Placement of self-expanding metallic tracheobronchial Y stent with laryngeal mask airway using conscious sedation under fluoroscopic guidance

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Abstract
Background: Central airway obstruction and fistula are treated with a tracheobronchial Y stent. In the currently used self-expandable metal Y stents, the delivery system is 8 mm in diameter and requires either a 9 mm tracheal tube or rigid bronchoscope to enable airway control during insertion. In this study we present a novel technique of laryngeal mask airway (LMA) assisted Y stent insertion, enabling airway control during deployment of the Y stent.

Methods: All procedures using LMA in assisting Y stent insertions between 2014–2020 were reviewed. Data collected included demographics, clinical diagnosis and disease characteristics, indication, procedural success rates, clinical outcome and survival.

Results: A total of 10 patients with a median age of 61.5 years (range 37–73) underwent LMA assisted Y stent insertion. Indications for stent insertion were malignant disease with central airway obstruction or fistula. In all cases airway patency was achieved leading to improvement of symptoms and performance status. No procedural complications were reported. The median survival was 4.5 weeks (range: 2–26).

Conclusions: LMA assisted Y stent insertion enables airway control during the procedure. In comparison to silicone Y stent insertion, the procedure is less cumbersome, shorter in duration and does not require the use of general anesthesia or rigid bronchoscopy.

Key points
Significant findings of the study
LMA assisted Y stent insertion enables airway control during the implantation of metallic self-expanding Y stent. The procedure does not require the use of general anesthesia or rigid bronchoscopy.

What this study adds
In this study we present the technique and outcomes of LMA assisted Y stent insertion. This method of Y stent insertion provides an additional treatment option for patients with central airway obstruction and fistula.

Introduction
Tracheobronchial obstruction and fistula are a major concern in patients with malignant disease that involves the central airway.1–5 For lesions involving the lower trachea, tracheal carina, main stem bronchi, and secondary carina, the Y-stent is best suited to obtain patency of the obstructed airway, or to isolate the fistula.6–13 Bilateral airway stenting of the left and right main bronchi is also a viable option in some cases.14 Silicone Y stent (Freitag and Dumon) placement is an accepted and widely integrated...
interventional pulmonary practice, albeit one that requires general anesthesia (GA), special equipment and the use and skill of performing rigid bronchoscopy. Self-expandable metal Y stents (SEMS) are a relatively recent addition to the armamentarium of interventional bronchoscopy and have not been widely adopted into practice. SEMS insertion does not require the use of rigid bronchoscopy and GA and can be inserted in the bronchoscopy suite under moderate sedation. However, as SEMS delivery system is 8 mm in diameter, it requires the use of a rigid bronchoscopy or 9 mm endotracheal tube for airway control during insertion. The laryngeal mask airway (LMA) is a well-accepted method for airway support and ventilation during bronchoscopy. The large diameter working channel of the LMA enables both a controlled and safe passage of the Y stent delivery system, while maintaining airway control. In this case series, we present a novel technic of Y stent insertion, using a laryngeal mask airway to enable airway patency during bronchoscopy and deployment of the Y stent.

Methods
We conducted a retrospective analysis of all cases of LMA assisted Y stent insertion, between 2014–2020, in Rabin Medical Center, Israel. The study was approved by the ethics committee (IRB) of Rabin Medical Center (RMC-0505-18). Patients or their families gave their consent to publish their case. The following data was collected: demographics, clinical diagnosis, indication for stent placement, need for preprocedural intubation, site of airway obstruction, presence of tracheoesophageal fistula, technical success rates and clinical outcome, and post procedure survival.

Patient and public involvement
Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Technique
LMA assisted bronchoscopy
All procedures were performed with flexible fiberoptic bronchoscopy under moderate sedation with fentanyl (50–100 μg), midazolam (1–2 mg), and propofol (50–350 mg). The patient was monitored with oxygen saturation and transcutaneous PCO₂ level (SenTec digital monitoring system). An assistant pulmonologist was present throughout each procedure. We used the I-gel laryngeal mask, and the size of the LMA was determined according to the patient’s weight (commonly size 4 or 5). The LMA was placed with its backside pressed against the hard palate and advanced over the tongue. Once the LMA was positioned over the supraglottic area, the larynx and trachea were visualized by passing a flexible bronchoscope that was inserted through a swivel adapter. The LMA was connected to a self-inflating resuscitation bag (Ambu with oxygen reservoir), breathing was spontaneous because only moderate sedation was used, and ventilation was performed if required according to the patient’s saturation and PCO₂. The site of stenosis and/or fistula were located visually with the bronchoscope, and the length diameter of the stenotic area were then evaluated (Fig 1a and b). A cryoprobe, YAG laser or balloon dilatation were used if predilation was necessary.

LMA assisted tracheobronchial (Y) stent insertion and deployment
A guide wire was inserted into the right lung through the working channel of the flexible bronchoscope beyond the stenotic lesion. The bronchoscope was then retracted leaving the wire positioned in the right main stem bronchus. A second wire was then positioned at the left main bronchus, beyond the stenotic lesion and then the bronchoscope was again retracted, leaving both wires positioned through the LMA. Fluoroscopy was then used to verify the position of the wires (Fig 1c). For inserting the Y stent apparatus, the airway was maintained with the LMA. The tracheobronchial (Y) stent (Micro-Tech Y stent; Micro-Tech; Nanjing, China) was inserted into the LMA (Fig 1d) and advanced over the guide wires into the correct position (Fig 1e). The delivery system is rotated slowly left and right until both wires are separated. Once position was verified the SEMS deployment was initiated, first the opening of the bronchial part followed by the tracheal part, until the full opening of all stent parts (Fig 1f and g). The delivery system and guide wires were quickly removed, and the location of the stent was confirmed with the bronchoscope (Fig 1h and Video S1). To ensure patient safety the bronchoscopy suite was equipped with endobronchial tube, rigid bronchoscopy and percutaneous tracheostomy, in case any of these options were needed.

Results
A total of 10 patients (eight males, two females) underwent treatment with LMA assisted Y stent insertion. The median age of patients was 61.5 years (range: 37–73). The indications for treatment were malignant central airway obstruction and/or fistula and all patients received concurrent anticancer treatment at the time the procedure was performed. Demographic, clinical and oncologic data is shown in Table 1. Four patients were hospitalized before the
procedure; one patient due to empyema, two patients due to mediastinitis and one patient due to respiratory collapse. Two patients were intubated before the procedure due to respiratory failure caused by airway tumor obstruction, the tracheal tube was replaced with LMA for Y stent insertion. These patients were able to breath spontaneously at the end of the procedure. All patients survived the procedure and patency of the airway was achieved with improvement of symptoms and performance status. Due to vocal cord paralysis, two patients also required percutaneous tracheostomy. The median survival was 4.5 weeks (range: 2–26).

Causes of death were related to the burden of malignant disease and unrelated to the procedure. Two ambulatory patients died two weeks after the procedure, one patient died from gastrointestinal bleeding after esophageal stent replacement and one from cardiac arrest.

Discussion

In this case series we present a technique for LMA assisted insertion of a self-expandable metallic tracheobronchial Y stent. We have shown that the Y stent’s loading system can be inserted through the LMA’s wide working channel and thus enable a secure and patent airway throughout the procedure.

Insertion of Y stents for central airway disease was first reported during the early 1990s, initially with the Hood and Freitag Y stents and later on with the Dumon and dynamic silicon stents. Until recently, silicone stent placement with rigid bronchoscopy was the only acceptable method for Y stent insertion while maintaining airway control. However, the silicone stent has two major limitations. First, the insertion procedure is complicated, requires experience, special equipment and several repositioning attempts until the stent is properly placed. Second, insertion of silicone stents requires the use of general anesthesia (GA) and a unique rigid bronchoscope designated for the procedure. The self-expandable metallic Y stents (Y SEMS) were developed to overcome the limitations of silicone stents. Two case series published in 2006 and 2008 have demonstrated good feasibility and high success rates. Overall, to date, 12 case series (including 370 patients) describing the use of tracheobronchial SEMS have been published, with similar success rates, efficacy and median survival as the silicone stents. A review of the insertion technique shows that despite the Y SEMS advantage, not requiring the use of a rigid bronchoscopy, its limitation is a wide delivery system that requires a large caliber deployment conductor. Consequently, during insertion, the airway is compromised. This case series and two case reports

Figure 1 (a) Computed tomography image: Anterior mediastinal mass causing severe tracheal obstruction. (b) Bronchoscopic view: severe tracheal compression. (c) Metal wires are located in the left and right main bronchi. The location is verified with fluoroscopy. (d) Insertion of the loading system of the Y stent through the LMA. (e) Fluoroscopy image: The Y stent is advanced on the wires to the correct position. (f) Deployment of the stent in the trachea and main bronchi on the metal wires. (g) Y stent fully deployed in the correct position after removal of delivery system and wires. (h) Bronchoscopic view after Y stent deployment.
Table 1 Patient characteristics

| Patient | Age | Gender | Comorbidities | Malignancy | Surgical treatment | Anticancer treatment | Airway pathology | Location | Percentage of lumen obstruction | Preprocedural status | Preprocedural intubation | Setting | Survival (weeks) |
|---------|-----|--------|---------------|------------|-------------------|----------------------|------------------|----------|-------------------------------|--------------------|----------------------|---------|------------------|
| 1       | 62  | M      | NC            |            |                   |                      | CAO              | Trachea | 80                           | No                 | Ambulatory           | 26      |
| 2       | 61  | M      | NSCLC         |            |                   |                      | CAO              | BMF      | 95                           | No                 | Ambulatory           | 8       |
| 3       | 62  | M      | CVA, DM, HTN  | NSCLC      |                   |                      | CAO              | BPF      | 80                           | Sepsis due to empyema | No                   | Oncology ward | 5     |
| 4       | 65  | F      | HTN           | EC         | Esophagectomy      |                      | TEF              | Carina   | Sepsis due to mediastinitis | Yes                | ICU                  | 4       |
| 5       | 58  | M      | PTC           | Large cell NET, Partial esophagectomy |                  |                      | Lenvatinib | Carina | Sepsis due to mediastinitis | Yes                | ICU                  | 8       |
| 6       | 73  | F      | HTN, HYT      | Large cell NET |                   |                      | CAO              | Carina   | 90                           | Respiratory collapse | Yes                   | Internal medicine ward | 3     |
| 7       | 65  | M      | NSCLC         |             |                   |                      | TEF              | Carina   | RMB                          | No                 | Ambulatory           | 2       |
| 8       | 59  | M      | NSCLC         |             |                   |                      | CAO              | RMB      | 80                           | No                 | Ambulatory           | 4       |
| 9       | 37  | M      | CRC           |             |                   |                      | FOLFOX           | Carina   | 95                           | No                 | Ambulatory           | 2       |
| 10      | 57  | M      | DM, HTN, OSA  | EC         | Esophagectomy      |                      | Carboptatin     | Carina   | 90                           | No                 | Ambulatory           | 12      |

DM, diabetes mellitus; HTN, hypertension; CVA, cerebrovascular accident; OSA, obstructive sleep apnea; NC, nasopharyngeal carcinoma; NSCLC, non-small cell lung cancer; EC, esophageal cancer; PTC, papillary thyroid carcinoma; NET, neuroendocrine tumor; CRC, colorectal cancer; RT, radiation therapy; CAO, central airway obstruction; BMF, bronchomediastinal fistula; RMB, right main bronchus; BI, bronchus intermedius; LMB, left main bronchus; BPF, bronchopleural fistula; TEF, tracheoesophageal fistula; TMF, tracheomediastinal fistula; ICU, intensive care unit.
are the only reports of LMA assisted Y stent insertion that enables airway support during the stent’s insertion and deployment.\textsuperscript{38,39} To date we have inserted 20 Y SEMS in Rabin Medical Center, the last 10 consecutive procedures were performed with LMA assistance with good results. The procedure can be done with moderate sedation, the positioning of the stent is simple, fast and does not require repositioning after insertion. Published with this case series is an informative video that describes the procedure stage by stage (Video S1). Since the procedure is complex and the patients are considered as high risk, we recommend the use of LMA, not only because it allows for a more safe and controlled stent insertion, but also because the use of LMA improves oxygenation and decreases desaturation events during the procedure.\textsuperscript{24}

The insertion of airway stents with flexible bronchoscopy (FB) under moderate/deep sedation is discussed often. While some pulmonologists consider this practice unsafe, others use FB for airway stenting frequently. A survey published in 2018 by the European Association of Bronchology and Interventional Pulmonology (EABIP) evaluated the current practice of airway stenting in the adult population in Europe, and reported that airway stenting is performed with the aid of both moderate/deep sedation with FB and GA with rigid bronchoscopy (RB).\textsuperscript{40} Furthermore, several trials have reported airway stenting, including Y SEMS that were inserted with FB without additional complications.\textsuperscript{28,30,31} In 2015, Madan et al. published the results of a multicenter trial that evaluated the placement of Y SEMS. Of 38 Y stents, six were inserted with FB, with a similar rate of complications with RB and FB.\textsuperscript{8} Finally, guidelines from the American Thoracic Society, European Respiratory Society, British Thoracic Society and the American College of Chest Physicians, all state that airway stenting should be done by experienced bronchoscopists, skilled in both FB and RB. None of these guidelines states against the insertion of airway stents via FB.\textsuperscript{1,41,42}

This procedure has several limitations. First during the insertion of the loading system, the patient cannot be ventilated. Second, the stent cannot be repositioned once deployed, although it can be gently moved for mild repositioning. However, if major repositioning is required the stent must be extracted, and a new stent must be used. Third, the stent length and circumference cannot be tailored for patients; however, several stent sizes are available.

In conclusion, LMA assisted Y stent insertion enables airway control during the procedure. In comparison to silicone Y stent insertion, the procedure is less cumbersome, shorter in duration and does not require the use of general anesthesia or rigid bronchoscopy.

Disclosure

No authors report any conflict of interest.

References

1 Ernst A, Silvestri GA, Johnstone D, American College of Chest Physicians. Interventional pulmonary procedures: Guidelines from the American College of Chest Physicians. \textit{Chest} 2003; \textbf{123} (5): 1693–717.
2 Saad CP, Murthy S, Krizmanich G, Mehta AC. Self-expandable metallic airway stents and flexible bronchoscopy: Long-term outcomes analysis. \textit{Chest} 2003; \textbf{124} (5): 1993–9.
3 Bolliger CT, Mathur PN, Beamis JF et al. European Respiratory Society/American Thoracic Society. \textit{Eur Respir J} 2002; \textbf{19} (2): 356–73.
4 Shamji FM, Inculet R. Management of malignant tracheoesophageal fistula. \textit{Thorac Surg Clin} 2018; \textbf{28} (3): 393–402.
5 Hürtgen M, Herber SCA. Treatment of malignant tracheoesophageal fistula. \textit{Thorac Surg Clin} 2014; \textbf{24} (1): 117–27.
6 Madan K, Dhoooria S, Sehgal IS et al. A multicenter experience with the placement of self-expanding metallic tracheobronchial Y stents. \textit{J Bronchol Interv Pulmonol} 2016; \textbf{23} (1): 29–38.
7 Ernst A, Majid A, Feller-Kopman D et al. Airway stabilization with silicone stents for treating adult tracheobronchomalacia: A prospective observational study. \textit{Chest} 2007; \textbf{132} (2): 609–16.
8 Cao M, Zhu Q, Wang W, Zhang TX, Jiang MZ, Zang Q. Clinical application of fully covered self-expandable metal stents in the treatment of bronchial fistula. \textit{Thorac Cardiovasc Surg} 2016; \textbf{64} (6): 533–9.
9 Debourdeau A, Gonzalez J-M, Dutau H, Benezeh A, Barthet M. Endoscopic treatment of nonmalignant tracheoesophageal and bronchoesophageal fistula: Results and prognostic factors for its success. \textit{Surg Endosc} 2019; \textbf{33} (2): 549–56.
10 Profili S, Manca A, Feo CF et al. Palliative airway stenting performed under radiological guidance and local anesthesia. \textit{Cardiovasc Intervent Radiol} 2007; \textbf{30} (1): 74–8.
11 Sehgal IS, Dhoooria S, Madan K et al. Placement of tracheobronchial silicone Y-stents: Multicenter experience and systematic review of the literature. \textit{Lung India} 2017; \textbf{34} (4): 311–7.
12 McGrath EE, Warriner D, Anderson P. The insertion of self expanding metal stents with flexible bronchoscopy under sedation for malignant tracheobronchial stenosis: A single-center retrospective analysis. \textit{Arch Bronconeumol} 2012; \textbf{48} (2): 43–8.
13 Wilson GE, Walshaw MJ, Hind CR. Treatment of large airway obstruction in lung cancer using expandable metal stents inserted under direct vision via the fiberoptic bronchoscope. \textit{Thorax} 1996; \textbf{51} (3): 248–52.
14 Inchingolo R, Sabharwal T, Spiliopoulos S et al. 
Tracheobronchial stenting for malignant airway disease: 
Long-term outcomes from a single-center study. Am J Hosp Palliat Care 2013; 30 (7): 683–9.
15 Dutau H, Cavaillès A, Sakr L et al. A retrospective study of 
silicone stent placement for management of anastomotic 
airway complications in lung transplant recipients: Short- 
and long-term outcomes. J Heart Lung Transplant 2010; 29 
(6): 658–64.
16 Freitag L, Eicker R, Linz B, Greschuchna D. Theoretical and 
experimental basis for the development of a dynamic airway stent. Eur Respir J 1994; 7 (11): 2038–45.
17 Pertusa V, Seller JM, Bellver J, Onrubia X, Barberá M. 
[Fiberoptic bronchoscopy through a laryngeal mask]. Rev Esp Anestesiol Reanim 1997; 44 (5): 207–8.
19 Özdemir C, Sökücü SN, Karasulu L, Önür ST, Dalar L. 
Placement of self-expandable bifurcated metallic stents 
without use of fluoroscopic and guidewire guidance to 
palliate central airway lesions. Multidiscip Respir Med 2016; 
11: 15.
20 Gottschall R. [Fiber optic bronchoscopy with the laryngeal mask]. Anaesthesiologie Intensivmed Notfallmedizin 
Schmerzther 2004; 39 (8): 497–501.
21 Pertusa V, Seller JM, Bellver J, Onrubia X, Barberá M. 
[Fiberoptic bronchoscopy through a laryngeal mask]. Rev Esp Anestesiol Reanim 1997; 44 (5): 207–8.
23 Birmingham B, Mentzer SJ, Body SC. Laryngeal mask airway for 
therapeutic fiberoptic bronchoscopic procedures. J Cardiothorac Vasc Anesth 1996; 10 (4): 519–20.
24 Alon D, Pertsov B, Gershman E et al. The safety of 
laryngeal mask airway-assisted bronchoscopy versus 
standard nasal bronchoscopy. Respir Int Rev Thorac Dis 2017; 
93 (4): 279–84.
25 About i-gel [Internet]. [cited 12 Sep 2018.] Available from URL: https://www.intersurgical.com/info/igel.
26 Freitag L, Tekolf E, Eicker R. Four years of palliation with 
airway stents. Results with 263 stent placements in 
179 patients. Eur Respir J 1993; 17: A1548.
27 Dumon JF, Dumon MC. Dumon-novatech Y-stents: A four- 
year experience with 50 tracheobronchial tumors involving the 
carina. J Bronchol 2000; 7: 26–32.
28 Han X-W, Wu G, Li Y-D et al. Overcoming the delivery 
limitation: Results of an approach to implanting an 
integrated self-expanding Y-shaped metallic stent in the 
carina. J Vasc Interv Radiol JVIR 2008; 19 (5): 742–7.
29 Yang R-M, Han X-W, Wu G, Li Y-D, Li F-B. Implantation 
of a self-expandable metallic inverted Y-stent to treat 
tracheobronchial stenosis in the carinal region: Initial 
clinical experience. Clin Radiol 2007; 62 (12): 1223–8.
30 Gompellmann D, Eberhardt R, Schuhmann M, Heussel CP, 
Herth FJF. Self-expanding Y stents in the treatment of 
central airway stenosis: A retrospective analysis. Ther Adv Respir Dis 2013; 7 (5): 255–63.
31 Wu G, Li Z-M, Han X-W et al. Right bronchopleural fistula 
treated with a novel, Y-shaped, single-plugged, covered, 
metallic airway stent. Acta Radiol 2013; 54 (6): 656–60.
32 Wang H, Tao M, Zhang N et al. Airway covered metallic 
stent based on different fistula location and size in 
malignant tracheoesophageal fistula. Am J Med Sci 2015; 350 
(5): 364–8.
33 Yu FY, Wei N, Zhang K, Xu H. Subcarinal ventilation- 
assisted Y-shaped stent insertion under local anesthesia for 
patients with complex tracheobronchial stenosis: Initial 
clinical experience. Diagn Interv Radiol Ank Turk 2014; 20 
(4): 330–4.
34 Fang Y, Li T, Han X et al. [The application of Y-shaped self- 
expandable covered metal stents in the thoracostomach- 
airway fistula: a single center, 11 years experience]. 
Zhonghua Jie He He Hu Xi Za Zhi 2015; 38 (8): 562–5.
35 Li T-F, Duan X-H, Han X-W et al. Application of 
combined-type Y-shaped covered metallic stents for 
the treatment of gastrotracheal fistulas and 
gastrobronchial fistulas. J Thorac Cardiovasc Surg 2016; 
152 (2): 557–63.
36 Qiao Y, Fu Y-F, Cheng L, Niu S, Cao C. Placement of 
integrated self-expanding Y-shaped airway stent in 
management of carinal stenosis. Radiol Med (Torino) 2016; 
121 (9): 744–50.
37 Conforti S, Durkovic S, Rinaldo A, Gagliardone MP, 
Montorsì E, Torre M. Self-expanding Y stent for the 
treatment of malignant tracheobronchial stenosis. 
Retrospective study. Arch Bronconeumol Engl Ed 2016; 52 
(11): e5–7.
38 Ye L, Yang P, Zuo Y. Sealing of tracheoesophageal fistula 
using a Y stent through fiberoptic bronchoscope during 
general anesthesia under laryngeal mask airway. Int J Clin Exp Med 2014; 7 (12): 5913–6.
39 Obeidat S, Badin S, Khawaja I. A new technique of 
deploying dynamic Y stent using flexible bronchoscope, 
video laryngoscope, and laryngeal mask airway. J Bronchol Interv Pulmonol 2010; 17 (2): 171–3.
40 Dutau H, Breen D, Bugalho A et al. Current practice of 
airway stenting in the adult population in Europe: A survey 
of the European Association of Bronchology and 
Interventional Pulmonology (EABIP). Respiration 2018; 
95 (1): 44–54.
41 Bolliger CT, Mathur PN, Beamis JF et al. ERS/ATS 
statement on interventional pulmonology. European
LMA assisted Y stent insertion

Respiratory Society/American Thoracic Society. Eur Respir J 2002; 19 (2): 356–73.

42 Du Rand IA, Barber PV, Goldring J et al. British Thoracic Society guideline for advanced diagnostic and therapeutic flexible bronchoscopy in adults. Thorax 2011; 66 (Suppl 3): iii1–21.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher’s website:

Video S1 Supplemental Digital Content 1.wmv