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Tracheoscopic Management of Postoperative High Tracheoesophageal Fistula Using Covered Self-Expanding Metallic Stents: A Comparative Report of 2 Cases With Divergent Outcomes

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Case series

Patient: Male, 67-year-old • Male, 78-year-old

Final Diagnosis: Postoperative high tracheoesophageal fistula

Symptoms: Difficulty in swallowing

Clinical Procedure: —

Specialty: Pulmonology • Surgery

Objective: Unusual clinical course

Background: Tracheoesophageal fistula (TEF) following esophageal cancer resection is a rare but life-threatening complication. Management of high postoperative TEF, particularly in the subglottic region, presents significant technical challenges due to anatomical constraints and the risk of stent migration. This report evaluates the efficacy of tracheoscopic placement of covered self-expanding metallic stents (CSEMS) for treating high postoperative TEF.

Case Reports: We report 2 cases of high TEF complicating esophageal cancer surgery. Case 1: A 67-year-old man with a 0.6 cm diameter fistula located 4 cm distal to the vocal folds. A straight CSEMS was successfully deployed. Four months later, after confirmation of complete mucosal healing and epithelialization, the stent was removed following the observation of granulation tissue hyperplasia. Case 2: A 78-year-old man with diabetes presented with a large (12 × 8 mm) fistula situated 3 cm distal to the vocal folds. An initial straight CSEMS failed due to repeated displacement. It was replaced with a customized ball-ended CSEMS and supplemented with biogel and gelatin sponges. Due to refractory displacement and impaired healing, external percutaneous fixation was ultimately used to stabilize the stent.

Conclusions: Tracheoscopic CSEMS placement represents a viable management strategy for high postoperative TEF. However, successful outcomes in the challenging subglottic region are highly dependent on individualized stent selection and adjunctive measures, as illustrated by the contrasting courses of our 2 cases. These experiences underscore the importance of technical adaptability, while larger studies are needed to define optimal management algorithms.

Keywords: Tracheoesophageal Fistula • Covered Self-Expandable Metallic Stents • Bronchoscopy • Case Report

Full-text PDF: https://www.amjcaserep.com/abstract/index/idArt/953942

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Introduction

The occurrence of a postoperative tracheoesophageal fistula (TEF) following the treatment of esophageal cancer is relatively uncommon, and when it does occur, it is associated with significant morbidity and mortality [1]. The use of an airway stent, either alone or in conjunction with an esophageal stent, for the treatment of TEF has been widely documented [2-5]. However, the utilization of an airway stent for the management of high TEF has rarely been reported. In our department, 2 patients with high TEF underwent tracheoscopic covered self-expanding metallic stents (CSEMS) placement as an intervention for TEF management. However, the patients exhibited distinct clinical trajectories and outcomes. The first patient achieved complete mucosal healing and successful stent removal within 4 months. In contrast, the second patient experienced persistent challenges, including repeated stent migration and incomplete fistula closure, which necessitated the transition to customized stent designs and external fixation to maintain airway stability.

This report presents a descriptive case-based evaluation of the feasibility, technical challenges, and necessary management adaptations associated with tracheoscopic CSEMS placement for postoperative high TEF. By analyzing 2 distinct clinical cases, we aim to demonstrate the situational applicability of this procedure and delineate specific conditions that necessitate technical modifications, such as anatomical constraints and stent migration. It should be noted that this report is intended to illustrate procedural utility and its inherent limitations in complex airway management rather than to establish generalized therapeutic efficacy.

Case Reports

Case 1

A 67-year-old man with a history of hypertension was diagnosed with esophageal cancer. Twenty-one days following esophagectomy, a computed tomography (CT) scan suggested the development of a TEF (**Figure 1A**), which was subsequently confirmed by tracheoscopy as a 0.6-cm diameter defect located 4 cm distal to the vocal folds (**Figure 1B, Video 1**). Four days later, a straight CSEMS (M00564890; Boston Scientific, Marlborough, MA, USA) measuring 20 × 40 mm was successfully deployed under tracheoscopic guidance. The stent was precisely positioned with its proximal end 20 mm below the vocal folds (**Figure 2A, Video 2**). A CT scan conducted 4 days postoperatively revealed that the stent had not undergone any displacement (**Figure 2B**). Two months after stent placement, the esophagram showed no evidence of TEF (**Figure 3A**).

Four months later, follow-up bronchoscopy revealed significant granulation tissue hyperplasia at both ends of the stent (**Figure 3B, Video 3**). While this indicated advanced healing of the fistula, the excessive granulation tissue had begun to overgrow the stent edges, posing a risk of airway

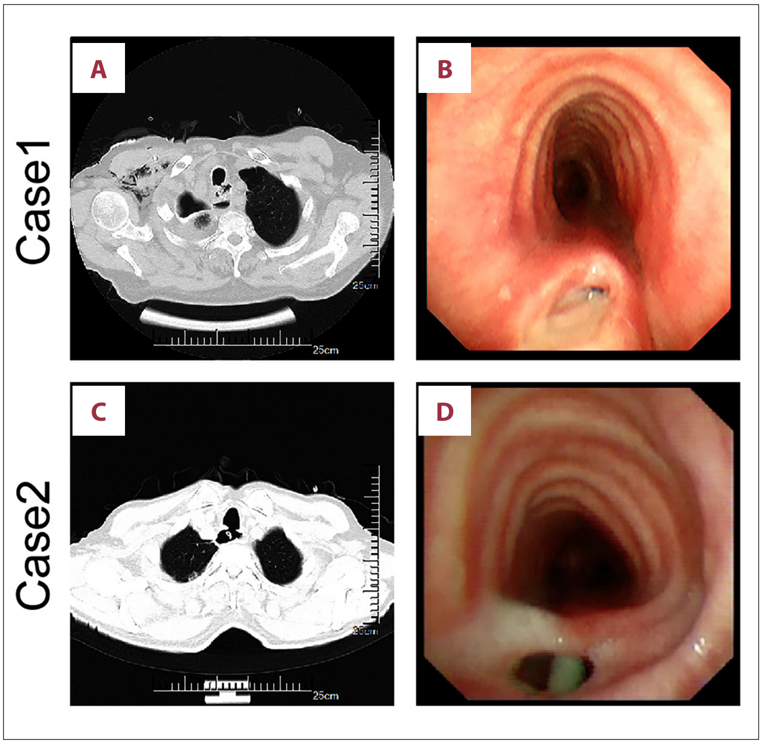

Figure 1. Diagnosis and localization of high-level tracheoesophageal fistulas (TEFs). Case 1: Twenty-one days after esophagectomy for esophageal cancer, computed tomography (CT) imaging suggested the development of a TEF (**A**). Tracheoscopy revealed a fistula measuring approximately 0.6 cm in diameter, located 4 cm distal to the vocal cords (**B**). Case 2: Thirty-two days after esophagectomy, CT imaging indicated the formation of a TEF (**C**). Before stent placement, tracheoscopy revealed a fistula measuring 12 × 8 mm, located 3 cm distal to the vocal cords (**D**).

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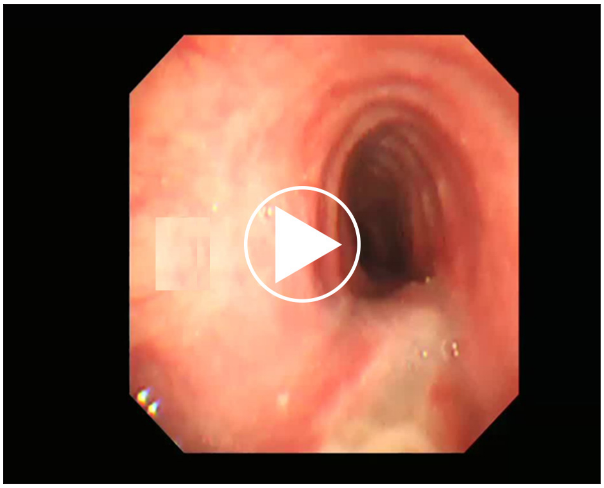
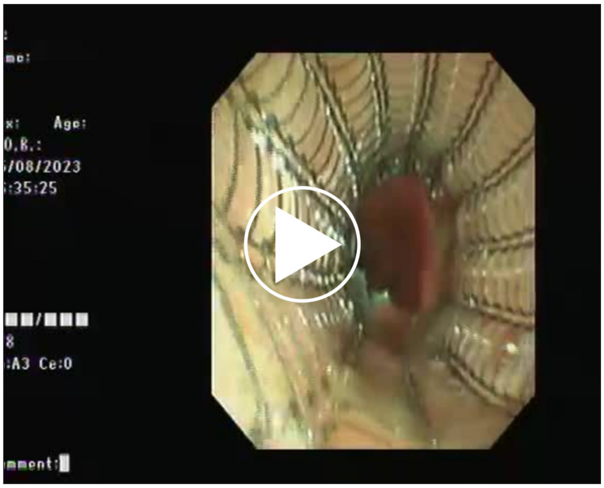


Video 1. Case 1: Tracheoscopic assessment. This video reveals the presence of a fistula with an approximate diameter of 0.6 cm, situated 4 cm distal to the vocal hilum of the trachea.



Video 2. Case 1: Stent placement procedure. This video shows the deployment of a straight covered self-expanding metal stent (CSEMS) (20 × 40 mm).

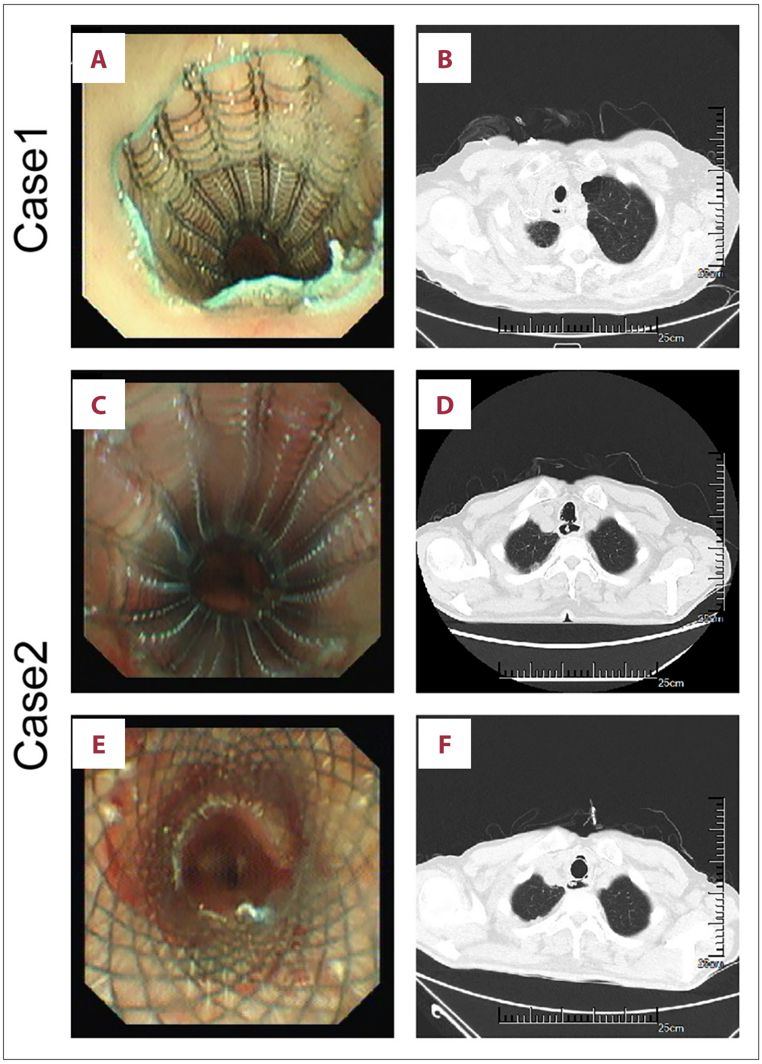


Figure 2. Stenting strategies and radiographic correlation. Case 1: Deployment of a straight covered self-expanding metal stent (CSEMS) measuring 20 × 40 mm (**A**). Poststenting computed tomography (CT) imaging demonstrated that the straight CSEMS was in an optimal position (**B**). Case 2: Initial deployment of a straight CSEMS measuring 20 × 60 mm (**C**). Poststenting CT imaging demonstrated displacement of the straight CSEMS (**D**). The stent was subsequently replaced with a customized ball-ended CSEMS measuring 22 × 50 mm (**E**). Poststenting CT imaging demonstrated that the ball-ended CSEMS was correctly positioned (**F**).

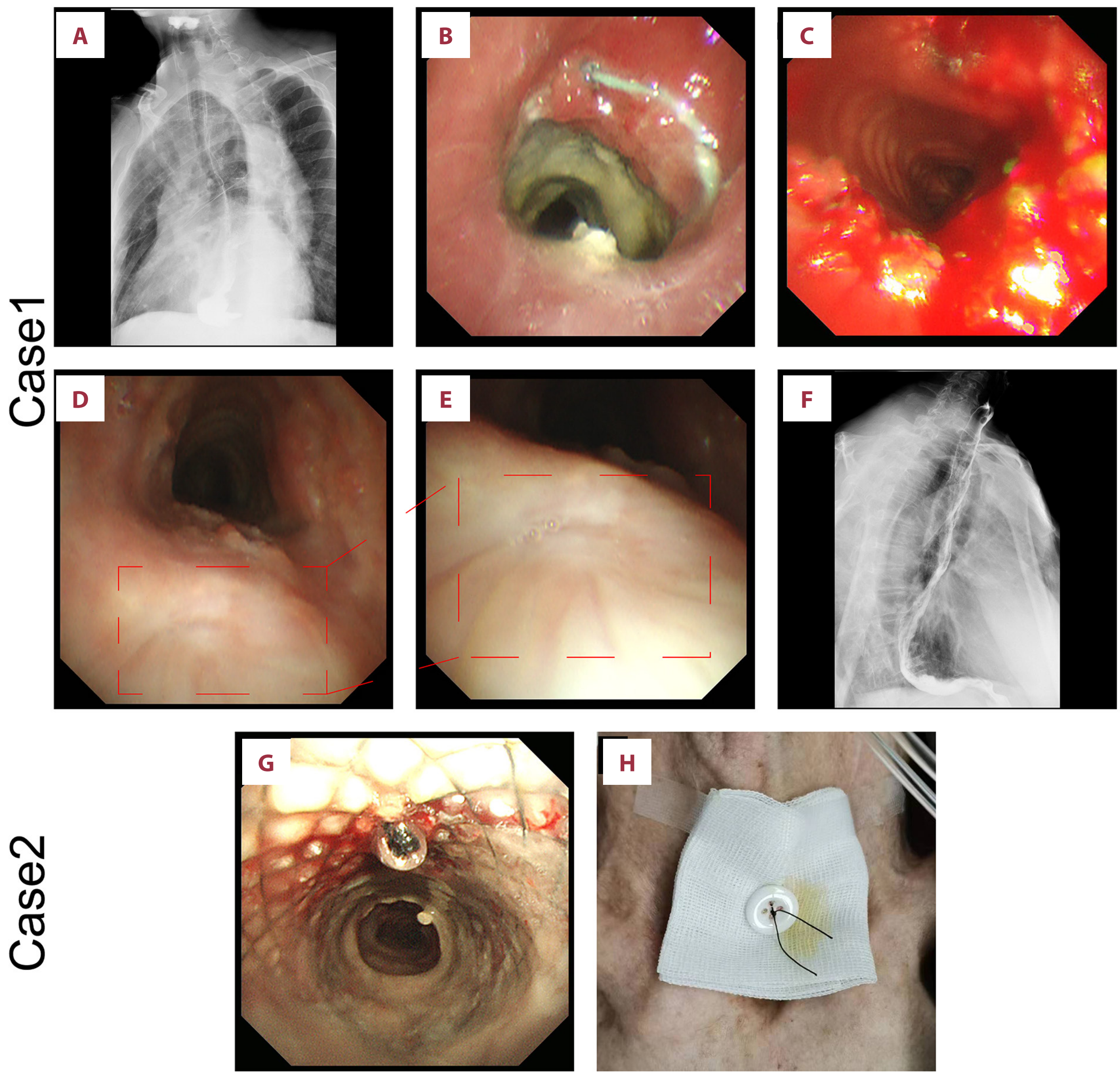


Figure 3. Follow-up, stent removal, and long-term outcomes. Case 1: Esophagram after stent placement showed no evidence of a residual tracheoesophageal fistula (TEF) (**A**). Follow-up fiberoptic bronchoscopy revealed granulation tissue hyperplasia at both ends of the stent (**B**). Granulation tissue hyperplasia was observed after stent removal (**C**). Bronchoscopy demonstrated mucosal healing of the previous TEF (**D, E**), with residual granulation tissue distal to the original fistula (**E**). Three months after stent removal, esophagram confirmed the sustained absence of fistula-related complications (**F**). Case 2: Tracheoscopy was performed 10 months after stent placement (**G**). The stent position was adjusted and secured using an external fixation technique (**H**).

structural remodeling and potential obstructive damage. To prevent further airway injury, the stent was promptly removed (**Figure 3C, Video 4**).

Following the procedure, a multi-modal and rigorous monitoring protocol was implemented to ensure the permanence of the closure. Two months later, fibrobronchoscopic evaluation demonstrated excellent mucosal recovery with complete epithelialization and no evidence of recurrence (**Figure 3D, 3E, Video 5**). Furthermore, 3 months after the stent removal, esophagram confirmed the sustained absence of any fistula-related complications (**Figure 3F**), verifying the definitive restoration of airway integrity and the successful management of the high-level defect.

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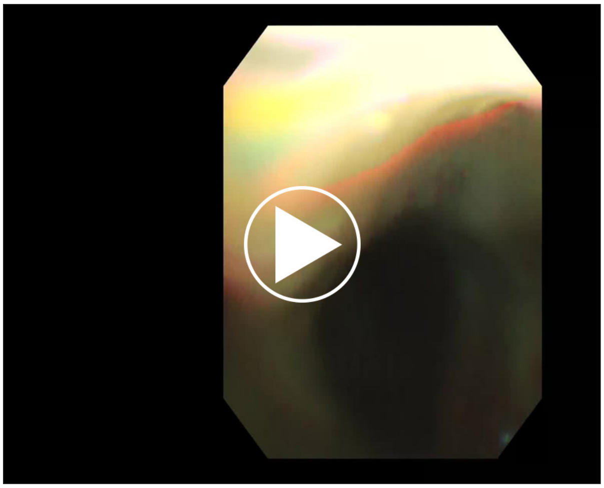
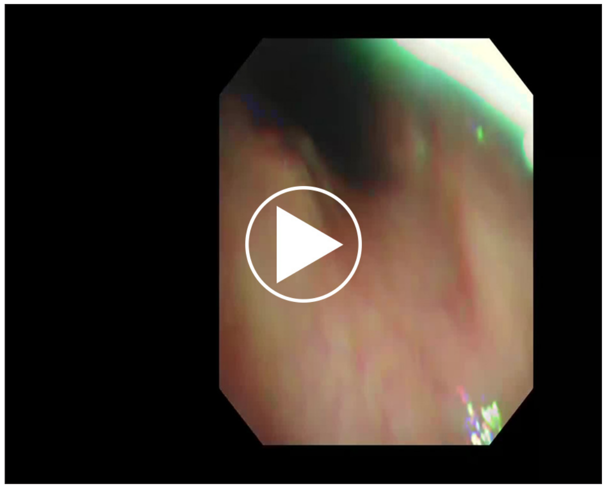
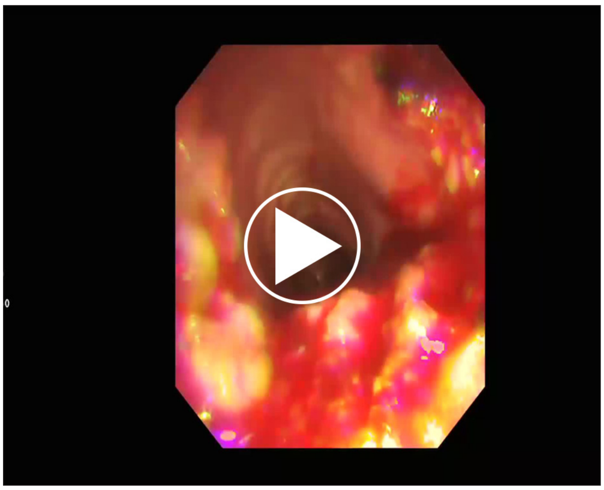


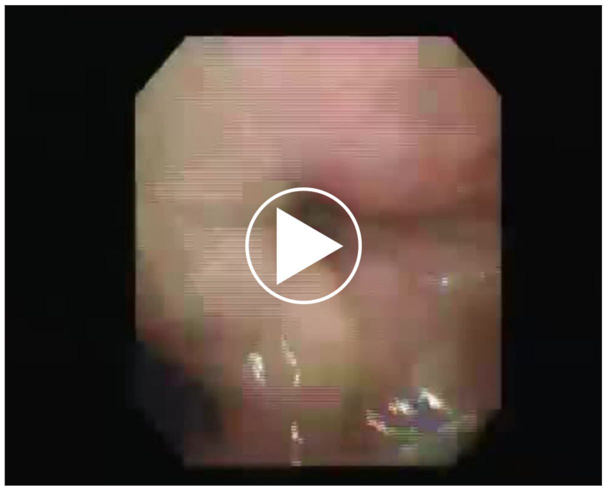
Video 3. Case 1: Assessment before stent removal. The video shows the presence of granulomatous tissue hyperplasia at both ends of the stent**.**



Video 5. Case 1: Follow-up tracheoscopy. This video reveals the mucosal healing of a previous tracheoesophageal fistula.



Video 4. Case 1: Stent removal procedure. This video illustrates the tracheoscopic removal of the covered self-expanding metal stent (CSEMS).



Video 6. Case 2: Tracheoscopic assessment. This video reveals the presence of a fistula measuring 12 × 8 mm in size, situated 3 cm distal to the vocal hilum of the trachea.

Case 2

A 78-year-old man with a significant medical history of hypertension and diabetes mellitus developed a TEF 32 days after esophagectomy (Figure 1C). Nine days later, tracheoscopy identified a large fistula (12 × 8 mm) situated at an extremely high level, approximately 3 cm distal to the vocal folds (Figure 1D, Video 6).

The clinical course of this case was notably complex and characterized by multiple technical adaptations. Initially, a straight CSEMS (M00564900; Boston Scientific) measuring 20 × 60 mm was implanted (Figure 2C, Video 7). However, the proximity of the fistula to the glottis caused severe subjective discomfort and resulted in repeated distal migrations within the first 24 hours (Figure 2D). To enhance fixation and patient tolerance, this was replaced with a 22 × 50 mm customized ball-ended CSEMS (Nanjing Micro-Tech Endoscopy Co, Ltd, Nanjing, Jiangsu Province, China) (Figure 2E, 2F, Video 8). While the spherical-head design significantly improved comfort and reduced the frequency of displacement, the large and irregular margins of the fistula necessitated supplementary sealing measures. Multiple tracheoscopic interventions were subsequently performed, utilizing a combination of biogel and gelatin sponges to fill the persistent gaps between the stent and the tracheal wall. Despite these efforts, the stent exhibited refractory displacement by the tenth month after implantation. Given the patient's advanced age and the impaired healing capacity associated with his diabetes, an external fixation method was ultimately employed to stabilize the stent

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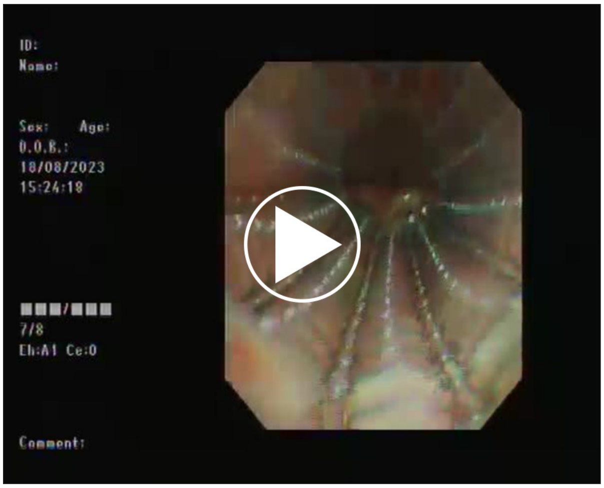
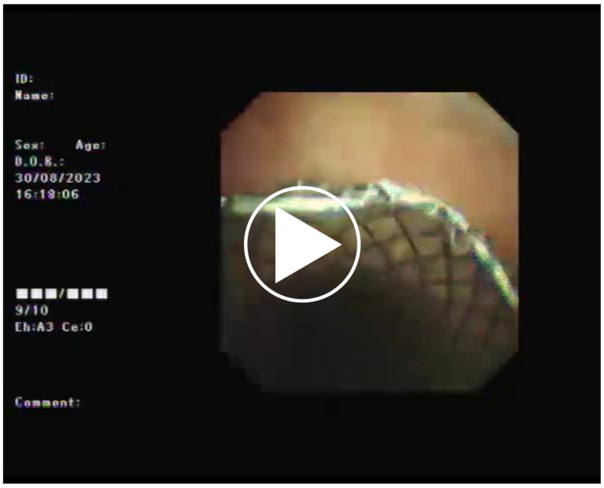


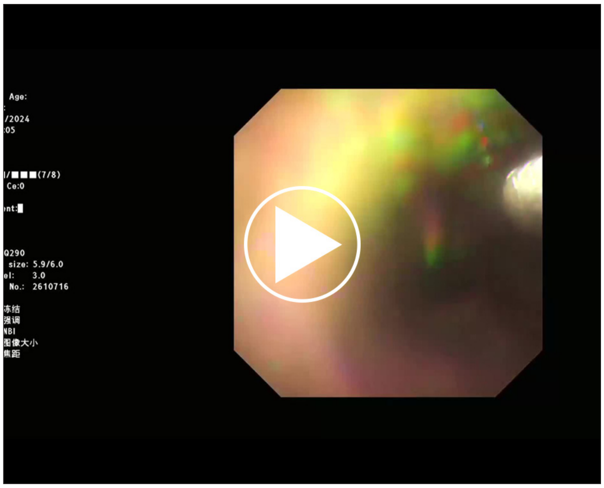
Video 7. Case 2: Initial Stent Placement Procedure. This video shows the deployment of a straight covered self-expanding metal stent (CSEMS) (20 × 60 mm).



Video 8. Case 2: Stent adjustment procedure. This video shows the adjustment to a customized ball-ended covered self-expanding metal stent (CSEMS) (22 × 50 mm).

(Figure 3G, 3H, Video 9). Currently, the fistula remains incompletely healed, and the stent is maintained in situ to ensure continued airway patency and safety.

The clinical management of these cases followed a stepwise decision-making framework based on specific procedural triggers and treatment responses. Initial stent selection was determined by the anatomical level and diameter of the fistula as measured by preoperative CT and tracheoscopy. A straight CSEMS was utilized as the standard first-line intervention. The recognition of migration failure was defined by the presence of subjective patient discomfort accompanied by radiographic or tracheoscopy evidence of poor stent apposition or displacement, or the clinical occurrence of stent expectoration. In case 2, following the transition to a customized ball-ended stent,



Video 9. Case 2: External fixation procedure. This video illustrates the external fixation technique.

auxiliary sealing with biogel and gelatin sponges was implemented because of persistent subjective discomfort and subsequent assessment via CT and tracheoscopy that confirmed suboptimal stent apposition. Finally, percutaneous external fixation was used as a definitive salvage strategy for refractory instability when these combined measures were insufficient to ensure airway safety.

Discussion

A TEF is a pathological connection between the trachea and esophagus, allowing entry of oral and digestive secretions into the airway. TEF is classified as congenital or acquired, with the latter further divided into non-malignant and malignant types. Congenital TEF typically presents with esophageal atresia during embryonic development [6]. Non-malignant acquired TEF is mainly caused by iatrogenic injuries, including mechanical ventilation complications, surgical trauma, infections, foreign bodies, corrosive injuries, and rare conditions such as Boerhaave syndrome [2,7-9]. Malignant TEF is most commonly associated with esophageal, lung, and thyroid cancers, resulting from either direct tumor invasion [10] or tumor-related treatments [11-13]. The postoperative TEF in our report falls within the malignant TEF spectrum. Although rare, these fistulas carry a poor prognosis and high mortality [3], and their management is uniquely challenged by prior surgical trauma and compromised local tissue integrity. Additional risk factors include diabetes, infection, and steroid use [4]. For patients unfit for repeat surgical repair due to nutritional status, age, or comorbidities, airway or esophageal stenting, alone or in combination, is a common treatment modality [5,14].

The efficacy of airway stents in the management of TEF has been extensively documented, both as a standalone

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intervention and in conjunction with esophageal stents for double stent placement [4]. For the conservative management of high TEF, tracheoscopic stent placement may be a more appropriate intervention than esophageal stent placement, given the potential for an esophageal stent to interfere with the patient's swallowing function and cause subjective discomfort that may impact their quality of life. With regard to the selection of stents, there is currently limited consensus in the literature regarding the optimal use of different stent configurations, including Y-shaped, straight, and other shapes, as well as materials such as silicone, metal, and covered stents. In addition to shape and material, when selecting a stent in clinical practice, it is necessary to consider the patient's fistula location, fistula size, airway internal diameter, airway structure, and other factors. These factors should be combined with the results of imaging, such as CT, 3-dimensional reconstruction of the airway, and endoscopy, such as esophagoscopy, tracheoscopy, and other endoscopic examinations, in order to make an informed decision regarding the most appropriate stent for the patient. To ensure adequate coverage and stability, the airway stent should ideally extend at least 20 mm beyond the proximal and distal margins of the fistula [15]. Regarding diameter selection, the external diameter of the stent should be approximately 10% to 20% larger than the internal diameter of the trachea at the level of the fistula [15]. This oversized approach promotes sufficient radial tension to maintain the position of the stent and prevent minor leaks around the defect. The CSEMS is a straightforward device to insert, with a malleable structure that allows it to adapt to intricate airway structures. It is designed to fit snugly against the tracheal wall and has a relatively lower inhibitory effects on airway cilia and mucus clearance compared with silicone stents [16]. However, regular tracheoscopic surveillance is still necessary for the prevention of risks of mucus plugging and biofilm formation. In light of the aforementioned considerations, the treatment team opted to proceed with CSEMS as the preferred course of action for both patients.

The clinical outcomes observed in these cases suggest that the success of tracheoscopic CSEMS placement is likely influenced by a complex interplay of clinical and anatomical factors. While case 1 achieved complete healing with a conventional straight stent, the challenges encountered in case 2 highlight how variations in fistula size, proximity to the cricoid cartilage, and systemic comorbidities, such as diabetes, can alter the therapeutic trajectory. These disparate results indicate that the choice of stent and the requirement for auxiliary measures should be viewed as individualized adaptations to specific clinical scenarios. Consequently, the observed healing or stent stability should be interpreted as being associated with a multifaceted management approach, as the relative contribution of any single factor remains difficult to isolate within this limited series of cases.

This study provides incremental value to the existing literature on airway stenting by addressing specific technical gaps in the management of high-level postoperative TEF. While the use of CSEMS for esophageal fistulas is well documented, our cases highlight the particular challenges associated with defects located in the immediate subcricoid region, where traditional straight stents are highly prone to migration. The novelty of this report lies in the systematic description of adaptive management strategies, including the transition from conventional straight stents to customized ball-ended designs and the implementation of percutaneous external fixation when primary stabilization fails. These observations complement prior practice by defining the situational utility of customized stent geometry and auxiliary sealing materials, such as biogel and gelatin sponges, in extremely distal airway defects that were previously considered unfavorable for purely endoscopic intervention.

The management of high TEF following esophagectomy remains a formidable challenge, particularly when the defect is situated within the subglottic region. While surgical repair is the preferred intervention, patients with severe comorbidities or poor nutritional status often require conservative endoscopic management. Our cases highlight that the success of airway stenting in high TEF depends not only on the immediate seal but also on the strategic adaptation to anatomical constraints and the management of tissue responses. The proximity of the fistula to the glottis presents a unique mechanical hurdle. In the funnel-shaped subglottic airway, standard cylindrical stents lack sufficient frictional resistance and are subject to constant displacement due to swallowing-induced laryngeal movement and cough-related pressure changes. This was vividly demonstrated in case 2, in which a conventional straight CSEMS failed repeatedly. The transition to a customized ball-ended CSEMS provided a "shoulder effect" (**Figure 4A-4C**), significantly enhancing proximal anchoring and reducing the subjective discomfort associated with stent irritation of the vocal folds.

A critical finding in case 1 was the exuberant granulation tissue hyperplasia observed 4 months after implantation. While granulation tissue is a hallmark of tissue repair and fistula consolidation, it can also become clinically harmful when it grows excessively. Although initial granulation facilitates the sealing of the defect, unchecked proliferation can cause the tissue to overgrow the stent margins. This progression may lead to irreversible airway structural remodeling or stent incarceration, which significantly complicates the eventual removal of the device. Meanwhile, the oversized stents can cause impingement at the proximal and distal edges, leading to granulation tissue formation and an increased risk of stent-induced stenosis. Consequently, the identification of such exuberant hyperplasia should be viewed as a critical clinical indicator for stent

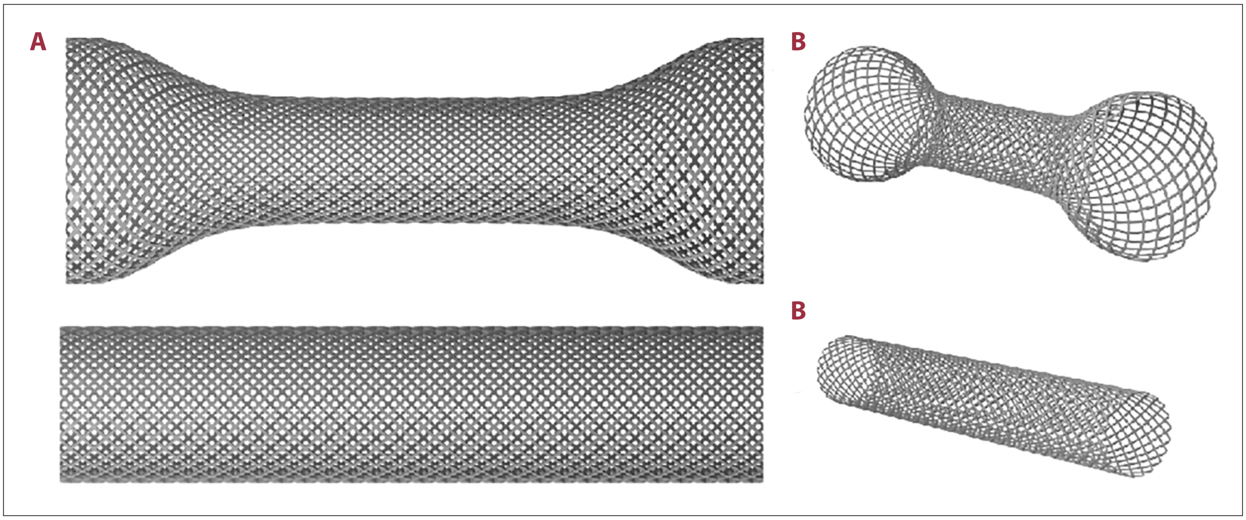

Figure 4. Schematic comparison of airway stents. Top-down view comparing the customized ball-ended stent and the conventional straight stent (**A**). Respectively customized ball-ended stent (**B**) and conventional straight stent (**C**).

decannulation to protect the integrity of the airway. Prompt stent removal helps to rescue the airway from potential obstructive damage once the fistula has achieved epithelialization.

For complex high TEF where customized stents alone do not achieve a complete seal, multi-modal supplementation is necessary. The use of biogel and gelatin sponges in case 2 proved vital in addressing micro-leaks at the irregular margins of the fistula. However, these loose materials have the potential risk of becoming an airway foreign body and therefore warrant careful consideration. Moreover, when all endoscopic fixation methods fail, external percutaneous fixation serves as a definitive salvage strategy to prevent life-threatening stent aspiration in extremely high TEF.

A review of the course of treatment for the 2 patients revealed that 1 fistula healed and the stent was removed, while the other was repeatedly dislocated after conventional stent placement. The latter patient's fistula was subsequently treated with a custom-made stent, which has remained in place to date. Several potential factors may explain the incomplete healing of the fistula and the continued necessity for the stent in case 2. One primary factor is the significantly prolonged interval between the initial CT diagnosis of the TEF and the eventual stenting procedure. In case 2, a period of 25 days elapsed before the fistula was sealed, whereas the interval in case 1 was only 7 days. This delayed closure likely impaired the healing process by allowing for chronic inflammation and continued tissue degradation. Mucosalization of a fistula may hinder spontaneous closure, and creating a circumferential mucosal injury, such as Bugbee cautery, is often necessary to promote scarring and healing. However, we would also like to note that the use of electrocautery in our cases was not routinely performed, which may be related to the location and size of the fistula, factors that could influence the feasibility and risk-benefit balance of such intervention. Furthermore, the clinical course was complicated by diabetes mellitus, which is a recognized risk factor for impaired wound healing in these patients.

Finally, the initial stent selection may not have provided an optimal fit for the patient's specific anatomy. Evidence for this includes the repeated displacement of the original straight stent and the subsequent need for frequent follow-up adjustments even after replacing it with a customized ball-ended design. Despite the use of biomaterials to fill persistent gaps and the challenges posed by the patient's large airway diameter, these factors suggest that the customized stent was a superior choice under the circumstances rather than a perfect fit. The efficacy of the custom-made ball-ended stent may be enhanced by combining tracheobronchial 3D imaging and 3D printing technology to develop a more efficacious solution.

Conclusions

This report demonstrates that tracheoscopic placement of CSEMS is a viable conservative strategy for selected high postoperative TEFs. Success depends on early intervention and technical adaptations to the complex subglottic anatomy. Conventional straight stents may suffice for smaller defects; however, larger or more distal fistulas may require customized ball-ended designs or percutaneous external fixation to prevent migration and ensure airway safety. These observations suggest that individualized approaches can facilitate airway stabilization in challenging scenarios. While our 2-case comparison provides valuable clinical experience and practical insights into the use of CSEMS for high postoperative TEF, these preliminary observations require further validation

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through larger clinical studies to confirm their broader applicability and long-term efficacy.

Institution Where Work Was Done

The First Affiliated Hospital of Soochow University, Suzhou, Jiangsu, PR China.

Patient Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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