

Third Edition

OPERATIVE OTOLARYNGOLOGY

HEAD AND NECK SURGERY

Eugene Myers
Carl Snyderman

ELSEVIER

Operative Otolaryngology

Head and Neck Surgery

THIRD EDITION

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Dedication

The Third Edition of Operative Otolaryngology: Head and Neck Surgery is dedicated to the faculty of the Department of Otolaryngology at the University of Pittsburgh School of Medicine, the second generation (our residents and fellows), the third generation (their residents and fellows), and future generations of the Pittsburgh family.

PERSONAL DEDICATION: Eugene N. Myers

To my wife, Barbara, our daughter, Marjorie Fulbright and her husband Cary, our son, Jeffrey N. Myers MD, PhD and his wife Lisa, our grandsons, Alex and Chip Fulbright, Keith, Brett, and Blake Myers, with love and many thanks for your patience with me during the creation of this book.

PERSONAL DEDICATION: Carl H. Snyderman

To my wife, Michelina Fato, MD, for her continuous support and encouragement, to my family (Kelly, Molly, Andrew, and Lucia) for providing perspective regarding life's goals, and to the memory of my father, Sanford Snyderman, MD, who continues to be an inspiration and role model for my life in medicine.

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[†] Deceased

Preface

We are extremely proud to present the Third Edition of *Operative Otolaryngology: Head and Neck Surgery*. Since the publication of the Second Edition in 2008, we have witnessed tremendous progress in our specialty driven by technological advances and scientific inquiry with the refinement of surgical techniques, the development of new surgical approaches, and the genesis of new surgical disciplines. The Third Edition recognizes these changes with new and expanded content to present the latest advances across all disciplines. While we have changed the format for easier access and reliability, we have not changed our commitment to provide an accurate and up to date description of the *hows* and *whys* of reliable surgical techniques for an international audience.

The third edition has 78 more chapters, than the second edition, with new sections on the nasopharynx, pediatrics, sialendoscopy, and sleep disorders. Sections are organized based on anatomical region and subspecialty. Within each section, chapters are arranged from the less-to-more complex. New features of each chapter include: Evidence-Based Medicine Question, Editorial Comment, and Review Questions. One of the biggest advances in head and neck surgery has been the development of robotic surgery. The third edition includes applications of robotic surgery for neoplasia of the oropharynx, nasopharynx, hypopharynx, and larynx; volumetric tongue base reduction for obstructive sleep apnea; tumors of the prestyloid parapharyngeal space; and management of the unknown primary. There are greatly expanded sections on cranial base surgery, otology, reconstruction, and thyroid/parathyroid surgery. Interesting new techniques include: balloon sinuplasty, drug-induced sedated evaluation of obstructive sleep apnea, hyoid suspension, repair of superior canal dehiscence, and implantable middle ear devices. Although surgical techniques eventually fall out of favor and risk becoming obsolete, we recognize the importance of maintaining

proficiency with classical procedures, especially in regions of the world where resources are limited or circumstances require a different philosophy of surgical management. We have retained these time-tested techniques alongside minimally invasive alternatives.

Operative Otolaryngology: Head and Neck Surgery has always been about the legacy of the Department of Otolaryngology at the School of Medicine and the University of Pittsburgh Medical Center (UPMC) under the leadership of Eugene N. Myers and Jonas T. Johnson. Collectively, the faculty has had a tremendous impact on generations of residents, fellows, and international scholars. Many of their trainees (both domestic and international) have gone on to establish their own legacy through the promulgation, around the world, of the Pittsburgh way of managing patients. The extended “Pittsburgh family” has grown since the last edition, with a pool of 196 authors and 21 section editors. We are deeply indebted to them for their contributions. All of the authors of this textbook are members of the faculty of the University of Pittsburgh School of Medicine or Dental Medicine, have received training at the University of Pittsburgh Medical Center, or have trained under a graduate of these institutions.

Acknowledgments

We gratefully acknowledge the enormous contributions of our Editorial Coordinator, Beverly Poremba, and her staff: Allison Reiber and Nancy Yim.

We also acknowledge the efficient, good-natured help, guidance, and advice from Belinda Kuhn, Senior Consultant Strategist at Elsevier, along with Sam Crowe, Content Development Specialist, Joshua Mearns, Content Development Specialist, Dr. Atiyaah Muskaan, Project Manager, and Miles Hitchen, Senior Designer, from Elsevier for making this Third Edition possible.

We are eternally indebted to Mary Jo Tutchko for her efforts over the years, on all projects big and small. Nothing would ever get done without her help.

In Memoriam



This edition is dedicated to the memory of Berrylin J. Ferguson, MD, who served as an Associate Editor for the second edition. Dr. Ferguson was Professor of Otolaryngology in the University of Pittsburgh School of Medicine and Director of the Division of Sinonasal Disorders and Allergy at the University of Pittsburgh Medical Center. She established herself as an International leader in rhinology. Her presence is greatly missed.

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- 108. Endoscopic Ethmoidectomy
- 109. External Ethmoidectomy
- 110. Endoscopic Sphenoidotomy
- 111. Trephination of the Frontal Sinus
- 112. Endoscopic Approach to the Frontal Sinus
- 113. Draf III, Endoscopic Modified Lothrop
- 114. Osteoplastic Obliteration of the Frontal Sinus

115. Frontal Sinus Cranialization

SECTION 1

Larynx: Voice

OUTLINE

1. Office-Based Laryngeal Procedures
2. Phonosurgery for Benign Vocal Fold Lesions
3. Recurrent Respiratory Papillomatosis
4. Vocal Fold Injection via Microlaryngoscopy
5. Medialization Laryngoplasty and Arytenoid Adduction
6. Intraoperative Medialization Laryngoplasty

Office-Based Laryngeal Procedures

Priya Krishna, and Clark A. Rosen

Introduction

Office-based laryngeal procedures are quickly gaining popularity. These procedures are cost effective and provide an important alternative for patients who are not good candidates for operative direct laryngoscopy. Included are those patients with contraindications to general anesthesia or who have anatomic variations that result in poor exposure when direct laryngoscopy is attempted. Advantages of procedures performed on an awake patient in the office include the performance of intraoperative assessment of vocal quality without interference from sedation or an endotracheal tube.¹ Described in this chapter are several procedures that can be successfully and relatively easily undertaken in the office setting under local anesthesia.

Key Operative Learning Points

1. The superior arcuate line is the key landmark lateral to the vocal fold for injection augmentation of the vocal fold.
2. Proper positioning of the patient, strong endoscopy skills, adequate anesthesia, and appropriate patient selection are critical to success of an in-office laryngeal procedure.
3. It is important to know exactly where the tip of the needle is prior to injection for *any* type of injection procedure. The angle of the needle in an injection procedure is also an important consideration in ensuring success of the procedure.
4. Avoiding multiple injection sites during injection augmentation improves retention of the injected material.

Preoperative Period

History

1. History of present illness—Patients may present a variety of complaints:
 - a. Hoarseness
 - b. Chronic cough
 - c. Shortness of breath
 - d. Throat pain
 - e. Difficulty swallowing
2. Past medical history
 - a. Recent surgery where the recurrent laryngeal nerve was at risk
 - b. Neurologic disorders (Parkinson's disease, multiple system atrophy, essential tremor)
 - c. History of recent intubation
 - d. Recent laryngoscopy or laryngeal surgery
 - e. History of laryngopharyngeal reflux
 - f. Occupational voice use, recreational voice use, or vocal misuse
 - g. History of smoking

Physical Examination

1. Perceptual assessment of voice: Breathy voice in glottic insufficiency or breathy breaks with abductor spasmodic dysphonia, strained–strangled voice in case of adductor spasmodic dysphonia, strained voice in case of vocal fold granuloma
2. Raspy voice quality and/or diplophonia with paralysis, paresis, presence of vocal fold lesions of any kind
3. Oral cavity/oropharyngeal anatomy: Interincisal distance, presence, and strength of gag reflex

4. Neck anatomy: Ease of palpating thyroid and cricoid cartilage landmarks, presence of masses
5. Flexible laryngovideostroboscopy demonstrating:
 - a. Vocal fold atrophy
 - b. Vocal fold hypomobility or immobility
 - c. Vocal fold scar demonstrating a decreased mucosal wave
 - d. Benign vocal fold lesions: Polyps, cysts, Reinke edema, vocal fold granulomata, and papillomas
 - e. Lesions of unknown malignant potential (leukoplakia/hyperkeratosis)
 - f. Laryngeal dystonia or tremor

Imaging

No imaging is required preprocedure, although imaging may be recommended in diagnosis of some disease processes being treated by office procedures (outside the scope of this chapter)

Indications

1. Vocal fold injection²
 - a. Augmentation: Glottic insufficiency of any kind (due to vocal fold paralysis, paresis, atrophy, scar)
 - b. Modulation of vocal fold scars (steroids) or subglottic/tracheal scar
 - c. Treatment of spasmodic dysphonia
2. Biopsy
 - a. Establishment of a diagnosis for a laryngeal lesion
3. Laser³
 - a. Treatment of vascular lesions of the vocal fold (i.e., ectasias, varices)
 - b. Treatment of epithelial and selected subepithelial lesions of the vocal fold (i.e., polyps, cysts, papilloma, Reinke edema, granulomata, glottic webs, leukoplakia, dysplasia)

Contraindications

1. Unstable cardiopulmonary status
2. Allergy to local anesthetics or injectable materials
3. Poor exposure of the endolarynx due to prolapsing arytenoid or severe supraglottic constriction
4. Poorly defined cervical anatomic landmarks (in case of percutaneous injection)
5. Significant tremor in the laryngopharynx

Contraindications to botulinum toxin use:

1. Pregnancy
2. Breast-feeding
3. Impaired abduction of vocal fold (in setting of posterior cricoarytenoid muscle (PCA) injection)
4. Any neuromuscular condition (i.e., myasthenia gravis)
5. Concurrent aminoglycoside treatment

Preoperative Preparation

1. Discontinue antiplatelet/anticoagulants (though no studies to show increased incidence of complications with in office injection).
2. Recommend prescribing a small dose of an anxiolytic (i.e., Xanax 0.5 mg 1 hour prior to procedure and may be repeated once 5 minutes prior to procedure if needed) for patients who know they might experience anxiety.

Operative Period

Perioperative Antibiotic Prophylaxis

1. Not required—rate of infection is very low, despite this being a clean-

contaminated surgical environment

Monitoring

No active monitoring is necessary during an in-office procedure; it is advisable to take preprocedure and postprocedure vital signs.

Anesthesia

1. Nebulizer: 5 cc 4% lidocaine delivered over 10 minutes—useful for per-oral procedures to eliminate the gag reflex
2. Flexible drip catheter: Silastic catheter guided through the channel of the flexible laryngoscope, direct application to larynx of 4% lidocaine, elicit laryngeal “gargle”
3. Percutaneous transtracheal/transcricothyroid injection of 4% lidocaine, which induces vigorous coughing
4. Anesthetize the skin with 1% lidocaine with epinephrine for percutaneous techniques (optional).
5. Be mindful of toxic limit of 7 to 8 mL (5 mg/kg; approximately 350 mg in 70-kg patient)⁴.

Positioning

1. Upright position in examination chair for the majority of procedures
2. Option is supine position during electromyographic (EMG)-guided injection of the botulinum toxin

Patient Factors⁵

“the ideal patient has:”

1. Normal or minimal gag reflex
2. Ability to remain calm for 10- to 30-minute duration of procedure
3. Adequate interincisal distance of 20 mm at least (i.e., no trismus)³

4. Adequate intranasal airway (to pass laryngoscope, which is 3 to 4 mm in diameter, or TNE scope, which is 5 mm in diameter)
5. Absence of neurologic conditions affecting stability of the head (no torticollis or tremor)
6. Motivated to have the procedure done in the “office” and not the operating room with general anesthesia

Instruments and Equipment to Have Available

- Flexible laryngoscope with distal chip with a channel for passage of a flexible catheter for anesthetic and/or flexible needle passage and/or fiber-based laser (or rigid 70-degree telescope for a one-person approach)
- C-mount camera (attaches to the flexible or rigid laryngoscope)
- Video monitor for visualization ([Fig. 1.1](#))
- Curved Abraham cannula for delivery of topical lidocaine and vocal fold palpation, as needed; alternative: flexible drip catheter placed inside flexible scope channel or an angiocatheter type device to fit in the working channel
- Injection device for transoral injection approach—oro-tracheal injector or proprietary malleable needles (Merz North America)
- 23-, 25-, or 27-gauge 1.5-inch needles for percutaneous injection (when required) or 20-gauge spinal needle for certain techniques
- Flexible fine-gauge injection needle for use with working channel in flexible laryngoscope
- Endoscopic biopsy forceps to place through working channel or per-oral type biopsy forcep
- Injectable material: Calcium hydroxylapatite, carboxymethylcellulose, hyaluronic acid, micronized dermis (for augmentation), dexamethasone, or triamcinolone
- Alcohol prep pad or topical prep solution (povidone-iodine) for

percutaneous injections

- Topical cetacaine spray (benzocaine/tetracaine)
- Topical oxymetazoline and/or 2% Pontocaine or 2% lidocaine mixture for nasal decongestion and anesthesia
- Cotton pledgets
- 4% lidocaine (topical) for drip and nebulization
- 2% lidocaine viscous
- Nebulizer
- Potassium titanyl phosphate (KTP), neodymium:yttrium aluminium garnet (Nd: YAG), or fiber-guided CO₂ lasers

Specific to Botox injection:

- EMG device—either handheld or traditional EMG apparatus
- Botulinum toxin

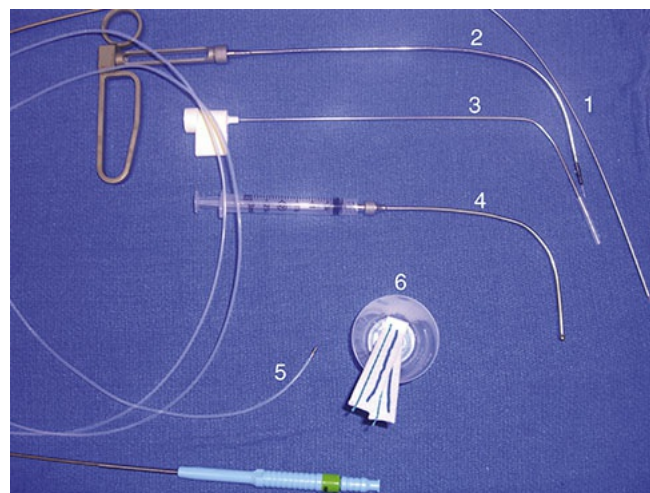


FIG. 1.1 Common equipment used for office laryngeal procedures. 1, flexible wire sheath with 27-gauge needle; 2, Xomed orotracheal injector device; 3, Merz -Bioform malleable 25-gauge orotracheal needle; 4, 3-mL syringe attached to Ab raham cannula; 5, end of flexible endoscopic catheter for administration of topical anesthetic; 6, nasal pledgets.

- Insulated 25- or 26-gauge needle electrode, which is also used to simultaneously administer Botox
- Local anesthetic for skin (1% lidocaine with 1:100,000 epinephrine)—optional

Key Anatomic Landmarks

1. Superior arcuate line—line starting at lateral border of vocalis and where the ventricle starts
2. Thyroid notch—for thyrohyoid technique
3. Thyroid cartilage
4. Cricothyroid membrane—for percutaneous augmentation or botulinum toxin injection

Prerequisite Skills

1. Strong skills with endoscopic procedures
2. Thorough knowledge of external and internal laryngeal anatomic landmarks
3. Laser safety training (for any laser procedure)

Operative Risks

1. Infection
2. Bleeding/hemorrhage
3. Worsening hoarseness due to misplaced injectable (if in a too superficial plane; i.e., Reinke space)
4. Airway obstruction
5. Aspiration due to residual local anesthetic
6. Anesthetic toxicity from overdose

Surgical Techniques

Percutaneous Methods

Percutaneous injection technique (two-person): Transcricothyroid (Fig. 1.2)

- Anesthetize skin with either 1% lidocaine with epinephrine or transtracheal 4% lidocaine injection.
- Bend 25-g 1.5" needle at 45-degree angle.
- Place needle through cricothyroid space just off midline of the side to be injected.
- Assistant can use flexible laryngoscope to confirm position of the needle.
- Can visualize needle in subglottic airway, aim toward infraglottic surface of vocal fold
- Botox injection using laryngeal EMG guidance does not need visual confirmation (one-person technique).

Percutaneous injection technique (two-person): Thyrohyoid (Fig. 1.3)

- Anesthesia techniques are the same as for the transcricothyroid method.
- Use either 25-g 1.5" needle or spinal needle.
- Enter thyrohyoid space at thyroid notch at an acute angle, nearly 90 degrees.

Percutaneous injection technique (two-person): Transthyroid cartilage

- Topical anesthesia administered similar to other percutaneous techniques
- Need an endoscopist to help confirm needle position
- Guide 20-gauge spinal needle through thyroid cartilage in perpendicular fashion, and then rotate it anteriorly and horizontal to the ground; position needle 6 to 8 mm lateral to midpoint of thyroid cartilage; spinning the needle through the cartilage like a screw eases insertion.
- Tilt needle laterally toward ipsilateral arytenoid cartilage to run needle

parallel to vocal fold; avoid puncturing the epithelium.

- Remove stylet and then attach syringe with injectate; slowly inject under direct visualization from above with laryngoscope.

Per-Oral Injection Technique (Fig. 1.4)

- Use either proprietary needle, which comes with injectable material (Merz Aesthetics), or Xomed orotracheal injector needle.
- For the orotracheal injector, load a slip tip tuberculin syringe with injectable material of choice and attach a disposable needle to the end of shaft.
- Can use nebulized 4% lidocaine (5 cc) to help with depressing gag reflex
- Place ½" × 3" pledgets, with a mixture of oxymetazoline and 4% lidocaine into both nasal cavities for at least 5 minutes.



FIG. 1.2 Transoral vocal fold augmentation with endoscopic guidance placement of Abraham cannula. Note positioning of patient.

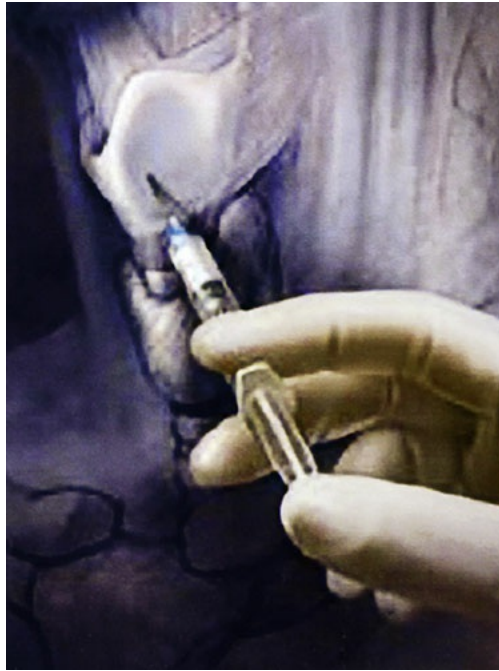


FIG. 1.3 Percutaneous trans-thyroid cartilage approach for vocal fold injection. Courtesy of LifeCell Corporation.

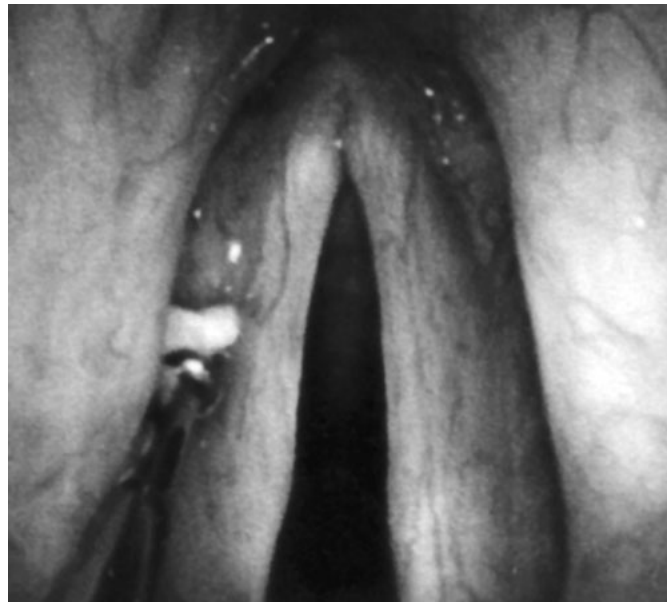


FIG. 1.4 Proper placement of the needle lateral to the vocal fold for augmentation using flexible endoscopy. Reprinted with permission from Andrade FP, Carrau R, Buckmire R: Safety and cost-effectiveness of intra-office flexible video-laryngoscopy with transoral vocal fold injection in dysphagic patients. *Am J Otolaryngol* 27:319-322, 2006.

- Remove pledgets. Then guide flexible channel laryngoscope, to the level of the base of the tongue; then use drip catheter with 4% lidocaine to drip sequentially over the base of the tongue, epiglottis, AE folds, and laryngeal vestibule and vocal folds; you can also use Abraham cannula perorally to deliver topical anesthesia.
- Gently palpate vocal folds with the tip of the catheter to confirm adequate anesthesia.
- Apply either a small amount of additional 4% lidocaine or 20% benzocaine (HurriCane) spray to the oropharynx for additional suppression of the gag reflex.
- Have the patient hold his/her own tongue with gauze downward, and ask the patient to bring the jaw forward; alternatively, the surgeon can hold the tongue with the gauze.
- Guide the needle through the oral cavity over the base of the tongue into the endolarynx while visualizing on the monitor.
- Aim for a point just anterior and lateral to the vocal process in the superior arcuate line lateral to the bulk of the thyroarytenoid muscle, feel a “pop” or loss of resistance, and inject the desired amount based on contouring of the vocal fold. Avoid injecting too far medially, which may place a superficial deposit with a poor phonatory result (Fig. 1.5).
- Can confirm adequate closure (if done for augmentation/medialization) via stroboscopy postinjection

Transnasal Biopsy, Laser, or Injection Technique

- Anesthesia is delivered in an identical fashion as described previously, with nebulization and directed delivery of topical anesthesia.
- All instruments—biopsy forceps, laser fiber ensheathed in a metal guide, or endoscopic needle—are placed through the working channel.
- When performing a biopsy, it is important to grasp the tissue in question in the vocal fold and pull with a quick movement to avoid excessive tearing of the mucosa, which can lead to vocal fold scarring; biopsy anywhere else in the larynx requires the same quick movement.



FIG. 1.5 Thyrohyoid approach in cadaver larynx. Reprinted with permission from Getz AE, Schar J, Amin M: Thyrohyoid approach to cidofovir injection: a case study. *J Voice* 19:501-503, 2005.

- When using a laser, all personnel must wear protective eyewear specific for the laser type and for papilloma treatment. Use of laser mask is advisable but not required; standard KTP laser settings are 30 to 35 watts, 15 ms pulse width, and 2 pulse per second rate of fire.
- For steroid injection, the needle can be guided to a superficial location within the vocal fold in the treatment of benign lesions, if applicable.

Commons Errors in Technique

1. Multiple injection sites or superficial injection
2. Plugging of the needle in transcartilaginous methods
3. Inadequate visualization
4. Inadequate level of anesthesia
5. Misplaced Botox or diffusion of Botox into surrounding musculature
6. Excessive removal of mucosa leading to vocal fold scarring

Postoperative Period

Postoperative/Postprocedure Management

1. No eating or drinking is allowed for 1 hour after the procedure in order to avoid aspiration.
2. For injection augmentation, the patient should observe voice rest for 24 hours.
3. The patient receiving Botox injection for laryngeal dystonia should be told to not expect any effect for at least 2 to 3 days.
4. Voice rest is recommended for between 3 and 6 days for laser treatment of benign vocal fold lesions, except in the case of papilloma (which depends on the amount of mucosal free edge of vocal fold being treated).

Complications

1. Vasovagal reaction
2. Respiratory compromise
3. Misplacement of injectable into the wrong plane, resulting in adverse phonatory outcomes
4. Inadvertent surrounding tissue burns from laser use or excessive laser use, which may cause vocal fold scarring
5. Aspiration pneumonia from too large an injection of botulinum toxin into the laryngeal adductor muscles

Alternate Management Plan

For augmentation/medialization:

1. Voice therapy alone but usually both pre- and postprocedure
2. Laryngeal framework surgery

For chemodenervation (use of Botox/Xeomin)

1. Selective laryngeal adductor denervation

For benign and premalignant vocal fold lesions

1. Microsuspension direct laryngoscopy ± microflap excision ± laser treatment
2. Voice therapy

Discussion

Evidence-Based Medicine Question

Are intralesional steroid injections in the office well tolerated and beneficial in treatment of benign vocal fold lesions?

A meta-analysis of six studies performed in 2013 indicated that these procedures are well tolerated under local anesthesia and demonstrated significant improvements in both objective and subjective measures of vocal quality.

Editorial Comment

Office-based laryngeal procedures have now become the preferred modality of treatment for many otolaryngologists. Not only are they time saving but they avoid the dangers of sedation or general anesthesia. This is not to say that office-based procedures are not without complications. However, serious complications that leave a patient with long-term morbidity or mortality are exceedingly rare. Knowing where one's needle tip is at all times before an awake office-based vocal fold injection augmentation is paramount. The per-oral technique offers the ideal visualization and angle of insertion into the layered vocal fold but also has the steepest learning curve of any of the techniques. Once mastered, though, it provides an effective and predictable intervention. The percutaneous techniques can be more facile to learn and can also offer visualization of the needle tip before injection; however, the depth of insertion can be more unpredictable due to the angle of needle insertion. Indications for office KTP laser continue to grow and now include some benign subepithelial vocal fold lesions and vocal fold scarring (with the

intention of remodeling/softening the scar). Patients with chronic epithelial disease such as papilloma and dysplasia are now returning to the OR much less frequently due to office-based KTP laser “maintenance” of these lesions. Almost all of these procedures require more than one person to complete. A reliable and easily reproducible one-man technique/device for vocal fold injection augmentation that can be performed in the office by any otolaryngologist is hopefully on the horizon.

Thomas L. Carroll

● Access the review questions and additional sources list online at <http://www.expertconsult.com>

Review Questions

1. All of these are relative contraindications for a per-oral approach, except
 - a. Head tremor
 - b. Trismus
 - c. Anxiety
 - d. **Previous head and neck cancer surgery**
2. All of these are approaches to vocal fold augmentation, except
 - a. Per-oral
 - b. Transcricothyroid
 - c. Thyrohyoid
 - d. **All of the above**
3. Vocal fold augmentation is typically done for which of the following indications?
 - a. **Vocal fold paralysis**
 - b. Vocal fold polyps
 - c. Respiratory papillomatosis
 - d. Reinke edema

Additional Sources

- Halum S.L, Moberly A.C. Patient tolerance of the flexible CO₂ laser for office-based laryngeal surgery. *J Voice*. 2010;24(6):750–754.
- Koufman J.A, Rees C.J, Frazier W.D, et al. Office-based laryngeal laser surgery: a review of 443 cases using three wavelengths. *Otolaryngol Head Neck Surg*. 2007;137:146–1151.
- Lippert D, Hoffman M.R, Dang P, et al. In-office biopsy of upper airway lesions: safety, tolerance and effect on time to treatment. *Laryngoscope*. 2015;125:919–9923.
- Shah M.D, Johns M.M. Office-based laryngeal procedures. *Otolaryngol Clin N Am*. 2013;46:75–84.
- Wang C.T, Liao L.J, Huang T.W, et al. Comparison of treatment outcomes of transnasal vocal fold polypectomy versus microlaryngoscopic surgery. *Laryngoscope*. 2015;125:1155–111160.
- Zalvan C.H, Brown D.J, Oiseth S.J, et al. Comparison of trans-nasal laryngoscopic office based biopsy of laryngopharyngeal lesions with traditional operative biopsy. *Eur Arch Otorhinolaryngol*. 2013;270:2509–252513.

References

1. Rosen C.A, Amin M.R, Sulica L, et al. Advances in office-based diagnosis and treatment in laryngology. *Laryngoscope*. 2009;119:S185–S214.
Synopsis: This is an excellent overview of the history of flexible endoscopy and advancements, anesthesia techniques, and indications for various in-office procedures.
2. Sulica L, Rosen C.A, Postma G.N, et al. Current practice in injection augmentation of the vocal folds: indications, treatment, principles, techniques, and complications. *Laryngoscope*. 2010;120:319–3325.
Synopsis: This is a specific review and comparison of office versus operative vocal fold injections as well as a description of the various

techniques currently used in-office for vocal fold injection.

3. Sheu M, Sridharan S, Kuhn M, et al. Multi-institutional experience with the in-office potassium titanyl phosphate laser for laryngeal lesions. *J Voice*. 2012;26(6):806–8310.

Synopsis: This is one of a few multi-institutional studies of KTP laser treatment of multiple types of vocal fold lesions showing lesion regression in 90% overall.

4. Wang S, Simpson C.B. Anesthesia for office procedures. *Otolaryngol Clin N Am*. 2013;46:13–119.

Synopsis: This is a specific overview of the different types of anesthesia available for in-office laryngeal procedures.

5. Young V, Smith L.J, Sulica L, et al. Patient tolerance of awake, inoffice laryngeal procedures: a multi-institutional perspective. *Laryngoscope*. 2012;122:315–3321.

Synopsis: This is a study demonstrating overall very good tolerance by patients of in-office vocal fold procedures.

Phonomicrosurgery for Benign Vocal Fold Lesions

Clark A. Rosen, and Libby J. Smith

Introduction

Patients complaining of hoarseness, vocal fatigue, diminished vocal range, strain, or other vocal issues require a complete laryngeal examination. Based on the findings of this examination, several treatments may be indicated, including surgery. Phonomicrosurgery (PMS) encompasses a variety of elective operations whose primary goal is to improve the quality of the voice. These procedures focus on precision microsurgical techniques to remove benign vocal fold lesions, while not disrupting surrounding normal tissue. Hirano's body cover theory of vocal fold vibration is paramount in the design of current microsurgical principles and surgical procedures.¹ The delicate interface between the mucosa (cover) and the deeper lamina propria layers and muscle (body) allows for the creation of a mucosal wave (Fig. 2.1). Alterations in the mucosal wave result in dysphonia. Stroboscopy, which provides vital information about the mucosal wave, is absolutely essential in the evaluation of dysphonic patients. Wound healing is optimized by preserving the mucosa whenever possible and limiting surgery to the vocal fold layers involved with pathology (staying as superficial in the vocal fold as possible). The higher content of fibroblasts in the vocal ligament may result in increased scar deposition if surgery extends to this region.² Fortunately, the majority of bilateral vocal fold lesions are located within the superficial lamina propria, resulting in expected better postoperative mucosal wave vibration, and thereby likely improving vocal outcomes. Our improved knowledge of vocal fold microanatomy and the use of stroboscopy have led to improved patient care and surgical advancement in PMS.

Sound is the product of subglottic airflow forcing closed vocal folds to open, thereby leading to the generation of a mucosal wave along the medial edge of the vocal fold. Closure of the vocal folds during this vibratory cycle is achieved by the inherent elastic recoil of the vocal fold and the Bernoulli effect. This is called the myoelastic aerodynamic theory of phonation. This cycle usually occurs 100 to 1200 times per second. A mass on the vocal fold can disrupt this normal process and lead to hoarseness and other vocal complaints. Therefore the use of stroboscopy, which allows visualization of the mucosal wave, is indispensable in the care of these patients. Depending on the patient's history and laryngeal examination, either flexible transnasal laryngoscopy with stroboscopy (vocal fold motion abnormalities), or rigid, per-oral, endoscopy with stroboscopy (lesions), or both may need to be performed to fully evaluate the larynx. Such laryngeal examinations will provide the surgeon with an idea of the depth and type of the lesion. Although all vocal fold lesions are sent to pathology for evaluation, it is difficult for pathologists to distinguish between various vocal fold lesions based on their histologic characteristics. Precise classification of benign vocal fold lesions is therefore based on the surgeon's evaluation in the operating room, including magnification with the operating microscope, palpation of the vocal fold, identification of the physical features of the lesion or lesions, such as a cystic or fibrous mass, and location of the pathology.³

Key Operative Learning Points

- The key surgical anatomy related to PMS for benign vocal fold lesions involves the layered structure of the membranous true vocal fold.
 - Major components to the layered structure of the vocal fold
 - Epithelium
 - Lamina propria
 - Muscle (thyroarytenoid-lateral cricoarytenoid)
 - The most medial aspect of the muscle that runs from the vocal process of the arytenoid to the thyroid cartilage is named the vocalis muscle.
- Excluding epithelial diseases of the vocal folds, all benign vocal fold lesions arise within the lamina propria, which can be defined as the

anatomic space between the epithelium and the muscle of the vocal fold. There are anatomically (or histologically) three distinct layers of the lamina propria.

- Superficial layer
- Intermediate layer
- Deep layer
 - The intermediate and deep layers, also called the vocal ligament, are not surgically distinct.
- From a surgical perspective, there are two key operative locations within the lamina propria
 - Subepithelial space
 - Ligamentous region
- The mucosa of the vocal fold is defined as being composed of the epithelium and the superficial layer of the lamina propria.
- The majority of benign vocal fold lesions occur within the subepithelial space. The most common pathology that occurs in this region includes⁴:
 - Vocal fold nodules
 - Vocal fold polyp(s)
 - Subepithelial cyst(s)
 - Subepithelial fibrous mass(es)
 - Reinke edema
- Lesions that occur in the area of the vocal fold ligament include:
 - Ligamentous vocal fold cyst(s)
 - Ligamentous fibrous mass(es)
 - Rheumatologic lesion(s)³
- The majority of benign vocal fold lesions occur in the midportion of the membranous vocal fold, which is positioned halfway between the anterior commissure and the vocal process of the true vocal fold.

Types of Benign Vocal Fold Lesions³

- Vocal Nodules

Vocal nodules are benign bilateral lesions, not always symmetrical, located within the lamina propria, with normal overlying epithelium. The mucosal wave is normal or near-normal. They are typically located at the midpoint of the musculomembranous vocal fold. Breathy and raspy dysphonia is the result of incomplete vocal fold closure. Vocal nodules tend to occur in patients who use their voices aggressively (i.e., children, cheerleaders). After the inciting phonotraumatic behavior is eliminated and voice therapy is implemented, these lesions always resolve. Accordingly, surgery is not indicated for vocal nodules.

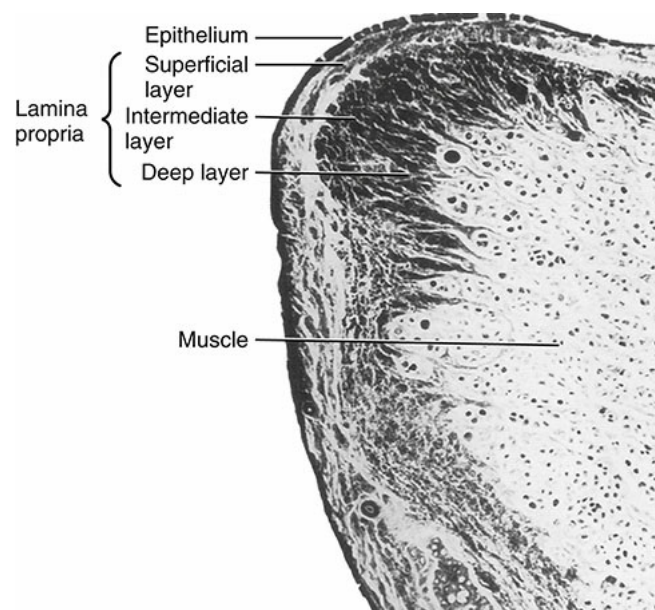


FIG. 2.1 Cross-sectional view of a vocal fold demonstrating layers of the vocal fold lamina propria. Reprinted with permission from Hirano M: *Clinical Examination of Voice*. New York: Springer-Verlag; 1981, p 5.

- Nonspecific Vocal Fold Lesion(s)

These vocal fold lesions are similar to vocal fold nodules. However, these lesions persist after voice therapy, despite resolution or significant improvement of the patient's dysphonia. Because the patients' dysphonia

resolves and the lesions are benign, no surgery is indicated.

- Vocal Fold Polyp

A vocal fold polyp is located in the subepithelial space, usually at the midpoint of the musculomembranous vocal fold. It is generally unilateral, sometimes with a contralateral reactive lesion. A vocal fold polyp can be sessile (broadly attached to a vocal fold) or pedunculated (hanging from a stalk). This lesion is believed to be the product of intense phonotrauma or vocal fold hemorrhage. Inflammatory agents, dehydration, hormone treatment, and anti-inflammatory medications may be predisposing factors. Truncation or microflap excision is performed for a vocal fold polyp if the voice is functionally impaired after conservative therapy.

- Vocal Fold Cyst

A vocal fold cyst, both subepithelial and ligamentous, is often unilateral and located at the edge of the midmusculomembranous portion of the vocal fold. The encapsulated structure is thought to be due to glandular duct blockage or phonotrauma or may be congenital. The mucosal wave is more reduced with a ligamentous vocal fold cyst. Proper voice use and voice therapy are often the initial treatments. If this is not adequate to meet the vocal demands of the patient, microflap excision is performed.

- Fibrous Mass

A fibrous mass is composed of irregular fibrous material without clearly defined borders. This lesion can occur in either the subepithelial space or near the ligament of the vocal fold, both with normal overlying epithelium. This mass is often located in the midmembranous vocal fold, either unilateral or bilateral, and therefore incomplete vocal fold closure is common. Unilateral lesions are frequently associated with a contralateral reactive lesion. Development of a fibrous mass is often associated with chronic phonotrauma or hemorrhage. Voice therapy is often the initial treatment. If this fails, surgical excision with a microflap technique is indicated.

Subepithelial fibrous mass(es) have a reduced mucosal wave but not usually as severely reduced as ligamentous fibrous mass(es). When deep dissection is needed to excise these lesions, there is a greater risk of

reduced postoperative voice improvement than with more subepithelial fibrous masses.⁴

- Reactive Lesion

Reactive lesions are believed to result from altered contact forces from a primary contralateral lesion, such as a polyp, cyst, or fibrous mass. Videostroboscopy will demonstrate a convex lesion (primary lesion) that fits into a concave reactive lesion (secondary lesion). This lesion can be surgically removed at the same time the primary lesion is removed or left to resolve during the postoperative period. This decision is based on the surgeon's preference and experience.

- Reinke Edema (Polypoid Degeneration, Diffuse Polyposis, Chronic Polypoid Corditis)

Reinke edema involves the deposition of gelatinous material within the subepithelial space. It is usually bilateral but may be asymmetrical or unilateral. These patients' voices are lower in pitch and dysphonic. Clinically, women are affected more often by Reinke edema; however, this may be due to selection bias because women are more bothered by lower vocal pitch and roughness and thus are more prone to seek treatment. The largest risk factor is smoking, followed by reflux and phonotrauma. When the pathologic accumulation is severe, airway obstruction can occur. Primary treatment is to remove the offending agents that led to the development of Reinke edema. Smoking cessation is vital. Voice therapy can occasionally be helpful if the probable cause is phonotrauma. Only after several months of compliance with smoking cessation and other conservative treatments (acid suppression and voice therapy) should surgery be considered, except in the case of airway obstruction. Conservative removal of a portion of the gelatinous material is achieved through a lateral cordotomy on the superior aspect of the vocal fold, followed by suctioning and/or near complete removal of material from the subepithelial space and excision of redundant tissue. Care must be taken because overly aggressive removal of redundant superficial lamina propria will lead to scarring and permanent hoarseness. Laser treatment with the potassium titanyl phosphate (KTP) laser may be a reasonable alternative treatment option.⁵

Preoperative Period

History

- Dysphonia
 - Speaking voice
 - Singing voice
- Vocal fatigue
 - Speaking voice
 - Singing voice
- Diminished singing range
 - Upper
 - Lower
 - Passaggio (transition from chest to head voice)
- Vocal strain
- Increased effort
 - Speaking voice
 - Singing voice
- Voice use history and demands
 - Speaking voice
 - Singing voice

Physical Examination

- Examination of the head and neck
- Specialized examination of the larynx
 - Flexible laryngoscopy ± rigid laryngoscopy
 - Stroboscopy
 - Evaluation of the vibratory margin so that the vibratory effects of the lesion(s) can be determined. Alteration or diminution of the mucosal wave (vibration along the medial/vibratory margin) leads

to dysphonia.

- This view also allows the clinician to look for associated vocal fold scar(s), which may be an important comorbidity and negatively impact surgical outcome.

Imaging

- Radiologic imaging is very rarely indicated.

Indications

- PMS is an elective procedure. The risks and benefits of surgery should be clearly explained to the patient.
- The patient's vocal limitations (speaking and singing) should be thoroughly reviewed, especially in relation to the vocal requirements of occupational, avocational, and social demands.
- This review process is often conducted over a period of several weeks and involves the patient, the family, a speech therapist, and possibly a singing voice specialist.
- After all nonsurgical therapies (when appropriate) have been exhausted and still more is required of the patient's voice, only then is it appropriate to proceed with PMS.

Contraindications

- Poor patient compliance with voice therapy and/or future healthy voice use
- Inadequate time postoperatively for voice rest and reduced voice use
- Severe comorbidities

Preoperative Preparation

- Preoperative voice therapy is very important in preparing the patient for surgery. One to two sessions are often scheduled if the patient did

not receive voice therapy before the decision to undergo surgery.

- Anticoagulant medications should be avoided preoperatively if medically possible.
- Smoking cessation is critical for improved postoperative healing.
- The patient should avoid vocal abuse and misuse preoperatively. These guidelines will prepare the patient and vocal folds for surgery.
- The need for an absolute voice rest (approximately 7 days) and reduced voice use (additional 7 to 10 days) after surgery should be discussed with the patient preoperatively. The amount of voice rest and restricted voice use is determined by the extent of surgery along the vibratory margin of the vocal fold (the medial portion of the vocal fold that makes contact with the other vocal fold during vibration).
- The patient should make the appropriate schedule changes to comply with the prescribed postoperative voice restrictions.
- If the patient has any laryngopharyngeal reflux symptoms (globus, throat clearing, excessive mucus, cough, heartburn⁴), proper acid suppression medications should be started several weeks before surgery. This may decrease the risk for postoperative wound-healing complications.
- Discussion of consent for PMS should include the risks associated with general anesthesia, infection, bleeding, dental injury, injury to the temporomandibular joint, and injury to the lingual nerve.⁶
 - A serious discussion between the patient and surgeon involving the small but real risk of no voice improvement or worsening of vocal function must take place before surgery.
 - Keeping in mind the elective nature of these surgeries, the patient must accept these risks.⁷

Operative Period

Anesthesia

- Close communication between the surgeon and the anesthesia team is

important for successful PMS.

- These procedures require general anesthesia, with complete relaxation of the patient throughout the procedure.
- Preoperative medications
 - Steroids (intravenous [IV])
 - Glycopyrrolate (Robinul) (unless contraindicated) will improve the surgical environment by minimizing swelling and secretions.
 - Acetaminophen (IV)
 - Antiemetic agent if indicated
 - A small endotracheal tube (size 5.0 to 5.5) should be placed without the aid of a stylet.
 - Not only does the smaller tube improve visualization for the surgeon, but it also diminishes the chance of injury to the vocal folds during intubation.
 - If a vocal fold(s) is injured during intubation, the planned surgery may need to be postponed.
 - Stressing the importance of careful intubation is often facilitated by discussing the planned surgery with the anesthesia team before the procedure and by the surgeon being present during intubation.
 - If an endotracheal tube will obscure adequate visualization, jet ventilation can be used. Tracheal jet ventilation is preferred over supraglottic jet ventilation because there is no vibration of the operative site nor desiccation of the vocal fold tissues.

Positioning

- Patient positioning is critical to obtain the best visualization of the larynx.
- The optimal position is supine with the neck flexed and the head extended ([Fig. 2.2](#)).
- Obese patients may require “ramping” to place their head and neck in an optimal position of large-bore laryngoscope placement.

- This can be done with the use of a troop pillow (works best with taller patients).
- Shorter patients who need “ramping” require multiple rolls of blankets under the shoulders and head to achieve body positioning so that the tragus is on an equal level with the sternal notch.

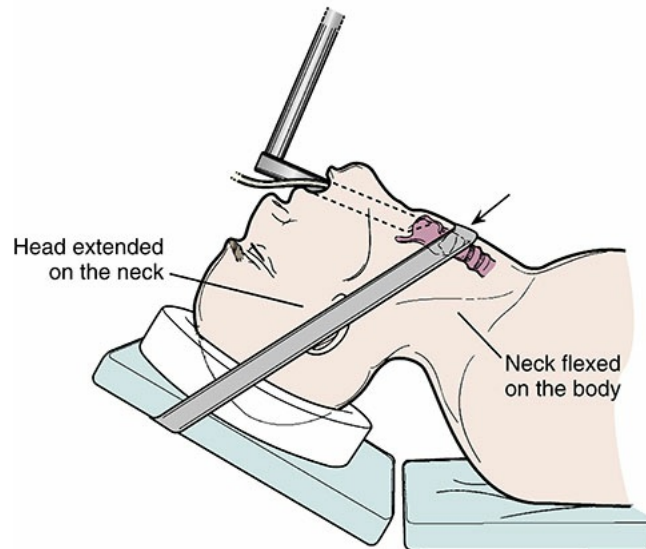


FIG. 2.2 Patient positioning for microsuspension laryngoscopy: neck flexion and head extension. “Arrows shows anterior neck pressure applied to enhance anterior commissure exposure”.

Perioperative Antibiotic Prophylaxis

- Required only for mucosal surgery associated with a heart or orthopedic implant

Monitoring

- It is wise to assess for excess tongue pressure from the suspended laryngoscope and consider intermittent release from suspension.
- Persistent complete or near-complete muscle relaxation throughout the procedure is helpful, and thus intermittent monitoring of this is wise.

Instruments and Equipment to Have Available

- A chair for the surgeon that has support for the arms is essential. This chair should be able to be adjusted for height of the base, arm support, and back support. Frequently these types of surgical chairs can be found being used by ophthalmologists.
- Dental guard, standard athletic mouthpiece or custom made by patient's dentist
- Variety of different sizes and shapes of laryngoscopes
 - Large-bore laryngoscopes are vital for precise, detailed, and controlled microsurgery of the vocal folds.
 - Specialized laryngoscopes aid with visualization for patients with "difficult" laryngeal anatomy or when specific areas of the larynx are to be viewed for surgery (posterior commissure, subglottis).
- Laryngoscope suspension device: gallows or rotation/fulcrum. We feel that the former is superior because the vector of force is more advantageous than a rotation/fulcrum device (Lewy or chest holder), which allows a larger laryngoscope to be used with less risk of laryngoscope-related dental injury.
- 0-, 30-, and 70-degree (Fig. 2.3) rigid telescopes (5-mm diameter, approximately 22-cm length)
- A high-quality operating microscope with adjustable eye pieces
- Specialized PMS instruments that include very small scissors, forceps, knife, retractors (triangular), suction, and elevators. The working end of these instruments is usually between 1 and 2 mm in diameter.
- A video tower/camera connected to the telescopes and microscope not only aids in student teaching but also allows the operating room staff to know what the surgeon is doing.
- Lasers are of limited use in PMS. There is no distinct advantage to using a laser over a "cold steel" technique, especially in view of the risk of thermal injury and the cost of using a laser.

Key Anatomic Landmarks

- This subepithelial plane is where most benign vocal fold pathology is found, and working in this plane can minimize postoperative scar formation that occurs from dissection in the deeper aspect of the vocal fold layered structure.
- Subligament area is near or within the vocal ligament. Fibrous masses or cysts can occur here and represent a greater chance of postoperative scar tissue from extensive dissection in this area.

Prerequisite Skills

- Able to perform binocular, high-power microscopy
- Bimanual surgery

Operative Risks

1. Intubation injury: Close collaboration with the anesthesia team is needed. Intubation with a small endotracheal tube (i.e., 5.0 or 5.5, designed specifically for microlaryngoscopy) should be carefully placed under direct visualization to avoid inadvertent injury to the vocal folds. Not only can this type of injury be deleterious to the treatment of the lesion but more importantly with severe injuries can be catastrophic to long-term voice outcome.

2. Dental injury: Although rare, major dental injury (i.e., broken tooth) is ameliorated by proper dental protection. It must be noted if the patient has poor dentition, multiple missing teeth, or caps, because these situations increase the risk of sustaining dental injury.

3. Laser airway fire: In situations when a laser is used in treatment of a benign vocal fold lesion (papilloma, Reinke, leukoplakia), all laser safety precautions must be followed at all times: $FiO_2 < 40\%$, bulb syringe of saline within reach of the surgeon, wet towels over the patient's head, use of a laser-resistant endotracheal tube, moist pledget over the endotracheal tube cuff, and proper staff eye protection. All operating room staff must be trained in what to do in case of airway fire: turn off

oxygen while removing the endotracheal tube, placement of saline into the airway, bronchoscopy to evaluate for injury, and then re-intubate.

Surgical Technique

- The teeth and alveolar ridge are protected with dental protection.
- The largest laryngoscope that can be accommodated should be placed because this allows the surgeon the best exposure while operating on the vocal folds.
- Suspension of the laryngoscope allows the surgeon to operate with both hands, which improves the level of precision achieved. Several suspension devices are currently available: gallows or rotation.
- Velcro or tape can be applied to the anterior aspect of the neck at the level of the cricoid or trachea to improve exposure.⁸ Placement of anterior pressure on the thyroid cartilage should be avoided because it will reduce tension on the vocal folds, thereby making PMS more difficult.

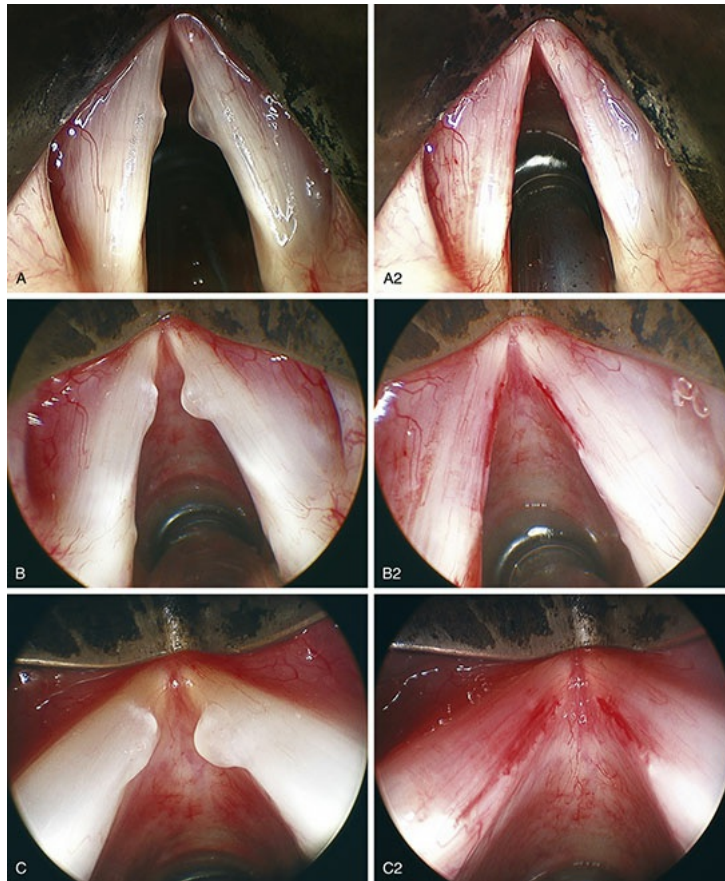


FIG. 2.3 Comparisons of preoperative views of the lesion and postoperative views after microflap surgery with 0-, 30-, and 70-degree telescopes. **A**, Preoperative view with a 0-degree scope. **A2**, Postoperative view with a 0-degree scope. **B**, Preoperative view with a 30-degree scope. **B2**, Postoperative view with a 30-degree scope. **C**, Preoperative view with a 70-degree scope. **C2**, Postoperative view with a 70-degree scope.

Surgeon Ergonomics

- After the patient and laryngoscope are in the operative position, attention should be made to address surgeon ergonomics during surgery.
- Taking a moment to achieve this, which usually requires the operating table to be placed into Trendelenburg position and the alteration of the height of the surgeon's chair, results in fewer musculoskeletal complaints from the surgeon and may improve surgical precision.

- Studies have shown that a favorable ergonomic position includes:
 - Laryngoscope angle of approximately 40 degrees from the horizon
 - Neutral surgeon neck position
 - Forearm stabilization and foot placement on the floor or stationary step⁹

Microflap

- The microflap technique historically involved an incision along the lateral aspect of the superior surface of the vocal fold, with subsequent medial dissection to the lesion. The lesion was then carefully dissected and removed, and the large, medially based microflap was put back into position. Scarring, denoted by decreased mucosal wave seen on stroboscopy, was found in the area of dissection. This observation led to modification of the procedure, with less scarring beyond the confines of the lesion. This new procedure was termed the mini microflap or medial microflap.^{2,10}
- This modern microflap involves starting the dissection immediately lateral to the lesion and avoiding unnecessary dissection in healthy tissue. The term *microflap technique* will be used from here on to denote this newer, and more focused, procedure.
- The three guiding principles of microflap excision of subepithelial pathology are as follows:
 - Make the epithelial incision as close to the submucosal pathology (lateral) as possible.
 - Do not disrupt normal tissue surrounding the vocal fold pathology.
 - Stay in as superficial a plane as possible.
- Epinephrine (1:10,000 concentration) is often injected at the base of the lesion before making the incision to ensure hemostasis and to achieve hydrodissection for better identification of the proper surgical plane (submucosal plane).
- The incision, using a sickle or straight knife, is made through the mucosa over, or immediately lateral to, the lesion (Fig. 2.4). This diminishes damage to surrounding normal tissue.

- A small curved elevator is then used to develop the plane between the mucosal microflap and the pathology. It is often easier to develop this plane anterior or posterior to the lesion and then extend it over the lesion itself (Fig. 2.5).
 - This is the most difficult maneuver of microflap surgery and must be done with great patience and caution.
 - In situations with significant epithelial attenuation, such as with polyps, not all the epithelium can be preserved. In these cases, preservation of as much healthy epithelium as possible is attempted.
 - Development of a plane between the submucosal pathology and vocal ligament is often easier, except with vocal fold cyst(s) and fibrous mass(es) involving the vocal ligament.
- Small curved microscissors may be necessary to release fibrous bands between the microflap and submucosal pathology or between the submucosal pathology and the underlying vocal ligament. Once the submucosal pathology has been dissected, it is carefully removed and sent for pathologic examination (Fig. 2.6).

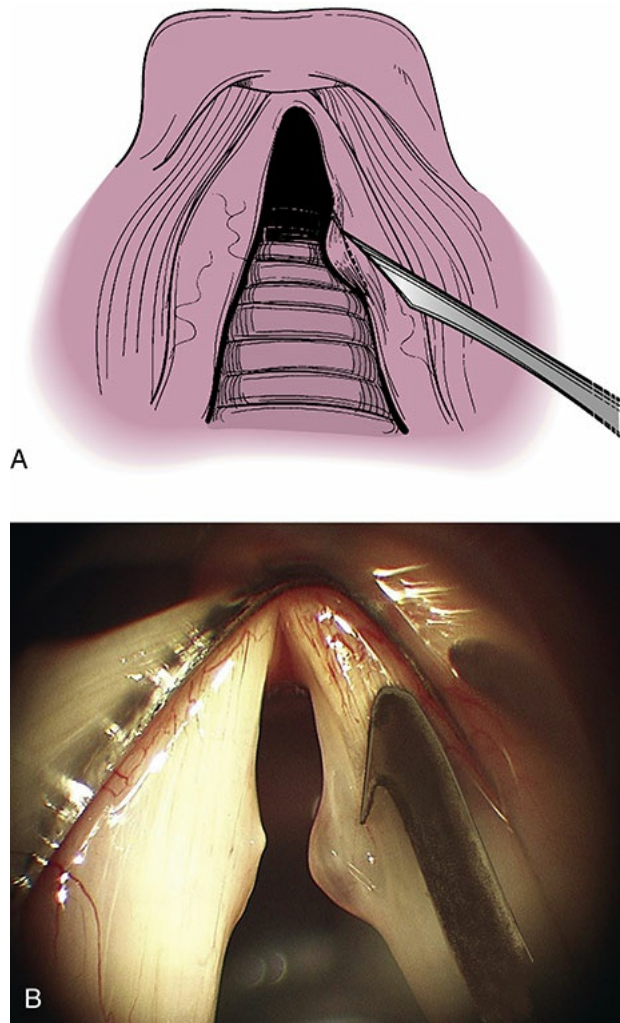


FIG. 2.4 **A**, Mucosal incision at the junction of vocal fold pathology and the superior surface of the vocal fold. **B**, Cordotomy at the lateral aspect of the lesion with a sickle knife.

- After removal of the primary lesion, the microflap should be retracted medially, and visual inspection of the operative site should be performed to make sure no other abnormal tissue is present.
- The microflap is then redraped (Fig. 2.7). Upon completion of the microflap excision, the free edge of the vocal fold (leading edge, medial edge) should be palpated and visually completely straight, without concavities or mucosal tags (see Fig. 2.3).
- Hemostasis is achieved by injecting epinephrine (1:10,000) at the surgical site before incision and placing epinephrine-soaked pledgets during and after surgical removal of the lesion.

Surgical Technique—Truncation

- Truncation (excision) of a vocal fold polyp is occasionally applicable. The lesion must be pedunculated. Indication for truncation versus microflap is severely abnormal epithelium surrounding the vocal fold lesion that would not be of any value to preserve with a microflap technique.
- Submucosal injection for hydrodissection is not recommended before truncation because it will obscure the desired excision location.

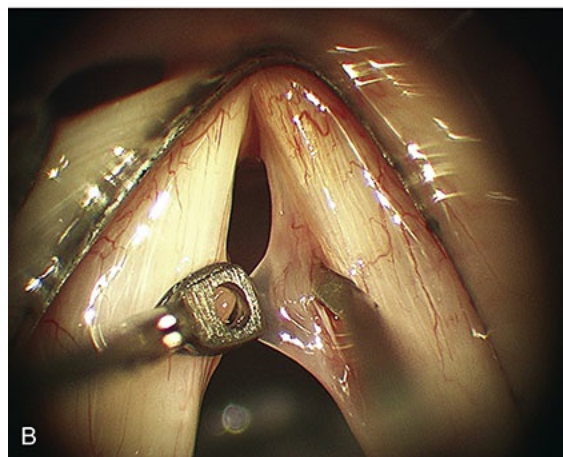
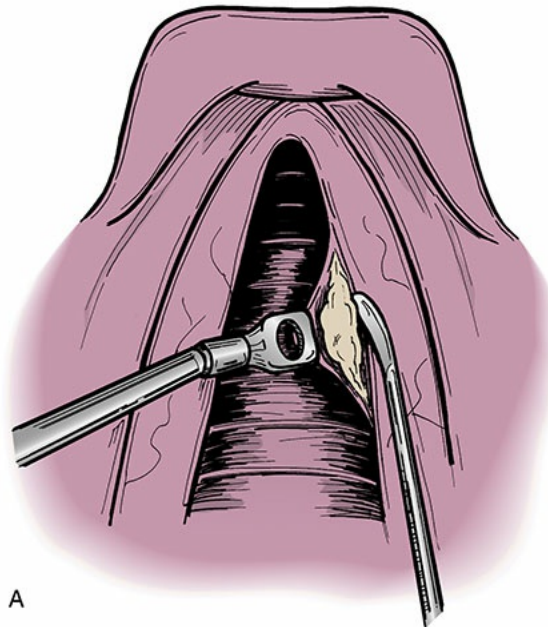


FIG. 2.5 A and B, Developing a plane with a blunt dissector between the lesion and deeper tissues.

- The pathology is grasped and gently retracted medially, and the stalk is cut at the level of the vocal fold mucosa (Fig. 2.8). A small epithelial defect will be produced.
- Great care should be taken to make sure that the truncation incision is precisely at the junction of the vocal fold pathology and the normal vocal fold free edge. Great care should be taken to not cut into the deeper aspect of the vocal fold during the truncation procedure.
- Hemostasis is achieved with pledgets soaked in epinephrine.

Common Errors in Technique

- Placing a small-bore laryngoscope resulting in suboptimal glottal exposure, which will negatively impact the precision of PMS
- Excessive resection of epithelium
- Placing the microflap incision too far lateral

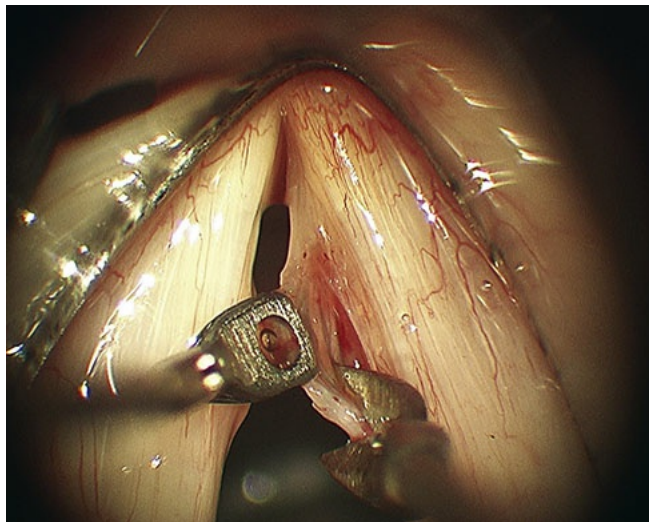


FIG. 2.6 Removal of the lesion and redundant mucosa.

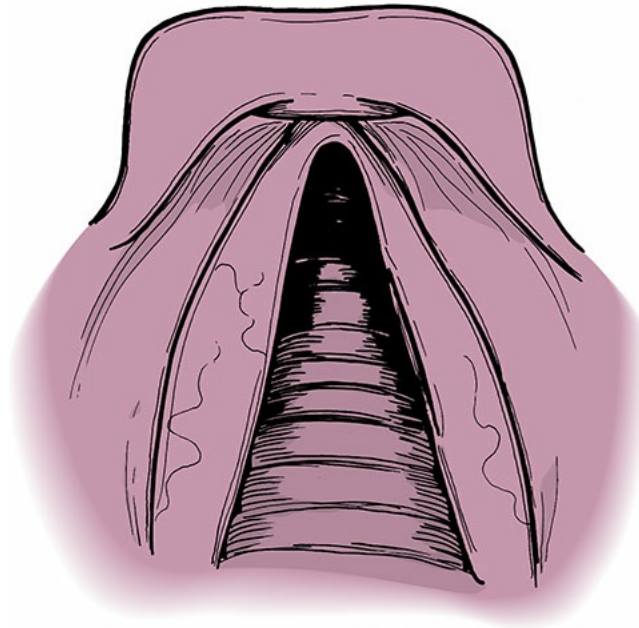


FIG. 2.7 Microflap redraped over the operative site.

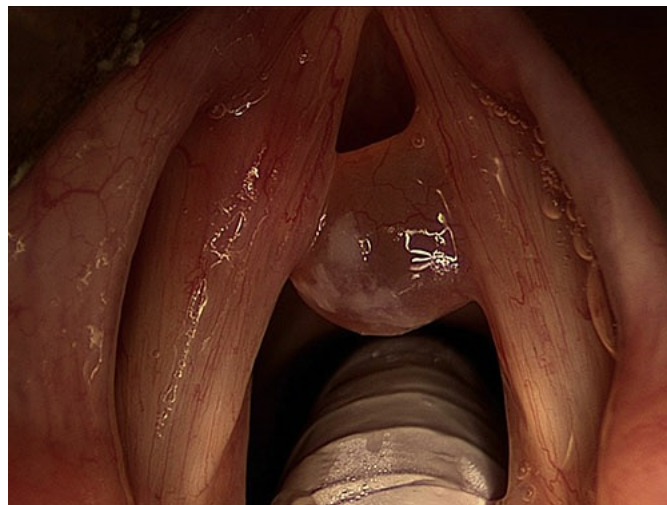


FIG. 2.8 Truncation of a vocal fold polyp (*dashed line*).

- Dissection deep to the lesion before performing the subepithelial dissection. This reduces the countertension that the surgeon relies on to perform the subepithelial dissection.
- Making the microflap incision too short, limiting exposure

Postoperative Period

Postoperative Management

- Voice rest is a component of almost every phonosurgical procedure. Absolute (strict) voice rest can range from as short as 2 days to as long as 14 days. The length of absolute voice rest depends on the extent of surgery, patient compliance, and the surgeon's philosophy and past experience.
- Absolute voice rest consists of restrictions on the following activities: talking, whispering, whistling, straining, Valsalva maneuvers, coughing, and sneezing.
- Upon completion of strict voice rest, stroboscopy should be performed to evaluate the level of healing of the vocal fold surgical site. If there is adequate epithelial coverage, the patient is transitioned to light voice use (relative voice rest), usually defined as 5 to 10 minutes of breathy, "airy" voicing per hour. The quantity of voice use is then increased over the subsequent weeks, often with the help of a speech-language pathologist.
- Patients should continue taking acid suspension medications after surgery to aid in the healing process.
- Proper hydration is strongly recommended.
- Continued smoking cessation after surgery is important for maximal healing.
- Postoperative voice therapy is indicated in the majority of PMS patients, to not only optimize final voice quality outcome but to also reduce the chances of return to phonotraumatic behaviors that likely resulted in formation of the initial benign vocal fold lesion.

Complications

- Outcomes of PMS for benign vocal fold lesions are generally extremely good.² Akbulut et al. demonstrated that the majority of midmembranous benign vocal fold lesions have an excellent prognosis for patient-perceived improvement in voice. Following PMS, the majority of patients report perceived voice handicaps within the normal range except for ligamentous fibrous mass lesions of the vocal

fold.⁴ The incidence of restoring the individual to a normal Voice Handicap Index-10 (VHI-10) after surgical excision of the majority of benign midmembranous lesions, except for ligamentous fibrous masses, ranges from 50% to 67%. In addition, the mean postoperative VHI-10 for all of the midmembranous vocal fold lesions (except for ligamentous fibrous masses) surgically treated is less than 11, which suggests a normal perception of voice handicap as patients without voice complaints. Overall, voice outcomes are typically very favorable after PMS; however, it is important that individual responses may vary from the overall core responses referenced previously.

- The factors that determine the level of success following surgical treatment for benign vocal fold lesions typically include:
 - Proper preoperative care,
 - Patient compliance,
 - Surgical precision,
 - Postoperative patient wound healing factors, and
 - Postoperative voice therapy.
- Complications of PMS range from the actions taken to achieve adequate exposure, to technical surgical points, to untoward vocal outcomes.
- The potential for injury to the teeth increases when the patient has poor dentition or multiple missing teeth and when difficulty is encountered in obtaining proper exposure of the larynx. Frequently, these patients can be detected before surgery. Use of reinforced plastic dental guards or firm, moldable splint (i.e., Aquaplast) may mitigate the risk of dental injury.
- Injury to the lingual nerve (numbness of the tongue, change in taste sensation) occurs in approximately 10% to 20% of patients. This is due to pressure from the laryngoscope, which usually resolves within 4 weeks.⁶
- There is a 1% to 2% risk of no voice improvement after PMS, in addition to a 1% to 2% risk of the voice becoming worse after surgery.
 - This is often due to poor wound healing with scar formation and/or comorbid vocal fold scar associated with the vocal fold lesion.

- If surgery requires deeper dissection into the vocal ligament, scar formation is likely.
- There is currently no cure for vocal fold scarring, so inadvertent disruption of tissues deep to the superficial lamina propria is discouraged unless mandated by the pathology.
- If the microflap is not appropriately draped over the surgical wound and therefore does not adhere to the vocal fold, epithelial ingrowth deep to the microflap may occur. Surgical excision of the microflap is then required.
- Microflap necrosis and flap death can occur with excessive edema and trauma. Accordingly, the flap must always be treated with great care.
- If necrosis of the microflap occurs, vocal fold healing on its own will take longer.
- Significant postoperative stiffness (scarring) can be treated with several monthly submucosal steroid injections, performed typically under local anesthesia, in an attempt to modify the wound-healing process.

Alternative Management Plan

1. Continued observation is an alternative choice of treatment for benign vocal fold lesions. This is a viable option for patients who are not bothered by their voice quality or it does not adversely affect their quality of life. Often serial, recorded examinations can be used to ensure that there is no progression of disease over time if no surgery is to be performed.
2. Prolonged voice rest is NOT a viable alternative management plan. Rather, it is critical to optimize the laryngeal mechanics of voicing to reduce adverse forces/tension during phonation. This is achieved through voice therapy and compliance on part of the patient. Voice therapy should be done by a dedicated speech-language pathologist who specializes in voice disorders.

Discussion

Evidence-Based Medicine Question

Is there a voice-related treatment outcome difference between ligamentous fibrous mass lesions compared with other subepithelial benign midmembranous vocal fold lesion(s) (subepithelial fibrous mass, vocal fold polyp, vocal nodules, etc.)?

Yes.

Akbulut et al. found that the treatment outcomes for patients with a ligamentous fibrous mass were worse compared with other benign subepithelial midmembranous vocal fold lesions.⁴ The difference in treatment outcome most likely occurs from the more extensive surgical dissection in and near the vocal ligament and the nature of the pathology of the lesion.

Editorial Comment

Laryngeal examination with videostroboscopy provides essential information about the possible type and depth of benign vocal fold lesion(s) and is a core aspect to the evaluation and treatment of patients with benign vocal fold lesions. Preoperative voice care in the form of voice therapy and counseling for surgery is required for most patients and establishes a platform for success after surgery. Worsening of the voice after surgery or no voice improvement (1% to 2% of patients for each) is a real risk and must be discussed with the patient preoperatively. Rushing a patient to surgery before thorough evaluations by a physician and speech therapist is a disservice to the ultimate care of the patient and may downgrade the outcome of the procedure.

A clear understanding of vocal fold anatomy is needed to perform precise microflap surgical dissection. Close collaboration with the anesthesia team, proper patient and surgeon positioning, adequate laryngeal exposure, and proper instrumentation are vital for success.

Imprecise dissection into the deeper layers of the vocal fold (vocal ligament and muscle) will lead to scar formation and thus worse vocal outcomes. Dental injuries do occur, often as a result of poor dentition or improper placement of the laryngoscope. The gallows suspension is superior to a rotation/fulcrum suspension device in both exposure and

minimizing dental injury.

Vyvy Young

● Access the review questions and additional sources list online at <http://www.expertconsult.com>

Review Questions

1. Select which are not principles of good ergonomics for phonomicrosurgery:
 - a. Neck and spine are aligned perpendicular to the floor
 - b. Establish a solid base by having the feet supported.
 - c. Keeping the arms near shoulder height**
 - d. Using adjustable eye pieces of the microscope, which are designed to minimize neck flexion or extension
 - e. Placing the proximal aspect of the laryngoscope near the height of the surgeon's umbilicus
2. Select which is not an indication for phonomicrosurgery:
 - a. Significant speaking voice limitations after maximum amount of nonsurgical therapy
 - b. The patient's desire to have "straight edges" of the vocal folds**
 - c. Significant singing voice limitations after maximum amount of nonsurgical therapy
 - d. Decreased pitch and roughness to the voice in a patient with Reinke edema
 - e. Frequent voice loss due to a vocal fold lesion despite voice therapy
3. Select statements that apply to microflap surgery of the vocal fold:
 - a. Care should be taken to conserve adjacent normal tissue.
 - b. The most common plane of dissection is in the subepithelial space.
 - c. Dissection deep to the vocal ligament is usually required.
 - d. Answers a & b**

- e. Answers a, b, & c
4. Appropriate surgical approach for vocal fold cysts and fibrous lesions includes which of the following?
- a. Vocal fold stripping
 - b. Partial cordotomy
 - c. **Microflap**
 - d. Open lateral approach
5. With surgical excision of a vocal fold cyst, which of the following statements is correct?
- a. Deep dissection to remove the cyst and surrounding cuff of muscle is most appropriate to prevent recurrence.
 - b. Stripping of the entire epithelial lining should be done first to better expose the cyst.
 - c. Purposeful puncture and drainage of the cyst are helpful for dissection.
 - d. **Dissection of the superficial epithelium from the cyst prior to deeper dissection is easier and helps to prevent inadvertent tearing of the epithelium.**
6. Which of the following patient-positioning techniques is NOT helpful for direct laryngoscopy?
- a. Head extension relative to the neck
 - b. Neck flexion
 - c. **Neck extension with shoulder roll**
 - d. Patient with head positioned at the end of the bed with the articulated head board of the operating table
7. Which of the following is NOT a key component of phonosurgery?
- a. **Wide local excision for prevention of recurrence**
 - b. Conservative removal of submucosal pathology with preservation of overlying epithelium

- c. Use of high-powered visualization with a microscope
 - d. Specialized microinstruments designed for the precision required to preserve the architecture of the vocal folds
8. A 36-year-old male has a left vocal fold exophytic lesion with normal overlying epithelium on examination with no other symptoms and no concerns with his voice or dyspnea. How would you manage this patient?
- a. Surgical removal with microflap
 - b. Observation**
 - c. Surgical removal with wide local excision
 - d. In-office biopsy

Additional Sources

Arffa R.E, Krishna P, Gartner-Schmidt J, et al. Normative values for the Voice Handicap Index-10. *J Voice*. 2012;26(4):462–465. doi: [10.1016/j.jvoice.2011.04.006](https://doi.org/10.1016/j.jvoice.2011.04.006).

Rosen C.A, Villagomez V.J. A unique complication of microflap surgery of the vocal fold. *Ear Nose Throat J*. 2001;80:623–624.

Wong A, Baker N, Smith L, et al. Prevalence and risk factors for musculoskeletal problems associated with microlaryngeal surgery: a national survey. *Laryngoscope*. 2014;124(8):1854–1861. doi: [10.1002/lary.24367](https://doi.org/10.1002/lary.24367).

References

1. Hirano M. Structure and vibratory behavior of the vocal fold. In: Sawashima M, Cooper F, eds. *Dynamic Aspects of Speech Production*. Tokyo: University of Tokyo; 1977:13–30.
2. Courey M.S, Garrett C.G, Ossoff R.H. Medial microflap for excision of benign vocal fold lesions. *Laryngoscope*. 1997;107:340–344.
3. Verdolini K, Rosen C.A, Branski R. *Classification Manual of Voice*

Disorders. Mahwah, NJ: Lawrence Erlbaum Associates; 2005:36–56.

4. Akbulut S, Gartner-Schmidt J, Gillespie A.I, et al. Voice outcomes following treatment of benign midmembranous vocal fold lesions using a nomenclature paradigm. *Laryngoscope*. 2016;126(2):415–420. doi: [10.1002/lary.25488](https://doi.org/10.1002/lary.25488).
5. Young V.N, Mallur P.S, Wong A.W, et al. Analysis of potassium titanyl phosphate laser settings and voice outcomes in the treatment of Reinke’s edema. *Ann Otol Rhinol Laryngol*. 2015;124(3):216–220. doi: [10.1177/0003489414549155](https://doi.org/10.1177/0003489414549155).
6. Rosen C.A, Andrade Filho P.A, Scheffel L, et al. Oropharyngeal complications of suspension laryngoscopy: a prospective study. *Laryngoscope*. 2005;115:1681–1684.
7. Zeitels S.M, Hillman R.E, Desloge R, et al. Phonomicrosurgery in singers and performing artists: treatment outcomes, management theories, and future directions. *Ann Otol Rhinol Laryngol Suppl*. 2002;190:21–40.
8. Zeitels S.M, Vaughan C.W. “External counterpressure” and “internal distention” for optimal laryngoscopic exposure of the anterior glottic commissure. *Ann Otol Rhinol Laryngol*. 1994;103:669–675.
9. Smith L.J, Trout J.M, Sridharan S.S, et al. Comparison of microsuspension laryngoscopy positions: a randomized, prospective study. *Laryngoscope*. 2015;125(3):649–654. doi: [10.1002/lary.24932](https://doi.org/10.1002/lary.24932).
10. Sataloff R.T, Spiegel J.R, Heuer R.J, et al. Laryngeal mini-microflap: a new technique and reassessment of the microflap saga. *J Voice*. 1995;9:198–204.

Recurrent Respiratory Papillomatosis

Thomas L. Carroll, and Anju Patel

Introduction

Recurrent respiratory papillomatosis (RRP) is a rare viral-induced disease of the upper aerodigestive tract characterized by epithelial lesions. Caused by human papillomavirus (HPV), this disease presents in both children and adults.¹ RRP is considered a benign neoplastic process; however, the disease can lead to significant morbidity and fatal complications, and there is a risk for RRP to transform into an epithelial malignancy (Fig. 3.1).²

The prevalence of RRP is approximately 4 in 100,000, with nearly 2000 pediatric cases diagnosed yearly.¹ Juvenile-onset RRP is typically diagnosed prior to age 5 and is considered more “aggressive” than adult-onset RRP, due to the significant impact the RRP lesions can have on the small pediatric airway.² In the United States, affected children may undergo more than four procedures yearly and on average nearly 20 in their lifetime.¹ Adult-onset RRP presents most commonly between 20 and 40 years of age (although it can present at any age), with a higher propensity in men. It also typically has a more indolent course with high remission rates.³

There are more than 100 HPV subtypes, though HPV 6 and 11 are most commonly associated with RRP. HPV 11 is typically more aggressive in disease progression. Less frequently, HPV 16 and 18 have been linked to RRP, though there is a higher rate of malignant transformation noted with these subtypes.² Vertical transmission is seen in juvenile-onset RRP. The route of transmission is not clearly known. Arguments have been made for hematogenous, intrauterine, and direct contact in the birth canal, as patients with juvenile-onset RRP are typically first born and vaginally delivered. Adult onset is associated with reactivation of

pediatric disease or secondary to a sexually transmitted disease.¹

It is theorized that microtears in the epithelium or co-infection with other microbes allows entry of HPV into the body. For example, increased cervical HPV rates are associated with concurrent *Trichomonas vaginalis* infections. These infections are believed to weaken the tight junctions of epithelial cells.³ Phonotrauma has been speculated as the etiology for entry into the vocal folds. After this occurs, an immune response is formed, and most individuals are able to clear the infection over the span of 2 years.³ Five percent of the population has HPV DNA identified in the larynx, though significantly fewer actually display findings consistent with RRP. The mechanism behind this remains unclear.³ Various factors including epidermal growth factor receptor, cyclooxygenase-2, and prostaglandins are overexpressed in papillomas, and this is currently an area of research for further treatment.³

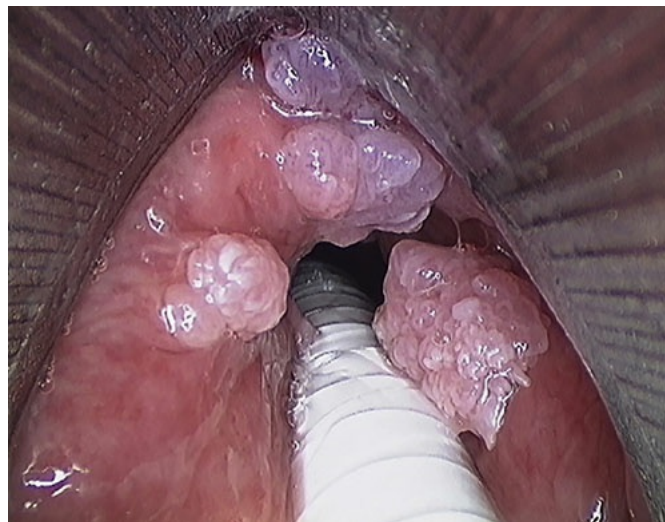


FIG. 3.1 Recurrent respiratory papillomatosis (RRP) of supraglottis and true vocal folds. Notice the frondlike appearance of a typical RRP lesion in this operative view.

Spread beyond the larynx is associated with increased morbidity and mortality and found in 30% of children and 16% of adults with RRP.¹ The most common sites of extralaryngeal spread include the oral cavity, trachea, and bronchi. Development of pulmonary RRP is linked to high mortality, despite aggressive medical and surgical management.³

Key Operative Learning Points

1. Potassium titanyl-phosphate (KTP) laser offers lesion excision, which is especially advantageous for awake, in-office treatment approaches but is also highly effective when used in the operating room (OR).
2. CO₂ laser and cold knife excision can be employed.
3. Office-based KTP laser is an effective method of removing the lesions and restoration of the voice.
4. Microdébriders can be used for bulky disease in the operative setting but should be used less preferentially in the supraglottis and/or subglottis.

Preoperative Period

History

1. Hoarseness without periods of clarity
2. Progressive stridor, cough, dyspnea
3. Recurrent pneumonia may be an indicator of pulmonary involvement.
4. Maternal or paternal history of genital warts
5. Immunization history

Physical Examination

1. Voice evaluation
 - a. Voice evaluation by a speech language pathologist (SLP) can establish a baseline from which to improve. The patient may require voice therapy after or between surgical procedures, and input from an SLP on the initial visit is helpful. However, voice therapy during active treatment is not usually helpful.
2. Vocal tract endoscopy
 - a. Endoscopy, either through a flexible laryngoscope or 70-degree

Hopkins rod, can delineate the extent of disease. Flexible endoscopy affords a view of the nasopharynx, which can often demonstrate concurrent RRP lesions on the pharyngeal surface of the soft palate. Laryngovideostroboscopy can be used as an adjunct to identify more sessile lesions or early recurrences. Chip tip flexible endoscopy can offer better visualization of vascularity and surface contours that often accompany RRP. This technology uses charge-coupled device chips to create digitally based images for endoscopy. Light filters can be employed diagnostically or as an adjunct to office-based KTP laser ablation of RRP.

3. Tracheoscopy

- a. In-office evaluation for extralaryngeal disease can be helpful for preoperative planning. Intubation may not be the best choice if subglottic lesions exist, and jet ventilation would need to be pursued.

4. Auscultation of the lungs

Imaging

Chest radiograph: Not typically indicated but could be used to identify pulmonary disease secondary to obstructive RRP lesions in the lower airways

Computed tomography: Not usually performed unless there is a concern for pulmonary involvement

Additional Testing

1. Pulmonary function tests (PFTs) if there is a concern for pulmonary involvement. Flow loops may be helpful, if there is stridor or dyspnea but no visualized laryngeal disease. It would be used as an adjunct to laryngoscopy and tracheobronchoscopy in cases of more extensive disease.

Indications

1. Dyspnea

2. Dysphonia
3. Globus sensation

Contraindications

None necessary

Preoperative Preparation

1. Discontinue anticoagulant and antiplatelet drugs for 1 week, if possible.
2. Consent for complications: Worsened voice, persistent dyspnea, need for further surgery, infection, injuries associated with suspension laryngoscopy (dental injury, mucosal injury, taste change; see [Chapter 2](#))

Operative Period

Anesthesia

OR: General, 5.0 microlaryngoscopy endotracheal tube (start with a laser-safe tube if planning on using a laser). This affords good airway control while providing unobstructed visualization of the glottis (see [Chapter 2](#)).

Office: Topical 4% lidocaine (techniques includes oxymetazoline-lidocaine spray to bilateral nares, insertion of cotton pledgets soaked with 4% lidocaine, nebulizer treatment with 4% lidocaine, topical drip of 4% lidocaine through a channel scope or with an Abraham cannula (see [Chapter 1](#)).

Positioning

OR: Supine, small round headrest, no shoulder roll, neck flexion may be useful if the larynx is very anterior

Office: Sniffing position, which has the patient rest his or her elbows on thighs, chin out, and nose out as if sniffing a flower

Perioperative Antibiotic Prophylaxis

None necessary

Monitoring

OR: Per anesthesia protocol

Office: Preprocedure vital signs. Brief monitoring for 15 to 20 minutes postprocedure in the waiting room is acceptable; no formal postprocedural monitoring or intraprocedure monitoring is used.

Instruments and Equipment to Have Available

1. KTP laser (or CO₂ laser with pattern generator)
2. Laser precaution equipment
3. Microdébrider (OR)
4. Microlaryngeal instruments
5. Suspension microlaryngoscopy setup
6. Microscope with 400 mm lens
7. Operating chair
8. Laryngotracheal anesthesia
9. Channel flexible laryngoscope (office procedure)

Key Anatomic Landmarks

Anterior commissure: Should be visualized at the time of surgery to evaluate for RRP and also monitor and minimize trauma

Prerequisite Skills

1. Flexible laryngoscopy

2. Direct laryngoscopy

Operative Risks

1. Injury to normal laryngeal structures
2. Intraoperative airway fire
3. Suspension laryngoscopy: Dental injury, mucosal injury, metallic taste. Numbness of the tongue may occur and typically resolves spontaneously over 2 to 6 weeks.⁴

Surgical Technique

- OR: Turn the bed 90 degrees. Keep the bed level with a headrest under the head. Apply a tooth guard to protect the maxillary dentition. All exposed facial and upper body skin are covered with wet towels if a laser is to be used. Airway evaluation should now be performed with examination of the oral cavity, oropharynx, hypopharynx, endolarynx, subglottis, and trachea to accurately stage the sites and extent of disease. Use the largest laryngoscope possible. Advance the laryngoscope until optimal exposure of the endolarynx is achieved. Suspend the laryngoscope. Use angled telescopes in 0, 30, and 70 degrees to (1) map out all RRP disease locations and nature, and (2) take photographic documentation. This helps in visualizing the locations of the lesions. The ventricle, undersurface of the vocal folds and anterior and posterior commissures are best visualized with 30- and 70-degree telescopes. The operating microscope is then brought in to further visualize the affected regions. A ½-by 3-inch pledget soaked in saline is placed in the subglottis above the endotracheal tube cuff if the CO₂ laser is to be used. A small amount of papilloma is excised with cold instruments and sent for biopsy. The remaining papillomas are now removed using the surgeon's method of choice:

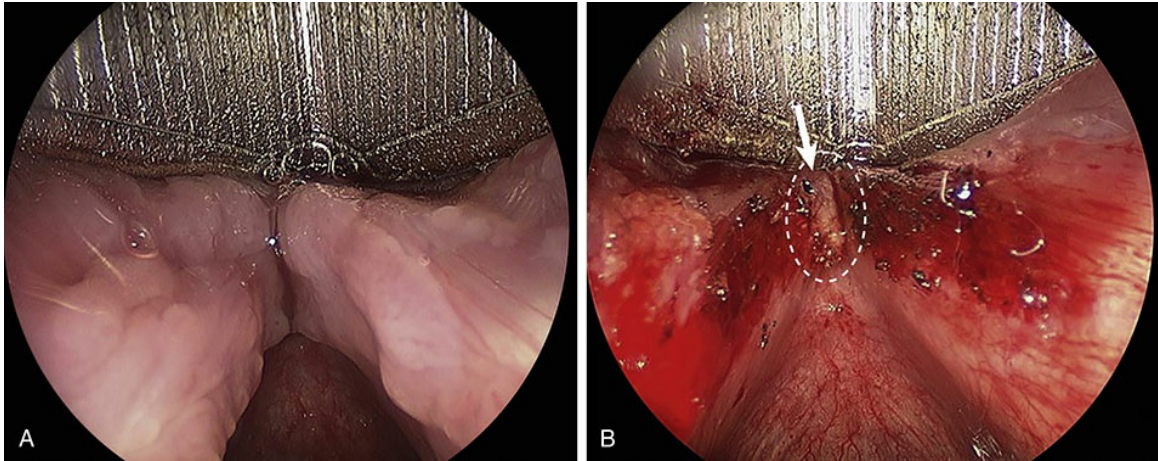


FIG. 3.2 Staging of recurrent respiratory papilloma (RRP) removal from the anterior commissure. **A**, Intraoperative photograph before RRP removal. Notice bilateral anterior commissure lesions. **B**, After right-sided RRP removal. Lesions are intentionally not removed from the left anterior commissure to prevent formation of an anterior glottic web (*arrow and circled area*).

- KTP laser removal of RRP can be done in several methods.⁵

1) KTP removal of RRP (outside-in)

To minimize the risk of thermal injury to the vocal fold while using the KTP laser for removal of RRP, the KTP laser is fired directly at the RRP, with the laser energy and working distance adjusted to result in a “blanching” effect on the RRP with the KTP laser energy. If the surgeon feels that this treatment effect, KTP-1, will be adequate, then the KTP treatment is done. Additional KTP laser energy can be applied to the operative site, which will cause small epithelial “craters” (i.e., disruption of the epithelium of the RRP tissue). Often this KTP-2 treatment effect will be sufficient for successful RRP treatment. If the RRP is bulky, additional KTP laser energy can be applied (often with laser fiber direct contact), resulting in a KTP-3 treatment effect. If the surgeon’s goal is complete removal of the RRP at the time of surgery, after the entire area of RRP has been “blanched” from a conservative and minimal KTP laser energy delivery approach, a suction (5 or 7 French) is used to remove the treated RRP surface. If there is additional RRP present after the treated

disease has been removed by suction or cup forceps, the same use of the KTP laser can be employed until there is no gross RRP present at the operative site (KTP-4).

2) KTP removal of RRP (inside-out)

Working within the plane between the papilloma and the normal underlying true vocal fold tissue, the lesions can be removed in their entirety while staying as superficial as possible. The KTP laser is often used for areas of minimal disease and can be time consuming if used in an angiolytic fashion. Alternatively, it can be used to remove bulky lesions via a dissection technique that seeks to achieve KTP-4 laser effects.⁵ This focuses on ablation of the interface between the normal vocal fold and RRP: Use settings of approximately 30 to 35 watts, 15 millisecond pulse width, and 2 to 3 pulses per second. Beginning at an area of transition between RRP and normal epithelium, the laser can be used to blanch this area until it can be sloughed off with another tool such as suction. Once this plane is established, dissection of the tissue can be performed along the entirety of the undersurface of the lesion (see Video 3.1).

- “Cold steel” may be used to dissect just below the epithelium and remove the RRP lesion, trying to preserve as much lamina propria as possible.
- CO₂ laser with pattern generator may also be considered when available and used to ablate the lesions.
- The microdébrider can be employed to remove bulky lesions and especially above and below the true vocal folds; however, it is not recommended to be used aggressively on the true vocal fold. Often the microdébrider is employed to debulk, and the KTP laser or cold steel can resect the lesions on the true vocal fold tissue.
- Oxymetazoline or 1:10,000 epinephrine-soaked pledgets are used for hemostasis. At the end of the procedure, laryngotracheal anesthesia is sprayed into the endolarynx for topical anesthesia.
- Care must be taken at the anterior commissure of the vocal folds. Leaving some residual RRP on one side and staging the surgery into two parts is often employed to avoid a laryngeal web. Alternatively,

when using KTP or CO₂ laser, a small amount of RRP can be blanched but left in place (not suctioned off) on one side of the anterior commissure to slough on its own (Fig. 3.2).

- Office: Fig. 3.3 and Video 3.2. Apply anesthetic as instructed previously. (It is optional to place a 14-French nasogastric tube through one nostril and attach it to suction to remove plume during surgery if the patient can tolerate it.) Laser safety precautions should be taken. Thread KTP laser fiber through channel scope. Using a setting of 30 to 35 watts, 2 pulses per second, and a 15 millisecond pulse width, ablate papillomas as tolerated from a patient standpoint. Ideally this technique is used for recurrent lesions or as a staged procedure after the initial biopsy or total surgical removal or for very limited initial lesions.
- KTP laser treatment effects are described using a five-point classification system⁵:
 - KTP V, noncontact angiolysis
 - KTP 1, epithelial blanching
 - KTP 2, epithelial disruption
 - KTP 3, contact epithelial ablation
 - KTP 4, contact epithelial ablation with tissue removal

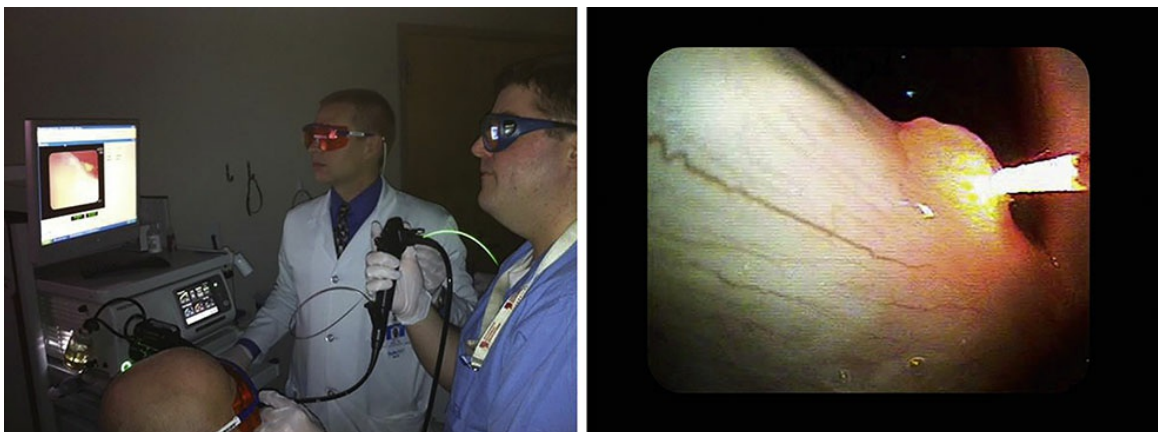


FIG. 3.3 In-office potassium titanyl-phosphate (KTP) laser use. The availability of office-based treatments of recurrent respiratory papilloma with KTP laser has

revolutionized the management of this disease. The patient can be seated comfortably and be given topical anesthesia, and the surgeon can accomplish in 5 minutes what typically would take an hour or more in the operating room.

Common Errors in Technique

1. Suboptimal exposure due to incorrect placement of the laryngoscope: Ensure that the head and neck are in good placement (neck flexion, head extension), adjust the laryngoscope to the optimal depth such that the anterior commissure can be visualized, and use adhesive tape to apply anterior cricoid pressure if needed.
2. Deep dissection: Deep, cold knife dissection or aggressive CO₂ laser used in a cutting rather than ablative fashion can lead to poor voice outcomes, especially after multiple surgeries due to scar formation in the lamina propria. With the advent of new technologies and techniques, RRP surgery can preserve the voice. Injury from laser heat (i.e., depth of penetration of laser energy) must be considered; the voice may suffer with delayed recovery of lamina propria vibration and possibly permanent scar tissue formation.
3. Patient tolerance of awake, unsedated KTP laser procedure: Nasal anesthesia is most important. Allow the cotton pledgets soaked in lidocaine to remain in the nose for at least 5 minutes. Confirming laryngeal anesthesia by touching areas to be treated with a drip catheter or scope before starting to use the laser helps reassure the clinician of appropriate topical anesthesia. The patient will feel the laser if the surgeon works for too long in one area. The surgeon should change locations to another area of RRP if the patient is uncomfortable during the laser procedure.

Postoperative Period

Postoperative Management

1. Initial 4- to 6-week postoperative follow-up

2. Office-based KTP laser procedures for recurrences to avoid another OR procedure
3. Adjust frequency of visits based on recurrence rate or if the location of the disease is impacting voice or breathing.

Complications

1. Worsened voice or breathing due to glottic or subglottic stenosis: May require further surgery to address the area of scarring, though this is a very difficult problem to treat, especially in the setting of active RRP. Anterior glottic webs are the most common scars to form as a result of aggressive, anterior, and bilateral resection with any of the previously listed methods, including KTP laser. This can be prevented by leaving a small area on one side of the anterior commissure with untreated RRP (with a plan to remove on “staged” second look in OR or in office) or ablated/blanched RRP but not removing it or sloughing it off with the suction.

Alternative Management Plan

1. Cidofovir: Antiviral medication that is an adjunct treatment to surgery. It is injected intralesionally and used in an off-label manner. It selectively inhibits viral DNA polymerase and stops viral replication. This medication gained popularity in the 1990s because it increases time intervals between treatments. Patients should be informed that studies in rats with very high-dose exposure have demonstrated an increased rate of malignant transformation. The RRP Task Force indications for cidofovir use include the need for six or more surgeries yearly, increasing frequency of surgeries, and extralaryngeal spread.⁶ The recommended dose is approximately 2 mL in children and 4 mL in adults of a 5 mg/mL solution every 2 to 4 weeks, for a trial of 3 to 5 injections.² Minimal medication is noted in the serum during and after the procedure.

2. Interferon: Nonspecific regulatory proteins that have antiviral, antiproliferative, and immunomodulating activities. This is a systemic therapy given via subcutaneous injection. Side effects include neuropsychiatric changes and bone marrow suppression. Altered hormone levels may lead to infertility. Effective therapy has been

documented; however, a rebound effect occurs once therapy is stopped.⁷

3. Bevacizumab (Avastin): An adjunct treatment to surgery. It is a chemotherapeutic agent that consists of recombinant humanized monoclonal immunoglobulin G1 antibodies that inhibits endothelial growth factor, also injected intralesionally.⁸

4. Indole 3-carbinol (I3C): Compound derived from cruciferous vegetables such as broccoli, brussel sprouts, cabbage, and cauliflower. I3C can also be found as an over-the-counter supplement. It affects cytochrome P450-regulated estrogen metabolism and, as a consequence, inhibits estrogen-dependent growth of papilloma tissue.⁷

5. HPV quadrivalent vaccine: This vaccine uses virus-like particles to produce an antibody response against subtypes 6, 11, 16, and 18. These subtypes are associated with RRP; therefore, it is critical to discuss this topic with patients and their families. This is not a therapeutic vaccine and thus has no role for patients with active disease. However, widespread pre-HPV-exposure vaccination will lead to the eradication of RRP. The eventual elimination of this disease could be achieved with widespread vaccinations and herd immunity.⁷

Discussion

1. The use of the KTP laser has become more commonplace, often replacing a pulse dyed laser with similar or possibly better tissue interaction.

2. The key to successful voice outcomes is preservation of the lamina propria and conservative surgery.

3. Follow up in office for surveillance and for KTP laser procedures for recurrences.

4. Adjunctive treatments can be helpful in the setting of severe disease, frequent recurrence, or recurrences that are in suboptimal position for voicing.

5. From a preventative standpoint the HPV vaccine offers the strongest potential for eliminating RRP in the future.

Evidence-Based Medicine Question

How is adult-onset RRP transmitted?

Two methods of disease acquisition are postulated in the literature. The first occurs by vertical transmission from mother to child. Patients may be infected with the HPV but do not become symptomatic until later in life. Literature has described increased risk in first-born individuals, delivered vaginally in teenage mothers. However, this is controversial, as Ruiz et al. did not show differences in RRP patients compared with control patients suggesting another mode of transmission is more likely.

The second method is through sexual contact. Having multiple sexual partners has been associated with HPV-related oropharyngeal squamous cell carcinoma and has been considered in other disease processes. Ruiz et al. observed a possible association between RRP and increased number of lifetime vaginal/anal sex partners. There was no association between RRP and the number of oral sex partners noted. They suspect that RRP is not correlated with orogenital contact but rather mouth-to-mouth contact. Therefore, any intimate oral contact could be associated with spread of the disease. Further studies will be needed to evaluate the RRP population more closely and on a greater scale.

Editorial Comment

The diagnosis of true vocal fold RRP is no longer a vocal “death sentence.” The implementation of photangiolytic lasers such as pulsed dye and KTP affords the user the ability to remove RRP lesions above the level of the lamina propria in their entirety, preserving vibration and voice. Office-based KTP laser ablation of RRP has afforded patients the ability to avoid multiple missed days from work for both the procedure and the recovery. Adjunctive therapies such as cidofovir continue to have a role in the treatment of RRP, and newer adjuncts such as bevacizumab show promise.

Thomas L. Carroll

● Access the review questions and additional sources list online at <http://www.expertconsult.com>

Review Questions

1. Which of the following is an indication for cidofovir use according to the RRP Task Force?
 - a. Age less than 10 at diagnosis
 - b. Age greater than 50 at diagnosis
 - c. Need for 6 or more surgeries yearly**
 - d. High-risk HPV subtype
 - e. RRP that reoccurs on an annual basis
2. Which HPV subtype is most commonly associated with RRP?
 - a. HPV 6 and 18
 - b. HPV 6 and 11**
 - c. HPV 11 and 16
 - d. HPV 16 and 18
 - e. HPV 22 and 27
3. Who is the HPV vaccine currently offered to?
 - a. All individuals
 - b. Only women over the age of 11 and under age 27
 - c. All individuals over the age of 11 and under age 27**
 - d. All individuals under age 27
 - e. Individuals with the recent diagnosis of RRP

Additional Sources

- Rosen C.A, Bryson P. Indole-3-carbinol for recurrent respiratory papillomatosis: long-term results. *J Voice*. 2004;18:248–2253.
- Ruiz R, Achlatis S, Verma A, et al. Risk factors for adult-onset recurrent respiratory papillomatosis. *Laryngoscope*. 2014;124(10):2338–232344.

References

1. Wilcox L.J, Hull B.P, Baldassari C.M, et al. Diagnosis and management of recurrent respiratory papillomatosis. *Pediatr Infect Dis J.* 2014;33(12):1283–1281284.
2. Silverman D.A. Pitman MJ. Current diagnostic and management trends for recurrent respiratory papillomatosis. *Curr Opin Otolaryngol Head Neck Surg.* 2004;12:532–537.
3. Taliercio S, Cespedes M, Born H, et al. Adult-onset recurrent respiratory papillomatosis: a review of disease pathogenesis and implications for patient counseling. *JAMA Otolaryngol Head Neck Surg.* 2015;141(1):78–83.
4. Rosen C.A, Andrade Filho P.A, Scheffel L, et al. Oropharyngeal complications of suspension laryngoscopy: a prospective study. *Laryngoscope.* 2005;115(9):1681–1681684.
5. Mallur P.S, Johns 3rd. M.M, Amin M.R, et al. Proposed classification system for reporting 532-nm pulsed potassium titanyl phosphate laser treatment effects on vocal fold lesions. *Laryngoscope.* 2014;124:1170–1171175.
6. Derkay C.S, Volsky P.G, Rosen C.A, et al. Current use of intralesional cidofovir for recurrent respiratory papillomatosis. *Laryngoscope.* 2013;123(3):705–7712.
7. Gallagher T.Q, Derkay C.S. Pharmacotherapy of recurrent respiratory papillomatosis: an expert opinion. *Expert Opin Pharmacother.* 2009;10(4):645–6655.
8. Zeitels S.M, Barbu A.M, Landau-Zemer T, et al. Local injection of bevacizumab (Avastin) and angiolytic KTP laser treatment of recurrent respiratory papillomatosis of the vocal folds: a prospective study. *Ann Otol Rhinol Laryngol.* 2011;120(10):627–6634.

Vocal Fold Injection via Microlaryngoscopy

Vyvy Young

Introduction

The term *vocal fold injection* (VFI) typically refers to global vocal fold augmentation for purposes of addressing glottic insufficiency,¹ although superficial injection into the lamina propria is performed occasionally (e.g., steroids, as for the treatment of vocal fold scar). In situations where the impact of global augmentation on symptoms is unpredictable, a trial VFI with a temporary material may also be beneficial.² Many options for augmentation material are currently available, with variable advantages, disadvantages, and durations of benefit. Advances in technology and techniques now allow Otolaryngologists to perform VFI under either local or general anesthesia.¹ This chapter focuses on VFI via microlaryngoscopy under general anesthesia.

Selection of injection material, type of anesthesia, and location of procedure (e.g., office, operating room, or endoscopy/procedure suite) should be determined on a case-by-case basis. Factors to consider include the patient's medical comorbidities and candidacy for the procedure, patient and/or surgeon preference, expected duration of symptoms/vocal fold motion abnormality (i.e., immediate postoperative period following surgery with high hopes for spontaneous recovery of motion vs. underlying malignancy), need or preference for hemodynamic monitoring, goal of the procedure (e.g., symptom treatment vs. trial), and insurance-related considerations.

VFI via microlaryngoscopy remains an important tool in the care of patients with symptomatic glottic insufficiency. Key advantages of this technique include immobility of the vocal folds and improved precision of injection material placement, complete airway control, and more

detailed investigation of the vocal folds (including direct palpation to assess for vocal fold scar or cricoarytenoid joint fixation). Results of VFI are typically excellent in patients with glottic insufficiency related to vocal fold immobility/paralysis; outcomes of VFI for other laryngeal conditions such as vocal fold atrophy or scar tend to be more variable.

Key Operative Learning Points

1. Adequate laryngeal exposure is critical.
2. Familiarity with different types of laryngoscopes
3. Familiarity with different injection material options
4. Typically the goal is global augmentation. (It is important to know when to use superficial injection.)
5. Superficial injection is to be avoided when global augmentation is the goal.

Preoperative Period

History

1. History of present illness
 - a. Voice
 - 1) Characteristics: breathy, raspy, decreased volume/projection, increased effort, vocal fatigue, vocal strain, tightness, pain with speaking
 - 2) Aggravating or alleviating factors
 - a) For example, voice rest versus prolonged speaking, change in weather/temperature/humidity, stress, medications
 - b. Swallowing
 - 1) Characteristics: dysphagia to liquids versus solids versus pills, coughing or choking episodes, need for Heimlich maneuver, weight loss, change in diet

2) Aggravating or alleviating factors

- a) Impact of compensatory strategies: head turn, chin tuck, double swallow, liquid wash

3) Asking about history of recent pneumonia is of critical importance.

c. Breathing

- 1) Characteristics: dyspnea with speaking versus exertion versus rest

2) Aggravating or alleviating factors

d. Precipitating factors

1) Surgery

- a) Thyroid
- b) Cervical spine
- c) Lung
- d) Esophagus

2) Intubation

- a) Size of endotracheal tube
- b) Duration of intubation

3) Upper respiratory infection

4) Accident/trauma

5) None identifiable

e. Other associated symptoms

1) Cough

2) Globus sensation

3) Throat clearing

4) Mucus

- 5) Other symptoms including reflux-related (e.g., heartburn, burning sensation in nose/mouth/throat, or bitter/sour taste)

2. Past medical history

a. Prior treatment and its efficacy

- 1) Surgery
- 2) Speech therapy
- 3) Over-the-counter (OTC) medications (mucolytics, antihistamines, throat sprays, lozenges)
- 4) Voice rest
- 5) Steroids
- 6) Antibiotics
- 7) Gargling
- 8) Increased fluids (e.g., water, tea)

b. Medical history

- 1) General assessment regarding candidacy for surgical procedure

c. Surgery

- 1) Especially important to include cervical spine, other neck, and/or chest surgery

d. Family history: usually not helpful

e. Medications

- 1) Antiplatelet drugs
 - a) Not a specific contraindication. Important to make sure that patient is counseled appropriately about risk of hemorrhage and even airway compromise.

f. Social history

- 1) Tobacco use
 - a) Active tobacco use can increase the risk of postoperative coughing (at extubation and in the early postoperative period), which may increase the risk of premature implant extrusion.
- 2) Occupation and associated vocal demands (e.g., teacher, cashier, call center worker, attorney, social worker, waiter/bartender)

Physical Examination

1. Examination of the head and neck with focused areas as listed here
2. Examination of the neck
 - a. Evidence of prior surgery (e.g., scars) or trauma
 - b. Degree of cervical range of motion and any restrictions (flexion or extension); this may affect ease of intubation and/or exposure with the laryngoscope
3. Oral cavity
 - a. Evaluate for trismus.
 - b. Assess status of patient's dentition. Pay particular attention to the presence of any of the following: caps, crowns, partial dentures, bridges, missing/loose/broken teeth.
 - c. Look for torus mandibularis (may require a smaller laryngoscope).
4. Flexible laryngoscopy
 - a. Flexible laryngoscopy is critical in the evaluation of patients with voice, swallowing, or breathing symptoms.
 - b. Flexible laryngoscopy is superior to rigid oral laryngoscopy in the assessment of vocal fold motion. The use of a rigid Hopkins rod telescope or high-definition chip-tip flexible laryngoscope may allow improved magnification and visualization of specific vocal fold abnormalities (e.g., vocal fold scar, lesions, sulcus vocalis).
 - c. Specific task: repeated alternating sniff-/i/ maneuvers are especially useful for assessing vocal fold ABDuction (opening) and ADDuction (closing).

Imaging

1. Typically imaging is indicated only in cases of vocal fold immobility of uncertain etiology.
2. Computed tomography (CT) of the neck can serve to evaluate the course of the recurrent laryngeal nerve.

- a. CT may not be indicated if the history is strongly suggestive of an etiology of vocal fold immobility/paralysis (e.g., anterior cervical discectomy and fusion (ACDF), thyroidectomy, esophagectomy, lung surgery).
3. Modified barium swallow if indicated to evaluate dysphagia
 - a. MBS may be useful in situations where the surgeon is trying to decide whether to proceed with VFI versus continuing with observation alone; the presence of aspiration is a strong indication to proceed. If there is no aspiration, observation may be a reasonable alternative.

Indications

1. Symptomatic glottic insufficiency (which may be due to vocal fold immobility, paresis, atrophy)¹
 - a. Voice
 - b. Swallowing
 - c. Breathing
 - d. Some combination of these symptoms
2. *Trial* VFI²
 - a. In some cases it is not obvious whether vocal fold augmentation alone will improve voice symptoms. In these patients, the use of a temporary augmentation material as a “trial” VFI may be helpful in clarifying the degree of benefit that may be achieved after vocal fold augmentation.
 - b. Examples of situations in which trial VFI may be helpful: vocal fold scar, atrophy, paresis, or concurrent neurologic disease (e.g., causing dysarthria)

Contraindications

1. Patients with medical comorbidities that carry an increased risk for general anesthesia need to carefully weigh the potential risks versus benefits of VFI. The presence of such a risk is not an absolute

contraindication, but in such patients VFI under local anesthesia may be a good alternative option. The reader is referred to [Chapter 94](#) and also item 3 under Additional Resources at the end of this chapter.

2. Although not an absolute contraindication, it is strongly suggested that VFI be considered with great caution in cases of a unilateral vocal fold immobility, which is associated with a contralateral vocal fold hypomobility, as these patients will have a baseline decrease in glottic airway size. Further vocal fold augmentation (either unilateral or bilateral) may additionally narrow this already restricted airway and should be undertaken with extreme care.

- a. It is uncommon that the benefits would outweigh the risks in patients with these vocal fold motion abnormalities. (An example might be a patient with documented aspiration who refuses a tracheostomy.) This issue should be considered in depth prior to proceeding.
- b. Extensive counseling of all parties including the patient, his or her family, and other associated services (e.g., Thoracic Surgery) is critical. It is particularly important to discuss the risk of airway compromise and the possibility of requiring urgent intubation and/or tracheostomy.
- c. If VFI is pursued, this should be performed very conservatively, as anteriorly as possible, and under as carefully controlled circumstances as possible.

Preoperative Preparation

1. Flexible laryngoscopy is imperative; additionally, *stroboscopy* is strongly recommended.

- a. Know which side to augment (critical in cases of planned unilateral injection).
- b. Know the size of the glottic gap (helps to guide the degree of augmentation to be performed).
- c. Evaluate the presence of vocal fold height mismatch. This may guide the location of injection material in an attempt to improve “matching” up of vocal fold levels.

d. Flexible stroboscopy is superior to laryngoscopy alone for the assessment of vocal fold closure, size of the glottic gap, and the presence of vocal fold height mismatch.

2. Counseling to establish expectations (for both patient and family)

a. The goal is to recover the patient's normal voice, but it is possible that the patient's symptoms may be improved or even resolved without a complete return to "normal." Use of patient self-report questionnaires (i.e., Voice Handicap Index [VHI], VHI-10, Voice Related Quality of Life [VRQOL]) may be helpful in monitoring the patient's degree of symptomatology and response to treatment. I assess pre- and postinjection VHI-10 scores in all patients.

b. The patient is advised about the potential need for additional procedures. This may be especially appropriate in cases of temporary VFI (such as following acute-onset vocal fold immobility), but it may even be needed following long-term augmentation, as with adipose tissue.

c. In cases of trial VFI, the patient is counseled that voice symptoms may improve, decline, or remain unchanged.

3. Discontinue antiplatelet drugs if possible.

Operative Period

Anesthesia

1. VFI is traditionally performed under general endotracheal anesthesia (GETA). More recent techniques to perform VFI under local anesthesia have been described; the reader is referred to [Chapter 1](#) for further details. This chapter focuses on VFI under GETA.

2. Use as small an endotracheal tube as possible to permit maximal visualization of the vocal folds during laryngoscopy. I prefer a 5.0 microlaryngoscopy tube (MLT) for all laryngeal surgery. This should be taped to the oral commissure, preferably along the upper lip. Taping to the lower lip can sometimes affect oral opening and thus laryngoscopic exposure. Moving the "tube tree" or endotracheal tube holder further down the body (not immediately next to the head and neck) is helpful for

keeping the anesthesia circuit out of the way.

3. Perioperative medications: one-time dosing at the start of the case
 - a. Dexamethasone (Decadron)—decreases laryngeal edema
 - b. Ondansetron (Zofran)—decreases nausea and associated risk for postoperative emesis
 - c. Glycopyrrolate—decreases secretions and facilitates visualization during laryngoscopy
4. Laryngotracheal anesthesia (plain lidocaine, either 4% or 2%, based on availability and/or surgeon preference. I prefer 4% spray).
 - a. Administered once at intubation (can be done by anesthesia)
 - b. Administered a second time at the end of the procedure prior to extubation—decreases risk of laryngospasm and coughing upon extubation
5. A short-duration muscle relaxant is helpful during the procedure.

Positioning

1. Supine
2. No shoulder roll—it would place the patient in a suboptimal position for laryngoscopy
3. It is helpful to have an adjustable headboard to allow neck flexion if needed. Having the operative bed backward can allow this.

Perioperative Antibiotic Prophylaxis

Not indicated

Monitoring

1. Routine anesthesia monitoring
2. Short-duration muscle relaxant

Instruments and Equipment to Have Available

1. Multiple sizes and types of laryngoscopes
 - a. Small-caliber laryngoscopes
 - b. Longer laryngoscopes
 - c. Laryngoscope with anterior “lip”
2. Small-caliber suction (5, 6, or 7 Fr)
3. Head light box depending on the type of light source
4. Reinforced dental guard to prevent injury to the teeth
5. Rigid telescope(s) versus microscope
 - a. With camera equipment and monitor—especially helpful in teaching situations

Key Anatomic Landmarks:

1. Superior arcuate line [Fig. 4.1](#)
2. Vocal process

Prerequisite Skills

1. Laryngoscopy

Operative Risks

1. Airway compromise
 - a. May result from bleeding, overaugmentation, or laryngospasm
2. Vocal fold hemorrhage
3. Poor injection (i.e., too superficial, too anterior, inadequate quantity) resulting in worsening or no change in symptoms
4. Injury to teeth/gums/lips

5. Tongue—numbness or change in taste

- a. Avoid by timely completion of surgery and/or releasing suspension during prolonged cases

Surgical Technique

- Ensure adequate anesthesia/relaxation.
- Eye protection. Drape head for laryngoscopy—this also protects the eyes.
- Reinforce a plastic dental guard with several layers of tape; this provides an easy, convenient, and inexpensive additional layer of protection. Place this reinforced guard over the maxillary dentition. For edentulous patients, a foam pad or moistened gauze may be used to protect the alveolar ridge.
- Pass the laryngoscope by mouth and advance to the larynx under direct visualization.
 - Keep the laryngoscope in the midline—this decreases pressure on the tongue.
 - Attempt to keep the epiglottis in the normal anatomic position as the laryngoscope slides underneath.(Exception: The Lindholm laryngoscope is designed to be placed into the vallecula and so does not pass under the epiglottis.) Folding over of the epiglottis can increase the difficulty of achieving an adequate laryngoscopic view of the vocal folds.
 - Flex the head if necessary.
 - Do not use a shoulder roll.
 - Maintain good direction of pull on the laryngoscope, primarily up and away. Avoid rocking back on the teeth.
- Special note on the choice of laryngoscope:
 - I prefer to use the laryngoscope with the largest possible distal aperture to allow full visualization of both true vocal folds simultaneously. My preference is to start with the largest-caliber universal modular glottiscope or the Dedo, depending on

availability. If adequate visualization cannot be achieved in this way, a smaller laryngoscope may be substituted.

- I prefer the use of the slotted anterior commissure scope when VFI is performed using telescopic guidance (as opposed to microscopic guidance). The slot facilitates manipulation of both a telescope and the needle within the confines of a small-diameter scope.

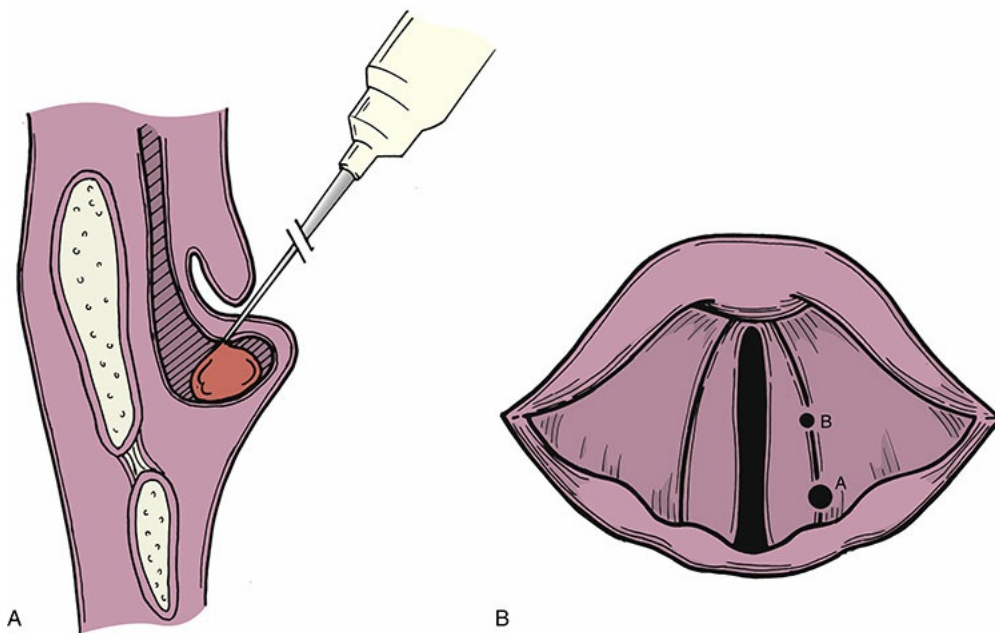


FIG. 4.1 Diagram of the ideal location for deep vocal fold injection, including coronal (**A**) and axial (**B**) views. In 4.1B, Point A represents the intersection between the longitudinal superior arcuate line and the vocal process and is the preferred initial injection site. If needed, additional augmentation can be performed at a secondary site (point B) at the mid-portion of the vocal fold along the superior arcuate line.

- Be prepared to use different laryngoscopes if adequate visualization cannot be achieved. Check the reinforced dental guard frequently and change it often if there is any evidence of wear or damage to the dental guard. I routinely change to a new reinforced dental guard after two manipulations or changes of laryngoscopes.
- Place the laryngoscope into suspension.
 - I strongly advocate the use of a suspension system that attaches

directly to the operating table. This provides maximal stability and minimizes risk to the patient (including dislodgement of the suspension system).

- Use of alternative suspension systems (such as a Lewy arm) resting on a Mayo stand is acceptable, but strong caution is advocated in these respects:
 - Place patient in optimal position for microscopic visualization prior to placing in suspension. This usually involves ensuring that the operating table is low enough. Trendelenburg positioning of the patient may also be helpful.
 - Remind all OR personnel that once in suspension, the Mayo stand cannot be touched. Have all cameras, light cords, and suction cords appropriately placed before suspension. This avoids inadvertent jostling of the stand with manipulation of any of these cords/lines.
- Use of alternative suspension systems which rest on the patient's chest are strongly discouraged due to inherent instability of that type of suspension.
- Ensure adequate visualization of the true vocal folds.
 - The goal is simultaneous visualization from the anterior commissure to the vocal processes bilaterally.
 - This may require anterior cricoid pressure, which can be applied with Velcro straps, adhesive tape, or manual pressure (this last option is not recommended but is feasible if no other option exists).
- Magnified examination of the true vocal folds
 - I like to use 5-mm rigid telescopes at various angles (0, 30, and 70 degrees) to fully evaluate the true vocal folds. This allows thorough inspection of the anterior commissure, ventricle, and infraglottic aspect of the vocal folds as well as the mid-membranous portion of the true vocal folds.
 - VFI can be performed using telescopic guidance if needed/preferred (I recommend a 0- or 30-degree telescope for this purpose). I suggest the use of the operating microscope when possible to maximize visualization and precise placement of the VFI.

- Palpation of the true vocal folds
 - Assess the status of cricoarytenoid joint motion by placing an instrument against the vocal process and displacing it laterally. This can be done with a curved blunt laryngeal elevator or a laryngeal suction (not attached to suction tubing).
 - Palpate the true vocal folds themselves to assess for lesions or stiffness suggestive of scar tissue.
- Identify proper location for the VFI.
 - Superficial injection—purposeful placement of injection material (e.g., dexamethasone) into the superficial lamina propria. The reader is referred to item 3 under Additional Resources, at the end of this chapter, for further details.
 - Deep injection
 - Proper placement is at the intersection of the superior arcuate line and the vocal process (see [Fig. 4.1B, point A](#)).
 - If needed, a secondary site can be injected in the midportion of the true vocal fold along the superior arcuate line (see [Fig. 4.1B, point B](#)). I prefer to avoid this, when possible, to avoid extrusion of the injection material through the initial injection site.

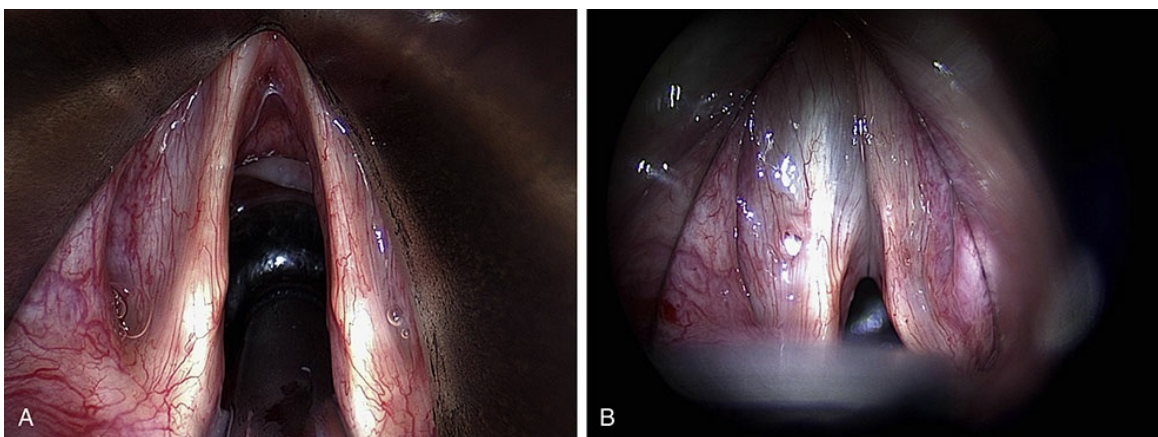


FIG. 4.2 Preoperative, **A**, and postoperative, **B**, photographs of a patient with right vocal fold paralysis who underwent bilateral deep vocal fold injection.

- Preparation of injection material

- This depends on type of injection material
- Prefabricated materials such as Prolarynx or Renu—follow directions in packaging
- Collagen products such as Cymetra—follow directions in packaging
- Adipose tissue
 - Briefly, abdominal adipose tissue is typically harvested (either via liposuction or through open harvest) for this purpose.
 - Prior to injection, I rinse the adipose tissue with 2 L of sterile lactated Ringer's solution and then soak it in an insulin bath for 5 minutes.
 - The reader is referred to items 3 and 4 under Additional Resources, at the end of this chapter, for further details.
- Options
 - Xomed orotracheal injector needle (27 Ga)
 - Needle (24 Ga) is included with prefab package—could be Prolarynx or Renu.
 - Lipoinjection device (e.g. Instrumentarium) (14 to 16 Ga) for adipose tissue
- Slow, steady deployment of injection material
 - Look for infraglottic augmentation first.
 - This augmentation should then move “up” to the medial aspect of the true vocal cord (TVF).
 - The end result should be global augmentation ([Fig. 4.2](#)).
- Gently suction any extruded material from the opening.
- Any bleeding typically resolves spontaneously. However, if necessary, control bleeding with an epinephrine-soaked cottonoid pledget. I use epinephrine 1:10,000 and a ½- by 3-inch pledget.
- Laryngotracheal anesthesia (4% or 2% plain lidocaine spray)
- Orogastric tube suctioning of gastric contents if desired. I recommend this to decrease the risk of postoperative emesis.

- Remove laryngoscope, check teeth, and check tongue.
- Communicate with anesthesia personnel regarding the importance of quiet emergence and extubation. This type of direct communication is critically important and cannot be overemphasized.

Common Errors in Technique

1. Inadequate visualization of larynx/vocal folds
 - a. Too much false vocal fold “show”
 - b. Epiglottis flopped down
2. Superficial injection when deep augmentation is desired
3. “Bubbling up” of the superior surface of the TVF—seen particularly with patients with vocal fold atrophy
4. Injecting too far laterally—material going into the paraglottic space is wasted because it does not improve vocal fold augmentation and closure. Avoid this by checking to see in which direction the bevel of the needle is pointed—medial or anterior is better.
5. Injecting too far anteriorly—the goal is global augmentation

Postoperative Period

Postoperative Management

1. I counsel patients to undergo a period of voice rest after deep VFI. For lipoinjection, 3 days; for other materials, 24 hours
2. Same-day surgery—routine surveillance in the postanesthesia care unit (PACU), after which the patient is discharged to home as appropriate. Overnight observation will rarely be required.
3. No narcotics necessary. Acetaminophen (Tylenol, extra-strength) is permitted as needed.
 - a. Caveat: patients may have abdominal discomfort and/or bruising after liposuction in cases of lipoinjection. These patients typically do not require narcotics but are more likely to require acetaminophen to

address their discomfort. It is important to counsel patients regarding the possibility of postoperative abdominal pain related to the harvesting of adipose tissue.

4. No restrictions on eating/drinking once the patient has been cleared after anesthesia
5. Anticoagulant/antiplatelet drugs can usually be resumed the next day.

Complications

1. Inadequate augmentation versus premature extrusion of injection material
 - a. Reassess symptoms, particularly dysphagia. Modified barium swallow if indicated
 - b. Consider repeat injection if indicated.
 - c. Consider evaluation for adjunctive treatments (swallowing therapy, voice therapy) to optimize symptoms in the event that a repeat injection is not desired.
2. Superficial injection
 - a. Typically causes decreased vibration and can worsen voice quality
 - b. Keep in mind that even temporary materials may have longer duration when injected superficially.
 - c. Depends on material
 - 1) Calcium hydroxylapatite (CaHA)—typically results in a visible white mass under the epithelium (often described as a “chiclet” because of its resemblance to the small piece of candy-coated chewing gum)—may require surgical removal (typically microflap incision with removal vs. suction)³
 - 2) Clear materials (Prolaryn gel, Restylane) are difficult to visualize and therefore are typically not removed.
3. Too much augmentation
 - a. Observation—some cases are associated with natural resorption initially (e.g., adipose tissue). Otherwise all temporary materials will resorb over time.

- b. If the patient is symptomatic from this, surgical excision and removal of excess material can be considered (degree of difficulty depends on the material).^{4,5}
4. Persistent symptoms
- a. Look for underlying reason for persistent symptoms.
 - b. Other measures may be required to address this.
 - 1) Voice therapy
 - 2) Swallowing therapy
 - 3) Respiratory retraining therapy
 - 4) Restructuring of patient expectations
5. Vocal fold hemorrhage
- a. Typically self-limited
 - b. Additional voice rest may be helpful.
6. Airway compromise
- a. Look for underlying etiology.
 - 1) Laryngospasm
 - a) Lidocaine IV push
 - b) Positive pressure ventilation
 - c) Reintubation—if this must be done, use as small a tube as possible. Often the patient may be observed in the recovery room for a short period of time (e.g., 1 hour) and then can often be extubated successfully. Less commonly, overnight intubation/observation may be required.
 - d) Low-dose succinylcholine
 - 2) Edema of the airway
 - a) Try to avoid this with an intraoperative dose of intravenous steroids.
 - 3) Overaugmentation
 - a) If identified in the immediate postoperative period and causing airway symptoms, reintubation is an option.

- b) Surgical removal of excess material if necessary
- 4) Anxiety
 - a) The anesthetist may be able to administer anxiolytic medication.
- 7. Injury to the teeth
 - a. Refer to family dentist or appropriate dental specialist.
 - b. Prevention is key.
- 8. Temporomandibular joint dysfunction
 - a. Soft diet, anti-inflammatory medication; a dental guard may help
 - b. Expectant management
- 9. Tongue dysgeusia/numbness
 - a. Conservative measures: passage of time and reassurance

Alternative Management Plan

1. VFI under local anesthesia
2. Evaluation of patient's candidacy for other treatments
 - a. Voice therapy
 - b. Swallowing therapy
3. Compensatory strategies to address dysphagia
 - a. Head turn, chin tuck

Discussion

Evidence-Based Medicine Question

What is the utility of trial VFI?

Initially described in 2010, trial VFI attempts to determine the degree of voice improvement that can be achieved following vocal fold augmentation when the anticipated results are not clear or predictable.

Carroll and Rosen presented a cohort of 25 patients with vocal fold atrophy and/or paresis who underwent temporary vocal fold augmentation.² In their study, 76% (19/25) of the patient cohort had improvement and 24% (6/25) did not. Furthermore, 10 of these patients underwent further permanent augmentation and all had good results. These authors suggest that trial VFI may be helpful in situations where expectations following vocal fold augmentation are not clear, as in the case of vocal fold atrophy, paresis, scar, or combined communication difficulties (e.g., concurrent dysarthria).

In 2015, Young and colleagues sought to compare voice outcomes after trial VFI and long-term augmentation in patients with vocal fold atrophy.⁶ They reviewed 19 patients and found that 42% (8/19) had a good response and 58% (11/19) had poor response to trial VFI. Among those with a good response, 75% (6/8) also had a good response to long-term treatment. Among those with a poor response to trial VFI, 55% (6/11) also had a poor response to long-term treatment. However, interestingly, 45% (5/11) of patients with poor response to trial VFI then went on to have a good response after long-term augmentation. The authors concluded that a good response to trial VFI appears to be predictive of a similar good response to long-term treatment. However, poor results following trial VFI are not necessarily suggestive of poor response following long-term augmentation and should be interpreted by the Otolaryngologist and patient with caution.

Based on these data, the predictive ability of trial VFI remains unclear, but trial VFI may still be useful in certain situations, such as those involving vocal fold atrophy, paresis, or scar. Appropriate expectations about the utility of results following trial VFI are critically important.

Editorial Comment

This chapter provides a very thorough discussion of a very important laryngologic procedure designed to reestablish vocal fold closure in cases of vocal fold paralysis, atrophy, paresis, or scar. In patients with vocal fold immobility, possibly due to paralysis versus cricoarytenoid joint pathology, cricoarytenoid joint palpation during microlaryngoscopy is extremely important. If mobilization is a major goal of the procedure, it is recommended that the surgeon perform cricoarytenoid joint palpation

without endotracheal tube intubation at the start of general anesthesia and without suspending microlaryngoscopy. This avoids any confounding variables affecting assessment of the motion of the cricoarytenoid joint. For this aspect of the procedure, it is recommended that the patient undergo general anesthesia and then direct laryngoscopy with cricoarytenoid palpation, as in [Chapter 5](#) describing the laryngoscope being purposely suspended manually high in the endolarynx, followed by a careful assessment of vocal fold motion when the vocal process of the arytenoid cartilage is displaced laterally.

When a patient with vocal fold paralysis causing dysphonia as well as dysphagia is considered for microlaryngoscopy and injection of the vocal fold, it may be prudent to proceed with vocal fold augmentation prior to a formal swallowing evaluation, given that history has demonstrated significant improvement of dysphagia following vocal fold augmentation. If dysphagia persists postoperatively, then proper swallowing evaluation is warranted.

Regarding intraoperative medication for microlaryngoscopy and vocal fold augmentation, it is important to note that intravenous steroid administration should be done with the patient sedated or in a very slow, controlled fashion to prevent a genital sensation from the IV push of the steroids. In addition, intravenous acetaminophen and intramuscular ketorolac are often very helpful for postoperative pain control. For individuals undergoing microlaryngoscopy with impaired dentition or dentition that has poor alignment, often a customized dental guard made by a dentist or one fabricated intraoperatively using nasal splint material (e.g., Aquaplast) can be very helpful in preventing dental injury in the face of pre-existing dental pathology.

It is important to note that overaugmentation of the vocal fold anteriorly will result in a severely strained voice and an unhappy patient; thus great care should be taken to avoid excessive augmentation of the anterior vocal fold.

Clark A. Rosen

● Access the review questions and additional sources list online at <http://www.expertconsult.com>

Review Questions

1. Reasons for persistent symptoms after VFI include all of the following *except*
 - a. Insufficient augmentation
 - b. Improperly placed augmentation
 - c. **Incorrect choice of augmentation material**
 - d. Underlying etiology of symptoms not addressed by VFI
2. The longest-lasting injection material is
 - a. Calcium hydroxyapatite
 - b. Hyaluronic acid
 - c. Carboxymethylcellulose
 - d. **Autologous adipose tissue**
3. The best landmarks to determine the location for VFI are the
 - a. Superior arcuate line and anterior commissure
 - b. **Superior arcuate line and vocal process**
 - c. Intersection of vocal ligament and midpoint of membranous vocal fold
 - d. Intersection of vocal ligament and vocal process

Additional sources

Lin RJ, Young VN, Rosen CA. Vocal fold lipoinjection. Csurgeries.com; accessed 01 February 2017.

Mallur P.S, Rosen C.A. Vocal fold injection: review of indications, techniques, and materials for augmentation. *Clin Exp Otorhinolaryngol*. 2010;3(4):177–182.

Rosen C.A, Amin M.R, Sulica L, et al. Advances in office-based diagnosis and treatment in laryngology. *Laryngoscope*. 2009;119(suppl. 2):S185–S212.

Rosen C.A, Simpson C.B. *Operative Techniques in Laryngology*. New York, NY: Springer; 2008:205–207.

References

1. Sulica L, Rosen C.A, Postma G.N, et al. Current practice in injection augmentation of the vocal folds: indications, treatment principles, techniques, and complications. *Laryngoscope*. 2010;120(2):319–325.
2. Carroll T.L, Rosen C.A. Trial vocal fold injection. *J Voice*. 2010;24(4):494–498.
3. Chheda N.N, Rosen C.A, Belafsky P.C, et al. Revision laryngeal surgery for the suboptimal injection of calcium hydroxylapatite. *Laryngoscope*. 2008;118(12):2260–2263.
4. Sanderson J.D, Simpson C.B. Laryngeal complications after lipoinjection for vocal fold augmentation. *Laryngoscope*. 2009;119(8):1652–1657.
5. Nakamura M, Tokashiki R, Issiki N, et al. Over-injection of autologous fat in the vocal fold: how to remove the excess? *Eur Arch Otorhinolaryngol*. 2009;266(10):1589–1593.
6. Young V.N, Gartner-Schmidt J, Rosen C.A. Comparison of voice outcomes after trial and long-term vocal fold augmentation in vocal fold atrophy. *Laryngoscope*. 2015;125(4):934–940.

Medialization Laryngoplasty and Arytenoid Adduction

R. Jun Lin, and Clark A. Rosen

Introduction

Medialization laryngoplasty (type I thyroplasty) and arytenoid adduction are excellent surgical options for rehabilitation of the voice in patients suffering from glottic insufficiency. These are great options for surgical therapy to augment and reposition the vocal folds to improve vocal fold closure and thereby improve vocal function.^{1,2} Glottic insufficiency may be caused by any combination of the following: vocal fold atrophy (presbylarynges), vocal fold scar, vocal fold paresis, or vocal fold paralysis. These procedures can also be used to address soft tissue deficits of the vocal folds after surgery or trauma.³

A variety of implant materials have been used to medialize the vocal folds in medialization laryngoplasty, including Silastic, hydroxylapatite block, and Gore-Tex. This chapter discusses the general approach to medialization laryngoplasty and does not discuss the different implants or the design of the shape of the implant, given that these are very personal choices for each surgeon and that medialization laryngoplasty can be done successfully with any of the aforementioned implant materials.

If the patient's dysphonia and/or dysphagia is related to a severe posterior glottic insufficiency, arytenoid adduction should be strongly considered because it is the only operation that consistently corrects glottic insufficiency in the posterior aspect of the glottis.⁴⁻⁶ Neither injection laryngoplasty nor medialization laryngoplasty can address clinical issues related to posterior glottic insufficiency. Arytenoid adduction simulates the contraction of the lateral cricoarytenoid muscle by placing a suture in the muscular process of the arytenoid to rotate the

arytenoid cartilage. This helps to medialize the posterior portion of the vocal fold, lengthen the vocal fold, close the posterior glottic gap, and change the height mismatch of vocal folds.^{6,7}

Key Operative Learning Points

- Identification of the entire aspect of the muscular tubercle located on the inferior border of the thyroid cartilage ala
- Slight overmedialization should be done during medialization laryngoplasty to account for intraoperative edema of the vocal fold and prevent undermedialization of the vocal fold postoperatively.
- Adjustment of implant based on findings of voice quality, vocal fold appearance, and vocal fold closure pattern. Intraoperative end results should include a slightly strained voice, medial augmentation of vocal fold, and complete glottal closure.

Preoperative Period

History

1. History of presenting illness

- Acute or gradual onset of hoarseness
- Precipitating events such as surgery, endotracheal intubation, or upper respiratory infection
- Voice quality weak, breathy, and effortful
- Dyspnea with speaking
- Coughing and choking, especially with drinking liquids
- History of aspiration pneumonia

2. Pertinent past medical history

- History of neck surgery (e.g., thyroid, parathyroid, carotid), cervical spine surgery, or thoracic/mediastinal surgery
- History of malignancy (e.g., head and neck, thyroid, esophagus, lung)

- History of cerebrovascular accidents
- Underlying pulmonary disease (e.g., chronic obstructive pulmonary disease [COPD])—These patients have a smaller pulmonary reserve and thus will require more urgent intervention for vocal fold paralysis.

Physical Examination

- Complete examination of the head and neck
- Examination of the cranial nerves
- Transnasal flexible laryngoscopy to evaluate vocal fold motion, including mobility of the contralateral vocal fold, and overall airway status
- Stroboscopy to assess glottic closure pattern and vocal fold levels

Imaging

- Computed tomography (CT) or magnetic resonance imaging (MRI) scan from skull base to aortic arch (along the course of the recurrent laryngeal nerve) with contrast in vocal fold paralysis with no clear precipitating events

Indications

- Symptomatic glottic insufficiency (dysphonia, dyspnea on phonation, aspiration), especially if there is little or no chance of return of vocal fold motion

Contraindications

- Coagulopathy (relative)
- Malignancy involving the laryngotracheal complex
- Poor abduction of the contralateral vocal fold due to airway concern
- Presence of vocal fold lesions