Vocal Health (excerpts)

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Key Facts

1. Voice disorders are common. Almost everyone experiences at least temporary hoarseness from time to time.
2. Good vocal quality and endurance are extremely important for personal and professional communication.
3. Some changes in voice quality or endurance indicate the presence of serious disease. Consequently, all voice disorders warrant thorough evaluation and accurate diagnosis.
4. Most voice problems are correctable.
5. Voice disorders may lead to permanent voice impairment. Accurate diagnosis and treatment often avoids long-term problems.
6. The state-of-the-art and medical standard of voice care have improved dramatically beginning in the late 1970s and 1980s

Introduction

The human voice is remarkable, complex and delicate. It is capable of conveying not only sophisticated intellectual concepts, but also subtle emotional nuances. Although the uniqueness and beauty of the human voice have been appreciated for centuries, medical scientists have begun to really understand the workings and care of the voice only since the late 1970s and early 1980s.

Anatomy and Physiology

What is the voice, and how does it work?
The wonderful sound we call voice results from interaction among numerous parts of the body. The larynx (voice box) is essential to normal voice production, but voice production is not limited to the larynx. The total vocal mechanism includes the abdominal and back musculature, rib cage, lungs, and the pharynx (throat), oral cavity and nose. Each component performs an important function in voice production, although it is possible to produce voice even without a larynx, for example in patients who have undergone laryngectomy (removal of the larynx) for cancer. In addition, virtually all parts of the body play some role in voice production and may be responsible for voice dysfunction. Even something as remote as a sprained ankle may alter posture, thereby impairing abdominal muscle function and resulting in vocal inefficiency, weakness and hoarseness.

What is the larynx?
The larynx is a structure found in the neck and composed of four basic anatomic units: skeleton, intrinsic muscles, extrinsic muscles and mucosa. The most important parts of the laryngeal skeleton are the thyroid cartilage, cricoid cartilage, and two arytenoid cartilages (Figure 1). Muscles of the larynx are connected to these cartilages. One of the intrinsic muscles (within the larynx), the vocalis muscle (part of the thyroarytenoid muscle), extends on each side from the arytenoid cartilage to the inside of the thyroid cartilage just below and behind the “Adam's apple,” forming the body of the vocal fold (popularly called the vocal cord) (Figure 2). The vocal folds act as the oscillator or voice source (noise maker) of the vocal tract. The space between the vocal folds is called the glottis and is used as an anatomic reference point. The intrinsic muscles alter the position, shape and tension of the vocal folds, bringing them together (adduction), apart (abduction) or stretching them by increasing longitudinal tension. They are able to do so because the laryngeal cartilages are connected by soft attachments that allow changes in their relative angles and distances, thereby permitting alteration in the shape and tension of the tissues suspended between them. The arytenoids are also capable of rocking, rotating and gliding, permitting complex vocal

fold motion (Figure 3) and alteration in the shape of the vocal fold edge. All but one of the muscles on each side of the larynx are innervated by one of the two recurrent laryngeal nerves. Because this nerve runs a long course from the neck down into the chest and then back up to the larynx (hence, the name "recurrent"), it is easily injured by trauma, neck surgery and chest surgery, which may result in vocal fold paralysis. The remaining muscle (cricothyroid muscle) is innervated by the superior laryngeal nerve on each side which is especially susceptible to viral and traumatic injury. It produces increases in longitudinal tension important in volume, projection and pitch control. The "false vocal folds" are located above the vocal folds and unlike the true vocal folds, do not make contact during normal speaking or singing.

Because the attachments of the laryngeal cartilages are flexible, the positions of the cartilages with respect to each other change when the laryngeal skeleton is elevated or lowered. Such changes in vertical height are controlled by the extrinsic (outside the larynx) laryngeal muscles, or strap muscles of the neck (Figure 4). When the angles and distances between cartilages change because of this accordion effect, the resting length of the intrinsic muscles is changed as a consequence. Such large adjustments in intrinsic muscle condition interfere with fine control of smooth vocal quality. This is why classically trained singers are generally taught to use their extrinsic muscles to maintain the laryngeal skeleton at a relatively constant height regardless of pitch. That is, they learn to avoid the natural tendency of the larynx to rise with ascending pitch, and fall with descending pitch, thereby enhancing unity of quality throughout the vocal range. Singing techniques may be different in selected Asian, Indian, Arabic and other musical traditions with different aesthetic values.

The soft tissues lining the larynx are much more complex than originally thought. The mucosa forms the thin, lubricated surface of the vocal folds which makes contact when the two vocal folds are closed. It looks like the mucosa lining the inside of the mouth. However, the vocal fold is not simply muscle covered with mucosa (Figure 5). The thin, lubricated squamous epithelium lines the surface. Immediately beneath it, connected by a complex basement membrane, is the superficial layer of the lamina propria, also known as Reinke's space, which consists of loose, fibrous components and matrix. It tends to accumulate fluid, and it contains very few fibroblasts (cells that cause scar formation). The epithelium is connected to the superficial layer of the lamina propria by a sophisticated basement membrane. The intermediate layer of the lamina propria contains primarily elastic fibers and a moderate number of fibroblasts. The deep layer of the lamina propria is rich in fibroblasts and consists primarily of collagenous fibers. It overlies the thyroarytenoid or vocalis muscle. The various layers have different mechanical properties important in allowing the smooth shearing action necessary for proper vocal fold vibration.

Mechanically, the vocal fold structures act more like three layers consisting of the cover (epithelium and superficial layer of the lamina propria), transition (intermediate and deep layers of the lamina propria), and body (the vocalis muscle).

What happens above the larynx?
The supraglottic vocal tract (above the larynx) includes the pharynx, tongue, palate, oral cavity, nose and other structures. Together, they act as a resonator and are largely responsible for vocal quality or timbre and the perceived character of all speech sounds. The vocal folds themselves produce only a "buzzing" sound. During the course of vocal training for singing, acting, or healthy speaking, changes occur not only in the larynx, but also in the muscle motion, control and shape of the supraglottic vocal tract.

What happens below the larynx?
The infraglottic (or subglottic) vocal tract (below the larynx) serves as the power source for the voice. Singers and actors refer to the entire power source complex as their "support" or "diaphragm." Actually, the anatomy of support for phonation is especially complicated and not completely understood; and performers who use the terms "diaphragm" and "support" do not always mean the same thing. Yet, it is quite important because deficiencies in support are frequently responsible for voice dysfunction.

The purpose of the support mechanism is to generate a force which directs a controlled airstream between the vocal folds which is necessary for vocalization to occur. Active respiratory muscles work together with passive forces. The principle muscles of inspiration are the diaphragm (a dome-shaped muscle that extends along the bottom of the rib cage), and the external intercostal (rib) muscles. During quiet breathing, expiration is largely passive. The lungs and rib cage generate passive expiratory forces under many common circumstances such as after a full breath.

Many of the muscles used for active expiration are also employed in "support" for phonation. Muscles of active expiration either raise the intra-abdominal pressure forcing the diaphragm upward, or lower the ribs, and sternum ("breast bone") to decrease the dimensions of the thorax, or both, thereby compressing air in the chest. The primary muscles of expiration are "the abdominal muscles," but internal intercostals, and other chest and back muscles are also involved. Trauma or surgery that alters the structure or function of these muscles or ribs undermines the power source of the voice as do diseases that impair expiration, such as asthma.

Deficiencies in the support mechanism often result in compensatory efforts which utilize the laryngeal muscles, not designed for power source functions. Such behavior can result in decreased voice function, rapid fatigue, pain and even structural pathology including vocal fold nodules. Currently, expert treatment (voice physical therapy) for such problems focuses on correction of the underlying malfunction. This often cures the problem, avoiding the need for laryngeal surgery.

How does it all work together to make a voice?

The physiology (functioning) of voice production is exceedingly complex. Production of voice begins in the cerebral cortex of the brain. Many other brain centers are involved in sending appropriate impulses to the nerves and muscles required for phonation. The brain also receives tactile (feeling) and auditory (hearing) feedback information and makes adjustments in order to control the voice sounds produced.

Phonation (using the vocal folds to make sound) requires interaction among the power source, oscillator and resonator. The voice may be likened to a brass instrument such as a trumpet. Power is generated by the chest, abdomen and back musculature producing a high pressure air stream. The trumpeter's lips open and close against the mouth piece producing a buzz similar to the sound produced by the vocal folds. This sound then passes through the trumpet which has resonance characteristics that shape the sound we associate with trumpet music. The non-mouthpiece portion of a brass instrument is analogous to the supraglottic vocal tract.

During phonation, rapid, complex adjustments of the infraglottic system are necessary because the resistance changes almost continuously as the glottis closes, opens and changes shape. At the beginning of each phonatory cycle, the vocal folds are together. As air pressure builds up against them, they are pushed apart and snap back together. Sound is actually produced by the closing of the vocal folds, in a manner similar to the sound generated by hand clapping. Contrary to popular opinion, the vocal folds are not "cords" that vibrate like piano or guitar strings. Also like hand clapping, the more forcefully the vocal folds snap together, the louder the sound; and the more frequently they open and close, the higher the pitch.

The sound produced by the vocal folds is a complex tone. As it passes through the supraglottic vocal tract, the pharynx, oral cavity and nasal cavity act as a series of interconnected resonators, more complex than a trumpet because the walls and shape are flexible. The ultimate voice quality is determined as the sound produced by the vocal folds passes through the resonator.

How can the voice be kept healthy?
Preventive medicine is always the best medicine. The more people understand about their voices, the more they will appreciate their importance and delicacy. Education helps us understand how to protect the voice, train and develop it to handle our individual vocal demands, and keep it healthy. Even a little bit of expert voice training can make a big difference. Avoidance of abuses, especially smoke, is paramount. If voice problems occur expert medical care should be sought promptly. Interdisciplinary collaboration among laryngologists, speech-language pathologists, singing teachers, acting teachers, many other professionals, and especially voice users themselves has revolutionized voice care since the early 1980s. Technological advances, scientific revelations, and new medical techniques inspired by interest in professional opera singers have brought a new level of expertise and concern to the medical profession, and improved dramatically the level of care available for any patient with voice dysfunction.

How can a "normal" voice be made better?
Voice building is possible, productive, and extremely gratifying. Speaking and singing are athletic. They involve muscle strength, endurance, and coordination. Like any other athletic endeavor, voice use is enhanced by training that includes exercises designed to enhance strength and coordination throughout the vocal tract. Speaking is so natural that the importance of training is not always obvious. However, running is just as natural. Yet, most people recognize that, no matter how well a person runs, he or she will run better and faster under the tutelage of a good track coach. The coach will also provide instruction on strengthening, warm-up and cool-down exercises that prevent injury. Voice training works the same way.

Voice building starts with physical development. Once vocal health has been assured by medical examination, training is usually guided by a voice trainer (with schooling in theater and acting voice techniques), singing teacher or a speech-language pathologist. In the author's setting, all three specialists are involved under the guidance of a laryngologist, and additional voice team members are utilized, as well, including a psychologist or psychiatrist (for stress-management), pulmonologist, neurologist, and others. Initially, training focuses on the development of a physical strength, endurance and coordination. This is accomplished not only through vocal exercises, but also through medically supervised bodily exercise that improves aerobic conditioning and strength in the support system. Singing skills are developed (even in people with virtually no singing talent at all) and used to enhance speech quality, variability, projection and stamina. For most people, marked voice improvement occurs quickly. For those with particularly challenging vocal needs, voice building also includes training and coordinating body language with vocal messages, organizing presentations, managing adversarial situations (interviews, court appearances, etc.), television performance techniques, and other skills that make the difference between a good professional voice user and a great one.

The process of voice building is valuable not just for premiere professional voice users. Virtually all of us depend upon our voices to convey our personalities and ideas. The right subliminal vocal messages can be as important in selling a product or getting a job as they are in winning a presidential election. The initial stages of voice building are no more complex than the initial stages of learning to play tennis or golf; and their potential value is unlimited. A strong, confident, well-modulated voice quietly commands attention, convinces, and conveys a message of health, strength, youth and credibility.

Vocal Health

https://www.otopa.org/Pages/Patient-Information-Vocal-Health.aspx