Repair of large airway defects with bioprosthetic materials

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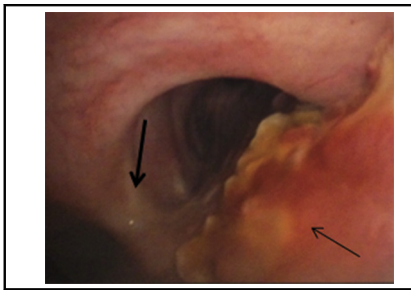
ABSTRACT

Objective: Patients with complicated airway defects that exceed the limits of primary repair represent a challenging clinical problem and require alternative techniques for repair. The aim of this study was to evaluate bioprosthetic reconstruction of large tracheal and bronchial defects.

Methods: Retrospective chart review of patients treated at a single tertiary center from 2008 to 2015 who underwent repair of tracheal or bronchial defects with a bioprosthetic device, namely aortic homograft or acellular dermal matrix.

Results: Eight patients, 3 men and 5 women with a mean age of 54 ± 13 years, underwent closure of complex central airway defects with bioprosthetic material. All but 1 patient underwent prior operative or stenting procedures. Three patients had isolated airway defects, whereas 5 had fistulas between the airway and enteric tract. Defects involved the membranous wall of the trachea (n = 5), the anterior wall of the trachea (n = 1), or the main stem bronchus (n = 2). Five reconstructions were with aortic homograft and 3 with acellular dermal matrix. Bioprosthetic material was buttressed with muscle flap (n = 4), omentum (n = 2), or left unbuttressed (n = 2). The airway defect was successfully closed in all patients. There was no postoperative mortality or recurrence of the airway defect in short-term follow-up. Two patients required debridement of granulation tissue and 1 additional patient required airway balloon dilation. Progression of underlying metastatic disease explained the majority of long-term mortality (75%).

Conclusions: Bioprosthetic materials represent a viable option for management of large airway defects, including airway-enteric fistulae, that exceed the limits of primary repair. (J Thorac Cardiovasc Surg 2016;152:1388-97)



Aortic homograft repair (*small arrow*) extending just proximal to the carina (*large arrow*).

Central Message

Bioprosthetic materials represent a viable option for management of airway defects, including airway-enteric fistulae, that exceed the limits of primary repair.

Perspective

Central airway defects whose size and complexity preclude primary repair present a challenging clinical problem. We examined the role of bioprosthetic materials (aortic homograft and acellular dermal matrix) in the repair of noncircumferential defects. In our experience these materials provide airtight closure and correction of complex defects in otherwise difficult-to-manage patients.

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Large central airway defects may be acquired in a variety of situations, whether it be from primary pathology or as a consequence of operative management of the airway.[1-3] Primary repair, which often entails resection and reconstruction, is the preferred treatment of large airway defects. Central airway defects are even more complex when there is fistulous communication with the esophagus. In these cases, optimal management requires primary closure of both defects and interposition of robust vascularized tissue. Whereas tracheal defects up to 5 cm may be resected with the help of laryngeal and hilar release, in larger defects and in patients with unfavorable characteristics, primary correction may not be possible.[4] Alternative methods must be used in these patients to close acquired airway defects and eliminate the complications associated with persistent fistulas.

Bioprosthetic materials such as aortic homograft and acellular dermal matrix have been used successfully in a variety of reconstructive applications, including repair of

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Abbreviation and Acronym
HBOT = hyperbaric oxygen therapy

pharyngeal and esophageal defects.[4-7] Additionally, a small number of patients with complex airway defects of the trachea and bronchi have undergone successful repair with bioprosthetic materials.[8-10] Bioprosthetics have several potential advantages over synthetic materials including ease of handling, minimal immunogenic response, and potential for tissue ingrowth. The aim of this study was to evaluate our experience with surgical management of complex airway defects with acellular dermal matrix and aortic homograft patches. We reviewed the patient characteristics, operative techniques, and postoperative management associated with successful closure.

METHODS

Patient Selection and Chart Review

We reviewed the medical records of all adult patients who underwent operative repair of tracheal or bronchial defects using bioprosthetic material with either acellular dermal matrix or aortic homograft at a single tertiary medical center. Patients with tracheal and bronchial defects that were amenable to primary repair were excluded from the study. The electronic medical record was reviewed for demographic characteristics, operative details, and outcome variables. The Social Security Death Index was consulted to determine vital status of 2 selected patients. The Institutional Review Board at Massachusetts General Hospital approved this retrospective chart review and waived informed consent for participation in the study.

Operative Management

All patients underwent bronchoscopic evaluation before repair to establish the location and size of the tracheal or bronchial defect. Computerized axial tomography imaging as well as esophagoscopy were also used to assess defects especially in cases of associated aerodigestive fistula. Before scheduling for operative correction underlying pneumonia was treated in an effort to prevent postoperative infection and contamination of the bioprosthetic. Based on the location of the defect, single-lung or 2-lung ventilation was performed during the procedure. In the operating room, airway defects were debrided to obtain grossly healthy tissue margins for repair. Defects were repaired with either acellular dermal matrix or banked aortic homograft patch. In no patient was a bioprosthetic used as a circumferential conduit. The choice of bioprosthetic material was based on surgeon preference.

After standard preparation the bioprosthetic was trimmed to size and meticulously sutured to healthy tracheal or bronchial mucosa using interrupted Vicryl suture (Ethicon Inc, Somerville, NJ). In the case of acellular dermal matrix the bioprosthetic was sutured so that the dermal side faced the airway lumen. Similarly, the aortic homograft was implanted so that the luminal aspect of the bioprosthetic faced the airway lumen. Before implanting the aortic homograft was perforated with a 16-gauge needle to encourage tissue ingrowth and neovascularization. These perforations did not compromise the pneumostasis of the repair. Only after the repair was deemed competent was additional buttressing with muscle flaps or omentum performed. Most commonly the latissmus dorsi and intercostal muscles were used to buttress the bioprosthetic, but there were cases in which strap muscle and omentum were used. The buttress was secured using a horizontal mattress stitch to tack the back of the bioprosthetic to the muscle or omentum. The choice of buttress material was based on surgeon preference and ability to harvest healthy tissue while preserving the vascular supply.

Postoperative Care

Immediately after surgery patients were transported to the surgical intensive care unit before transfer to a floor unit. Postoperative care was variable, but included antibiotic treatment, serial bronchoscopy, speech and swallow evaluations, video fluoroscopic swallow studies, and hyperbaric oxygen therapy (HBOT).

RESULTS

Patient Characteristics and Etiology of Airway Defect

The study identified 8 patients with tracheal and bronchial defects repaired with bioprosthetic materials between 2008 and 2015. It should be emphasized that all patients possessed complex defects that due to size, location, and challenging patient factors were preoperatively deemed not amenable to primary repair (Figure 1). These patients represent a small minority of the 342 patients treated within the same time period who were able to undergo conventional repair (Figure 2). There were 3 male and 5 female patients with a mean age of 54 $\pm$ 13 years. Each patient included in the study underwent a preoperatively planned repair with a bioprosthetic and no repair was aborted intraoperatively. Patient data are summarized in Table 1. Patients were followed for a median period of 150 days with a range of 2 months to 6 years. All patients had substantial comorbidities, including prior esophageal, tracheal, and thyroid surgery. The etiology of the airway defect in the series varied, and included HIV/AIDs-associated esophagitis, malignancy, mesh erosion, and complications secondary to prolonged intubation. Three patients had also received prior radiation therapy to the neck or chest.

Surgical Approach

The goal of operative intervention in all cases was repair of the airway defect and closure of any associated fistula. Secondary goals in select cases included airway decannulation and resumption of oral nutrition. The majority of patients had defects that were localized to the membranous wall of the trachea. However, 2 patients had defects that involved the mainstem bronchus or bronchus intermedius, whereas 1 patient had a large defect of the anterior wall of the trachea (Table 2). Surgical approach to the airway defect was determined by the location of the lesion, with the majority accessed via a right posterolateral thoracotomy (Table 3). Five patients (63%) required interruption of a fistula to the esophagus or gastric conduit from prior esophagectomy. Esophageal or gastric defects were resected in 3 patients and primarily repaired with a double layer closure in 2 patients. One patient was left in discontinuity with an end pharyngostomy. In 6 of 8 patients, the repair was buttressed with pedicled muscle flap or omentum. The