How I Do It

A Novel Technique for Tracheal Reconstruction Using a Resorbable Synthetic Mesh

David Chen, MD; Christopher J. Britt, MD; Wojciech Mydlarz, MD; Shaun C. Desai, MD

INTRODUCTION
Surgical reconstruction of the trachea may be necessary following the resection of congenital, traumatic, or neoplastic airway lesions. Smaller defects up to 2 cm may be closed primarily. However, larger defects may require more extensive reconstruction with autologous tissue transfer and/or alloplastic grafts. Such reconstruction is guided by several key requirements, including an epithelialized surface to line the luminal side of the defect, lateral rigidity to prevent airway collapse, and longitudinal flexibility to allow for neck flexion and extension. A number of reconstructive materials and techniques have been developed to this end, including microvascular free tissue transfer. However, in patients with extensive comorbidities or limited recipient vessels in the neck due to prior surgery, free tissue transfer may not be a feasible option. Here, we present a novel technique for the repair of an anterior tracheal defect using a moldable, resorbable synthetic mesh inserted into a pedicled myocutaneous pectoralis major flap.

METHODS
Patient History
The patient is a 68-year-old woman with a history of morbid obesity and squamous cell carcinoma of the larynx who underwent total laryngectomy and radiation 8 years prior at an outside institution. She had a recurrence in her right neck a year after her laryngectomy and underwent a salvage right neck dissection and chemotherapy at that time. Several months before presentation to our clinic, she developed bleeding from her tracheostoma and underwent a biopsy of her anterior trachea, which revealed squamous cell carcinoma.

She opted for surgical management with resection of her paratracheal tumor and a level 6 and 7 lymph node dissection followed by tracheal reconstruction. Given her history of prior neck surgery with lack of suitable vessels, multiple medical comorbidities, and radiation, reconstruction was planned with a pedicled myocutaneous pectoralis flap as opposed to a free flap.

Surgical Technique
The patient was brought back to the operating room and laid supine. General anesthesia was induced, and she was intubated through her preexisting tracheostoma. Rigid bronchoscopy was performed to visualize the extent of tumor invading into her tracheal lumen. She then underwent transcervical resection of her paratracheal tumor along with dissection of her central neck and mediastinal lymph nodes. The resection resulted in a large left anterior tracheal wall defect extending from rings 2 to 7, approximately 5 cm in length, and encompassing 50% of the anterior and lateral circumference of the trachea (Fig. 1).

To reconstruct this defect, a left pectoralis major flap was raised with a myocutaneous portion in the inferomedial aspect where we had identified skin perforators using a Doppler stethoscope. The skin was marked out in an elliptical fashion just above the mammary crease, and the flap was raised in the usual manner off the intercostal muscles and ribs. The pectoral branch of the thoracoacromial artery was identified and preserved. The nerve to the pectoralis major was clipped and ligated. The flap was then rotated on itself into a pocket that was already created from the sternotomy.

The inferior aspect of the flap was then inset into the anterior tracheal wall, using 3-0 polydioxanone (PDS) to suture the tracheal wall to the dermis of the skin paddle. To provide rigidity to the tracheal wall reconstruction, we used a resorbable 1.5-mm-thick copolymer mesh (DePuy Synthes, New Brunswick, NJ), cut into a half-ring that would emulate a tracheal ring. This was heated up in 70°C water, and shaped into an arc that was roughly 0.8 cm in height and 3.5 cm in length (Fig. 2). A small tunnel was created underneath a segment of the dermis of the skin paddle, into which the mesh was placed to provide support for the tracheal reconstruction.
mesh was inserted (Fig. 3). Careful attention was paid to not create the tunnel directly over a skin perforator, by marking out a “safe” area with the Doppler stethoscope. The posterior edges of the ring, which protruded from the subdermal tunnel, were then carefully placed on the vertebral column to stent open the flap, with careful attention paid not to impede the esophagus (Figs. 3–5). The remainder of the inset was then completed with 3-0 PDS suture, using the skin paddle to seal the tracheal defect. At this point, bronchoscopy was performed through the tracheostoma, and the inset was noted to be appropriately positioned with good flap perfusion and minimal malacia of the anterior trachea. The donor site was closed primarily with 3-0 Vicryl (Ethicon, Somerville, NJ) sutures followed by staples. Two Jackson-Pratt drains were placed into the large pectoralis cavity. The wounds were then closed up with a combination 3-0 Vicryl sutures followed by staples. The endotracheal tube was replaced with a 7-0 Bivona (Smiths Medical, Ashford, United Kingdom) tracheostomy tube, with the end of the tube distal to the tracheal repair. The patient was awakened and was put on bilevel positive airway pressure.

**RESULTS**

The patient’s postoperative course was complicated by a pulmonary embolus requiring a prolonged stay in the intensive care unit. She did not have any airway complications for the duration of her hospitalization, and her pectoralis flap remained intact with good perfusion. At her 4-week follow-up appointment, the flap was noted to be well-perfused and intact with no evidence of tracheomalacia. At 12 weeks, her tracheostomy tube was removed and she was able to breathe comfortably and phonate using her tracheoesophageal prosthesis. Flexible tracheoscopy at 9 months follow-up showed a well-healed flap, again with no tracheomalacia on inspiration or expiration (Fig. 6) (see Supporting Video 1 in the online version of this article). After 12 months, she continued to do well with her repair without any breathing complaints or other complications.

**DISCUSSION**

Although numerous techniques exist for the repair of large tracheal defects, there remains no single method that is clearly superior. In cases where a lesion requires resection of a circumferential length of trachea, mobilization of the airway followed by primary anastomosis may be performed up to half the length of the trachea in adults. However, anastomotic complication rates increase with the length of the defect and with a prior history of radiation therapy. Furthermore, certain tracheal lesions may result in defects that do not require
circumferential resection but are too large to be closed primarily. The use of microvascular free tissue transfer has been well described and is a versatile option for reconstruction in these cases.\textsuperscript{3–5} However, for patients who are not ideal candidates for a free flap, a pedicled myocutaneous flap may be a more suitable alternative. To our knowledge, this is the first report that describes the use of a local pedicled myocutaneous flap, in conjunction with a moldable, resorbable synthetic mesh, to repair a tracheal defect following tumor resection.

The need for a rigid framework in addition to soft tissue is crucial to tracheal reconstruction, as a soft tissue flap alone will inevitably lead to collapse. This was demonstrated as early as the 1950s in animal studies and has since been recapitulated in the tracheal reconstruction literature.\textsuperscript{1,3,8,9} A number of materials have been used to maintain structural rigidity in tracheal repairs, including autologous cartilage, metal, and Teflon, to name only a few.\textsuperscript{2} A synthetic resorbable material has the advantage of minimizing the risks of migration, chronic inflammation, and infection that comes with nonresorbable hardware. At the same time, it circumvents the need for harvesting an autologous cartilage graft, which can result in additional donor-site morbidity. The resorbable copolymer that we used in our patient is commonly available for craniofacial repair. It can be trimmed to specific dimensions and also has the benefit of being moldable to the contour of the defect being repaired. Our method of tunneling the rigid mesh into the subdermal plane of the flap allows for the mesh...
to be in close proximity to the skin paddle, which counteracts inward collapse of the skin paddle both from negative airway pressure during inspiration as well as from the bulk of the flap itself. Therefore, bulkiness to the pectoralis flap was not as much an issue in this morbidly obese patient.

CONCLUSION

Although additional patients are necessary to better understand the outcomes of this technique, we believe it represents a simple, novel, and versatile method for the reconstruction of larger tracheal defects in these complex patients who are not ideal candidates for a free flap, and could have possible indications in benign airway stenosis cases in the future.

BIBLIOGRAPHY