



# Challenge of Lung Isolation in Patients with Vocal Cord Implants

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## Abstract

Glottic closure insufficiency increases the risk of aspiration and pneumonia, particularly in the elderly. Medialization thyroplasty is an open surgical procedure for treating glottic incompetency by approximating both vocal folds. The vocal fold medialization is achieved by inserting an implant to bring the nonmobile fold to the unaffected side. Lung isolation in patients with vocal cord implantation poses a unique challenge. Understanding the risks of different modalities of lung isolation and their impacts on the vocal cord implant is crucial to implementing a specifically tailored plan. Preoperative bronchoscopy, intraoperative video laryngoscopy, and bronchoscopy are ideal methods for assessing the vocal fold implants and guiding the lung isolation technique. Bronchial blocker through a single-lumen endotracheal tube may be the preferred choice to avoid the injury of the stretched vocal cords and dislodgement of the implant by a larger diameter double-lumen tube.

**Keywords:** Vocal Fold Implants, Lung Isolation, Endotracheal Tube, Anesthesia

## 1. Context

Medialization thyroplasty with vocal cord implantation is a procedure typically done under monitored anesthesia care or office-based sedation, in which a small incision is made on the ipsilateral side of the neck; then, a small window is created into the larynx, and an implant is inserted for more adduction of the affected side. To date, there is no study discussing lung isolation techniques in the setting of vocal fold implants. Therefore, we discuss the different vocal fold implants used and anesthetic considerations to achieve one-lung ventilation while preserving the implant.

## 2. Vocal Cord Paralysis

Phonation is a complex process involving both laryngeal and extra laryngeal structures. A retrospective study showed one-third of adults worldwide complain of dysphonia during their lifetime (1). Dysphonia is attributed to disturbances in laryngeal structures. Common causes include nonspecific dysphonia, benign vocal fold lesions,

and vocal cord paralysis. Vocal fold paralysis is the absence of movement of one or both vocal cords that can be attributed to different causes. Vocal cord paralysis can be classified into surgically induced, neurologic, traumatic, neoplastic, and idiopathic paralysis (2). Vocal cord paralysis may be bilateral or unilateral. Bilateral vocal cord paralysis causes inspiratory dyspnea due to the paramedian position of both vocal cords. The current treatment options include tracheostomy, cordotomy, reinnervation techniques, and recently, neuromodulation and laryngeal pacing (3). Unilateral vocal cord paralysis, on the other hand, is characterized by dysphonia and aspiration (4). Since it predisposes the patient to aspiration, vocal cord paralysis is an independent risk factor for pneumonia (5, 6). Therefore, the anesthesiology team should seek out signs and symptoms of pneumonia during the preoperative visit.

## 3. Vocal Cord Implant

Over the last decade, several laryngoplastic phonosurgical approaches for unilateral vocal cord paralysis have

been evolved, including endoscopic injection and medialization thyroplasty with arytenoid adduction (7). The endoscopic injection merely increases the bulk of the paralyzed vocal cord. However, medialization thyroplasty brings the cord to a phonatory position by inserting an implant through a surgical window in the thyroid cartilage (8). Nowadays, medialization thyroplasty is the modality of choice for managing vocal cord paralysis and paresis (9). The procedure is performed in the operating room under local anesthesia combined with conscious sedation or general anesthesia using a laryngeal mask airway (10). There are many types of vocal cord implants that can be divided into autologous (fat, muscle, or fascia), synthetic (Silastic, Gore-Tex), and prefabricated synthetic (Montgomery) (11). Various synthetic implants differ respecting durability, stability (risk of migration), the time required to customize the implant, and insertion technique. The Gore-Tex implants are advanced in the para-glottic area as ribbons. These Gore-Tex ribbons are placed in a titrating manner until satisfactory medialization is achieved. On the other hand, the Silastic and Montgomery type implants are pre-sized implants that require patient-specific customization by the surgeon.

#### 4. One Lung Ventilation

One-lung ventilation (OLV) is essential for many thoracic and several non-thoracic procedures such as spine fixation (12). One-lung ventilation is typically achieved by placing either a double-lumen ETT (DLT) or endobronchial blocker (EBB) via a conventional single-lumen endotracheal tube (13). The complications of DLT include malposition, increased airway resistance due to the narrower lumen, and airway injury. Airway trauma includes tracheal mucosa erosion (cuff inflation with 2 mL of air can generate a pressure of 50 mmHg) and laryngeal injury during both intubation and extubation (14, 15). When a DLT causes airway rupture, the mortality has been reported to be 8.8% (16). Endobronchial blockers placed via standard, single-lumen ETT can be an effective alternative to DLT for lung isolation and may help reduce airway trauma from OLV (17). The EBB was used as early as the 1970s, followed by multiple modifications made through the years (18). The older versions of EBB were also relatively “high-maintenance” devices because of the frequent dislodgment during surgery. Moreover, the time needed to achieve lung isolation may be longer with EBB than with DLT (19). However, EBB is associated with a lower incidence of postoperative hoarseness and sore throat compared with DLT (20).

Therefore, the EZ-blocker was developed to be an efficient, more reliable, and easier-to-use alternative to DLT when compared to its predecessors (21). The EZ-blocker is

a Y-shaped semirigid catheter with a bifurcation into two distal extensions with two inflatable cuffs to be inserted in both main-stem bronchi. This design eases the transition from the isolation of one lung to the other and decreases secondary malposition by anchoring the Y bifurcation on the carina (22). Hence, the EZ-blocker combines the advantages of DLT design and EBB size without additional serious complications (23). Limitations of the EZ-blocker include the small suction channels that interfere with either suction or oxygen insufflation. In addition, the EZ-blocker is not suitable for lobar blockade or in the case of pneumectomy or bronchial sleeve surgery because of the potential to become ensnared in the sutures.

#### 5. Lung Isolation in the Setting of Vocal Cord Implant

##### 5.1. Preoperative Assessment and Planning

The vocal fold implants should be evaluated concerning detailed history, preoperative laryngoscopy by the otolaryngologist, and patient counseling. The history of particular interest involves the type of implant and follow-up reports. Identifying the type of material is significant to assess the risk of displacement during intubation (24). The technique of advancing the Gore-Tex implants as ribbons makes their extrusion into the airway lumen or migration a common complication (25). A case of Gore-Tex implant displacement was reported, presenting with an actual vocal fold mass (26). On the contrary, the pre-sized implants (Montgomery and Silastic) may be less liable for migration and displacement. However, a case of late displacement of a Montgomery implant was reported after general anesthesia due to traumatic endotracheal intubation. This complication caused a revision medialization laryngoplasty for the patient (27). The preoperative flexible laryngoscopy is a vital tool to evaluate the vocal cords, glottic configuration, and implant status (28). It may help the anesthesiologist plan the intubation to decrease potential adverse events. Finally, a discussion involving the anesthesiologist, otolaryngologist, and the patient is of utmost importance to establish a plan and discuss the possibility of implant displacement.

##### 5.2. Choice of Endotracheal Tubes

Medialization laryngoplasty with the placement of implants causes structural changes in the vocal cords. In one patient, magnetic resonance images of the larynx after implant placement showed the vocal cords being stretched by 70% into a thin layer wrapped around the implant (29). Therefore, implants make the vocal cords more prone to injury during endotracheal intubation. Even with atraumatic intubation, the placement of a DLT has been associated with the formation of vocal cord granuloma (30).

This warrants selecting the smallest possible endotracheal tube to provide adequate lung isolation and airway pressure. It is imperative to understand that the outer diameter, not the inner diameter, is implicated in vocal cord trauma, postoperative hoarseness, and airway edema (31). Therefore, it is crucial to ascertain both internal and external diameters to allow smooth passage of the ETT and DLT through the fixed, narrowed glottic aperture with the vocal cord implant. Ultrasound is a reliable non-invasive tool that may help the anesthesiologist measure the subglottic diameter and select the proper size of the ETT (32). A prospective observational study showed that ultrasound could guide the choice of best fit DLT, as well (33). Computed tomography of the chest, which may be routine imaging in most surgeries demanding lung isolation, is also an accurate tool to assess the airway dimensions. Computed tomography provides a good air-tissue interface that promotes it as a well predictable modality for determining the best fit endotracheal tube (34).

### 5.3. Anesthetic Plan

Lung isolation can be accomplished with a single-lumen endotracheal tube with an incorporated bronchial blocker. This method may be preferred to promote the stability of the implant. After the induction of general anesthesia, flexible fiberoptic bronchoscopy is crucial to evaluate the airway anatomy and any complication of the implants (35). The use of video laryngoscopy allows for obtaining a better glottic view and recording the intubation for future laryngoscopy planning (36). Directing the endotracheal tube away from the implant may decrease the incidence of displacement. Ideally, an ETT larger than 7.5 mm internal diameter is selected to ensure adequate space for both the bronchial blocker and the fiberoptic bronchoscope. There are many types of bronchial blockers. However, the EZ-blocker with its double endobronchial balloon system has been used successfully in such situations (37). At extubation, it is essential to check the implant while the patient is anesthetized. This can be achieved by replacing the endotracheal tube with a laryngeal mask airway through which fiber optic laryngoscopy can be performed to verify the implant position (38). The attendance of an otolaryngologist throughout the surgery can be helpful in the case of implant displacement.

## 6. Special Considerations

### 6.1. Difficult Airway Intubation

Fiberoptic intubation is the primary option in the difficult airway algorithm (39). However, it has a blind spot-on passage of the tube through the airway that carries the risk

of displacement in the case of vocal fold implants. Therefore, simultaneous video laryngoscopy or a second fiberoptic bronchoscope inserted nasally (or orally) may add the benefit of watching the tube as it passes through the larynx (40).

### 6.2. Lung Isolation in Pediatric Patients with Vocal Fold Implants

Vocal fold immobility is the second common congenital laryngeal anomaly after laryngomalacia. The preferred lung isolation method, in this case, may be a double-lumen tracheal tube in children over eight years and either bronchial blockers or a single-lumen tracheal tube for children under eight years (41). Under six months, a single-lumen tracheal tube may be the only method due to the narrow airway. However, having a narrower airway diameter limits the simultaneous use of different airway devices (tube, bronchoscope, bronchial blocker) and may increase the risk of implants displacement. Therefore, a video laryngoscope may help visualize the glottis and monitor the tube passage through the airway (42). Moreover, the extraluminal EZ-blocker is efficient in providing stable lung isolation in pediatrics (small diameter endotracheal tubes) compared to other types of bronchial blockers (43).

## 7. Conclusions

Lung isolation in the setting of vocal cord implantation poses a unique challenge. Understanding the risks of different modalities of lung isolation and their impacts on the vocal cord implant is crucial to implementing a specifically tailored plan. Preoperative measurement of the airway diameter using computed tomography and ultrasound can guide choosing the best fit ETT.

Preoperative bronchoscopy and intraoperative video laryngoscopy and bronchoscopy are ideal for assessing the vocal cord implants and guiding the isolation method. Bronchial blocker placement through a single-lumen ETT may be the preferred choice to avoid the injury of the stretched vocal cords and dislodgement of the implant by the larger diameter DLT. Discussing the potential complications with the patient and the airway approach with the otolaryngologist is of paramount importance.

## Footnotes

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