

## To Stent or not to Stent and if Stented When to Remove it? Glimpse of Interventional Pulmonology Conundrums with an Illustrative Series

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### Abstract

The role of airway stenting to alleviate airway obstruction was first described in the late 1800s. Airway stents have since been used for fistulas in the bronchial tree as well. Airway stenting has the ability to rapidly achieve the short-term goals. However, the long-term side effects of a foreign body in the airway should temper the enthusiasm for indiscriminate use. We present this series to highlight the need for proper assessment of need before the placement of the stent, followed by constant vigilance after the placement.

**Keywords** Stent; Central airway obstruction; Tracheal fistulas; Trachea-esophageal fistula

### Introduction

The role of airway stenting to alleviate airway obstruction was first described in the late 1800s. Airway stents have since been used for fistulas in the bronchial tree as well. Airway stenting has the ability to rapidly achieve the short-term goals of alleviating airway obstruction. However, the long-term side effects of a foreign body in the airway should temper the enthusiasm for indiscriminate use. We present this series to highlight the need for proper assessment of need before the placement of the stent, followed by constant vigilance after the placement.

### Case Presentations

#### Case 1

A 48 year old with large left sided mass with combination of extrinsic and intrinsic attenuation of the left main bronchus. After ablation of the endo-bronchial component, a 14 × 40 mm Boston-Scientific self-expanding metallic stent was placed. The patient went into remission after chemo-radiation but was lost to follow-up. He returned after 12 months with complete occlusion of the left main bronchus. Attempt was made to retrieve the stent from the airway, however only a short segment could be extracted when the patient had hemodynamic collapse and required a stay in the intensive care for multiple days. He has since declined any further attempts to remove the stent. He remains short of breath at modest exertion.

#### Case 2

A 52-year old Caucasian male with hemoptysis. A chest CT (Computed Tomography) demonstrated a large right upper mass with lower tracheal attenuation from a large necrotic para-tracheal node. A diagnosis of adenocarcinoma (lung primary) was made. Patient continued to have an increase in the size of the tumor in spite of concurrent chemotherapy and radiation. A 16 × 60 mm Merritt (Aero tracheobronchial metallic stent) was placed with rapid improvement in symptoms. Three months after diagnosis his wife was diagnosed with colon cancer and had a hemi-colectomy. He decided to forgo his therapy, so family resources could be devoted to her care. Two months into his wife's treatment he developed some dysphagia, decreased appetite and a weight loss of 60 pounds. He attributed this to the airway stent and requested that his stent be removed. The stent was removed without complication; during the same procedure an esophagoscopy was performed and demonstrated a stricture distal to the stent (it's etiology was thought to be a combination of the stent and the radiation). He refused dilation of his stricture and chose comfort measures and died two days later.

#### Case 3

Fifty three year old Hispanic male who presented to the emergency room with cough and fever. His chest X-ray demonstrated a right upper lobe obstruction and a rounded opacity occluding the right main bronchus, there was post obstructive pneumonia. A CT scan confirmed the presence of a right upper lobe mass pouring through the right upper lobe bronchus and obstructing the right main bronchus. He was homeless and did not want any cancer therapy. After detailed discussion regarding pros and cons a rigid bronchoscopy was performed to at least allow him a potential of longer survival. At first electro-cautery snare was used to debulk a significant amount of the tumor, pathology demonstrated adenocarcinoma of lung. A 12 × 40

mm Boston scientific stent was then placed into the right main bronchus “jailing” the upper lobe bronchus. However, after 1 month the patient returned with increasing shortness of breath and now expressed a desire to have treatment for his malignancy. Repeat imaging demonstrated distant metastasis; most impressively the left adrenal gland was now 4 cm in size and contributing to significant amount of pain. He was started on systemic chemotherapy and radiation therapy for pain control from the enlarged adrenal. Few weeks into the therapy he started to have an increase in cough and a bronchoscopy was done, this revealed that the stent was slightly loose. This was removed with plans to evaluate the native airway. The airway was widely patent and decision was made to not perform any further endo-bronchial interventions. He is eight months out from his diagnosis and except for the flank pain is doing well and works at a convenience store 6 out of 7 days a week.

#### Case 4

Sixty year old with COPD on home oxygen therapy arrived to the emergency room with hemoptysis. He was found to have a right mainbronchus tumor occluding the bronchus intermedius. A diagnosis of squamous cell cancer was made by bronchoscopy. With a Karnofsky score of 30, only palliative chemotherapy and radiation were planned,

however the post-obstructive pneumonia precluded chemotherapy initiation. A rigid bronchoscopy was performed with debulking of the tumor and a decision was made to place a 14 × 40 Boston scientific (tracheobronchial) stent as the likelihood of even short-term survival at that point was remote. The patient did surprisingly well, not only did he tolerate chemo therapy, his dyspnea and hypoxia resolved. With improvement in overall wellbeing, the presence of the stent became anxiety provoking. The stent was removed 4 months after the insertion as previously planned. There was minor bleeding, due to granulation tissue embedded in the uncovered part of the stent. The patient remains healthy 2 months after the stent removal. The decrease in anxiety from the presence of the stent provided significant symptomatic benefit.

#### Case 5

A 55 year old with neurofibromatosis, in otherwise good health,presented with endo-bronchial lesions. He had a bradycardic cardiac arrest during an airway survey. Subsequently a Y Silicone stent was placed in to alleviate the distal tracheal obstruction. He did well in the short term but died in his sleep three months after the procedure.Autopsy revealed a migrated stent and cause of death was listed due to asphyxiation.

Case no	Age (years)	Malignancy	Location	Stent type	Stent size	Complications	Duration (months)	Removed	Alive
1	48	Adenocarcinoma of Lungs	Left main bronchus	Partially covered metallic	14×40 mm	In stent stenosis with granulation tissue dyspnea	18	N	Y
2	52	Adenocarcinoma of Lungs	Distal third of trachea	Fully covered metallic	16×60 mm	Esophageal stricture, dysphagia	5	Y	N
3	53	Adenocarcinoma of Lungs	Right main bronchus	Partially covered metallic	12×40 mm	Cough	4	Y	Y
4	60	Squamous cell carcinoma of lung	Right main bronchus	Partially covered metallic	14×40 mm	Anxiety	4	Y	Y
5	55	Neuro-fibroma with extrinsic compression Neuro-fibroma	Distal third of tracheaand right main bronchus	Dynamic silicone stent	15×12×70 mm	Death	3	N	N

**Table 1:** A brief summary of the cases.

#### Discussion

The role of airway stenting to alleviate airway obstruction was first described by Trendlenburg [1] and Bond [2] in the late 1800s. Although airway stenting has the ability to rapidly relieve airway obstruction, the long-term side effect of a foreign body in the airway has led to limited use. It was not until the 1965 that the use of silicone stents was introduced [3]. This was followed by the introduction of self-expandable metallic stents in the late 1990's. With the advent of interventional pulmonology, airway stenting has been combined with other endoscopic treatments such as micro and macro debridement, laser, balloon dilation and cryotherapy.

Surgical resection and reconstruction is the standard of care for definitive management of tracheobronchial stenosis caused due to benign and malignant pathologies. The role of endoscopic management is essential for nonsurgical patients for palliative purposes. Airway stenting in patients with malignant lesion

obstructing airways provides excellent palliation and improves quality of life. It also expands the pool of patients who can receive radiation and chemotherapy by improving performance status. While endoscopic resection is the preferred modality of initial management in patients with bulky endo-luminal tumor, patients with external malignant compression or mixed stenosis may require stenting [2-6]. Self-expanding metallic stent have found excellent use in the management of post-transplant dehiscence [7].

Long-term use of stents, whether metallic or silicone, can still result in multiple complications. Given the complexities of placement techniques for different types of stents and the difference in the level of expertise, the insertion itself is fraught with potential for catastrophe, with misplacement, stent fracture during deployment and failure to deploy being the more common ones [8]. A local inflammatory reaction against the stent material can lead to development of granulation tissue at the proximal and distal end of the stent. Another

complication includes migration of the stent due to violent coughing or resolution of the extrinsic compression that was keeping the stent in place [8]. Long-term stent is also associated with increased lower respiratory tract inflammation and infections [9,10]. The stent is a foreign tube in the airway tract, it lacks muco-ciliary apparatus and its rigidity can lead to impairment of the cough mechanism leading to inspissation of secretion and thereby causing in-stent obstruction, making the stent a problem rather than the solution. Murgu et al. demonstrated that 46% of the stent related complication (SRC); 12 out of 26 were due to plugging. Emergent procedures were often required to salvage these patients [10]. Obstruction of the stent can occur by the recurrence of tumor as well. The stents can also cause a fistula into mediastinum and blood vessel with equally ominous implication. These fistulas can happen at any time but are more likely to occur the longer the stent remains in-situ or when multiple procedures are required to maintain patency [11]. The broncho-vascular fistulas could present with a sentinel bleed or a massive and often fatal hemoptysis. When recognized in time, the patients could benefit from surgery [12]. These patients usually complain of cough, mild haemoptysis and should precipitate a bronchoscopic evaluation and possibly a CT angiogram to evaluate and potentially provide therapeutic relief from the complication. As with case 5 there is probably an unknowable amount mortality associated with the stents, however this is very difficult to establish etiology, as majority of the stents are placed for palliation of malignant processes that could be equally responsible for the death. The most tragic SRC is when the stent gets epithelialized and obstructed, the once life saving device now serves as a nidus for a life limiting process. The stent may still be removed but has potential for significant morbidity and mortality. This should not be attempted without a multi-disciplinary consultation, amongst interventional pulmonology and cardiothoracic surgery [13]. Due the multitude of SRCs, we recommend that the stents should be removed once the indication is resolved. While there is an associated risk associated with the removal of the stent, appropriate technique can minimize this risk. None of our patients suffered from any complication during their stent removal. If there is associated granulation tissue, then that should be addressed prior to removal of the stent, we used Argon Plasma Coagulation (APC) for this purpose. APC uses high-frequency electric current for thermal coagulation and devitalisation of biological tissue. The susceptibility of tissue to APC depends on its water content. Thus mucous membranes and fresh granulation tissue are more sensitive to APC than cartilage and connective tissue owing to their higher water content. APC gives a controlled and limited penetration into the tissue and also provides good control of bleeding [14]. Various techniques have been employed for the removal of these stents. Filler et al. [6] has demonstrated the use of a metal suction catheter to initially dissect the stent away from the airway wall. Then the stent was extracted with the forceps. Zakaluzby et al. [8] used a rigid suspension laryngotracheoscope and then used optical forceps to dissect the stent from the airway wall. This was followed by the use of alligator forceps grasp and extract the stent using a rigid scope. Chawla et al. [15] separated the stent from the tracheal wall and then removed the scope, forceps and the stent in one piece. In our patients, the stents were first dissected away from the airway with the bevel of the rigid scope and the bleeding was controlled with APC. The stent was then removed with the help of a rigid forceps through a rigid bronchoscope. We usually perform a counter clockwise turn with the forceps after the stent has been grasped and then pull the folded stent into the barrel of the rigid scope and removed in total. We then re-intubate with rigid bronchoscope

quickly to achieve haemostasis. Four cornerstones of trachea-bronchial stent deployment evaluation

**Do no harm:** This ideal is paramount. One must be prepared for all contingencies. Stents for a benign disease are worse than the disease itself, especially metallic ones. Stents misplaced due to lack of experience and stents that don't improve the caliber of the airway significantly, put the patient at grave risk. These should be extracted when placement not optimal.

**Stent should be the last option:** If tumor is highly sensitive to chemo- radiation or debulking when the majority of the tumor is endo-luminal, a stent should not even be considered. When being considered for a broncho-pulmonary/mediastinal fistula, an infection should obviate any stent deployment. On the other hand tracheo-esophageal fistulas definitely need a stent, as the communication leads to increased potential of lower respiratory infections [3].

**Will the stent be of benefit?** Central airway diseases benefit most from stenting. For high tracheal masses that cannot be respected and not amenable to endo-bronchial debulking, we choose to do a tracheostomy rather than place an unstable and migration prone stent. For severe extrinsic compression we usually use a metallic stent due to its higher expansive forces [3,4].

**When can it be removed?** There should be a plan for removal the day of placement. We perform bronchoscopic and radiologic surveillance to monitor both the status of the etiology that required placement, for example a mass and potential complications that would require an urgent extraction. If the patient has had a stent that has been in place for a significant duration, a multi-disciplinary approach may be indicated for planning as a surgical intervention as the first approach or as a rescue if a tracheobronchial integrity is breached during the extraction [15]. It goes without saying that there will always be patients who do not respond to chemo-radiation in a positive way and need the stent for the remainder of their life

Once the decision is made for a stent, it then becomes important to determine the type of stent that would be ideal. No stent is perfect as they are all foreign to the body. They have their advantages and their disadvantages. The metal stents are relatively easy to place and can be placed through a flexible bronchoscopy alone (we don't recommend this practice as it is quite difficult to remove or adjust if deployed incorrectly). The fully covered share the disadvantage of being prone to migrate with the silicone stents. The partially covered stents promote granulation tissue, if adhered to the wall these can be difficult to remove. We recommend a heat source to address any bleeding (this can be APC, laser or the applicant of choice for your institution). The only time an uncovered stent should be placed is for post-transplant dehiscence. We do airway survey every 3-4 weeks to assess for in-stent granulation and need for removal (urgent or planned). Silicone stents are more challenging to place but can be placed with various techniques; direct laryngoscopy, suspension laryngoscopy and rigid bronchoscopy. Their tendency to migrate also makes them easy to extract. They are prone to in-stent occlusion due to decreased mucociliary clearance leading to mucous concretion. We recommend metallic stents for a majority of the malignant obstruction and only silicone stents for benign obstructions.

## Conclusion

Airway stents are lifesaving with rapid amelioration of symptoms. But care and planning is needed prior to deployment and the plan

should always be to extract the stent as soon as possible. There should be no stent left behind once the etiology requiring the deployment is resolved!

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