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Cross-sectional Study

Factors associated with complication after gastrectomy for gastric or esophagogastric cancer compared among surgical purpose, surgical extent, and patient age: Retrospective study from a high volume center in Thailand

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ABSTRACT

Background: This study aimed to investigate the prevalence of and factors associated with complication after gastrectomy for gastric or esophagogastric cancer compared among surgical purpose (curative *vs.* palliative), surgical extent (subtotal *vs.* total *vs.* extended), and patient age (adult *vs.* older adult *vs.* octogenarian).

Materials and methods: Medical records of patients with gastric/esophagogastric junction cancer who underwent gastrectomy at Siriraj Hospital (Bangkok, Thailand) during January 2005 to June 2017 were retrospectively reviewed. Complications were compared and risk factors were identified.

Results: Of 454 included patients, 84.8% and 15.2% underwent curative and palliative gastrectomy, respectively. Overall postoperative morbidity was not significantly different between groups. Extended and total gastrectomy demonstrated a trend towards higher postoperative complication. Age ≥70 years in curative gastrectomy, and age ≥80 years in palliative gastrectomy were significantly associated with increased postoperative complications (OR: 4.67, 95%CI: 1.46–14.9 and OR: 17.50, 95%CI: 1.22–250.36, respectively). Multivariate analysis revealed age ≥70 years, coronary artery disease (CAD), tumor size >5 cm, and operative time >210 min to be independent risk factors for postoperative complication. ASA class III-IV and preoperative serum albumin <3.5 g/dL did not survive multivariate analysis.

Conclusion: Purpose and extent of surgery were not associated with incidence and severity of postoperative morbidity. Age ≥70 years was associated with higher postoperative complication after curative gastrectomy, and age ≥80 years was associated with adverse events after palliative gastrectomy. Patients with age ≥70 years, CAD, tumor size >5 cm, and operative time >210 min should be considered high-risk patients.

1. Introduction

Radical gastrectomy is the main curative treatment for gastric or esophagogastric junction cancer, especially in early and locally advanced stage. According to Japanese Gastric Cancer Treatment Guidelines, standard gastrectomy with lymphadenectomy is recommended for curable disease. Palliative gastrectomy is reserved for symptom alleviation, such as bleeding or obstruction, in metastatic diseases [1–3]. Appropriate operative decisions can influence outcomes since postoperative complications may result in poor survival prognosis due to decline in performance status, prolonged recovery period, and delayed adjuvant treatment. Continuously improving operative techniques and perioperative strategies have helped to minimize adverse outcomes. Enhanced recovery after surgery (ERAS) protocol was proposed as an adjunct to standard care in upper gastrointestinal surgery [4]. The ERAS protocol involves preoperative education and counseling to ensure that the patient is well-prepared prior to surgery. Perioperative nutritional support and prehabilitation are advised, and early postoperative ambulation and feeding are essential for improving recovery to regain strength and readiness for further necessary treatment. However, the postoperative morbidity rates still range from 18 to 46% of gastrectomy cases [5], and a 3–5% mortality rate was reported, even in

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high-volume centers [6]. Several possible complications and potential risk factors have been variously reported and classified into patient-related and operation-related factors. However, data specific to postoperative morbidity and mortality after gastrectomy reported from the developing world remain scarce.

This study was conducted before the routine application of the ERAS protocol for gastrectomy at Siriraj Hospital [4,7]. The aim of this study was to investigate the prevalence of and factors associated with complication after gastrectomy for gastric or esophagogastric cancer compared among surgical purpose (curative *vs.* palliative), surgical extent (subtotal *vs.* total *vs.* extended), and patient age (adult *vs.* older adult *vs.* octogenarian). Increased awareness of risk factors will help to prevent or early detect complications, which will help to improve patient outcomes.

2. Material and methods

This retrospective study included adult patients (age ≥18 years) who underwent open transabdominal gastrectomy for of stomach or esophagogastric junction cancers at the Department of Surgery of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during January 2005 to June 2017. Emergency surgery and concurrent cytoreductive surgery with hyperthermic intraperitoneal chemotherapy (HIPEC) were excluded. Demographic and clinical data, including gender, age, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, preoperative serum albumin level, and preoperative tumor location, were collected and recorded. Tumor staging was according to the 8th edition of the American Joint Committee on Cancer (AJCC) Staging System [8]. The purpose of the operation (curative or palliative gastrectomy) and extent of gastrectomy and lymphadenectomy (subtotal, total, or extended) were also collected and recorded. In curative gastrectomy, all patients underwent standard gastrectomy with lymphadenectomy following Japanese Gastric Cancer Treatment Guidelines. Operations were defined as palliative gastrectomy when the patient had incurable disease or the presence of macroscopic residual tumor. Extent of gastrectomy was classified as subtotal, total, or extended gastrectomy, and was determined by tumor location with adequate proximal resection margin. Either D1, D1+, or D2 lymph node dissection was performed according each patient's clinical staging. All patients were operated by experienced attending surgeons.

Postoperative complications were documented and graded according using the Clavien-Dindo classification system [9]. Grade 3a or higher was defined as a major complication. Postoperative mortality was defined as postoperative death from any cause within 30 days after surgery or death during postoperative hospitalization. All complications were classified into surgery-related or non-surgery-related causes. Association between postoperative complication and extent of surgery was analyzed. Patients were divided into 3 age-groups, as follows: adult (age 18–59 years), older adult (age 60–79 years), and octogenarian (age 80 years and older). Subgroup of patients aged 60 years and over were analyzed as an age interval of increasing every 10 years to evaluate for significant association between age and postoperative complication. Risk factors for adverse outcomes were also identified.

The study was conducted in accordance with the Declaration of Helsinki. The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB) (COA no. Si 082/2018), and written informed consent to participate was not obtained from study subjects due our study's retrospective and anonymity-preserving design. Our study has been registered with Thai Clinical Trials Registry (ID: TCTR20220527001). This study has been reported in line with the STROCSS criteria [10].

2.1. Statistical analysis

Patient demographic and clinical characteristics were summarized using descriptive statistics. Categorical variables were compared using chi-square test or Fishers exact test, and the results of those comparisons are shown as number and percentage. Continuous variables were compared using Student's t-test for normally distributed data, and using Mann-Whitney *U* test for non-normally distributed data. Normally distributed continuous data are expressed as mean ± standard deviation (SD), and non-normally distributed continuous data are given as median and interquartile range (IQR). Logistic regression model was used to identify significant association between postoperative complication and age group. Univariate and multivariate analysis was employed to identify factors independently associated with postoperative complication. Variables with a *p*-value of less than 0.05 in univariate analysis were entered into the multivariable model. The results are presented as odds ratio (OR) with 95% confidence interval (CI) for univariate analysis, and as adjusted OR (aOR) with 95% CI for multivariate analysis. A two-tailed *p*-value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS Statistics version 18.0 (SPSS, Inc., Chicago, IL, USA).

3. Results

3.1. Demographic data

A total of 560 gastric or esophagogastric junction cancer patients underwent surgical treatment during the study period. Of those, 106 non-resection surgical procedures were excluded. Of the remaining 454 cases, there were 402 (88.5%) cases of gastric cancer, and 52 (11.5%) cases of esophagogastric junction cancer. Curative gastrectomy was performed in 385 (84.8%) patients, and palliative gastrectomy was performed in 69 (15.2%) patients. For gastric resection, extended gastrectomy was performed in 14 (4.4%) adult and older adult patients, whereas only 1 (1.6%) octogenarian patient underwent extended surgery. A total gastrectomy was performed in 167 (42.8%) and 18 (28.1%) patients respectively. 281 (72.1%) adult and older adult patients underwent D2 lymphadenectomy and 41 (64.1%) octogenarian patients underwent this radical lymphadenectomy. A total of 445 (98.0%) patients were diagnosed with adenocarcinoma. Tumor differentiation was poorly differentiated type in 251 (55.3%) patients. The median age of patients was 65 years (IQR: 54–75), and 235 (51.8%) patients were male. The curative gastrectomy group had a significantly higher preoperative BMI ($p = 0.005$), higher serum albumin level ($p = 0.008$), longer operative time ($p < 0.001$), and more blood loss ($p < 0.001$) compared to the palliative gastrectomy group (Table 1).

3.2. Postoperative complication

Of the 454 patients who underwent gastrectomy, 175 (38.5%) patients experienced postoperative complications, including 143 (37.1%) patients in the curative group, and 32 (46.4%) patients in the palliative group ($p = 0.147$). Most complications were classified as less than grade 3 or minor according to Clavien-Dindo classification. Only 35 (9.1%) curative patients and 4 (5.8%) palliative patients had major complications ($p = 0.142$). Acute kidney injury, pneumonia, volume overload, and surgical site infection (SSI) were recorded as major complications. Gastroparesis was the most frequently observed surgery-related complication (8.1% in the curative group, and 17.6% in the palliative group). The percentage of gastroparesis and postoperative bleeding was significantly higher in the palliative gastrectomy group ($p = 0.013$ and $p = 0.049$, respectively). Volume overload was the most common non-surgery-related complication in both groups (4.7% in curative gastrectomy, and 8.8% in palliative gastrectomy). There were 1 death in the curative group, and 2 deaths in the palliative group (2 from postoperative bleeding, and 1 from pneumonia). The rates of other complications were not significantly different between the curative and palliative groups. Regarding the intention of gastrectomy, the overall complication rate and rate of major complications between groups were

Table 1
Demographic and clinical characteristics compared between the curative and palliative gastrectomy groups.

Characteristics	Curative gastrectomy (n = 385)	Palliative gastrectomy (n = 69)	*p*-value
Male gender, n (%)	209 (54.3%)	26 (37.6%)	0.150
Age (years), median (IQR)	66 (55, 75)	61 (48, 74)	0.080
Body mass index (kg/m^2), n (%)			***0.005***
<18.5	77 (20.6%)	26 (40.6%)	
18.5–24.9	209 (55.3%)	30 (46.9%)	
≥25	90 (24.1%)	7 (12.5%)	
ASA grade, n (%)			0.910
I-II	291 (75.6%)	53 (76.8%)	
III-IV	94 (24.4%)	16 (23.2%)	
Preoperative albumin (g/dL), mean ± SD	3.31 ± 1.32	2.77 ± 1.57	***0.008***
Preoperative tumor location, n (%)			0.340
Esophagogastric junction	41 (10.6)	11 (15.9))	
Stomach	344 (89.4)	58 (84.1)	
Operative time (min), median (IQR)	250 (180, 315)	85 (60, 185)	***<0.001***
Blood loss (ml), median (IQR)	350 (150, 555)	50 (25, 135)	***<0.001***
Procedure, n (%)			***0.005***
Subtotal gastrectomy	194 (50.4%)	57 (82.6%)	
Total gastrectomy	173 (44.9%)	12 (17.4%)	
Extended gastrectomy	18 (4.7%)	0 (0.0%)	
Reconstruction, n (%)			0.094
Billroth-I gastroduodenostomy	3 (0.8%)	0 (0.0%)	
Billroth-II gastrojejunostomy	138 (36.6%)	40 (65.6%)	
Roux-en-Y gastrojejunostomy	46 (12.2%)	9 (14.7%)	
Roux-en-Y esophagojejunostomy	190 (50.4%)	12 (19.7%)	
Lymphadenectomy, n (%)			***<0.001***
D0	0 (0.0%)	40 (87.0%)	
D1	18 (4.7%)	0 (0.0%)	
D1+	20 (5.3%)	0 (0.0%)	
D2	316 (83.4%)	6 (13.0%)	
Resection category, n (%)			***<0.001***
R0	300 (82.4%)	0 (0.0%)	
R1	64 (17.6%)	2 (8.3%)	
R2	0 (0.0%)	22 (91.7%)	
Pathologic staging, n (%)			***<0.001***
0	3 (0.8%)	0 (0.0%)	
I	64 (18.1%)	0 (0.0%)	
II	121 (33.7%)	5 (20.5%)	
III	141 (39.2%)	3 (12.5%)	
IV	29 (8.1%)	16 (66.7%)	
Length of hospital stay (days), median (IQR)	15 (9, 17)	14.8 (9, 17)	0.893
Postoperative mortality, n (%)	1 (0.3%)	2 (2.9%)	0.061

A *p*-value<0.05 indicates statistical significance.
Abbreviations: IQR, interquartile range; ASA, American Society of Anesthesiologists physical status score, SD, standard deviation.

Table 2
Postoperative complications compared between the curative and palliative gastrectomy groups.

Postoperative complications	Curative gastrectomy (n = 385)	Palliative gastrectomy (n = 69)	*p*-value
Postoperative complications	143 (37.1%)	32 (46.4%)	0.147
Clavien-Dindo classification			
I	11 (2.9%)	2 (2.9%)	
II	97 (25.2%)	26 (37.7%)	
IIIa	27 (7.0%)	1 (1.4%)	
IIIb	4 (1.0%)	0 (0.0%)	
IVa	2 (0.5%)	1 (1.4%)	
IVb	1 (0.3%)	0 (0.0%)	
V	1 (0.3%)	2 (2.9%)	
Major complication	35 (9.1%)	4 (5.8%)	0.142
Surgery-related complication	65 (16.9%)	12 (17.4%)	0.273
Superficial surgical site infection	27 (7.0%)	2 (2.9%)	0.285
Deep surgical site infection	1 (0.3%)	0 (0.0%)	0.318
Bleeding	6 (1.6%)	4 (5.8%)	***0.049***
Gastroparesis/ileus	31 (8.1%)	12 (17.4%)	***0.013***
Anastomosis leakage	3 (0.8%)	0 (0.0%)	0.463
Duodenal stump leakage	1 (0.3%)	0 (0.0%)	0.673
Perforation	1 (0.3%)	0 (0.0%)	0.673
Chyle leakage	6 (1.6%)	0 (0.0%)	0.298
Postoperative pancreatic fistula	9 (2.3%)	0 (0.0%)	0.200
Intraabdominal collection	12 (3.1%)	0 (0.0%)	0.138
Intestinal obstruction	3 (0.8%)	0 (0.0%)	0.463
Non-surgery-related complication			
Atelectasis	16 (4.2%)	1 (1.5%)	0.489
Pneumonia	18 (4.7%)	2 (2.9%)	0.752
Myocardial infarction	3 (0.8%)	2 (2.9%)	0.165
Arrythmia	4 (1.0%)	3 (4.4%)	0.073
Congestive heart failure	1 (0.3%)	0 (0.0%)	0.673
Acute kidney injury	8 (2.1%)	4 (5.9%)	0.091
Volume overload	18 (4.7%)	6 (8.8%)	0.234
Stroke	1 (0.3%)	0 (0.0%)	0.673
Delirium	4 (1.0%)	0 (0.0%)	0.396
Urinary tract infection	7 (1.8%)	0 (0.0%)	0.260
Catheter-related blood stream infection	1 (0.3%)	0 (0.0%)	0.170
Septicemia	1 (0.3%)	0 (0.0%)	0.673

A *p*-value<0.05 indicates statistical significance.

not significantly different ($p = 0.147$ and 0.142) (Table 2).

The overall complication rates among the various extents of surgery were 37.5% in subtotal gastrectomy, 38.4% in total gastrectomy, and 55.6% in extended gastrectomy ($p = 0.312$). The major complication rates were 8.0%, 8.7%, and 16.7%, respectively ($p = 0.818$). Regarding subgroup analysis of curative and palliative surgery, the rates of overall complications and major complications were statistically comparable between groups for each of the 3 extents of surgery (Table 3).

Compared among the 3 evaluated age groups, the rates of overall and major complications were both significantly higher in the octogenarian group than in the adult and older adult groups (Table 4). Logistic regression analysis found significant association between postoperative complication and age 70–79 years (OR: 4.67, 95%CI: 1.46–14.91; $p = 0.009$), and between postoperative complication and age ≥80 years in the curative gastrectomy group (OR: 3.59, 95%CI: 1.06–12.11; $p = 0.04$). In palliative group, age ≥80 year was found to be significantly associated with postoperative complication (OR: 17.50, 95% CI: 1.22–250.36; $p = 0.035$).

In univariate analysis, ASA class III-IV, coronary artery disease (CAD), tumor size >5 cm, preoperative serum albumin <3.5 g/dL, prolonged operative time >210 min, and age ≥70 years were found to be significantly associated with postoperative complications. Multivariate analysis identified age ≥70 years, CAD, tumor size >5 cm, and operative time >210 min as independent predictors of postoperative complications (Table 5). ASA class III-IV and preoperative serum albumin <3.5 g/dL did not survive multivariate analysis.

4. Discussion

Enhanced perioperative care, such as preoperative improvement in nutritional status, smoking cessation, and antimicrobial prophylaxis, as an adjunct to intraoperative management improves surgical outcomes. Malnutrition is known to precipitate complications, such as wound complication and anastomotic leakage. Moreover, meticulous intraoperative technique may reduce postoperative adverse events and shorten the recovery period. Enhanced understanding of related

Table 3
Complication rates for both curative and palliative surgery compared among the subtotal, total, and extended gastrectomy groups.

Complication type	Subtotal Gastrectomy (n = 251)	Total Gastrectomy (n = 185)	Extended Gastrectomy (n = 18)	*p*-value
Overall complication	94 (37.5%)	71 (38.4%)	10 (55.6%)	0.312
Curative	67 (34.5%)	66 (38.1%)	10 (55.5%)	0.197
Palliative	27 (47.3%)	5 (41.6%)	0 (0.0%)	0.719
Major complication	20 (8.0%)	16 (8.6%)	3 (16.7%)	0.818
Curative	16 (23.9%)	16 (24.2%)	3 (30.0%)	0.914
Palliative	4 (14.8%)	0 (0.0%)	0 (0.0%)	0.358

A *p*-value<0.05 indicates statistical significance.

Table 4
Complication rates for both curative and palliative surgery compared among the adult, older adult, and octogenarian groups.

Complication type	Adult (n = 165)	Older adult (n = 225)	Octogenarian (n = 64)	*p*-value
Overall complication	44 (26.7%)	98 (43.6%)	33 (51.6%)	***<0.005***
Curative surgery	33 (24.6%)	84 (42.9%)	26 (47.3%)	***0.001***
Palliative surgery	11 (35.5%)	14 (48.3%)	7 (77.8%)	0.078
Major complication	5 (3.0%)	22 (9.8%)	12 (18.8%)	***0.033***
Curative surgery	5 (15.2%)	20 (23.8%)	10 (38.5%)	0.115
Palliative surgery	0 (0.0%)	2 (14.3%)	2 (28.6%)	0.195

A *p*-value<0.05 indicates statistical significance.

Table 5
Univariate and multivariate analysis for factors independently associated with postoperative complications.

Factors	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
ASA class III-IV	1.97 (1.23–3.16)	***0.005***		
Coronary artery disease	4.95 (1.89–12.98)	***0.001***	5.29 (1.79–15.56)	***0.002***
Tumor size >5 cm	1.69 (1.11–2.50)	***0.015***	1.92 (1.16–3.16)	***0.011***
Albumin <3.5 g/dl	0.5 (0.31–0.81)	***0.005***		
Operative time >210 min	2.36 (1.49–3.71)	***<0.001***	2.66 (1.55–4.59)	***<0.001***
Age ≥70 years	2.88 (1.88–4.42)	***<0.001***	3.74 (2.26–6.18)	***<0.001***

A *p*-value<0.05 indicates statistical significance.
Abbreviations: OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; ASA, American Society of Anesthesiologists physical status score.

complications and what causes them is the key to reducing postoperative complications. Baiocch et al. proposed an international consensus on a list of complications after gastrectomy for malignancy [6]. Although postoperative complications are often unavoidable after gastrectomy, increased awareness of the factors that contribute to complications will reduce their incidence and improve patient outcomes. In general, surgeons tend to perform a less extensive procedure that may reduce the postoperative morbidity and mortality in elderly patients. Our study demonstrated the less proportion of the extensive gastrectomy and radical lymphadenectomy in octogenarian group.

The rate of postoperative complications in this study was comparable to those reported from previous studies. Even though palliative gastrectomy is assumed to be less invasive with less lymphadenectomy, the postoperative complication rate was reported to be as high as 42% [11]. However, we found no significant difference in the rates of overall or major complications compared among patients who underwent subtotal, total or extended gastrectomy. Gockel et al. reported a similar finding [12]. In contrast, Lee, et al. reported significantly more complications in the extended gastrectomy group compared to the other two procedures [13].

Our analyses showed no significant correlation between surgical intent and complication, or between surgical extent and complication. We found a similar rate of SSI, anastomotic and duodenal leakage, perforation, chyle leakage, postoperative pancreatic fistula, intra-abdominal collection, and bowel obstruction between the curative and palliative groups. Prevention of SSI at our center is in accordance with current recommendations [14–16] that include alcohol-based antiseptic solution for skin preparation, glycemic control, thermal regulation, and prophylactic antimicrobial agents. Superficial and deep surgical site infections are both managed by adequate local drainage and proper antibiotics as clinically indicated. Anastomotic leakage, which is one of the most undesirable postoperative complications, occurred less frequently in our study than in previous studies. The 3 cases of anastomotic leakage in our study occurred at the site of the esophagojejunostomy anastomosis. All 3 patients had stable hemodynamics without peritonitis, so empirical antibiotics and parenteral nutrition were prescribed, which resulted in successful conservative management. In the past, anastomotic integrity was evaluated by inspection, air-leak test, methylene blue feeding, or intraoperative endoscopy. However, postoperative leakage may occur up to 4.9% of cases with negative air-leak test [17], and in 3.9% of cases with negative methylene blue leakage [18]. A more recent technique that can be used to investigate for anastomotic integrity is indocyanine green fluorescence angiography [19,20]. We also found one case of duodenal stump leakage after subtotal gastrectomy. Fortunately, that patient had an abdominal drain placed intraoperatively, so drainage was sufficient to allow for successful conservative management of this patient. One case of delayed small bowel perforation (clinical signs: abdominal distension and sepsis) was identified at 6 days after total gastrectomy with en bloc left adrenalectomy. Percutaneous access was first attempted to evacuate intra-abdominal collection, but bilious fluid was found, so surgical exploration was successfully performed to repair the perforation and decontaminate the abdominal cavity. Chyle leakage, which commonly occurs after lymphadenectomy [21], was found in curative gastrectomy cases only. Diagnosis was made after milky fluid was observed in the abdominal drain, and the triglyceride level in the fluid was over 130 mg/dl. Total resolution was achieved after dietary modification to non-fat and medium-chain triglyceride diet. Postoperative pancreatic fistula (POPF) was defined according to the International Study Group for Pancreatic Surgery [22]. An increased rate of POPF was observed in concomitant splenectomy and gastrectomy, and in concomitant gastrectomy and pancreatectomy. Leakage could be controlled conservatively in most cases. Gastroparesis was significantly more often encountered in the palliative gastrectomy group. This may be explained by the palliative intent to relieve a gastric outlet obstruction from advance disease, which is a precipitating factor for gastroparesis. These patients were treated with gastric decompression and nutritional supplementation. Concerning postoperative bleeding, one extremely old patient died of postoperative bleeding after curative subtotal gastrectomy. Bleeding occurred at the anterior surface of the pancreas, and reoperation was unable to stop the bleeding. Careful and cautious inspection of the surgical bed and anastomosis is essential for

avoiding/minimizing early postoperative bleeding [23]. The other complications were medical complications, and there was no significant difference between the curative and palliative groups for any of those complications.

Several studies reported that older age status may adversely influence postoperative morbidity, especially among octogenarians. Tran et al. enrolled 953 patients, and 127 of them were aged older than 80 years. They found significantly more complications in the octogenarian group than in the younger age group (54.3% *vs.* 41.2%, respectively) [24]. Other studies also reported more complications among older aged patients compared to younger patients [25–28]. In the present study, we divided patients into the 3 following groups: adult (age 18–59 years), older adult (age 60–79 years), and octogenarian (age 80 years and over). We found that the octogenarian group had significantly more overall complications after curative gastrectomy. In contrast, octogenarians who underwent palliative gastrectomy had similar overall and major complications to those in the other two age groups. This may be due to the lower number of cases in the palliative group. Our analysis to determine association between age and postoperative complications revealed significant association between age 70 years and over and increased risk of complications in curative gastrectomy, and between age 80 years and over and increased risk of complications in palliative operations. Despite higher adverse outcomes were followed in elder patients, survival outcome remained equivalent among operable disease in age over 70 years [29]. Similar to the results from a previous study [30], we found patient age equal to or greater than 70 years, underlying CAD, tumor size greater than 5 cm, and prolonged operative time >210 min to be independently associated with postoperative complication in multivariate analysis. Physician awareness of these risk factors will reduce postoperative complications and improve patient outcomes.

4.1. Limitations

This study has some mentionable limitations. Most notably, because of our study was a retrospective analysis, we encountered a lack of complete information relative to complication diagnosis, management, and follow-up data. However, our complication and mortality rates are comparable to those previously reported. Another limitation is our study's single-center design. Further prospective study is needed to confirm the findings of this study.

5. Conclusion

The purpose and extent of surgery were not associated with incidence and severity of postoperative morbidity. Age ≥70 years was associated with higher postoperative complication after curative gastrectomy, and age ≥80 years was associated with adverse events after palliative gastrectomy. Patients with age ≥70 years, CAD, tumor size >5 cm, and operative time >210 min should be considered high-risk patients.

The following information is required for submission. Please note that failure to respond to these questions/statements will mean your submission will be returned. If you have nothing to declare in any of these categories then this should be stated.

Ethical approval

The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB) (COA no. Si 082/2018).

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None.

Author contribution

Thammawat Parakonthun-study concept and design, data collection, data analysis, writing, review.Bhurithat Sirisut-sutdy design, data collection, data analysis, writing.Chawisa Nampoolsuksan-data analysis, writing.Gritin Gonggetyai-data analysis, writing.Jirawat Swangsri-data collection, data analysis, review.Asada Methasate-data collection, data analysis, writing, review.

Conflicts of interest

None.

Registration of research studies

1. Name of the registry:
2. Unique Identifying number or registration ID:
3. Hyperlink to your specific registration (must be publicly accessible and will be checked):

Guarantor

Thammawat Parakonthun, MD.
Asada Methasate, MD, PhD.

Consent

The study was conducted in accordance with the Declaration of Helsinki and written informed consent to participate was not obtained from study subjects due our study's retrospective and anonymity-preserving design.

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Appendix A. Supplementary data

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