

OUTLINE

[Home page](#)

[Cancer \(vocal fold\)](#)

[Cyst \(vocal fold\)](#)

Dysplasia / carcinoma in situ (vocal fold)

Nodules (vocal fold)

Paralysis / Paresis (vocal fold)

[Polyp \(vocal fold\)](#)

[Recurrent Respiratory Papillomatosis \(RRP\)](#)

[Reinke's Edema](#)

[Microlaryngoscopy](#)

Laryngoplasty

[Office-based KTP laser surgery](#)

Office-based vocal fold injections

KTP Laser

[Surgical Results](#)

[Blog](#)

[About Dr. Friedman](#)

[Contact](#)

CONTENT

HOME PAGE

Welcome

This website is designed first and foremost as an educational resource for patients with voice disorders and those interested in voice disorders who want to learn about laryngeal surgery. It has the goal of educating visitors about medical conditions affecting the vocal folds and voice box (larynx) and focuses on state-of-the-art surgical management of the larynx for purposes of voice preservation and voice restoration.

Millimeters Matter

Laryngeal surgery, and particularly surgery on the delicate vocal folds, demands precision and meticulous surgical technique. It is optimally performed by an experienced laryngeal surgeon with access to specialized surgical equipment. When operating on the vocal folds, much as with other "high value" tissues in the human body, there is limited room for error in either technique or surgical judgment. Nevertheless, the resulting vocal improvement from well-performed laryngeal surgery can be quite dramatic and even life-changing for some patients.

Surgery When Indicated

For certain types of conditions, laryngeal surgery may be a last resort, when all other more conservative treatment options have failed. For other laryngeal diseases,

surgery may be the only treatment option, or there may be a pressing need to optimize an individual's voice as quickly as possible with surgical treatment. Regardless, a patient's candidacy for laryngeal surgery must be assessed in the context of the disease process itself, other co-existing medical conditions, and a patient's vocal needs.

See and Hear for Yourself

The subspecialty of laryngology is a somewhat unique field of medicine, as the results of treatment can be both seen on examination of the voice box and often heard by patients and others around them. Unless otherwise noted, the before and after results of surgical treatments shown and heard on this website are exclusively those of its author, [Dr. Aaron D. Friedman](#), a laryngologist and laryngeal surgeon who practices in Chicago, IL. They are intended to represent the realm of possibility of laryngeal surgery for voice disorders, but are not a guarantee of vocal outcome for any particular patient or pathology.

ABOUT DR. FRIEDMAN

Undergraduate Education

University of California (Berkeley, CA)

Medical Degree

Columbia University, College of Physicians & Surgeons (New York, NY)

Internship

General Surgery – Cleveland Clinic (Cleveland, OH)

Residency

Otolaryngology–Head & Neck Surgery – Cleveland Clinic (Cleveland, OH)

Fellowship

Laryngeal Surgery (Laryngology) – Massachusetts General Hospital (Boston, MA)

Clinical Appointment

Attending Surgeon, Department of Surgery – NorthShore University HealthSystem (Evanston / Highland Park, IL)

Academic Appointment

Clinical Assistant Professor, University of Chicago Pritzker School of Medicine

Professional Board Certification

American Board of Otolaryngology

Professional Society Memberships

American Broncho-Esophagological Association, American Laryngological Association (post-graduate member), Triological Society (post-graduate member), American Academy of Otolaryngology-Head and Neck Surgery, Chicago Laryngological & Otological Society

Awards

Triological Society, Joseph H. Ogura Resident Research Award – First Place; American College of Surgeons, Massachusetts Chapter, Resident/Fellow Essay Contest – First Place; American Broncho-Esophagological Association – Presidential Citation for Foreign Body Management; National Institutes of Health Research Service Award; Phi Beta Kappa

Peer Reviewed Publications

About Dr. Friedman

Education and Training

Aaron D. Friedman, MD was born in southern California and graduated with highest honors from the **University of California at Berkeley**, receiving undergraduate degrees in both Molecular and Cellular Biology and Economics. After obtaining his medical degree from the **College of Physicians and Surgeons at Columbia University** in New York City, Dr. Friedman completed an internship year in General Surgery and four clinical years of residency training in Otolaryngology-Head & Neck Surgery at **The Cleveland Clinic** in Ohio. He devoted an additional year during residency to basic science research in immunology and laryngeal transplantation under the direction of his program chairman, Dr. Marshall Strome, who had previously performed the world's first human total laryngeal transplant. Dr. Friedman received one of six national research grants and a first place Joseph H. Ogura Resident Research Award from the American Academy of Otolaryngology-Head and Neck Surgery for his work on "Post-Allograft Donor and Recipient Dendritic Cell Trafficking in the Rat Larynx," which investigated the immune system's response to laryngeal transplantation in an animal model.

Following residency, Dr. Friedman completed a fellowship in Laryngeal Surgery under the mentorship of world-renowned laryngologist / laryngeal surgeon, **Dr. Steven Zeitels** at the **Massachusetts General Hospital (MGH) Voice Center**, a teaching affiliate of Harvard Medical School.

Move to Chicago

After spending several years as an **Instructor at Harvard Medical School** and as an **Attending Laryngeal Surgeon at MGH** and practice partner of Dr. Zeitels, Dr. Friedman came to Chicago with the mission of providing state-of-the-art laryngeal care. A board-certified otolaryngologist-head and neck surgeon, he is the founder and Medical Director of the [NorthShore University HealthSystem Voice Center](#), located in Northbrook and Evanston, Illinois, less than 13 miles from the Chicago city center. It is the only comprehensive center for voice care led by a fellowship-trained laryngologist on the North Shore of Chicago.

Skill Set

While he is adept at treating all types of laryngeal disorders, Dr. Friedman has special interest, experience, and expertise in advanced laryngeal surgical techniques such as [minimally invasive treatment of early glottic cancer](#), framework surgery (laryngoplasty) for vocal fold paralysis, management of laryngeal airway stenosis, and [phonosurgery](#) for benign laryngeal lesions in professional voice users. In addition, he commonly performs [office-based laryngeal surgery](#) for certain chronic laryngeal disorders such as recurrent respiratory papillomatosis (RRP) and vocal fold dysplasia.

Philosophy of Care

One of Dr. Friedman's passions is helping people to learn about laryngology, whether it be patients, practicing otolaryngologists, fellows, residents, medical students,

speech pathologists, or the interested public (eg singers, teachers, and other professional voice users). While he has published numerous peer-reviewed medical journal articles, taught many formal courses, and given multiple national, regional, and local presentations in the field of laryngology, it is the day-to-day education of patients that is often one of the most gratifying parts of his practice. In particular, laryngology is such an auditory and visual field of medicine, and by way of being able to record examinations of the functioning larynx and then review them with patients, people are able to gain new insight and understanding into the marvelously complex “black box” that is the origin of voice. The circumstance and privilege of being able to help restore patients’ disordered voices is just icing on the cake...

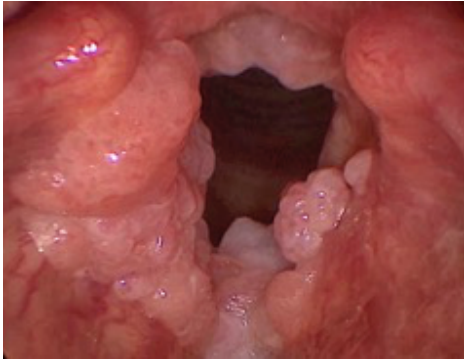
Peer-Reviewed Publications

1. Friedman AD, Bhayani R, Memeo L, Kuriloff DB. [Localized laryngeal amyloidosis](#). Otolaryngol Head Neck Surg 2002; 127:487-489.
2. Friedman AD, Shah JB, Takoudes TG, Haddad J, Jr. [The role of free radicals in chronic rhinosinusitis](#). Arch Otolaryngol Head Neck Surg 2002; 128:1055-1057.
3. Friedman A, Batra PS, Fakhri S, Citardi MJ, Lanza DC. [Isolated sphenoid sinus disease: etiology and management](#). Otolaryngol Head Neck Surg 2005; 133:544-550.
4. Friedman AD, Maurer WG, Byrd MC, Cook JR, Lorenz RR. [A cytomegalovirus-associated mass presenting with laryngeal obstruction](#). Arch Otolaryngol Head Neck Surg 2006; 132:1375-1378.
5. Friedman AD, Dan O, Drazba JA, Lorenz RR, Strome M. [Quantitative analysis of OX62-positive dendritic cell distribution in the rat laryngeal complex](#). Ann Otol Rhinol Laryngol 2007; 116:449-456.
6. Friedman AD, Dan O, Drazba JA, Lorenz RR, Strome M. [Postallograft donor and recipient dendritic cell trafficking in the rat larynx](#). Laryngoscope 2007; 117:1615-1621.
7. Friedman AD, Cook JR, Scharpf J. [Precursor T-cell acute lymphoblastic lymphoma presenting as a tongue mass](#). J Otolaryngol Head Neck Surg 2009; 38:E16-18.
8. Shipchandler TZ, Lott DG, Lorenz RR, Friedman AD, Dan O, Strome M. [New mouse model for studying laryngeal transplantation](#). Ann Otol Rhinol Laryngol 2009; 118:465-468.

9. Burns JA, Friedman AD, Lutch MJ, Hillman RE, Zeitels SM. [Value and utility of 532 nanometre pulsed potassium-titanyl-phosphate laser in endoscopic laryngeal surgery.](#) J Laryngol Otol 2009;1-5.
10. Zeitels SM, Lopez-Guerra G, Burns JA, Lutch M, Friedman AD, Hillman RE. [Microlaryngoscopic and office-based injection of bevacizumab \(Avastin\) to enhance 532-nm pulsed KTP laser treatment of glottal papillomatosis.](#) Ann Otol Rhinol Laryngol Suppl 2009; 201:1-13.
11. Friedman AD, Burns JA, Heaton JT, Zeitels SM. [Early versus late injection medialization for unilateral vocal cord paralysis.](#) Laryngoscope 2010; 120:2042-2046.
12. Kwak PE, Friedman AD, Lamarre ED, Lorenz RR. [Selective reinnervation of the posterior cricoarytenoid and interarytenoid muscles: an anatomical study.](#) Laryngoscope 2010; 120:463-467.
13. Zeitels SM, Barbu AM, Landau-Zemer T, Lopez-Guerra G, Burns JA, Friedman AD, Freeman MW, Halvorsen YD, Hillman RD. [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; 120:627-634.
14. Best SR, Friedman AD, Landau-Zemer T, Barbu AM, Burns JA, Freeman MW, Halvorsen YD, Hillman RE, Zeitels SM. [Safety and dosing of bevacizumab \(Avastin\) for the treatment of recurrent respiratory papillomatosis.](#) Ann Otol Rhinol Laryngol 2012; 121:587-593.
15. Burns JA, Friedman AD, Lutch MJ, Zeitels SM. [Subepithelial vocal fold infusion: a useful diagnostic and therapeutic technique.](#) Ann Otol Rhinol Laryngol 2012; 121:224-230.
16. Friedman AD, Burns JA, Lutch MJ, Zeitels SM. [Submucosal neoplasms of the laryngeal introitus.](#) J Laryngol Otol 2012:1-8.
17. Friedman AD, Kobler JB, Landau-Zemer T, Barbu AM, Burns JA. [High-force simulated intubation fails to dislocate cricoarytenoid joint in ex vivo human larynges.](#) Ann Otol Rhinol Laryngol 2012; 121:746-753.
18. Mehta DD, Zeitels SM, Burns JA, Friedman AD, Deliyski DD, Hillman RE. [High-speed videoendoscopic analysis of relationships between cepstral-based acoustic measures and voice production mechanisms in patients undergoing phonomicrosurgery.](#) Ann Otol Rhinol Laryngol 2012; 121:341-347.

19. Barbu AM, Burns JA, Lopez-Guerra G, Landau-Zemer T, Friedman AD, Zeitels SM. [Salvage endoscopic angiolytic KTP laser treatment of early glottic cancer after failed radiotherapy.](#) Ann Otol Rhinol Laryngol 2013; 122:235-239.
20. Friedman AD, Hillman RE, Landau-Zemer T, Burns JA, Zeitels SM. [Voice outcomes for photoangiolytic KTP laser treatment of early glottic cancer.](#) Ann Otol Rhinol Laryngol 2013; 122:151-158.
21. Best SR, Kobler JB, Friedman AD, Barbu AM, Zeitels SM, Burns JA. [Effect of mandibular tori on glottic exposure during simulated suspension microlaryngoscopy.](#) Ann Otol Rhinol Laryngol 2014; 123:188-194.
22. Barbu AM, Gniady JP, Vivero RJ, Friedman AD, Burns JA. [Bedside Injection Medialization Laryngoplasty in Immediate Postoperative Patients.](#) Otolaryngol Head Neck Surg 2015.

RECURENT RESPIRATORY PAPILLOMATOSIS

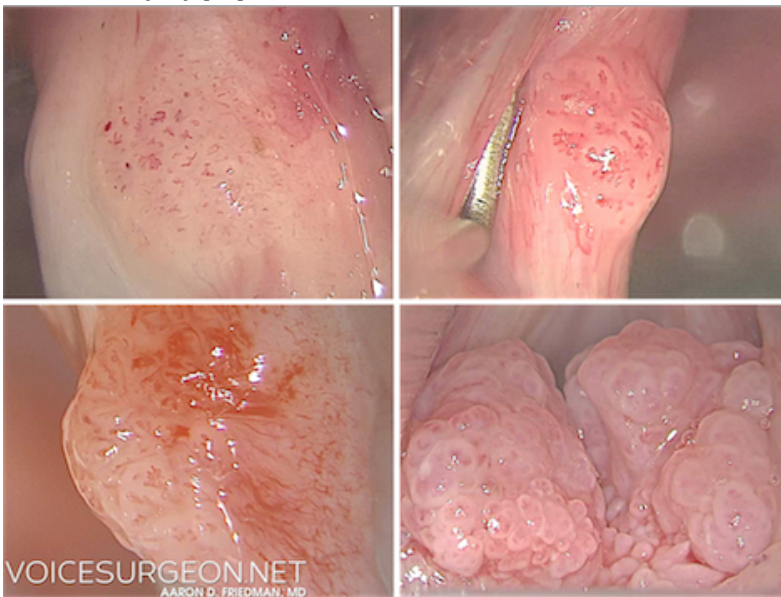


Background

Recurrent respiratory papillomatosis (RRP) is a typically a chronic disease characterized by proliferation of non-cancerous, wart-like growths in the airway. It is caused by infection of cells that line the airway with human papilloma virus (HPV). As the name implies, the disease tends to be recurrent in spite of treatment; this may have to do with HPV infecting cells that remain visibly normal around the periphery of the obviously papillomatous tissue as well as a selective immunodeficiency on the part of patients who suffer from the disease.

When RRP occurs in the voice box (***larynx***), it is called laryngeal papillomatosis, but it can also occur in the throat, mouth, esophagus, and anywhere else in the airway, including the lungs. When the vocal folds are involved, patients typically experience a raspy voice as a result of the disease impairing vocal fold closure and/or vibration. Symptoms of airway obstruction and/or swallowing difficulties can also result depending on disease volume and location.

The vascularity of papillomatosis



A)

VOICESURGEON.NET
AARON D. FREEDMAN, MD

{CAPTION} Different examples of the vascular nature of papillomatosis, at various stages of growth in different patients

The vascularity of the growth (papillomatosis) is perhaps the most important factor in determining the rapidity of its reappearance...

Franklin Hooper, MD - 1882

Well over a century ago, laryngeal surgeons like Dr. Hooper realized that papillomatosis requires a robust local blood supply to grow. Two technologies today take advantage of this fact: the KTP laser and Avastin (bevacizumab), an anti-cancer drug that prevents new blood vessel growth. Avastin was only recently introduced into the field of laryngology (in an off-label manner) in the form of local injection of the drug directly into laryngeal tissues following surgical removal of papillomatosis (a non-cancerous disease). Preliminary studies demonstrate it to be safe for use in the vocal folds and to augment the effect of treating papilloma with the KTP laser alone.^{1,2,3}

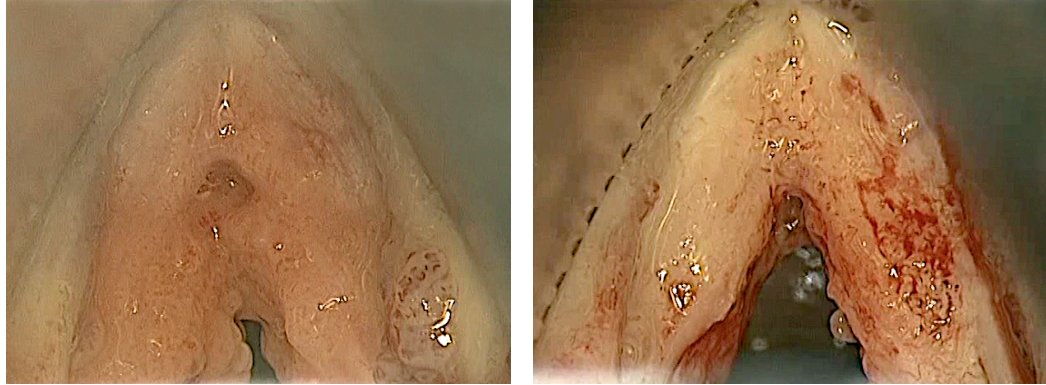
Surgical Treatment

Microlaryngeal surgical excision is the mainstay of management for laryngeal papillomatosis. Because papilloma generally returns, repeated surgical treatments are usually the rule rather than the exception. Some patients with severe disease may require hundreds of surgeries over their lifetimes.

By definition, papillomatosis is a disease of the surface lining (***epithelium***) and does not invade deeper (as a cancer does). When it involves the vocal folds, proper surgery should not damage the vibratory layer that underlies the diseased epithelium but should attempt to remove as much of the disease as is safely possible. *In some senses, surgery for laryngeal papillomatosis involving the vocal folds is like mowing a lawn: the goal is to cut the grass as short as possible (since it will likely grow back), but without getting into the dirt.*

Microdebrider

Surgical management of papillomatosis involves either removal of diseased epithelium with the aid of lasers or “cold” instruments (named as such in contrast to the heat that is generated by lasers). One of the more common cold instrument techniques involves using a microdebrider, which is a powered, small rotating blade that rapidly sucks papilloma into a chamber and then cleaves it. It is efficient at removing bulky disease but does not allow for precise removal of vocal fold papilloma at its interface with deeper, healthy tissues, in part because it results in bleeding that can impair visualization and because the device is generally too aggressive to safely operate with such a narrow margin of error at this location. This is not to say that the microdebrider cannot be used to treat vocal fold papillomatosis, but rather that the result may not be as efficacious as other treatment modalities.



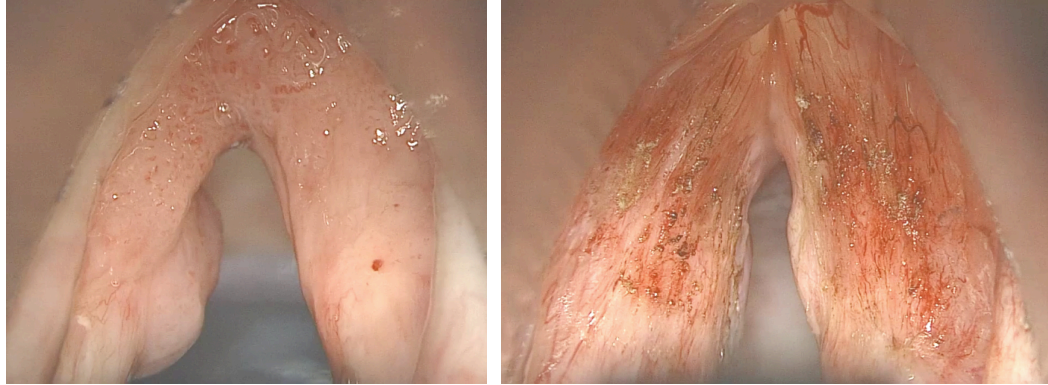
B & C)

{Caption} Laryngeal papillomatosis treated by another surgeon, before and after microdebrider treatment, as visualized in the operating room. After treatment, the bulky airway disease has been removed, but a “carpet” of papilloma remains on both vocal folds. As is often the case, the surgeon has wisely erred on the side of removing too little papillomatosis, rather than removing too much and permanently damaging the vibratory layer of the vocal folds that exists just below the diseased epithelium.

KTP Laser

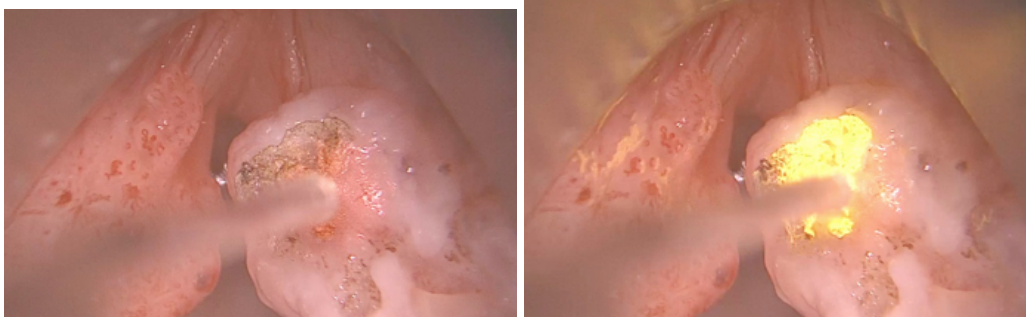
In contrast to the microdebrider and other “cold” surgical techniques, *the KTP laser takes advantage of the robust local blood supply that is required for papilloma to grow*. It not only provides for a comparatively less bloody (and therefore more accurate) surgical field, but it allows the surgeon to selectively treat the diseased, papillomatosis epithelium (because of its increased density of blood vessels). This permits the surgeon to more accurately remove all of the visible disease with less risk of damaging the deeper tissues than might occur if attempting to use the microdebrider to achieve the same amount of disease volume reduction.

Additionally, the KTP laser has a “photoangiolytic” effect whereby the microscopic blood vessels a millimeter or two beyond the visibly treated and removed tissue may also be selectively destroyed by the laser (experimentally demonstrated in a animal cancer model⁴). *For disease involving the vocal folds, appropriate use of the KTP laser may result in a better voice outcome and longer treatment intervals as compared to microdebrider excision (although no comparative studies have been performed to date).*



D & E)

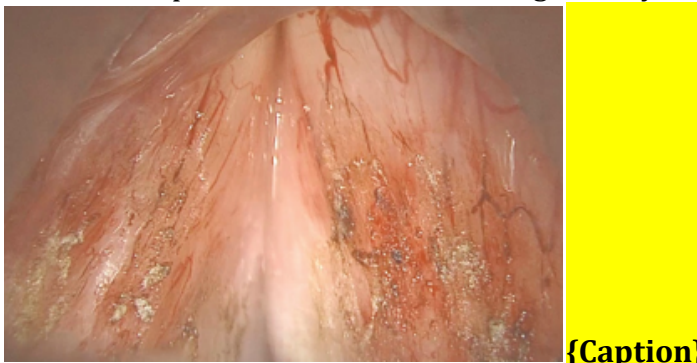
{Caption} Laryngeal papillomatosis involving the vocal folds, before and after KTP laser treatment, as viewed in the operating room. All visible disease has been treated (compare to end result of the microdebrider example above). The vocal folds appear swollen at the end of the operation because saline has been injected into them to reduce thermal trauma from the laser and to distend the tangential surfaces for better exposure during treatment.



F & G)

{Captions}

F&G) Additional magnified pictures of the case shown above demonstrating the KTP laser fiber aimed at vocal fold papilloma before and a split second later, during pulsed firing of the laser. While the KTP laser is green, it appears yellow in this picture due to a protective filter for the surgeon's eyes.



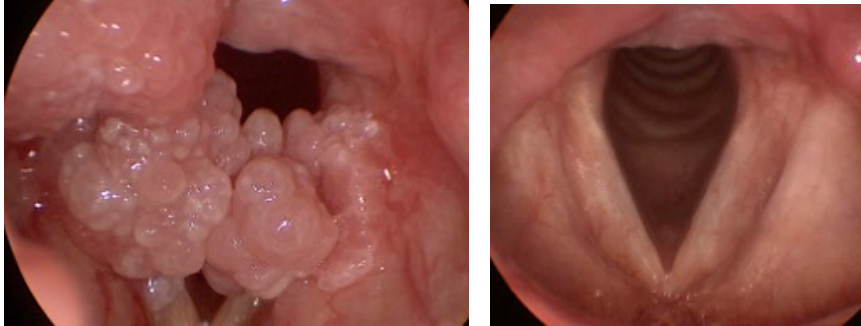
H)

{Caption}

H) A magnified picture of the above patient's vocal folds showing the precision with which the KTP laser can be used to remove the grossly diseased epithelium with minimal risk to the underlying vibratory tissue deep to it. (This is not to say that

damage to the deeper tissue cannot be done with the KTP laser; like any surgical tool, successful and prudent use is still dependent on the operator.)

Examples of Laryngeal Papillomatosis – Before and After KTP Laser Treatment



{Caption} Laryngeal papillomatosis before and after treatment with the KTP laser and localized Avastin (bevacizumab) injections.

REINKE'S EDEMA OF THE VOCAL FOLDS



About

Reinke's edema of the vocal folds, also called **smoker's polyps** of the vocal folds, or **polypoid corditis**, is chronic swelling and inflammation of the surface and vibratory layer of the vocal folds. It is almost exclusively a condition that affects smokers.

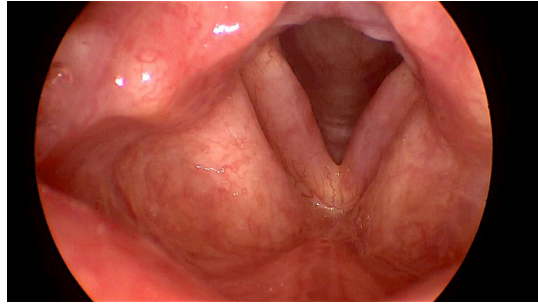
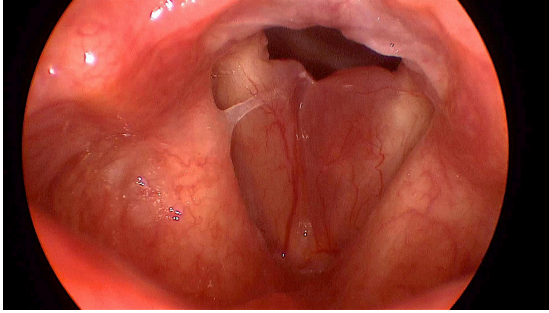
Because the vocal folds in patients with this disorder inappropriately develop more mass (but remain pliable), they continue to vibrate during speaking but at a slower rate (eg a lower frequency than normal). This results in a deepened voice, which is most noticeable in women, who typically have higher speaking pitches than men.

Because of this, women with more severe forms of Reinke's edema may commonly be mistaken for men when talking on the phone. Additionally, the voice may become raspy and effortful, and in some cases the vocal fold polyps can become large enough to obstruct the airway and create breathing difficulty. Reinke's edema usually develops over years, and so a patient (and even family and friends) may not notice the gradual progression over time.

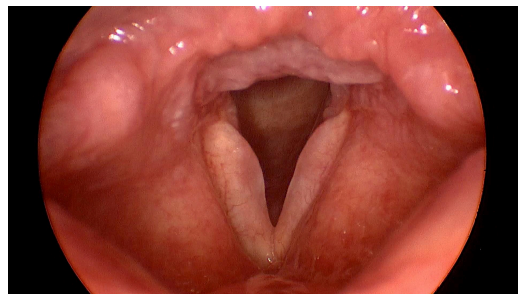
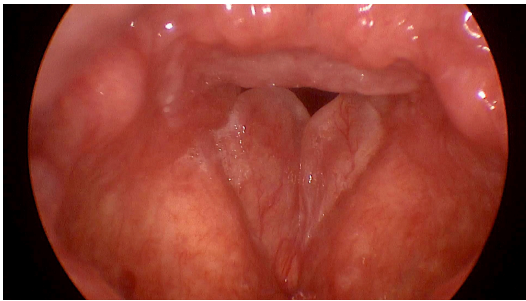
Surgical Treatment

While cessation of smoking and anti-reflux treatment may be helpful in reducing progression over time, typically, surgical reduction of the inappropriately massive vocal folds is required to treat Reinke's edema. This is usually accomplished by [microlaryngeal surgery](#) in which the vocal folds are conservatively reduced in size. While it is impossible to restore the vocal folds to a "normal" state with surgery alone, the subsequent vocal improvement can be quite dramatic.

Examples of Reinke's Edema - Before and After Surgical Treatment



{CAPTION} Female smoker before and after (3 months). As a result, the average pitch of her speaking voice was raised from 131 Hz to 166 Hz.



{CAPTION} Another female smoker before and after (3 months). As a result, the average pitch of her speaking voice was raised from 99 Hz to 185 Hz.

VOCAL FOLD (GLOTTIC) CANCER



About {would like these to be drop down options, to save space}

How Common is Vocal Fold Cancer?

Cancer of the larynx (voice box) is relatively rare in the general population (20th most common cancer), with an estimated 13,560 new cases diagnosed in the United States in 2015.¹ About half of those cases arise from the vocal folds² (as opposed to other sites of the larynx), and perhaps ½ to 1/3 of these are considered “early” stage vocal fold (glottic) cancer: this translates to approximately 2200 to 3300 new cases of early glottic cancer per year in the United States by recent estimates.

What are the Symptoms of Vocal Fold Cancer?

Like the majority of head and neck cancers, most vocal fold cancers arise from the surface membrane, with the most common type being squamous cell carcinoma (SCC). Because they are solid masses that arise from the vocal fold(s), they distort the ability of the vocal folds to close and/or vibrate normally during sound production. Thus, **vocal fold cancers usually present with the initial symptom of hoarseness**; often the degree of voice change is of a magnitude that others (aside from the patient) can hear. For early stage glottic cancer, there is typically no pain, change in breathing or swallowing, or coughing up of blood.

How is early stage vocal fold cancer defined?

Like other cancers, vocal fold cancer is staged by the TNM Staging System: T = original (primary) tumor, N = regional lymph node status, M = distant metastasis status. The T stage ranges from T1 (lowest) to T4 (highest). Overall stage is a combination of T, N, and M status – ranging from I (earliest) – IV (highest). Early stage cancer is considered stage I or stage II.

Glottic cancer T stage depends on geographic cancer distribution along one or both vocal folds, whether the cancer has spread to the laryngeal tissues above the vocal folds (**supraglottis**) or laryngeal tissues below the vocal folds (**subglottis**), and whether the normal opening / closing capabilities of the vocal folds during breathing and speaking are preserved or absent. Specifically:

- **T_{1a}** = cancer limited to one vocal fold (but not supraglottis or subglottis), with both vocal folds fully mobile
- **T_{1b}** = cancer involves both vocal folds (but not supraglottis or subglottis) with both vocal folds fully mobile
- **T₂** = either cancer extension to other portions of the larynx (supraglottis or subglottis), and/or impaired vocal fold mobility
- **T₃** = cancer limited to the larynx with vocal cord fixation or paraglottic space involvement, or minor thyroid cartilage erosion (eg inner cortex)
- **T₄** = cancer invading beyond the larynx

An early stage vocal fold cancer is one with a T stage including T1a, T1b, or T2 and no lymph node metastases to the neck (N0) and no distant metastases (M0) . Cancers that meet these criteria are stage I if T1a or T1b, and stage II if T2.

How is Early Stage Vocal Fold Cancer Treated?

Unlike other head and neck cancers, early stage glottic SCC has a low tendency to metastasize (spread to sites beyond the initial presenting location). As a result, **treatments for early vocal fold cancer are typically limited to the vocal fold(s) themselves.**

In general, treatment for early stage vocal fold cancer is either surgical excision or radiation therapy. Surgery is usually performed in one or sometimes two operations, and most commonly is done in a minimally invasive way (through the mouth) under general anesthesia using a laser, or less commonly with “cold steel” microinstruments (eg microflap excision). **Radiation** therapy is typically administered over 6 weeks, 5 days / week, in incremental doses.

How Curable is Early Stage Vocal Fold Cancer?

Fortunately, **most early stage vocal fold cancers are highly curable** (local control rates between ~75 to ~90+% at 5 years, depending on stage and the particular study), irrespective of whether surgery or radiation is used. ³

KTP Laser Treatment of Early Stage Vocal Fold Cancer

Since ~ 2004, a growing number of laryngeal surgeons have started performing endoscopic surgical resection of *early stage vocal fold cancers* (T₁ – T₂ N₀ M₀) using angiolytic lasers, most recently the KTP laser. There is emerging data showing that, in experienced hands, the cure rate of the KTP laser for this disease is equivalent to more conventional minimally-invasive surgical techniques (eg CO₂ laser endoscopic resection) or radiation.

KTP Laser Treatment Voice Outcomes for Early Glottic Cancer

As opposed to radiation therapy (or even CO₂ laser resections, which are typically done with small margins of normal vocal fold tissue), KTP laser treatment of early glottic cancer focuses on removing only the portions of the vocal fold(s) that are

affected by cancer, leaving the non-diseased areas undamaged, so as to maximally preserve voice quality. This is a result of both the surgical technique used (photoablation) and the physics of the KTP laser itself, which cause it to be preferentially absorbed by tissues that have a dense blood supply (like cancers). Contrast this to the physics of the CO₂ laser, which has an affinity for water, not blood.

The end result is that KTP laser treatment of early glottic cancer may translate into superior voice outcomes compared to traditional endoscopic surgical techniques (CO₂ laser or cold instrument microflap excision). In fact, **one study on voice outcomes of the KTP laser treatment of early glottic cancer found that the need for surgical reconstruction of the voice following use of the KTP laser was approximately 25% of the need in a similar historical cohort of different patients who were previously treated with the CO₂ laser or microflap excision**, presumably as a result of removal of less normal, non-cancerous vocal fold tissue.⁴

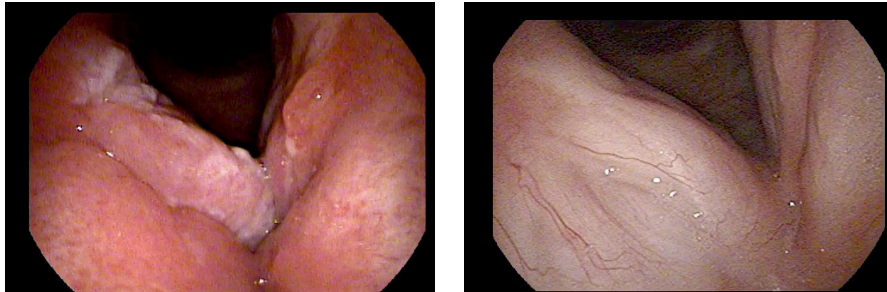
On its own, the KTP laser is simply a tool, and optimal oncologic and voice outcomes in treating glottic cancer still require meticulous operative laryngoscopy, high-powered magnification at all times, and prudent surgical judgment. Nevertheless, with these pre-requisites in place, the KTP laser can be used to methodically vaporize (photoablate) early stage glottic squamous cell carcinoma (SCC), as opposed to the traditional method of cutting around it with a margin of normal tissue, as is typically been done with the carbon dioxide (CO₂) laser or sometimes “cold” microinstruments (for smaller cancers)..

The KTP laser photoablation technique takes advantage of the fact that most early stage glottic SCC's are not a uniform depth over the entire surface area of their disease. Provided that they have not been previously treated, glottic SCC's are essentially contiguous masses that are deepest at their epicenter but become increasingly superficial as they approach the peripheral boundary with normal, healthy vocal fold tissue. There is commonly a visually identifiable, variable length zone of pre-cancer (dysplasia) at the surface perimeter; but treatment in these areas need not be over-aggressive if voice is to be maximally preserved.

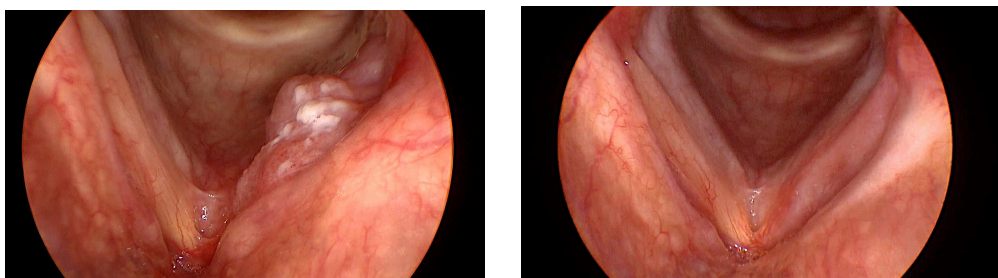
The KTP laser photoablation technique precisely “maps” a vocal fold cancer (in a relatively bloodless field) along its entire deep surface and periphery, with ultra-narrow margins. The end result is that the maximum amount of normal, non-cancerous tissue on the affected vocal fold(s) is saved, without sacrificing oncologic effectiveness. It is not uncommon for patients with shallow but bulky early vocal fold cancers to actually have vocal improvement (and not degradation) after healing from KTP laser treatment.

Disclaimer: It is to be emphasized, however, that there is a limit to what can be achieved with the KTP laser photoablation method for treating glottic cancer. In particular, this technique is applicable to

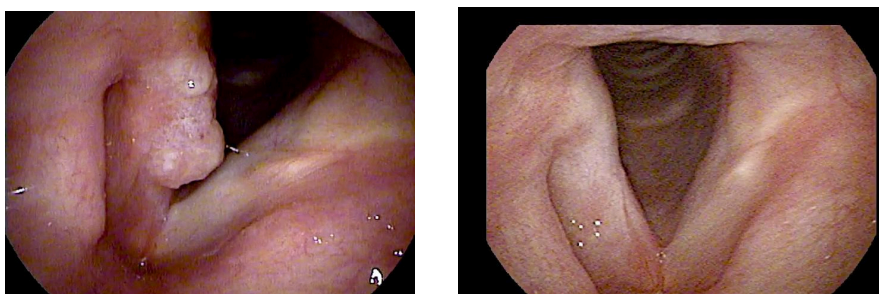
mainly to early stage glottic cancers that arise from the surface (eg squamous cell carcinomas), not to advanced stage ones (stage III or IV). Moreover, this KTP laser photoablation technique is not generally successful in treating cancers originating in other parts of the larynx (supraglottis or subglottis) or head and neck, which act biologically different, even though they are still commonly the same cancer type (squamous cell carcinoma).



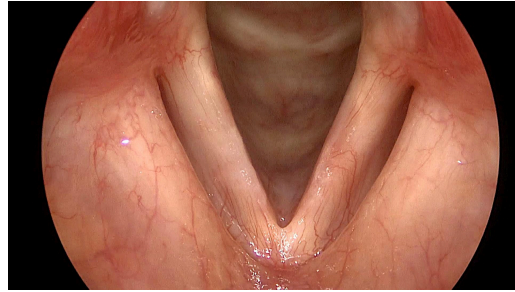
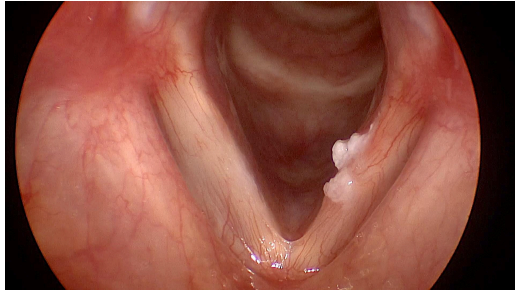
CAPTION} Before and after KTP laser surgery for squamous cell carcinoma of both vocal folds. The patient is more than 3 years beyond treatment without evidence of cancer recurrence.



CAPTION} Before and after KTP laser surgery for squamous cell carcinoma of the left vocal fold (right side of image). The patient is more than 3 years beyond treatment without evidence of cancer recurrence.



CAPTION} Before and after KTP laser surgery for squamous cell carcinoma of the right vocal fold (left side of image). The patient is more than 2 years beyond treatment without evidence of recurrence.



CAPTION} Before and after KTP laser surgery for squamous cell carcinoma of the left vocal fold (right side of image). The patient is more than 1 year beyond treatment without evidence of recurrence.



CAPTION} Before and after KTP laser surgery for squamous cell carcinoma of the right vocal fold (left side of image). The patient is more than 1 year beyond treatment without evidence of recurrence.

VOCAL FOLD CYST

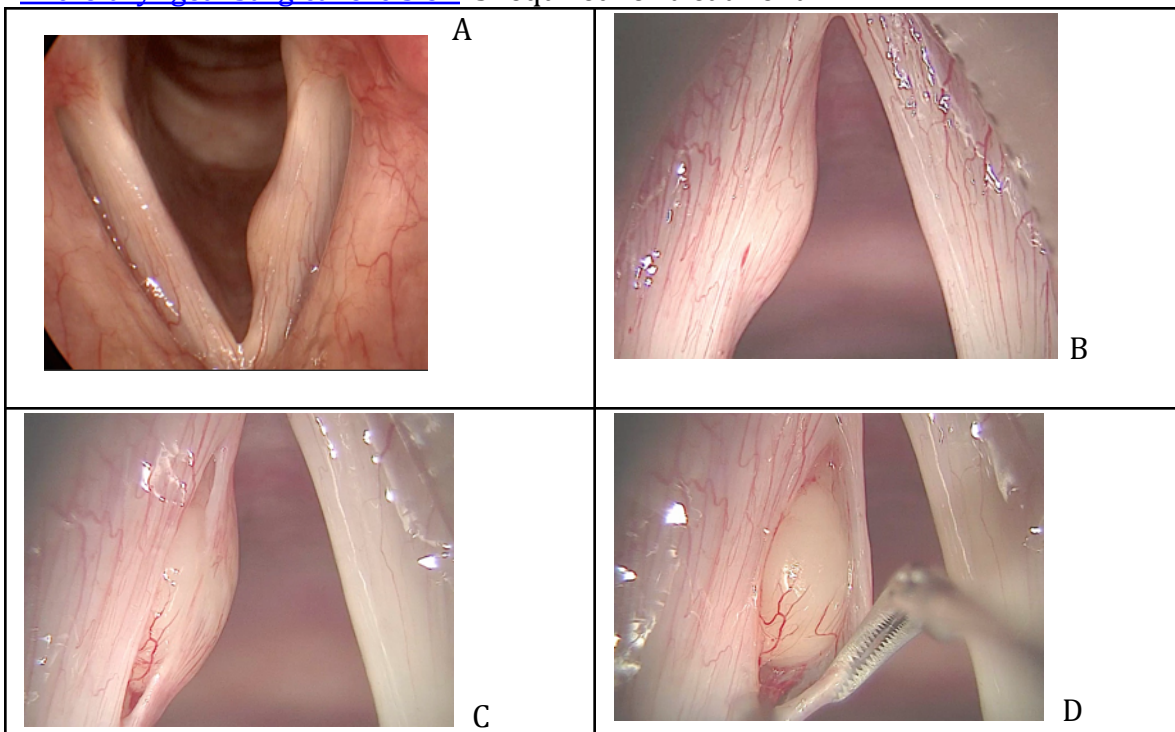
About

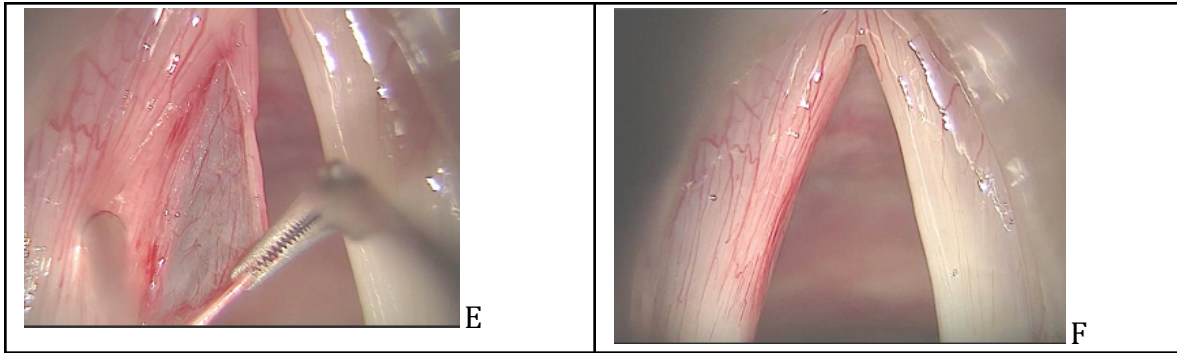
A cyst is a three dimensional, spherical or ovoid, non-cancerous structure buried within the vibratory layer of one, or rarely both, vocal folds. It typically causes hoarseness by either impairing how the vocal folds close and/or how they vibrate during speaking and/or singing. A cyst can be fluid filled (***mucus retention cyst***) or more rarely, solid (keratin, or ***epidermoid cyst***). While epidermoid cysts tend to be more opaque white in color, it is usually very difficult to predict which type of cyst is present without an operation.

While a vocal fold cyst is usually acquired (many times in the setting of excessive voice use and/or phonotrauma), it may also be congenital (eg present from birth).

Surgical Treatment

A mucus retention cyst can sometimes spontaneously rupture, but it typically re-accumulates with time; on the other hand, an epidermoid cyst tend to remain constant or expand over time. In general, however, for both types of cysts, [microlaryngeal surgical excision](#) is required for treatment.





{CAPTIONS}

A) Left vocal fold mucus retention cyst, as viewed in the office

B) Same cyst as in image A, as viewed in the operating room.

C) Microscissors have been used to create an incision in the epithelium that is laying over the cyst. It is crucial not to rupture the cyst at the onset of the dissection when doing this.

D) After careful dissection, the discrete cyst is now partially visible as a three dimensional lesion, buried within the vibratory layer of the vocal fold. This vibratory layer should be maximally preserved during surgery to optimize the vocal outcome.

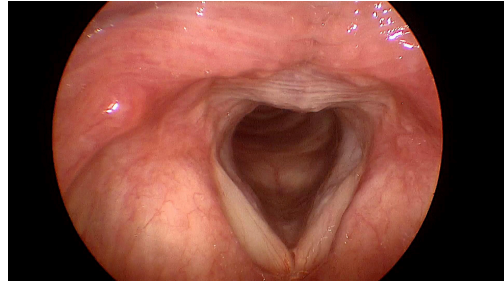
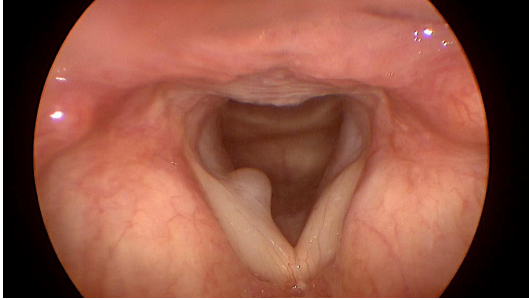
E) Following complete removal of the cyst, the microflap has been preserved, and the void where the cyst was is now apparent.

F) The microflap has been laid back down (where it will heal in place without sutures) resulting a smooth vocal fold edge contour (compare to image A).

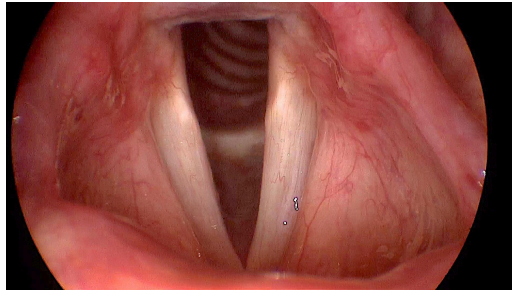
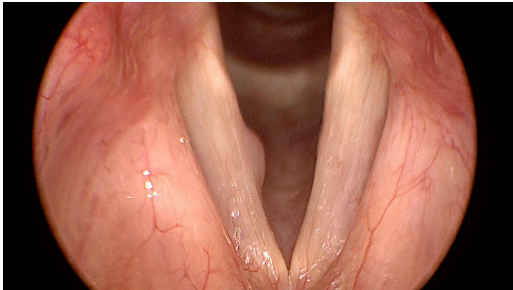
The surgical technique of vocal fold cyst removal involves meticulous and patient microdissection, as rupture of the thin cyst wall (in the case of the more common mucus retention cyst) can make identification of the decompressed cyst wall very difficult. If a cyst wall remnant is left behind, the cyst may re-accumulate, requiring revision surgery. A surgery that simply drains a mucus retention cyst may be only temporary in its effect, since the cyst may re-form, and is likely best avoided.

While the borders of a cyst represent a very discrete surgical target, this type of phonosurgery can be challenging: with respect to the more common mucus retention cyst, surgery is like removing a water balloon that is buried in a pile of hay using small scissors mounted on a foot long pole, all while trying not to rupture the water balloon.

Examples of Vocal Fold Cysts – Before and After Surgical Treatment



{CAPTION} Before and after (3 months) excision of right vocal fold mucus retention cyst



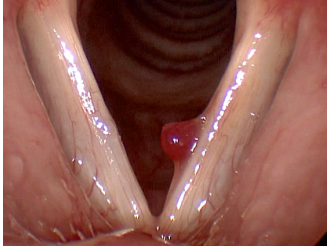
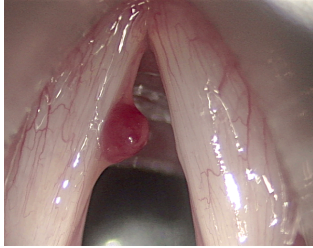
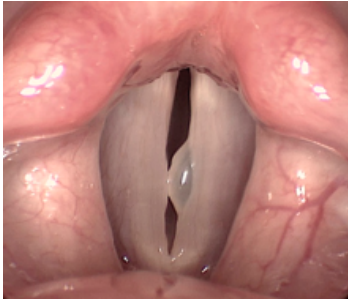
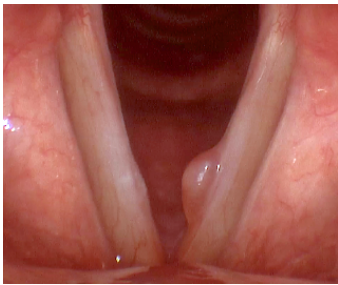
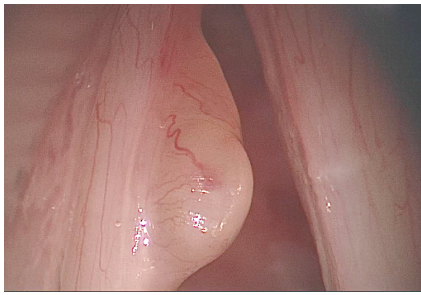
{CAPTION} Before and after (3 months) excision of right vocal fold mucus retention cyst

VOCAL FOLD POLYPS

About

Vocal fold polyps are benign (non-cancerous) masses that classically occur just below the surface membrane of the vocal fold. In contrast to other parts of the body (eg polyps in the colon), there is no chance of degeneration of a genuine vocal fold polyp into cancer.

In general, vocal fold polyps can be classified as either hemorrhagic (blood filled) or non-hemorrhagic (which some further divide into translucent or fibrotic (opaque, firmer) types). These likely represent evolving stages of the same pathology over time, with the hemorrhagic polyp being the acute form that progresses to a non-hemorrhagic form.

Polyp Type		Office Examination	Operating Room View
Hemorrhagic			
Non-hemorrhagic	Translucent		
	Fibrotic		

While a polyp classically involves just one vocal fold, they can involve both, or there can be a “reactive” lesion along the other vocal fold. Vocal fold polyps typically occur

along the free edge of the vocal folds, typically at the point of maximal vibration amplitude (central zone), where the physical forces are the greatest during phonation. They are considered “phonotraumatic” lesions because they often result from significant voice use or abuse.

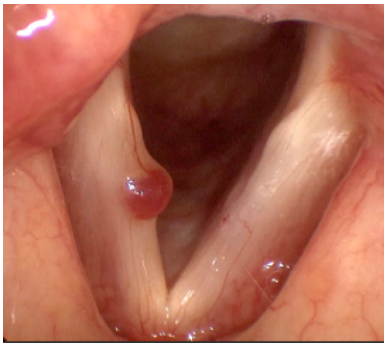
Like most other structural lesions of the vocal folds, a vocal fold polyp produces a disordered voice by affecting how the vocal folds close and / or vibrate during speaking or singing. The degree of vocal impairment often correlates with the size of the lesion, but not always; in some cases, even a small vocal fold polyp can result in a very disordered voice if it is located in the right (wrong) location, much as a pebble in the bottom of one’s shoe can produce disproportionate symptoms if located in the wrong spot.

Surgical Treatment

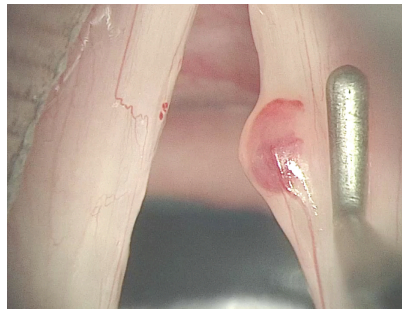
While voice therapy, voice rest, and/or sometimes observation alone can be management strategies for vocal fold polyps, [microlaryngeal surgical excision](#) is currently the gold standard for restoration of voice. The timing of surgery may depend on a number of factors, including how important it is for a patient to have his or her voice restored. For example, a professional opera singer may have little tolerance for trials of non-surgical management, whereas a casual voice user with minimal occupational and social vocal demands may elect for a non-operative treatment initially.

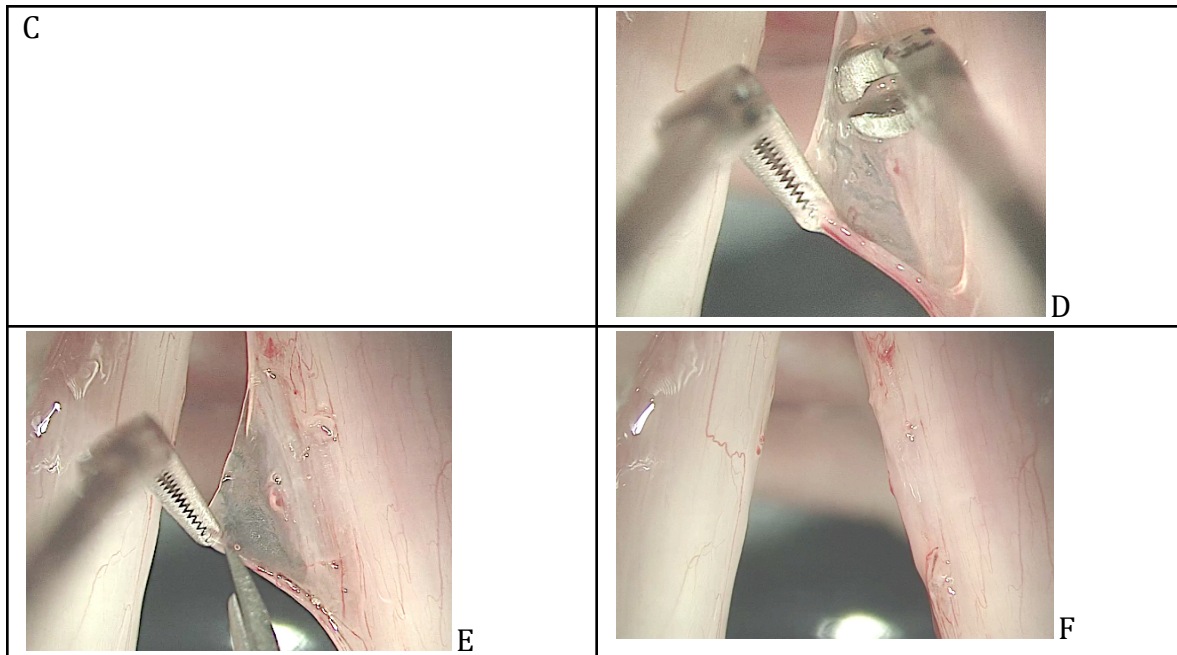
Surgical excision of a vocal fold polyp is most precisely performed under general anesthesia using an operating microscope and a microflap technique, during which a small flap of tissue containing the lesion is carefully raised. Then the typically gelatinous polyp contents are removed from the delicate surface membrane (***epithelium***) of the vocal fold without tearing or poking a hole in it. (In otherwise healthy vocal folds, the epithelium is typically 10 – 15 cell layers thick and translucent, similar to Saran Wrap™.) While redundant epithelium must usually be trimmed after removal of the polyp (which has stretched it), the goal is to preserve the surface membrane as much as possible so as to minimize the wound gap that has to heal post-operatively. This is most achievable in polyps that are ***sessile*** (have a broad attachment).

A



B





{CAPTIONS}

A) Right vocal fold hemorrhagic polyp, as viewed in the office

B) Same hemorrhagic polyp, as viewed in the operating room, with [4 millimeter probe](#) next to lesion.

C) After the hemorrhagic portion of polyp has been removed, a microflap with residual polypoid material remains. Because of this, the translucent nature of normal vocal fold epithelium is not obvious (compared to image E).

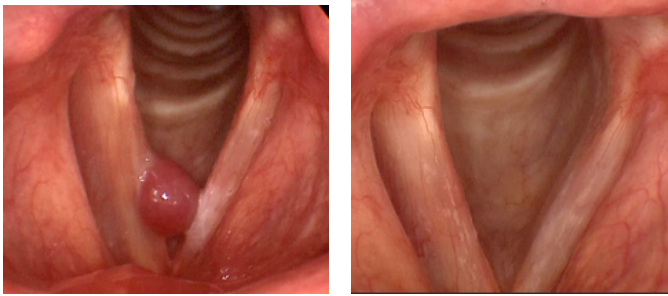
D) Removal of the polypoid contents from the microflap with 1 millimeter cup forceps. The microflap is extremely delicate and can be easily torn or punctured.

E) After the microflap has been thinned of residual polypoid material, the translucent character of healthy vocal fold epithelium is now apparent (compare to image C). Microscissors are being used to trim the redundant edge of the microflap.

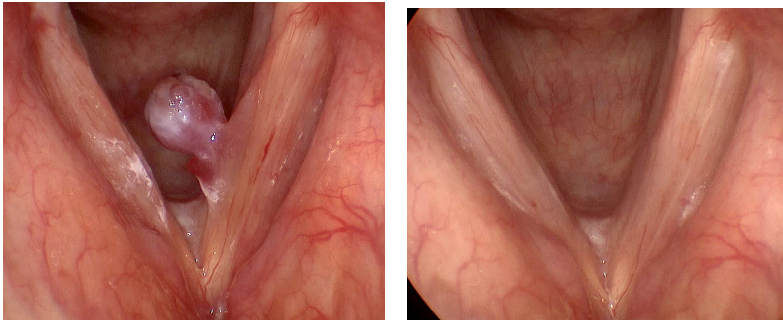
F) The incision in the vocal fold is barely visible after re-draping of the trimmed microflap.

For polyps that are ***pedunculated*** (narrow attachment), it may not be possible to preserve much (or any) of the overlying epithelium. Nevertheless, a key step in phonosurgery for vocal fold polyps is to accurately define the deep interface of the polyp and to isolate it from the healthy vibratory tissue next to it (superficial lamina propria (SLP)), which should be maximally preserved. Failure to do so may result in an irreversibly stiffened vocal fold and a less optimal vocal outcome.

Examples of Vocal Fold Polyps – Before and After Surgical Treatment



{CAPTION} A right vocal fold hemorrhagic polyp before and after (2 months) microlaryngeal surgical excision. (There are excess secretions along the left vocal fold in the before picture, causing the vocal fold to appear focally white in the collision zone with the polyp.)



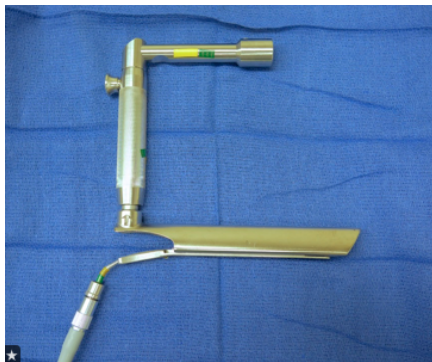
{CAPTION} A pedunculated left vocal fold hemorrhagic polyp before and after (2 months) microlaryngeal surgical excision.

MICROLARYNGOSCOPY

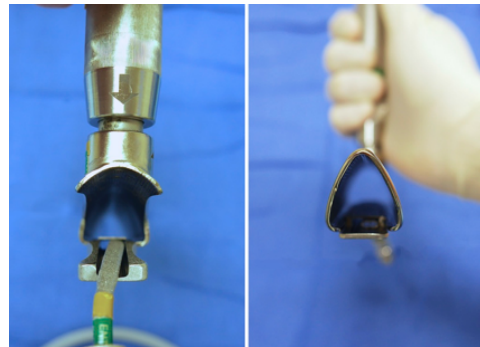
Tools of the Trade

Viewing the Larynx and Vocal Folds

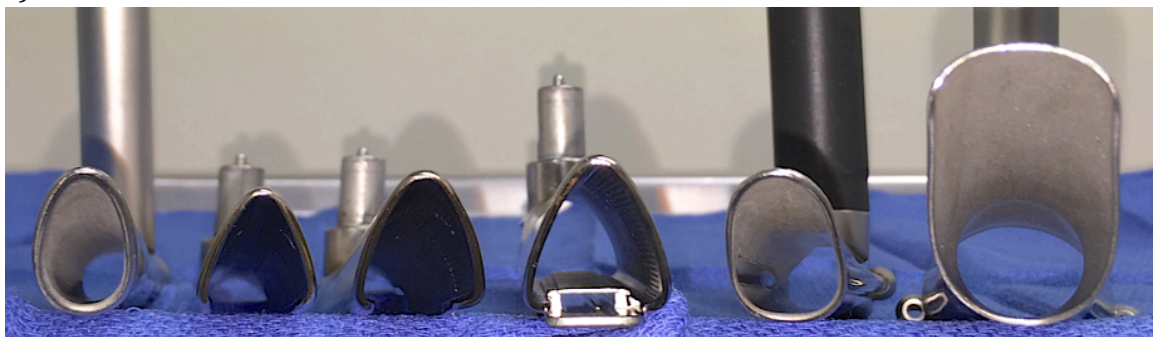
Microlaryngoscopy is surgery done on the voice box (***larynx***) with the aid of magnification via a relatively small diameter, rigid metal tube (***laryngoscope***) through which microlaryngeal instruments and/or lasers are inserted. The laryngoscope is placed through a patient's mouth (while he or she is under general anesthesia) and positioned to optimally view the larynx. It is typically then temporarily fixed into position in order to free the surgeon's hands. The laryngoscope contains a light source, which illuminates the inner part of the laryngoscope, since room light is insufficient to view beyond the very outer portions of even the mouth. Additionally, the magnification device also provides its own, additional light source.

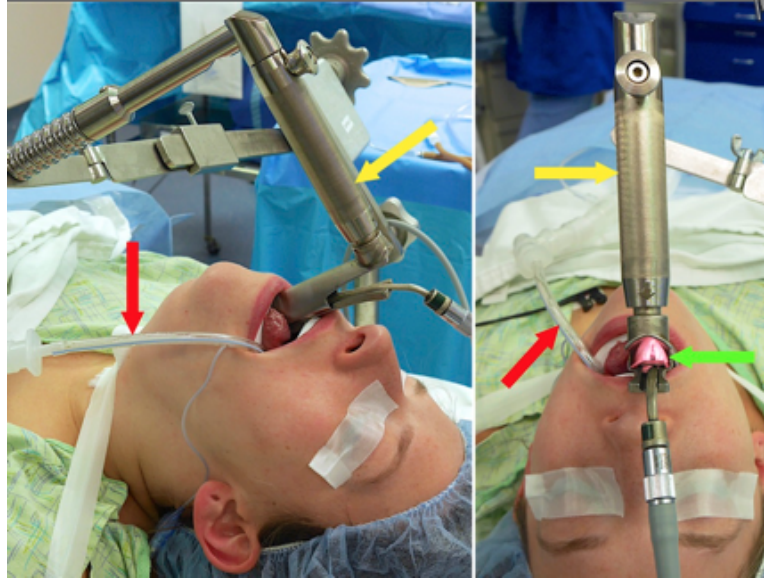


A & B) *



C)





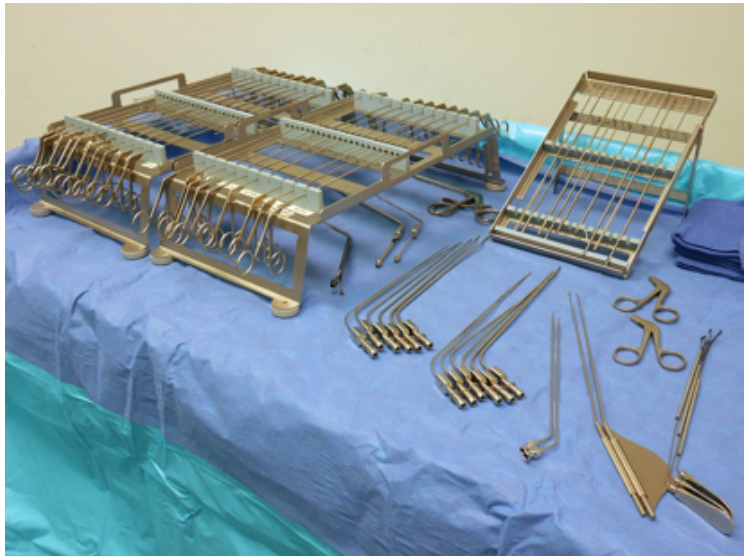
D)

{Captions}

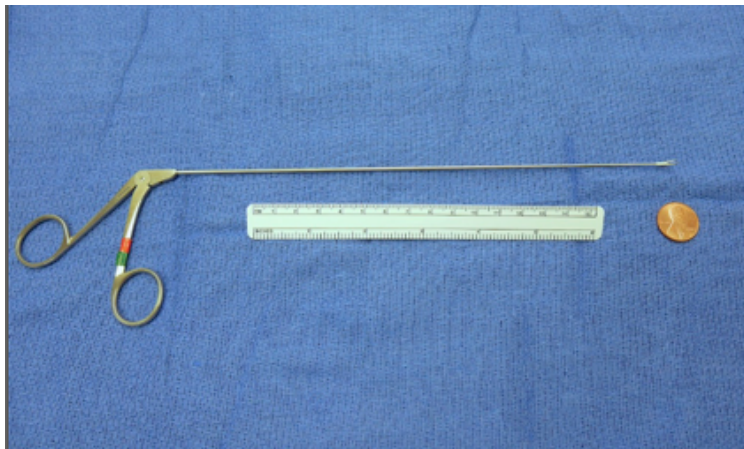
- A) An example of a laryngoscope that is used for direct visualization of the larynx in the operating room (direct laryngoscopy). The gray cable in the bottom left is attached to a light source to provide illumination within the laryngoscope.
- B) Views through the tubular part of the laryngoscope in Image A, with the end closest to the surgeon (**proximal end**) on the left and the end closest to the patient (**distal end**) on the right. Note the roughly triangular shape of the distal end of this particular laryngoscope, which is well suited to the triangular configuration of the vocal folds.
- C) The distal ends of several different laryngoscopes used in microlaryngeal surgery in adult patients. Note the various sizes and shapes, which are necessary to accommodate the variety of voice boxes (larynges) that exist across the anatomical spectrum. Additionally, patients have different capacities to have their larynges visualized during surgery due to a multitude of other anatomic factors, necessitating a wide variety of laryngoscopes to ensure the best visualization possible.
- D) Side and frontal views of a laryngoscope that has been inserted into a patient's mouth under general anesthesia in the operating room. Red arrows indicate the breathing (**endotracheal**) tube, yellow arrows indicate the laryngoscope, and the green arrow shows the illuminated but unmagnified view of the vocal folds. An magnified view through the laryngoscope (see below) is necessary to provide maximal operative precision.

Operating on the Vocal Folds

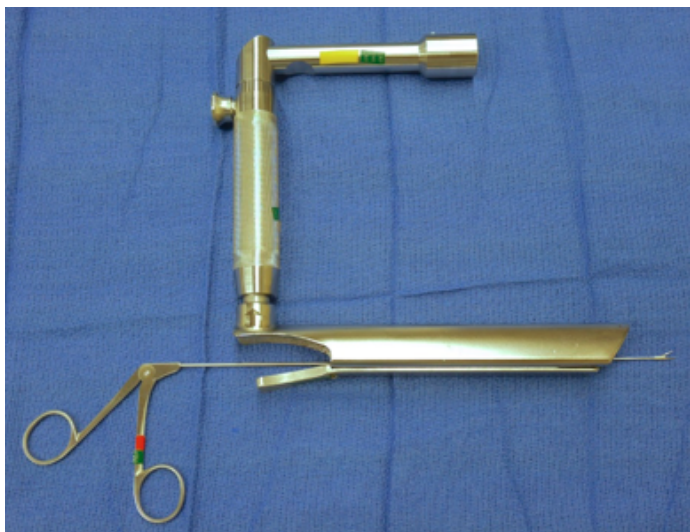
Depending on the pathology, various “cold” microinstruments may be used to operate on the vocal folds. (They are often termed cold instruments, in opposition to lasers, which are often used for laryngeal surgery and generate heat.)



E)



F)



G)

{Captions}

- E) A sample of the many instruments that are used for microlaryngeal surgery. These include an array of delicate forceps, scissors, probes, and suctions.
- F) In general, each instrument is ~ 1 foot long, as seen with this curved forceps, which is used to precisely pick up vocal fold tissue.
- G) The extended length of each microinstrument allows it to be placed through the tubular portion of a laryngoscope. In general, microlaryngeal surgery is performed with two instruments at a time, one in each of the surgeon's hands.

The Scale of Microlaryngeal Surgery

To operate on small, high value tissue like the vocal folds with any degree of precision requires magnification. At present, microlaryngoscopy (and, in particular, surgery on the vocal folds) is generally performed with either the use of: (1) a binocular operating microscope, or (2) a magnified, rigid telescope. There are advantages and disadvantages to each technology, but the point is that laryngeal surgery is more precise with better magnification.

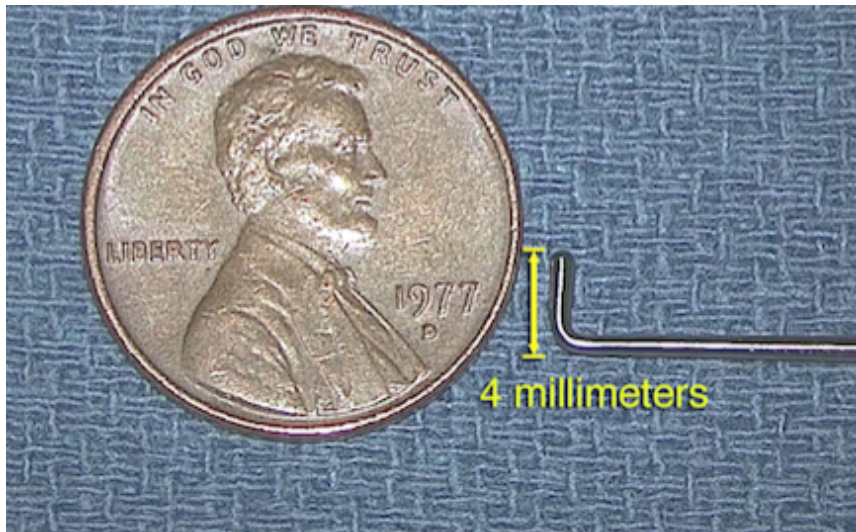


H)

{Caption} A binocular operating microscope provides high-powered magnification when working through the laryngoscope. Notice that it is crucial for the surgeon's arms and wrists to be supported, in order to maximally stabilize the long instruments when performing laryngeal surgery.

I & J)

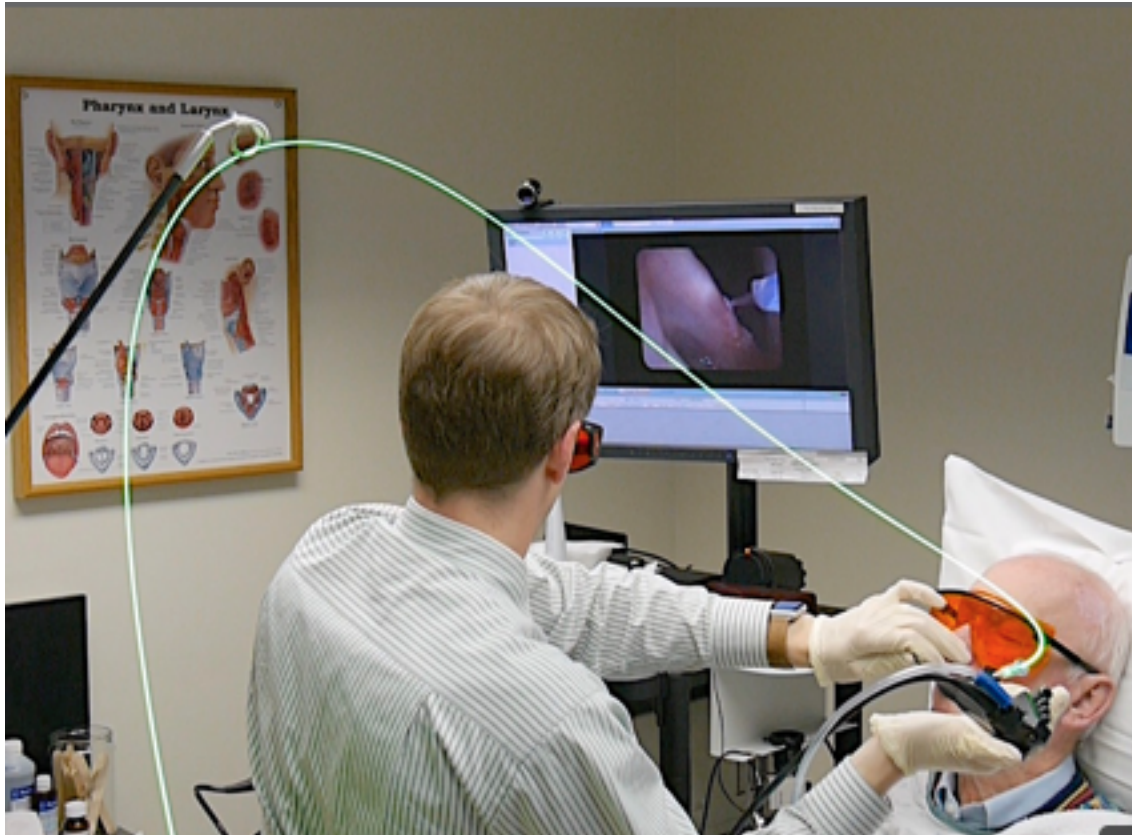
{Caption} View of a hemorrhagic polyp of the right vocal fold in the operating room, via an operating microscope at minimal and maximal zoom, with a 4 millimeter microlaryngeal probe placed beside the lesion for size calibration (see next image).



{Caption} In many places on this website, you will see a right-angled, blunt microlaryngeal probe that is used intra-operatively to size vocal fold lesions. The vertical segment on this probe is 4 millimeters in length and is shown here next to a penny for a sense of scale.

OFFICE-BASED LARYNGEAL SURGERY

Office-Based KTP Laser Surgery



The KTP laser has the advantage of being delivered through a small, flexible glass fiber, which can be inserted through a channel of specialized flexible laryngoscope which is then placed through the nose of a fully awake patient. After sufficient topical anesthetic is administered to the nose, throat, and larynx, the KTP laser can be used to treat small amounts of disease along the vocal folds. This can be tremendously valuable in treating certain types of chronic laryngeal pathologies like and vocal fold dysplasia, which can require multiple treatments over time. For patients who are appropriate candidates, office-based KTP laser surgery can reduce the need for repeated general anesthetics, after disease is first optimally controlled in the operating room, where precision is admittedly better since the vocal folds are not a moving target.

SURGICAL RESULTS

Before and After

The subspecialty of laryngology is a somewhat unique field of medicine, as the results of treatment can be both seen on examination of the voice box and often

heard by patients and others around them. Unless otherwise noted, the before and after results of surgical treatments shown and heard on this website are exclusively those of its author, [Dr. Aaron D. Friedman](#). They are intended to represent the realm of possibility of laryngeal surgery for voice disorders, but are not a guarantee of vocal outcome for any particular patient or pathology.

{BELOW IMAGES AND TEXT SHOULD HYPERLINK TO RESPECTIVE PAGES AT BEFORE / AFTER ANCHOR POINTS}



[Recurrent Respiratory Papillomatosis \(RRP\)](#)



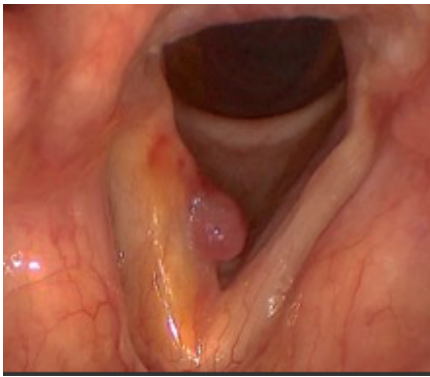
[Reinke's Edema](#)



[Vocal Fold \(Glottic\) Cancer](#)



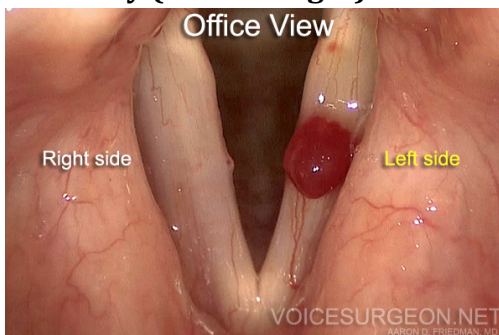
Vocal Fold Cyst



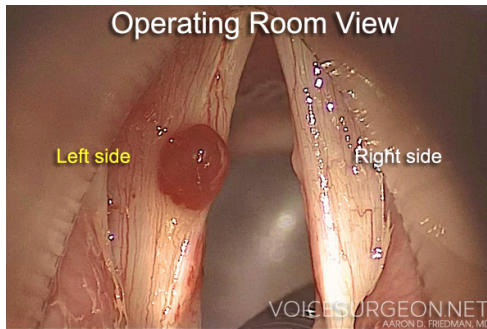
Vocal Fold Polyp

BLOG

Laterality (left and right) – office versus operating room



Caption: A hemorrhagic polyp of the left vocal fold (with small reactive nodule on the right vocal fold), as viewed in the office.



Caption: The same hemorrhagic polyp of the left vocal fold (with small reactive nodule on the right vocal fold), as viewed in the operating room.

When the vocal folds (and larynx) are viewed in the office, by convention, the resultant image on the screen is usually* the mirror image of the way things actually are, with respect to the left and right sides. Conversely, in the operating room, during [microlaryngeal surgery](#), the patient is placed on his or her back, laying on a table. As a result, the left hand side of an image generated by looking through a rigid laryngoscope now correlates with the patient's left side. One can think of the office image as being rotated 180 degrees from the view that is obtained in the operating room and vice versa.

I have chosen not to rotate the office images on this website primarily because:

- it will allow the reader to easily identify which images represent views in the operating room ("V" shape of the vocal cords is upside down)
- it will get your brain used to seeing vocal folds in the same way that you might see them in the office, should you have a laryngeal exam performed
- many of the published images of office-based laryngeal exams adhere to the above convention

* To make matters more confusing, some clinicians may hold their laryngoscopes "upside down" while examining larynges in the office, thereby producing an inverted V image of the vocal folds in the office. In this case, the left side of the image truly represents the patient's left.