

## A Safe Method of Tracheal Polyflex Stent Placement: A Review of 20 Patients

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**Background:** Surgery is an appropriate therapeutic approach for tracheal stenosis due to various benign and malignant conditions. When surgery is postponed for certain reasons, other options are chosen for airway patency. One alternative is using airway stents.

**Objectives:** We aimed to introduce a safe method of tracheal polyflex stent placement in patients with tracheal stenoses.

**Patients and Methods:** During a 7-year period (2002 - 2008), polyflex stents were used 29 times among 20 patients for various indications. After encountering many difficulties in earlier cases, we gradually developed our new method and used it in most of our patients. In this method, without using large rigid bronchoscopes, the introducer tube could be used as a bronchoscope with the aid of a zero-degree lens and ventilating apparatus. In this method, the rate of possible trauma to the airway can be minimized by avoiding the use of thick rigid bronchoscopies and the stent can be placed faster and more accurately.

**Results:** Polyflex stents were used in 11 men (55%) and 9 women with a mean age of 38.5 years. Stents were removed and changed in 12 cases and replaced with another type of stent in 3 patients. Indications were recurrence of tracheal stenosis (7), multisegmental tracheal stenosis (3), anesthesia limitations (3), tracheal tumors (2), dehiscence of tracheal anastomosis (1), severe inflammation of the tracheal mucosa (1), esophagobronchial fistula (1), and external pressure on the left main bronchus (1). In one patient, a stent was used to open a kinked Dumon stent as a temporary life-saving procedure. We found 6 cases of stent migration, 3 cases of granulation tissue formation, 1 case of infection, and 1 case of surgical site dehiscence.

**Conclusions:** Stents would be regarded as a temporary means of reaching the ideal condition for resection and reconstruction in most patients with tracheal stenoses. Although an optimal stent has not been introduced yet, we used polyflex stents in most of our patients with tracheal stenosis due to its availability and ease of use. We suggest that this method is safe and less time consuming than its traditional method of placement.

**Keywords:** Stents; Treatment; Thoracic; Tracheal Stenosis; Methods

### 1. Background

The use of stent placement in the respiratory system setting dates back to the late 19th century when Trendelenburg and Bond published a relevant manuscript (1, 2) that introduced a modern treatment approach for airway obstructions. Their work was carried on thereafter by Harkins half a century later, in 1952 (3). Many types of stents have been used, ranging from metal to silicon stents, through surgery and later by bronchoscopic methods.

Stenosis and obstruction of the central airway resulted from malignancies such as primary or metastatic tracheal neoplasms and from benign conditions such as airway stenosis due to long-term intubation. These circumstances can direct people to dyspnea, stridor, or even suffocation. In many cases, resection and reconstruction of the trachea would be the main choice. This procedure might be impossible when a long segment of the trachea is in-

involved by a mass or stricture. Furthermore, many conditions limit the practicability of surgery. Thus, the use of bronchoscopic resection, laser therapy, tracheostomy, T-tubes, and other stents are worth the try. Stents, which were the focus of this study, are applied permanently, for instance, in cases of tumors or fistulas. Some are used temporarily in a period when the patient is looking forward to an opportunity to undergo elective operation (4, 5). Multisegmental stenosis, long-segment inflammation and granulation tissue growth and recurrent stricture are some examples of temporary usage of stents.

Nowadays, although the more widely used silicone stent may be Dumon (Novatech; France) (6-9), expandable metal stents have also a wide range of usage because they are well tolerated and adapted by patients, apart from their minor complications (10). A self-expandable polyflex

stent (Willy Rosch AG, Germany) is a silicon-covered polyester wire mesh (6, 11), including two types with a smooth or spiked outer surface. Between the two types, the latter is much superior due to the lesser chance of migration (6). Stent migration seems the most predominant complication related to stenting airways. Wassermann et al. reported an acceptable rate of 6% migration in 1997 in 33 cases of insertion in 19 patients, encouraging the use of Polyflex stents (12).

## 2. Objectives

We aimed to introduce a safe method of tracheal polyflex stent placement in patients with tracheal stenoses.

## 3. Patients and Methods

This case series article introduces 29 cases of Polyflex stent implementation among 20 patients in a 6-year period between 2002 and 2008 in our referral center. We currently use various types of stent in our center. We used stents in our patients from 2002 to 2008. We mainly used polyflex stents because of their availability and acceptable price. After using the conventional method of inserting this type of stent for a few patients, we faced serious problems such as prolonged hypoxia due to lack of ventilation during the procedure; improper placement of the stent, mandating repeated bronchoscopies; and excessive stent manipulation. Thus, we made some changes and found a new method for inserting polyflex stents.

Because of the small number of patients who needed airway stents, we did not mention any inclusion or exclusion criteria. All of the patients who had received a polyflex stent with a certain method were included in the study. Routinely, patients were transported to the operating room after giving a history of illness, undergoing radiographies, and signing a written informed consent form in our research center. Finally, the relevant indications are reviewed by the physicians.

Local anesthesia and intravenous sedation were used to evaluate the larynx and vocal cords. A tracheal map was provided based on rigid bronchoscopy results by using zero-degree lens. We used Storz rigid bronchoscopes of different sizes for gradual dilatation of tracheal strictures and for measuring the diameter of the strictures and the diameter of the stricture according to the outer diameter of the last bronchoscope, which could be passed without too much force through it. In all cases, at least two of the surgeons (Authors) participated in performing the procedure. The map showed the distance of stenosis from the vocal cords and carina, as well as its length and diameter.

The suitable length and diameter of the stent are usually considered to be half a centimeter more than the length and diameter of the stricture, which is going to be stented. The diameter was measured slightly bigger than the diameter of the last rigid bronchoscope, which could be safely passed through the stenotic area and, in the most cases, directly through the vocal cords. After

mapping, the stent-containing introducer needs to be demarcated before entering the trachea via a large bore rigid bronchoscope.

In our experience, we found that the stent can be loaded into its trimmed introducer and placed under direct vision in the target area and pushed to the end point by its loader. As can be seen in Figure 1, the distal part of the introducer was crosscut and trimmed like the tip of a bronchoscope in order to pass more easily through the vocal cords and the stricture itself. The introducer was connected to a ventilator by a plastic connector at its proximal end, so ventilation was also facilitated through the process. Then, a zero-degree lens can be passed through the stent for a better view and direct control of the entire process.

The introducer along with such a lens served as a bronchoscope but with a much accurate sight. After placing the tip of the introducer in the right place, usually at least 5 mm distal to the edge of the stenotic area, the lens is emitted before entering the loader to maintain the stent in position in order to bring the introducer out (Figure 2). The competence of stenting was finally checked by using rigid bronchoscopy. Data were analyzed by using the SPSS version 16 software.

**Figure 1.** Introduction of the Tube After Shortening its Length to Fit a Zero-Degree Lens



The tip is also cut obliquely for safe passage through the vocal cords and the stenotic area in the trachea.



**Figure 2.** Insertion of the New Introducer Into the Trachea by Using a Zero-Degree Lens While the Ventilation Can be Maintained Simply by Connecting the Ventilator Tubing to it

## 4. Results

From 2002 to 2008, 20 patients were stented by using polyflex stents (Rosch, Germany), including 11 men and 9 women with a mean age of  $38.5 \pm 37.95$  years. In total, 29 implementations were performed. Among the stents used, Dumon and Niti-s stents were used 3 times. The main indications for stentings are shown in Table 1.

In 12 cases, the stents were removed and changed. Table 2 shows the main causes of repeating the procedure.

The duration of stent staying depends on the indication of its use and the cause of tracheal involvement besides the patient's general condition was from 1 day to 16.5 months. The most prolonged duration of stent usage was for a tracheal stenosis induced by long-term intubation in a patient with myocardial infarction and heart failure with very low ejection fraction. The stent was changed four times and, finally, was replaced with a Dumon stent. Unfortunately, the patient died because of asphyxia due to obstruction and migration of the last stent.

Three of our patients had multisegmental strictures, of whom 2 had a complete stenosis in the proximal trachea and 1 had a complete stenosis in the distal trachea. In these patients, the stents were used in the distal stenosis after resection of the proximal stenosis.

**Table 1.** Indications of Stent Placement

Indications	Values <sup>a</sup>
Post-resection recurrence	7 (40)
Multisegmental stricture	3 (9.3)
Anesthesia limitation	3 (9.3)
Widespread inflammation and granuloma	1 (3.1)
Tracheal long-segment damage	1 (3.1)
Esophagobronchial fistula	1 (3.1)
Unresectable thyroid medullary carcinoma	1 (3.1)
Recurrence of medullary carcinoma	1 (3.1)
Left atrium pressure effects	1 (3.1)
Keeping open the kinked Dumon stent	1 (3.1)

<sup>a</sup> Values are presented as No. (%).

**Table 2.** Causes of Repeated Stenting or Discontinuing Its Use

Causes	Values <sup>a</sup>	% of 29
Stent migration	6 (50)	14
Granulation tissue	3 (25)	7.5
Infection	1 (8.3)	2.5
Intolerance	1 (8.3)	2.5
Surgical site dehiscence	1 (8.3)	2.5

<sup>a</sup> Values are presented as No. (%).

Two patients had invasion of medullary carcinoma of the thyroid with invasion to the trachea. One of the cases was considered unresectable because of excessive length of involvement. The second patient had a tumor recurrence after tracheal resection and anastomosis. Polyflex stents were used for both cases, but owing to infection in the latter case, it was replaced with a Nitinol stent. In one of our patients, the pressure in the enlarged left atrium on the left main bronchus was relieved by placing a stent in the narrowed airway. In another patient, recurrent aspirations in a malignant esophagobronchial fistula were also stopped by stenting the right main bronchus.

In the last case, this method served as a life-saving procedure. A young patient with a distal tracheal stenosis who underwent surgery via partial sternotomy developed a fulminant mediastinitis on the fourth postoperative day. During our attempt at drainage of pus, the anastomosis was completely disrupted, and we placed a Dumon stent via right emergent thoracotomy in the gap between the proximal and distal trachea. Three days after distal migration and folding of the Dumon stent, we placed a polyflex stent into the lumen of the Dumon stent by using our method. Again, it was possible to maintain a patent airway for the patient. Both stents were replaced with a T-tube 3 weeks later.

## 5. Discussion

One of the methods to treat benign or malignant tracheal strictures is stenting (13, 14), which could be either temporary or permanent. Stenting is associated with many complications, including unsuitable deployment, infection, granulation tissue formation, and tumor encroaching into stent tissue and infection.

Anastomotic stenosis was the most frequent indication for the use of stents in the present study, as in Gildea's study (15), in which 3 cases were stented because of some surgical limitations and 1 case had an esophagobronchial fistula. We had two cases of thyroid medullary carcinoma.

Stent migration occurred in 6 of the 29 cases in our study, while the mentioned complication occurred in 3 cases just a day through Gildea's trial (15), although they used a polyflex stent with a spiked outer surface to prevent migration and dislocation. The rate of stent migration in our study was a bit lower than one-fourth of 83%, which Bolliger et al. (6) reported. Wassermann (12) reclaimed a 100% rate of total failure caused by migration and mucus retention during their study. Likely, Jog et al. (16) obtained the same failure rate as that obtained by Wassermann when subglottic stenting was concerned.

Unlike Gildea's decision to abandon using polyflex stents, we recognized the mentioned stent as safe regarding the rather low rate of complications, especially using the mentioned method of placement and the easy availability of these types of stents during the study.



Granulation tissue formation was the second most frequent complication in our study, with a rate of 7.5%, higher than that reported by Martinez-Ballarín (6.3%) (17) and Wassermann (12). The latter recognized no granulation tissue growth among the 11 studied patients (18), which was the same as that in Bolliger's study (11). Infection occurred in a case that was not out of expectation regarding the case followed by Schildge et al. (19) after polyflex application because of tracheostomy-induced subglottic stricture.

Bronchial rupture almost always occurs with the use of thick rigid bronchoscopes through serial dilatations at the site of strictures. Furthermore, rigid bronchoscopes have insufficient inner diameter to pass through the introducer. Thus, the introducer needs to be passed directly through the vocal cords and airway almost blindly. Having neither sight of the path nor efficient ventilation, the process may increase the incidence rate of trauma to the trachea, bronchi, and vocal cords. Moreover, patients may have episodes of hypoxia.

Through the current introduced method, we had adequate visualization of the area in addition to suitable ventilation for the patients. These could facilitate passing the introducer through airways and approaching the stenosis. The new method decreased the need of manipulations to correct the situation of the stent.

In conclusion, this simple method by using direct vision may decrease the incidence rate of airway trauma and provide efficient ventilation during the procedure. By more accurate stent placement under direct vision, the need for repeated manipulations of stents will be reduced.

### Authors' Contributions

Saviz Pejhan wrote the first draft of the manuscript and performed the literature review. Mojtaba Javaherzadeh collected the data and revised the manuscript. Abolghasem Daneshvar performed the literature review and revised the manuscript. Roya Farzanegan collected the data and revised the manuscript.

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