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Retrospective Analysis of Complications and Causes of Mortality in Patients Undergoing Esophagectomy for Esophageal Cancer

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Abstract

Background: Esophageal cancer is the eighth most common cancer and the sixth most common cause of death from cancer. Esophagectomy is still the essential treatment for esophageal cancer despite its high morbidity rate. The prediction of complications that are likely to appear after surgery can be the most critical factor in reducing morbidity.

Objectives: The present study aimed to examine the postoperative complications and causes of mortality in patients undergoing esophagectomy for esophageal cancer.

Methods: Data from 34 patients with esophageal adenocarcinoma or squamous cell carcinoma undergoing esophagectomy in the general surgery clinic of Çukurova University Medical School Hospital were collected and analyzed retrospectively between January 1, 2011, and January 1, 2020. Postoperative complications were identified according to the Clavien-Dindo classification (CD). "The patients were assigned into two groups (Group 1 and Group 2). Group 1 and Group 2 included patients with CD grade <3 and CD grade >3, respectively."

Results: The mean±SD age of patients (n=34) undergoing resection for esophageal cancer was obtained at 56.38±11.00 years. The ratio of female to male patients was equal. The most common accompanying disease was diabetes mellitus. The number of patients with the American Society of Anesthesiologists score 3 was higher in Group 2 (P=0.034). The tumor was most frequently located in the lower thoracic esophagus of patients in Group 1 and Group 2, and the rate of cervical anastomosis was higher in Group 2. The rate of manual anastomosis was higher in both groups. Respiratory complications were the most frequent complication in both groups; however, a higher rate of respiratory complications was observed in Group 2 (P=0.038). The postoperative 30-days mortality and the reoperation rate were higher in Group 2.

Conclusion: Radical surgery for esophageal cancer results in a high rate of complications and death due to the location of the tumor and diagnosis at the advanced stage. Complications and mortality may result from patient-related factors and the surgical technique. The diagnosis and treatment of the correctable causes before surgery can enhance the chance of survival and the quality of life in patients.

Keywords: Clavien-Dindo classification, Complication, Esophageal cancer, Mortality

1. Background

The incidence of esophageal cancer is 6.4 per 100,000 people worldwide, and it is the sixth most common cause of death from cancers. This cancer is prevalent in East Asian and South American countries (1) and appears more frequently in Eastern Anatolia in Turkey. Most of the patients have an advanced stage of the disease when diagnosed and the mortality rate is nearly 50% in the patients who can be operated (2). The five-year survival is lower than 20% in patients with esophageal cancer. Esophageal cancer is rarely observed in people under the age of 30, and the mean age of patients when the disease appears is 60 years. The condition is 2-4 times more frequent in males than in females (3).

Patients with esophageal cancer cannot be diagnosed during the early stages since this condition is asymptomatic in the early stages due to its anatomical features. Therefore, patients usually present with an advanced stage of the tumor. In addition, as the disease invades the organs neighboring the mediastinum, most of the patients are not likely to undergo curative surgery (4). Therefore, surgical success depends on the early diagnose of this cancer. The patients having the most prolonged survival are those who can be operated (3). It is also important to determine the tumor grade accurately for the treatment plan and prognosis.

In the current study, the complications developing in the postoperative period as well as factors affecting patients undergoing resection for esophageal cancer were analyzed retrospectively.

2. Objectives

The present study aimed to examine the postoperative complications and causes of mortality in patients undergoing esophagectomy for esophageal cancer.

3. Methods

The present study had a retrospective design and included 34 patients undergoing surgery for esophageal adenocarcinoma or squamous cell carcinoma in the general surgery clinic of Çukurova University Medical School Hospital between January 1, 2011, and January 1, 2020. The patients with esophageal cancer undergoing palliative surgery (aged over 80 years and FEV1<1.25, an ejection fraction rate <%40, and a tumor length >8cm), the patients aged under 18 years, and those without medical records were excluded from the study. Ethical approval (approval number: 102; approval date: August 7, 2020) was obtained from the Ethical Committee in Çukurova University Medical School.

The diagnosis of esophageal cancer was based on histopathological examinations of biopsy specimens obtained during endoscopy. The degree of tumor invasiveness was evaluated using ultrasonography when necessary. Tumor stages were determined using computed tomography with contrast enhancement and positron emission tomography of the thorax and the upper and lower quadrants of the abdomen.

Data were gathered from the hospital records of patients and through phone calls. Subsequently, the obtained data were analyzed retrospectively .

The severity of complications was determined through Clavien-Dindo (CD) grading. Grade 1 included minor complications that did not require treatment or required minor antibiotic or drug therapy. Grade 2 complications were defined as potentially life-threatening complications requiring intervention and the need to stay in a hospital longer than twice the length of a normal hospital stay. Grade 2 complications were divided into two subgroups (Group 2a and Group 2b), according to the severity of the treatment chosen for the complication. Grade 2a complications require only drug therapy, and grade 2b complications require an invasive procedure. Grade 3 complications are those involved with permanent problems or complications leading to organ resection. A grade 4 complication is death due to a complication (5). The patients with CD grade 3 complications (5) were assigned into Group 1, and those with grades 4 and 5 complications were assigned into Group 2. Data about demographic features, body mass index, accompanying diseases, American Society of Anesthesiologists (ASA) scores, reception of neoadjuvant therapy, preoperative laboratory results, tumor locations, and disease stage were documented. The surgical technique (open and laparoscopic) was evaluated in terms of the duration of surgery; the mean amount of blood loss; intraoperative complications; resection of other organs; tumor diameter, type and grade on histological examination, the total number of lymph nodes, and metastatic lymph nodes removed, disease stage on pathological examination, postoperative complications, respiratory and cardiac complications, surgical wound infection, anastomosis leakage, postoperative hospital stay, postoperative 30-days mortality, long-term anastomosis stricture, the presence of local recurrences and metastases, the mean length of follow-up, and the mean duration of survival.

Anastomosis leakage was considered a disruption in the anastomosis integrity documented by using clinical, radiological, and surgical tools. The surgical site infection was regarded as superficial or deep incisional infection, according to the definition made by the Disease Control Center (6). Unplanned reoperation was considered as surgery under spinal or epidural anesthesia for any reasons within 30 days from the index operative procedure, except for the follow-up procedures, based on the results of pathological examinations, according to the definition by American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) (7). Tumor staging was performed following the Tumor-Nod-Metastasis (TNM) 2010 or 2016 staging system.

Data were analyzed using the SPSS software (Version 23.0). Categorical variables were presented as numbers and percentages. Comparisons of the categorical variables were carried out using Pearson's chi-square test. Shapiro-Wilk was used to determine the normal distribution of data. The student's t-test was utilized to compare the normally distributed data of continuous variables and the Mann-Whitney U test was employed to compare the continuous variables without normal distribution. A p-value less than 0.05 ($P<0.05$) was considered statistically significant in this study.

4. Results

The patients were categorized into Group 1 and Group 2, according to the CD classification of their complications. Group 1 included 22 patients with CD grade <3 and Group 2 included 12 patients with CD grade >3. The number of smokers was the same in both groups. However, the number of patients who consumed alcohol was significantly higher in Group 2 ($P=0.025$). Regarding ASA scores, the number of patients with the ASA scores =3 was significantly higher in Group 2 ($P=0.034$). Preoperative hemoglobin ($P=0.671$) and albumin levels were similar in both groups ($P=0.824$) (Table 1).

The tumor was located in the lower thoracic esophagus in many cases in Group 1 and Group 2. Conventional surgery was more frequent and cervical anastomosis was the most commonly performed

Table 1. Demographic and clinical features of the patients

		Group 1 <3 (n: 22) n(%)	Group 2 ≥3 (n: 12) n(%)	P-value*
Gender	Male	10 (45.5)	7 (58.3)	0.473[c]
	Female	12 (54.5)	5 (41.7)	
Smoking	No	16 (72.7)	6 (50.0)	0.185[c]
	Yes	6 (27.3)	6 (50.0)	
Age (year)		55.41±10,69	58.17±11.81	0.493[a]
BMI (kg/m²)		24.12±4.37	23.46±3.60	0.656[a]
Hemoglobin (gr/dl)		12.15±1.45	12.40±2.04	0.671[a]
Albumin (mg/dl)		3.45±0.54	3.41±0.60	0.824[a]
Alcohol intake	No	20 (90.9)	7 (58.3)	0.025[c]
	Yes	2 (9.1)	5 (41.7)	
ASA	1	5(22.7)	4(33.3)	0.034[c]
	2	16(72.7)	4(33.3)	
	3	1(4.5)	4(33.3)	
Neoadjuvant therapy	Chemoradiotherapy	12(54.5)	9(75.0)	0.241[c]
	No	10(45.5)	3(25,0)	

* P<0.05, a: Independent Samples t-test; c: Chi-square test; Values presented as Mean±SD; Median (min-max); ASA: American Society of Anesthesiologists; BMI: Body mass index

anastomosis. In addition, the duration of surgery and the amount of intraoperative blood loss were similar in both groups (Table 2).

The mean±SD number of the dissected lymph nodes was 19.73±10.90 and 17.08±7.24 in Group 1 and Group 2, and the mean±SD number of the metastatic lymph nodes was 1.23±2.81 and 0.75±1.60 in Group 1 and Group 2, respectively, which showed no significant difference. In Group 2, the tumor size was more frequently T4 (41.7%), though it was not statistically significant (P=0.213). Stage 0, 1, and 2 of the disease were more frequent in Group 1, though the difference was not statistically significant (P=0.327) (Table 3).

Group 2 had a significantly higher rate of respiratory complications (P=0.038), cardiac complications (P=0.048), anastomosis leakage (P<0.001), and recurrent laryngeal nerve (RLN) injury (P=0.014). The study groups did not significantly differ in terms of surgical site infections (P=0.076) and rates of chylous fistula (P=0.169). Group 2 had significantly higher rates of reoperation (P=0.001) and postoperative 30-days mortality (P=0.048). Moreover, postoperative hospital stay was significantly longer in Group 2 (30.42±22), compared to Group 1 (18.0±8.59 days) (P=0.0289). The rates of anastomosis stricture (P=0.486) and reflux esophagitis (P=0.654) during follow-ups did not significantly differ between the two groups either (Table 4).

There was no significant difference in terms of the local recurrence rate between the groups (4.5% in Group 1 and 8.3% in Group 2; P=0.654). The metastasis rate was not significantly different in both groups (9.1% in Group 1 and 25% in Group 2; P=0.211). However, the mean±SD survival time was significantly shorter in Group 2 (48.06±7.22 months in Group 1 and 23.51±5.09 months in Group 2; P=0.017) (Table 5 and Figure 1).

Table 2. Surgery features

		Group 1 <3 (n: 22) N (%)	Group 2 ≥3 (n: 12) N (%)	P-value*
Tumor Location	Lower thoracic esophagus	14 (63.6)	7 (58.3)	0.822[c]
	GEJ	2 (9.1)	1 (8.3)	
	Middle thoracic esophagus	5 (22.7)	4 (33.3)	
	Upper thoracic esophagus	1 (4.5)	0 (0.0)	
Anastomosis	Intrathoracic	11 (50.0)	5 (41.7)	0.642[c]
	Cervical	11 (50.0)	7 (58.3)	
Surgical Technique	Open	13 (59.1)	8 (66.7)	0.664[c]
	Laparoscopy assisted	9 (40.9)	4 (33.3)	
Anastomosis Technique	Manual	15 (68.2)	9 (75.0)	0.677[c]
	Stapler	7 (31.8)	3 (25.0)	
Duration of Surgery		290.0±97,08	282.08±94.90	0.820[a]
Intraoperative blood loss		205 (200-300)	100 (80-150)	0.083[b]

* P<0.05, [a]: Independent Samples t-test, [b]: Mann Whitney U test, c: Chi square test and Fisher exact test, Values presented as Mean±SD and Median (95% CI)

Table 3. Results of the pathological examinations

		Group 1 <3 (n: 22) N (%)	Group 2 ≥3 (n: 12) N (%)	P-value*
Tumor Diameter		2.77±2.32	3.22±1.87	0.571[a]
The number of dissected lymph nodes		15.5 (13-25,5)	15.5 (13-22)	0.458[b]
The number of metastatic lymph nodes		0.0 (0-0)	0 (0-1)	0.593[b]
Pathologic T	T0	6 (27.3)	2 (16.7)	0.213[c]
	T1a	1 (4.5)	0 (0.0)	
	T1b	2 (9.1)	0 (0.0)	
	T2	6 (27.3)	2 (16.7)	
	T3	5 (22.7)	2 (16.7)	
	T4	2 (9.1)	5 (41.7)	
	T4b	0 (0.0)	1 (8.3)	
Pathologic N	N0	17 (77.3)	9 (75.0)	0.566[c]
	N1	1 (4.5)	2 (16.7)	
	N2	3 (13.6)	1 (8.3)	
	N3	1 (4.5)	0 (0.0)	
Pathologic Grade	0	5 (22.7)	2 (16.7)	0.327[c]
	1A	4 (18.2)	0 (0.0)	
	1B	5 (22.7)	2 (16.7)	
	2B	1 (4.5)	2 (16.7)	
	3A	3 (13.6)	2 (16.7)	
	3B	2 (9.1)	0 (0.0)	
	3C	2 (9.1)	3 (25.0)	
	4B	0 (0.0)	1 (8.3)	
Pathologic complete response	Yok	17 (77.3)	10 (83.3)	0.676[c]
	Var	5 (22.7)	2 (16.7)	

* P<0,05, [a]: Independent Samples t-test, [b]: Mann Whitney U test, c: Chi-square test and Fisher exact test, Values presented as Mean±SD and Median (95% CI)

Table 4. Results of the postoperative follow-ups

		Group 1 <3 (n: 22) N (%)	Group 2 ≥3 (n: 12) N (%)	P-value*
Respiratory complications	None	17 (77.3)	5 (41.7)	0.038[c]
	Unplanned intubation	1 (8.3)	2 (9.1)	
	Pleural effusion, thorax tube	1 (8.3)	0 (0.0)	
	Pneumonia	3 (25.0)	5 (22.7)	
Cardiac complications	No	22 (100.0)	10 (83.3)	0.048[c]
	Yes	0 (0.0)	2 (16.7)	
Anastomosis leakage	No	22 (100.0)	5 (41.7)	<0.001[c]
	Yes	0 (0.0)	7 (58.3)	
Surgical site infection	No	20 (90.9)	8 (66.7)	0.076[c]
	Yes	2 (9.1)	4 (33.3)	
RNL injury	No	22 (100.0)	9 (75.0)	0.014[c]
	Yes	0 (0.0)	3 (25.0)	
Chylous fistula	No	22 (100.0)	11 (91.7)	0.169[c]
	Yes	0 (0.0)	1 (8.3)	
Reoperation	No	22 (100.0)	7(58.3)	0.005[c]
	Anastomosis leakage	0 (0.0)	4 (33.3)	
	Bleeding	0 (0.0)	1 (8.3)	
30-days mortality	No	22 (100.)	10 (83.3)	0.048[c]
	Yes	0(0.0)	2 (16.7)	
References to the hospital within 90 days of surgery	No	18 (81.8)	11(91.7)	0.438[c]
	Yes	4 (18.2)	1 (8.3)	
Anastomosis stricture during follow-ups	No	16 (72.7)	10 (83.3)	0.486[c]
	Yes	6 (27.3)	2 (16.7)	
Reflux esophagitis	No	21 (95.5)	11 (91.7)	0.654[c]
	Yes	1 (4.5)	1 (8.3)	
Postoperative intensive care unit stay		4.5 (4-6)	6.5 (2-15)	0.162[b]
Postoperative hospital stay		16.0 (14-19)	25.5 (14,01-30)	0.028[b]

* P<0,05, [a]: Independent Samples t-test, [b]: Mann Whitney U test, c: Chi square test and Fisher exact test, Values presented as Mean±SD and Median (95% CI)

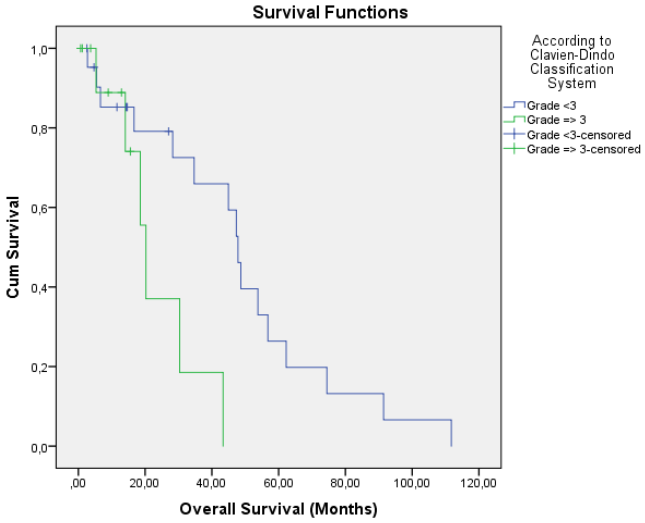

Figure 1. Total survival according to the Clavien-Dindo classification system

5. Discussion

Esophagectomy has been reported to be associated with high morbidity and mortality despite recent advances in surgical procedures and postoperative management (8). Complications occurring after esophagectomy considerably affect postoperative mortality. Pulmonary complications and anastomosis leakages are still severe complications and need to be diagnosed early and treated appropriately. Various factors, such as older age, prior pulmonary dysfunction, poor performance status, the adoption of open thoracic approaches for esophagectomy, insufficient nutrition, and preoperative smoking are related to the development of pulmonary complications after esophagectomy. Neoadjuvant therapy may also lead to pulmonary complications due to prior pathologies of other organ systems (9). Pneumonia, atelectasis, aspiration, and respiratory insufficiency requiring prolonged intubation may appear in the postoperative period. The rate of pulmonary complications varies from 20% to 50%.

Only complications grade 3 and higher (according to the CD classification) were considered in the present study. The patients with the CD grade 3 and higher were assigned to Group 2 and those with the CD grade lower than 3 were assigned to Group 1. Out of 34 patients undergoing esophagectomy, 12 (35.2%) patients were found to have the CD grade 3 and higher and formed Group 2. Out of these 12 patients, seven (58%) had pulmonary complications. Out of seven patients with pulmonary complications, five had pneumonia and two had a sudden need for unplanned intubation. Moreover, anastomosis leakage was observed in 7 (58%) out of 12 patients with pulmonary complications. None of the patients in Group 1 developed anastomosis leakage. In addition, 2 (16%), 4 (32%), 3 (25%), and 1 (8%) patients had cardiac complications, surgical site complications, RLN injury, and chylous fistula, respectively. The present study showed that the most frequent complications included pulmonary complications and anastomosis leakages, however, they were statistically insignificant (P>0.05). It is worth mentioning that this finding was inconsistent with the existing literature. Pneumonia was the most frequent pulmonary complication.

Anastomosis leakage is regarded as a remarkable risk factor for the development of cervical stricture. Based on the existing literature, cervical stricture is more frequently encountered in cervical anastomoses. In a study conducted by Cooper et al., anastomosis leakage was shown to be an independent risk factor for the development of anastomosis stricture (10). In seven patients with anastomosis leakage who were assigned into Group 2, leakage appeared following cervical anastomosis in 5 (71.42%) patients and following intrathoracic anastomosis in 2 (28.3%) patients. In addition, two patients with anastomosis leakage were suffering from long-term anastomosis stricture (28.5%).

Some studies showed a strong association between advanced age during esophagectomy and poor prognosis (11, 12). Cardiac and pulmonary complications are particularly more frequent in older age groups (13-15). Group 2 had a higher mean age; however, the difference was not statistically significant.

Esophageal cancer is more common in males. The female to male ratio was reported to be 1/6 (16). The results of a study by Wang et al. conducted on 110 patients with esophageal cancer indicated that gender is significantly correlated with postoperative complications. They noted that 45% of the female patients and 19% of the male patients had

postoperative complications (P=0.017) (17). Although the effect of age was found to be insignificant on complications after esophageal surgery in the current study, the female to male ratio was 5/7, which was consistent with the existing literature.

Many studies have revealed that smoking plays an important role in the development of esophageal cancer and other cancers. Türkdoğan M. et al. reported that 58% of the patients with upper gastrointestinal cancer smoked one or more packages of cigarettes per day for 10 years or longer (P<0.04) (18). In the present study, 6 (50%) out of 12 patients in Group 2 and 6 (27.3%) out of 22 patients in Group 1 were found to be smokers. Although the difference was insignificant (P<0.05), a higher rate of the patients in Group 2 were cigarettes smokers. Moreover, 5 (41.7%) out of 12 patients in Group 2 and 2 (9.1%) out of 22 patients in Group 1 consumed alcohol. Alcohol intake was shown to increase post-surgery complications significantly (P=0.025), which was in line with the existing literature.

Only a few large studies have examined the role of comorbidities in post-surgery complications for esophageal cancer. In a multi-center cohort study conducted on 955 patients undergoing surgery for upper gastrointestinal cancer in England, a higher comorbidity score was shown to be associated with an increased risk of post-surgery complications. However, the study did not present specific data about esophageal cancer surgery (19). A study performed on 2,315 patients with esophageal cancer from 73 hospitals in the United States revealed an increased risk of complications in the patients with various comorbidities, such as heart disease, diabetes, and hypertension (19,20). In line with the existing literature, in the present study, 4 (33%) out of 12 patients in Group 2 and only 1 (4.5%) out of 22 patients in Group 1 had the ASA score of 3, indicating a significant difference between the two groups (P<0.05). The obtained results in the present study revealed that the increase of ASA scores complications (which were already high) became inevitable in esophagectomy.

Recently, it has been agreed worldwide that neoadjuvant therapy is necessary for advanced esophageal cancer that can be resected. While neoadjuvant chemoradiotherapy (CRT) is a standard treatment in Western countries, neoadjuvant chemotherapy is preferred in Japan (21). Van Hagen et al. in their multi-center randomized study revealed that neoadjuvant CRT can be beneficial to patients with esophageal cancer and that chemotherapy or CRT has become the first treatment option to improve general survival in some patients (22). However, there are concerns about preoperative CRT due to increased incidence of cardiopulmonary side-effects followed by increased morbidity and mortality (23). In the current study, 12 (54.5%) out of 22 patients in Group 1, and 9 (75%) out of 12 patients in Group 2 received neoadjuvant CRT. Although the difference between the groups was statistically insignificant (P>0.05), the number of patients with CD grade 3 or higher who received CRT was high, which is consistent with the existing literature .

Currently, the primary treatment for esophageal cancer is surgical-based comprehensive therapy, including neoadjuvant and adjuvant therapy, such as chemotherapy and/or radiotherapy. Various techniques are utilized for the surgical treatment of esophageal cancer. The adopted surgical procedure is important in terms of postoperative morbidity and mortality. Although the transhiatal technique could provide better outcomes with respect to complications, lymphadenectomy was performed in our clinic. In addition, Ivor Lewis esophago-gastrectomy (Laparotomy and right thoracotomy) and McKeown esophagogastrectomy (right thoracotomy, laparotomy, cervical anastomosis) were utilized due to their ease of implementation. Generally, McKeown esophagogastrectomy is performed for the treatment of the tumors with upper and middle thoracic locations, and Ivor Lewis esophagogastrectomy is performed for the treatment of the tumors with lower thoracic locations. Chassery et al. compared laparotomy, right thoracotomy, and intrathoracic esophagogastrectomy with laparotomy, right thoracotomy, cervical exploration, and cervical esophagogastric anastomosis in their prospective randomized study and reported that the incidences of cervical anastomosis leakage and intrathoracic anastomosis leakage were 26% and 4%, respectively (24). Other studies showed that the rate of cervical anastomosis leakage was higher than intrathoracic anastomosis leakage (25). In the present study, transhiatal surgery was not performed on any of the patients; however, Ivor Lewis and McKeown esophagogastrectomy was performed. Out of 34 patients included in the study, 16 and 18 patients underwent intrathoracic anastomosis and cervical anastomosis, respectively, depending on the tumor locations. Most of the tumors appear in the lower two-thirds of the esophagus. In a study performed by Tuncer et al., esophageal cancer was frequently encountered, and it was revealed that four-fifths of the patients had cancer located in the lower esophagus (2). In the current study, the tumor was located in the middle-upper thoracic region in 30% of the patients. Anastomoses were performed in the cervical region in patients with a tumor in the middle and lower thoracic region since in these patients the tumor remained in the lower thoracic region after neoadjuvant treatment. Therefore, the number of cervical anastomoses was high. In total, 11 (50%) patients out of 22 patients in Group 1 underwent cervical anastomosis and 11 (50%) patients had thoracic anastomosis. Moreover, 5 (41.7%) patients out of 12 patients in Group 2 underwent thoracic

anastomosis, and 7 (58.3%) underwent cervical anastomosis, which led to more complications. However, the results were not significant, which was inconsistent with the existing literature. A total of seven patients in Group 2 had anastomosis leakages, which developed after cervical anastomosis in 5 (71.4%) patients and intrathoracic anastomosis in 2 (28.6%) patients. In the present study, 71.4% of anastomotic leaks were due to cervical anastomosis, which was consistent with the rates in the literature. In addition, the patients undergoing laparoscopy-assisted esophagectomy had a lower rate of complications.

The accurate determination of the disease stage is essential for cancer treatment and research. It also plays an important role in cancer prognosis (26). Some studies have demonstrated that advanced cancer stages may lead to an increased risk of surgical complications. McCulloch et al. reported that a stage 4 disease is a risk factor for postoperative complications and mortality (19). Viklund et al. in their study on 275 patients with esophageal cancer and gastric cardia cancer found that about half (51%) of the patients had stage 3 and 4 tumors. However, they noted that the disease stage did not affect the risk of postoperative complications (27). In the present study, 6 (28%) out of 21 patients with stage 0, 1, and 2 diseases were evaluated and were found to have a CD grade 3 and higher. In addition, 6 (46%) out of 13 patients with stage 3-4 disease were found to have a CD grade 3 or higher. Eventually, although the advanced stages of the diseases did not significantly affect postoperative complications (P=0.327), the stage 3-4 disease created a high rate of postoperative complications.

6. Conclusion

Based on the obtained results in this study, it can be suggested that surgery for esophageal cancer leads to high rates of complication and mortality due to the anatomic location of cancer and diagnosis of cancer in its advanced stages. However, both patient-related and surgical complications can be reduced even though these complications and mortality cannot be prevented completely. Moreover, neoadjuvant therapy and breathing exercises before surgery should be recommended to patients with preoperative pulmonary insufficiency. As previously mentioned, smoking and alcohol intake can have an impact on postoperative complications and mortality in patients undergoing esophageal surgery; therefore, the patients must be recommended to give up these habits before surgery. In addition, it should be kept in mind that the patients provided with nutritional support can develop fewer complications after neoadjuvant therapy and surgical resection.

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Footnotes

Authors' contributions: M.H.A and OY conceived the original idea and planned the study. O.Y, C.K.P, U.T, and M.O.G supervised the project. M.H.A, U.T, M.O.G, and I.C.E wrote and revised the manuscript. I.A. and C.K.P performed the statistical analysis.
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