Early Complications of Esophagectomy

Subjects: Surgery
Contributor: Jenifer Edmondson , John Hunter , Gennadiy Bakis , Amber O'Connor , Stephanie Wood , Alia P. Qureshi

Esophagectomy is a technically complex operation performed for both benign and malignant esophageal disease. Medical and surgical advancements have led to improved outcomes in esophagectomy patients over the past several decades; however, surgeons must remain vigilant as complications happen often and can be severe. Post-esophagectomy complications can be grouped into early and late categories.

esophagectomy post-operative complications anastomotic leaks

1. Anastomotic Leaks

1.1. Incidence and Definitions

Without a doubt, anastomotic leak is the most feared complication of esophagectomies. Per the ESODATA database, the incidence rate of anastomotic leak is 11.4% [1]. For, clarity, the different classification systems for esophageal leaks are reviewed here. The Oesophago-Gastric Anastomosis Audit (OGAA) sought to find the rates of anastomotic complications and calculated a leak rate of 14.2% [2]. Both studies used the ECCG definitions of anastomotic leak when analyzing their data sets. The ECCG definition of anastomotic leak is a "full thickness gastro-intestinal defect involving the esophagus, anastomosis, staple line, or conduit, irrespective of presentation or method of identification" [3]. The ECCG further divides anastomotic leaks and conduit necrosis into three types based on the type of intervention required to manage the leak or necrosis. In the OGAA study, 15.7% of patients with anastomotic leak also had conduit necrosis associated with the leak, and 83% of patients with conduit necrosis had an associated anastomotic leak. The rates of conduit necrosis increased significantly with increasing anastomotic leak type [2].

Another classification system for anastomotic leak was developed by Bruce and colleagues in 2001 [4] using the definition from the Surgical Infection Study Group: a leak of luminal contents from a surgical joint between two hollow viscera [5]. The Surgical Infection Study Group is a UK multidisciplinary group and, in addition to defining anastomotic leak, also recognizes a category of subclinical leak that is defined by the escape of luminal contents from the anastomosis, which is detected with imaging in the absence of clinical symptoms. Using these definitions, Bruce and colleagues classified grades of anastomotic leak into categories including radiological, clinical minor, and clinical major [4]. This classification schema uses a combination of clinical and radiologic indications to categorize anastomotic leaks in contrast with the ECCG classification schema, which uses the level of intervention needed to treat anastomotic leaks for their categorization. Both classification systems help attribute a sense of the severity of individual anastomotic leaks. Broadly speaking, the two classification systems complement each other in that the Bruce and Colleagues grading system attributes a clinical severity indicator that correlates with the ECCG classification of anastomotic leak management.

The OGAA prospective cohort study described an overall anastomotic leak rate of 14.2% and further investigated leak rates for intra-thoracic versus cervical anastomoses. The leak rate for intra-thoracic anastomoses was 12.2%, and the leak rate for cervical anastomoses was 20.1% [2]. Though intra-thoracic anastomotic leaks occurred at a lower rate than cervical leaks, the intra-thoracic leaks were of significantly higher morbidity (ECCG Type II and III), had a higher likelihood of needing surgical intervention, and were associated with a longer length of hospital stay and ICU stay compared with cervical anastomotic leaks, which occurred at a higher incidence but were less morbid.

1.2. Risk Factors and Prevention

Risk factors can be categorized into tissue factors, patient factors, and technical factors. Within each category, there may be risk factors that are modifiable and risk factors that are not. Risk factors that are intrinsic to the esophagus (tissue factors) and not modifiable include the absence of serosa and the longitudinal muscle fibers of the esophagus. The lack of serosa and the presence of longitudinal muscle fibers means the remnant esophagus is delicate. This especially rings true when one considers suture holding in the esophagus compared with other tissues with serosa and circular muscle fibers like the stomach and small bowel. These tissue factors can mean a more tenuous anastomosis, especially when combined with other risk factors.

There are several patient factors that are modifiable, and thus, the prevention of anastomotic leaks should focus on these modifiable factors. Patient risk factors can be further categorized into preoperative factors and perioperative factors. Some modifiable preoperative factors to consider are malnutrition, diabetes, cardiovascular conditions, respiratory insufficiency, and smoking and drinking habits, as well as applied neoadjuvant therapies. These factors can contribute to poor or prolonged healing and are also risk factors for other post-operative complications. Efforts at preoperative optimization should consider these factors and may reduce the risk of anastomotic leaks and other complications. Two notable perioperative factors that may contribute to anastomotic leak risk are hypotension and hypoxemia. Hypotension contributes to poor tissue perfusion, thus increasing the risk of conduit tissue ischemia and necrosis. The use of vasopressors in the perioperative period may also negatively impact tissue perfusion and oxygenation but may be necessary for blood pressure support. Hypoxemia negatively impacts tissue oxygenation and thus can also contribute to conduit ischemia and necrosis [6].

The reconstruction aspect of esophagectomy is a technical factor to consider and is not modifiable. Not only is there extensive dissection, but the mobilization of the neo-esophagus, most often the stomach [7], requires the sacrifice of part of the gastric blood supply. Consequently, there is potential for ischemia and necrosis that can then result in anastomotic breakdown and leakage when meticulous attention is not paid to detailed dissection. Another technical factor that may contribute to the risk of anastomotic leak is the type of esophagectomy. Different types of esophagectomy are associated with different incidences of anastomotic leak. Ozawa and colleagues [8] performed a review of 48 studies with more than 50 patients who underwent minimally invasive esophagectomy to further evaluate the incidence of post-esophagectomy complications. In their review, the overall incidence of anastomotic leak was 9.3% for minimally invasive esophagectomy (MIE). They further evaluated the incidence of leak by type of MIE and found values of 7.8% for McKeown MIE, 10% for Ivor Lewis MIE, 18.5% for robotic-assisted McKeown MIE, 6% for robotic-assisted Ivor Lewis MIE, and 9.8% for trans-mediastinal esophagectomy. It is also important to note that the severity of presentation of anastomotic leak differs between McKeown esophagectomy and Ivor Lewis esophagectomy due to the location of the anastomosis (cervical anastomosis in McKeown versus thoracic anastomosis in Ivor Lewis). A thoracic anastomotic leak is more likely to have a more severe and dramatic presentation due to a leak of contents into the mediastinum/thoracic cavity, whereas a leak from a cervical anastomosis is less likely to be as severe (drainage from cervical incision, neck abscess, etc.) [8].

Other technical factors have been studied to assess their effectiveness in preventing anastomotic leaks, which include the manner of anastomosis (hand-sewn versus stapled, circular versus triangular, end-to-end versus end-to-side) and gastric ischemic preconditioning (the practice of ligating short gastric and left gastric vessels to redistribute gastric blood supply with the aim to improve perfusion to the future anastomotic site) [9][10]. However, no significant decrease or difference in leak rate has been identified. Prevention measures should focus on preoperative optimization and conditioning, intraoperative care that minimizes hypotension, hypoxemia, and blood loss, and maneuvers that cause direct trauma to the conduit [7]. Post-operative preventive maneuvers should focus on resuming early enteral nutrition, emphasizing good pulmonary toilet, and preventing hypotension and hypoxemia [11].

1.3. Presentation

Depending on the severity of anastomotic leak, the presentation of this problem may vary from having minimal clinical signs to having fulminant sepsis. A patient may have a subclinical leak where they display no clinical signs of tachycardia, fever, leukocytosis, or changes in drain output. These subclinical leaks are found on routine post-operative contrast esophagograms or CT imaging that is obtained for other reasons. Some patients may present with subtle clinical signs such as tachycardia, atrial fibrillation, and elevated inflammatory markers on blood tests [7]. In some cases, atrial fibrillation may be the only sign of anastomotic leak, so any post-esophagectomy patient with atrial fibrillation within the first week and after post-operative fluid shifts occurred should be at high suspicion for leak. Post-operative fluid shifts occur within the first 3 post-operative days; therefore, atrial fibrillation may be expected in the first 3 days after esophagectomy. However, any onset of atrial fibrillation after post-operative day 3 should increase the clinician's index of suspicion for a possible anastomotic leak or other post-operative complications. For larger leaks, the signs may be more drastic and can create a septic picture. Additionally, there may be increased contents from surgical drain or neck incision if present. If the anastomosis is in the thoracic cavity, leaks may present with oxygenation issues, hydropneumothorax, effusions, and the need for pulmonary support [12]. Some key pieces of information to remember are that cervical anastomoses have a higher incidence than thoracic anastomoses [1], the presentation of a leak can occur on a spectrum from asymptomatic to needing an ICU level of care with ventilatory and ionotropic support, leaks can be large (high output) but may not have a drastic septic picture if adequately drained via surgical drain or neck incision or if well-contained, and the clinician's level of suspicion for leak needs to remain high with even the most subtle of clinical signs.

1.4. Diagnostic Work-Up

There is no gold standard for diagnosing a post-esophagectomy anastomotic leak. There are, however, various diagnostic tools and considerations that can aid in the diagnosis, and these include clinical signs, drain fluid, laboratory tests, endoscopic examination, contrast esophagograms, and CT imaging. The clinical signs discussed previously can certainly support the diagnosis of anastomotic leak. A patient with tachycardia, fever, leukocytosis, and elevated inflammatory markers (such as C-reactive protein) may have anastomotic leak, but these same signs could be present with other post-operative complications as well. Saliva or gastric contents in the surgical drain or draining from the neck incision are obvious indicators of a leak. Drain fluid can be tested for amylase levels and high amylase would support leak diagnosis. It has been proposed that routine drain amylase testing on post-operative day 4 could serve as an early leak detection [13]. Such early detection can aid in expediting intervention and possibly preventing further associated complications.

Upper endoscopy is a diagnostic modality that can be considered when diagnosing leaks. In addition to finding the leak, endoscopy can also assess the integrity of the conduit, which can help determine which patients may need surgical revision. Understandably, many may be hesitant to pursue upper endoscopy due to the fear of disrupting the anastomosis. Endoscopy in this setting should be performed by an experienced endoscopist, and only gentle and progressive insufflation should be used. In their porcine studies, Raman and colleagues [14] were able to demonstrate that even at maximal insufflation, the anastomotic endoluminal pressure did not exceed 8.7 cm H_2O pressure, which is far below what is needed to disrupt anastomosis or disturb tissue perfusion. The theoretical risk of further disruption of the anastomosis is a valid concern but should be weighed against the benefits of endoscopy in a patient with a suspected anastomotic leak. Endoscopy can serve to confirm the presence of a leak, further characterize the size and severity, and assess the viability of the conduit. All these factors should be considered to determine if the patient would be best served with surgical, endoscopic, or medical interventions.

Contrast esophagogram is a common tool modality for the diagnostic work-up of anastomotic leak and entails using a water-soluble contrast agent followed by thin barium (improves sensitivity for leak detection). It is important to assess the patient's swallowing function prior to performing this test as the contrast agent can cause chemical pneumonitis if aspirated. Using a water-soluble contrast (e.g., gastrograffin) first is a safe maneuver because if there is a leak appreciated with gastrograffin, the diagnosis of the leak is confirmed. If no leak is detected, thin barium is then utilized because it improves the sensitivity for leak detection. Water-soluble contrast is used first because it is thought to be safer if there is a leak with contrast entering the mediastinum and/or thoracic cavity. Barium is utilized following a negative water-soluble contrast study because it is more radiopaque and better detects smaller leaks. Unfortunately, even with a negative contrast study, a leak cannot be ruled out. The sensitivity for leak detection is about 93% for intra-thoracic anastomoses and even lower (33–52%) for cervical anastomoses [7]. However, it is highly specific, so a positive study does confirm the diagnosis of a leak. If a contrast esophagogram is negative for a leak but there remains a high level of suspicion for a leak, further work-up should be sought.

CT imaging is a quick and non-invasive modality that can help diagnose an anastomotic leak, and it can provide additional information on the surrounding tissues and structures of the neck, thorax, and abdomen. A CT scan may be able to detect a leak and appreciate peri-anastomotic fluid collections, pulmonary effusions, mediastinal fluid, etc. However, even with oral contrast use, a leak may not be detected. Additionally, findings of peri-anastomotic free air and fluid may be consistent with expected post-operative changes. However, findings of mediastinal fluid and air, anastomotic wall discontinuity, and fistula are significantly associated with anastomotic leak [7]. Another benefit of CT imaging is that it may identify fluid collections that can be targeted for drainage.

1.5. Treatment Strategies

General management strategies are discussed in this section. Treatment options vary from little change in medical therapy to surgical intervention. Treatment modalities include observation, medication (octreotide, proton-pump inhibitors, antibiotics), drainage (IR drainage, wound drainage, nasogastric drainage), endoscopic stenting, endoscopic vacuum-assisted closure, and surgical repair/diversion/re-anastomosis. When considering treatment strategies for anastomotic leaks, factors that should be considered include leak location, leak size, conduit drainage, clinical stability of the patient, and availability of interventional resources [15].

Small occult leaks found on routine post-operative esophagograms can be treated by delaying oral food intake. Small symptomatic leaks in stable patients can be treated by restricting oral intake while supporting nutrition with enteral nutrition if access is in place; otherwise, parenteral nutrition can be used. Any infectious signs should prompt the initiation of antibiotic therapy. Any sizable fluid collections should be drained for infectious control. Other medical therapies that can be initiated include the initiation of somatostatin to decrease gastric acid secretion and proton pump inhibitors (decreases gastric acid production) to promote anastomotic healing [11]. For cervical anastomoses, if drainage is present around the incision, the incision should be opened to allow for adequate drainage and then allowed to heal by secondary intention.

Larger leaks, especially those not contained will likely require more invasive treatment. Interventional radiology may be needed to drain thoracic fluid collections. Endoscopy should be considered to evaluate the viability of the conduit mucosa. If necrotic and ischemic tissue is present, surgical intervention to revise or divert the anastomosis may be necessary. Some leaks may be amenable to endoscopic stenting of the anastomosis or endoscopic vacuum-assisted closure of the defect, which will be discussed in a later section. However, if the patient is in or heading toward fulminant sepsis, the patient needs to return to the operating room to evaluate the anastomosis and debride any necrotic tissue. Diverting esophagostomy may also be necessary, and if a feeding jejunostomy tube is not already present, it should be considered upon return to the operating room.

The clinician must be aware that the complication of anastomotic leak may precipitate other complications including empyema and fistula to the airways (both tracheal and bronchial). Prompt, adequate drainage is necessary to help prevent these complications, but is also a key aspect of treatment if these complications of anastomotic leaks occur. Esophagobronchial fistulas following esophagectomy have a reported incidence of 0.25–3% and mortality rates of up to 67%, according to a literature review performed by Sato and colleagues [16].

2. Atrial Fibrillation

2.1. Incidence and Etiology

Atrial fibrillation and other tachyarrhythmias are common post-operative complications. Across ECCG centers, the incidence of atrial arrhythmias occurred at 14.5%, making atrial fibrillation and pneumonia (14.5%) the most common post-esophagectomy complications [1]. Atrial fibrillation in the first three post-operative days is most likely secondary to expected post-surgical fluid shifts. After post-operative day 3, atrial fibrillation should be considered as a clinical sign of another complication, especially anastomotic leaks. Atrial fibrillation can be the first and only sign of an underlying septic etiology: anastomotic leak, pneumonia, wound infection, urosepsis, etc. Therefore, the clinician’s index of suspicion should be high that there could be another problem when atrial fibrillation is encountered in this setting.

2.2. Risk Factors

Risk factors for post-operative atrial fibrillation can be divided into pre-operative, intra-operative, and post-operative groups. Pre-operative risk factors include old age (70+), cardiac factors, diabetes, and obesity [17]. Some of these risk factors are modifiable, which can serve as a prevention strategy in the pre-operative care setting. Some peri-operative risk factors can be mitigated with the judicious use of fluids, minimizing blood loss, encouraging early ambulation, and good pulmonary toileting.

2.3. Presentation and Diagnostic Work-Up

Atrial fibrillation can present as new onset tachycardia, sudden onset of dyspnea, lightheadedness or dizziness, diaphoresis, chest pain, and other changes in vital signs such as desaturation and hypotension. Frequently, though, patients may be asymptomatic, and atrial fibrillation is found after work-up of irregular tachycardia. If atrial fibrillation is suspected in a post-operative patient, the initial steps that should be taken include new vital signs and bedside examination of the patient, and an electrocardiogram should be obtained immediately to confirm the diagnosis and an assessment of whether the patient is symptomatic from the arrhythmia (dyspnea, chest pain, hypotension, diaphoretic, etc.). Laboratory tests should be ordered and should include an assessment of electrolyte levels, cardiac enzymes, complete blood count (look for leukocytosis or anemia), and plus/minus inflammatory markers. Chest X-ray should also be considered to evaluate possible effusion or pneumonia that could have precipitated the arrhythmia.

2.4. Treatment

Management of post-operative atrial fibrillation is guided by the underlying etiology. The main goal in treating atrial fibrillation is to maintain hemodynamic stability. Treatment approaches include rhythm control versus rate control and consideration of cardioversion therapy if needed. Rate control (a heart rate of 90–115) can be achieved with a beta-blocker (metoprolol, esmolol, or propranolol), non-dihydropyridine calcium channel blocker (verapamil or diltiazem), or digoxin. Beta-blockers tend to be the preferred agents and most effective at controlling the ventricular response in the setting of atrial fibrillation but may be contraindicated in severe asthmatics (beta-blockers may cause bronchospasm) and atrioventricular conduction disorders (high degree AV block is an absolute contraindication) as beta-blockers are AV nodal blocking agents and can worsen such conduction disorders and may even progress to complete heart block. Calcium channel blockers should be avoided in AV conduction disorders as well for this same reason [17]. Digoxin may be helpful in the setting of congestive heart failure, but cardiology consultation would be recommended in this setting.

If rate control is not achieved, the patient may have to be transferred to the intensive care unit or an acute care floor to receive amiodarone. Amiodarone is an antiarrhythmic drug that works primarily by blocking potassium channels but also has a blocking effect on sodium and calcium channels, as well as at the beta- and alpha-adrenergic receptors.

Most cases of post-operative atrial fibrillation spontaneously convert to normal sinus rhythm within 24 h. Until then, supportive measures include repletion of electrolytes, encouraging ambulation, and good pulmonary toilet. Underlying causes should be investigated and treated appropriately. If a patient becomes hemodynamically compromised or is not responsive to pharmacologic therapy, electrical cardioversion may be necessary. If atrial fibrillation is persistent (>48 h), anticoagulation therapy should be considered if clinically safe to do so, as there is an increased risk of cerebrovascular incidents with persistent atrial fibrillation [17].

3. Pulmonary Complications

3.1. Incidence and Risk Factors

Pulmonary complications occur more often than any other post-esophagectomy complication. According to the ECCG standardization of complications reporting, pulmonary complications include pneumonia, pleural effusion, pneumothorax, atelectasis, mucous plugging, respiratory failure, acute respiratory distress syndrome, acute aspiration, tracheobronchial injury, and prolonged air-leak [3]. The reported incidence of post-operative pulmonary complications is between 8% and 36% [7]. Pneumonia is the most common pulmonary complication with an incidence of 14.6% [1] according to Low and colleagues' analysis of data from the ESODATA database.

Risk factors for post-operative pulmonary complications can be categorized into pre-operative factors, technical factors, and post-operative factors. Preoperative risk factors are age (especially >70 years of age), nutritional status, underlying pulmonary disease (COPD, tuberculosis, lung fibrosis, etc.), and poor baseline pulmonary function. In their series of 421 patients, Law and colleagues [18] demonstrated that increased age over 70 conferred a twice as high risk for developing post-operative pneumonia with an associated mortality risk that was elevated fourfold. Smoking habits and alcohol use also contribute to risk. Smoking cessation one month prior to an operation may reduce rates of pulmonary complications [7]. Pre-operative pulmonary optimization can help mitigate some of these risks. Pulmonary rehabilitation can include breathing and cough exercises, spirometry, and the use of expectorants and bronchodilators.

Technical risk factors include the location of a tumor, surgical approach, blood loss, and duration of the surgery. Tumors located above the tracheal bifurcation were associated with the risk of pneumonia in Law's 421-patient series [18]. A multicenter trial [15][19] found that pulmonary complications were less likely when thoracotomy was not used and when patients were able to be extubated immediately following surgery. This same trial also found that pneumonia was less common with MIE versus open esophagectomy and more common when a pyloric drainage procedure was not performed. These intraoperative risk factors indicate that minimally invasive techniques and maneuvers that minimize blood loss and surgical duration may aid in the prevention of pneumonia.

Post-operative risk factors that contribute to pulmonary complications include vocal cord paralysis, recurrent laryngeal nerve palsy, swallowing problems, poor pulmonary hygiene, poor pain control, and post-operative respiratory muscle dysfunction. Swallowing problems and dysphagia are common causes of respiratory complications in the post-esophagectomy setting. Swallowing and vocal cord dysfunction are commonly thought to be caused by injury to the recurrent laryngeal nerve (RLN) during surgery. This can consequently lead to aspiration and other pulmonary complications including pneumonia. It was reported that 50% of patients with vocal cord paralysis suffered from respiratory complications [7]. If vocal cord paralysis or RLN injury is suspected, prompt work-up and therapy is warranted to prevent further complication and improve outcomes (dysphagia, voice hoarseness, and aspiration). Poor pulmonary toileting and pain control can contribute to the development of atelectasis, mucous plugging, and pneumonia. Encouraging ambulation, spirometry use, and deep breathing exercises can help mitigate this risk. Good pain control is a key factor in patients being able to perform these tasks. Adequate post-operative analgesia should be achieved with a multimodal approach to include consideration of epidural analgesia.

3.2. Presentation and Diagnostic Work-Up

Pneumonia and other post-operative pulmonary complications can present in several ways and with different severity. Pneumonia may be first suspected with a persistent and possibly productive cough that may be accompanied by fever and leukocytosis. There may be changes to vital signs that include tachycardia (possibly atrial fibrillation), increased respiratory rate, and lower oxygen saturation. The patient may complain of dyspnea and chest pain. Physical exam may reveal rales, rhonchi, or wheezing. Other pulmonary complications may be present that can contribute to the development of pneumonia such as atelectasis, aspiration, and mucous plugging.

If pneumonia or other pulmonary problems are suspected, a work-up should include a focused physical exam of the chest and swallowing function. A chest radiograph should be obtained to make the diagnosis clear. Other diagnostic adjuncts that are helpful include blood tests (looking for leukocytosis, elevated inflammatory markers, and blood cultures if febrile) and CT imaging if the pneumonia is suspected to be complicated or secondary to another cause such as anastomotic leak. If the etiology of the pneumonia is suspected to be secondary to vocal cord paralysis, delayed gastric emptying, or leak, a further work-up should be pursued to evaluate these potential etiologies.

3.3. Treatment

Management of post-operative pulmonary complications may require a multidisciplinary approach. As stated previously, it is important to work up underlying etiologies and treat them appropriately. Antibiotics are needed in cases of pneumonia, empyema, or leaks. Some patients may require mechanical ventilatory support in the intensive care unit. Pre-operative factors such as the patient's comorbidities are also likely to be at play and should be considered when considering management strategies, e.g., patients with COPD may require steroids if they experience a post-operative exacerbation. Consultation with respiratory therapists for aggressive pulmonary toilet and speech–language pathologists (especially in cases of vocal cord dysfunction or dysphagia) can also be helpful depending on the clinical picture. Supportive measures that should be encouraged if feasible for the patient are early ambulation, early extubation, multimodal pain control, incentive spirometry use, and aggressive pulmonary hygiene.

References

1. Low, D.E.; Kuppusamy, M.K.; Alderson, D.; Cecconello, I.; Chang, A.C.; Darling, G.; Davies, A.; D'Journo, X.B.; Gisbertz, S.S.; Griffin, S.M.; et al. Benchmarking Complications Associated with Esophagectomy. Ann. Surg. 2019, 269, 291–298.
2. Oesophago-Gastric Anastomosis Study Group on behalf of the West Midlands Research Collaborative. Rates of Anastomotic Complications and Their Management Following Esophagectomy: Results of the Oesophago-Gastric Anastomosis Audit (OGAA). Ann. Surg. 2022, 275, e382–e391.
3. Low, D.E.; Alderson, D.; Cecconello, I.; Chang, A.C.; Darling, G.E.; D'Journo, X.B.; Griffin, S.M.; Holscher, A.H.; Hofstetter, W.L.; Jobe, B.A.; et al. International Consensus on Standardization of Data Collection for Complications Associated With Esophagectomy: Esophagectomy Complications Consensus Group (ECCG). Ann. Surg. 2015, 262, 286–294.
4. Bruce, J.; Krukowski, Z.H.; Al-Khairy, G.; Russell, E.M.; Park, K.G. Systematic review of the definition and measurement of anastomotic leak after gastrointestinal surgery. Br. J. Surg. 2001, 88, 1157–1168.
5. Peel, A.L.; Taylor, E.W. Proposed definitions for the audit of postoperative infection: A discussion paper. Surgical Infection Study Group. Ann. R. Coll. Surg. Engl. 1991, 73, 385–388.

6. Lerut, T.; Coosemans, W.; Decker, G.; De Leyn, P.; Nafteux, P.; van Raemdonck, D. Anastomotic complications after esophagectomy. Dig. Surg. 2002, 19, 92–98.
7. Grimminger, P.P.; Goense, L.; Gockel, I.; Bergeat, D.; Bertheuil, N.; Chandramohan, S.M.; Chen, K.N.; Chon, S.H.; Denis, C.; Goh, K.L.; et al. Diagnosis, assessment, and management of surgical complications following esophagectomy. Ann. N. Y. Acad. Sci. 2018, 1434, 254–273.
8. Ozawa, S.; Koyanagi, K.; Ninomiya, Y.; Yatabe, K.; Higuchi, T. Postoperative complications of minimally invasive esophagectomy for esophageal cancer. Ann. Gastroenterol. Surg. 2020, 4, 126–134.
9. Wang, W.P.; Gao, Q.; Wang, K.N.; Shi, H.; Chen, L.Q. A prospective randomized controlled trial of semi-mechanical versus hand-sewn or circular stapled esophagogastrostomy for prevention of anastomotic stricture. World J. Surg. 2013, 37, 1043–1050.
10. Kechagias, A.; van Rossum, P.S.N.; Ruurda, J.P.; van Hillegersberg, R. Ischemic Conditioning of the Stomach in the Prevention of Esophagogastric Anastomotic Leakage After Esophagectomy. Ann. Thorac. Surg. 2016, 101, 1614–1623.
11. Chen, K.N. Managing complications I: Leaks, strictures, emptying, reflux, chylothorax. J. Thorac. Dis. 2014, 6 (Suppl. S3), S355–S363.
12. Sharma, S. Management of complications of radical esophagectomy. Indian J. Surg. Oncol. 2013, 4, 105–111.
13. Baker, E.H.; Hill, J.S.; Reames, M.K.; Symanowski, J.; Hurley, S.C.; Salo, J.C. Drain amylase aids detection of anastomotic leak after esophagectomy. J. Gastrointest. Oncol. 2016, 7, 181–188.
14. Raman, V.; Moodie, K.L.; Ofoche, O.O.; Kaiser, L.R.; Erkmen, C.P. Endoscopy after esophagectomy: Safety demonstrated in a porcine model. J. Thorac. Cardiovasc. Surg. 2017, 154, 1152–1158.
15. Fabian, T. Management of Postoperative Complications After Esophageal Resection. Surg. Clin. N. Am. 2021, 101, 525–539.
16. Sato, Y.; Tanaka, Y.; Suetsugu, T.; Takaha, R.; Ojio, H.; Hatanaka, Y.; Yoshida, K. Three-step operation for esophago-left bronchial fistula with respiratory failure after esophagectomy: A case report with literature review. BMC Gastroenterol. 2021, 21, 467–474.
17. Omae, T.; Kanmura, Y. Management of postoperative atrial fibrillation. J. Anesth. 2012, 26, 429–437.
18. Law, S.; Wong, K.H.; Kwok, K.F.; Chu, K.M.; Wong, J. Predictive factors for postoperative pulmonary complications and mortality after esophagectomy for cancer. Ann. Surg. 2004, 240, 791–800.

19. Bakhos, C.T.; Fabian, T.; Oyasiji, T.O.; Gautam, S.; Gangadharan, S.P.; Kent, M.S.; Martin, J.; Critchlow, J.F.; DeCamp, M.M. Impact of the surgical technique on pulmonary morbidity after esophagectomy. Ann. Thorac. Surg. 2012, 93, 221–226, discussion 226–227.