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Management and outcomes of patients who developed tracheoesophageal fistula in the cardiovascular surgery intensive care unit

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ABSTRACT

Introduction: Tracheoesophageal fistula (TEF) is a rare but serious complication, particularly in critically ill patients undergoing prolonged mechanical ventilation or tracheostomy. Management of non-malignant TEFs in intensive care settings is particularly challenging. This retrospective descriptive case series was designed to evaluate the characteristics, management strategies, treatment methods and clinical outcomes of patients with acquired TEF in a cardiovascular surgery intensive care unit, with Ethics Committee approval.

Materials and Methods: All patients who were followed for more than 24 hours in the cardiovascular surgery intensive care unit during a 6.5-year period were evaluated. Adult patients who underwent endoscopy due to suspected TEF and were confirmed to have TEF were included in the study. The following parameters were examined: patient age, sex, type of surgery performed, use of mechanical ventilation, presence of tracheostomy and tracheostomy-related complications, length of ICU stay, use of inotropic support, presence of infections, timing of TEF development, TEF treatment methods, mortality, and outcomes.

Results: Total of 23 patients underwent endoscopic evaluation due to suspected TEF. Among these, TEF was confirmed in 10 patients. Four of these patients underwent endoscopic and surgical treatment for TEF. These methods included endoscopic clipping alone (n=1), surgical repair alone (n=2), or a combination of endoscopic clipping and surgical repair (n=1). Two of these four patients died during hospitalization. One patient was discharged with complete recovery, while the other was discharged with a tracheostomy.

Conclusion: Given the complexity of TEF management, both surgical and endoscopic treatment approaches should be undertaken in specialized centers with a multidisciplinary team.

Keywords: Cardiac surgery, endoscopic methods, tracheoesophageal fistula

Introduction

Tracheoesophageal fistula (TEF) is an abnormal communication between the trachea and the esophagus. It can be either congenital or acquired. Although rare, it represents a serious, difficult-to-treat complication, particularly in patients undergoing prolonged mechanical ventilation, and is associated with increased morbidity and mortality.

Acquired TEFs most commonly occur due to erosion of the tracheal and esophageal walls caused by endotracheal or tracheostomy tube cuffs. The incidence has declined with

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the use of low-pressure cuffs. Other causes of acquired TEF include trauma, malignancy, tracheostomy, infections, and certain surgical procedures such as aortic surgery.

Management of non-malignant TEFs in intensive care settings is particularly challenging. Recurrence is common. In appropriate candidates, either surgical repair or endoscopic approaches—such as clipping or stenting—may be employed. In a limited number of recent studies in the literature, perioperative mortality in patients undergoing surgical intervention has been reported to be approximately 5%.[1] Endoscopic approaches are also recommended in selected patients.The non-surgical management of these patients is also complex and requires multidisciplinary care.

This study was designed to evaluate the characteristics of patients who developed acquired TEF in a cardiovascular surgery intensive care unit, the management strategies, the treatment methods and the clinical outcomes.

Materials and Methods

This study was designed as a retrospective descriptive case series (without comparative statistics) with the approval of the Koşuyolu High Specialization Training and Research Hospital Ethics Committee (Date: 05/08/2025, No: 2025/13/1200) and it's conducted according to Helsinki Declaration.

All patients followed in the cardiovascular surgery intensive care unit (ICU) for more than 24 hours between January 1, 2019, and June 30, 2025, were evaluated. This included patients who underwent cardiovascular and thoracic surgery, those awaiting or having undergone heart or lung transplantation, patients on venoarterial (VA) or venovenous (VV) extracorporeal membrane oxygenation (ECMO), and those who underwent peripheral arterial surgery. The total number of patients followed and treated in the intensive care unit during this period was recorded.

In the intensive care unit, tracheostomy cuff pressures in all patients are monitored primarily by palpation (they should be about the size of an earlobe), monitoring inspiratory and expiratory tidal volumes on the ventilator, and assessing for air leaks in the neck. These checks are performed several times a day and only when necessary. While cuff pressure monitoring is not routinely used, intermittent cuff pressure measurements are also made.

Adult patients who underwent endoscopy with suspicion of TEF in the intensive care unit and whose diagnosis of TEF was confirmed were included in the study. Patients who underwent endoscopy for other reasons were excluded. The following parameters were examined: Patient age, sex, type of surgery performed, use of mechanical ventilation, presence of tracheostomy, tracheostomy technique, presence of tracheostomy-related complications, length of ICU stay, use of inotropic support, presence of infections, timing of TEF development, nutritional and medical management due to TEF, TEF treatment methods, mortality, and outcomes.

Statistical Analysis

Due to the limited number of patients diagnosed with TEF (n=10), statistical evaluation was performed using descriptive statistics. The total number of patients admitted to the intensive care unit during the study period was recorded. Data were presented as the number of patients who developed TEF. Patients who underwent endoscopy due to suspected TEF were reported as both number and percentage. The presence of cerebrovascular events, use of inotropic support, presence of sepsis, length of ICU stay, and time to TEF development were calculated as median values with minimum and maximum ranges. Mortality among patients who developed TEF was expressed as a number and percentage relative to the total number of TEF cases. The treatment method applied for TEF was described on a per-patient basis.

Results

Between January 2019 and June 2025, a total of 22,273 patients were admitted to the cardiovascular surgery intensive care unit for more than 24 hours. During this period, a total of 23 patients underwent endoscopic evaluation due to suspected TEF. Among these, TEF was confirmed in 10 patients. The median age of patients with confirmed TEF was 56 years (range: 27–76), and 6 of them were female. The demographic characteristics of the patients included in the study are presented in Table 1. In the remaining 13 patients who underwent endoscopy for suspected TEF, no fistula was identified. However, esophageal mucosal thinning was observed in 2 of these patients.

All patients had undergone percutaneous tracheostomy using the single dilatation technique (Blue Rhino method). None of the patients received surgical tracheostomy.

The clinical signs that led to suspicion of TEF were as follows: Appearance of enteral feeding through the tracheostomy cannula (n=6), presence of air through the na-

Table 1. Demographic characteristics (n=10)

Age (years)	56.2 (27-76)	
Gender (F/M)	6 / 4	
Diagnosis/Surgery performed (n)	ARDS + VV ECMO	2
	CABG + MEDIASTINITIS	1
	CABG	1
	AASGI	1
	AASGI +CABG	1
	AVR +MVR +TRICUSPIT RING	1
	MVR + TRICUSPIT RING+ PFO AND ASD CLOSURE	1
	BULLOUS LUNG +VV ECMO	1
	REDO MVR + INFECTIVE ENDOCARDITIS	

ARDS: Acute Respiratory Distress Syndrome; VV-ECMO: Veno-Venous Extracorporeal Membrane Oxygenation; CABG: Coronary Artery Bypass Grafting; AASGI: Ascending Aorta Separate Graft Interposition; AVR: Aortic Valve Replacement; MVR: Mitral Valve Replacement; PFO: Patent Foramen Ovale; ASD: Atrial Septal Defect.

sogastric tube (n=1), abdominal distension (n=2), and incidental detection during rigid bronchoscopy performed for tracheal stenosis (n=1). The location of the TEF identified via endoscopy was between 17–20 cm from the incisors in 8 patients and starting at 14 cm in 2 patients. The fistula lengths ranged from 1 to 4 cm.

The median time between endotracheal intubation and the development of TEF was 38 days (range: 18–67). The median duration of intubation before tracheostomy was 17.5 days (range: 8–34), while the median time between tracheostomy and TEF development was 18 days (range: 0–60).

Prior to or at the time of TEF diagnosis, 9 patients were receiving inotropic and/or vasopressor support. Additionally, 9 patients were either being treated for sepsis or were septic at the time TEF was diagnosed. Mediastinitis was present in 2 patients. Only 2 patients were discharged from the hospital (Table 2).

Among the patients who developed TEF, 8 had undergone tracheostomy due to prolonged mechanical ventilation, while in 2 patients, TEF developed iatrogenically during tracheostomy procedures. In one patient, the TEF occurred during percutaneous tracheostomy and in the other, it developed during rigid bronchoscopy performed for tracheal stenosis.

One patient with iatrogenic TEF had been on VV-ECMO support due to ARDS secondary to COVID-19 pneumonia. On the 8th day of ECMO support, the patient underwent cesarean section and delivered a live infant. On the 27th day of post-cesarean intubation, a percutaneous tracheostomy was performed under bronchoscopic guidance while ECMO support was ongoing. The patient was

Table 2. Clinical characteristics of patients who developed TEF

Duration of entubation before tracheostomy (days) median (min–max)	17.5 (8-34)
Duration from tracheostomy to TEF diagnosis (days) median (min–max)	18 (0-60)
Duration from Intubation to TEF diagnosis (days) median (min–max)	38 (18-67)
Inotropic and/or vasopressor support prior to or during TEF (n)	6
Previous or ongoing sepsis (n)	9
Mediastinitis (n)	2
Discharge from hospital (n)	3
Exitus (n)	7

TEF; Tracheoesophageal fistula.

weaned from ECMO on day 40 and subsequently transferred to the ward. A follow-up bronchoscopy performed in the ward revealed significant tracheal stenosis just below the vocal cords. However, during the rigid bronchoscopy procedure, an iatrogenic tracheoesophageal fistula developed. The patient underwent two surgical interventions and was eventually discharged with a tracheostomy and percutaneous endoscopic jejunostomy (PEJ) due to recurrent laryngeal nerve paralysis. In the 8th month following discharge, the patient experienced massive bleeding from the tracheostomy site. Despite emergency surgery, further repair was not possible, and the patient died due to hemorrhagic complications.

The other patient who developed iatrogenic TEF underwent ascending aortic graft interposition surgery due to ascending aortic dissection and had a prolonged mechanical ventilation duration. This patient experienced postoperative cerebrovascular events (CVE). Neither surgical repair nor endoscopic treatment was considered. Enteral feeding was discontinued, and TPN was initiated. The tracheostomy cannula balloon was adjusted to remain below the fistula site. The patient was transferred to another suitable center for continuation of treatment under these conditions.

Among the patients, 6 developed CVE, had low Glasgow Coma Scale (GCS) scores, infections, poor general condition, and required high-dose inotropic support. Due to these factors, neither intervention nor surgery for TEF was deemed appropriate. These 6 patients died due to causes other than TEF, such as sepsis.

Among the patients, four received treatment for TEF as follows:

Endoscopic clipping alone (n=1)

Surgical repair alone (n=2),

Combined endoscopic clipping and surgical repair (n=1).

The endoscopic and/or surgical interventions performed for TEF and their outcomes are summarized in Table 2 and 3. Two of these four patients died during hospitalization. One patient was discharged with complete recovery, while the other was discharged with a tracheostomy due to bilateral vocal cord paralysis. One of the patients who died was a 68-year-old who had undergone mitral valve replacement (MVR) and tricuspid ring annuloplasty. The patient required prolonged mechanical ventilation due to pneumonia and the need for inotropic and vasopressor support. TEF was diagnosed during endoscopy performed for abdominal distension. The patient was taken to surgery for TEF repair after pneumonia improved and inotropic support was discontinued. Primary repair and jejunostomy were performed, and the patient was extubated postoperatively. However, reoperation was required days later due to air leakage from the tracheostomy site. Despite this, the patient died due to sepsis and renal failure during the postoperative period. The second patient who died was on VV-ECMO support due to bullous lung disease and could not be weaned off. This patient underwent two endoscopic clipping procedures but ultimately died from multidrug-resistant Klebsiella sepsis.

Table 3. Interventions, surgeries, and outcomes for TEF

Interventions and surgical procedures	Reoperation	Result	n
Endoscopic clip placement and percutaneous endoscopic jejunostomy	Additional clip placement	Exitus	1
Primary repair and jejunostomy	-	Recovery	1
		Exitus	1
Endoscopic clip placement	Tracheal ring resection and end-to-end anastomosis + fistula tract repair (with muscle flap) + percutaneous jejunostomy (1. reoperation) Placement of a silicone cylindrical stent + tracheostomy cannula on the stent (2. reoperation)	Discharge with tracheostomy (Exitus with bleeding after 8 months)	1

TEF: Tracheoesophageal fistula.

Discussion and Conclusion

In this study, a total of 22,273 patients admitted to the cardiovascular surgery intensive care unit for more than 24 hours over a 6.5-year period were reviewed. Endoscopy was performed in 23 patients with suspected TEF. It was confirmed in 10 patients, while 11 patients showed no evidence of TEF, and esophageal thinning was observed in 2 patients. Among the patients with TEF, four received treatment: Endoscopic intervention alone (n=1), surgical repair alone (n=2), or a combination of endoscopic and surgical interventions (n=1). Surgical or endoscopic treatment was not planned for six patients due to sepsis or CVE. In these patients, the tracheostomy cannula balloon was advanced to remain below the fistula, and TPN was initiated for feeding. The overall mortality rate among the 10 patients diagnosed with TEF was 70%. These deaths were primarily attributed to sepsis, CVE, and/or cardiac failure. The mortality rate among the four patients who underwent endoscopic and/or surgical treatment was 50%. One patient, who was discharged with a tracheostomy cannula, died six months later due to massive bleeding at the TEF site. In this study, 60% of the patients were receiving inotropic support at the time of TEF diagnosis, and 90% were on antibiotic therapy due to pneumonia or sepsis.

Non-malignant TEFs remain a rare but significant complication in intensive care units despite advances in diagnosis, treatment, and increased awareness. Surgical repair of TEFs has been reported to result in excellent or good long-term anatomical and functional outcomes in 93–93% of cases.[2] Preparation for surgical correction is crucial and may take several months. Key factors for successful repair include weaning the patient off mechanical ventilation, adequate treatment of infections, respiratory physiotherapy, and full nutritional optimization.[3]

In this study, among the four patients in whom TEF closure was achieved via endoscopic or surgical methods, two underwent surgery after being transferred from the intensive care unit (ICU) to the general ward. Both of these patients were successfully discharged. In the remaining two patients, TEF closure was performed via endoscopic or surgical intervention during their ICU stay when their condition was deemed suitable. However, both patients died in the ICU due to sepsis.

It was considered that the success of TEF treatment in these patients was strongly influenced by the patient's overall clinical condition, the presence of underlying comorbidities, and a history of sepsis. According to the literature, the number of patients reported in studies addressing TEF treatment modalities and the timing of interventions remains limited. Each case must be evaluated individually to determine the optimal timing and type of surgical or endoscopic intervention.

The most common cause of TEF is prolonged mechanical ventilation. Tracheal ischemia caused by endotracheal tube or tracheostomy cuff pressure is a significant factor in the development of TEF. Ischemia and infections resulting from sustained local pressure contribute to the pathogenesis of TEF. Cuff pressure-related TEFs typically present with symptoms within 21–30 days.[4] Tracheoesophageal fistulas have been reported in patients who were endotracheally intubated or tracheostomized, with a median mechanical ventilation duration of approximately 30 days. In our study, the median time between endotracheal intubation and the diagnosis of TEF was 38 days (range: 18–67). Eight of the patients had a prolonged duration of mechanical ventilation prior to the development of TEF and were receiving antibiotic therapy due to concurrent infections. All patients were fed enterally via a nasogastric tube prior to the diagnosis of TEF, provided they had adequate enteral tolerance. Other reported causes of TEF include complications related to tracheal or esophageal surgery, aortic surgery, iatrogenic injuries, and trauma.[2] In our study, iatrogenic TEF occurred in 2 out of 10 patients, during percutaneous tracheostomy in one case and during rigid bronchoscopy in another.

In TEFs caused by endotracheal tube or tracheostomy cuff pressure, the defect is typically located in the mid or distal trachea.[5] In this study, TEFs were most commonly observed between 17 and 20 cm from the incisors, corresponding to the position of the endotracheal or tracheostomy tube cuff. The fistulas were primarily located in the mid to distal trachea. In two patients, the TEF was identified at approximately 14 cm from the incisors. One of these patients was on VV-ECMO support with vasopressor infusion due to ARDS. The other had undergone AVR + MVR + tricuspid ring annuloplasty and was hemodynamically unstable, requiring inotropic support.

During the COVID-19 pandemic, an increase in the incidence of TEF was observed, rising from 0.5% to 1.5%.[6] Following the pandemic, 23% of patients referred to thoracic surgery centers with tracheolaryngeal complications were reported to have developed TEF.[7] During this period, the management of TEFs related to prolonged mechanical

ventilation was particularly challenging. Among patients undergoing endoscopic or surgical treatment, mortality rates as high as 43% were reported, largely due to infectious complications.[6]

In this study, two postpartum patients who developed ARDS due to COVID-19 were managed with VV-ECMO support. Both patients underwent tracheostomy during ECMO. In the first patient, tracheal stenosis was detected following 40 days of prolonged mechanical ventilation and VV-ECMO support. During rigid bronchoscopy performed for tracheal stenosis, an iatrogenic TEF occurred. The patient required multiple endoscopic and surgical interventions. She was eventually discharged with a tracheostomy due to bilateral vocal cord paralysis. While awaiting recovery of vocal cord function, the patient developed severe bleeding from the fistula site. Surgical repair was not feasible during the emergent procedure, and the patient died due to hemorrhagic complications. The second patient also underwent percutaneous tracheostomy during VV-ECMO support. A TEF was diagnosed 16 days after the tracheostomy. Surgical primary repair of the trachea and esophagus was performed 35 days after ECMO decannulation. This patient recovered fully and was discharged without a tracheostomy and with no long-term sequelae.

The management of patients with tracheoesophageal fistula involves several critical supportive measures. Restriction of oral intake, frequent oral suctioning, and head-of-bed elevation to ≥45° are essential components. In patients under mechanical ventilation, the endotracheal tube cuff should be positioned distal to the fistula. If a tracheostomy is in place, a long, adjustable tracheostomy tube should be used to ensure the cuff lies below the fistula site. H_2-receptor antagonists or proton pump inhibitors are recommended for gastric acid suppression. Nasogastric and orogastric tubes should be removed, and when feasible, a jejunostomy feeding tube may be considered for enteral nutrition.[5] In this study, it was determined that these methods were followed in all patients.

Symptoms such as coughing during oral intake, aspiration, fever, pneumonia, or air leakage via a nasogastric tube—particularly in mechanically ventilated patients—should raise suspicion for TEF.[8] The most commonly reported symptoms of TEF include respiratory distress, dysphagia, and recurrent pulmonary infections.[5] Patients may present with feeding difficulties, including choking during meals, and recurrent aspiration pneumonias, which can be life-threatening. Even in the absence of overt aspiration pneumonia, patients presenting with severe septic states may have an underlying TEF that should not be overlooked.[9] In our study, the most common clinical sign suggesting TEF was the presence of enteral feeding material leaking through the tracheostomy cannula (n=6). Additional findings included air leakage from the nasogastric tube (n=1) and abdominal distension (n=2). However, especially in patients undergoing prolonged mechanical ventilation, clinicians should maintain a high index of suspicion for TEF and conduct a thorough and vigilant assessment.

Interventional or Surgical Treatments in Patients with TEF;

Endoscopic Approaches

In the treatment of benign TEF, after supportive care, surgical intervention or endoscopic methods such as stenting or clipping are performed at the most appropriate time. Stents are generally placed in the esophagus and less frequently in the airway. Airway stents are used when esophageal stenting fails to adequately close the fistula or cannot be placed.[10] However, stents themselves may also cause TEF. Therefore, close follow-up of patients after stent placement is crucial.[11] Endoscopic treatment methods such as clipping or metallic stenting should be considered as a therapeutic option in patients who developed TEF following COVID-19 infection.[6] In the literature, endoscopic management has been reported to achieve successful fistula closure in approximately 57% of cases, with an average of 1.7 procedures per patient. However, 43% of patients eventually required surgical repair.[12] In our study, one patient who developed ARDS and underwent veno-venous extracorporeal membrane oxygenation (VV-ECMO) received two endoscopic interventions with clip placement at the site of the TEF, resulting in successful closure. Unfortunately, the patient later died due to multidrug-resistant sepsis. In another case, following VV-ECMO decannulation for COVID-19-related ARDS, endoscopic clips placement was attempted. Due to treatment failure, elective surgical repair was performed. Shortly thereafter, dehiscence at the anastomotic site occurred, and a cylindrical stent was endoscopically placed in the trachea. The patient was eventually discharged with a tracheostomy. Despite lower success rates and the need for repeated interventions compared to surgery, endoscopic techniques are increasingly considered a valuable component in the management of TEF in selected patients.[12]

Surgical Treatment of TEF

In thoracic surgery centers, segmental tracheal resection with end-to-end anastomosis and esophageal suturing is the preferred treatment for patients who develop post-intubation TEF, particularly those with adequate nutrition and spontaneous respiration. In such cases, perioperative mortality has been reported as 3.8%.[13] It is crucial to select an individualized surgical approach to eliminate the fistula and restore normal respiration and swallowing. The use of muscle flap interposition can reduce the risk of fistula recurrence in high-risk conditions such as prior esophagectomy or cervical radiation.[14] Deciding on the appropriate surgical strategy for TEF is a complex process. Factors influencing this decision include the location, size, and morphology of the fistula, underlying comorbidities, nutritional status, and the type and number of previous reconstructive procedures.[15]

Surgical Treatment

In patients who develop TEF after intubation in a thoracic surgery center, the preferred treatment for those with spontaneous respiration and adequate nutrition is segmental tracheal resection with end-to-end anastomosis and esophageal suturing. Perioperative mortality in these patients has been reported as 3.8%.[13] It is crucial to select an individualized surgical approach to eliminate the fistula and restore normal respiration and swallowing. Muscle flap interposition reduces the risk of fistula recurrence in high-risk cases such as those with prior esophagectomy or cervical radiation.[14] Deciding on the surgical strategy and treating TEF is a complex process. Factors influencing the strategy include the location, size, and contour of the TEF, underlying disease, malnutrition, and the type and number of previous reconstructive interventions.[15]

The surgical approach most commonly involves an anterior technique with tracheal resection and end-to-end anastomosis. In cases of large-sized fistulas, atypical surgical techniques may be required. Esophageal defects or membranous tracheal wall disruptions can be repaired with primary suturing. Additionally, placement of a T-tube combined with protective tracheostomy may be utilized as part of the surgical repair strategy. To separate the esophagus from the trachea and reduce the risk of recurrence, muscle flaps harvested from pretracheal muscles or the sternocleidomastoid can be interposed between the two structures.[7] For patients requiring nutritional support, simultaneous placement of gastrostomy and jejunostomy tubes is recommended to allow both enteral feeding and gastric decompression. Surgical intervention should ideally be postponed until the patient can be weaned off mechanical ventilation. In surgical repair of TEF, reported morbidities include partial dehiscence of the tracheal anastomosis, transient recurrent laryngeal nerve palsy, temporary dysphagia, tracheal anastomotic granulation tissue formation, and surgical site infections.[13]

In our study, one patient who underwent surgical closure of TEF developed bilateral recurrent laryngeal nerve paralysis and dehiscence at the tracheal anastomosis site. In patients undergoing tracheal resection and anastomosis, routine postoperative bronchoscopic evaluations are crucial to assess the integrity of the anastomotic suture line.

Clinicians should maintain a high index of suspicion for TEF in patients undergoing prolonged mechanical ventilation, tracheostomy procedures, or during episodes of infection, particularly in those followed with a tracheostomy. To prevent TEF in intensive care units, continuous monitoring of tracheal or endotracheal tube cuff pressures, ensuring adequate nutritional support, close monitoring of at-risk patients, and proper suctioning techniques are essential.

Tracheoesophageal fistula is a rare but serious complication, particularly in critically ill patients undergoing prolonged mechanical ventilation or tracheostomy. Given the complexity of TEF management, both surgical and endoscopic treatment approaches should be undertaken in specialized centers with a multidisciplinary team. Such an approach significantly improves treatment success and patient outcomes.

Disclosures

Ethics Committee Approval: This study was with the approval of the Koşuyolu High Specialization Training and Research Hospital Ethics Committee (Date: 05/08/2025, No: 2025/13/1200).

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