Airway stent placement for malignant tracheobronchial strictures in patients with an endotracheal tube

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Aims and objectives

Malignant tracheobronchial obstruction can cause dyspnea, stridor, and obstructive pneumonia and is occasionally life-threatening due to the possibility of suffocation [1, 2]. When obstruction occurs, an endotracheal tube is inserted into the trachea, usually for the primary purpose of establishing and maintaining the patient’s airway. There are many options for splinting narrowed airways, such as surgical resection, T-tube insertion, laser therapy, balloon dilation, and stent placement. Among these options, the most successful treatment for tracheal stricture is surgical resection and reconstruction; however, this remains a controversial issue due to the risk of recurrence at the anastomosis site and also as these patients are often at a higher surgical risk [3]. Meanwhile, stent placement is known to be a safe and useful therapy for malignant airway stricture and it has both lower morbidity and mortality rates compared with those of corrective surgery [4]. Moreover, it provides prompt and durable palliation for patients who cannot undergo surgical treatment [5-7].

Most fluoroscopically-guided stent placement procedures are performed via the mouth [8, 9]; however, there are situations in which stent placement should be performed in patients with an endotracheal tube. Previously published reports focusing on airway stent placement in patients with an endotracheal tube are limited [10-12]. Therefore, the purpose of our study is to evaluate the technical feasibility and safety of stent placement using an endotracheal tube in patients with malignant tracheobronchial strictures.
Methods and materials

Patient population

Informed consent for stent placement was obtained from each patient. This retrospective study was approved by our institutional review board.

The patient cohort consisted of 20 patients (14 men, six women) ranging in age from 43 to 77 years (mean, 62 years), and who suffered from malignant tracheobronchial strictures between June, 2007 and April, 2014. The patient characteristics are shown in Table 1. All of these patients had previously undergone endotracheal intubation 0-42 days (mean, five days) before stent placement in order to maintain a patent airway.

The inclusion criterion for stent placement consisted of documented patients with intubation. The exclusion criteria included patients in whom stents were placed transorally and who experienced airway narrowing due to benign strictures. The diagnosis of malignant tracheobronchial strictures was established by means of bronchoscopic percutaneous biopsy and chest computed tomography (CT).

Stents and placement technique

The stents used in this study were described in detail in earlier studies [8, 9, 13]. In brief, the stents were woven from a single thread of 0.2-mm-diameter nitinol wire in a tubular configuration and were covered with a silicone membrane made using the dipping method or with polytetrafluoroethylene (PTFE). Tracheal stents were 20 mm in diameter when fully expanded and 40 - 80 mm in length, and bronchial stents were 10 or 12 mm in diameter and 30 - 50 mm in length (S&G Biotech, Seongnam, Korea).

The site, severity, and length of the stricture were evaluated before stent placement using CT or bronchoscopy. With or without bronchoscopic guidance, a 180-cm, 0.035-inch exchange guide wire (Radifocus M; Terumo, Tokyo, Japan) was inserted through an endotracheal tube across the stricture into the distal trachea or bronchus under fluoroscopic guidance. When strictures were located in the distal trachea, carina or main bronchus, a tracheal or bronchial introducer was passed through an endotracheal tube as the inner diameter of the introducer was less than that of the endotracheal tube. When strictures were located in the upper trachea, the endotracheal tube had to be removed, after which a stent was inserted as the strictures and the endotracheal tube overlapped.

A straight, 5-F, graduated-sized catheter (Cook, Bloomington, IN, USA) was passed over the guide wire to the distal portion of the stricture in order to measure its length. If necessary, the location of the narrowed tracheobronchial lumen was marked on the patient’s skin using fluoroscopic guidance. When a stricture was not well-defined by fluoroscopy, the guide wire was removed from the catheter and a small amount of
contrast medium (Omnipaque 300, GE healthcare, Cork, Ireland) was injected through the catheter in order to opacify the narrowed lumen, after which the length of the stricture was measured. Using fluoroscopic guidance, the entire introducer set was passed over the guide wire and advanced until the distal tip of the stent reached beyond the stricture. A stent at least 1 cm longer than the stricture was then placed. A 7-mm tracheal introducer or a 5-mm bronchial introducer was used in our study.

Follow-up

All patients underwent conventional radiography and bronchoscopy 1 - 3 days following stent insertion in order to verify the degree of stent expansion as well as the stent position. Patient interviews as well as fluoroscopic examinations were performed 1 - 5 days later and then monthly in order to obtain detailed clinical information and to detect possible complications such as stent migration, sputum retention or tumor overgrowth. Subsequent treatment was performed when indicated. During the follow-up period, the degree of dyspnea, technical and clinical success, as well as complications and their treatment data were evaluated.

Definition and data analysis

The clinical outcomes were assessed with regard to the following variables: technical and clinical success; procedure- and stent-related complications; and duration of intubation following stent placement.

Technical success was defined as successful stent insertion in the appropriate position with the endotracheal tube. Clinical success was defined as successful extubation of the endotracheal tube within five days following the stent placement.

Procedure-related complications were defined as complications occurring during the procedure, and stent-related complications were defined as complications related to the stent following its placement. The duration of intubation following stent placement was defined as the period between the initial stent placement and extubation of the endotracheal tube. When calculating the intubation period, patients whose tube remained throughout their lifetime were excluded from the calculation.
Results

Technical and clinical outcomes

Fluoroscopic stent placement was technically successful in all 20 patients (100%). Overall, 18 of the 20 patients (90%) had sufficient improvement in their respiratory state to prolong their lives without maintaining the endotracheal tube and which occurred within five days following the stent placement. Of the 20 patients in whom stent placement was technically successful, extubation of the endotracheal tube was possible during the procedure (n = 7) or after the procedure (n = 11) (mean, 2 days, range 0-4 days) (Fig. 1-4).

In four patients (Nos. 1, 2, 3, and 9) with upper tracheal strictures, the endotracheal tubes had to be removed before stent placement. Re-intubation was only necessary in one (No. 9) of these patients due to respiratory arrest probably caused by swelling of the pharynx and larynx caused by radiation therapy treatment for thyroid cancer. In this patient, the cyanosis disappeared and the vital signs became stable after performing endotracheal re-intubation. In 16 patients with lower tracheal or bronchial strictures, stents were placed through an endotracheal tube. The 7-mm tracheal introducer or 5-mm bronchial introducer used in this study could be passed through the endotracheal tube with a diameter of 7.5-mm (n = 5) to 8-mm (n = 15). Two patients with clinical failure died nine and 52 days, respectively, following stent placement in the intubation state.

Complications and secondary treatments

Procedure-related complications occurred in one patient (No. 1) who had mild bleeding which resolved spontaneously within three days and who could then have her endotracheal tube removed four days following the stent placement.

Stent-related complications occurred in four patients one to 168 days following stent placement (mean, 64 days). Complications and their management are summarized in Table 1. Partial (n = 2) or complete (n = 1) upward stent migration occurred in three patients one to 85 days following stent placement (mean, 29 days). In two patients with partial migration (Nos. 2, 18), a second stent placement was performed under bronchoscopic and fluoroscopic guidance. In the patient with complete migration (No. 17), the stent which had migrated from the left bronchus to the carina was removed and a second stent was inserted under bronchoscopic guidance. As granulation tissue occurred in one patient (No. 1) 168 days following stent placement, an additional stent was placed.

<table>
<thead>
<tr>
<th>Patient No./Age (y)/Sex</th>
<th>Underlying cause</th>
<th>Diameter of the E-T tube (mm)</th>
<th>Stricture site</th>
<th>Extubation (Y/N)</th>
<th>Duration of intubation (days)</th>
<th>Complications</th>
<th>2nd treatment</th>
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<table>
<thead>
<tr>
<th>Date</th>
<th>Age</th>
<th>Diagnosis</th>
<th>Size</th>
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<th>Malignancy</th>
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<td>2nd stenting</td>
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<td>Both MB</td>
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<td>Lt, Both MB</td>
<td>Y</td>
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</table>

Table 1. Data from 20 patients with airway stent placement through an endotracheal tube (Note: LT, Lower trachea; UT, Upper trachea; MB, Main bronchus; Ca., Cancer) (Y*: Patients who could remove the E-T tube during the procedure)
Fig. 1: A 66-year-old male (No. 8) with a left main bronchial obstruction caused by small-cell lung cancer. Radiograph obtained one day before stent placement shows complete obstruction of the left main bronchus with total collapse of the left lung. An endotracheal tube (arrows) is located near the carina.

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Fig. 2: A 66-year-old male (No. 8) with a left main bronchial obstruction caused by small-cell lung cancer. A guide wire (arrows) and a sizing catheter (arrowheads) were passed through the 8-mm-diameter endotracheal tube. Note the stricture (long arrow) of the left main bronchus.

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Fig. 3: A 66-year-old male (No. 8) with a left main bronchial obstruction caused by small-cell lung cancer. Radiograph shows successful placement of the stent (arrows) at the left main bronchus. The endotracheal tube was removed the same day that stent placement was performed.

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Fig. 4: A 66-year-old male (No. 8) with a left main bronchial obstruction caused by small-cell lung cancer. Radiograph obtained one month following the stent placement shows successful stent expansion (arrowheads) and appropriate aeration of the left lung.

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Conclusion

Tracheal stenosis is a life-threatening, emerging disease seen with increasing frequency [14, 15]. We determined that stent placement using an endotracheal tube and under fluoroscopic guidance is effective and safe for patients with malignant tracheobronchial strictures. As most recurrent tumors are unsuitable for further resective or palliative surgery, palliative therapy using stent placement is the only option for relieving dyspnea and improving respiratory deficiencies [16, 17].

As a stent can keep airway strictures open, even under mechanical ventilation [18], it is sometimes necessary to place airway stents in patients with endotracheal tubes. When performing airway stent placement in patients with an endotracheal tube, it is essential to secure the airway in order to maintain both the patients' oxygen saturation and stable vital signs. It is also very important to maintain the placed endotracheal tube following airway stent placement due to the uncertainty of stable airway security following stent placement. In our study, as we could maintain the endotracheal intubation following the airway stent placement, we were able to maintain both the patients’ oxygen saturation and stable vital signs and could remove the endotracheal tube depending on the patient’s condition [18, 19].

To date, there have only been a few case series dealing with the airway stent placement procedure via an endotracheal tube [10-12]. Considering the acute angulation made by the endotracheal tube and coaxial insertion of the stent introducer through the endotracheal tube, stent placement through an endotracheal tube can be technically difficult. However, our study demonstrated that stent placement via an endotracheal tube is associated with a high technical success rate (100%) in patients with malignant tracheobronchial strictures. Our technical success rate was similar to the 98% - 100% technical success rates seen in several previous studies in which stent placement was performed via the patient's mouth [20].

In patients with upper tracheal stenosis, an endotracheal tube can straddle the stricture. Therefore, the endotracheal tube which is blocking the stricture should be removed, after which a stent is inserted into the stricture. Therefore, the operators must quickly insert the stent and decide whether or not to reinsert the endotracheal tube immediately following stent placement. However, in patients who undergo stent placement through an endotracheal tube, the operators can manage respiratory problems more easily during insertion of the airway stent. There is also an advantage to inserting a guide wire into the airway through the endotracheal tube without the help of a bronchoscope. When inserted through the mouth, the guide wire is usually inserted into the airway via the working channel of the bronchoscope.

The primary limitation of our study is its retrospective design, although we believe that our results will support the viability of future, prospective investigations. Secondly, we only had a small number of study patients.
In conclusion, airway stent placement using an endotracheal tube under fluoroscopic guidance in patients with malignant tracheobronchial strictures, is technically feasible and safe.
References


