		2
Anastomotic stenosis	2	3	3						1	9
Intra-abdominal bleeding	4	10	5	4			1			24
Fluid collection	5	6	6	12			1	3		33
Wound problem	4	6	7	5	2			1	2	27
Enterocutaneous fistula				2					1	3
Biliary fistula		1								1
Pancreatic fistula				1						1
Total no. of patients with complication	13	32	24	22	4	0	3	4	4	106

BI, Billroth I; BII, Billroth II; TG, total gastrectomy; PG, proximal gastrectomy; PPG, pylorus-preserving gastrectomy; STG, subtotal gastrectomy.

Table 3 Factors related to operative morbidity

	No. of patients	No. with complications	Postoperative stay (days)	P^{\dagger}	P^{\ddagger}
Age (years)					
< 50	196	18 (9.2)	11.6		
≥ 50	523	107 (20.5)	13.5		
Sex				0.049	
M	493	95 (19.3)	13.6		
F	226	30 (13.3)	11.7		
Curability				0.582	
Curable	646	114 (17.6)	12.8		
Incurable	73	11 (15)	14.8		
Type of gastrectomy*				0.103	
Subtotal	403	55 (13.6)	11.7		
Total	145	28 (19.3)	13.4		
Combined resection*				< 0.001	< 0.001
No	573	88 (15.4)	12.2		
Yes	73	26 (36)	17.7		
Type of reconstruction*				0.030	< 0.041
Gastroduodenostomy (Billroth I)	179	17 (9.5)	11.4		
Gastrojejunostomy (Billroth II)	224	38 (17.0)	12.5		
Tumour stage				0.065	
I	380	59 (15.5)	12.4		
II	115	29 (25.2)	12.6		
III	98	13 (13)	12.6		
IV	126	24 (19.0)	15.3		

Values in parentheses are percentages. *Curative procedures only. $\dagger\chi^2$ test; \ddagger multiple logistic regression analysis.

logistic regression analysis identified older age (odds ratio (OR) 1.04 (95 per cent confidence interval (c.i.) 1.02 to 1.06)), combined resection (combined resection *versus* gastrectomy only, OR 3.25 (95 per cent c.i. 1.76 to 6.03)) and Billroth II reconstruction after radical subtotal gastrectomy (Billroth II *versus* Billroth I, OR 2.00 (95 per cent c.i. 1.05 to 3.79)) as independent predictors of a higher operative morbidity rate.

Intra-abdominal fluid collection and wound problems were more frequent in patients aged 50 years or more compared with younger patients ($P = 0.032$ and $P = 0.003$ respectively). The incidence of intra-abdominal fluid collection was higher after combined resections than after gastrectomy alone ($P < 0.001$). Postoperative bowel movement disorder (ileus or obstruction) developed more frequently after radical subtotal gastrectomy with Billroth II than with Billroth I anastomosis ($P = 0.036$).

Four patients died in hospital. One of these patients had undergone gastrectomy with contiguous resection of pancreas and colon with superior mesenteric vein reconstruction. Three had undergone Billroth II reconstructions and one total gastrectomy. Of the four deaths, one was due to a cerebrovascular accident and the other three were surgically related (renal failure with methicillin-resistant *Staphylococcus aureus*-related sepsis, disseminated intravascular coagulation, biliary fistula).

Discussion

Although improved survival has not been proven by extended lymph node dissection (D2) in two Western randomized trials^{3,4}, these and other studies involving total or extended total gastrectomy and D2 or more lymph node dissection have been associated with high morbidity rates^{1,2,8,9}. These results contrast with those of a single-centre retrospective study in which morbidity and mortality rates of radical lymphadenectomy (D2) did not differ significantly from those of less extensive lymphadenectomy¹⁰.

Total gastrectomy has also been reported to have higher morbidity and mortality rates than distal gastrectomy^{8,11,12}, but without long-term survival benefit¹³. Leakage from the oesophagojejunostomy may account for this^{8,12}. In the present study the morbidity rate was higher for total gastrectomy than for subtotal gastrectomy, but the difference was not significant and there were no clinical leaks from the oesophagojejunal anastomosis.

In keeping with other series showing increasing postoperative morbidity and mortality rates with age⁵⁻⁷, the present study demonstrated that age is an independent contributor to postoperative complications. Preoperative co-morbidity has also been reported to affect postoperative

morbidity and mortality rates^{14,15}, although this was not examined in the present study.

When gastric cancer invades adjacent organs such as the spleen, pancreas, transverse colon, duodenum or liver, combined *en bloc* resection can be performed to achieve clear margins. Combined resection results in higher morbidity and mortality rates^{7,9,15–18}, and one multivariate analysis reported a significant relationship between concomitant splenectomy and postoperative complications⁷. The multivariate analysis in the present study also showed that combined resection was independently associated with a higher morbidity rate.

Billroth II reconstruction had a higher morbidity rate than Billroth I reconstruction after radical subtotal gastrectomy in this study. In particular, ileus and obstruction were more frequent after Billroth II than after Billroth I procedures, possibly reflecting increased manipulation of the bowel during Billroth II anastomosis.

Morbidity and mortality rates are higher in Western countries than in Japan⁷. Postoperative morbidity (17.4 per cent) and mortality (0.6 per cent) rates in the present study were low, although there are important differences with Western series^{1,2,15}, in that patients were younger and the proportion of early gastric cancers was relatively high^{2,19}. The present study demonstrated that low morbidity and mortality rates for gastric cancer surgery can be achieved in a large-volume hospital by experienced gastric surgeons.

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