

# An Introduction to Vocal Fold Masses

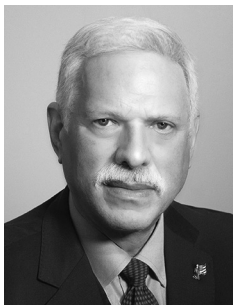
Vishnu V. Martha, Swetha Vontela, and Robert T. Sataloff



Vishnu V. Martha



Swetha Vontela



Robert T. Sataloff

## INTRODUCTION

**M**ANUEL GARCIA, THE INVENTOR of laryngeal mirror and renowned singing teacher, clearly appreciated the practical importance of scientific knowledge about the voice.<sup>1</sup> There are several components that constitute the absolute power of the voice of an individual: the capacity of the vocal folds to vibrate; the dimensions of larynx, the thorax, the lungs, the pharyngeal cavity, the buccal cavity and nasal cavities; and the resonance characteristics of these cavities to determine the characteristics of the voice. In order to master his/her art, the singer must have a thorough knowledge of all these components.<sup>2</sup> Singing teachers can combine new scientific knowledge with traditional pedagogy to improve teaching techniques and outcomes, recognize unhealthy voice, and collaborate on medical voice care teams.

The role of singing voice rehabilitation specialist was originally defined as a singing teacher who was trained specifically to work with patients with voice pathology. In 1981, the term singing voice specialist (SVS) was coined in the practice of senior author Robert T. Sataloff where this field was established as a full time model within a medical practice. When singing teachers began to participate more formally in the treatment of voice pathology and in collaboration with speech-language pathologists, the training usually occurred through an apprenticeship with a laryngologist specializing in singers. When this unique patient group needed rehabilitation of the voice following injury or surgery, the ideal professional was an experienced singing teacher who possessed expert knowledge of voice anatomy, physiology, and pathology.

Vocal anatomy encompasses not just the larynx or even the throat, but extends to include the oral cavity, chest, and abdomen. Virtually all body systems may affect voice production. Consequently, laryngologists caring for voice patients have learned to take thorough histories that investigate all body functions, as have speech-language pathologists and SVSs.

Singers often are called on for performance activities other than singing. Both singers and their teachers should be aware of the potential hazards of nonvocal performance and should recognize signs of problems in a timely manner. Fortunately, voice problems usually can be corrected; however, if left unattended, they may worsen and interfere not only with singing, but also with speaking. Help is usually available through laryngologists who specialize in voice care.

In the case of the injured singer, the goal is to enable the singer to return to the demands of normal singing requirements safely and quickly. Recovery

times from a vocal injury or surgery vary widely and are difficult to predict. It is the responsibility of the SVS in conjunction with the laryngologist and speech-language pathologist to create a recovery plan that remains flexible enough to be adjusted to the unpredictable course of individual healing.<sup>3</sup> The non-SVS singing teacher is an invaluable component of the diagnosis and treatment team, and the more knowledge the teacher has, the more helpful he/she can be to the student.

### CAUSES AND TREATMENT OF VOCAL MASSES

Many performers consider vocal fold masses, such as nodules, to be the bane of their existence. It is rare, however, that these lesions are true career enders.<sup>4</sup> It is essential that the many issues contributing to the development of vocal fold lesions be identified and a multidisciplinary approach instituted to obtain the best possible outcome. In professional voice users, lesions are generally benign. However, professional voice users engage in carcinogenic activities such as smoking, alcohol abuse, and use or abuse of recreational drugs; such behaviors increase the risk for malignancies and such possibilities cannot be overlooked. Multifactorial contributions to voice disorders are reviewed in this article along with elaboration on the types of masses encountered in professional voice users.

Voice use demands (overuse) and improper vocal technique (misuse) are central to the trauma and pathogenesis of most vocal fold masses in professional voice users. Underlying medical conditions such as laryngopharyngeal reflux (LPR), medications, and the environment contribute to the development of vocal fold masses. Many lesions result at least in part from mechanical stress,<sup>5</sup> including nodules, polyps, and cysts, but other pathologies occur, such as reactive lesions, scar, varices, and granulomas and other lesions. A mass may impair vocal fold closure during phonation, resulting in excess air egress. Clinically, this makes the voice breathy and also contributes to vocal fatigue due to hyperfunctional compensation.

Since the evolution of vocal masses is complex and the laryngologist initially evaluates patients after they have experienced voice limitations over long period of time, it is uncommon to have an isolated lesion without concomitant or confounding findings. Nodules are often

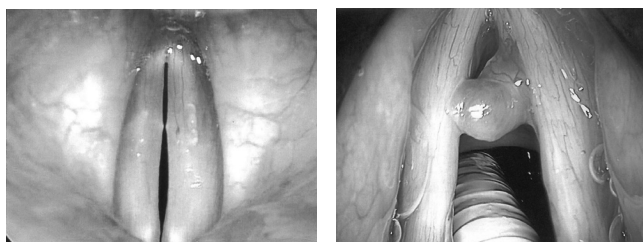
a “waste basket” diagnosis for those clinicians without the skills and equipment to differentiate between nodules, polyps, cysts, reactive lesions, and other pathology. Although it may be difficult to classify a lesion, the description is always helpful in considering prognosis and therapeutic plan. Nagata et al. reviewed their 10-year experience with 1,156 patients and found 372 who had nodules and 784 who had polyps.<sup>6</sup> A detailed understanding of each of these masses helps singing teachers understand their implications.

#### Nodules

Vocal nodules are bilateral symmetric epithelial masses at the center of the musculo-membranous portion (striking zone) of the true vocal folds. They occur in children, adolescents, and predominantly female adults working in professions with high voice demands, as well as others who abuse or misuse their voices. The female preponderance is due to decreased audibility of female voices leading to more hyperfunction in adult professional environments with loud background noise. De Bodt et al. reinforce that several etiologies lead to the development of nodules, including behavior.<sup>7</sup>

The pathophysiology of vocal nodules relies on the mid-membranous vocal fold experiencing the highest shearing and collision forces. This location corresponds to the junction of the anterior to middle vocal folds, or the middle of the musculo-membranous portion, because the posterior third of the vocal folds is coupled to the vocal process of the arytenoids. Repeated collision initially results in localized vascular congestion with edema. Eventually, hyalinization of Reinke space with thickening of overlying epithelium occurs, leading to epithelial hyperplasia. This process is analogous to a carpenter using a hammer over a long period of time without gloves, leading to calluses at the areas of maximal impact with the hand. The calluses soften if the carpenter stops the activity or wears gloves. This analogy may help patients understand that conservative nonsurgical treatment may help the patient who has true vocal nodules.

On stroboscopy, the mucosal wave of the vocal fold is slightly decreased in amplitude but remains generally symmetric. Nodules may cause hourglass-shaped glottal closure (Figure 1). Nodules may be associated with irregular vibration of the surface mucus layer,



**Figure 1.** (left) Vocal nodules in a classical singer. Reproduced with permission from Robert T. Sataloff et al., *Atlas of Laryngoscopy* (San Diego: Plural Publishing, 2012), 192.

**Figure 2.** (right) Pedunculated polyp on left vocal fold. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 19.

leading to impaired lubrication and an exacerbation of the surface stresses leading to the formation of nodules.<sup>8</sup>

Hogikyan et al. recognized a consensus among otolaryngologists, speech-language pathologists, and teachers of singing regarding the treatment of singers who have nodules.<sup>9</sup> Addressing voice use demands, improper technique, optimizing other contributing factors, and coordinating care were believed to be of paramount importance. Indications for microsurgical treatment include longstanding nodules, particularly when treatments such as voice therapy have been maximized, or if there is suspicion of a lesion other than bilateral nodules.

A widespread misconception among singers and singing teachers is that a singer will never return to full vocal function following vocal fold surgery. This error has led many vocalists to end their careers prematurely, fearing that surgery will not improve their singing voices. Furthermore, substantial morbidity and loss of professional development have occurred from this fallacy because many singers delay surgery leading to significant loss of income and/or injure their voices further.<sup>10</sup>

### Polyps

Vocal polyps are usually unilateral masses on the true vocal fold. They occur more often in males, people with a history of aspirin or anticoagulant use, or after intense intermittent voice abuse and other vocal trauma, such as endotracheal intubation. The polyp may be sessile or pedunculated (i.e., on a stalk), and hemorrhagic or nonhemorrhagic (Figure 2).<sup>11</sup>

Stroboscopy reveals that vocal folds with larger polyps have more prominent decreased mucosal

wave amplitude. Vocal folds with small polyps generally have intact mucosal waves but impaired phase closure.

Both polyps and nodules often result in excess air escape during phonation, leading to a breathy voice, vocal fatigue due to compensatory hyperfunction, voice breaks in singers, and often worse hoarseness with mid-range and high-pitched soft phonation. The decreased vocal efficiency with mucosal wave impairment has been quantified with decreased subglottal and acoustic power.<sup>12</sup> Because polyps are asymmetric masses of the vocal folds, they are more prone to result in chaotic vibrations and aperiodic mucosal waves.<sup>13</sup> Small vocal polyps may resolve completely with conservative non-surgical treatment.<sup>14</sup> The many factors that contribute to voice disorders in patients with vocal polyps should be addressed from a multidisciplinary perspective, and polyps usually require microsurgery. Office-based surgery may be an option for some cases.

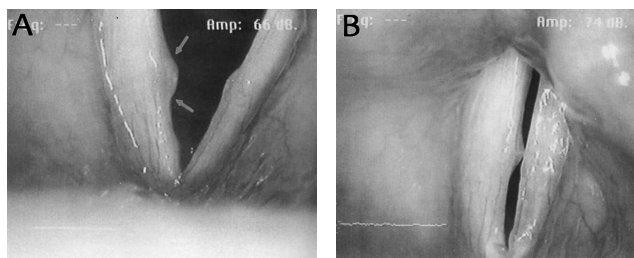
### Cysts

Cysts are subepidermal, sometimes epithelial lined sacs located within the lamina propria and come in two types: mucus retention or epidermoid. Mucus retention cysts form when a mucous gland duct becomes obstructed (usually during an upper respiratory infection, with over-use, or after trauma such a cough or scream), retaining glandular secretions. Epidermoid cysts develop either from congenital cells in the subepithelium of the fourth and sixth branchial arches or from healing injured mucosa burying epithelium. A ruptured cyst may result in scar within the lamina propria or in a sulcus. Cysts commonly irritate the contralateral vocal fold, producing a reactive lesion on that vocal fold, and cysts with reactive lesions often are misdiagnosed as nodules; but they do not respond to conservative treatment as well as nodules.

The patient who has a vocal cyst is similar to patients who have nodules and polyps, but often with fewer complaints. The voice may sound diplophonic (particularly with epidermoid cysts) due to production of two fundamental frequencies, one anterior to the masses and one posterior. This can occur with any bilateral masses. Cysts were present more commonly in females. Female professional singers may note increased voice limitation and voice roughness when they are premenstrual,<sup>15</sup> and there is anecdotal evidence of varying cyst size with the female monthly cycle. Consequently, some



**Figure 3.** Cyst on left vocal fold. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 175.



**Figure 4.** (A) Right cyst (arrows) and left reactive mass during abduction. (B) Right cyst and left reactive mass during adduction. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 193.

phonosurgeons exercise caution when operating on premenstrual women.

On strobolaryngoscopy, the vocal folds appear asymmetric with evidence of the subepithelial mass or masses (Figure 3). The mucosal wave can be an important parameter in differentiating cysts from polyps.<sup>16</sup> Shohet et al. found the mucosal wave to be diminished or absent in 100% of vocal fold cysts, and the wave to be present in 80% of polyps, although we have found less difference between these lesions. Treatment again requires a multidisciplinary approach addressing factors that contribute to voice disorders. A true cyst usually does not resolve with conservative management. The phonosurgical approach requires careful dissection because in the submucosal plane, and cysts often are associated with scar that can worsen after surgery. Consequently, recovery of the mucosal wave is sometimes prolonged and may never return to completely normal. Leaving behind a microscopic fragment of epithelium in the cyst sac may result in recurrence of the cyst, and new cysts may form even after successful resection. Some vocal professionals have been known to have cysts that do not cause substantial limitation to their singing careers, and those cysts have been observed without surgery.

### Reactive Lesions

The presence of a unilateral vocal fold lesion results in hourglass-shaped glottic closure. The vocal fold mass causes trauma to the contralateral vocal fold that may produce a reactive mass with epithelial hyperplasia. A unilateral lesion with reactive mass formation may appear as bilateral lesions, such as nodules, and that may cause errors in diagnosis, prognosis, and management.

Distinguishing bilateral lesions, such as nodules, from a primary lesion with reactive mass is important from the viewpoint of prognosis and surgical planning. Figure 4A shows an example of a singer who has a left vocal fold polyp and reactive right vocal fold, broad based soft mass. With reducing voice use for one month, voice therapy, and treatment of LPR, the right reactive mass resolved (Figure 4B). Reactive lesions often are not removed during microsurgery for the primary lesion, because the reactive lesion tends to resolve with conservative management.

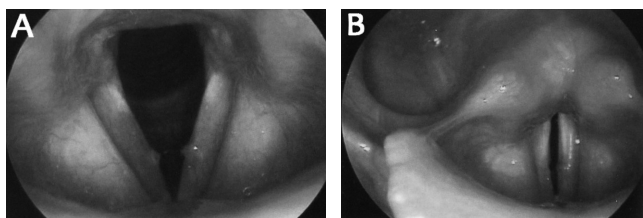
### Vocal Fold Scarring

Vocal fold trauma, vocal hemorrhage, inflammation, and the presence of mass predispose to scar that can obliterate Reinke's space. Vocal fold scar often is associated with a cyst, particularly after surgery involving the lamina propria, with the use of the laser, and after repeated epithelial procedures, such as those for malignancy, leukoplakia, and papilloma.

Vocal fold scar is suspected on strobolaryngoscopy when there is reduced or absent mucosal wave. From a professional voice standpoint, it is crucial to differentiate between an uncomplicated subepithelial cyst or other mass and one with scar because the latter is a more complex problem with worse prognosis for professional voice rehabilitation. Treatment of scar is complex.<sup>17</sup>

### Varices, Ectasias, and Hemorrhage

Varices and ectasias of the vocal fold are aberrant vessels of the microcirculation within the superficial lamina propria or on the superior or inferior surfaces. Although they are not true masses, they often develop as a result



**Figure 5.** (A) Hemorrhage of right vocal fold with bilateral masses. (B) Two weeks later, the hemorrhage has resolved but the masses remain. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 134.

of the same multifactorial and shearing forces that lead to masses, and they also predispose to the development of polyps and vocal fold hemorrhage. Figures 5A and B show strobolaryngoscopic examples of a varix and hemorrhage.

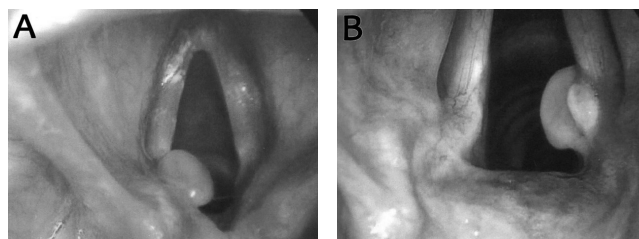
Traditionally, these lesions have been treated by microdissection and by carbon dioxide laser, but these methods led to increased risk for postoperative scarring. Recently, there has been renewed interest in the use of pulsed angiolytic lasers that have a wavelength within the absorption of oxyhemoglobin, because they can ablate microvessels selectively without substantial damage to the overlying epithelium.

### Granulomas

Although vocal process granulomas are not on the membranous vocal fold and often do not cause voice symptoms, it is important for the clinician to understand their differences in comparison with other vocal fold masses. Vocal process granulomas occur in response to trauma, most commonly from LPR, which exacerbates chronic cough or throat clearing. The lesions are inflammatory, not “granulomas” in the pathological definition. They also may occur after endotracheal intubation resulting in contact ulceration, or by forceful glottal closure when compensating for vocal paresis or presbylaryngis (age-related voice changes). Kiese-Himmel and Kruse documented a male predominance with 27 out of 28 patients who had contact granuloma being male.<sup>18</sup>

A granuloma may appear as solitary, bilobed, or multilobed and often does not affect mucosal wave or phase closure on strobolaryngoscopy, unless there is underlying vocal paresis, presbylaryngis, or sulcus (Figure 6).

Treatment relies on addressing the underlying LPR and other factors, such as vocal process impact on



**Figure 6.** (A) Left arytenoid granuloma. (B) Right, bilobed vocal process granuloma. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 50–51.

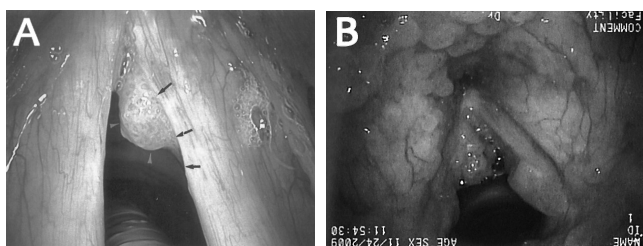
cough or phonation. Botox to the lateral crux of the thyroarytenoid muscle also has been shown to be helpful in reducing the glottal impact in cases refractory to LPR treatment and voice therapy. Because there is a high recurrence rate after surgical excision, surgery is reserved for cases in which the lesion is (1) enlarging; (2) compromising the voice, breathing, or swallowing; or (3) suspicious for malignancy or other neoplasm.

### Papilloma

Respiratory papillomatosis is an infection caused by human papilloma virus (HPV), which causes cervical, vaginal, penile, and anal warts. Although relatively uncommon in the larynx, it is still among the most common laryngeal neoplasms. There are more than 50 strains of HPV, but HPV 6 and 11 are among the most common in the larynx. As with genital warts, there is an approximately 2% likelihood of malignant degeneration in laryngeal papilloma, particularly with strains HPV 16 and 18.<sup>19</sup> Once the papilloma occurs, it can spread to the trachea or other sites.

Papillomata appear as a cauliflower-like, exophytic protuberance, typically found at the transition between columnar and squamous epithelium. Papillomata can have vascular stippling on the mass because they contain multiple fronds of fibrovascular stalks (Figure 7). Early forms may have a superficial spreading presentation, again with vascular stippling seen on laryngoscopy, providing a clue to the diagnosis. Strobolaryngoscopy is exceptionally helpful in making an early diagnosis, especially when recurring disease is suspected, because the mass effect of thickened, diseased epithelium can present with a decreased mucosal wave.

Although there are many treatments available, shaver excision and cold instrument resection is preferred.

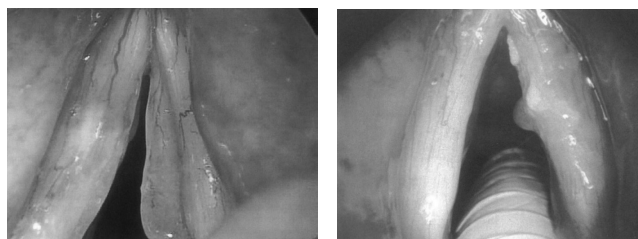


**Figure 7.** (A) Right papilloma (arrows). (B) Extensive papillomata along laryngeal surface of epiglottis, posterior glottis, entire left vocal fold and posterior and anterior inferior lip of right vocal fold. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 249–252.

Laryngeal laser excision was commonly used in the past but are used only in select instances today. The greater depth of penetration of the laser than is visibly apparent increases the risk for scar and implantation of the virus (an epithelial disease) into deeper tissues of the vocal fold, so use of the carbon dioxide laser is avoided by the authors in most cases. The HPV vaccine and the evolving use of cidofovir injections to control regrowth are important adjunct treatments.

### Reinke's Edema

Reinke's edema, vocal polyposis, and polypoid corditis (a misnomer since there is no inflammation) are all terms that refer to a proliferation or redundancy of the superficial lamina propria in Reinke's space. It is seen in patients who have chronic irritant exposure such as to tobacco smoke, LPR, some occupational exposures, and occasionally low thyroid function. Reinke's edema appears as an outpouching of the membranous vocal folds with an edematous, almost water balloon appearance (Figure 8). Strobolaryngoscopy may reveal increased but ineffective mucosal wave because of the low mass effect of the edema, often with irregular oscillation because of ball valving and asymmetric edema. Treatment is aimed at reducing airway obstruction and improving voice quality. Laser reduction of the edema in the operating room or office is useful for some patients, and new treatments are under development. However, microsurgery remains the mainstay for treatment. The senior author (RTS) considers it important to stage procedures whenever possible in patients who have bilateral disease to reduce the likelihood of anterior web formation post operatively. Cessation of smoking and



**Figure 8.** (left) Reinke's edema, left greater than right. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 188.

**Figure 9.** (right) Right leukoplakia (arrow). Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 218.

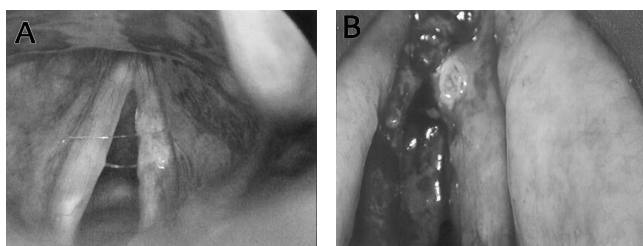
control of reflux disease are important factors in preventing recurrence of the disease after surgical excision and should be instituted before surgery to optimize the postoperative outcome.

### Leukoplakia and Dysplasia

Leukoplakia, or white plaque, refers to a spectrum of diseases affecting the vocal fold epithelium, and includes hyperkeratosis, dysplasia, early verrucous changes, “pre-cancer,” and early cancer. Overall, leukoplakia has a 6% to 7% likelihood of developing malignancy.<sup>20</sup> The pathophysiology is still unknown, but it is likely that chronic irritation and genetic predisposition form a synergy in such patients. The plaque may present initially with subtle hyperkeratotic epithelium resulting in decreased or sluggish mucosal wave on strobolaryngoscopy (Figure 9). Progression, particularly with dysplastic or premalignant changes, may be exophytic in a surrounding bed of erythema. Microflap excision, carbon dioxide lasers, and vascular lasers are all treatment options, but appropriate pathologic staging must be performed because the visual appearance does not always correspond to the degree of dysplasia.<sup>21</sup> Treatment of hyperkeratosis and mild dysplasia is centered on eradication of disease while preserving neighboring normal anatomy and voice quality. Severe dysplasia, carcinoma in situ, and invasive cancer must be treated more aggressively.

### Vocal Fold Carcinoma (Cancer)

Squamous cell carcinoma is by far the most common form of laryngeal malignancy. Those patients who have a history of tobacco smoking account for about 90% of cases, and the likelihood is far greater with a concur-



**Figure 10.** (A) Carcinoma of the right vocal fold. (B) Left vocal fold carcinoma crossing the anterior commissure and extending onto the right vocal fold. Reproduced with permission from Sataloff et al., *Atlas of Laryngoscopy*, 218.

rent history of excess alcohol consumption. There are also anecdotal and indirect data to support the role of laryngopharyngeal reflux in causing and compounding the development of vocal fold carcinoma. Any mass lesion in a patient who has such a history should raise the appropriate level of suspicion.

Squamous cell carcinoma may demonstrate exophytic, ulcerative, and/or infiltrative features. Consequently, one may see on strobolaryngoscopy an area of focally decreased mucosal wave at the site of an exophytic epithelial lesion (Figure 10). This area is distinguished from papilloma, which remains an epithelial disease, whereas carcinoma tends to infiltrate into the lamina propria and deeper, accounting for the decreased mucosal wave. Papillomata are generally softer than the exophytic mass produced in carcinoma, and so carcinoma tends have a more detrimental effect on closure. Clinical suspicion and evidence of even microinvasion with focally decreased mucosal wave should mandate further evaluation, including biopsy.<sup>22</sup>

## SUMMARY

Singing teachers often are the first people to hear “something wrong” and recommend medical evaluation. Several vocal masses can affect the professional voice, and it is important to understand the multifactorial contributions and pathogenesis of each to determine prognosis. Strobolaryngoscopy plays a crucial role in differentiating masses and in guiding optimal management. In all cases, a multidisciplinary approach to treatment is highly recommended. Close collaboration between laryngologists, singing teachers, and other voice professionals is essential to provide singers with optimal outcomes.

## NOTES

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**Dr. Vishnu Vardhan Reddy Martha, MD, PhD** is Instructor in the Department of Otolaryngology—Head and Neck Surgery at Drexel University College of Medicine. He currently is involved in several research projects with the department.

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**Swetha Vontela, MD** is a graduate of Drexel University College of Medicine. She currently is completing a residency in internal medicine at the University of Pittsburgh Medical Center.

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**Robert T. Sataloff, MD, DMA, FACS** is Professor and Chair, Department of Otolaryngology-Head and Neck Surgery and Senior Associate Dean

for Clinical Academic Specialties, Drexel University College of Medicine. Dr. Sataloff is Director of Otolaryngology and Communication Sciences Research at the Lankenau Institute for Medical Research, and Director of Otolaryngology Education at Lankenau Medical Center. He also holds adjunct professorships in the Departments of Otolaryngology – Head and Neck Surgery at Thomas Jefferson University, Temple University and the Philadelphia College of Osteopathic Medicine; and he is on the faculty of the Academy of Vocal Arts. He serves as Conductor of the Thomas Jefferson University Choir. Dr. Sataloff is also a professional singer and singing teacher. He holds an undergraduate degree from Haverford College in Music Theory and Composition; graduated from Jefferson Medical College, Thomas Jefferson University; received a Doctor of Musical Arts in Voice Performance from Combs College of Music; and he completed Residency in Otolaryngology—Head and Neck Surgery and a Fellowship in Otolaryngology, Neurotology and Skull Base Surgery at the University of Michigan. Dr. Sataloff is Chair of the Boards of Directors of the Voice Foundation and of the American Institute for Voice and Ear Research. He also has served as Chair of the Board of Governors of Graduate Hospital; President of the American Laryngological Association, the International Association of Phonosurgery, the Pennsylvania Academy of Otolaryngology – Head and Neck Surgery, and The American Society of Geriatric Otolaryngology, and in numerous other leadership positions. Dr. Sataloff is Editor-in-Chief of the *Journal of Voice*; Editor Emeritus of *Ear, Nose and Throat Journal*; Associate Editor of the *Journal of Singing*; on the Editorial Board of *Medical Problems of Performing Artists*, and is an editorial reviewer for numerous otolaryngology journals. He has written over 1,000 publications including 71 books, and he has been awarded more than \$5 million in research funding. His H-index is 43 (as of May 2022). He has invented more than 75 laryngeal microsurgical instruments distributed currently by Integra Medical, ossicular replacement prostheses produced by Grace Medical, and a novel laryngeal prosthesis (patent pending). He holds a patent on a unique thyroplasty implant. His medical practice is limited to care of the professional voice and to otology/neurotology/skull base surgery. Dr. Sataloff has developed numerous novel surgical procedures, including total temporal bone resection for formerly untreatable skull base malignancy, laryngeal microflap and mini-microflap procedures, vocal fold lipoinjection, vocal fold lipoinplantation, and others. Dr. Sataloff is recognized as one of the founders of the field of voice, having written the first modern comprehensive article on care of singers, and the first chapter and book on care of the professional voice, as well as having influenced the evolution of the field through his own efforts and through the Voice Foundation for over 4 decades. Dr. Sataloff has been recognized by Best Doctors in America (Woodward White Athens) every year since 1992, *Philadelphia Magazine* since 1997, and Castle Connolly’s “America’s Top Doctors” since 2002.