



The surgical treatment of bilateral vocal fold impairment

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KEYWORDS

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lateralization

Bilateral vocal fold impairment is a potentially life threatening condition. The otolaryngologist must be able to quickly identify its etiology and select the appropriate surgical procedure to treat the airway obstruction while attempting to maintain phonation and deglutition. Multiple techniques, both endoscopic and open, are available to the surgeon in treating this clinical problem. Endoscopic procedures covered in this article are: arytenoidectomy; including laser and laser medial arytenoidectomy; suture lateralization; and partial posterior laser cordectomy or transverse cordotomy. Posterior lateral extralaryngeal arytenoidectomy and laryngeal reinnervation are discussed in regard to open techniques.

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Bilateral vocal fold impairment is a potentially life-threatening condition. The otolaryngologist must be able to quickly identify its etiology and select the appropriate surgical procedure to treat the airway obstruction while attempting to maintain phonation and deglutition. Although tracheotomy remains the mainstay of treatment, especially regarding acute airway compromise, current surgical options for bilateral vocal fold impairment are divided into 3 categories: procedures involving removal of vocal fold and/or arytenoid tissue, vocal fold lateralization, and laryngeal reinnervation; the first 2 being the primary methods. Procedures can be further categorized as endoscopic or open. Endoscopic procedures covered in this article are arytenoidectomy, including laser and laser medial arytenoidectomy; suture lateralization; and partial posterior laser cordectomy or transverse cordotomy. Posterior lateral extralaryngeal arytenoidectomy and laryngeal reinnervation will be discussed in regard to open techniques. The challenges of surgery with bilateral vocal fold immobility are centered on the balance between airway maintenance and vocal quality as further lateralization of the vocal fold leads to a better airway but poorer phonation.¹⁻³

Anatomy

Innervation to the intrinsic muscles of the larynx is primarily from the recurrent laryngeal branch of the vagus nerve. The primary action of these muscles is adduction of the vocal folds. These muscles include the posterior and lateral cricoarytenoids, the thyroarytenoid, and the interarytenoid muscles; the posterior cricoarytenoid being the only abductor muscle. The cricothyroid muscle is the only laryngeal muscle innervated by the superior laryngeal nerve and serves to modify the tension and length of the vocal fold, resulting in vocal pitch changes.

Patients with bilateral vocal fold impairment primarily present with airway obstruction secondary to loss of vocal fold abduction. The vocal quality may remain relatively preserved secondary to the near midline position of the vocal folds. In contrast, loss of adduction leads to an unobstructed airway with a breathy voice. Unilateral vocal fold impairment leads primarily to loss of vocal quality, rather than airway compromise; therefore, its treatment will not be covered in this chapter. The objective of this chapter is the management of airway obstruction seen more often in bilateral vocal fold impairment.

The etiology of vocal fold impairment is diverse, ranging from neurologic deficits to local mechanical issues. These issues may arise secondary to extrinsic injury to the larynx or recurrent laryngeal nerve, central nervous system insult, local endolaryngeal injuries such as prolonged endotracheal intubation or iatrogenic scarring, neoplasm, or even inflammatory disorders of the cartilaginous framework of the larynx. Further etiologies of

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Table 1 Etiologies of bilateral vocal fold impairment³

Paralysis/neurologic
Surgical trauma
Prolonged intubation
Thyroid, esophageal, and tracheal malignancies
Midbrain stroke
Amyotrophic lateral sclerosis
Arnold-Chiari malformation
Diabetic neuropathy
Postpolio syndrome
Multiple sclerosis
Guillain-Barré syndrome
Cricoarytenoid joint fixation
Arytenoid dislocation secondary to blunt or intubation trauma
Rheumatoid arthritis
Ankylosing spondylitis
Infiltrative or inflammatory lesions of the vocal fold
Sarcoidosis
Amyloidosis
Wegener's granulomatosis
Lipoid granulomatosis
Radiation therapy
Laryngeal neoplasms
Idiopathic fibrosis
Posterior glottic scar
Prolonged intubation
Cicatrical pemphigoid
Endolaryngeal surgery
Gastroesophageal reflux disease

bilateral vocal fold impairment are listed in [Table 1](#). Iatrogenic injuries remain the primary cause of bilateral vocal fold impairment. Vocal fold paralysis or paresis can result from thyroidectomy, anterior approaches to the cervical discs, esophageal surgery, carotid endarterectomy, and any other surgery that may put the recurrent laryngeal nerve at risk for injuries. Prolonged intubation can also lead to fibrosis of the interarytenoid muscles and cricoarytenoid joint ankylosis. Infiltrative disorders such as amyloidosis, tuberculosis, and sarcoidosis may lead to bilateral vocal fold motion impairment, whereas neoplasms most often present with a unilateral impairment. Rheumatoid arthritis should also be considered in cricoarytenoid or cricothyroid joint ankylosis.

Evaluation

The cornerstone of office laryngeal examination is indirect mirror or direct laryngoscopy with flexible fiberoptic endoscopy. Visualization of the vocal fold movement during phonation and inspiration can reveal a wealth of information to provide adequate diagnosis and guide management for the impaired vocal folds, although more invasive, endoscopic palpation of the cricoarytenoid joint can help differentiate paralysis from fixation. Besides this, laryngeal electromyography can help distinguish between neurologic and structural causes of immobility and may aid to predict recovery. Flow volume loop spirometry is also a useful adjunct to quantify respiratory flow limitations. There are 2 main patterns seen in bilateral vocal fold impairment that give information regard-

ing the site of obstruction, as well as the severity of the airway obstruction. Inspiratory flow rate is mostly affected in a variable extrathoracic obstruction pattern, while the expiratory flow rate remains normal. This pattern is seen in laryngeal paralysis, cricoarytenoid ankylosis, interarytenoid fibrosis, and posterior glottic scarring. In contrast, patients with infiltrative lesions present with a flow rate limited on both inspiration and expiration, referred to as a fixed obstruction. In general, a midvital capacity inspiratory flow rate of less than 1.5 L per second for an adult is considered severe enough to warrant surgical intervention.

Surgical techniques

Before 1922, the treatment for bilateral vocal fold impairment was the tracheotomy. In 1922, Chevalier Jackson⁴ introduced the cordectomy and the ventriculocordectomy to expand the airway, but unfortunately patients were left with poor vocal quality and scarring. Surgeons began to search for ways to lateralize the vocal folds but still preserve functional phonation. In 1932, Hoover⁵ described submucosal resection of the vocal fold, but this was also complicated by glottic narrowing secondary to scarring. Seven years later, King⁶ published his technique of extralaryngeal arytenoidectomy in which the ipsilateral arytenoid cartilage was sutured to the anterior belly of the omohyoid muscle. Scarring produced further lateralization of the vocal folds. The technique underwent further modification by Kelly⁷ in 1941, where the arytenoids were removed through a window made in thyroid cartilage. Woodman⁸ further modified the arytenoidectomy in 1946, using a posterolateral approach that spared the thyroid cartilage. With the advent of endoscopic arytenoidectomy by Thornell⁹ in 1948, surgeons were able to decrease the complications and morbidity related to open procedures, but the new procedure was technically challenging and not immune to scarring. In the 1970s, authors such as Kirchner¹⁰ advocated a more conservative approach using suture lateralization. This was especially attractive for patients who might have needed a reversible procedure for temporary bilateral vocal fold immobility. With the introduction of the CO₂ laser in endolaryngeal surgery, laser arytenoidectomy techniques followed, as described by Ossoff and others.¹¹ Posterior transverse laser cordectomy was then introduced by Dennis and Kashima¹² in 1989 to open the posterior glottis without needing a preoperative tracheotomy. Presently, endoscopic cordectomy remains the most popular technique.

Endoscopic techniques

Endoscopic arytenoidectomy

Endoscopic arytenoidectomy, as described by Thornell⁹ in 1948, was the first endoscopic technique for vocal

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