Evaluation of bronchoscopic placement of tracheobronchial silicone stents: an Ain Shams University Hospital experience

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Introduction Therapeutic rigid bronchoscopy with tracheobronchial stenting using silicone stents is a well-established procedure in the management of malignant and benign tracheobronchial stenosis. However, there is limited experience with this technique in Egypt.

Aim This study aimed to retrospectively evaluate the results of our experience with bronchoscopic placement of tracheobronchial silicone stents.

Materials and methods Between January 2007 and December 2011, 44 Dumon stents were inserted in the central airways of 40 patients using rigid bronchoscopy under general anesthesia. Data related to stent application were collected from patient's records.

Results Of the 40 patients with either benign (20) or malignant (20) tracheal stenosis, stents were indicated in stabilizing airway patency after tumor debulking, counteracting extrinsic compression, sealing malignant fistulas, and treating complex-type benign strictures in 22.5, 27.5, 7.5, and 42.5% of patients, respectively. One stent was placed in 36 (90%) patients and two stents in four (10%) patients. Four (10%) patients required two stent procedures for adequate airway stabilization. Procedural complication in the form of trivial perforation of the bronchial wall occurred in one (2.5%) patient. Stent migration occurred in 10% of the patients, granuloma formation in 17.5%, tumor ingrowth in 7.5%, and stent obstruction by mucus secretions in 7.5% during the first 3 months after stent insertion, with an overall complication rate of 45%. All complications were non-life-threatening and all were reversibly managed. There was no mortality resulting from stent placement recorded during the first 3 months after stent insertion.

Conclusion This study showed that bronchoscopic placement of Dumon silicone tracheobronchial stent is easily applied and effective in the maintenance of airway patency in malignant and benign tracheobronchial stenosis. Non-life-threatening stent-related complications occur but are easily managed. *Egypt J Broncho* 2014 8:38–43

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Introduction

Tracheobronchial obstruction due to benign or malignant disorders can often be successfully managed with bronchoscopic mechanical and ablative means. However, debulking of airway obstruction may not always be feasible. Airway integrity can also be impaired by extrinsic compression. In these circumstances, stents can be placed to support the airways [1,2].

Tracheobronchial stents are hollow tubular devices designed to maintain the patency of the tracheobronchial tree. Stents are used in stabilizing airway patency after tumor debulking, counteracting extrinsic compression, sealing malignant fistulas, and treating benign strictures [3].

A perfect stent is capable of stabilizing the airway, despite external pressure, and is nonirritating, easy to insert and remove, resilient, sterile, not prone to migration, and affordable. Unfortunately, such a device is not yet available [3]. Various stent models are applied for endoscopic treatment. Among silicone stents, the Dumon model is currently the most widely used [4]. Despite being reliable, the Dumon stent is associated with migration, necessitates rigid bronchoscopy for placement, mucus plugging, granulation tissue formation, and an unfavorable outer-to-inner diameter ratio that results in a narrow final lumen [5].

Several international studies have been published describing the indications and results of stents applications [6–9]. However, there is limited experience with this technique in Egypt, especially among pulmonologist. Sporadic stent application by otolaryngologist and thoracic surgeons has only been observed. After establishment of an interventional bronchoscopy unit and gaining experience in therapeutic interventional bronchoscopic procedures, we decided as pulmonologists to share in tracheobronchial silicone stents application since 2003 [10].

After accumulation of experience and familiarity with airway stenting procedure, it seems appropriate to evaluate the results of our experience with bronchoscopic placement of tracheobronchial silicone stents.

Materials and methods

A retrospective data collection was performed in all patients who underwent bronchoscopic placements of tracheobronchial silicone stents in the Interventional Bronchoscopy Unit, Pulmonary Medicine Department, Ain Shams University Hospital during the period from January 2007 to December 2011. The study was approved by the institutional review board.

During the study period, 44 silicone stents were inserted in the central airways of 40 patients. Tracheobronchial stenting is commonly part of a multimodality bronchoscopic intervention. Airway stenting was performed only if the bronchoscopy team agreed that this is the most appropriate option available and was guided with airway stenting international standards of practice [4,7]. Stents are placed only by operators who are well trained in all aspects of therapeutic bronchoscopy.

The following data were collected from patient's records: age, sex, primary anatomical indications, diagnoses leading to stent insertion, site of placement, stent diameter, number of stents applied in each patient, number of procedure to stabilize the stent, complications, and available follow-up data.

Anesthesia

General anesthesia was established by the anesthesiologist in all patients using total intravenous anesthesia and controlled ventilation through the ventilation port of the rigid bronchoscope (RB).

Bronchoscopic procedure

RB was performed with the proper size tube according to the site of endoluminal lesion using Bryan Dumon Rigid Bronchoscope (Bryan Corp.; Woburn, Massachusetts, USA).

Flexible bronchoscopy usually supplemented RB, with the flexible videobronchoscope (Pentax Instruments; Asahi Optical, Tokyo, Japan) used through the rigid scope to improve distal airway visualization, perform initial exploration distal to the stenotic lesion, and assist in aspirating blood and secretions.

Before stent insertion, whenever necessary airway dilatation was performed using one or more of the following modalities: mechanical debridement with bevel of the RB, bougie with successively larger RB, balloon bronchoplasty, cryotherapy, electrocautery, or argon plasma coagulator.

Stent deployment

The appropriate length of the stenosis was determined by withdrawing the telescope from the distal edge to the proximal edge of the stenosis and by measuring the amount of displacement from the rigid tube to measure the length of lesion to be covered in addition to 5 mm overextension above and below the stenosis. The diameter of stenotic lesion was assessed with respect to the largest barrel of the bronchoscope utilized in the airway. Tissue resection by mechanical debulking or electrocautery must be performed before measuring the diameter of the stenotic area.

In all patients, the Dumon silicone stent (Tracheobronxane; Novatech, La Ciotat, France) was used (Fig. 1). It was loaded into the dedicated stent-deployment device (Rigid Stent Placement Kit; Bryan Corp.) first (Fig. 2). The diameter of the selected Dumon stent ranged from 10 to 16 mm according to the width of stenotic lesions. The airway stenting procedure followed the standard technique previously prescribed in details by Dumon *et al*. [4,6].

The bronchoscope was placed with its tip at the distal end of the stenosis, and the telescope was removed. The stent-deployment device was then passed through the RB and positioned just distal to the lesion. The lubricated stent was ejected as the bronchoscope was progressively withdrawn. The telescope was then inserted, and the position of the stent was verified. In most cases, the stent was subsequently pulled more proximally into an ideal position with the RB forceps. A balloon catheter (CRE; Boston Scientific, Massachusetts, USA) or one of the rigid instruments (rigid scope itself or the gripping forceps) was used, if complete expansion of the stent was not achieved to unfold the stent.

After the procedure, daily aerosols of saline solution and respiratory physiotherapy were recommended to prevent stent obstruction by secretions. The patients were asked to visit for follow-up after 2 weeks, 1 month, and 3 months of the procedure or

Fig. 1

Dumon silicone stent (Tracheobronxane; Novatech).

in-between if warranted by clinical symptoms and/or signs. Subsequent follow-ups were every 3 months or whenever needed. Flexible bronchoscopy was carried out after 2 weeks and 3 months of the procedure or whenever needed to check the stent position or any other abnormality.

Results

Between 2007 and 2011, 44 silicone stents were inserted in the airways of 40 patients. There were 27 male patients and 13 female patients, aged 30–60 years (mean 54 years).

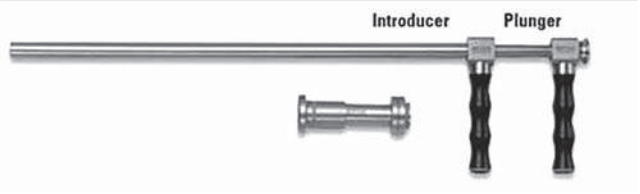
Of the 40 patients, primary anatomic indications for stenting were stabilizing airway patency after tumor debulking in nine (22.5%) patients, counteracting extrinsic compression in 11 (27.5%) patients, sealing malignant fistulas in three (7.5%) patients, and treating complex-type benign strictures in 17 (42.5%) patients. The diagnoses leading to stent insertion are shown in Table 1. Figures 3–5 show examples of indications and diagnoses leading to stent insertion.

Of the 40 patients, a solitary stent was placed in 36 (90%) patients and two stents in four (10%) patients. A total of 44 stents were placed in which 26 were tracheal and 18 were bronchial stents. The stents of diameter 10, 12, 14, and 16 mm were placed in 18, 7, 17, and 2 patients, respectively. However, the data concerning the stent length were incomplete. Some stents were cut to shorten its length when the needed length was not available.

The majority of patients (n = 36, 90%) required only one stent procedure, whereas four (10%) patients required two stent procedures to maintain stent position and airway patency.

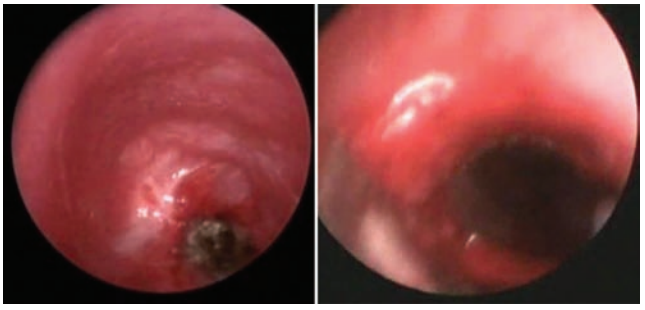
Complications of the stent insertion occurred in 18 (45%) patients during the first 3 months of insertion (Table 2). Procedural complications occurred in one patient who developed trivial perforation of the bronchial wall, which was managed conservatively without consequence. Postprocedural complications occurred in 17 patients. Four patients (all of benign etiology) had stent migration, which required repetition of the bronchoscopy with either repositioning of stent (n = 2) or placement of greater diameter stent (n = 2).

Fig. 2



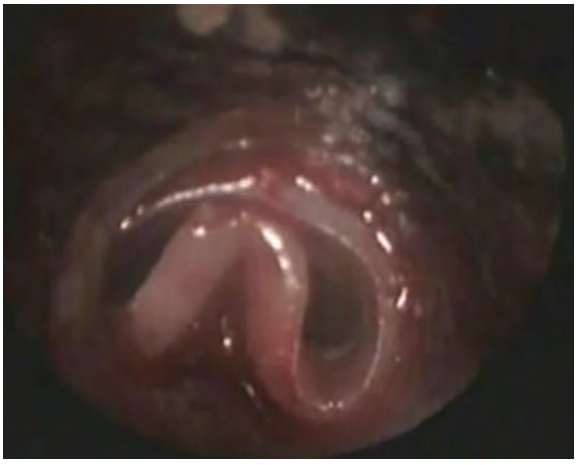
Rigid Stent Placement Kit (Bryan Corp.).

Fig. 3



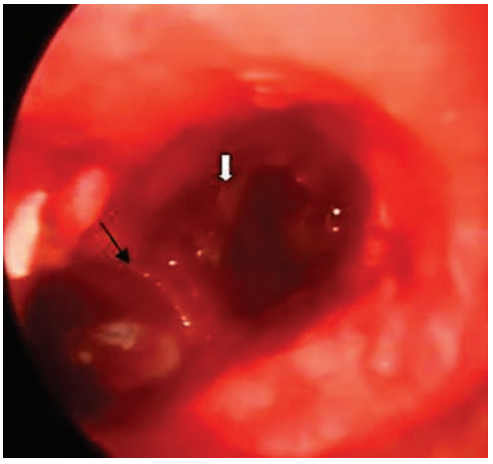
Postintubation critical tracheal stenosis before (right) and after the insertion of Dumon stent (left). Multiple tracheal dilatations and electrocautery preceded stent insertion.

Fig. 4



Folded Dumon stent shortly after deployment in patient with malignant bronchial obstruction, which necessitates balloon catheter dilation and gripping forceps for complete stent expansion.

Fig. 5



Two silicone stents in place in the right (black arrow) and left (white arrow) main stem bronchus in patient with lung cancer.

Table 1 The diagnoses leading to stent insertion

Types	Number of patients (%)
Benign	20 (50)
Postintubation tracheal stenosis	17 (42.5)
Tracheobronchial lipomatosis	1 (5)
Tracheal papillomatosis	2 (2.5)
Malignant	20 (50)
Lung cancer	16 (40)
Mediastinal neoplasm	1 (2.5)
Tracheoesophageal fistula	3 (7.5)

Table 2 Complications of the stent insertion

Types	*N* (%)	Intervention
Procedural complications		
Perforation of the bronchial wall	1 (2.5)	Conservative
Postprocedural complications		
Stent migration	4 (10)	Repositioning of stent (2), placement of greater diameter stent (2)
Retention of secretions	3 (7.5)	FOB+bronchial toilet+medical treatment
Excessive granulation tissue	7 (17.5)	Endobronchial debridement
Tumor ingrowth	3 (7.5)	Endobronchial debridement

FOB, fiberoptic bronchoscopy.

Three patients (one of benign etiology) had retention of secretions with airway obstruction. Fiberoptic bronchoscopy was performed to facilitate bronchial toilet and suction together with appropriate medical treatment. Partial obstruction by excessive granulations tissue occurred in seven patients (five of benign etiology) and by tumor ingrowth in three patients. In both situations, endobronchial debridement was performed using one or more of the following modalities: argon plasma coagulator, electrocautery, cryotherapy, or mechanical debulking. There was no intraoperative mortality resulting from stent placement in any patient. There was no recorded mortality during the first 3 months after stent insertion. Follow-up data beyond 3 months of stent insertion were not complete, hence excluded from results.

Discussion

This study showed that bronchoscopic placement of Dumon silicone tracheobronchial stent is easily applied and effective in the maintenance of airway patency in malignant and benign tracheobronchial stenosis. Stent-related complications occurred in 45% of patients, but none of them were life-threatening and all were reversibly managed.

Dumon developed a dedicated endobronchial silicone stent, which is now considered the 'gold standard' stent by many experts [2,4]. We used Dumon stent in current study for the following benefits: available in different sizes, lengths, and configurations; easily placed, removed, and repositioned; can be customized; has external studs to prevent migration; and is relatively inexpensive. However, most recorded drawbacks of Dumon stent were problems with transport of secretions, necessitation of RB and general anesthesia for insertion, and poor thickness to lumen ratio [2,4,11,12].

Airway stenting is a major component of an integrated interventional pulmonology service [12]. Thus, in the current study, combination of therapeutic mechanical approaches such as RB or balloon dilatation for opening the airway and heat or cold therapy to relieve endoluminal obstructions always preceded airway stenting. Bronchoscopic management of central airway obstruction often requires repeated interventions to obtain or maintain an airway patency [9].

In interventional bronchoscopy studies, randomized controlled series are not feasible because of the difficulty for patients as well as for interventional bronchoscopists to accept observation alone when a known relieving patient's symptoms intervention is available. Thus, we are limited to patient-controlled series to estimate the impact of immediate and significant improvement in respiratory symptoms and the presence of any complications after tracheobronchial stenting [7,13].

The indications and diagnoses leading to stent insertion in the present study as well as in other studies are similar [2,7,8]. In general consideration of indications for different airway stents, the Dumon silicone stents can be used in both benign and malignant airway stenoses unlike metallic stents that is confined to malignant diseases [11].

In all our patients, stenting was performed for palliative intent or curative restoration of airway narrowing for benign lesions. It has been previously emphasized that airway stenting should be considered only after exhaustion of all other treatment options or in patients not amenable to surgery or who have failure after airway resection [12,14,15].

Postintubation tracheal stenosis (PITS) was one of the main indications for stent insertion in our study as in other studies [8,9]. The incidence of PITS has been considerably reduced by widespread use of low-pressure/high-volume cuffs, but they have not totally prevented this complication. The reported incidence of PITS is still found in 10–19% of patients after intubation [16–18]. The extensive complex stenosis, important diseases affecting other vital organs, or

refusal of surgery has mandated stent insertion in our patients.

We applied silicone stent for two of our patients suffering from extensive tracheal papillomatosis. Airway stenting with silicone prosthesis has been previously emphasized to be useful in refractory endobronchial papillomatosis when medical and endobronchial therapies fail to restore airway patency, and it may offer permanent control of symptoms. It has been hypothesized that airway stenting can induce regression of tracheobronchial papillomas through a number of putative mechanisms including mechanical compression of the tumor or its blood supply by the stent or containment of the papillomas by the radial pressure from the stent on the airway wall, thus preventing local spread of the disease [19].

Complications from stenting occurred in 45% of patients studied, which was comparable with the complication rate (41%) that was recorded by Lemaire *et al.* [20]. However, none of our cases were life-threatening and all were reversibly managed. Stent migration occurred in 10% of the patients, granuloma formation in 17.5%, tumor ingrowth in 7.5%, and stent obstruction by mucus secretions in 7.5% during the first 3 months after stent insertion follow-up. Commonly encountered complications of Dumon silicon stents are migration (5–13%), granuloma formation (1–8%), and mucus plugging (2–4%) at the site of application [6,21,22]. Notwithstanding, our results corroborate those of other investigators, with granuloma formation and migration rates being more frequent in benign cases [6,8,22]. The higher rates of granuloma formation in our series could be attributed to the fact that half our patients were of benign etiology and sometimes due to burrs present at the edge of stent after cutting it to shorten its length when the needed length is not available. This cutting abolishes one of the advantages of Dumon stents – that is, its rims are polished to remove burrs to reduce the risk of granuloma formation [6].

Overall, the patients treated with airway stents were not burdened by frequent reinterventions, as only four (10%) patients required two stent procedures to maintain stent position and airway patency. Other interventions to treat encountered complications were diagnosed and managed in the same setting of routine scheduled after stent insertion follow-up bronchoscopy.

The study has certain limitations. There was a complexity of assessing symptomatic improvement effect and median survival of airway stenting in current study and also in most of other similar previous series because of limited long-term follow-up data and the retrospective study nature [7,13]. This is due to the following facts. The majority of patients were referred from outside Cairo. Half of our patients also had advanced disease, usually terminal cancer, combined with geographic considerations, which limited the practicality of returning for follow-up care. Wood *et al.* [7] stated that it is difficult to determine, without 100% follow-up at the endoscopy center, whether patients failing to return is because of excellent results, poor results with an unwillingness to return for further intervention, or because of death from progression of the underlying disease.

Bronchoscopic placement of tracheobronchial silicone stents is one of the successful services applied simply and effectively in our hospital to maintain airway patency in palliative treatment of malignant and benign tracheobronchial stenosis. Non-life-threatening stent-related complications occur but are easily managed.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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