

Reoperation for early postoperative complications after gastric cancer surgery in a Chinese hospital

Birendra Kumar Sah, Ming-Min Chen, Min Yan, Zheng-Gang Zhu

Birendra Kumar Sah, Ming-Min Chen, Min Yan, Zheng-Gang Zhu, Department of General Surgery, Ruijin Hospital, Shanghai Jiaotong University, School of Medicine, Shanghai Institute of Digestive Surgery, Shanghai 200025, China

Author contributions: Sah BK designed the study, collected the data, and drafted the manuscript; Chen MM and Yan M assisted in interpretation of data and assisted in drafting the manuscript; Zhu ZG participated in the design and final approval of the study and critical revision of the article.

Correspondence to: Zheng-Gang Zhu, Professor, Department of General Surgery, Ruijin Hospital, 197 Ruijin Er Road, Shanghai 200025, China. rjzhuzhenggang@hotmail.com

Telephone: +86-21-64370045 Fax: +86-21-53821171

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CONCLUSION: Reoperation significantly increases the mortality rate and raises the burden of the surgical unit. More prospective studies are required to explore the potential risk factors.

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Key words: Reoperation; Gastric cancer; Surgery; Postoperative complications

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Abstract

AIM: To investigate the occurrence of postoperative complications of gastric cancer surgery, and analyze the potential causes of reoperation for early postoperative complications.

METHODS: A total of 1639 patients who underwent radical or palliative gastrectomies for gastric cancer were included in the study. The study endpoint was the analysis of postoperative complications in inpatients.

RESULTS: About 31% of patients had early postoperative complications, and complications of infection occurred most frequently. Intra-abdominal hemorrhage and anastomotic leak were the main causes of reoperation, which accounted for about 2.2%. Mortality was 11.1% in the reoperation group, but was only 0.8% in other patients. The duration of postoperative stay in hospital was significantly longer and the total expenditure was markedly higher in the patients who underwent reoperation ($P < 0.001$). There was no significant association of any available factors in this study with the high rate of reoperation.

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INTRODUCTION

Though the occurrence of postoperative complications and mortality rate after surgery for gastric cancer have significantly decreased over the past years, they are still considered high^[1,2]. Radical gastrectomy with D2 lymph node dissection is widely accepted, but the extent of lymph node dissection is controversial among different centers^[3-10]. It is well accepted that the extent of surgery (particularly aggressive dissection of the lymph nodes) does not extend the overall survival, and postoperative complications were significantly related to the extent of surgery, particularly the extent of lymph node dissection. This was proved by Japanese surgeons who conducted several clinical randomized controlled trials (RCTs)^[3,9-11]. Sasako *et al*^[9] conducted a RCT in 24 hospitals in Japan to compare D2 lymphadenectomy alone with D2 lymphadenectomy plus para-aortic nodal dissection

(PAND) in patients undergoing gastrectomy for curable gastric cancer. They concluded that compared with D2 lymphadenectomy alone, D2 lymphadenectomy plus PAND does not improve the survival in curable gastric cancer; extended D2 lymphadenectomy plus PAND should not be performed to treat curable stage T2b, T3, or T4 gastric cancer; and that D2 gastrectomy is associated with the low mortality and reasonable survival of the patients.

Many researchers at leading centers for gastric cancer, including those in Korea and China, have indicated that combined resection of other organs is not of long-term benefit and it significantly increased the prevalence of postoperative complications and mortality^[3,4,11-13]. The occurrence rates of postoperative complications in the spleen-preservation group and splenectomy group were 11.6% and 29.3%, respectively. There was a higher frequency of pleural effusion, intra-abdominal abscess, and pancreatitis in splenectomized patients. A higher recurrence was observed in the splenectomy group (40.4%) compared with the spleen-preservation group (25.1%). The mean survival time was 72.0 mo in the spleen-preservation group compared with 56.7 mo in the splenectomy group^[13]. Investigation of early postoperative complications would therefore be beneficial to optimize the extent of gastric cancer surgery.

Reoperation after routine surgery, particularly after gastric cancer surgery, increases the overall burden for both the surgical ward and the patients. We therefore investigated the factors causing reoperation and their effects on the recovery of patients who undergo surgery for gastric cancer.

MATERIALS AND METHODS

A total of 1639 patients who underwent radical or palliative gastrectomies for gastric cancer in five consecutive years were included in the study (Table 1). Data were collected directly by comprehensive review of the original records of all patients. Sixty-seven patients with missing data and 13 patients who underwent emergency surgery were excluded from the analysis. Exclusion criteria were disease other than gastric cancer, and any type of palliative surgery (including exploratory laparotomy and gastrojejunal anastomosis) other than gastrectomy. The median age of the patients was 59 years (range, 17-93 years). The ratio of male and female patients was approximately 7:3.

Patients with early and resectable advanced gastric cancer underwent radical surgery (gastrectomies with D2 lymphadenectomy). Patients with late-stage gastric cancer underwent palliative gastrectomy. Most patients were diagnosed to be in stage III. The tumor invaded the serosa or adjacent structures in 38.1% of patients which was classified as pT3, and in 11.4% of patients classified as pT4 (Table 1). With respect to combined organ resection, 19 splenectomies, 14 partial pancreatectomies with splenectomy, 14 partial colectomies, two partial colectomies with splenectomy, seven partial hepatectomies (lobectomy),

Table 1 Demographic data of the patients

Items	Percentage (%)
Age group (yr)	
≤ 60	54.1
61-70	25.2
≥ 71	20.7
Sex	
Male	68.9
Female	31.1
Diagnosis	
Primary gastric cancer	97.4
Gastric stump cancer ¹	2.6
Site of tumor	
Proximal	17.6
Body	13.5
Distal	43.3
Large or multiple	25.6
No. of procedures	
Partial gastrectomy	76.0
Total gastrectomy	24.0
Type of resection	
Radical gastrectomy	91.6
Palliative gastrectomy	8.4
Combined resection	
Yes	4.4
No	95.6
Type of anastomosis	
Billroth I	47.6
Billroth II	13.9
Billroth reverse ²	13.4
Roux-en-Y	21.6
Roux-en-Y (P-shape)	3.0
Others	0.5
Unknown	0.3
TNM stage	
I A	12.1
I B	8.5
II	18.1
III A	20.8
III B	16.2
IV	24.3

¹Including recurrent gastric cancer; ²Oesophago-gastric anastomosis.

one total hysterectomy and one partial pancreatectomy were carried out in 58 patients (Table 1). About 25% of the patients underwent total gastrectomy. Billroth I, typical Roux-en-Y, and Billroth reverse (esophagogastric anastomosis) were the preferred methods for anastomosis after distal gastrectomy, total gastrectomy and proximal partial gastrectomy. Above 85% patients underwent surgery by senior surgeons with experience of 20-30 years. The minimal working experience of the surgeons was > 15 years. No surgical fellow or surgeons-in-training was allowed to perform the surgery independently. All the patients were managed by senior attendants under direct supervision of the surgeons.

The endpoint was analysis of postoperative complications and postoperative mortality in inpatients. Complications were recorded according to the definitions stated in the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM)^[14]. As there are many complications that are not covered by its definitions, an undefined complication was therefore

recorded as “innominate” and the details were provided in separate tables. Severities of all complications were stratified according to Rui Jin Hospital Classification of Complications^[15].

We also audited the overall expenditure in US dollars (\$) of patients during their stay in hospital and compared it between the reoperation group and non-reoperation group.

Statistical analysis

The statistical analysis was done using the Statistical Package for Social Science (SPSS) version 13.0 for Windows (SPSS, Incorporated, Chicago, IL, USA). Non-parametric methods were used to test the data without normal distribution. $P < 0.05$ was considered significant.

RESULTS

About 31% of patients had different types of complications according to POSSUM criteria. The prevalence of individual complications was not equal to the total number of complications. Multiple complications were possible in a single patient (Table 2). Postoperative infection was the most common complication. The occurrence of anastomotic leak was about 2%, and postoperative mortality was only 1%.

There were numerous innominate complications (Table 3), most of which were accompanied by complications described in POSSUM. Most patients had pleural effusion or/and seroperitoneum, most of which were accompanied by low fever but pathological diagnosis of infection could not be confirmed. A substantial number of patients had persistent fever or recurring fever of unknown origin. About 5% of patients had persistent nausea or vomiting caused by gastroplegia or enteroplegia, anastomosis edema, or ileus. Some patients were clinically suspected to have a minor leak but there was no sufficient objective evidence to support this finding. Although these patients were managed by conservative treatment (mainly NPO, intravenous antibiotics, and total parenteral nutrition), they still increased the burden on the surgical ward. Complications were rare such as pancreatic fistula, chyle leak, and bleeding at the anastomosis site.

Innominate complications were recorded empirically and merged to calculate different levels of complication type according to the Rui Jin Hospital Classification of Complications^[15]. Most complications were minor (11.0%) or moderate (15.2%), only 8.3 % of patients had severe complications.

Patients were categorized into three levels according to the length of postoperative stay in hospital. About 75% of patients were discharged in good condition in less than 15 d after uneventful recovery and removal of sutures, 19.7% of patients discharged within 16-30 d and only 6% of patients stayed in hospital for more than a month.

There was a significant difference in the occurrence rate of overall complications between partial and total gastrectomy with radical lymphadenectomy, but no significant difference between partial and total gastrectomy with palliative lymphadenectomy was observed (Table 4).

Table 2 Details of complications

Complications	Frequency	Percentage (%)
Hemorrhage		
Wound	1	0.1
Deep	16	1.0
Wound dehiscence		
Superficial	9	0.5
Deep	5	0.3
Anastomotic leak	38	2.3
Infection		
Wound	15	0.9
Deep	80	4.9
Pyrexia of unknown origin	253	15.4
Septicemia	7	0.4
Chest	172	10.5
Urinary tract infection	20	1.2
System failure		
Renal	28	1.7
Respiratory	22	1.3
Cardiac	13	0.8
Hypotension	16	1.0
Deep venous thrombosis	4	0.2
Death	17	1.0
Overall	506	30.9

Table 3 Innominate complications

Complications	Frequency	Percentage (%)
Pleural effusion	213	13
Continuous or relapsing pyrexia of unknown origin	170	10.4
Seroperitoneum	118	7.2
Gastro or enteroplegia, anastomosis edema, ileus	75	4.6
Suspicious or sub-clinical anastomotic leak	57	3.5
Pancreatitis	22	1.3
Central vein catheter infection	14	0.9
Anastomosis site or upper GI bleeding	10	0.6
Chyle leak	8	0.5
Pancreatic fistula	6	0.4

The occurrence of complications of infection (including deep infection, pulmonary infection), system failure, and mortality was significantly higher in total gastrectomy with radical lymphadenectomy. After stratification of patients into partial and total gastrectomy groups, we noted no significant difference in complication occurrence between radical lymphadenectomy and palliative lymphadenectomy (Table 5).

Thirty-six patients underwent reoperation for different causes, with intra-abdominal hemorrhage and anastomotic leak as the main causes (Table 6). There was no significant difference in physiological score (PS; $P = 0.382$) and operative severity score (OSS; $P = 0.849$) between patients in the reoperation group and the non-reoperation group. Median values of PS and OSS in the reoperation group were 14.5 (range, 12-25) and 18 (range, 16-24) respectively, whereas they were 15 (range, 12-38) and 18 (range, 11-28) in the non-reoperation group. Mortality was significantly higher in patients who underwent reoperation ($P < 0.001$), being 11.1% in the reoperation group but only 0.8% in

Table 4 Difference of complication rate between partial and total gastrectomy

LN dissection Gastrectomy	Radical			Palliative		
	Partial	Total	Sig	Partial	Total	Sig
Overall	308 (26.7)	142 (40.9)	< 0.001	32 (34.8)	24 (52.2)	NS
Reoperation	23 (2.0)	12 (3.5)	NS	1 (1.1)	0	NS
Hemorrhage						
Wound	1 (0.1)	0	NS	0	0	
Deep	11 (1.0)	4 (1.2)	NS	1 (1.1)	0	NS
Wound dehiscence						
Superficial	7 (0.6)	1 (0.3)	NS	1 (1.1)	0	NS
Deep	4 (0.3)	1 (0.3)	NS	0	0	
Leak	22 (1.9)	12 (3.5)	NS	1 (1.1)	3 (6.5)	NS
Infection						
Wound	8 (0.7)	6 (1.7)	NS	1 (1.1)	0	NS
Deep	42 (3.6)	30 (8.6)	< 0.001	5 (5.4)	3 (6.5)	NS
PUO	165 (14.3)	65 (18.7)	0.044	13 (14.1)	10 (21.7)	NS
Septicemia	1 (0.1)	6 (1.7)	< 0.001	0	0	
Chest	86 (7.5)	61 (17.6)	< 0.001	14 (15.2)	11 (23.9)	NS
UTI	13 (1.1)	6 (1.7)	NS	1 (1.1)	0	NS
System failure						
Renal	15 (1.3)	12 (3.5)	0.008	1 (1.1)	0	NS
Respiratory	12 (1.0)	7 (2.0)	NS	3 (3.3)	0	NS
Cardiac	5 (0.4)	6 (1.7)	0.034	2 (2.2)	0	NS
Hypotension	8 (0.7)	6 (1.7)	NS	2 (2.2)	0	NS
DVT	1 (0.1)	3 (0.9)	NS	1 (1.1)	0	NS
Death	6 (0.5)	8 (2.3)	0.007	2 (2.2)	1 (2.2)	NS

Sig: Significance; LN: Lymph node; PUO: Pyrexia of unknown origin; UTI: Urinary tract infection; DVT: Deep vein thrombosis.

Table 5 Difference of complications rate between radical and palliative LN dissection

LN dissection Gastrectomy	Partial			Total		
	Radical	Palliative	Sig	Radical	Palliative	Sig
Overall	308 (26.7)	32 (34.8)	NS	142 (40.9)	24 (52.2)	NS
Reoperation	23 (2.0)	1 (1.1)	NS	12 (3.5)	0	NS
Hemorrhage						
Wound	1 (0.1)	0	NS	0	0	NS
Deep	11 (1.0)	1 (1.1)	NS	4 (1.2)	0	NS
Wound dehiscence						
Superficial	7 (0.6)	1 (1.1)	NS	1 (0.3)	0	NS
Deep	4 (0.3)	0	NS	1 (0.3)	0	NS
Leak	22 (1.9)	1 (1.1)	NS	12 (3.5)	3 (6.5)	NS
Infection						
Wound	8 (0.7)	1 (1.1)	NS	6 (1.7)	0	NS
Deep	42 (3.6)	5 (5.4)	NS	30 (8.6)	3 (6.5)	NS
PUO	165 (14.3)	13 (14.1)	NS	65 (18.7)	10 (21.7)	NS
Septicemia	1 (0.1)	0	NS	6 (1.7)	0	NS
Chest	86 (7.5)	14 (15.2)	0.008	61 (17.6)	11 (23.9)	NS
UTI	13 (1.1)	1 (1.1)	NS	6 (1.7)	0	NS
System failure						
Renal	15 (1.3)	1 (1.1)	NS	12 (3.5)	0	NS
Respiratory	12 (1.0)	3 (3.3)	NS	7 (2.0)	0	NS
Cardiac	5 (0.4)	2 (2.2)	NS	6 (1.7)	0	NS
Hypotension	8 (0.7)	2 (2.2)	NS	6 (1.7)	0	NS
DVT	1 (0.1)	1 (1.1)	NS	3 (0.9)	0	NS
Death	6 (0.5)	2 (2.2)	NS	8 (2.3)	1 (2.2)	NS

other patients (Table 7). In the reoperation group, the mortality rate of patients with radical lymphadenectomy was higher than that of patients who underwent palliative lymphadenectomy. Mortality rate was higher in patients who underwent total gastrectomy than in those who

Table 6 Causes of reoperation

Causes	Surgical management	Frequency
Intra-abdominal hemorrhage ¹	Simple hemostasis	16
Anastomotic leak	Repair and placement of drainage	10
Deep wound dehiscence	Closure of abdominal wall	4
Abdominal infection	Debridement and placement of drainage	3
Ileus	Adhesiolysis of small intestine	2
Anastomotic obstruction	Reconstruction	1

¹Including 2 cases of anastomosis site bleeding.

Table 7 Potential causes of death

Complications	Reoperation <i>n</i> (%)	
	Yes (<i>n</i> = 36)	No (<i>n</i> = 1603)
Death	4 (11.11)	13 (0.81)
Extent of surgery		
LN dissection		
Radical	4 (11.11)	10 (0.62)
Palliative	0	3 (0.18)
Gastrectomy		
Partial	1 (0.03)	7 (0.44)
Total	3 (8.33)	6 (0.37)
Complications		
Intra abdominal hemorrhage	1 (0.03)	0
Anastomotic leak	2 (5.55)	0
Infection		
Deep	1 (0.03)	2 (0.12)
Pyrexia of unknown origin	0	3 (0.18)
Septicemia	0	1 (0.06)
Chest	3 (8.33)	7 (0.44)
Urinary tract	2 (5.55)	0
System failure		
Renal	3 (8.33)	8 (0.49)
Respiratory	4 (11.11)	10 (0.62)
Cardiac	2 (5.55)	9 (0.56)
Hypotension	1 (0.03)	9 (0.56)
Deep venous thrombosis	0	3 (0.18)
Pancreatitis	0	1 (0.06)
Anastomosis site bleeding	0	1 (0.06)

underwent partial gastrectomy (Table 7).

Except for four patients with wound dehiscence who were discharged within one month, the other 32 patients were treated in hospital for more than one month. The length of postoperative stay was significantly longer in patients who underwent reoperation ($P < 0.001$). The mean duration of postoperative stay was 44.6 d (standard deviation, SD = 29.41 d) in patients with reoperation, but was only 14.6 d (SD = 8.09 d) in other patients.

Reoperation caused a significant economic burden for patients. There was a significant difference in the total expenditure between groups of patients with or without reoperation ($P < 0.001$). The median expenditure in patients with reoperation was 7946.36 \$ (SD = 8930.38 \$) but it was only 3238.32 \$ (SD = 4404.63 \$) in other patients.

Univariate analysis of the data revealed no significant association of any available factors in this study with the higher rate of reoperation, including age, hypertension,

anemia, hypoalbuminemia, hyperglycemia, type of gastrectomy, combined organ resection, type of anastomosis, surgeon's experience (number of operations performed), tumor stage.

DISCUSSION

In the surgical approach for early and selective advanced gastric cancer, gastrectomy with D2 lymphadenectomy is justified^[6,16-19]. The procedure of surgery, particularly the extent of lymphadenectomy for gastric cancer, varies among individual centers. The occurrence of postoperative complications was higher in inexperienced hands, and there was a considerable difference in early surgical outcomes among centers^[3,20]. Postoperative complications were inversely correlated with the number of patients undergoing treatment in a surgical unit^[21]; similar results were published for patients undergoing surgery for gastric cancer^[15]. Overall survival rate was higher at specialized centers. It was therefore stressed in many articles that gastric cancer surgery was safe at specialized centers^[3,6,22,23].

The postoperative complications at our institution were in the acceptable range because most patients had a smooth recovery and postoperative mortality was not high. Overall surgical outcome was acceptable because of the occurrence rate of complications was below the moderate level. Postoperative infection was the commonest complication. There are several complications (e.g. gastroplegia or enteroplegia, suspicious anastomotic leak, pleural effusion) which are not covered by POSSUM. These complications cannot be ignored because they have a big impact on the overall burden (patient-related and economic) of our hospital. A substantial number of patients had persistent fever without a clear diagnosis; appropriate investigation was necessary to find the cause. Further investigation was required to classify or define the diagnosis of sub-clinical anastomotic leak. The Ruijin Hospital Classification of Complication, stratifies complications to different levels according to the severity of the disease, and is a validated classification^[2,15]. We suggest that other hospitals use this classification for assessment of surgical outcome.

Reoperation was in the acceptable range as compared with a recent report from the Korean Institute, and the mortality caused by reoperation was low^[24]. Most reoperations were carried out for intra-abdominal hemorrhage, which may be related to the experience of surgeons and necessitates additional efforts to examine the easily missed bleeding sites (particularly anastomosis sites). The four cases of rupture of the abdominal wall may be attributed to the poor surgical technique because these patients had their linea alba closed by an interrupted silk suture. We did not observe this complication in patients with linea alba closed by a continuous absorbable suture. Anastomotic leak was followed by intra-abdominal infection which often caused peripancreatic abscess, and eventually pancreatic fistulas in some cases. Improvement of surgical

technique is therefore crucial to lower the occurrence of intra-abdominal hemorrhage and anastomotic leak.

In conclusion, although the overall occurrence of postoperative complications was high after gastric cancer surgery, the occurrence rate of severe complications and mortality were low. Reoperation after gastric cancer surgery significantly increases the mortality and overall burden of the surgical unit. As the gastric cancer surgery is considered as a routine surgery, it is important to control the postoperative complications. Univariate analysis of the data revealed no significant association of any available factors in this study with the high rate of reoperation; however, more prospective studies are required to explore the potential risk factors for the higher rate of reoperation after gastric cancer surgery.

COMMENTS

Background

Though the occurrence of postoperative complications and mortality after surgery for gastric cancer have significantly decreased over the past years, they are still considered high. It was well accepted that the extent of surgery does not extend the overall survival and that postoperative complications were significantly related to the extent of surgery. Therefore, surgical extent should be seriously considered and postoperative complications should not be ignored.

Innovations and breakthroughs

The postoperative complication is highly variable among different centers. However, surprisingly there are very few reports on this issue, especially from Chinese surgical centers. This study was conducted at a leading center for gastric cancer surgery in China, and analyzed a large cohort of patients for a long period. It provides the details on the occurrence of postoperative complications and analyzed its impact on patients and surgical ward. The finding of this study certainly provides very useful reference to the surgeons working in this field.

Applications

The better understanding about the occurrence of different types of the postoperative complications and its underlying causes may help surgeons reduce the postoperative complications and upgrade the quality of surgical treatment.

Terminology

"POSSUM" is an internationally accepted scoring system which is applied for the evaluation of surgical treatment. "Rui Jin Hospital Classification of the complications" is a novel system which stratifies all the complications in three different levels and provides objective idea about the severity of complications.

Peer review

The article has some very good information and is worthy of publication.

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