Laryngeal Split and Rib Cartilage Interpositional Grafting

Treatment Option for Glottic and Subglottic Stenosis in Adults

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KEYWORDS

• Laryngotracheal stenosis • Cricotracheal resection • Vascularized composite autograft
• Rib cartilage interposition graft • Airway reconstruction

KEY POINTS

- A good understanding of the respiratory function if essential to determine the optimum reconstruction technique.
- Adequate airway reconstruction requires the creation of a functional airway that is able to maintain adequate ventilation with preservation of the mucociliary function.
- Tracheal resection is ideal for short segment stenosis where tension free end-to-end anastomosis is feasible.
- Airway reconstruction with a vascularized composite autograft is the minimal requirement for a complex functional reconstructed airway.

INTRODUCTION

Historical Perspective

The first tracheal resection on humans was performed by Kuester in 1884. The resection was limited to 4 tracheal rings or 2 cm, and extensive resection remained infrequent. It was considered to be an impractical procedure owing to expected tension risk on the anastomosis. Multiple synthetic materials were tried in extensive resections and were found unsuccessful; these include steel wire, silicone, and mesh.

However, Hermes Grillo was considered the father of tracheal surgery, revolutionized our anatomic understanding of the trachea, and described various techniques and surgical principles in his book "Surgery of the Trachea and Bronchi" in 2004. This better understanding of laryngotracheal pathophysiology and anatomy has resulted in more advanced surgical techniques and more extensive resections and reconstructive procedures.[1–7]

Etiology

The optimal management of tracheal stenosis depends on correctly identifying the causative factors in each case. Risk factors for the development of stenosis include high tracheostomy, cricothyroidotomy, prolonged intubation, and proximal

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migration of an endotracheal tube cuff. However, iatrogenic stenosis from intubation with an endotracheal or tracheostomy tube is the most commonly reported cause. In this type, the pressure exerted on the tracheal mucosa results in ischemic necrosis and subsequent loss of mucosal integrity. This can progress with bacterial infection of exposed cartilage resulting in chondritis or cartilage loss. Healing by secondary intention then begins, resulting in dense scar contracture and stenosis owing to fibroblast proliferation and collagen deposition.[8]

Relapsing polychondritis and Wegener's granulomatosis involvement in airway stenosis is long recognized. The incidence of subglottic involvement in Wegener's granulomatosis is around 20%. Up to 55% of patients with relapsing polychondritis have airway manifestations with high mortality rates of approximately 50%.[8,9]

ASSESSMENT AND EVALUATION

History

When evaluating a patient with cricotracheal stenosis, the most important clinical symptoms are the onset, duration, and progressive nature of the disease. The severity of the symptoms and their impact on the patient's daily living and quality of life are most indicative factors for active management and surgical intervention. A history of previous intubation and the coexistence of obstructive airway symptoms such as dyspnea, wheeze, or stridor should raise the suspicion of iatrogenic tracheal stenosis.

Physical Examination

Flexible fiberoptic laryngoscopy is the first and most available rapid in-office upper airway assessment. The mobility of the vocal cords, laryngeal sensation, and laryngeal inflammatory upper airway findings, with limitation, can be rapidly assessed and help to initiate the first steps in the management plan. Patients with findings on flexible laryngoscopy suggestive of an upper airway obstruction should undergo further evaluation of their entire laryngotracheobronchial tree.

Examination under anesthesia with direct laryngoscopy and bronchoscopy provides detailed upper airway assessment, allowing accurate disease and stenosis staging, cricoarytenoid joint mobility evaluation, and tissue diagnosis of suspicious findings, as well as anatomic abnormalities. During this examination, a clear documentation of the length of the stenotic segment is essential as well as the endotracheal tube size by which the patient is intubatable with minimal resistance while maintaining adequate pressure ventilation.

Pulmonary Function Testing

The peak expiratory flow rate is the most sensitive test for the diagnosis of tracheal obstruction and the peak inspiratory flow rate is the most sensitive test for detecting inspiratory flow limitations. In a fixed upper airway obstruction, both inspiratory and expiratory loops demonstrate a plateau effect. However, this plateau is only visible when the tracheal lumen is wider than 1 cm in diameter, making this test somewhat limited as a primary diagnostic method in the evaluation of tracheal stenosis.[10,11]

Imaging

At initial assessment, all patients with suspected airway compromise should undergo a plain radiography with anteroposterior and lateral views that include both upper and lower airway evaluation. Careful examination of plain films can identify signs such as inflammatory processes; signs of subglottic stenosis, tracheal deviation, or widening of the mediastinum that help to distinguish upper from lower airway obstructive pathologies.

High-resolution computed tomography scans with 1-mm fine cuts is the most commonly used imaging modality to assess the extent of the disease and to plan reconstruction. More recently, the advanced 3-dimensional reconstruction technology has helped to enhance anatomic understanding of the tracheobronchial tree and improved surgical and reconstructive outcomes in all the reconstructive domains.

MANAGEMENT OPTIONS

Presenting symptoms of patients with laryngotracheal stenosis vary widely. These symptoms can range from mild silent dyspnea on exertion to severe, life-threatening, acutely exacerbated events.

The management of this condition ranges accordingly from simple conservative observational regimen, to active endoscopic procedures, or, in more complex cases, open surgical resections.

The stage of stenosis determines the level of treatment required. The disease stages vary based on the degree on intraluminal narrowing, lesion size, and the involvement of other laryngotracheal subsites (**Box 1**).[12–14]

The goal of surgical repair is to create an adequate airway, achieve decannulation, and preserve normal laryngeal function—namely, speech, swallowing, and airway protection. For most early stage disease, and in the absence of acute distressing symptoms, the management of conditions that are refractory to conservative and