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Occurrence and outcomes of acquired tracheoesophageal fistula in mechanically ventilated adults in a five year single center study

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Research Article

Keywords: Critical care, Intensive care, Mechanical ventilation, Tracheoesophageal fistula, Tracheostomy, Endotracheal intubation

Posted Date: November 1st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11267288/v1

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Additional Declarations: No competing interests reported.

Abstract

Purpose

Acquired tracheoesophageal fistula (TEF) can complicate invasive ventilation, but its occurrence across an entire intensive care population is poorly characterized. Treatment-focused series may not capture patients who remain critically ill and cannot undergo definitive repair. We aimed to quantify the observed institutional occurrence of TEF and describe the clinical course and outcomes of affected patients.

Methods

We retrospectively reviewed adults with endoscopically confirmed acquired TEF diagnosed in a tertiary intensive care unit between 2021 and 2025. Annual ventilation records were merged and deduplicated to identify 3,442 unique invasively ventilated patients. Clinical and anatomical findings, treatment, and all-cause in-hospital mortality were summarized descriptively. Exact 95% confidence intervals (CIs) were calculated for selected proportions.

Results

TEF was identified in 20 patients, corresponding to an observed five-year institutional proportion of 0.58% (95% CI, 0.36–0.90%), or 5.81 per 1,000 ventilated patients. Median age was 70 years, and median time from intensive care admission to TEF diagnosis was 46 days (interquartile range, 33–65.5). Median total ventilation duration was 60.5 days. Tracheostomy preceded TEF diagnosis in 14 patients (70%). Ventilator-associated pneumonia was documented in 19 (95%) and septic shock in all 20. Median fistula diameter was 2.0 cm. Five patients underwent esophageal metallic stenting; closure was not documented, and none underwent definitive surgical repair. All 20 died during hospitalization (100%; 95% CI, 83.2–100%).

Conclusions

Acquired TEF was detected in approximately one in 172 invasively ventilated patients and occurred in a cohort with an exceptionally poor hospital outcome. Clinically triggered ascertainment may underestimate its occurrence. These findings support sustained diagnostic vigilance during prolonged airway instrumentation, while neither a higher-than-expected incidence nor mortality attributable specifically to TEF can be established.

Clinical Trial Or Systematic Review Registration

Not applicable. This retrospective observational study was not registered in a public registry.

Introduction

Acquired tracheoesophageal fistula (TEF) creates an abnormal communication between the airway and esophagus that can compromise ventilation and permit recurrent aspiration. In critically ill adults,

prolonged endotracheal intubation and tracheostomy are important settings for its development. Pressure-related tissue injury, infection, and impaired local perfusion have been implicated, although the contribution of individual exposures is difficult to establish in severely ill patients [1, 2, 3]. The clinical concern extends beyond the fistulous defect: a patient with continuing organ support requirements may have limited opportunities for definitive treatment.

Recent studies illustrate the range of TEF populations represented in the literature. Mo et al. compared silicone and metallic airway stents in 38 patients, 36 of whom had malignant fistulas [4]. Dai et al. examined treatment and prognosis in 100 adults with non-neoplastic esophageal fistulas, encompassing several anatomical subtypes and etiologies [5]. These studies address clinically relevant treatment questions but do not estimate the occurrence of acquired TEF across an entire invasively ventilated ICU population. Surgical series likewise describe patients selected for referral and repair [6, 7, 8]. Patients who develop TEF while remaining too unwell for surgery may therefore be incompletely represented in treatment-focused evidence.

The frequency of TEF in intensive care is also difficult to interpret because reported denominators include different populations, such as patients undergoing tracheostomy or those receiving prolonged ventilation during the COVID-19 pandemic [9, 10, 11, 12]. An institutional estimate based on all unique invasively ventilated patients can help contextualize the burden, provided that clinically detected disease is distinguished from systematic surveillance and that recognition is not equated with the onset of injury.

We therefore reviewed five years of acquired TEF diagnoses in a tertiary adult ICU. Our primary aim was to estimate its observed institutional occurrence using a defined denominator of unique invasively ventilated patients. We also described the clinical course, anatomical findings, treatment, and all-cause in-hospital mortality of affected patients. The study was descriptive and was not designed to identify independent risk factors or determine the mortality attributable to TEF.

Methods

Study design and setting

This retrospective single-center study combined a case series of adults with acquired TEF and an institutional analysis of its occurrence among invasively ventilated patients. It was conducted in the tertiary Anesthesiology and Reanimation Intensive Care Unit of Hitit University Erol Olçok Training and Research Hospital, Çorum, Türkiye, covering 2021–2025. Patients were identified when TEF was diagnosed during their ICU stay; the recorded diagnosis date represented recognition rather than the biological onset of the fistula. No patient-level comparison cohort without TEF was available.

The protocol was approved on May 6, 2026 (Decision No. 2026-91), and the ethics committee waived individual consent to participate because of the retrospective design. The study was conducted in accordance with the Declaration of Helsinki. The committee name and publication-consent statement are provided under Declarations.

Case ascertainment and eligibility

A stepwise record review was used because TEF diagnoses might not have been uniformly coded in the hospital information system. Adults who underwent endotracheal intubation and invasive mechanical ventilation in the study ICU were identified. Clinical records and endoscopy reports were reviewed for patients who underwent esophagoscopy or bronchoscopy. Thoracic surgery and gastroenterology consultation records were also screened. Cases were confirmed by the documented clinical diagnosis together with endoscopic findings. This was a clinically triggered ascertainment strategy; patients were not routinely screened endoscopically for TEF.

Eligible patients were aged at least 18 years, had received invasive mechanical ventilation in the study ICU, had acquired TEF diagnosed during ICU follow-up, and had the essential clinical data available. Congenital TEF and previous caustic substance exposure were exclusion criteria. All 20 consecutive eligible patients identified during the study period were included. No a priori sample size calculation was performed; the sample comprised the available cases over the defined period.

Institutional denominator and outcomes

Annual patient-level records of adults who received invasive mechanical ventilation in the study ICU between 2021 and 2025 were obtained from the hospital administrative system and exported to Microsoft Excel. The annual records were merged, and repeat records for the same patient across the study period were removed. The denominator comprised 3,442 unique patients, rather than ventilation episodes or ICU admissions.

The primary measure was the number of endoscopically confirmed TEF cases divided by the number of unique invasively ventilated patients, expressed as a percentage and per 1,000 patients. We describe this as the observed five-year institutional proportion because it reflects diagnoses captured during the study period, without uniform follow-up or systematic screening of all patients. Additional outcomes were the timing of TEF recognition, documented treatment and closure, and all-cause in-hospital mortality among the cases. This measure is not an incidence rate per ventilator-day or an estimate specific to patients with prolonged ventilation.

Clinical and anatomical variables

Data were extracted retrospectively from electronic medical records, endoscopy reports, and the institutional database. Recorded variables included age, sex, ICU admission diagnosis, comorbidities, ICU length of stay, admission Acute Physiology and Chronic Health Evaluation II (APACHE II) and Sequential Organ Failure Assessment (SOFA) scores, and durations of endotracheal intubation and total mechanical ventilation. Tracheostomy timing and technique, nasogastric tube use, clinically documented ventilator-associated pneumonia (VAP) and septic shock, vasopressor or inotropic support, corticosteroid treatment, and serum albumin at ICU admission were also recorded.

Time to TEF diagnosis was measured from ICU admission. Tracheostomies were classified as percutaneous or surgical, and the interval from tracheostomy to TEF diagnosis was calculated from the recorded procedure and diagnosis dates. Total ventilation duration and other durations that could extend beyond diagnosis were treated as descriptors of the hospital course, not as pre TEF etiological exposures. The temporal relationship of infection and organ support to fistula formation could not be reliably established.

Fistula location was the distance from the incisors recorded at endoscopy, and size was the largest reported diameter. The distribution at 16–20 cm from the incisors was examined descriptively. Measurements were extracted from clinical reports without a standardized research measurement protocol. Patient-level tube fixation depth, serial cuff pressures, and cuff position were unavailable. Treatment and any documented closure after stenting were extracted from the records; lack of documented closure was not classified as proven stent failure.

Statistical analysis

Continuous variables were summarized as medians and interquartile ranges (IQRs), with ranges where informative; categorical variables were summarized as counts and percentages. Complete data were reported for the variables included in the analyses of all 20 cases, and no imputation was performed. Exact 95% confidence intervals (CIs) for selected proportions were calculated using the Clopper–Pearson method.

Exploratory associations were evaluated with Spearman rank correlation or the Mann–Whitney U test. The six tests in Table 3 were treated as one family for Benjamini–Hochberg false-discovery-rate adjustment. Two-sided nominal P values and adjusted q values were reported, with thresholds of 0.05. These analyses were hypothesis-generating. Tracheostomy comparisons were particularly susceptible to time-dependent selection because patients had to survive and remain ventilated long enough to undergo the procedure. No multivariable risk-factor model or binary mortality-prediction model was fitted. Analyses were performed using Python 3.13.5, NumPy 2.3.5, and SciPy 1.17.0.

Results

Observed institutional occurrence and hospital mortality

Between 2021 and 2025, 20 cases of acquired TEF were identified among 3,442 unique invasively ventilated patients. The observed institutional proportion was 0.58% (95% CI, 0.36–0.90%), corresponding to 5.81 per 1,000 patients (95% CI, 3.55–8.96) or approximately one case per 172 patients. All 20 patients with TEF died during hospitalization (100%; exact 95% CI, 83.2–100%). This was all-cause in-hospital mortality; the proportion of deaths specifically attributable to TEF could not be determined.

Clinical course and airway characteristics

Median age was 70 years (IQR, 56–81.8), and 12 patients (60%) were female. Median ICU stay was 61 days (IQR, 50.5–80), median APACHE II score was 19 (IQR, 19–20.5), and median SOFA score was 5 (IQR, 4.8–6). Median serum albumin at ICU admission was 32.5 g/L (IQR, 28.8–37.3) (Table 1).

Table 1
Demographic and intensive care characteristics

Variable	Result
Number of patients	20
Age, years	70 [56-81.8]
Female sex	12/20 (60%)
Male sex	8/20 (40%)
Length of ICU stay, days	61 [50.5–80]
APACHE II score	19 [19-20.5]
SOFA score	5 [4.8-6]
Endotracheal intubation	20/20 (100%)
Duration of intubation, days	31 [18.3–52.8]
Duration of mechanical ventilation, days	60.5 [42.3–79.3]
Tracheostomy	14/20 (70%)
Nasogastric tube	19/20 (95%)
VAP	19/20 (95%)
Septic shock	20/20 (100%)
Vasopressor/inotropic support	19/20 (95%)
Corticosteroid therapy	8/20 (40%)
Serum albumin, g/L	32.5 [28.8–37.3]
In-hospital mortality	20/20 (100%)

Values are presented as median [IQR] or n/N (%). APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment; VAP, ventilator-associated pneumonia; ICU, intensive care unit.

All patients received endotracheal intubation and invasive ventilation. Median intubation duration was 31 days (IQR, 18.3–52.8), and median total ventilation duration was 60.5 days (IQR, 42.3–79.3). Fourteen patients (70%) underwent tracheostomy, including five percutaneous and nine surgical procedures.

Tracheostomy occurred at a median of 21.5 days after ICU admission (IQR, 13.8–35.5) and preceded TEF diagnosis in all 14 patients. The median interval from tracheostomy to TEF diagnosis was 31 days (IQR, 20–41; range, 7–153) (Tables 1 and 2).

Table 2
Airway and TEF characteristics

Variable	Result
Day of TEF diagnosis	46 [33-65.5]
Diagnosis by esophagoscopy	20/20 (100%)
Fistula location, cm	17 [16–18]
Range of fistula location, cm	13–22
TEF located 16–20 cm from the incisors	16/20 (80%)
Fistula size, cm	2.0 [2.0-2.5]
Range of fistula size, cm	1.0-3.5
Tracheostomy	14/20 (70%)
Percutaneous tracheostomy	5/14 (35.7%)
Surgical tracheostomy	9/14 (64.3%)
Day of tracheostomy	21.5 [13.8–35.5]
Tracheostomy before TEF diagnosis	14/14 (100%)
Tracheostomy to TEF interval, days	31 [20–41]
Esophageal metallic stent placement	5/20 (25%)
Documented fistula closure after stenting	0/5 (0%)
Definitive surgical repair	0/20 (0%)
TEF, tracheoesophageal fistula; cm, centimeters	

Nasogastric tube use and VAP were each documented in 19 patients (95%). Septic shock was recorded in all 20, vasopressor or inotropic support in 19 (95%), and corticosteroid treatment in eight (40%). These variables describe the observed clinical course and cannot be interpreted as independent predictors of TEF (Table 1).

Recognition and anatomical findings

TEF was diagnosed at a median of 46 days after ICU admission (IQR, 33–65.5; range, 4–163). All 20 cases were confirmed by esophagoscopy. The median location was 17 cm from the incisors (IQR, 16–

18; range, 13–22); 16 fistulas (80%; exact 95% CI, 56.3–94.3%) were located at 16–20 cm. Median fistula diameter was 2.0 cm (IQR, 2.0–2.5; range, 1.0–3.5), with 11 patients (55%) having a recorded diameter of 2.0 cm (Table 2). A representative endoscopic image shows the inflated endotracheal cuff visible through the defect (Fig. 1). The distribution of locations is presented in Fig. 2.

Treatment

Five patients (25%) underwent esophageal metallic stent placement. Fistula closure was not documented for any of these five patients. Thoracic surgical assessments indicated that repair was unlikely to alter the clinical outcome, and no patient underwent definitive surgical repair. These observations do not provide a comparison of treatment efficacy (Table 2).

Exploratory associations

TEF was recognized later in patients who underwent tracheostomy than in those who did not (median, 55.5 versus 26.5 days; P = 0.008; q = 0.048). Fistula location was positively correlated with diameter (Spearman ρ = 0.529; P = 0.0165; q = 0.0495). Both findings met the adjustment threshold across the six reported tests but remain exploratory. No statistically significant associations were detected between diagnosis timing and age, APACHE II score, SOFA score, or admission albumin (Table 3).

Table 3
Selected exploratory analyses

Analysis	Effect/Summary	P	BH-adjusted q
Day of TEF diagnosis: tracheostomy vs no tracheostomy	55.5 vs 26.5 days	0.008	0.048
Fistula location vs fistula size	Spearman rho = 0.529	0.0165	0.0495
Age vs timing of TEF diagnosis	Spearman rho = 0.049	0.839	0.839
APACHE II score vs timing of TEF diagnosis	Spearman rho=-0.395	0.085	0.1275
SOFA score vs timing of TEF diagnosis	Spearman rho=-0.407	0.075	0.1275
Albumin level vs timing of TEF diagnosis	Spearman rho=-0.210	0.374	0.4488

All analyses were exploratory. The six tests shown in Table 3 *were treated as a single family for false-discovery-rate control using the Benjamini-Hochberg procedure. Nominal P values and BH-adjusted q values are reported; findings should be interpreted as hypothesis-generating and not as evidence of causality.*

Discussion

Clinical burden beyond the label of rarity

In this five-year study, acquired TEF was identified in approximately one in 172 invasively ventilated adults. Every affected patient died before hospital discharge, and none underwent definitive repair. These findings describe a clinically consequential complication in patients with continuing organ support needs. The contribution of this study is the combination of a defined institutional denominator with a description of patients whose critical illness constrained treatment options. The observed frequency alone does not establish that TEF is more common than previously believed, but it gives a concrete estimate of its detected burden in routine intensive care.

The denominator is central to that interpretation. Previous reports have evaluated selected tracheostomy populations [9, 10, 11]; Fiacchini et al. identified TEF in four of 30 patients with COVID-19 who received invasive ventilation for at least 14 days [12]. Our denominator included all unique invasively ventilated patients, including those with shorter exposure. Direct comparison of these proportions would therefore be misleading. Conversely, case ascertainment in our study depended on clinical suspicion and diagnostic procedures. Unrecognized fistulas could have been missed, so the observed proportion may underestimate occurrence. Neither the magnitude of underdetection nor the frequency among long-term ventilated patients can be quantified from these data.

Prognosis in the context of treatment selection

The 100% hospital mortality is the most concerning clinical finding, but it must be interpreted in the context of patient selection and severity. Septic shock was documented in every case, and most patients required vasopressor or inotropic support and had VAP recorded. These observations cannot establish whether TEF initiated deterioration, aggravated an existing critical illness, or was recognized during a terminal course. They do show that detected TEF in this population coexisted with exceptionally poor hospital outcomes. Without comparable ventilated patients without TEF, attributable mortality cannot be estimated.

Dai et al. studied 100 adults with non-neoplastic esophageal fistulas and reported on fistula healing and survival after conservative, endoscopic, or surgical management [5]. Their cohort included several fistula subtypes, and patients with pre-existing severe cardiovascular or pulmonary disease were excluded. It therefore differs substantially from an ICU series with persistent organ support requirements. Their findings help frame prognosis as a function of both the fistula and the underlying patient condition; they cannot be used as a direct mortality benchmark for our cases.

Mo et al. reported complete remission in 15 of 21 patients treated with metallic airway stents and 13 of 17 treated with silicone airway stents [4]. However, 36 of their 38 patients had malignant fistulas, and the intervention was airway rather than esophageal stenting. Their defined remission assessment and bronchoscopic follow-up differ from our retrospective documentation of closure. Our finding that closure was not documented after five esophageal stent procedures does not establish technical failure or contradict their results. More directly relevant to critical illness, Eleftheriadis and Kotzampassi reported temporary sealing in 12 mechanically ventilated patients, nine of whom subsequently died from their underlying diseases [13]. Anatomical sealing and survival are distinct outcomes.

Operative series also represent a different stage of clinical selection. Repair can achieve favorable outcomes in selected adults [6, 14, 15, 16]. Feng et al. reported thoracoscopic repair in 22 children with recurrent TEF after congenital esophageal atresia repair, with one re-recurrence during follow-up [17]. That pediatric population is etiologically and physiologically distinct from our adult ICU cohort and provides no estimate of adult acquired TEF incidence or mortality. Its relevance here is to emphasize that successful repair in a selected surgical population cannot be extrapolated to patients who cannot undergo definitive treatment.

Airway injury and clinical recognition

Pressure-related injury at the interface between an airway cuff and the posterior tracheal wall is a recognized mechanism of acquired TEF; a nasogastric tube may contribute to compression of intervening tissue [1, 18, 19]. Reports in severely ill ventilated patients also describe infection and systemic factors that may increase tissue vulnerability [20, 21, 22]. Nasogastric tubes were used in 95% of our cases, and 80% of fistulas were located 16–20 cm from the incisors. These observations are compatible with the proposed mechanism but do not demonstrate it. Distance from the incisors does not establish the position of an airway cuff, and the contributions of endotracheal intubation, subsequent tracheostomy, and other injuries could not be separated.

The clinical implication is sustained attention to TEF when the respiratory course becomes difficult to explain. Persistent air leakage, inadequate delivered tidal volume, gastric distension, recurrent aspiration, or pneumonia can prompt targeted investigation [1, 2, 3]. Our median diagnosis time of 46 days describes when TEF was recognized; it does not establish a 46-day delay or a safe period before investigation. Objective cuff-pressure assessment and attention to tube position are relevant elements of airway care, supported by mechanistic and practice-based literature [18, 23, 24]. This study did not test whether monitoring or earlier detection prevents TEF or improves survival. Prospective work should evaluate clinically triggered diagnostic pathways and document disease severity at recognition.

The exploratory results do not alter the principal clinical message. The later diagnosis in patients with tracheostomy is vulnerable to time-dependent selection and should not be interpreted as a protective or delaying effect. The location–diameter correlation only narrowly met the adjusted threshold and rests on retrospective measurements in 20 patients. It requires independent confirmation before any anatomical or therapeutic inference.

Strengths and limitations

A defined denominator of unique invasively ventilated patients and endoscopic confirmation of every included case strengthen the description of institutional occurrence. The retrospective, single-center design and small case series limit generalizability. The lack of a non-TEF comparison cohort prevents estimation of independent risk factors or attributable mortality. Clinical suspicion and access to endoscopy determined case detection, potentially missing unrecognized cases while preferentially identifying severe presentations. The detected proportion is therefore neither a surveillance-based incidence estimate nor the risk among patients receiving prolonged ventilation.

The date of diagnosis may differ from fistula onset, and previous airway exposure before admission was not characterized in the reported analysis. ICU admission scores and albumin may not reflect status at fistula recognition. VAP and septic shock were based on clinical documentation, and their temporal relationship to TEF was uncertain. Total ventilation duration could include post-diagnosis exposure. Anatomical measurements were not standardized, and serial cuff pressures and patient-level cuff position were unavailable. Treatment selection was influenced by clinical condition, while documentation of closure was insufficient for formal evaluation of stent efficacy. These limitations preclude causal conclusions about device injury, treatment, or mortality. Multicenter studies should record exposure before diagnosis, severity at recognition, the indications and timing of investigations, treatment eligibility, verified closure, and survival from diagnosis.

Conclusions

Acquired TEF was detected in 20 of 3,442 invasively ventilated adults, approximately one in 172 patients. All affected patients died during hospitalization, and none underwent definitive surgical repair. This observed burden and exceptionally poor hospital outcome support sustained diagnostic vigilance for TEF during prolonged airway instrumentation. Clinically triggered detection may underestimate occurrence, but the study does not establish a higher-than-expected incidence or mortality specifically attributable to TEF.

Abbreviations

APACHE II
Acute Physiology and Chronic Health Evaluation II
BH
Benjamini–Hochberg
CI
confidence interval
ICU
intensive care unit
IQR
interquartile range
SOFA
Sequential Organ Failure Assessment
TEF
tracheoesophageal fistula
VAP
ventilator-associated pneumonia.

Declarations

Ethics approval and consent to participate

The study was approved by the Hitit University Faculty of Medicine Research Ethics Committee on May 6, 2026 (Decision No. 2026-91). Individual informed consent to participate was waived by the committee because of the retrospective design. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication:

Not applicable, as the study analyzed publicly available YouTube content and did not involve direct human participation.

Use of generative artificial intelligence

ChatGPT (OpenAI) was used to assist with English language editing, manuscript organization, and drafting revisions. All interpretations, source attribution, and the final manuscript require author review, and the authors retain responsibility for the published content

Availability of data and materials

The de identified data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional and ethical approval.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Acknowledgements

Not applicable.

Clinical trial number

Not applicable.

Authors' contributions

Sibel Önen Özdemir: Conceptualization, Methodology, Investigation, Data curation, Project administration, Supervision, Writing – original draft, and Writing – review and editing.

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Hülya Topçu: Methodology, Supervision, and Writing – review and editing.

Sibel Önen Özdemir served as the corresponding author and guarantor of the work. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Ethics approval

Hitit University Faculty of Medicine Research Ethics Committee, Decision No. 2026-91, May 6, 2026. The requirement for individual informed consent was waived because of the retrospective study design.

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Figures

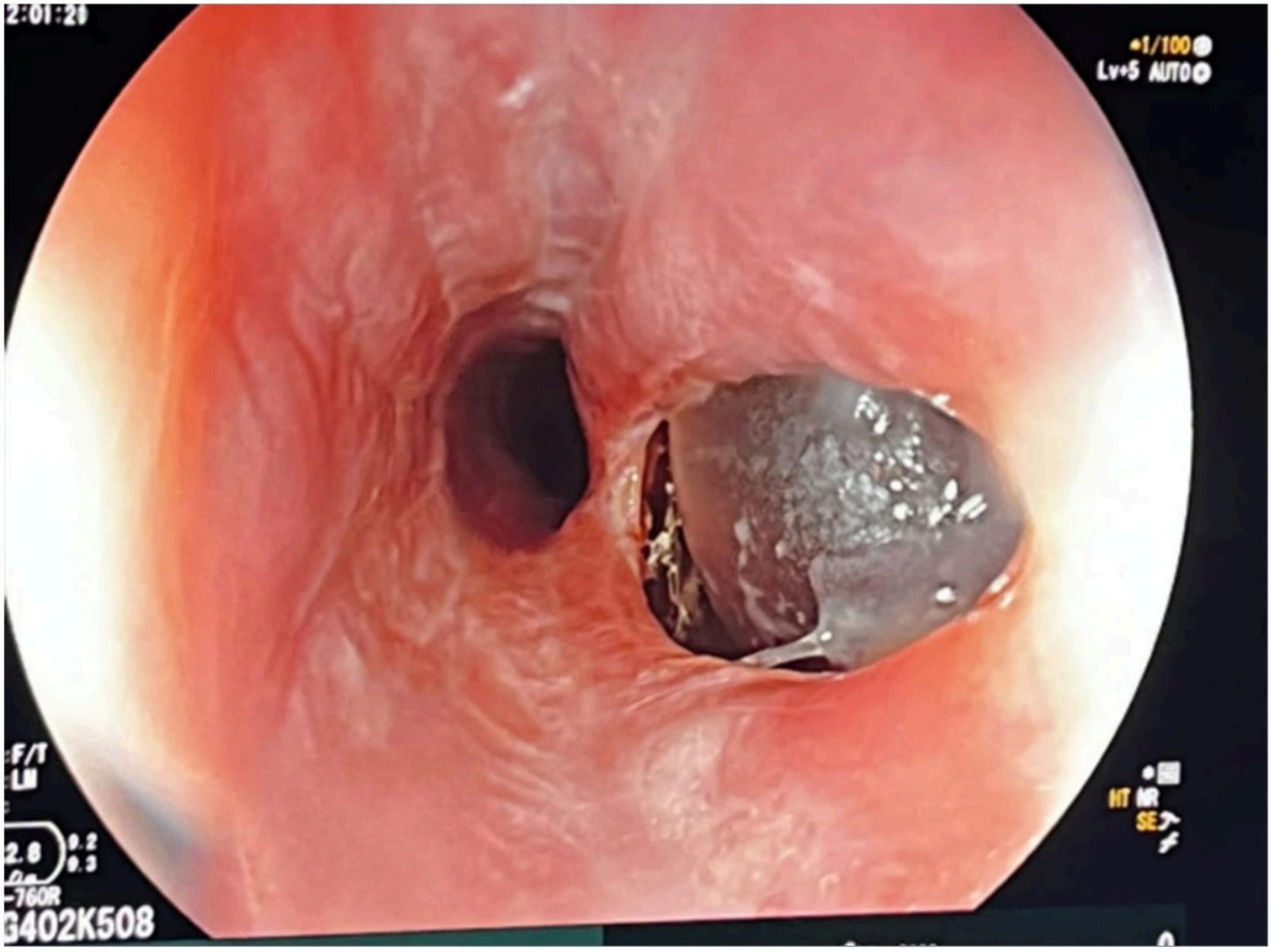


Figure 1

Endoscopic appearance of an acquired tracheoesophageal fistula located 18 cm from the incisors and measuring approximately 2.0 cm in diameter. The inflated cuff of the endotracheal tube is visible through the fistulous defect.

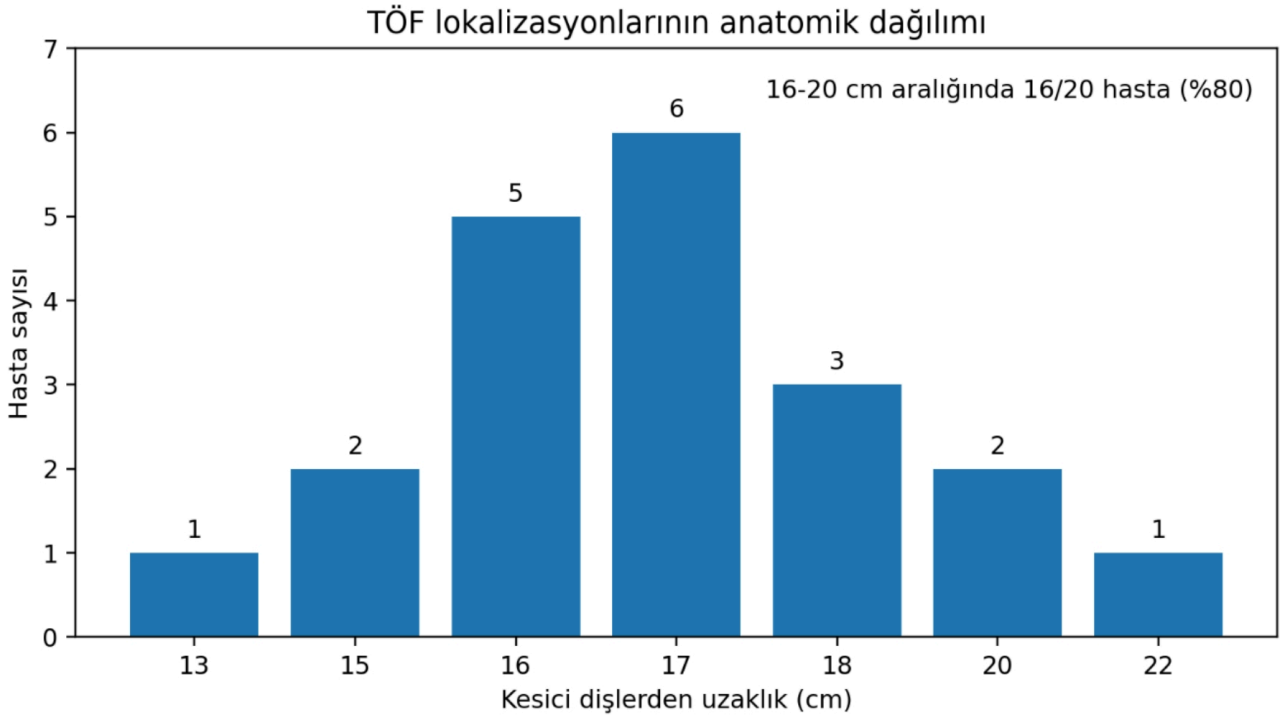


Figure 2

Distribution of TEF locations according to distance from the incisors. Sixteen of 20 fistulas (80%) were located 16-20 cm from the incisors.