Section 3 – LARYNX

Chapter 36 – Office-Based Laryngeal Procedures

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Office-based laryngeal procedures are quickly gaining popularity. These procedures are cost effective and provide an important alternative in 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. Described in this chapter are several procedures that can be successfully and relatively easily undertaken in the office setting under local anesthesia.

PATIENT SELECTION

Patient selection for office-based laryngeal procedures is critical. Because a hyperactive gag reflex can lead to aborting a procedure prematurely, the ideal patient should be able to tolerate an examination with a flexible fiberoptic laryngoscope (FFL) without excessive gagging or undue anxiety. It should be kept in mind that gagging during the mirror examination should not be a contraindication to FFL. The patient should have an adequate interincisal distance (at least 20 mm) for optimal transoral exposure and manipulation.[1] The patient who has severe torticollis or a head tremor may not be suitable candidate for these office procedures.

Indications for office-based laryngeal procedures vary. The use of botulinum toxin is indicated in patients who have spasmodic dysphonia, certain types of essential voice tremor, and vocal fold granuloma. Transoral vocal fold augmentation is indicated in patients with symptomatic glottal incompetence or insufficiency due to unilateral vocal fold paralysis or paresis, vocal fold atrophy, vocal fold scar, sulcus vocalis, or loss of the soft tissue of the vocal folds.

Contraindications to office-based laryngeal procedures include unstable cardiopulmonary status, allergy to any injectable materials including local anesthetic, poor exposure of the endolarynx due to a prolapsing arytenoid or severe supraglottic constriction, and the use of anticoagulants or antiplatelet agents (nonsteroidal anti-inflammatory drugs, aspirin, warfarin). Relative contraindications to vocal fold augmentation in the office include a large posterior glottal gap or large interarytenoid defects that require laryngeal framework surgery. Specific contraindications to the use of botulinum toxin (Botox) are pregnancy, breast-feeding, impaired abduction of vocal fold for PCA injection (relative), any neuromuscular condition such as myasthenia gravis, as well as concurrent aminoglycoside treatment. Specific contraindications to percutaneous procedures for vocal fold augmentation include poorly defined anatomic landmarks of the neck.

PREOPERATIVE PLANNING

The following is a list of recommended equipment and medications for the performance of most office laryngeal procedures (Fig. 36-1):

- Flexible fiberoptic laryngoscope with distal chip (the fiberoptic image clarity makes these procedures more difficult) for a two-person approach, with a channel for passage of a flexible catheter for anesthetic or flexible needle passage (or rigid 70-degree telescope for a one-person approach)
- C-mount camera (attaches to the laryngoscope)
- Video monitor for visualization
- Curved Abraham cannula for delivery of topical lidocaine and vocal fold palpation, as needed
- Orotracheal injection device for transoral injection approach (Medtronic-Xomed, Jacksonville, FL)
- 23-, 25-, or 27-gauge 1.5-inch needles for percutaneous injection (when required)
- Flexible fine-gauge injection needle for use with working channel in flexible laryngoscope
- Injectable material
- Alcohol prep pad or topical prep solution (povidone-iodine) for percutaneous injections
- Cetacaine spray (benzocaine/tetracaine topical)

- Oxymetazoline and/or 2% Pontocaine for nasal decongestion and anesthesia
- Cotton pledgets
- 4% lidocaine (topical)
  Specific to Botox injection:
- Electromyographic (EMG) device (The AccuGuide [Medtronic-Xomed, Jacksonville, FL] is a hand-held device that offers principally acoustic output that may be used as a lower cost alternative to more expensive traditional EMG machines)
- Botulinum toxin
- Insulated 26-gauge needle electrode, which is also used to simultaneously administer Botox
- Ground and reference electrodes
- Tuberculin syringe
- Local anesthetic for skin (1% lidocaine with 1:100,000 epinephrine)—optional

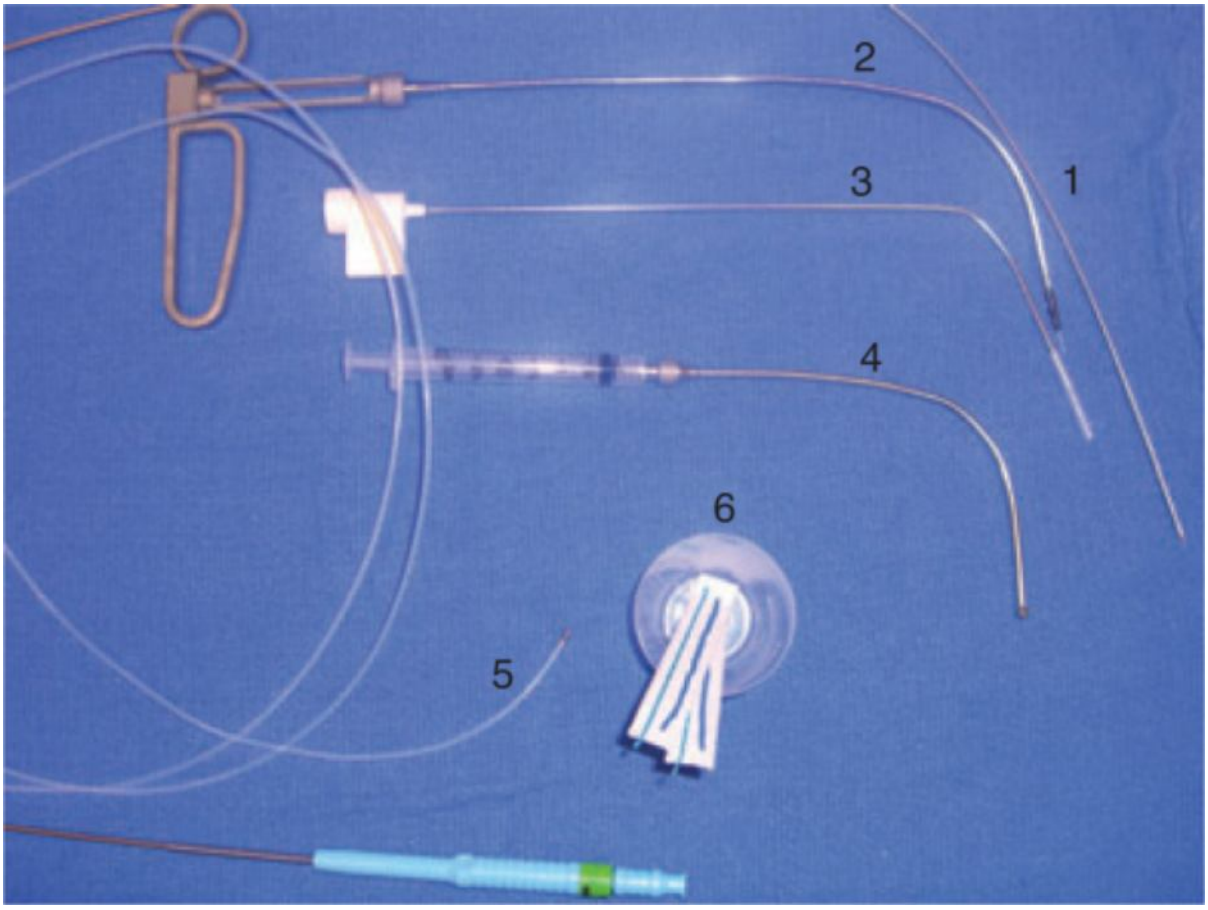

Figure 36-1 Common equipment used for office laryngeal procedures. 1—flexible wire sheath with 27-gauge needle; 2—Xomed orotracheal injector device; 3—Bioform malleable 25-gauge orotracheal needle; 4—3-mL syringe attached to Abraham cannula; 5—end of flexible endoscopic catheter for administration of topical anesthetic; 6—nasal pledgets.

SURGICAL TECHNIQUE

Botulinum Toxin Injection in the Office via Percutaneous and Transoral Approaches

Botulinum toxin is a naturally occurring clostridial neurotoxin that reversibly inhibits release of acetylcholine into the synaptic cleft of the neuromuscular junction, thereby causing flaccid paralysis. Clinically, this results in a reversible, dose-dependent weakening of injected muscles. Botulinum toxin also may have an effect on efferent feedback to the central nervous system. This efferent effect may explain the broad success of botulinum toxin in the treatment of dystonia, particularly in comparison with surgical denervation. Botulinum toxin is or can be used for the treatment of spasmodic dys-phonia, essential tremor of the larynx, and vocal fold granuloma.

There are seven different serotypes of botulinum toxin, only two of which are available for clinical use: type A (Botox, Allergan, Irvine, CA, and Dysport; Ipsen Ltd, Slough, UK) and type B (Myobloc; Elan Pharmaceuticals, Dublin, Ireland). Type A has been most widely used in laryngology. Dose is expressed in mouse units (U) and differs substantially among the commercial preparations. All dosages discussed in this chapter refer to Botox. For

a more in-depth description of the pharmacology of botulinum toxin, refer to “Pharmacology of Botulinum Neurotoxins” by Aoki.[2]

Botulinum Toxin Reconstitution and Dilution

Botox is supplied as a freeze-dried powder in 100-unit vials and is reconstituted with preservative-free saline. The product insert provides dilution instructions to achieve a wide variety of concentrations (1.25 units to 10 units/0.1 mL). Injection volume should be limited to minimize diffusion. Preferable volume is 0.1 mL per vocal fold; however, a volume of 0.2 mL is also acceptable to minimize airway difficulty from vocal fold engorgement. A larger than 21-gauge needle should be used for reconstitution, dilution, and transfer from vial to injection syringe.

There are two basic injection approaches to deliver botulinum toxin to the larynx. Percutaneous injection with EMG guidance is the traditional approach, but the percutaneous technique with laryngoscopic guidance is an alternative. Each approach has advantages and disadvantages. Selection of the best approach is related to the experience of the surgeon, availability of proper equipment, characteristics of the disease being treated and patient preference (Fig. 36-2).

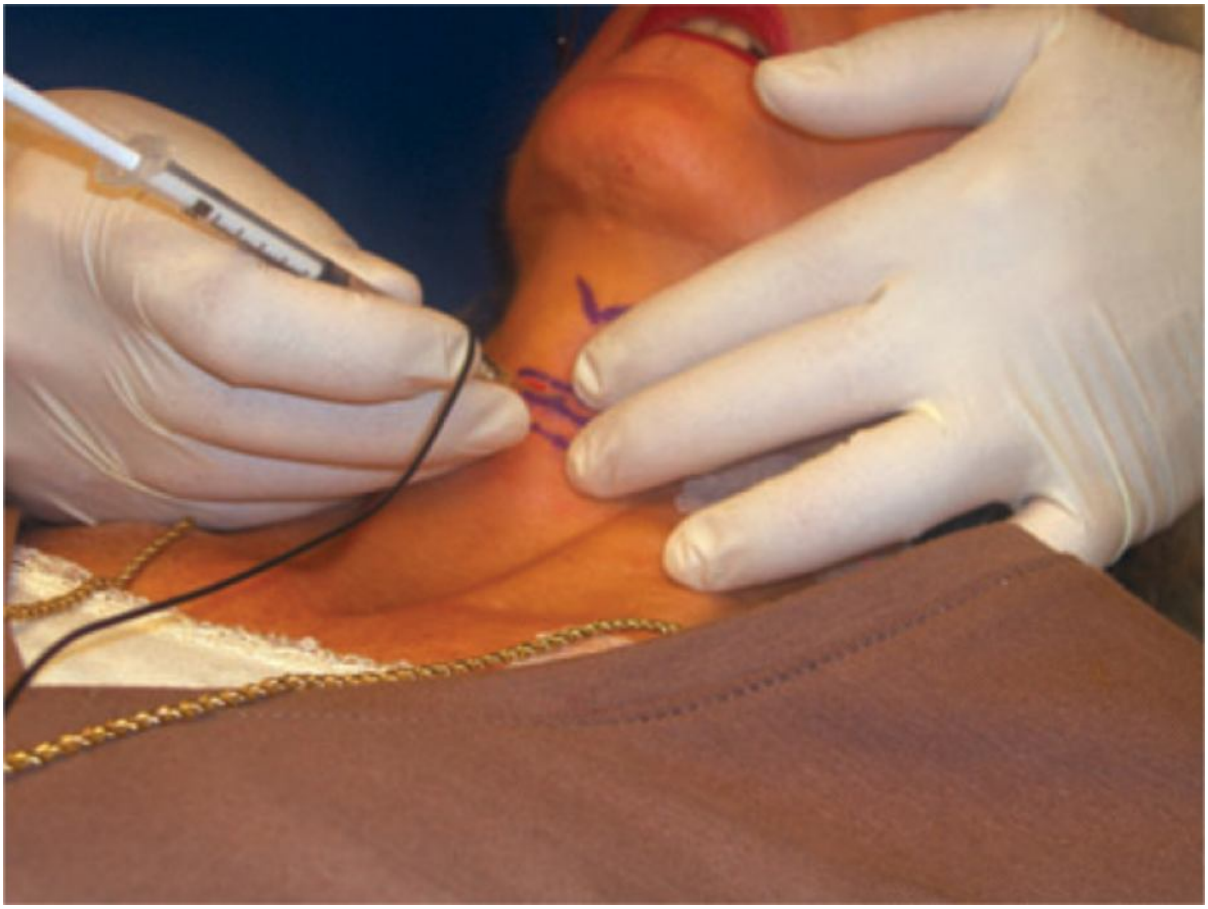

Figure 36-2 Percutaneous electromyographically guided Botox injection. Note landmarks and needle position.

Although percutaneous injection under EMG guidance is the quickest and most precise method of delivery of botulinum toxin into the larynx, this technique has a learning curve and takes time and practice to master. The technique also requires the purchase of an EMG machine and familiarity with EMG interpretation. Those surgeons who perform injections of laryngeal botulinum toxin relatively infrequently should consider the alternative method of percutaneous injection technique using direct visual guidance with a laryngoscope. These approaches without EMG guidance are less precise and often the toxin dose of Botox used is higher than when EMG-guided percutaneous injection is used.

Spasmodic Dysphonia

The most common treatment for adductor spasmodic dysphonia (SD) is EMG-guided bilateral percutaneous injections of the thyroarytenoid–lateral cricoarytenoid muscle complex (TA-LCA) using equal amounts of botulinum toxin. This procedure is based on the understanding that the motor control disorder is bilateral and symmetrical.[3–5] In patients with abductor spasmodic dysphonia, both posterior cricoarytenoid muscles are

treated, although injections are staggered for reasons of airway safety. For both forms of SD, the dose is adjusted based on the initial severity of the disease and on the response to treatment. Unilateral injection may provide essentially equivalent symptomatic relief in patients with adductor spasmodic dysphonia, although the dose is usually increased and the duration of benefit may not be as long.

A reasonable initial dose in adductor spasmodic dysphonia is 1.25 units of Botox per side, which is a low-average dose. The dose used at subsequent treatments is adjusted based on the patient's response. For abductor spasmodic dysphonia, the first posterior cricoarytenoid (PCA) muscle is injected with 5 units of Botox. Improvement in the voice and vocal fold mobility are evaluated 2 weeks after the injection. The contralateral dose is determined based on the above, so that the dose is inversely proportional to the degree of muscle weakness observed. Asymmetrical dosing is the rule in abductor spasmodic dysphonia. Botulinum toxin treatment results in an initial period of marked muscle weakness with transient breathy dysphonia lasting for several days, followed by a 3- to 4-month-long plateau of milder weakening that constitutes the principal therapeutic effect. In general, the length of the period of breathiness and the length of the therapeutic effect are approximately proportional, so that attempts to shorten the breathiness may compromise the duration of therapeutic effect. Naturally, patients prefer to minimize the frequency of their injections, but each will have a different tolerance for the initial breathy voice phase of their treatment and the subsequent duration of effect.

Dyspnea is the equivalent early treatment effect following the injection for abductor SD. Because this may be life-threatening, only one side is treated at a time to allow partial recovery before chemical denervation of the contralateral side. Injections into the PCA muscle are technically more difficult than the TA-LCA injections and may be less satisfactory in patients with abductor SD because (1) the PCA muscle injection is more difficult to access and/or (2) some patients believed to have abductor SD have mixed SD, a combination of adductor and abductor SD.

Essential Voice Tremor

Essential voice tremor (EVT) is typically treated with bilateral symmetrical muscle injections of Botox into the TA-LCA muscle complex similar to adductor SD. Essential voice tremor often involves a variety of muscles of the upper aerodigestive tract. Many of the muscles such as the straps and pharyngeal constrictors cannot be treated due to the negative impact on swallowing function. When the tremor is found to be predominantly at the level of the true and false vocal folds, injection of botulinum toxin into the TA-LCA muscles and/or the supraglottis can be very effective. If the tremor is predominantly located in the soft palate, base of tongue, pharyngeal walls, and/or extrinsic laryngeal muscles, then Botox will not be effective.[6] EVT patients are more likely to be troubled by prolonged post-treatment breathiness, thus a lower dose is preferred by most patients.

Vocal Fold Granuloma

Vocal fold (or vocal process) granulomas (Fig. 36-3) are associated with three inciting conditions: gastroesophageal reflux disorder (GERD), intubation trauma, and vocal abuse. GERD-related granulomas are usually seen in adult males in the fourth to fifth decades of life. Adult women with granulomas usually have had a history of endotracheal intubation in the recent past. Habits such as forceful throat clearing or coughing may also lead to the development of granulomas. The mainstay of treatment is voice therapy, including vocal rest, antireflux medication, and lifestyle modifications.[7] Botulinum toxin injection has been advocated by some in more refractory cases to weaken the vocal adductor force of the arytenoid to allow better healing and resolution of vocal fold granuloma. Botulinum toxin is injected into the ipsilateral or bilateral TA-LCA muscle complexes in doses ranging from 1.25 to 20 units. Most often, 5 units injected unilaterally is adequate. In most cases, a single application, either alone or in conjunction with surgical removal, has been sufficient to allow for resolution of the granuloma. Patients treated in this fashion will have a significantly breathy, weak voice for several months, which they must be told may have major functional impacts on their voice capacity (work and social).

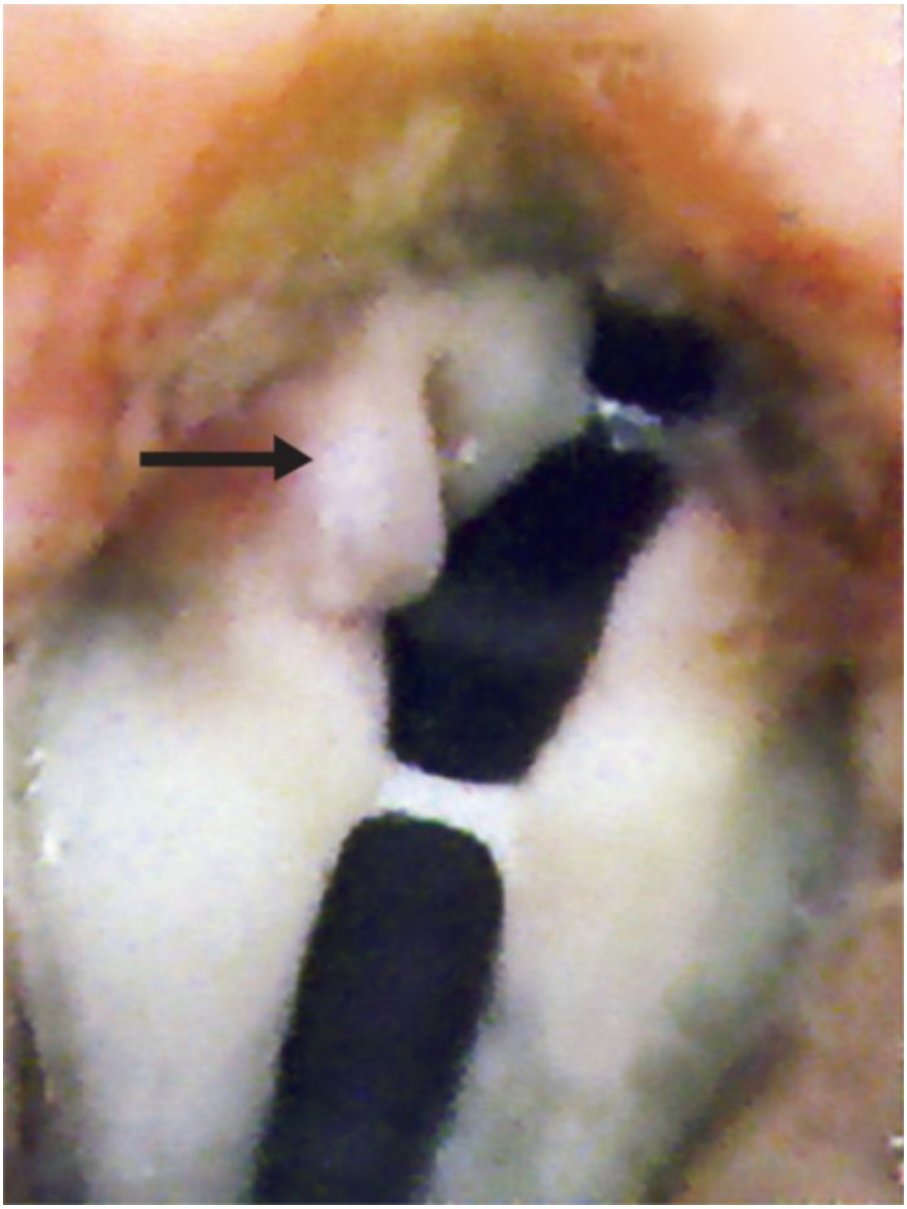

Figure 36-3 Vocal fold granuloma *(arrow)*.
(Reprinted with permission from Leonard R, Kendall K: Effects of voice therapy on vocal process granuloma: A phonoscopic approach. Am J Otolaryngol 26:101-107, 2005.)

Percutaneous Electromyographically Guided Botulinum Toxin Injection

Connecting Electromyogram Electrodes

A ground and a reference electrode are coated with a conducting gel and attached to the patient's skin at a convenient site so as not to obstruct the injection pathway. The insulated injection needle (26 gauge), which serves as a monopolar sampling electrode during the injection, is attached to an EMG recording device.

Thyroarytenoid–Lateral Cricoarytenoid Muscle Complex Localization and Injection

The patient is positioned in a semirecumbent position with the chin elevated and the head extended. If the patient's neck is thin and laryngeal landmarks are easily palpable, a shoulder roll may be omitted. If the patient has a short and stocky neck, or if the larynx is canted forward, a shoulder roll is helpful. Alternatively, the head piece of the chair can be positioned to allow extension of the neck. The patient is asked to breathe quietly and to try not to swallow during the procedure. Local anesthetic may be injected into the skin. The use of local anesthesia is highly variable among experienced clinicians. Some surgeons argue that the discomfort to the patient from the anesthetic injection is approximately equivalent to that from the injection of the toxin itself, whereas others believe that the skin injection (30-gauge needle using 1% lidocaine with 1:100,000 epinephrine and sodium bicarbonate) is justified in ameliorating discomfort or pain of the procedure. Bending the needle upward approximately 30 to 45 degrees is

helpful, especially when injecting the female larynx, because the shorter anteroposterior distance requires a more acute angle of entry under the inferior rim of the thyroid cartilage.

The EMG needle is inserted through the cricothyroid membrane approximately 2 to 3 mm off of the midline toward the side to be injected and advanced superiorly and laterally. This lateral entry point is used to avoid the airway, because traversing endolaryngeal mucosa is uncomfortable for the patient and may cause coughing or even laryngospasm during the procedure. If it is possible to remain entirely submucosal, the patient finds the procedure much less painful and stimulating to airway reflexes. Entry into the airway produces a characteristic “buzz” in the EMG signal that should alert the surgeon to redirect the needle more laterally or even start again. The location where the needle penetrates the cricothyroid membrane from a superior-inferior perspective is determined by the surgeon's preference. Some surgeons enter the larynx at the junction of the inferior border of the thyroid cartilage and the membrane, whereas others prefer to be at the halfway point of the membrane.

The needle is maneuvered within the tissue until the tip lies in an area of crisp motor unit potentials found by EMG. The patient is asked to phonate, and when a brisk recruitment and a full interference pattern confirm placement, the botulinum toxin is injected (Fig. 36-4). It is especially good to see a characteristic prephonatory burst of EMG activity for optimal localization of the injection.

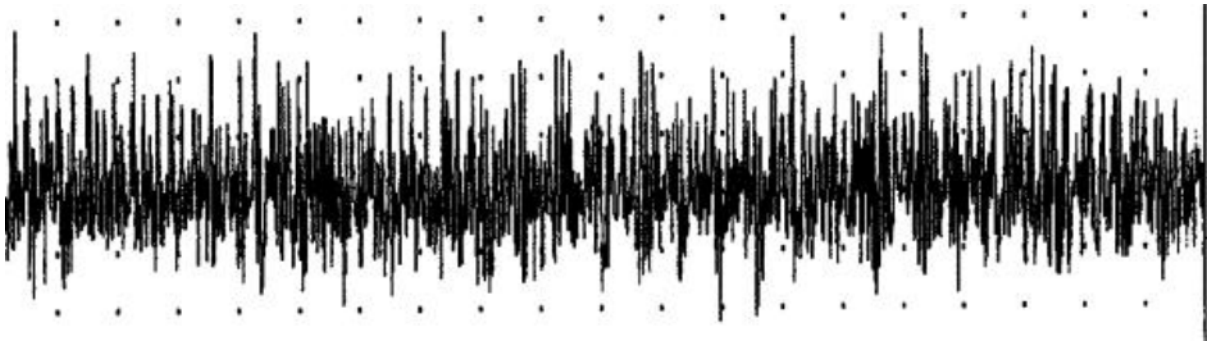

Figure 36-4 Electromyographic recording during “ee” maneuver for thyroarytenoid muscle localization.
(Reprinted with permission from Munin M, Murry T, Rosen CA: Laryngeal electromyography: diagnostic and prognostic applications. Otolaryngol Clin N Am 33:759-770, 2000.)

Posterior Cricoarytenoid Muscle Localization and Botox Injection

The patient is seated upright, and the surgeon who will inject the Botox places his or her thumb at the posterior border of the thyroid cartilage on the side to be injected. Using counterpressure on the opposite side of the thyroid cartilage from the other four fingers, the larynx is gently rotated to expose its posterior aspect (posterior plate of the cricoid cartilage). The needle pierces the skin along the lower one half of the posterior border of the thyroid cartilage, and is advanced until it stops against the posterior surface of the cricoid. The needle is then pulled back slightly and the patient is asked to sniff to confirm placement. When this produces brisk recruitment, the toxin is injected.

Botulinum Toxin Injection with Laryngoscopic Guidance (Two-Person)

A puncture through the cricothyroid membrane is performed for administration of local anesthesia, instilling approximately 3 mL of 4% lidocaine into the airway. The nasal cavity is anesthetized and a flexible laryngoscope, attached to a video monitor, is inserted through the nasal cavity and advanced to a level slightly above the vocal folds. An assistant keeps the scope in position to provide exposure and visual feedback during the procedure. A 1-mL syringe filled with botulinum toxin is attached to a 27-gauge needle, and the needle is placed through the cricothyroid membrane near the midline while under visualization by video monitoring to confirm the location of the needle tip in the subglottic airway. The needle is angled toward the posterior aspect of the vocal fold, piercing the infraglottic mucosa, and advancing the needle laterally into the musculature of the vocal fold. The posterior one third of the membranous vocal fold is targeted for Botox placement. A similar injection is then performed on the opposite vocal fold through the same approach. Using flexible laryngoscopic visualization to confirm correct placement is a precise technique that ensures that inadvertent “loss” of the Botox does not occur.

Transoral Vocal Fold Injection and Other Transoral Procedures

Transoral (or per oral) vocal fold augmentation (Fig. 36-5) in the office is indicated in the treatment of symptomatic glottic insufficiency as previously described. This technique can also be used for temporary or permanent correction of the patient's glottic insufficiency. A typical case is a patient with idiopathic unilateral vocal fold

paralysis who presents early (1 to 3 months after onset) in the course of this condition. Temporary augmentation is an excellent option in treating the patient who aspirates and has significant dysphonia and vocal demands. The procedure addresses the patient's vocal/swallowing needs, while allowing for spontaneous recovery of function without having to have a surgical procedure in the hospital or a general anesthesia. Vocal fold augmentation can also be offered to a patient as a minimally invasive opportunity to evaluate their voice after correction of glottic insufficiency. This may help the patient decide whether a permanent treatment option for glottic insufficiency is desirable. This approach is referred to as a *trial vocal fold augmentation.*

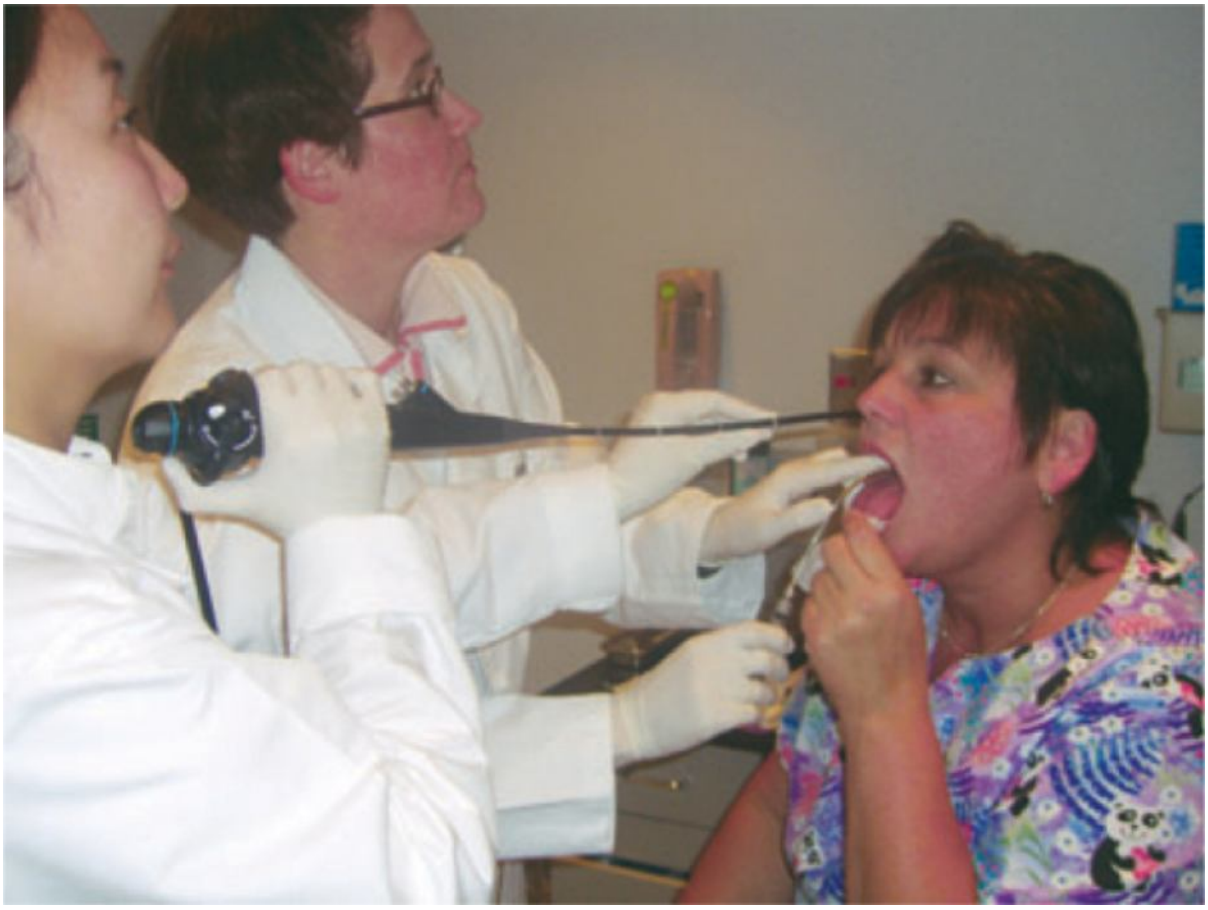

Figure 36-5 Transoral vocal fold augmentation with endoscopic guidance placement of Abraham cannula. Note positioning of patient.

Topical Anesthesia Nasal/Oropharynx

Topical oxymetazoline/Pontocaine 2% is sprayed into nasal cavities (medication-soaked cotton pledgets placed intranasally are an alternative). Topical Cetacaine spray is also administered to the palate and pharyngeal walls.

Video Monitoring/Topical Anesthesia of the Larynx

A video camera is attached to a flexible fiberoptic laryngoscope or a distal chip flexible laryngoscope system, which is inserted through the nasal cavity (typically the side opposite the intended vocal fold to be injected) by an assistant, employing a “videocart system.” The laryngoscope is generally maintained slightly below the palate so that the tongue base and larynx can be easily viewed on the video monitor.

Four percent lidocaine is then dripped onto the larynx under flexible laryngoscope guidance (3 to 5 mL).[8] The patient is bent forward at the waist with the neck extended in a “sniffing” position to maximize exposure of the larynx. The tongue is grasped with gauze with the surgeon's left hand. An Abraham cannula attached to a 3-mL syringe of 4% lidocaine is passed from the oral cavity into the pharynx under flexible laryngoscopy guidance. Approximately 1 mL of lidocaine is deposited over the tongue base, and 2 to 4 mL are dripped onto the vocal folds during phonation (sustained “i”), producing the characteristic “laryngeal gargle.” **Note:** The maximum recommended dose of 4% lidocaine is approximately 7 to 8 mL (4.5 mg/kg; approximately 300 mg in 70-kg patient).

The initial dose is usually followed by a brisk cough as the anesthetic is aspirated and then distributed over the laryngotracheal mucosa. Absence of the laryngeal gargle and cough may indicate that the patient has swallowed the anesthetic, and additional topical applications may be indicated until topical anesthesia has been obtained.

Alternative Methods of Topical Anesthesia

Nebulization

An alternative method of obtaining anesthesia of the larynx involves nebulization of lidocaine using a simple disposable nebulization device (e.g., those used by respiratory therapy) and an external source of pressurized air (i.e., from an oxygen tank) (Fig. 36-6). Four percent lidocaine can be nebulized and inhaled by mouth by the patient. This method of anesthesia provides a simple and less physician-involved method for obtaining laryngeal anesthesia. Typically, 6 mL of 4% plain lidocaine is nebulized over a 5- to 10-minute time period, achieving excellent anesthesia of the larynx. After the nebulization process, a curved Abraham cannula can be used to supplement any additional need for laryngeal anesthesia on an as-needed basis and to test for complete anesthesia of the larynx and, specifically the vocal folds.

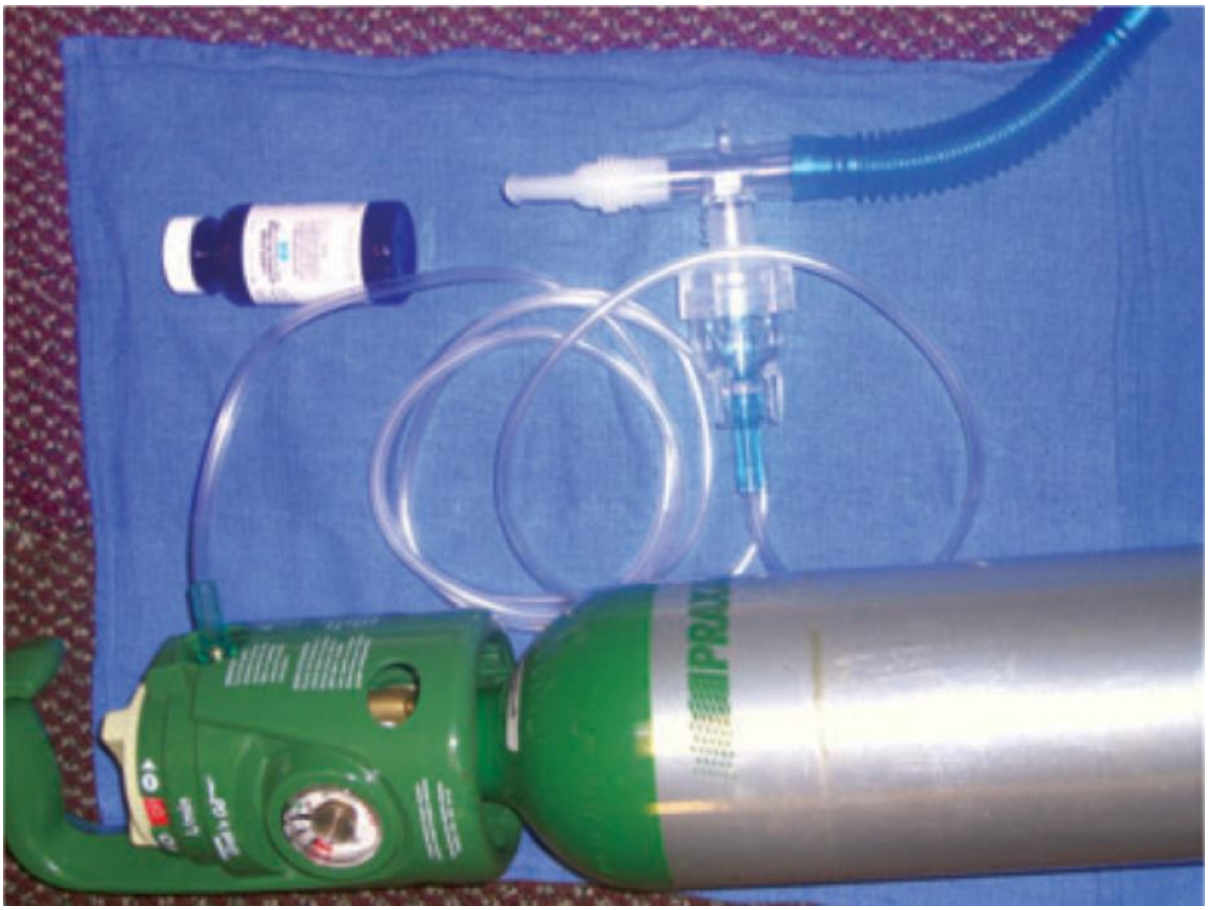

Figure 36-6 Equipment needed for nebulization.

Flexible Catheter

Another technique of delivering the anesthetic agent to the larynx is by using a small silastic, flexible cannula through the working channel of the flexible laryngoscope or an EndoSheath with a working channel (Medtronic-Xomed, Jacksonville, FL). This silastic catheter (Olympus America, PW-2L-1.B, Center Valley, PA) passes through the working channel of the flexible laryngoscope and is used to deliver 4% plain lidocaine to the endolarynx during sustained phonation to achieve the “laryngeal gargle” as described earlier. This catheter allows direct application of the anesthesia to the specific areas intended for the vocal fold injection and is very well tolerated by most patients.

Transoral Passage of the Needle into the Endolaryngeal Region

The two most commonly used needles for transoral vocal fold augmentation in the office are the orotracheal injector device (Medtronic-Xomed, Jacksonville, FL) and the injection needle developed by Bioform Medical (Bioform Medical, San Mateo, CA). Each of these injection devices is fine-gauge (27- and 25-gauge, respectively.) The former device is precurved for transoral injection and the latter is malleable and must be bent to the appropriate dimensions and curvature needed for transoral vocal fold augmentation. In preparation for vocal fold injection, the intended injection material should be attached to the injection needle and the needle “primed” to

eliminate the dead space within the needle. The orotracheal injector is designed to inject thin liquids and not thick, viscous augmentation materials.

Preferably, patients hold their own tongue with a gauze pad, or the surgeon grasps the patient's tongue with the left hand. The needle is passed through the oral cavity and then advanced into the oropharynx under direct visualization with the flexible laryngoscope. The patient is instructed to say “a” as the needle enters the oral cavity, which results in palatal elevation, providing visualization into the oropharynx. The assistant should position the fiberoptic scope just above the palate, until the needle is visualized in the oropharynx.

The needle is then guided into the oropharynx and the endolarynx under endoscopic visualization as the assistant follows closely behind with the flexible laryngoscope. The assistant must be facile with manipulating the flexible scope. Consistent visualization of the needle is especially important in a narrow airway with copious secretions. The flexible scope should be positioned a few millimeters above the true vocal folds, providing a clear, well-illuminated view before, during, and immediately after the injection.

Vocal Fold Injection

For unilateral VF paralysis, the injection should be placed at two sites: the posterior aspect (lateral to the vocal process) and the mid-membranous vocal fold (Fig. 36-7). The initial injection should be at the posterior aspect of the vocal fold, where, typically, the most correction is needed. The depth of injection should be into the substance of the vocal fold lateral to the body of the TA muscle. Great care should be taken to avoid superficial placement into Reinke's space, which results in a stiff vocal fold and poor voice quality. If the subglottis begins to bulge during injection, the needle should be withdrawn slightly. Once the posterior vocal fold is adequately medialized, a smaller additional amount can be deposited at the mid vocal fold, if needed. If the injected substance extrudes from the puncture hole, patients can clear this themselves with a gentle cough or throat clear (this rarely is a problem when a fine-gauge needle is used). The patient's vocal quality should be checked periodically during the procedure to determine the optimal volume of injected material. Only when a steroid injection for superficial scar is per-formed is the injection performed superficially along the medial surface of the vocal fold into the lamina propria (Reinke's space). Steroid injection is best done via the transoral or transnasal approach.[9]

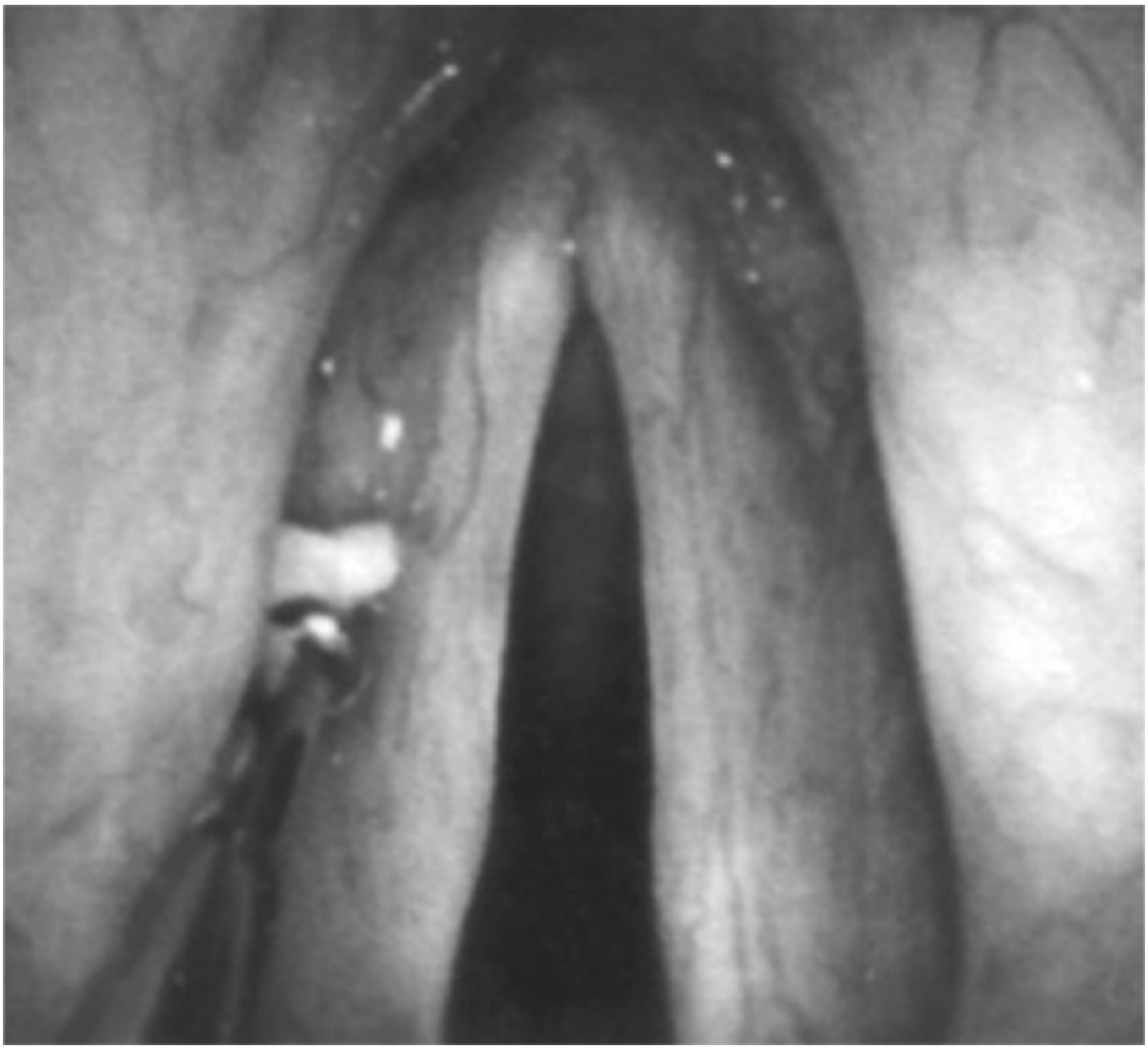

Figure 36-7 Proper placement of the needle lateral to the vocal fold for augmentation using flexible endoscopy.
(Reprinted with permission from Andrade FP, Carrau R, Buckmire R: Safety and cost-effectiveness of intra-office flexible video-laryngoscopy with transoral vocal fold injection in dysphagic patients. Am J Otolaryngol 27:319-322, 2006.)

For most injectable substances, the medialized vocal fold should be overinjected (past midline) to a variable degree depending on the specific nature of the material and the primary goal of the procedure (long duration of the temporary agent versus immediate need for optimal voice function). In general, the vocal fold is medialized until the voice is maximally improved, and then an additional 0.1 to 0.2 mL is injected to achieve overcorrection. Overcorrection is necessary because all injectables have a small aqueous component that will be absorbed 3 to 5 days after injection leading to loss of volume. The total amount necessary for unilateral augmentation is typically less than 1 cm^3, but the amount injected should be determined visually and audioperceptually.

For patients with a bowed vocal fold due to atrophy or paresis, the injection differs slightly from the previous technique. These cases typically require injection principally in the midportion of the vocal fold, where the maximal glottal gap usually occurs. In severe cases of muscular atrophy, the posterior vocal fold can be augmented to fill in the atrophy that occurs just anterior to the vocal process. Again, overcorrection is the rule, even in the case of bilateral injections. Airway compromise should not be a concern, because the posterior respiratory glottis remains patent and in cases of vocal fold atrophy both vocal folds are usually fully mobile.

Percutaneous (Transcervical) Vocal Fold Injection

Vocal fold augmentation using a percutaneous approach in the office or at the bedside has been successfully performed with a number of different materials and can be performed with either temporary or permanent augmentation materials (Fig. 36-8). There are multiple percutaneous vocal fold augmentation approaches, including transthyroid cartilage, transcricothyroid membrane, and transthyrohyoid membrane.

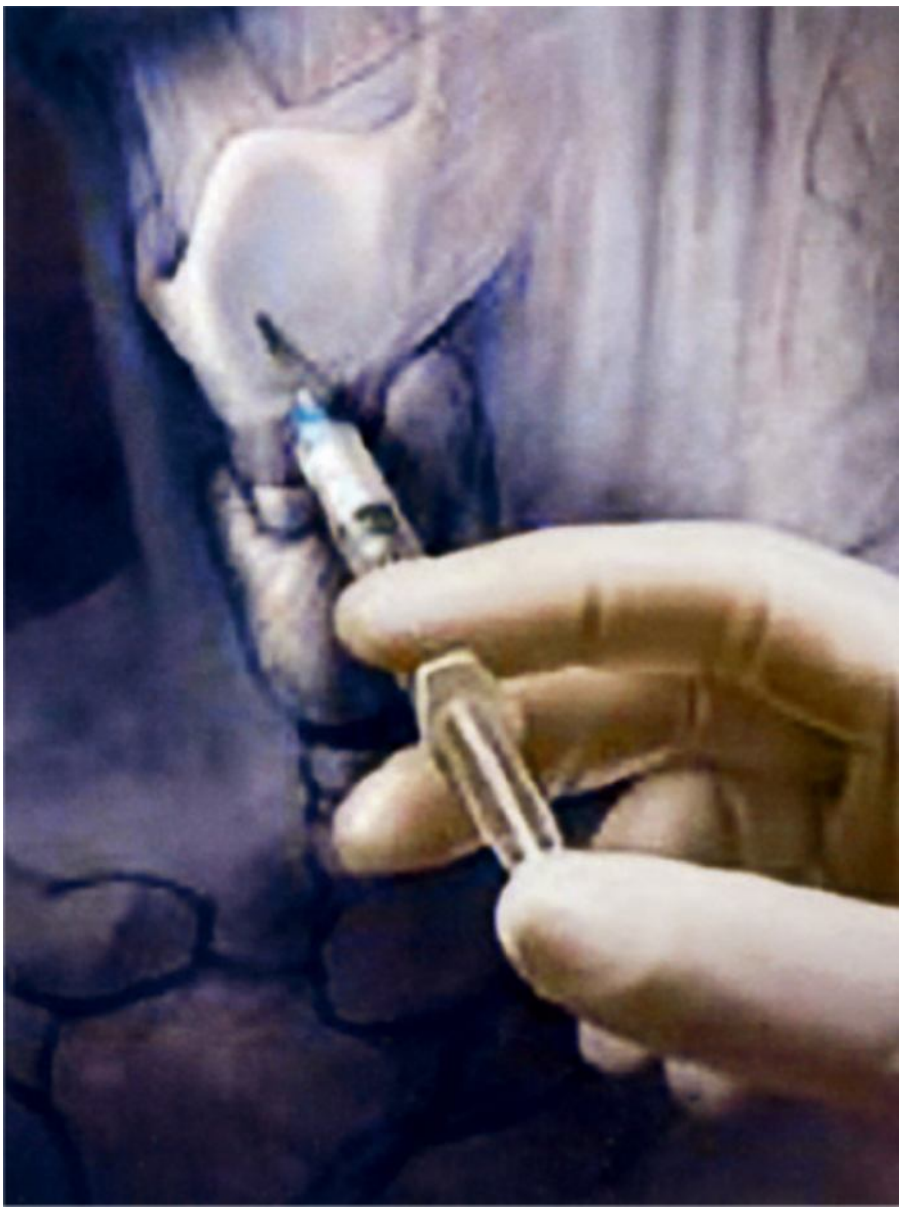

Figure 36-8 Percutaneous vocal fold augmentation procedure.
(Reprinted with permission from LifeCell Corporation.)

All of these approaches require anesthesia of the overlying skin, a skilled endoscopist as an assistant, and a 23- to 25-gauge needle (1.5 inches long). The transthyroid cartilage and cricothyroid membrane approaches are similar. Ossification of the thyroid cartilage can prevent passage of the injection needle through the thyroid cartilage and thus a cricothyroid (subthyroid) or thyrohyoid approach is required.

The thyrohyoid approach can be used for VF augmentation as well as for injection of therapeutic substances, such as cidofovir and Botox (Fig. 36-9).[10,11] The transthyrohyoid approach is an excellent alternative to transoral or traditional percutaneous approaches (transthyroid cartilage and cricothyroid approach). This technique is as well tolerated as other percutaneous approaches and provides good visualization and precision.

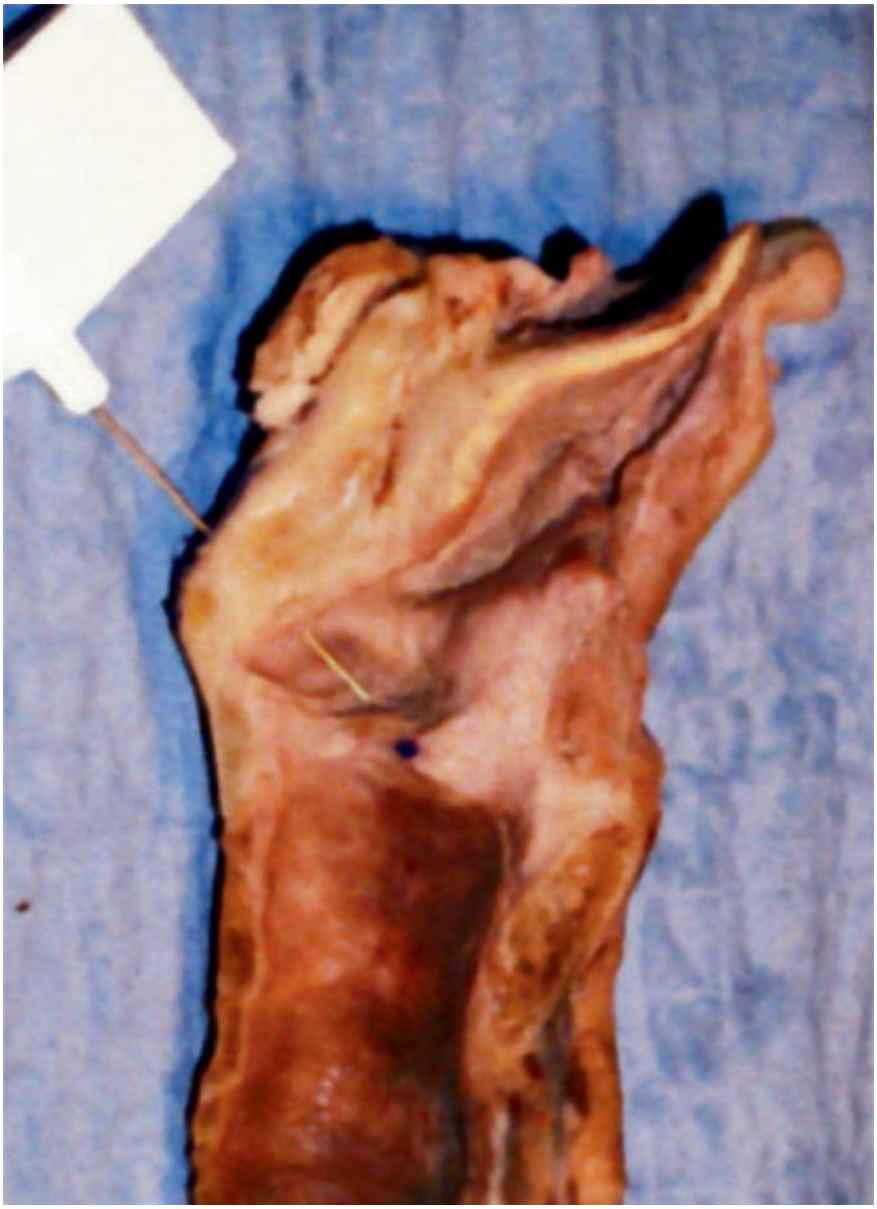

Figure 36-9 Thyrohyoid approach in cadaver larynx.
(Reprinted with permission from Getz AE, Schar J, Amin M: Thyrohyoid approach to cidofovir injection: A case study. J Voice 19:501-503, 2005.)

Percutaneous vocal fold augmentation in the clinic setting has the same indications as transoral vocal fold augmentation. These are unilateral vocal fold paresis or paralysis, vocal fold atrophy, vocal fold scar, sulcus vocalis, and soft tissue loss of the vocal folds. Injection can be performed as trial, temporary, or permanent for augmentation as described in the section on transoral augmentation. With the percutaneous approach, interincisal opening and gag reflex are not concerns.

Percutaneous Vocal Fold Augmentation in the Office

1. The area overlying the injection site is swabbed with an alcohol prep pad or povidone-iodine prep.
2. The patient is positioned in the sitting position but slightly reclined with the neck in neutral position and the head slightly extended on the neck.
3. It is important to anesthetize both the skin over the area to be injected as well as the upper airway in preparation for flexible laryngoscopy. To anesthetize the skin and subcutaneous tissues, approximately 0.5 mL of local anesthetic (1% lidocaine with 1:100,000 epinephrine) is sufficient. The skin and subcutaneous tissues overlying the cricothyroid membrane are injected as well as the area over the inferior aspect of the thyroid cartilage on the side(s) intended for injection. The surgeon must avoid overinjection of this area with anesthetic because this may transiently impair cricothyroid function, thus clouding the picture of paresis/paralysis at the time of injection.

4. The nasal cavity is anesthetized and decongested as is customary for the surgeon. Topical anesthesia to the endolarynx is helpful per the surgeon's preference but is rarely necessary for the percutaneous procedure.
5. Flexible laryngoscopy is performed by the assistant and the preprocedure diagnosis/diseases are confirmed. Ideally, the tip of the scope is maintained over the contralateral arytenoid, as posteriorly as possible to avoid stimulating the supraglottic structures. This position allows for some visualization of the infraglottic surface of the vocal fold to be injected.
6. The cricothyroid membrane is palpated by the injecting surgeon. In many patients, it is possible to see (endoscopically) the depression of the underlying mucosa during this maneuver. This is very helpful in estimating the height of the vocal fold relative to the cricothyroid membrane. If the impression from the palpating finger is not seen, this maneuver may be performed with the injection needle without penetrating into the airway.
7. The vertical and horizontal distances from this point to the midpoint of the membranous vocal fold are estimated by the surgeon. The needle (23- or 25-gauge, 1.5 inches long) is placed along a vertical line approximately 6 to 12 mm from the midline; this distance depends on the size of the larynx. The needle should be oriented perpendicularly in relation to the thyroid ala.
8. The needle is placed against the thyroid ala at the desired vertical level along this line. In most females and younger males, gentle steady pressure will allow the needle to pass through the cartilage. The surgeon should avoid “past pointing” as the needle is passed through the thyroid cartilage to avoid entering the airway. If the needle meets significant resistance, the needle is kept in the same line and “walked” down the thyroid ala until the inferior aspect of the thyroid cartilage is reached.
9. The needle is then advanced medially, again perpendicularly to the thyroid ala for approximately 3 to 4 mm through the junction of the thyroid ala and the cricothyroid membrane. At this point, the tip of the needle is in the infraglottic vocal fold and needs to be directed nearly straight up vertically. All attempts should be made to avoid entering the airway. The needle may be seen indenting the infraglottic mucosa or penetrating the floor of the ventricle with the image from the flexible laryngoscope.
10. To facilitate identifying where the needle has entered into the endolarynx, the needle can be moved back and forth rapidly several times over a short distance.
11. The tip of the needle is then redirected to the main bulk of the vocal fold if found not to be located in the membranous vocal fold.
12. Once the needle location is confirmed, vocal fold injection is started slowly. Good visualization of the vocal fold is essential at this stage. As the material is injected, the vocal fold will swell. The end point for injection will be determined by the endoscopic appearance of the vocal fold as well as by the patient's voice. Depending on the nature of the substance injected, modest to moderate overcorrection is often desirable. The patient may immediately notice the improvement in the voice—it is important in most cases to overcorrect past this point, if possible, to allow for a longer duration of overall benefit for temporary augmentation materials.
13. If the contour is not ideal (focally overinjected) immediately following injection, a hard cough may “straighten out” the vocal fold as seen during the endoscopy. In the case of bilateral vocal fold pathology, there is generally no limitation to treating both sides at the same setting.

Thyrohyoid Approach to the Larynx

1. The surgeon first sprays (topical 50:50 mix of oxymetazoline/lidocaine) into the nasal cavities.
2. Skin and subcutaneous tissues overlying the thyrohyoid notch are injected using a 25-gauge needle and 1% lidocaine.
3. The patient should be positioned sitting upright with neck extended to expose the thyrohyoid notch.
4. An assistant passes the flexible laryngoscope through the nasal cavity (usually left side) and positions the scope so the tongue base and larynx are clearly visualized.
5. A 25-gauge needle (1.5 inches long) and syringe with topical 4% lidocaine is passed into the airway above the vocal folds via the thyrohyoid mem-brane. The needle is passed immediately above the thyroid notch and directed acutely downward until the needle enters the airway in the area of the petiole.
6. Proper positioning is confirmed by fiberoptic guidance and the ability to draw back air into the syringe. Note that absence of a laryngeal gargle or cough suggests the patient swallowed the anesthetic and additional 4% lidocaine may be needed. Adequate anesthesia is achieved after 3 to 5 minutes. Alternatively, topical laryngeal anesthesia may be administered through a working channel of the flexible laryngoscope if this is available.
7. The implant/injectable material is prepared in an appropriate syringe attached to a 25- or 23-gauge, 1.5-inch needle.

8. The needle is passed in the midline just above the thyrohyoid notch in a downward, acute angle just under the patient's chin. If the patient turns his or her head slightly away from the surgeon, this will help establish the optimal angle.
9. The tip of the needle passes through the pre-epiglottic space and enters the larynx at the petiole of the epiglottis.
10. Under direct guidance on the monitor, the assistant advances the flexible scope to follow the needle as it is guided to the appropriate injection site(s).
11. Bilateral VF injection may be achieved by backing out the needle slightly (without removing it) and redirecting the needle tip under direct visualization to the other side (see Fig. 36-9).

POSTPROCEDURE CARE/COMPLICATIONS

Botox

Patients may leave the office immediately after the injection. Patients receiving TA-LCA injections should be cautioned regarding an initial period of (1) breathiness and (2) dysphagia, especially to liquids, as discussed earlier. Patients receiving their second posterior cricoarytenoid injection should be advised regarding the possibility of dyspnea and stridor.

Vocal Fold Injection or Augmentation

Immediately following vocal fold injection in the office, patients should be observed for 20 to 30 minutes to monitor for any complications of the vocal fold injection, particularly airway distress. Patients need to be instructed that they should not take anything orally for approximately 2 hours following vocal fold injection to allow adequate time for the local anesthesia to wear off. In addition, patients should take care as they resume oral intake to be sure that any residual anesthetic effects have dissipated. The use and duration of strict voice rest following vocal fold injection are not standardized and are often determined by the size of the vocal fold injection needle and surgeon preference. Because most vocal fold injections are now performed with fine-gauge needles, prolonged voice rest (exceeding 24 hours) is usually not indicated. Some surgeons do not suggest the use of voice rest, whereas others use a 24-hour period of voice rest. The rationale for voice rest following vocal fold injection is to minimize loss of the injected material being extruded through the injection site(s) if immediate phonation is allowed. Antibiotics and steroids are not typically indicated for this procedure. Patients should be instructed that, because of the vocal fold edema and overinjection of the augmentation material, optimal voice quality is typically not achieved for 1 to 2 weeks following vocal fold injection.

Complications of transoral vocal fold injection include inappropriate placement of the vocal fold injection material: too superficially into Reinke's space, very lateral into the paraglottic space (this can cause increased pain), and inferior into the subglottis. If these inappropriate locations of vocal fold injection are recognized during the procedure, often the material can be “milked” out of the vocal fold with the use of an Abraham cannula, applying gentle lateral pressure to the vocal fold. If this is not possible, it is advisable that the vocal fold material, if permanent in nature (e.g., calcium hydroxylapatite), be removed under microlaryngoscopy with general anesthesia in the near future. Injection should be aborted with the first sign of airway embarrassment, laryngeal spasm, or unexpected vocal fold swelling. Dramatic swelling may occur if air is inadvertently injected. Complications unique to the percutaneous approaches include plugging of the needle with cartilage (transthyroid approach) and bleeding into the airway. Bleeding is typically minimal, although when it leads to coughing, the endolarynx may be covered with a thin film of blood, which limits visibility. The patient is asked to gargle (if possible) and the procedure may be continued. A hematoma in the skin overlying the injection site may occur also but it is usually self limited.

In-Office Laryngeal Biopsy Using EndoCDx

This procedure uses surface exfoliative cytology as its basis. The indications for this procedure are epithelial lesions that are preneoplastic or of uncertain behavior. This brush biopsy technique can be used both for initial diagnosis and pathologic surveillance. The contraindications are as mentioned previously for any in-office procedure.[12]

1. The endolarynx should be anesthetized as for any transoral or transnasal vocal fold injection through the working channel of a flexible laryngoscope. Instillation of 2 mL of 4% lidocaine one to three times while the patient's vocal folds are in adduction appears to be adequate but the amount is left to the discretion of the surgeon.
2. The EndoCDx brush (Fig. 36-10) is guided through the working channel of the flexible laryngoscope. Alternatively, it can be guided via indirect rigid endoscopy using an alligator or cup forceps to hold the brush.

3. The EndoCDx brush should be placed against the lesion while maintaining pressure by angulating the laryngoscope. The brush is rotated against the lesion unless pinpoint bleeding is observed. A vigorous up and down direction should be used while rotating the brush.
4. Care must be taken to not contaminate the sample by touching other sites during withdrawal/retraction. The brush is retracted into its sheath and removed, and the material (cells) is spread evenly onto the bar-coded side of an enclosed glass slide. Care must be taken to not contaminate the sample by touching other sites during withdrawal/retraction. A fixative packet is emptied onto the slide and should saturate the material on the slide. The slide should be set aside to dry for 15 minutes and then placed in the slide holder supplied by the company.
5. The bristle end of the brush is clipped off into a supplied vial. The vial is closed and is then sent to the CDx laboratories. The brush and slide are analyzed both by a trained cytopathologist and a proprietary computerized program. The only significant complication to be aware of is bleeding because the procedure itself is short in duration. This can be avoided by paying particular attention before the procedure to the patient's coagulation status, medical history, and medications.

Figure 36-10 EndoCDx brush.
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PEARLS

- Percutaneous EMG-guided injection provides effective administration of botulinum toxin, minimizes diffusion to neighboring muscles, and confirms placement of needle during EMG by muscle activation during appropriate activity.

- Percutaneous injection of Botox under flexible (or rigid) laryngoscopic guidance is ideal for practitioners who perform laryngeal injections infrequently because it is easier to master and relies on visual confirmation of the target rather than on blind needle placement.
- Percutaneous vocal fold augmentation in the office is an alternative for patients who prefer not to undergo general anesthesia or will not tolerate transoral vocal fold augmentation in the office.
- Proper patient positioning, skilled endoscopy by the assistant, the skill of the surgeon, and knowledge of multiple approaches to the vocal fold provide the highest chance of success for vocal fold augmentation in the office.
- In-office brush biopsy can be used for diagnostic and pathologic surveillance of suspicious lesions on the vocal fold.

PITFALLS

- Patients who have a hyperactive gag reflex, anxiety, or copious secretions are poor candidates for an in-office laryngeal procedure.
- Patients with essential tremor that is not confined to the glottis and supraglottis do poorly with Botox injections compared with those with focal laryngeal essential tremor.
- Multiple injection sites during vocal fold augmentation and early phonation may cause premature extrusion of the injected substance.
- Too superficial injection of material into the vocal fold (into Reinke's space) during augmentation procedures causes stiffness and decreased vibration of the vocal fold, leading to a less than optimal voice result. Too much overinjection during augmentation may cause airway obstruction, which is a potentially disastrous complication.