Airway Complications After Lung Transplantation

Laura Frye, MD[a,*], Michael Machuzak, MD[b]

KEYWORDS

• Lung transplant • Bronchoscopy • Stent • Bronchial stenosis • Airway necrosis
• Airway dehiscence

KEY POINTS

- Airway complications following lung transplantation may occur as a myriad of issues, including necrosis, dehiscence, stenosis, or malacia, and develop at any site from the anastomosis to the lobar and segmental airways.
- Bronchoscopy has a major role as the gold standard in diagnosis.
- Flexible and rigid bronchoscopy are key procedures used in the management of complications with an array of therapeutic interventions targeted at maintaining airway patency.
- Airway stenting is an option of last resort given the complications and challenges of long-term management.

INTRODUCTION

Airway complications (ACs) following lung transplantation remain a significant contribution to postoperative morbidity and mortality. Although the early incidence of ACs was especially high at 60% to 80%, improvements in organ preservation, surgical technique, and the medical management of the recipient have led to complication rates in the 10% to 15% range with a related mortality of 2% to 3%.[1–5]

ACs have a significant impact on posttransplant quality of life. Unfortunately, approximately 35% of patients with a previously treated airway complication will experience a second, and the chance of 3 or more after the second is approximately 70%.[2] The frequent office visits, increased number of procedures, hospitalizations, and potential need for additional medications can be a financial and time burden and, in some cases, minimize the perceived benefit from this complex undertaking.

The recognition and management of ACs varies based on the time from transplant, location of the lesion, and severity. Institution-specific protocols also account for the variance in the surveillance, diagnosis, and management of these complications. ACs can be classified temporally (early or late), by cause (ischemia, infection, iatrogenic, or idiopathic), anatomically (anastomotic or postanastomotic), or descriptively (necrosis, dehiscence, fistula, infection, stenosis, granulation tissue, or malacia). This article reviews a brief history of transplant airway complications, transplant-specific anatomy and surgical technique, risk factors for ACs, classification of ACs, and management strategies for the various types of complications.

HISTORICAL BACKGROUND

James Hardy performed the first human lung transplantation at the University of Mississippi in 1963. The recipient was a 58-year-old man with

[a] Section of Pulmonary and Critical Care, University of Chicago, 5841 S. Maryland Avenue, MC 6096, Chicago, IL 60637, USA; [b] Department of Pulmonary, Allergy, and Critical Care, Respiratory Institute, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195, USA
* Corresponding author.
E-mail address: laura.frye@uchospitals.edu

Clin Chest Med ■ (2017) ■–■
http://dx.doi.org/10.1016/j.ccm.2017.07.010
0272-5231/17/

lung cancer and malignant airway obstruction. He developed progressive kidney failure and died 18 days after the transplant.[6] Over the next 20 years, 38 transplants were performed by 26 different surgical teams working on 5 continents. More than 80% of these patients failed to survive beyond the 18th postoperative day, with a primary obstacle being poor healing of the airway anastomosis.[7]

In 1983, the Toronto Lung Transplant Group performed the first successful lung transplant. The patient was treated with cyclosporine and azathioprine for immunosuppression and initially did not receive steroids to minimize the risk of airway anastomotic dehiscence. Additionally, the patient underwent a laparotomy and had a mobilized vascularized omental flap brought into the chest to minimize the risk of dehiscence, a technique no longer performed. However, in the first 2 weeks he developed 2 episodes of acute rejection that resulted in respiratory failure and required corticosteroids and lymphocyte depletion. When the group reported their experience in 1986, their initial patient was alive with a good quality of life.[8]

ANATOMY

Lung transplantation presents a unique challenge when compared with other transplanted organs. The lungs contain a dual vascular supply, with a pulmonary and bronchial circulation. The bronchial circulation provides the blood supply to the large airways and travel and branch with the bronchi ending at the level of the respiratory bronchioles. The proximal mainstem bronchi receive their primary blood supply from these vessels with a small contribution from the pulmonary circulation via retrograde collaterals.

The bronchial arteries typically arise from the thoracic aorta at the level of T3-T8 with approximately 70% (range 64%–80%) arising from the level of T5-T6.[9] There are usually 2 bronchial arteries on the left that arise directly from the anterior surface of the thoracic aorta. There is a single right bronchial artery that has a common origin with an intercostal artery and this is referred to as the intercostobronchial trunk (ICBT). The ICBT arises from the right posterolateral aspect of the thoracic aorta. Ectopic origin is present in approximately 20% (range 8.3%–35.0%) of patients.

Most surgeons do not routinely perform bronchial artery revascularization. The added risk of bleeding, additional time, and painstaking dissection with particular attention to the preparation of the donor lung to preserve the vascularity, in addition to varied opinions on the benefit of the technique are the primary reasons for this. This technical factor leaves the reestablished pulmonary circulation responsible for the blood supply to the newly transplanted lung and places the bronchial viability and anastomotic healing completely dependent on retrograde blood flow from the pulmonary circulation.[10] The anastomosis and distal airways are subsequently at risk of active ischemia until rearterialization of the recipient bronchial arteries occurs 1 to 2 weeks after the operation.[11] The main carina and both proximal mainstem bronchi are supplied via the coronary collaterals, explaining why the proximal airways experience less ischemic injury.

INCIDENCE AND PREVALENCE

There is a wide range in the reported incidence of ACs following lung transplantation. Reports of ACs range from as low as 1.6% to as high as 33.0% in recent literature, although numbers of approximately 15% to 18% seem to be the consensus.[2,4,12–15] The incidence of ACs in heart-lung recipients is lower, ranging from 3% to 14%.[14,16] ACs are a complex process with many risk factors, but the largest reason for the wide range reported in the literature is the absence of a standardized grading system. As a result, what may be classified as a complication at one center may be considered “routine” healing at another institution. The existing grading systems are discussed later in this review.

RISK FACTORS

Multiple studies have been done identifying various risk factors implicated in the development of ACs. What was previously felt to be related to surgical factors and ischemia of the donor bronchus is now far more complex with interplay between donor and recipient characteristics, surgical technique, postoperative recovery, infections, and medication administration.

Donor and Recipient Factors

A significant relationship was found between the length of donor mechanical ventilation and the development of ACs. Van De Wauwer and colleagues[13] noted an increased risk of ACs with a long (>50 to <70 hours) of mechanical ventilation. They also noted an increased risk in tall recipients. This is likely related to a recipient-donor size discordance with a larger bronchial circumference in the recipient and a need for intussusception of the donor bronchus. Characteristics such as age, gender, body mass index, pretransplant