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The Relationship among Demographic Factors, Treatment Modalities, Surgical Techniques, and Postoperative Complications in the Management of Esophageal Squamous Cell Carcinoma

Godwin Botwe[1*], Weifeng Tang[2*], Michael Adu-Frimpong[3], Yusif M. Mukhtar[3]
[1]*School of Medicine, Jiangsu University, Zhenjiang, Jiangsu, 212013, People's Republic of China*
[2]*Department of Cardiothoracic Surgery, First People's Hospital, Zhenjiang, Jiangsu, People's Republic of China*
[3]*School of Pharmacy, Jiangsu University, Zhenjiang, Jiangsu, 212013, People's Republic of China*
**Corresponding authors: Godwin Botwe*

Abstract
Background *Surgery alone or surgery after neoadjuvant chemoradiotherapy or chemotherapy, often cause complications of varying degrees of severity. There seems to be an association between these complications and patient age, gender, as well as the treatment modalities and surgical techniques employed. This study investigated these probable relationships with regards to the current management of esophageal squamous cell carcinoma (ESCC).*
Methods *A total of 245 ESCC patients who had received either neoadjuvant chemoradiotherapy or chemotherapy plus surgery or surgery alone, were recruited for this study. The relationships among patients' demographic factors, treatment modalities, surgical techniques, as well as postoperative complications were analyzed.*
Results *Two hundred and forty patients (98%) received surgery alone, 3 (1.2%) received neoadjuvant chemotherapy plus surgery, and 2 (0.8%) received neoadjuvant chemoradiotherapy plus surgery. Ivor-Lewis approach was the main surgical technique used. Pneumonia and pleural effusion were among the most frequent postoperative complications. There was a significant association between age and postoperative complications (χ^2=10.194, P=0.017). Gender and postoperative complications also had a significant association (χ^2=9.274, P=0.026). Neither age nor gender had a significant correlation with treatment modalities (χ^2=1.297, P=0.523 and χ^2=1.348, P=0.510, respectively). Surgical techniques and postoperative complications had no significant relationship (χ^2=9.308, P=0.409).*
Interpretations *Age and gender are risk factors that determine the occurrence of postoperative complications. Patients can be offered any potentially good treatment irrespective of their age and gender. The surgical approach used may not be a risk factor to postoperative complications.*
Keywords: *Esophageal squamous cell carcinoma, Locally advanced disease, Neoadjuvant chemoradiotherapy, Neoadjuvant chemotherapy, Surgical resection, Postoperative complication*

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I. Introduction

Cancer in general, is a global burden. In 2012, it was estimated that about 14.1 million new cases and 8.2 million deaths occurred worldwide. (Torre, Bray et al. 2015) Among all global cancer incidence, esophageal carcinoma places the eighth most common carcinoma (Montgomery, Basman et al. 2014), and is estimated to have affected 746, 000 people globally as of 2015 (Hay, Jayaraman et al. 2016), resulting in 439,000 deaths. (Wang, Naghavi et al. 2016) Although it occurs all over the world, its incidence and mortality are rather higher in Eastern Asia and Eastern and Southern parts of Africa. (Zhang, Jin et al. 2012, Middleton, Bouaoun et al. 2018) The predominant histological subtype in these regions is esophageal squamous cell carcinoma (ESCC). (Zhang, Jin et al. 2012, Arnold, Soerjomataram et al. 2015) Age and gender have been implicated in the incidence of esophageal carcinoma. (Chong, Telisinghe et al. 2015, Middleton, Bouaoun et al. 2018) Globally, esophageal carcinoma has a higher incidence in persons above 60 years (Tobias, Hochhauser et al. 2013), and in the United States the median age is 67 years. (Ginsberg 1998) Esophageal squamous cell carcinoma has been shown to occur predominantly in males worldwide, especially where the incidence of esophageal cancer in general is high. (Zhang, Jin et al. 2012, Chasimpha, Parkin et al. 2017) It is estimated that the global incidence

of ESCC is 2.4 times more in males than females. (Hyland, Freedman et al. 2013, Chasimpha, Parkin et al. 2017) (Middleton, Bouaoun et al. 2018) Gender has also been shown to play a role in treatment outcomes (Nishino, Yoshida et al. 2017), but its influence on decisions about the choice of treatment, has not yet been clarified. Understanding the relationships among age and gender of patients, treatment modalities, surgical techniques, and postoperative complications is a good course in the management of esophageal squamous cell carcinoma.

Several techniques may be used in esophagectomy. These include Ivor-Lewis (also Lewis-Tanner) approach, McKeown approach, and transhiatal approach (Teng and Karl 1999, Davies, Forshaw et al. 2008) (Watanabe, Baba et al. 2012), with the first two being transthoracic approach. (Ma, Liu et al. 2015) Recent studies have shown that the Mckeown technique is the most widely practiced approach in China. (Huang, Wang et al. 2015, Ma, Liu et al. 2015) Regardless of the surgical approach, surgery after neoadjuvant therapy or immediate surgery carries a risk of postoperative complications, as have been shown by several studies. (Bagheri, RajabiMashhadi et al. 2012, Ma, Liu et al. 2015) They include pneumonia or pneumothorax, anastomotic fistula or leakages, hepatic insufficiency, surgical wound infections and so on. Advanced age is a risk factor for postoperative complications, especially in patient above 60 years. (Wright, Kucharczuk et al. 2009) (Ruol, Portale et al. 2007) The higher the patient's age, the greater risk of postoperative complications occurring. Besides, male gender has been reported to increase the risk of postoperative complications. (Wright, Kucharczuk et al. 2009)

II. Material And Methods

Data collection

A total of 245 patients who were diagnosed of esophageal squamous cell carcinoma between October 2008 and January 2017, and underwent surgical resection with lymph node dissection in the department of cardiothoracic surgery, were retrospectively selected for inclusion in this study. There were 156 males and 89 females, with the median age of 66 years (47-79). The pretreatment disease stages, per the TNM classification, were stages 0 to III. Patients were evaluated by clinical examination, CT scan of the neck, chest, and abdomen, endoscopy, barium swallow, and endoscopic ultrasound. Two hundred and forty patients received surgery alone, 3 received neoadjuvant chemotherapy plus surgery, and 2 received neoadjuvant chemoradiotherapy plus surgery. In the neoadjuvant therapy groups, surgery was performed 4-9 weeks after the last day of neoadjuvant treatment. The surgery alone group had the resection performed soon after diagnosis. Surgery was performed by Ivor-Lewis and McKeown approaches, with or without minimally invasive esophagectomy (MIE). All patients provided informed consent before receiving the treatments.

Data analysis

Statistical analysis was performed with the statistical package for the social sciences (SPSS) version 21.0 software (SPSS Inc., Chicago, IL, USA). The Pearson's Chi-Square test was used to test for any associations among the study parameters. To fully establish the association among the study parameters, a logistic regression analysis was also carried out. A confidence interval of 95% and a *P value* of 0.05 were used throughout the analyses. The association among the test variables was considered significant if the *P value* was less than 0.05.

III. Results

General characteristics

A total of 245 patients between the ages of 47 and 79 years (median 66) were assessed. Sixty-two patients were below 60 years, while 183 were above 60 years, as shown in Table 1. Two hundred and forty patients received surgery alone, 3 received neoadjuvant chemotherapy plus surgery, and 2 received neoadjuvant chemoradiotherapy plus surgery, as indicated in Table 1. One hundred and fifty-six were males, whereas 89 were females. Eighteen, 65, 117, and 45 patients had disease stage 0, I, II, and III, respectively, as shown in Table 1. Majority of the patients were examined by the combination of CT scan, barium swallow, and endoscopy, as depicted in Figure 1. As stated earlier, the Ivor-Lewis approach was the main surgical technique used. From Table 2 it can be observed that pneumonia and pleural effusion were among the most frequent postoperative complications.

Tests for association among study parameters

When age and gender were compared to postoperative complications, the Pearson Chi-Square *P values* were 0.020 and 0.037, respectively, indicating a significant association. The comparison of age and gender to treatment modalities yielded the Pearson Chi-Square *P values* of 0.677 and 0.501, respectively, indicating no significant association. The Pearson Chi-Square test for the association between surgical technique and postoperative complications yielded a *P value* of 0.446, indicating that no statistically significant association existed between the test variables. Table 3 shows the details of the above tests for association among the study parameters. Results from the logistic regression analysis also showed that both age and gender had a significant

association with postoperative complications (P=0.017 and 0.026, respectively), but not with treatment modalities (P=0.523 and 0.510, respectively). No significant association was observed between surgical techniques and postoperative complications (P=0.409). Table 4 depicts the results of the tests for association using logistic regression analysis.

IV. Discussion

It is known that ESCC mostly occur in patients above 60 years. (Pennathur, Gibson et al. 2013, Tobias, Hochhauser et al. 2013) Likewise, in the present study, majority of the patients were more than 60 years (75%). Results from the present study demonstrated a male predominance among ESCC patients. This observation reflects what has been documented by previous studies for the past recent years. (Hyland, Freedman et al. 2013) (Middleton, Bouaoun et al. 2018) A recent study found a higher incidence of ESCC in Chinese males (69%), with a mean age of 66.3±13.1. (Chong, Telisinghe et al. 2015) In fact, male predominance in ESCC has been observed not only in Asia, but also in other parts of the world, especially where the incidence of esophageal cancer in general is high. Hyland *et al* reports that the global incidence of ESCC is 2.4 times more in males than females. (Hyland, Freedman et al. 2013) Other recent studies conducted to investigate the global epidemiological trend in ESCC, also found a higher male to female ratio in Africa. (Middleton, Bouaoun et al. 2018) (Chasimpha, Parkin et al. 2017) This male predominance probably results partly from heavy tobacco smoking and alcohol consumption in males (Pampel 2008, Sreeramareddy, Pradhan et al. 2014), since these habits are well-known risk factors for ESCC worldwide. (Coleman, Quaresma et al. 2008, Sankaranarayanan, Swaminathan et al. 2010) (Kamangar, Chow et al. 2009) Hence, effective strategies for the prevention of heavy tobacco smoking and alcohol consumption should be implemented to curtail this menace.

Results from this study showed no significant correlation between age and treatment modalities, indicating that age alone cannot be a contraindication to any potentially good treatment for patients with ESCC. One study compared the long-term survival outcomes of older patients (70 years or more) to younger patients after neoadjuvant chemoradiotherapy plus surgery or definitive chemoradiotherapy and found that the younger patients did not have treatment outcomes better than their older counterparts. The authors concluded that elderly patients should not be denied potentially curative chemoradiotherapy-based treatment based on advanced age alone. (Voncken, Sikorska et al. 2017) Another study also compared the perioperative outcomes and long-term survival of elderly patients (70 years or above) to those of younger patients and found similar outcomes between the two groups. The conclusion drawn by this study was that advanced age alone should not be a contraindication to esophagectomy. (Ruol, Portale et al. 2007) Nevertheless, some other studies have reported that advanced age is associated with an increased risk of postoperative complications (Ferguson and Durkin 2002, Wright, Kucharczuk et al. 2009) (Nagawa, Kobori et al. 1994, Kuwano, Sumiyoshi et al. 1998) (Toyoizumi, Usui et al. 1990), as confirmed by the present study. This implies that elderly patients can be offered these treatment options, but a careful selection must be done to reduce the risk of postoperative complications as much as possible. Like age, the present study did not find any association between gender and the choice of treatment assigned to ESCC patients, indicating that patients could be administered either neoadjuvant chemoradiotherapy or chemotherapy plus surgery, or surgery alone irrespective of their gender. However, the outcome of the treatments given may be influenced by gender, as shown by a recent study. (Nishino, Yoshida et al. 2017) Male gender has been shown to be a risk factor for postoperative complications. (Wright, Kucharczuk et al. 2009) Results from the present study confirmed this observation.

To date, the best choice of surgical approach for esophagectomy remains a subject of debate. (Tobias, Hochhauser et al. 2013) (Kamangar, Chow et al. 2009) (Voncken, Sikorska et al. 2017) However, depending on the surgeon's preference, patient's comorbidities, among others, any suitable approach may be chosen by the surgical team. (Nozoe, Kakeji et al. 2005) Participants in the present study were mostly operated on by the Ivor-Lewis technique. Although both Ivor-Lewis and Mckeown approaches are widely practiced universally, recent reports show that McKeown approach is the most widely used in China, where the tumor is commonly located in the middle esophagus. (Ma, Liu et al. 2015) (Huang, Wang et al. 2015) In the present study, the McKeown approach was found to be the commonly used technique after Ivor-Lewis. Despite its association with several major and minor complications, as in all other techniques, the Ivor-Lewis approach has been reported to favorably improve quality of life of these patients, as compared to a healthy reference population. (Däster, Soysal et al. 2014)

Besides, the use of neoadjuvant chemoradiotherapy and chemotherapy plus surgery has seen a dramatic improvement in treatment effects in recent years. But, the proportion of patients in this study who received either of these therapies is extremely low. This observation could possibly mean that these therapeutic strategies have not yet been accepted in this elderly population, possibly due to the risks associated with them. It could also mean that per the best knowledge of the surgical teams involved, these cases could equally be managed by surgery alone without necessarily exposing the patients to the risks of neoadjuvant therapy, since most of them had early locally advanced disease (stage II).

Both immediate surgery and surgery after neoadjuvant chemoradiotherapy or chemotherapy involve postoperative complications, whether short-term or long-term. (Gronnier, Tréchot et al. 2014) (Etxaniz, Reyna et al. 2013) There is growing evidence that neoadjuvant chemoradiotherapy increases the risk of postoperative complications (Kumagai, Rouvelas et al. 2014), especially anastomotic leakages due the exposure to radiation. (Lee, Vaporciyan et al. 2003) The present study found pulmonary complications to be the most common postoperative complications, as shown in previous literature. (Bagheri, RajabiMashhadi et al. 2012) (Ferguson and Durkin 2002) Recent studies established that pulmonary complications, especially pneumonia, are most common in patients who undergo open surgery, for which Ivor-Lewis in the present study, is not an exception. (Ruol, Portale et al. 2007) (Ferguson and Durkin 2002) (Tanaka, Yoshida et al. 2016)

A comparison between surgical techniques and postoperative complications showed no significant correlation, implying that the choice of surgical approach does not necessarily determine the postoperative complications associated with the approach. This observation however, conflicts the augments of some documented previous studies. For instance, a randomized control study reported a reduction in the rate of pulmonary complication in patients who underwent minimally invasive techniques with thoracoscopy more than those who were assigned to open surgery. (Dittrick, Weber et al. 2012) Although minimally invasive techniques have been shown to reduce postoperative complications (Biere, van Berge Henegouwen et al. 2012), its usage for this study's participants was comparatively less.

In conclusion, both age and gender do not have any significant influence on the choice of treatment, indicating that patients should not be denied treatment based on their age or gender alone. However, treatments should be carefully selected for patients, especially the elderly, to reduce the occurrence of postoperative complications as far as possible. Although tobacco smoking and alcohol abuse are the major reasons for male predominance in ESCC occurrence, other probable risk factors that dispose them to ESCC need further investigations. Future large, well-designed randomized control trials could be carried out for this course. In addition, patients could be well educated on the benefits of neoadjuvant chemoradiotherapy and chemotherapy prior to surgery, notwithstanding the risks involved, to help boost patients' acceptance of neoadjuvant therapies.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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References

[1]. Arnold, M., et al. (2015). "Global incidence of oesophageal cancer by histological subtype in 2012." Gut **64**(3): 381-387.
[2]. Bagheri, R., et al. (2012). "The effect of neoadjuvant chemoradiotherapy on airway colonization and postoperative respiratory complications in patients undergoing oesophagectomy for oesophageal cancer." Interactive cardiovascular and thoracic surgery **14**(6): 725-728.
[3]. Biere, S. S., et al. (2012). "Minimally invasive versus open oesophagectomy for patients with oesophageal cancer: a multicentre, open-label, randomised controlled trial." The Lancet **379**(9829): 1887-1892.
[4]. Chasimpha, S. J., et al. (2017). "Three year cancer incidence in Blantyre, Malawi (2008-2010)." International journal of cancer **141**(4): 694-700.
[5]. Chong, V. H., et al. (2015). "Esophageal cancer in Brunei Darussalam over a three decade period: an epidemiologic study of trends and differences between genders and racial groups." Asian Pac J Cancer Prev **16**(9): 4123-4126.
[6]. Coleman, M. P., et al. (2008). "Cancer survival in five continents: a worldwide population-based study (CONCORD)." Lancet Oncol **9**: 730-756.
[7]. Däster, S., et al. (2014). "Long-term quality of life after Ivor Lewis esophagectomy for esophageal cancer." World journal of surgery **38**(9): 2345-2351.
[8]. Davies, A. R., et al. (2008). "Transhiatal esophagectomy in a high volume institution." World journal of surgical oncology **6**(1): 88.
[9]. Dittrick, G. W., et al. (2012). "Pathologic nonresponders after neoadjuvant chemoradiation for esophageal cancer demonstrate no survival benefit compared with patients treated with primary esophagectomy." Annals of surgical oncology **19**(5): 1678-1684.
[10]. Etxaniz, S. L., et al. (2013). "Cervical anastomotic leak after esophagectomy: diagnosis and management." Cirugía Española (English Edition) **91**(1): 31-37.
[11]. Ferguson, M. K. and A. E. Durkin (2002). "Preoperative prediction of the risk of pulmonary complications after esophagectomy for cancer." The Journal of thoracic and cardiovascular surgery **123**(4): 661-669.
[12]. Ginsberg, R. J. (1998). "Cancer treatment in the elderly." Journal of the American College of Surgeons **187**(4): 427-428.
[13]. Gronnier, C., et al. (2014). "Impact of neoadjuvant chemoradiotherapy on postoperative outcomes after esophageal cancer resection: results of a European multicenter study." Annals of surgery **260**(5): 764-771.
[14]. Hay, S. I., et al. (2016). "GBD 2015 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015." Lancet **388**(10053): 1545-1602.
[15]. Huang, H.-T., et al. (2015). "Comparison of thoracolaparoscopic esophagectomy with cervical anastomosis with McKeown esophagectomy for middle esophageal cancer." World journal of surgical oncology **13**(1): 310.
[16]. Hyland, P. L., et al. (2013). "Genetic variants in sex hormone metabolic pathway genes and risk of esophageal squamous cell carcinoma." Carcinogenesis **34**(5): 1062-1068.
[17]. Kamangar, F., et al. (2009). "Environmental causes of esophageal cancer." Gastroenterology Clinics North America **38**(1): 27-57.
[18]. Kumagai, K., et al. (2014). "Meta-analysis of postoperative morbidity and perioperative mortality in patients receiving neoadjuvant chemotherapy or chemoradiotherapy for resectable oesophageal and gastro-oesophageal junctional cancers." BJS **101**(4): 321-338.

[19]. Kuwano, H., et al. (1998). "Relationship between preoperative assessment of organ function and postoperative morbidity in patients with oesophageal cancer." The European journal of surgery **164**(8): 581-586.
[20]. Lee, H. K., et al. (2003). "Postoperative pulmonary complications after preoperative chemoradiation for esophageal carcinoma: correlation with pulmonary dose–volume histogram parameters." International Journal of Radiation Oncology• Biology• Physics **57**(5): 1317-1322.
[21]. Ma, Q., et al. (2015). "Right versus left transthoracic approach for lymph node-negative esophageal squamous cell carcinoma." Journal of cardiothoracic surgery **10**(1): 123.
[22]. Middleton, D. R., et al. (2018). "Esophageal cancer male to female incidence ratios in Africa: A systematic review and meta-analysis of geographic, time and age trends." Cancer epidemiology **53**: 119-128.
[23]. Montgomery, E., et al. (2014). "Oesophageal cancer." World cancer report: 374-382.
[24]. Nagawa, H., et al. (1994). "Prediction of pulmonary complications after transthoracic oesophagectomy." British journal of surgery **81**: 860-862.
[25]. Nishino, T., et al. (2017). "Gender difference in clinicopathological features and prognosis of squamous cell carcinoma of the esophagus." Esophagus **14**(2): 122-130.
[26]. Nozoe, T., et al. (2005). "Two-field lymph-node dissection may be enough to treat patients with submucosal squamous cell carcinoma of the thoracic esophagus." Diseases of the Esophagus **18**(4): 226-229.
[27]. Pampel, F. (2008). "Tobacco use in sub-Sahara Africa: estimates from the demographic health surveys." Social science & medicine **66**(8): 1772-1783.
[28]. Pennathur, A., et al. (2013). "Oesophageal carcinoma." The Lancet **381**(9864): 400-412.
[29]. Ruol, A., et al. (2007). "Results of esophagectomy for esophageal cancer in elderly patients: age has little influence on outcome and survival." The Journal of thoracic and cardiovascular surgery **133**(5): 1186-1192.
[30]. Sankaranarayanan, R., et al. (2010). "Cancer survival in Africa, Asia, and Central America: a population-based study." The lancet oncology **11**(2): 165-173.
[31]. Sreeramareddy, C. T., et al. (2014). "Prevalence, distribution, and social determinants of tobacco use in 30 sub-Saharan African countries." BMC medicine **12**(1): 243.
[32]. Tanaka, Y., et al. (2016). "Phase II trial of biweekly docetaxel, cisplatin, and 5-fluorouracil chemotherapy for advanced esophageal squamous cell carcinoma." Cancer chemotherapy and pharmacology **77**(6): 1143-1152.
[33]. Teng, S. and R. Karl (1999). "Surgical Approaches to Esophageal Cancer: The optimal surgical treatment approach for esophageal cancer remains controversial." Cancer Control **6**(1): 36-42.
[34]. Tobias, J. S., et al. (2013). Cancer and its management (6th ed.), John Wiley & Sons.
[35]. Torre, L., et al. (2015). "Global Cancer Statistics, 2012." CA Cancer J Clin **00**: 00-00.
[36]. Toyoizumi, S., et al. (1990). "Study of risk factors for postoperative pulmonary complications following esophageal cancer surgery: multivariate statistical analysis." Nippon Kyobu Geka Gakkai Zasshi **38**: 215-221.
[37]. Voncken, F. E., et al. (2017). "Advanced Age is Not a Contraindication for Treatment With Curative Intent in Esophageal Cancer." American journal of clinical oncology **609**: 1.
[38]. Wang, H., et al. (2016). "Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015." The Lancet **388**(10053): 1459-1544.
[39]. Watanabe, M., et al. (2012). "Surgical Treatment for Esophageal Cancer." Journal of Nuclear Medicine & Radiation Therapy **0**(1): 1-5.
[40]. Wright, C. D., et al. (2009). "Predictors of major morbidity and mortality after esophagectomy for esophageal cancer: a Society of Thoracic Surgeons General Thoracic Surgery Database risk adjustment model." The Journal of thoracic and cardiovascular surgery **137**(3): 587-596.
[41]. Zhang, H.-Z., et al. (2012). "Epidemiologic differences in esophageal cancer between Asian and Western populations." Chinese journal of cancer **31**(6): 281.

Table 1: Pretreatment patient characteristics and surgical techniques

Characteristics	Treatment modalities			Total (n=245)
	Surgery alone (n=240)	nCRT+S (n=2)	nCT+S (n=3)	
Age, years				
<60	61 (98.4)	0 (0.0)	1 (1.6)	62 (100.0)
>60	179 (97.8)	2 (1.1)	2 (1.1)	183 (100.0)
Gender ratio				
M	154 (98.7)	1 (0.6)	1 (0.6)	156 (100.0)
F	86 (96.6)	1 (1.1)	2 (2.2)	89 (100.0)
Grade, ASA				
I	76 (97.4)	1 (1.3)	1 (1.3)	78 (100.0)
II	119 (100.0)	0 (0.0)	0 (0.0)	119 (100.0)
III	45 (93.8)	1 (2.1)	2 (4.2)	48 (100.0)
Tumor stage, TNM				
0	17 (94.4)	0 (0.0)	1 (5.6)	18 (100.0)
I	63 (96.9)	1 (1.5)	1 (1.5)	65 (100.0)
II	115 (98.3)	1 (0.9)	1 (0.9)	117 (100.0)
III	45 (100.0)	0 (0.0)	0 (0.0)	45 (100.0)
Surgical techniques				
Ivor-Lewis	142 (97.9)	1 (0.7)	2 (1.4)	145 (100.0)
McKeown	37 (97.4)	1 (2.6)	0 (0.0)	38 (100.0)
Ivor-Lewis (MIE)	31 (100.0)	0 (0.0)	0 (0.0)	31 (100.0)
McKeown (MIE)	30 (96.8)	0 (0.0)	1 (3.2)	31 (100.0)

Legends: nCRT: neoadjuvant chemoradiotherapy, nCT: neoadjuvant chemotherapy, ASA: American Society of Anesthesiologists, MIE: Minimally invasive esophagectomy, TNM: Tumor node metastasis. Values in parentheses are percentages.

Table 2: Postoperative complications resulting from the various treatment modalities

Complications	Treatment modalities			Total (n=245)
	Surgery alone (n=240)	nCRT+S (n=2)	nCT+S (n=3)	
Pleural effusion	37 (100.0)	0 (0.0)	0 (0.0)	37 (100.0)
Hemorrhage	20 (95.2)	1 (4.8)	0 (0.0)	21 (100.0)
Pneumonia	98 (98.0)	0 (0.0)	2 (2.0)	100 (100.0)
Anastomotic fistula	12 (92.3)	0 (0.0)	1 (7.7)	13 (100.0)
Incision wound infection	10 (90.9)	1 (9.1)	0 (0.0)	11 (100.0)
Hepatic insufficiency	9 (100.0)	0 (0.0)	0 (0.0)	9 (100.0)
Pulmonary atelectasis	6 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)
Subcutaneous emphysema	9 (100.0)	0 (0.0)	0 (0.0)	9 (100.0)
Chyle fistula	5 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)
None	34 (100.0)	0 (0.0)	0 (0.0)	34 (100.0)

Legends: nCRT: neoadjuvant chemoradiotherapy, nCT: neoadjuvant chemotherapy. Values in parentheses are percentages.

Table 3: Chi-Square tests for association of association among study parameters

Association	Pearson Chi-Square test	
	χ^2 value	Significance
Age versus postoperative complication	9.874	0.020
Gender versus postoperative complication	8.471	0.037
Surgical techniques versus postoperative complications	8.905	0.446
Age versus treatment modalities	0.781	0.677
Gender versus treatment modalities	1.381	0.501

Legends: χ^2: Chi-Squared

Table 4: Logistic regression tests for association among study parameters

Association	Likelihood ratio test	
	χ^2 value	Significance
Age versus postoperative complication	10.194	0.017
Gender versus postoperative complication	9.274	0.026
Surgical techniques versus postoperative complications	9.308	0.409
Age versus treatment modalities	1.297	0.523
Gender versus treatment modalities	1.348	0.510

Legends: χ^2: Chi-Squared

Figure 1: Major pretreatment examinations used for diagnosis in study participants