Airway Covered Metallic Stent Based on Different Fistula Location and Size in Malignant Tracheoesophageal Fistula

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Abstract: *Background:* Malignant tracheoesophageal fistula (MTEF) is a devastating complication of esophageal cancer, lung cancer or other carcinoma with a shorter life-span and poor life quality. The aim of this study was to assess the effect of airway stent insertion on MTEF patients. *Methods:* A total of 63 MTEF patients were included, 12 patients with lung cancer and 46 patients with esophageal cancers. Eight zones were proposed to classify various fistula locations. Airway stents were selected based on the various zones and fistula size. *Results:* Airway stents were successfully inserted in all patients, and both airway and esophageal stents in 8 patients. Most fistula were located in locations II (18/63, 28.6%), III (22/63, 34.9%), then VII (9/63, 14.3%). The stents included 10 (15.9%) I shaped, 8 (12.7%) L shaped and 45 (71.4%) Y shaped. Different stents were placed based on different locations and sizes of fistulas. Overall, mean survival time was 163 days (2–270 days). Most symptoms relieved after stent insertion. Mean Karnofsky score jumped from 43.0 ± 10.7 before stent placement to 66.7 ± 10.8 after stent insertion ($P = 0.000$). Complete closure was achieved in 45 patients (71.4%), and incomplete closure and leakage were found in 18 patients. *Conclusions:* Airway stent insertion provides an effective approach to improve symptoms and quality of life. The choice of stent based on different fistula location and size may be a reasonable way in clinical practice.

Key Indexing Terms: Airway stent; Eight zones; Malignant tracheoesophageal fistula. **[Am J Med Sci 2015;350(5):364–368.]**

A malignant tracheoesophageal fistula (MTEF), a pathological communication between the esophagus and the airway, can occur after surgery, radiotherapy, chemotherapy, or airway invasion.[1,2] Approximately, 5% to 15% patients with esophageal malignancy, less than 1% bronchogenic carcinoma patients, and very few from other malignant carcinomas, develop MTEF.[2–4] Autopsy data indicate that MTEF incidence is higher than diagnosed.[3] Tracheoesophageal fistula (TEF) is a negative predictor of long-term survival, and those patients generally have a very poor prognosis and quality of life. Severe cough, pneumonia, frequent aspiration to the airway, malnutrition and life-threatening hemoptysis can lead to rapid deterioration, and most patients die within 3 to 4 months.[2,5]

Several different management strategies have been used for MTEF, including surgical resection/repair of the fistula, feeding gastrostomy/jejunostomy, esophageal stenting, radiotherapy, airway stenting or both in combination.[1,6,7] Undoubtedly, operative resection of the fistula and reconstruction of the airway and alimentary tract will provide the best opportunity of full recovery, however, it carries a high risk of complications, especially for malignant patients, therefore is seldom performed.[7] Feeding gastrostomy/jejunostomy is generally regarded as the ultimate method to treat MTEF before the application of stenting, but some patients refuse the option and insist on eating food again. Palliative therapy with a stent to the tracheobronchial tree and/or esophagus will relieve symptoms immediately, extend the survival period, improve the quality of life and may offer the opportunity for potential multimodal oncologic treatment based on existing data.[3] Since most MTEFs are because of esophageal cancer and there are usually some degree of stenosis associated with fistula, esophageal stenting is preferred than tracheal stenting.[8] However, when an esophageal stent elicit respiratory restriction due to compressed trachea, a tracheal stent is a preferred option.[9]

Unlike the esophageal, the tracheal is divided into different parts. Limited studies have reported the effect of airway covered metallic stent placement in MTEF based on different locations in the tracheal.[10] The aim of this report was to summarize the experience with airway covered metallic stents for palliation of MTEF in 63 patients according to the fistula location and size.

SUBJECT AND METHODS

Design

This investigation was a retrospective study. Informed consents were obtained from all patients or their representatives before stent implantation. This study was approved by Meitan general Hospital Institutional Review Board (IRB no. 2006.08).

Patients

A total of 63 patients with malignant inoperable MTEF were treated using covered metallic stents from September 2006 to February 2014, including 51 men and 12 women, ageing from 27 to 76 years old with the mean age of 57. All patients (or their families) were informed about the procedures, possible results and complications.

All patients were not suitable to accept surgery due to illness severity, higher surgical risk or their refusal. These patients conformed to at least one of following criteria: (1) esophageal unsuitable for stenting; (2) respiratory complications due to esophageal stent only and (3) airway stenosis. The decision regarding airway stent placement was based on the location of the stenosis and esophageal peristalsis. From experiences one can find that if esophageal peristalsis is strong, the esophageal metallic stent is prone to move. Therefore, placement of the airway stent in these patients is preferable. Firstly, airway stent was inserted. If the fistula was not satisfactorily closed, another esophageal stent was implanted depending on the situation of esophagus.

Stent Implantation

All patients in this study received covered metallic airway stents (Micro-Tech, Nanjing, China). The choice of

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stent length and diameter was determined by the endoscopic examination and chest computed tomography scan. Airway Y stents were implanted using a rigid bronchoscopy (KARL STORZ GmbH and Co, Tuttlingen, Germany) under general anesthesia. Other stents were placed with flexible video bronchoscopy (Olympus Medical, Tokyo, Japan) under general anesthesia. The flexible bronchoscope was inserted at the proximal end of the lesion through the mouth or rigid bronchoscopy. A guide wire was inserted through the bronchoscope and passed through the lesion and then the bronchoscope was withdrawn. The location of the guide wire was confirmed by the bronchoscope, which was reinserted. The delivery catheter (Micro-Tech) was advanced over the guide wire to deploy the stent under bronchoscopic visualization. The delivery catheter, guide wire and bronchoscope were withdrawn, leaving the stent in the lesion site. The bronchoscope was used to check the position and the extension of the stent.

Fistula Location and Size

Five locations of the central airway were proposed to classify airway stenosis in a previous study: (1) location I, upper 3rd of the trachea; (2) location II, middle 3rd of the trachea; (3) location III, lower 3rd of the trachea; (4) location IV, right main bronchus; (5) location V, left main bronchus.[11] Based on the above classification method, 8 zones were proposed to classify various fistula locations in this study. As illustrated in Figure 1, locations I, II and III were defined the same as 5 locations. Location IV, trachea carina; location V, right main bronchus; location VI, right middle bronchus; location VII, proximal of left main bronchus; location VIII, distal of left main bronchus. Fistula was classified into small (<1 cm) and big (>1 cm) according to a previous study.[12]

As illustrated in Table 1, the I-shaped stent was adopted for patients with small fistula in the location I, location II and location VIII. The Y-shaped stent was used for patients with big fistula in the location II, location III, location V, location VII, and for patients with small fistula in the location III and location IV. The L-shaped stent was chosen for patients with small fistula in the location V, location VI and location VII.

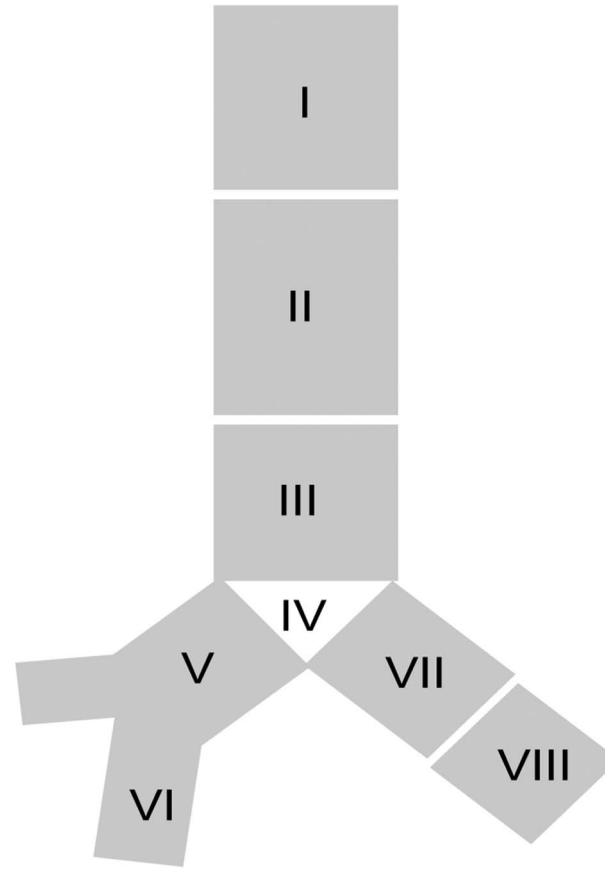

FIGURE 1. Eight locations of the central airway: (1) location I, upper 3rd of the trachea; (2) location II, middle 3rd of the trachea; (3) location III, lower 3rd of the trachea; (4) location IV, trachea carina; (5) location V, right main bronchus; (6) location VI, right middle bronchus; (7) location VII, proximal of left main bronchus; (8) location VIII, distal of left main bronchus.

Data Acquisition

The baseline study characteristics were recorded, including the site of fistula and previous treatment with chemotherapy, radiation and surgery. Successful stent implantation, symptomatic relief and complications were also recorded.

Patient Follow-up

Patients were followed up both in clinical and in endoscopy. All patients received first follow-up at 1 month, then every 2 months or based on patient's symptoms. Clinical and endoscopic follow-up were more frequent in those patients for the growth of granulation tissue due to stent. A long-term follow-up has also been made through telephone by the referring doctors when patients could not visit doctors routinely.

Karnofsky Score Analysis

Karnofsky Score (KPS) has been developed to assess the quality of life of cancer patients. The first KPS score was administered to all patients before stenting. The 2nd KPS score was given to the same patients at 1 month during follow-up.

Statistical Analysis

An exploratory analysis was performed by using SPSS16.0. The χ^2 test was used for categorical data. The paired *t* test was used for manifestations before and after treatment. Survival data were assessed by the Kaplan–Meier method.

RESULTS

As shown in Table 2, patients included 46 cases of esophageal cancer, 12 cases of squamous cell lung carcinoma, 1 case of esophageal lymphoma, 3 cases of tracheal adenoid cystic carcinoma and 1 case of thyroid cancer. Seventeen patients received conventional radiotherapy. The demography and clinical data are listed in Table 1. All patients underwent airway stent insertion and 8 patients (12.7%) with both airway and esophageal stent insertion. Clinical manifestations of these patients before and after stent placement are listed in Table 3, including dyspnea (25 [39.7%] versus 2 [3.2%]; $P = 0.000$), cough (63 [100%] versus 15 [23.8%]; $P = 0.000$) and pulmonary infection (63 [100%] versus 10 [15.9%]; $P = 0.000$). Mean KPS was 43.0 ± 10.7 before stent placement and mean KPS was 66.7 ± 10.8 after stent placement ($P = 0.000$) (Figure 2). Complete closure was achieved in 45 patients (71.4%), and incomplete closure and leakage were found in 18 patients. But stents were not removed in 18 patients due to the improvement of clinical manifestations.

Most fistulas were located in location II (18/63, 28.6%), location III (22/63, 34.9%), then location VII (9/63, 14.3%).

TABLE 1. Different stents for tracheoesophageal fistula based on fistula size and location

Site of fistula	Size of fistula	Type of airway stent	Number of airway stent	Number of esophageal stents	Number of fistula closure
I	Small	I shaped	2	0	0
II	Small	I shaped	6	3	5
	Big	Y shaped	12	1	12
III	Small	Y shaped	7	2	6
	Big	Y shaped	15	2	11
IV	Small	Y shaped	2	0	1
V	Small	L shaped	3	0	1
	Big	Y shaped	3	0	3
VI	Small	L shaped	2	0	1
VII	Small	L shaped	3	0	1
	Big	Y shaped	6	0	3
VIII	Small	I shaped	2	0	1

The total number of airway stents was 63, including 10 (15.9%) I shaped, 8 (12.7%) L shaped and 45 (71.4%) Y shaped, as shown in Figures 3 and 4. Different stents were placed based on different locations and sizes of fistulas. Thirty-four Y-shaped stents were placed in the locations II and III.

All patients developed secretions adhered to the stents. Twenty-eight patients (44.5%) had chest pain and the airway stents were removed from 2 patients due to intolerable pain and the symptom relieved gradually in other patients within 2 weeks without any intervention. Two patients without stents were admitted into local hospitals and the authors were informed by telephone that they died at 90 and 70 days after removing stents. Two patients developed stents migration at 3 and 4 days after the implantation and then stents were repositioned. Massive haemoptysis occurred in 2 patients with double stenting at 30 and 65 days. Both patients died within 2 days after the onset of bleeding. Airway restenosis occurred in 2 patients due to the progression of tumor at 60 and 85 days. They refused any further adjustment except supportive therapy until death.

The median survival time (from stent insertion to death) was 163 days (2–270 days). The Kaplan–Meier survival curve of 63 patients after stenting is shown in Figure 5. The cause of death included the following: 2 patients by massive haemoptysis, 35 patients by malnutrition and cachexia, 17 by pneumonia and respiratory failure (17 included 2 patients whose stents were removed), 2 by acute myocardial infraction, 2 by airway restenosis and 5 by unclear reasons (3 patients died at home and 2 patients suffered from sudden death in hospital, but all families refused autopsy).

TABLE 2. Demographic data of the patients

	All
Patients	63
Age years mean (range)	57 (27–76)
Males/females	51/12
Type of cancer	
Esophageal	46
Squamous cell lung carcinoma	12
Esophageal lymphoma	1
Tracheal adenoid cystic carcinoma	3
Thyroid cancer	1
Site of fistula in airway	
I	2
II	18
III	22
IV	2
V	6
VI	2
VI	9
VIII	2
Complications	
Respiratory failure	0
Stent migration	2
Granulation	25
Chest pain	28
Previous radiotherapy	17

TABLE 3. Respiratory manifestations before and after stent placement

Respiratory manifestations	Before	After	*P*
Dyspnea	25 (39.7%)	2 (3.2%)	0.000
Cough	63 (100%)	15 (23.8%)	0.000
Pulmonary infection	63 (100%)	10 (15.9%)	0.000

DISCUSSION

MTEF poses as a serious complication in patients with esophageal or pulmonary malignancy. As reported in previous studies, esophageal carcinoma was the most common cause of TEF, then squamous cell lung carcinoma. Patients with MTEF had frequent pulmonary infection in general, even dyspnea, which was closely associated with their survival time and quality of life in the end. Therefore, symptomatic relief was very important for those patients. Palliative therapy could provide a seal between the airway and the esophagus and restore the patency of the trachea by reducing the extrinsic compression, thereby permitting oral feeding and reducing bronchial contamination. Stent insertion in the tracheobronchial tree and the

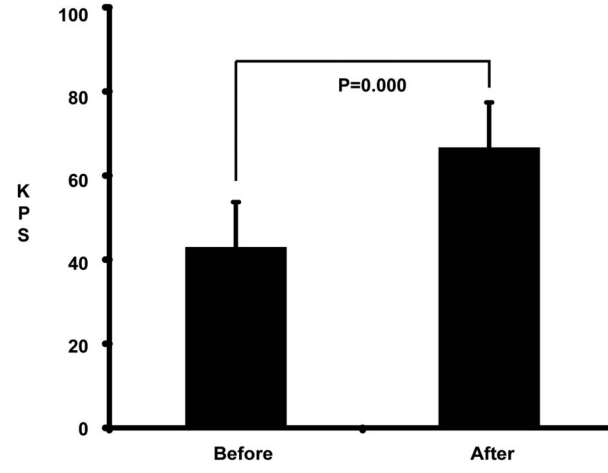

FIGURE 2. Comparison of KPS before and after placement of stents.

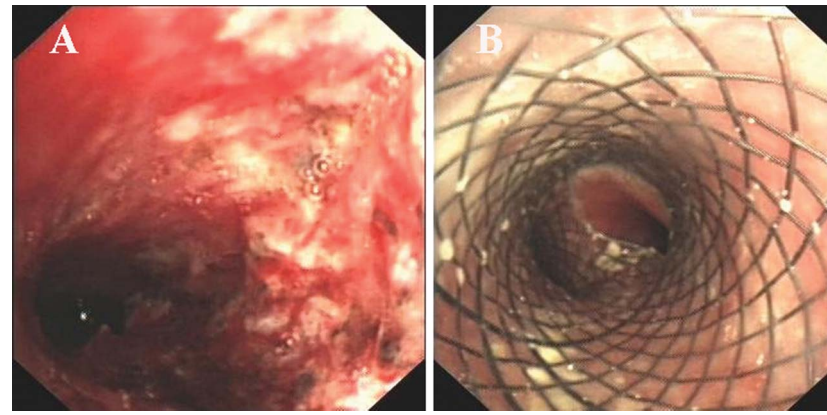

FIGURE 3. (A) The erosion of bronchial mucosa could be observed at location VII and a TEF was hidden in the mucosa. (B) The L-shaped airway metallic stent covered the fistula.

esophagus was widely used to relieve symptom in many reports.[8,13,14] When airway stenosis existed or when esophageal was not fit for stent planting because of previous surgery, stent should be placed firstly in the airways under the bronchoscope or then both systems.[15] Airway stents were placed in all patients and 8 patients with double stenting in this study.

Closure of the TEF can reduce the risk of aspiration pneumonia, relieve coughing and restore the patency of the passages with resumption of oral feeds. When fistula was closed, the symptom was relieved promptly. The clinical manifestations also improved immediately, even in 18 patients with incomplete closure, which may result from protecting lungs from continuous food contamination.[16] It is undoubted that stents serve as the bridge to improve the closure of fistula. Covered metallic stents were the most commonly used type in the literature, followed by Polyflex stents and silicone stent. An analysis found that a covered metallic stent could achieve a better initial closure rate compared with other stent types.[17] Li et al[18] adopted 2 types of partially covered nitinol stents to treat MTEF, and initial fistula closure was obtained in 75% patients. A recent study reported that a fistula was successfully closed by combining a modified silicon stent and metallic stents in a patient with carina TEF due to bronchial arterial infusion chemotherapy. Modified Y-shaped silicon stent was made by the combination of 2 type stents in this study, therefore fistula closure was achieved in this patient.[19] Three shaped stents were applied in this study, and fistula closure was achieved in approximately 72% patients. Y-shaped stent conform to the airway anatomic structure in locations II, III, IV, V and VII. The better attachment and radial forces could boost the seal of fistula effectively. However, sputum excretion was unsmooth and technique requirement was higher when using Y-shaped stent. L-shaped stents were mainly used in locations V, VI and VII in this study. I-shaped stent was mainly used for upper and middle airway-esophageal fistula, or bronchial fistula.

The size and location of fistula were closely associated with the prognosis of malignant patients with esophagorespiratory fistula when receiving stenting treatment. Unlike the uniformity of esophageal, the tracheal is divided into different parts, such as main tracheal, carina, right main tracheal and left main tracheal. Different locations have various physical parameters, such as inner diameter, pipe thickness and neighboring anatomic structure. Limited data were available for analysis of the stent type and the location of fistula. A recent study found that MTEF patients with stents placed in right main bronchus had a shorter survival time than those with stents in trachea.[20] In another previous study, 2 patients with carina MTEF were treated with covered self-expandable metallic stents, but incomplete closure and leakage were found in the patients. Therefore, authors suggested that Y stent should be the first choice for carina MTEF.[9] In addition, the small benign fistula could heal through routine therapy; however, even small malignant fistula generally could not self-cure, especially when patients were in poor nutrition condition. Therefore, it is reasonable to select different airway stents based on the location of trachea and size of fistula for MTEF patients.

The best palliation for malignant tracheoesophageal or bronchoesophageal fistula was achieved with endoscopic

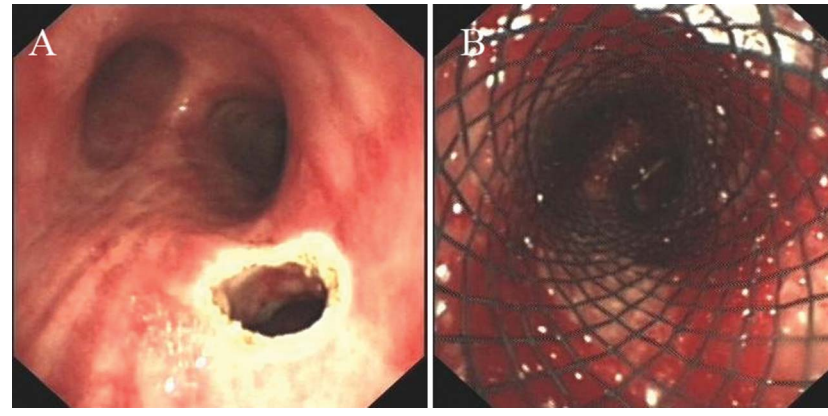

FIGURE 4. (A) A TEF (approximately 1 cm in size) was located at location III. (B) Bronchoscopy showed that a Y-shaped airway metallic stent covered the fistula at the location III.

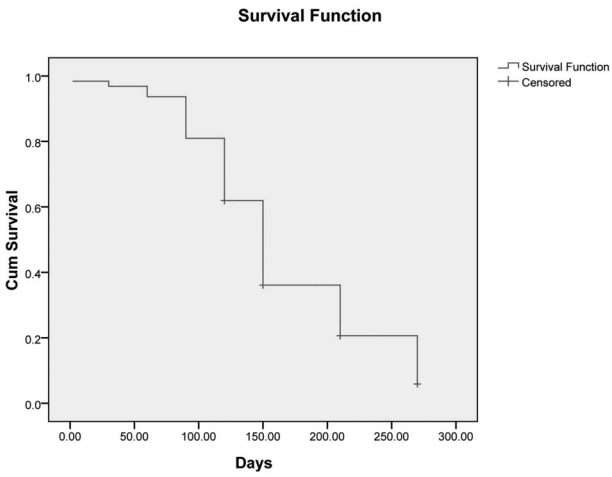

FIGURE 5. The Kaplan–Meier survival curve for 63 patients after the placement of stents.

placement of esophageal, respiratory or esophagus and airway stenting. Dual stenting seemed to work better than single prosthesis for palliation, however, mechanical friction between the 2 devices may cause a breakdown of the interposed portion of the tracheobronchial wall.[21] Therefore, esophageal stent was only used for patients with an unsatisfactory closure through airway stent. Interventional bronchoscopic procedures, including balloon dilation, laser ablation, CO_2 cryosurgery, electrocautery and implantation of airway stents, have been widely used to establish patent airway.[22] Rigid bronchoscopy under general anesthesia is also one common method of stent implantation. Most stents were implanted through bronchoscopy in this study. Generally, patients in this study had a similar survival time and complication rate, compared with previous studies.[16,20]

CONCLUSION

It seemed to be safe and feasible to place different covered metallic stents based on fistula location and size for the palliative treatment of MTEF. However, more patients may be needed in a controlled clinical trial to elucidate the topic.

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