MEDS Clinical Medicine (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/medsc.2025.060114
ISSN 2616-1907 Vol. 6 Num. 1

Analysis of postoperative pulmonary infection and its risk factors in patients with esophageal cancer treated with thoracoscopic McKeown and thoracotomy

Peirui Chen, Zheng Qin, Jing Lv, Mingqiang Diao

Department of Cardiothoracic Surgery, People's Hospital of Deyang City, Deyang, Sichuan, China

Keywords: Esophageal cancer; Lung infection; Total endoscopic surgery; Open-heart surgery; Influencing factor

Abstract: This study aims to compare the incidence of postoperative pulmonary infections between thoracoscopic McKeown esophagectomy and open thoracotomy for esophageal cancer, and to identify risk factors associated with this complication. A retrospective analysis was conducted on the clinical data of 89 patients with esophageal cancer who underwent surgical treatment. Among them, 45 patients received McKeown's method via thoracoscope (laparoscopic group), and 44 patients received open chest surgery (open chest surgery group). The incidence of postoperative pulmonary infection and the levels of neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), red blood cell immune complex ring rate (RBC-ICR), and red blood cell adherence to tumor cell ring rate (TRR) were compared between the two groups. Logistic regression analysis was used to analyze the risk factors influencing postoperative pulmonary infection. Compared with total endoscopic surgery, thoracic surgery for esophageal cancer is more likely to cause pulmonary infection. Age, operation time, thoracotomy, diabetes mellitus and the level of NLR, PLR and TRR 2 days after surgery may be the risk factors for postoperative pulmonary infection.

1. Introduction

In recent years, as the prevalence of esophageal cancer has increased year by year, the accompanying medical burden has also become increasingly heavy. Clinical exploration and optimization of diagnosis and treatment prescriptions are needed to control the disease and reduce the medical burden of patients as much as possible [1-2]. At present, surgical resection of the lesions is still the main means for clinical treatment of early esophageal cancer, which can effectively control the progression of the disease. In particular, the development and application of thoracic laparoscopic equipment can help reduce the injuries and complications caused by surgery, thereby reducing the additional medical burden and promoting further benefits for patients [3-4]. However, the invasion of surgical instruments provides conditions for the colonization of respiratory tract by pathogenic bacteria, which increases the risk of postoperative lung infection. Once infected lung not only delays the recovery process of patients, but also increases the medical burden of patients, and some patients may even be life-threatening [5-6]. Therefore, it is necessary

to identify and screen high-risk patients with lung infection at an early stage. The authors conducted a comparative study of esophageal cancer patients undergoing total endoscopic surgery and thoracotomy to analyze the risk factors of postoperative pulmonary infection.

2. Data and Methods

2.1 Case collection

A total of 89 patients with esophageal cancer admitted to our hospital from August 2022 to November 2023 were retrospectively selected for the study. Inclusion criteria: (1) All patients met the diagnosis of esophageal cancer [7] and received surgical treatment; (2) Male or female, age >18 years old; (3) No language, hearing and other functional impairments affecting communication; (4) Complete clinical medical records. Exclusion criteria: (1) Recent history of use of immunomodulators and antibiotics; (2) Combined with chronic infection and respiratory diseases; (3) Combined with coagulation disorders; (4) Combined with other malignant tumors; (5) Serious dysfunction of important organs. Among the 89 patients, 45 patients received McKeown's method via thoracoscope (endoscopic group) and 44 patients received thoracotomy (thoracotomy group). There was no statistical significance in the comparison of general data between the two groups (P> 0.05), indicating comparability.

2.2 Thoracotomy operation Group

After conventional intravenous combined anesthesia, patients in this group were placed in the left lateral position of 90 °, and incision was made into the chest cavity in the fourth lateral space of the right chest. The lesions were routinely explored, the thoracic segment of the esophagus was free, and lymph nodes were dissected. After adjustment of the horizontal position, incision was made in the middle of the upper abdomen into the abdominal cavity. Routine exploration of the abdominal cavity was performed, the abdominal esophagus was freed, lymph nodes were removed, the stomach was freed and a tubular stomach was made, and the two transverse fingers above the sternum were cut to anastomose the esophagus at both ends after resection of the lesion.

2.3 Endoscopic group

The patient was given tracheal intubation under general anesthesia. During the operation, the patient was kept in the left lateral position, and the chest was injected with 4-hole method. The thoracic esophagus was gradually freed, and the lymph nodes around the esophagus, the left and right recurrent laryngeal nerve and the subcarina were cleared, and the drainage tube was placed to close the chest after no bleeding was confirmed. Then the body position was changed to a supine position, the surgical incision was made beside the left sternoclavicular muscle of the neck, and the cervical esophagus was dissociated and severed. An artificial pneumoperitoneum was established in the abdomen by using 5-hole method, and thoracoscopic instruments were placed to clamp and dissociate the left blood vessel of the stomach, free the greater and lesser curvature of the stomach, and remove the lesser curvature of the stomach and lymph nodes around the greater curvature of the stomach. The right blood vessel of the stomach was severed 5cm above the pylorus, and a tube stomach was made with a suture device to preserve the gastric fundus tissue. For the stump of the tube stomach, an absorbable line could be used to discontinuously enclose the plasma muscle layer under the endoscope, and after strict hemostasis, the tube stomach was lifted up to the neck, and anastomosis was performed with a stapler. The duodenal nutrition tube and gastric tube should not be cut off, and the patient was given thoracoscopic examination. To determine whether there was

thoracic hemorrhage and observe the position of the tubular stomach, the patient was given an indignant drainage tube in the neck, chest, and abdomen, and an additional mediastinal drainage tube was indignant in the chest, and then the incision was stitched.

2.4 Detection methods

(1) Immunoinflammatory indicators: 4 mL of fasting venous blood samples were collected from patients in both groups before and on the second day after surgery. Neutrophils, lymphocytes and platelets were determined by flow cytometry, and the ratio of neutrophils to lymphocytes (NLR) and ratio of platelets to lymphocytes (PLR) were calculated. Erythrocyte immune complex garland rate (RBC-ICR) and erythrocyte adhesion to tumor cell garland rate (TRR) were determined by microscopy. (2) Types of disease bacteria: Sputum samples were collected and cultured after patients cleaned their mouths according to hospital procedures, and bacteria types were identified by microbiological analyzer (VITEK-32 type).

2.5 Outcome measures

(1) NLR, PLR, RBC-ICR, TRR were compared between endoscopic group and thoracotomy group. (2) The distribution of pathogenic bacteria in postoperative pulmonary infection was compared between endoscopic group and thoracotomy group. (3) To analyze the factors of postoperative pulmonary infection in patients with esophageal cancer.

2.6 Statistical Methods

SPSS22.0 statistical software was used to analyze the data. The statistical data were compared by χ^2 test. The measurement data followed normal distribution and were expressed as mean ± standard deviation ($\bar{x} \pm s$). Independent sample t test was used for inter-group comparison, paired sample t test was used for intra-group comparison, and the risk factors of postoperative pulmonary infection were analyzed by Logistic regression. $P<0.05$ indicated that the difference was statistically significant.

3. Results

3.1 NLR and PLR

There was no statistical significance in the ratio of NLR and PLR before and after operation between the two groups compared with that before operation ($P>0.05$); 2 days after surgery, the level of NLR and PLR in the two groups was significantly higher than that before surgery, and the level of NLR and PLR in the total endoscopic group was significantly lower than that in the thoracotomy group, with statistical significance ($P<0.05$), as shown in Table 1.

Table 1 Comparison of NLR and PLR between the two groups

Group	number of cases	NLR		PLR	
		pre-operation	2 days after surgery	pre-operation	2 days after surgery
endoscopy group		1.89±0.39	2.65±0.45	93.82±7.94	111.32±11.46
thoracotomy operation group		1.91±0.41	(2.89±0.49	94.11±8.17	121.27±11.01
t		0.614	2.613	0.933	2.872
P		0.498	0.021	0.451	0.012

3.2 RBC-ICR and TRR

Comparison of RBC-ICR and TRR before and after surgery between the two groups showed no statistical significance in the level of RBC-ICR and TRR between the two groups before and after surgery (P>0.05). 2 days after surgery, the level of RBC-ICR and TRR in the two groups were significantly higher than before surgery, and the level of RBC-ICR in the endoscopy group was significantly lower than that in the thoracotomy group, while the level of TRR was significantly higher than that in the thoracotomy group, with statistical significance (P< 0.05).

3.3 Pathogenic bacteria

The distribution ratio of pathogenic bacteria of postoperative pulmonary infection in the two groups was compared with that of the 89 patients with postoperative infection in 19 cases. A total of 32 pathogenic bacteria were detected after identification, including 21 gram-negative bacteria, 10 gram-positive bacteria and 1 fungi. In the endoscopy group, 10 strains (8 gram-negative bacteria and 2 gram-positive bacteria) accounted for 31.25%, and in the thorotomy group, 22 strains (13 gram-negative bacteria, 8 gram-positive bacteria and 1 fungi) accounted for 68.75%.

3.4 Univariate analysis

Univariate analysis of the influencing factors of postoperative pulmonary infection in patients with esophageal cancer The results of univariate analysis showed that the levels of NLR, PLR, RBC-ICR and TRR were related to postoperative pulmonary infection in patients with age, operation time, operation mode, adjuvant chemotherapy, diabetes mellitus and postoperative postoperative 2 days (P<0.05).

3.5 Logistic regression analysis

Logistic regression analysis of the influencing factors of postoperative pulmonary infection in patients with esophageal cancer was performed with postoperative pulmonary infection as the dependent variable, and age, time of operation, mode of operation, adjuvant chemotherapy, combined with glycosuria, and the level of NLR, PLR, RBC-ICR and TRR after 2 days of surgery as the independent variables. The results showed that age, operative time, thoracotomy, adjuvant chemotherapy, diabetes mellitus and the levels of NLR, PLR and RBC-ICR 2 days after surgery were risk factors for postoperative pulmonary infection (P<0.05), and TRR 2 days after surgery was protective factor for postoperative pulmonary infection (P<0.05), as shown in Table 2.

Table 2 Logistic regression analysis of influencing factors of postoperative pulmonary infection in patients with esophageal cancer

index	β	SE	Wald $\chi 2$	*P*	OR
age	0.865	0.369	5.181	0.021	2.247
Operation time	1.130	0.471	4.867	0.023	2.333
Surgical method (thoracotomy)	1.134	0.454	6.879	0.008	3.314
Adjuvant chemotherapy	0.720	0.311	5.331	0.022	2.028
Combined diabetes	1.341	0.522	7.021	0.007	3.891
NLR	0.179	0.087	4.731	0.032	1.216
PLR	0.091	0.035	7.985	0.007	1.151
RBC-ICR	0.513	0.189	9.361	0.001	1.721
TRR	-0.472	0.209	5.023	0.021	0.628

4. Discussion

In recent years, endoscopy technology has achieved great development in the diagnosis and treatment of esophageal cancer, promoting the trend of minimally invasive clinical esophageal cancer surgery, helping to reduce surgical trauma and reduce the risk of postoperative complications [8-9]. Postoperative complications caused by surgical trauma are not uncommon in clinic, especially respiratory tract related complications, including pulmonary infection, etc., which are adverse events that clinicians need to pay close attention to and be vigilant about, and need to be identified and screened at an early stage [10-11]. At present, the recognition and screening of pulmonary infection after esophageal cancer surgery is an important clinical work. In this study, Klebsiella pneumoniae, pseudomonas aeruginosa and other gram-negative bacteria were the main causes of pulmonary infection after esophageal cancer surgery, and Staphylococcus aureus was the main gram-positive bacteria, which was roughly similar to many studies reported. The study of Si et al. [12] also showed that the bacteria isolated from patients with postoperative pulmonary infection were mainly gram-negative strains, and the serum inflammatory factors such as tumor necrosis factor-α and interleukin-1β in patients with postoperative pulmonary infection showed high expression levels, and the expression levels were closely related to the severity of pulmonary infection. At the same time, screening studies have found that a long history of smoking, diabetes mellitus, upper/middle tumors, and high levels of inflammatory factors are high risk factors for lung infection. Niu et al. [13] also found that Klebsiella pneumoniae, pseudomonas aeruginosa and staphylococcus aureus were the main pathogens of postoperative pulmonary infection in patients with esophageal cancer. At the same time, age, diabetes, chronic obstructive pulmonary disease, smoking, operation time and other factors were risk factors for postoperative pulmonary infection, and clinical attention and early intervention should be given according to the patient's situation. Reduces the risk of infection. With the promotion of clinical screening of patients susceptible to postoperative pulmonary infection in recent years, many risk factors have been identified and recognized, which is helpful to guide the prevention and control of postoperative infection of esophageal cancer in clinical patients [14-15]. This study also found that age, time of operation, mode of operation, adjuvant chemotherapy, diabetes mellitus and the levels of NLR, PLR, RBC-ICR and TRR 2 days after surgery were related to postoperative pulmonary infection. Age and diabetes are clinically recognized risk factors for postoperative pulmonary infection. The higher the age of patients, the worse the body function, the ability to resist pathogens will decline, and diabetes patients are mainly due to the decline in body immunity, the ability to remove pathogens is insufficient. Thoracotomy, operation time and NLR and PLR levels reveal the severity of trauma to patients. Thoracotomy not only increases the stress injury of the body, but also increases the risk of pathogen invasion because it increases the exposure time of the chest and abdominal organs. The abnormal increase of NLR and PLR levels indicates that the degree of inflammation in the body is aggravated, and it also indicates that the more severe the trauma caused to the patient by surgery, which will lead to the deterioration of the physical resistance [16-17]. Adjuvant chemotherapy will increase the damage to the patient's body, especially the toxic effect of chemotherapy drugs will cause immune suppression, so it is necessary to carefully select chemotherapy drugs and doses for patients with high risk of infection. Jin et al. [18] found that the incidence of anemia at all levels, leukopenia, neutropenia, thrombocytopenia and lung infection was significantly reduced by optimizing the drug dose of chemotherapy regimen. The data from this study show that adjuvant chemotherapy is a risk factor for lung infection and also confirm acceptance

Patients with adjuvant chemotherapy are at high risk for lung infection. In addition, this study found that compared with open-chest surgery, the level of RBC-ICR was lower and the level of TRR was higher in patients undergoing total endoscopic surgery 2 days after surgery. Hao Yanhong

etc. [19] pointed out that RBC - the higher the level of ICR prompt the body's immune activity, poor ability to resist pathogens, and TRR can enhance the function of phagocyte, immune stability, the low tip the immune function to reduce its level.

It is found that patients with thoracotomy surgery are more likely to have immunosuppression, and these two indicators are index factors affecting postoperative lung infection, so these two indicators can be observed clinically after surgery.

In summary, compared with open-chest surgery, the levels of NLR, PLR and RBC-ICR in patients with esophageal cancer undergoing endoscopic surgery are lower 2 days after surgery, while the levels of TRR are significantly higher, suggesting that postoperative inflammation and immunosuppression are relatively mild in patients undergoing endoscopic surgery, which may help to reduce the risk of pulmonary infection.

References

[1] CAO W, CHEN H D, YU Y W, et al. Changing profiles of cancer burden worldwide and in China: a secondary analysis of the global cancer statistics 2020 [J]. Chin Med J, 2021, 134(7): 783-791.

[2] ARUN J S, BINGENER J. Diagnostic transgastric endoscopic peritoneoscopy for staging of pancreatic and esophageal cancer [J]. Minerva Chirurgica, 2012, 67(2): 127-140.

[3] PETROPOULOS K, MACHERAS A, LIAKAKOS T, et al. Minimally invasive esophagectomy for esophageal cancer: techniques and outcomes [J]. Chirurgia (Bucharest, Romania : 1990), 2015, 110(2): 99-108.

[4] BREMNER R M, DEMEESTER T R. Surgical treatment of esophageal carcinoma [J]. Gastroenterology clinics of North America, 1991, 20(4): 743-763.

[5] KATO H. Surgical treatment of esophageal varices [J]. [Hokkaido igaku zasshi] The Hokkaido journal of medical science, 1992, 67(6): 757-760.

[6] VAN WORKUM F, SLAMAN A E, HENEGOUWEN M I V, et al. Propensity Score-Matched Analysis Comparing Minimally Invasive Ivor Lewis Versus Minimally Invasive Mckeown Esophagectomy [J]. Ann Surg, 2020, 271(1): 128-133.

[7] VAN WORKUM F, BERKELMANS G H, KLARENBEEK B R, et al. McKeown or Ivor Lewis totally minimally invasive esophagectomy for cancer of the esophagus and gastroesophageal junction: systematic review and meta-analysis [J]. J Thorac Dis, 2017, 9: S826-S833.

[8] XING H J, HU M Y, WANG Z Q, et al. Short-term outcomes of Ivor Lewis vs. McKeown esophagectomy: A meta-analysis [J]. Frontiers in Surgery, 2022, 9.

[9] WANG J P, HU J F, ZHU D Y, et al. McKeown or Ivor Lewis minimally invasive esophagectomy: a systematic review and meta-analysis [J]. Translational Cancer Research, 2020, 9(3): 1518.

[10] DRöGE W. Free radicals in the physiological control of cell function [J]. Physiol Rev, 2002, 82(1): 47-95.

[11] CHEN S, LU D C, WANG W, et al. Plasma metabolomic profiling of repeated restraint stress in rats [J]. Journal of Chromatography B-Analytical Technologies in the Biomedical and Life Sciences, 2020, 1160.

[12] QING H, DESROULEAUX R, ISRANI-WINGER K, et al. Origin and Function of Stress-Induced IL-6 in Murine Models [J]. Cell, 2020, 182(2): 372.

[13] KHAN A R, GEIGER L, WIBORG O, et al. Stress-Induced Morphological, Cellular and Molecular Changes in the Brain-Lessons Learned from the Chronic Mild Stress Model of Depression [J]. Cells, 2020, 9(4).

[14] RINALDI A, VINCENTI S, DE VITO F, et al. Stress induces region specific alterations in microRNAs expression in mice [J]. Behavioural Brain Research, 2010, 208(1): 265-269.

[15] HIGUCHI F, UCHIDA S, YAMAGATA H, et al. Hippocampal MicroRNA-124 Enhances Chronic Stress Resilience in Mice [J]. Journal of Neuroscience, 2016, 36(27): 7253-7267.

[16] LONER R A. Lessons learned about stress and the heart after major earthquakes [J]. American Heart Journal, 2019, 215: 20-26.

[17] Zhu ZJ, Zhao YF, Chen LQ, et al. Clinical application of layered anastomosis during esophagogastrostomy. World J Surg.2008;32:583-588.

[18] LI J, FAN J G. Characteristics and Mechanism of Liver Injury in 2019 Coronavirus Disease [J]. Journal of Clinical and Translational Hepatology, 2020, 8(1): 13-17.

[19] QUĹEZ M E, LóPEZ-AGUILAR J, BLANCH L. Organ crosstalk during acute lung injury, acute respiratory distress syndrome, and mechanical ventilation [J]. Current Opinion in Critical Care, 2012, 18(1): 23-28.