

Chapter 37 – Phononicrosurgery for Benign Vocal Fold Lesions

Libby J. Smith,
Clark A. Rosen

Patients complaining of hoarseness, vocal fatigue, diminished vocal range, strain, or other vocal issues require a complete laryngeal examination. Based on findings of the laryngeal examination, several treatments may be indicated, including surgery. Phononicrosurgery encompasses a variety of elective operations whose primary goal is to improve the quality of the voice. These procedures focus on precision microsurgical techniques to remove benign vocal fold lesions, which usually occur in the subepithelial space. Hirano's body cover theory of vocal vibration is paramount in the design of current microsurgical principles and surgical procedures.[1] The delicate interface between the mucosa and superficial lamina propria (cover) and the deeper lamina propria layers and muscle (body) guides surgical advancements in phononicrosurgery (Fig. 37-1). Wound healing is optimized by preserving the mucosal superficial lamina propria whenever possible and limiting surgery to the vocal fold layers involved with pathology (staying as superficial in the vocal fold as possible). This is believed to result in better postoperative mucosal wave vibration, thereby probably improving vocal outcomes.

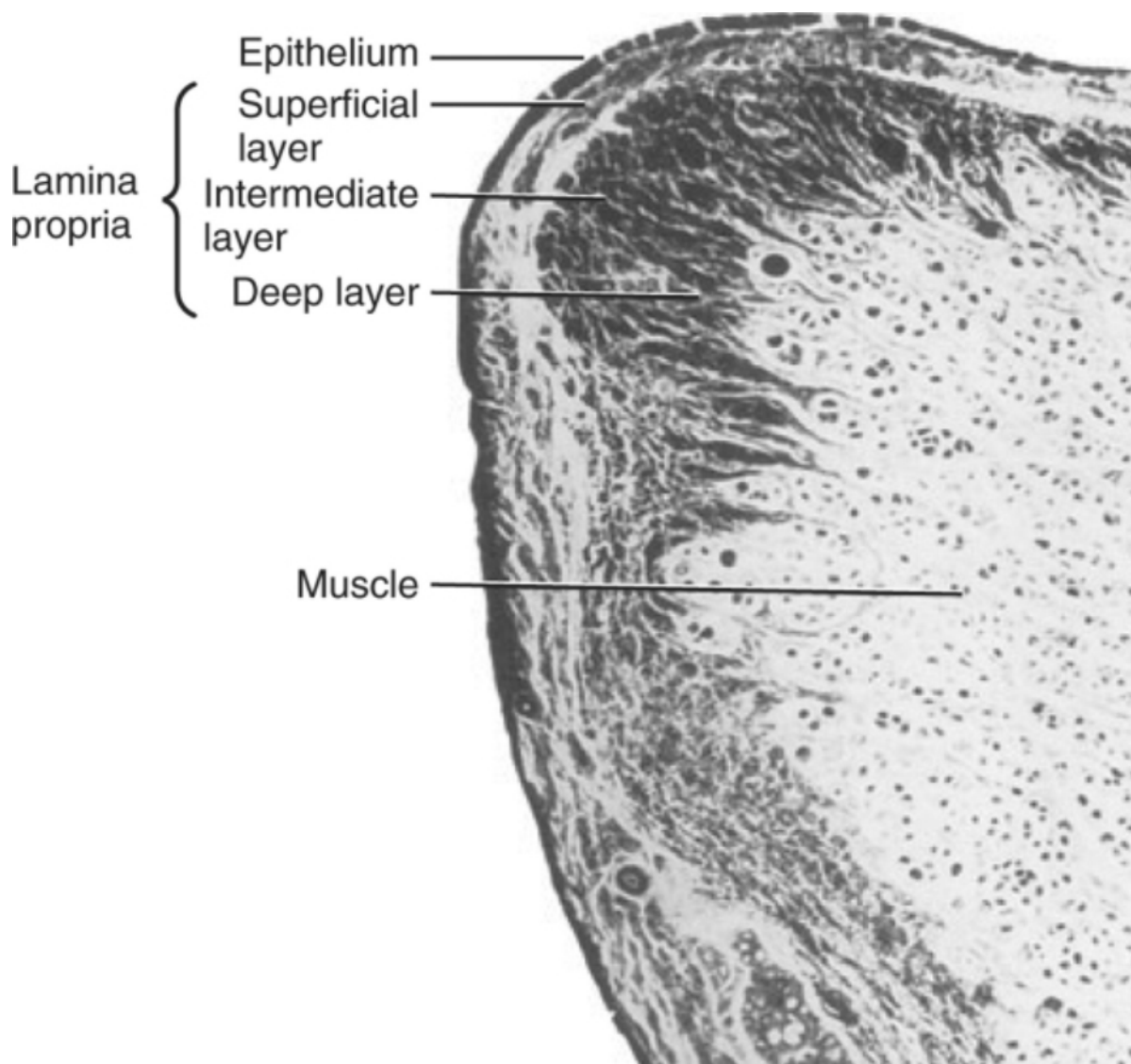


Figure 37-1 Cross-sectional view of a vocal fold demonstrating layers of the vocal fold lamina propria.

(Reprinted with permission from Hirano M: *Clinical Examination of Voice*. New York, Springer-Verlag, 1981, p 5.)

PATIENT SELECTION

Phononicrosurgery is an elective procedure. The risks and benefits of surgery should be clearly delineated to the patient. The patient's vocal limitations (speaking and singing) should be thoroughly reviewed, especially in relation

to the vocal requirements of jobs and hobbies. This review process is often conducted over a period of several weeks and involves the patient, the family, a speech therapist, and possibly a singing voice specialist. Once all nonsurgical therapies have been exhausted and even more is required of the patient's voice, only then is it appropriate to proceed with phononicrosurgery.

Types of Benign Vocal Fold Lesions[2]

Nodules

Nodules are benign bilateral masses, not always symmetrical, located within the lamina propria. They are typically located at the midpoint of the musculomembranous vocal fold. Breathly dysphonia is the result of incomplete vocal fold closure. Nodules tend to occur in patients who use their voices aggressively (children, cheerleaders). After phonotraumatic behavior is eliminated, these lesions almost always resolve on their own. Accordingly, surgery and exploratory cordotomy are rarely indicated.

Fibrous Masses

Fibrous masses are composed of irregular fibrous material without clearly defined borders and can occur in either the subepithelial space or near the ligament of the vocal fold. These masses are often located in the midmembranous vocal fold, either unilateral or bilateral, and therefore incomplete vocal fold closure is common. Unilateral lesions are frequently associated with a contralateral reactive lesion. Development of a fibrous mass is often associated with chronic phonotrauma or hemorrhage. Reduced and proper voice use is the initial treatment. If this fails, surgical excision with a microflap technique is indicated.

Ligamentous fibrous masses are located deeper in the vocal fold and are often attributed to chronic phonotrauma or hemorrhage. They may be unilateral or bilateral, frequently with a contralateral reactive component. Microflap surgery is indicated. Because of the deep dissection required, the risk of worse postoperative voice quality is higher than with more superficial masses.

Cysts

Vocal fold cysts, both subepithelial and ligamentous, are often unilateral and located at the leading (medial) edge of the midmusculomembranous portion of the vocal fold. These encapsulated structures are attributed to glandular duct blockage or phonotrauma or may be congenital. Hoarse voice from an hourglass closure pattern, vocal fatigue, and altered pitch control are common. Proper voice use is the initial treatment. If this is not adequate to meet the vocal demands of the patient, microflap excision is performed.

Reactive Lesions (Secondary Lesions)

Reactive lesions are believed to result from altered contact forces from a primary contralateral lesion, such as a polyp, cyst, or fibrous mass. Rigid videostroboscopy will demonstrate a convex lesion (primary lesion) that fits into a concave lesion (secondary lesion). Surgical excision of a reactive lesion is not generally necessary. Voice rest, reduced voice use, or voice therapy is often all that is required. In addition, after the primary lesion is addressed therapeutically, the reactive lesion usually reduces in size or resolves. If these measures fail, microflap excision is performed.

Polyps

Polyps are located in the superficial lamina propria, at the midpoint of the musculomembranous vocal fold. They are generally unilateral, sometimes with a contralateral reactive lesion. Polyps can be sessile (broadly attached to a vocal fold) or pedunculated (hanging from a stalk). These lesions are believed to be the product of intense phonotrauma or vocal fold hemorrhage. Inflammatory agents, dehydration, hormone treatment, and anti-inflammatory medications may be predisposing factors. Acute polyps are treated by reduced voice use. If this is unsuccessful, microflap excision with preservation of normal mucosa is performed for sessile polyps. Truncation (excision) is performed for pedunculated polyps.

Reinke's Edema (Polypoid Degeneration, Diffuse Polyposis, Chronic Polypoid Corditis)

Reinke's edema signifies the chronic presence of increased gelatinous material in the superficial lamina propria. It is usually bilateral but may be asymmetrical or unilateral. The patient's voice is lower in pitch and dysphonic. Women are affected more often by Reinke's edema; however, this is probably due to selection bias because women are more bothered by lower vocal pitch and roughness. Interestingly, many women employed in traditionally male-dominated fields (lawyer, newscaster, etc.) have Reinke's edema. In this patient population, eradication of Reinke's edema could be detrimental to their professional livelihood, because a lower pitch voice is often desired. The largest risk factor is smoking, in addition to environmental toxins, reflux, and phonotrauma.

When the pathologic accumulation is severe, airway obstruction can occur. Primary treatment is to remove the offending agents that led to the development of Reinke's edema. Smoking cessation is absolutely necessary. Voice therapy can occasionally be helpful if the probable cause is phonotrauma. Only after several months of compliance with smoking cessation and other conservative treatments (medical reflux therapy, avoidance of toxins, and speech therapy) should surgery be considered. Conservative removal of a portion of the gelatinous material is achieved through a small access incision on the superior aspect of the vocal fold, followed by minimal suctioning and milking of material from the superficial lamina propria. Removal of too much superficial lamina propria will lead to scarring and permanent hoarseness.

PREOPERATIVE EVALUATION

A thorough history plus physical examination is paramount in evaluating a patient with voice problems. Not only complete examination of the head and neck but also an extensive history on vocal demands, employment, and singing is required. Laryngeal examination with flexible nasopharyngeal laryngoscopy is the best way to evaluate gross vocal fold motion, as in the case of vocal fold paresis or paralysis. Rigid stroboscopy plays a major role in examination of the vocal folds. It allows superior evaluation of the vibratory margin so that the vibratory effects of the lesion can be determined. Alteration or diminution of the mucosal wave (vibration along the medial/vibratory margin) leads to hoarseness. This view also allows the clinician to look for associated vocal fold scars, which may be an important comorbidity with various vocal fold lesions.

Sound is the product of subglottic airflow forcing closed vocal folds to open, thereby leading to the generation of a mucosal wave along the medial edge of the vocal fold. Closure of the vocal folds during this vibratory cycle is achieved by the inherent elastic recoil of the vocal fold and the Bernoulli effect. This is called the myoelastic aerodynamic theory of phonation. This cycle usually occurs 100 to 800 times per second, as determined by the patient's pitch. A vocal fold mass can disrupt this normal process and lead to hoarseness and other vocal complaints. Depending on the patient's history and laryngeal examination, either flexible nasolaryngoscopy (gross vocal fold motion abnormalities), rigid stroboscopy (lesions), or both may need to be performed to fully evaluate the larynx. Such laryngeal examinations will provide the surgeon with an idea of the depth and type of the lesion. Although all vocal fold lesions are sent to pathology for evaluation, it is difficult for pathologists to distinguish between nodules, cysts, and polyps based on histologic characteristics. Precise classification of benign vocal fold lesions is therefore based on the surgeon's evaluation in the operating room, including magnification with the operating microscope, palpation of the vocal fold, and identification of the physical features of the lesion or lesions, such as a cystic or fibrous mass.

Preoperative voice therapy is very important in preparing the patient for surgery. One to two sessions are often scheduled if the patient did not receive voice therapy before the decision to undergo surgery. Anticoagulant medications should be avoided preoperatively if medically possible. Smoking cessation is critical for improved postoperative healing. The patient should also avoid vocal abuse and misuse preoperatively. These guidelines will prepare the patient and vocal folds for surgery.

Absolute voice rest (\approx 7 days) and reduced voice use (additional 7 to 10 days) after surgery should be discussed with the patient preoperatively. The amount of voice rest is determined by the extent of surgery along the vibratory margin of the vocal fold (the medial portion of the musculomembranous vocal fold that makes contact with the other vocal fold during vibration). The patient should make the appropriate schedule changes to comply with the prescribed postoperative voice restrictions. If the patient has any laryngopharyngeal reflux symptoms (globus, throat clearing, excessive mucus, cough, heartburn^[3]) or signs (infraglottic edema, ventricular obliteration, laryngeal erythema, vocal fold edema, diffuse laryngeal edema, posterior laryngeal hypertrophy, granuloma, or thick endolaryngeal mucus^[4]), proper reflux medications should be started at least 4 weeks before surgery. This will decrease the risk for postoperative wound-healing complications.

Discussion of consent for phonemic surgery should include the risks associated with general anesthesia, infection, bleeding, dental injury, injury to the temporomandibular joint, and injury to the lingual nerve.^[5] A serious discussion between the patient and surgeon involving the small but real risk of no voice improvement or worsening of vocal function must take place before surgery. Keeping in mind the elective nature of these surgeries, the patient must accept these risks.^[6]

SURGICAL APPROACHES

Anesthesia

Close communication between the surgeon and anesthesia team is important for successful phonemic surgery. These procedures require general anesthesia, with complete relaxation of the patient throughout the procedure. Preoperative intravenous administration of steroids and glycopyrrolate (Robinul) (unless contraindicated) will make the surgical environment better by minimizing swelling and secretions. A small endotracheal tube (size 5.0 to 5.5) should be placed without the aid of a stylet. Not only does the smaller tube improve visualization for the surgeon,

but it also diminishes the chance of injury to the vocal fold on intubation. If the vocal fold is injured during intubation, the surgery may need to be cancelled. Stressing the importance of careful intubation is often facilitated by discussing the planned surgery with the anesthesiologist before the procedure and by the surgeon being present during intubation. If an endotracheal tube will obscure adequate visualization, jet ventilation can be used. Tracheal jet ventilation is preferred over supraglottic jet ventilation because there is no vibration of the operative site or desiccation of the vocal fold tissues and it enables the anesthesia team to monitor CO₂ levels.

Patient Positioning

Patient positioning is critical to obtain the best visualization of the larynx. The optimal position is supine with the neck flexed and the head extended (Fig. 37-2). Trendelenburg positioning will often aid in providing the proper angle for surgery. The teeth and alveolar ridge are protected, followed by atraumatic insertion of the laryngoscope. The largest laryngoscope possible should be used to allow the surgeon the maximal amount of exposure for operating at the level of the vocal folds. Suspension of the laryngoscope is then performed once the surgeon is content with the exposure. Several suspension devices are currently available. A "gallows" form of suspension system is preferred by the authors because the vector of force is more advantageous than a fulcrum (Lewy or chest holder). Velcro or tape can be applied to the anterior aspect of the neck at the level of the cricoid or trachea to improve exposure.^[7] Placement of anterior pressure on the thyroid cartilage should be avoided because it will reduce tension on the vocal folds, thereby making phonemicicrosurgery more difficult.

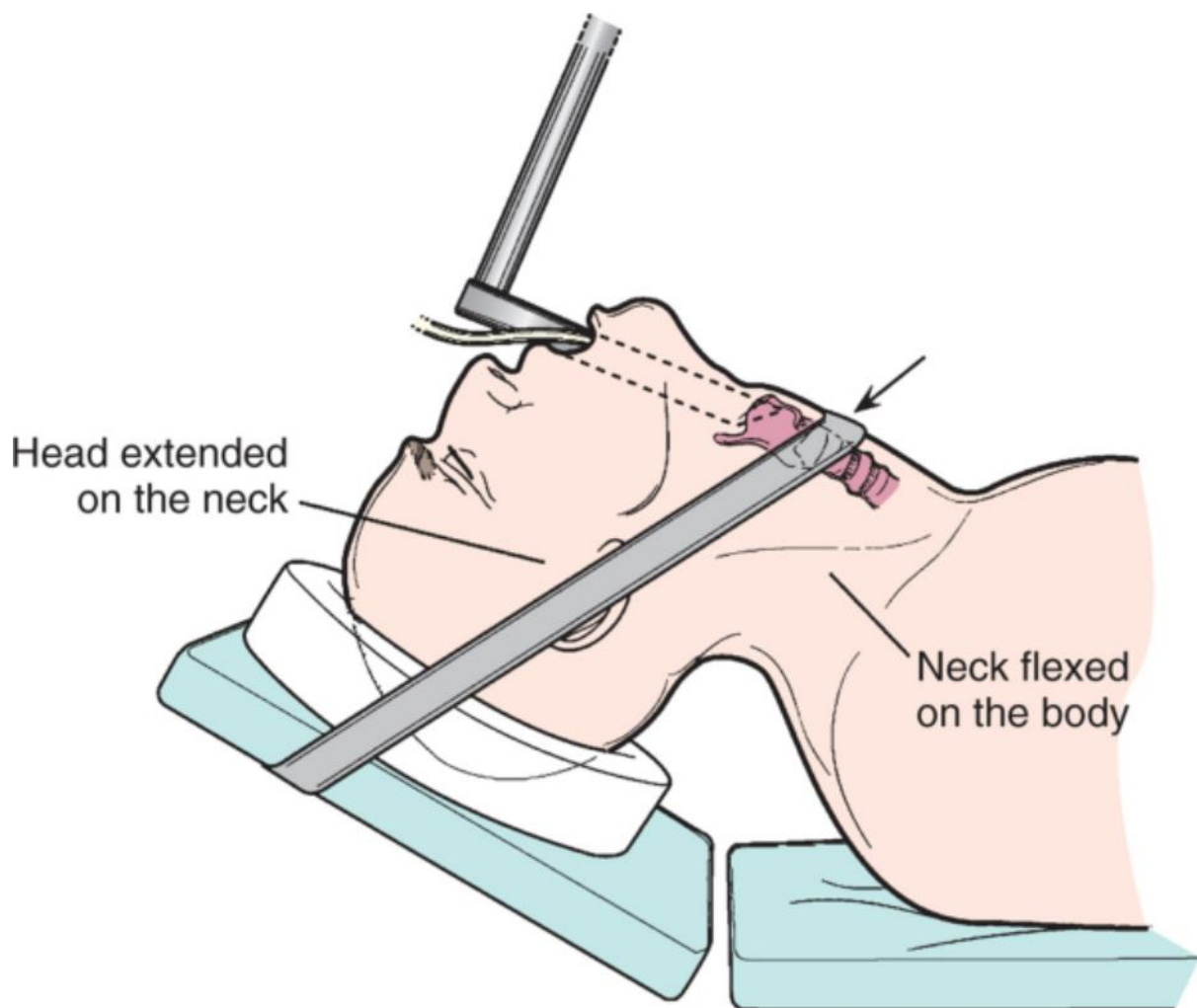


Figure 37-2 Patient positioning for microsuspension laryngoscopy: neck flexion and head extension.

Equipment

After the patient is in the proper position and the larynx is adequately exposed, visualization with 0-, 30-, 70-, (Fig. 37-3) and possibly 120-degree rigid telescopes will enhance the surgeon's understanding of the extent of the vocal fold pathology. Photodocumentation from both medical and medical-legal aspects is important. An operating microscope is then used to provide binocular vision. Connecting the microscope to a video tower will not only aid in student teaching but also aid the operating room staff in knowing what the surgeon is doing.

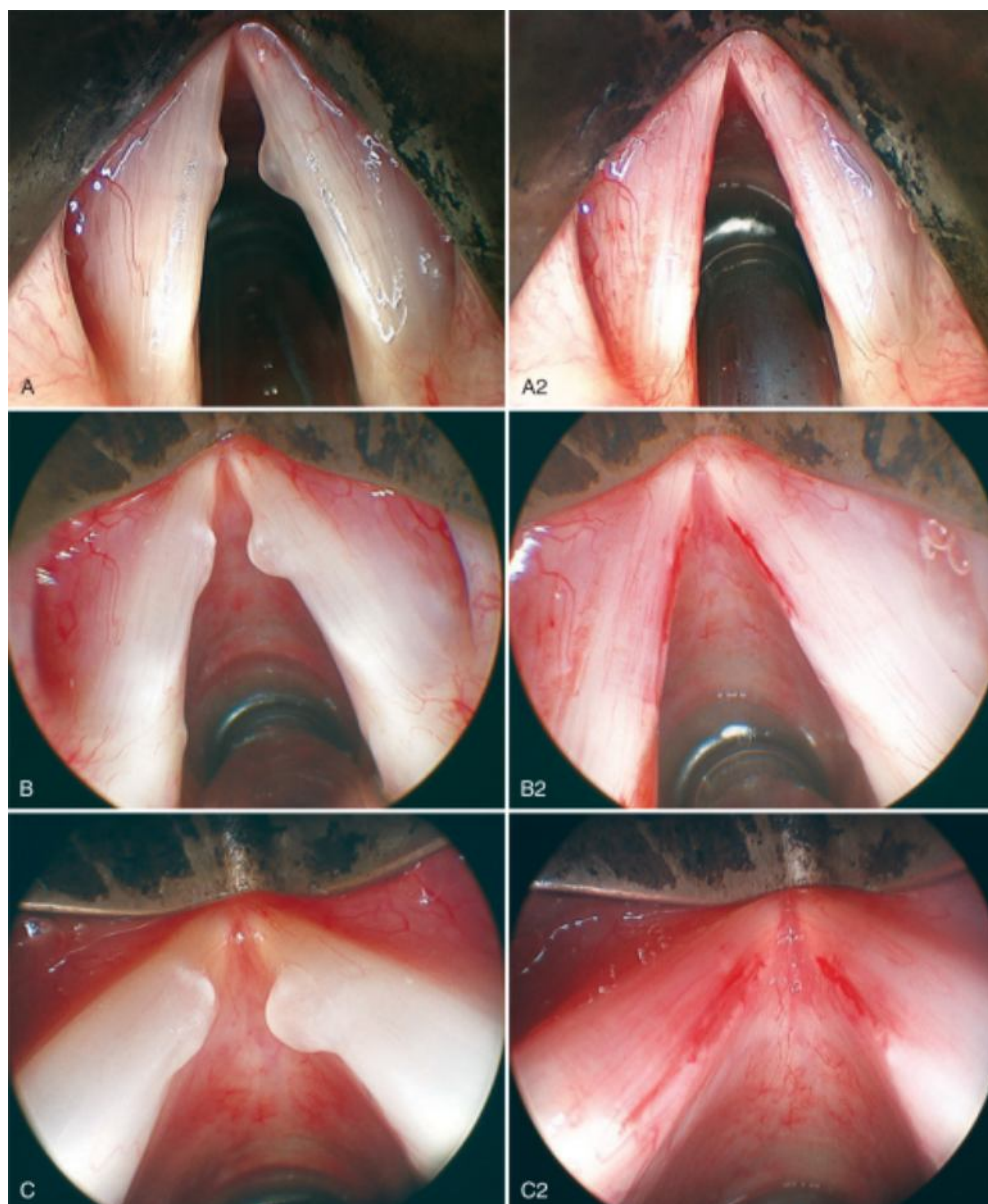


Figure 37-3 Comparisons of preoperative views of the lesion and postoperative views after microflap surgery with 0-, 30-, and 70-degree telescopes. **A**, Preoperative view with a 0-degree scope. **A2**, Postoperative view with a 0-degree scope. **B**, Preoperative view with a 30-degree scope. **B2**, Postoperative view with a 30-degree scope. **C**, Preoperative view with a 70-degree scope. **C2**, Postoperative view with a 70-degree scope.

Phonemic surgery is precision surgery. Therefore, optimal hand control of instrumentation is aided by stable forearm support by means of a specialized chair with arm supports, similar to that used in neurologic or ophthalmic surgery.

Microalaryngeal instruments are required to perform these procedures. Specialized cup forceps, triangular forceps, scissors, curved alligator forceps, small suction devices (3 French, 5 French, 7 French), and knives (sickle, straight) are the most commonly used instruments. Knives tend to dull quickly, so they should be replaced when needed to decrease the incidence of tearing instead of cutting tissue.

Lasers are of limited use in phonemic surgery. There is no distinct advantage to using a laser over a “cold steel” technique, especially in view of the risk of thermal injury and the cost of using a laser.

Microflap Technique (Mini Microflap, Medial Microflap)

Historically, the microflap technique involved an incision along the lateral aspect of the superior surface of the vocal fold, with subsequent dissection medial to the lesion. The lesion was then carefully dissected and removed. The large laterally based flap was replaced. Scarring, denoted by decreased mucosal wave seen on rigid stroboscopy, was found in the area of dissection. This problem led to revision of the procedure, with less scarring beyond the confines of the lesion. This new procedure was termed the mini microflap^[8] or medial microflap.^[9] The approach

involves starting the dissection immediately lateral to the lesion and avoiding unnecessary dissection in healthy tissue. The term microflap technique will be used from here on to denote this newer procedure.

Three guiding principles make the microflap approach to subepithelial pathology the most useful of phononimicrosurgery operations: (1) make the epithelial incision as close to the submucosal pathology as possible, (2) do not disrupt normal tissue surrounding the vocal fold pathology, and (3) stay in as superficial a plane as possible. Epinephrine (1:10,000 concentration) is often injected at the base of the lesion before making the incision to ensure hemostasis and achieve hydrodissection for better identification of the proper surgical plane (submucosal plane). The incision is made over or immediately lateral to the lesion (Fig. 37-4). This diminishes damage to surrounding normal tissue. A sickle or straight knife can be used. A small curved elevator can then be used to develop the plane between the mucosal microflap and the pathology. It is often easier to develop this plane anterior or posterior to the lesion and then extend it over the lesion itself (Fig. 37-5). This is the most difficult maneuver of microflap surgery and must be done with great patience and caution. Small curved microscissors may be necessary to release fibrous bands between the microflap and submucosal pathology or between the submucosal pathology and the underlying vocal ligament. Development of a plane between the submucosal pathology and vocal ligament is often easier, except with vocal fold cysts and fibrous masses involving the vocal ligament. Once the submucosal pathology has been dissected, it is carefully removed and sent for pathologic examination (Fig. 37-6). The microflap is then redraped (Fig. 37-7). On completion of the excision, the free edge (leading edge, medial edge) should be completely straight, without concavities or mucosal tags (see Fig. 37-3). Hemostasis is achieved by injecting epinephrine at the surgical site before incision and placing epinephrine-soaked pledgets during and after surgical removal of the lesion.

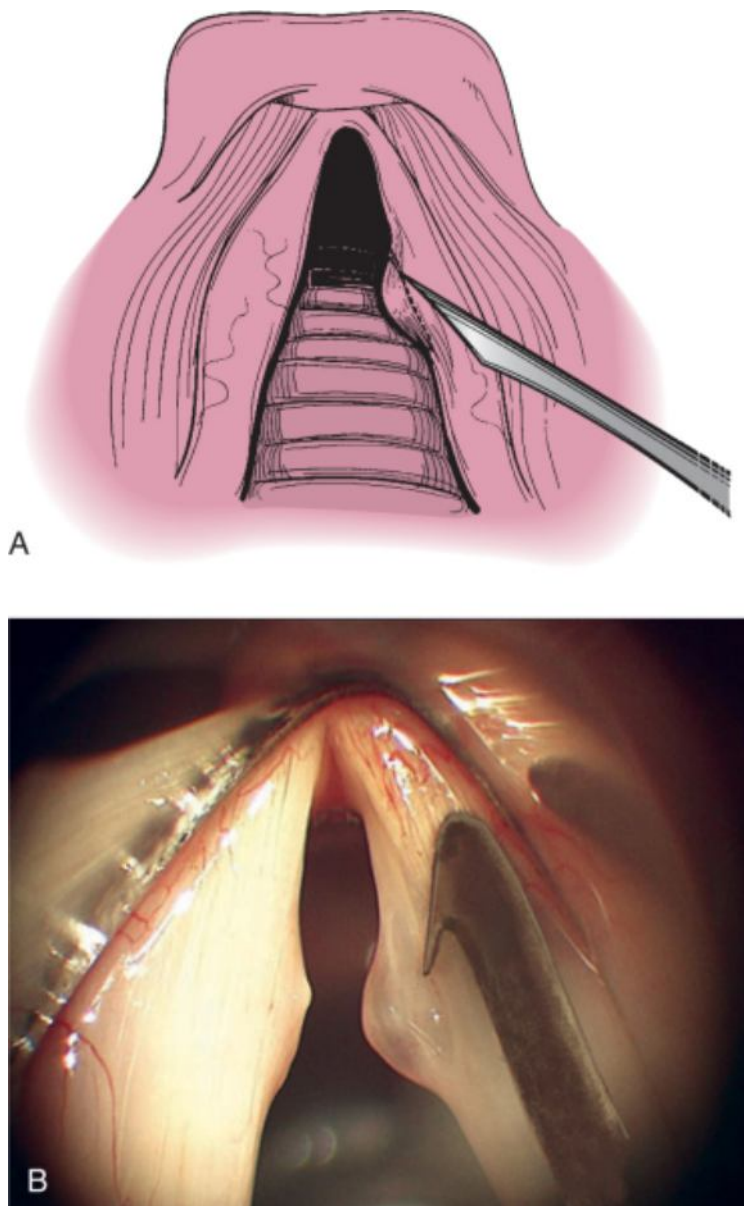


Figure 37-4 A, Mucosal incision at the junction of vocal fold pathology and the superior surface of the vocal fold. B, Cordotomy at the lateral aspect of the lesion with a sickle knife.

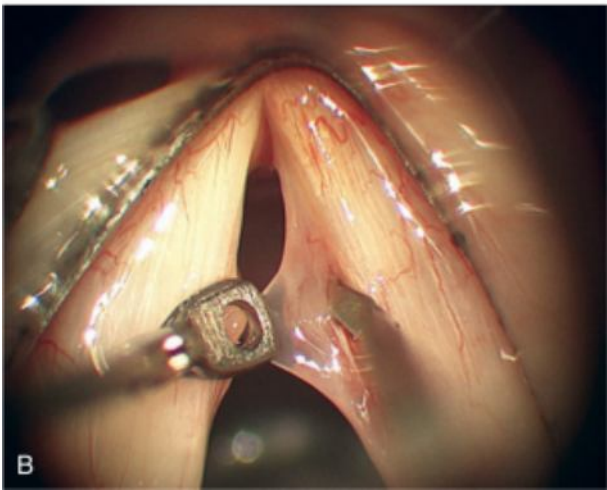
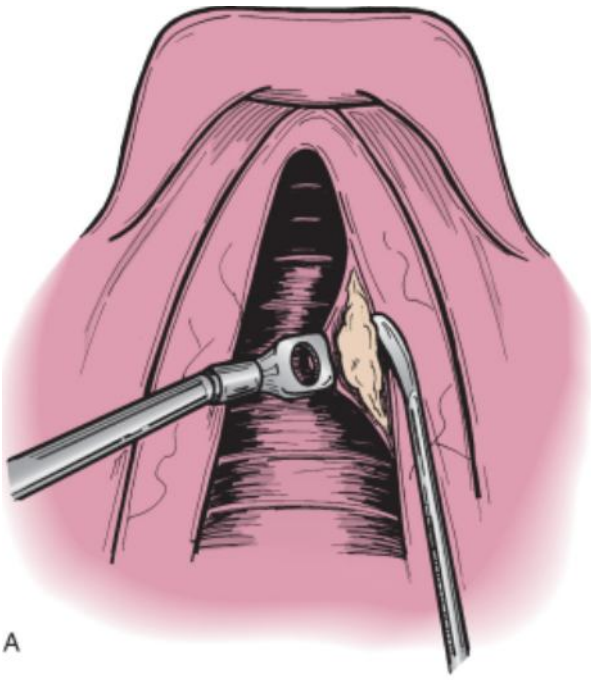


Figure 37-5 A and B, Developing a plane with a blunt dissector between the lesion and deeper tissues.

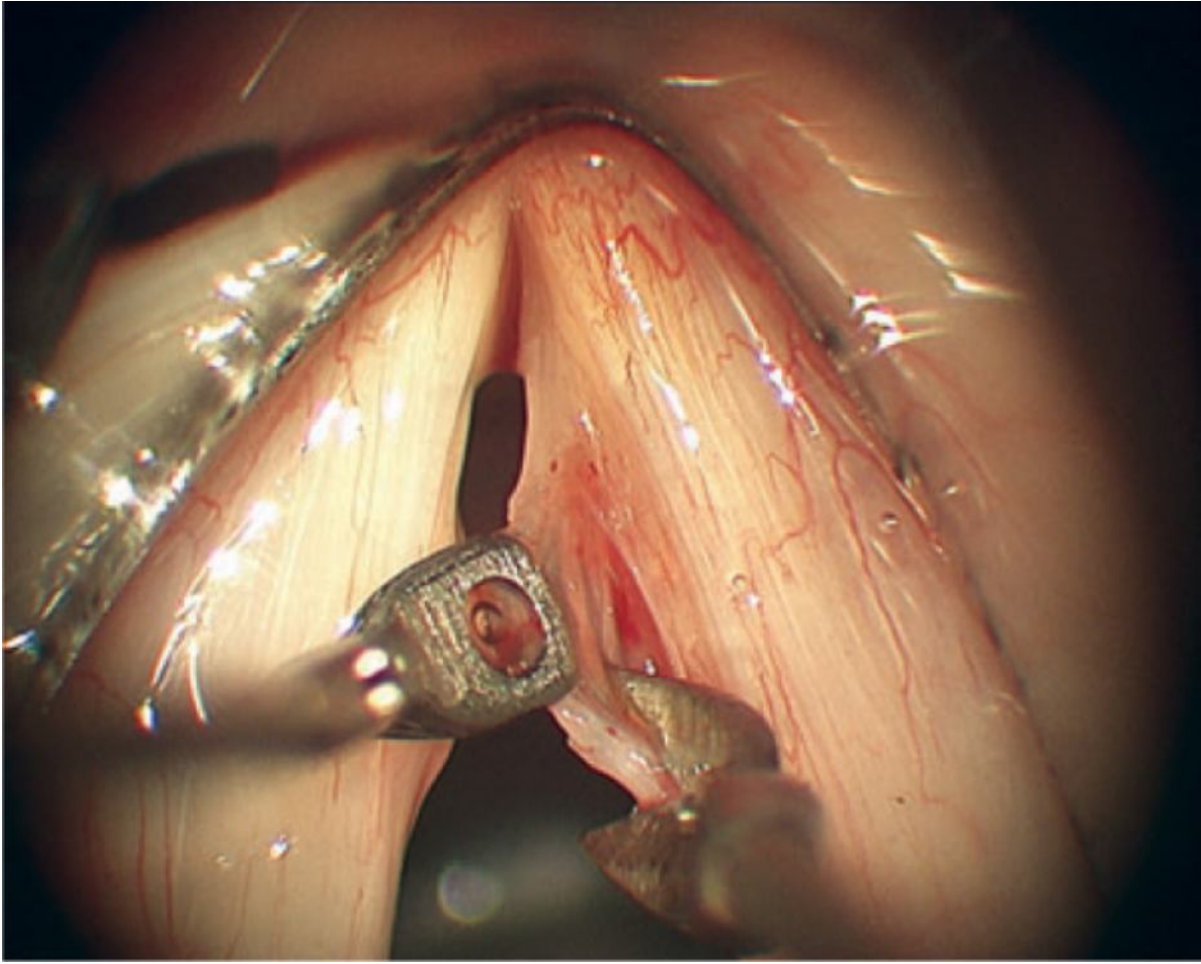


Figure 37-6 Removal of the lesion and redundant mucosa.

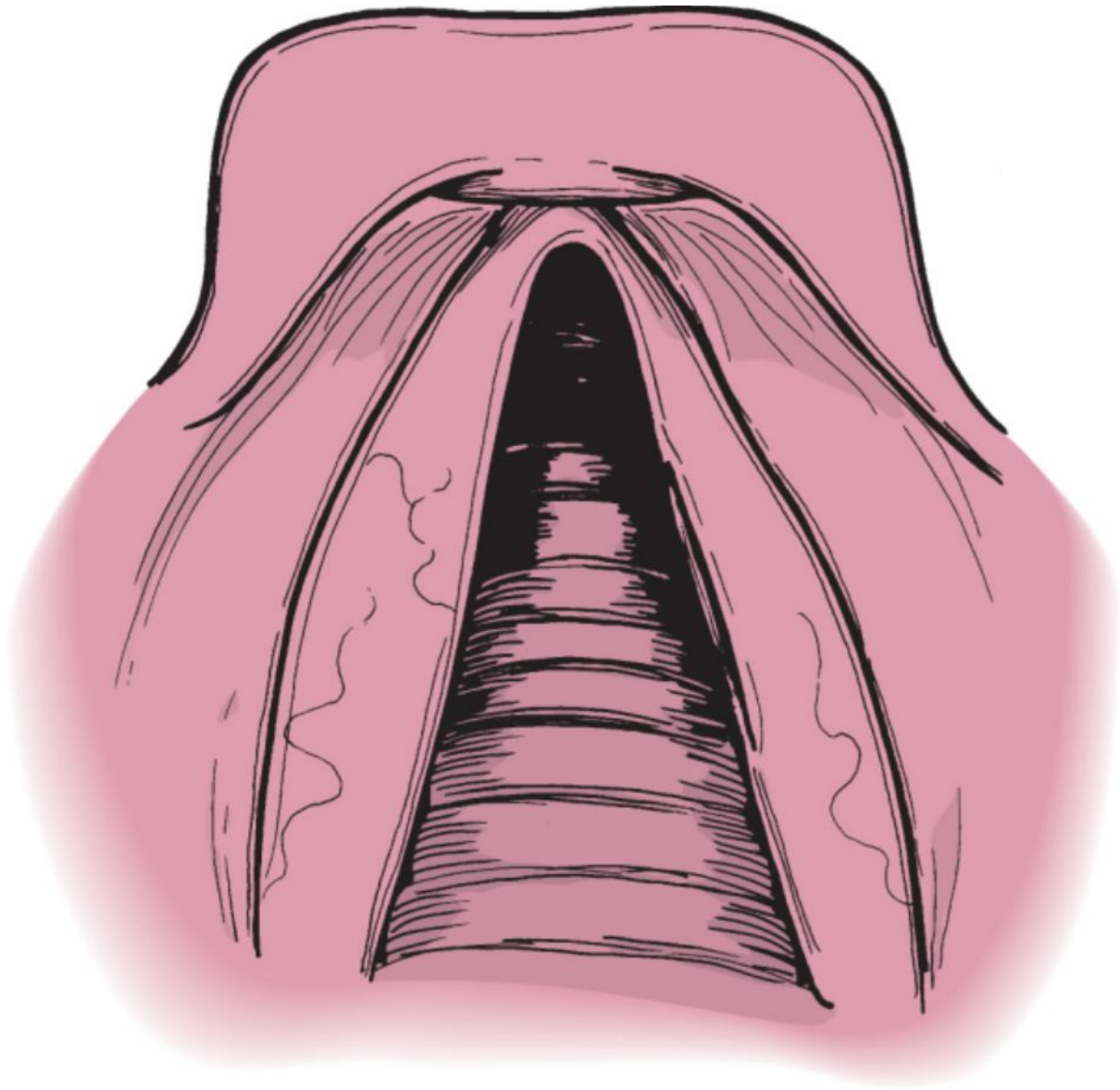


Figure 37-7 Microflap redraped over the operative site.

Truncation Technique

Truncation (excision) of benign vocal fold pathology is occasionally applicable. The lesion must be pedunculated, with no involvement of deeper tissue. In such cases a microflap approach is not feasible. The pathology is grasped and gently retracted medially, and the stalk is cut at the level of the vocal fold mucosa (Fig. 37-8). A small epithelial defect will be produced. Hemostasis is achieved with pledgets soaked in epinephrine.

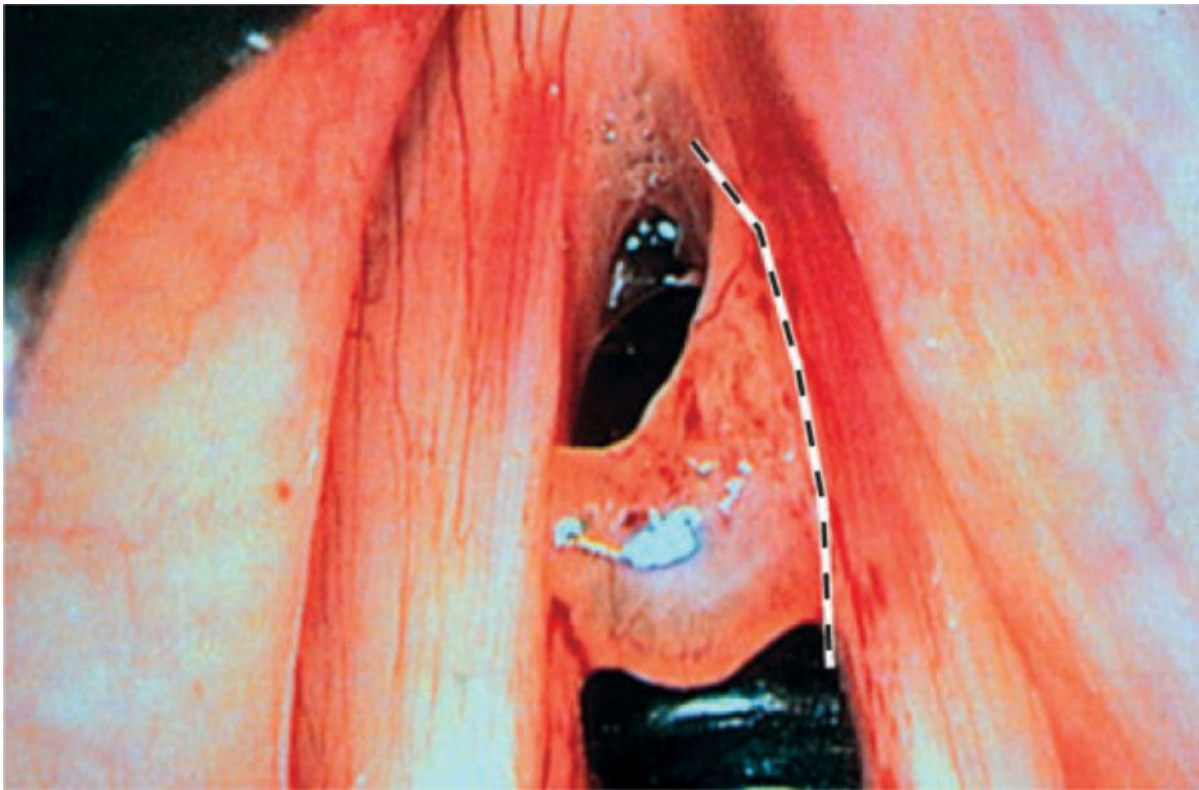


Figure 37-8 Truncation of a vocal fold polyp (*dashed line*).

POSTOPERATIVE MANAGEMENT

Voice rest is a component of almost every phonemicrosurgical procedure. Absolute (strict) voice rest can range from as short as 2 days to as long as 14 days. The length of absolute voice rest depends on the extent of surgery, patient compliance, and the surgeon's philosophy and past experience. Absolute voice rest consists of restrictions on the following activities: talking, whispering, whistling, straining, Valsalva maneuvers, coughing, and sneezing. On completion of strict voice rest, rigid stroboscopy should be performed to evaluate the level of healing of the vocal fold surgical site. If there is adequate epithelial coverage, the patient is transitioned to light voice use (relative voice rest), usually defined as 5 to 10 minutes of breathy, "airy" voicing per hour. The quantity of voice use is then increased over the subsequent weeks, often with the help of a speech-language pathologist.

Patients should continue taking reflux medications after surgery to aid in the healing process. Proper hydration is strongly recommended. Continued smoking cessation after surgery is important for maximal healing.

COMPLICATIONS

Complications of phonemicrosurgery range from the actions taken to achieve adequate exposure, to technical surgical points, to untoward vocal outcomes. The potential for injury to the teeth increases when the patient has poor dentition or multiple missing teeth and when difficulty is encountered in gaining exposure of the larynx. Frequently, these patients can be detected before surgery. If a dental injury does occur, it should be promptly repaired to the patient's satisfaction to minimize negative feelings toward the surgeon and anesthesiologist. Injury to the lingual nerve (numbness of the tongue, change in taste sensation) occurs in approximately 10% to 20% of patients. These symptoms are transitory and due to pressure from the laryngoscope, and they usually resolve within 4 weeks.

There is a 1% to 2% risk of no voice improvement after phonemicrosurgery, in addition to a 1% to 2% risk of the voice becoming worse after surgery. This is often due to poor wound healing with scar formation. If surgery requires deeper dissection into the vocal ligament, scar formation is likely. There is currently no cure for vocal fold scarring, so inadvertent disruption of tissues deep to the superficial lamina propria is discouraged unless mandated by the pathology. If the microflap is not appropriately draped over the surgical wound and therefore does not adhere to the vocal fold, epithelial ingrowth deep to the microflap will occur. Surgical excision of the microflap is then required. Microflap necrosis and flap death can occur with excessive edema and trauma.^[10] Accordingly, the flap must always be treated with great care. If microflap necrosis does occur, the vocal fold will adequately heal on its own, but it will take longer. Significant postoperative stiffness (scarring) can be treated with several monthly submucosal steroid injections in an attempt to modify the wound-healing process.

PEARLS

- Laryngeal examination with a rigid videostroboscope provides valuable information about the possible type and depth of benign vocal fold lesions.
- Preoperative voice care in the form of voice therapy and counseling for surgery is paramount in providing the patient with realistic expectations and to promote proper wound healing.
- Clear understanding of vocal fold anatomy is needed to perform precise microflap surgical dissection.
- Close collaboration with the anesthesia team, proper patient positioning, adequate laryngeal exposure, and proper instrumentation are vital for success.
- Postoperative voice rest, vocal restrictions, and voice therapy are important steps in recovery.

PITFALLS

- Imprecise dissection into the deeper layers of the vocal fold (vocal ligament and muscle) will lead to scar formation and worse vocal outcomes.
- Phonotrauma immediately after surgery will lead to scarring.
- Dental injuries do occur, often as a result of poor dentition or improper placement of the laryngoscope.
- Worsening of voice after surgery or no voice improvement (1% to 2% of patients for each) is a real risk and must be discussed frankly preoperatively.
- Rushing a patient to surgery before thorough evaluations by a physician and speech therapist is a disservice to the ultimate care of the patient and may downgrade the outcome of the procedure.

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