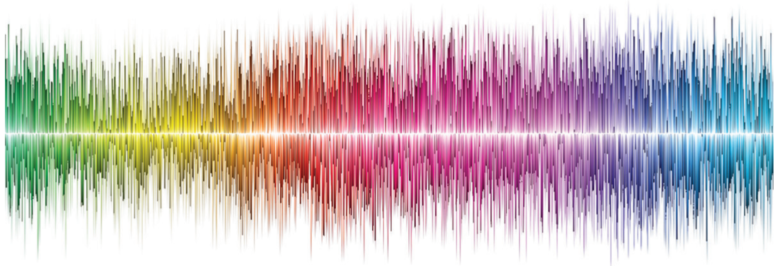
CLINICAL VOICE PATHOLOGY

THEORY AND MANAGEMENT

Sixth Edition



CLINICAL VOICE PATHOLOGY

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Joseph C. Stemple, PhD, CCC-SLP, ASHAF
Nelson Roy, PhD, CCC-SLP, ASHAF
Bernice K. Klaben, PhD, CCC-SLP, BCS-S

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PLURAL PUBLISHING
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Preface

With each new edition of *Clinical Voice Pathology: Theory and Management* comes change, including societal, professional, and educational; this sixth edition is no exception. This is a clinical textbook meant to lay the groundwork for speech-language pathology students to eventually become competent providers for the care and management of patients with voice disorders. As technology rapidly changes, so does our profession evolve: necessary skills are modified and expanded, and research demonstrates new and better methods for evaluation and treatment. Technology has also impacted how students acquire and retain information, and as a result, our teaching approaches must also be modified. To meet these changes, the 6th edition of this text has also been modified to take advantage of technology that will assist both speech-language pathology students and their instructors to build the foundational knowledge necessary to evaluate and treat voice disorders. This knowledge includes the history and common causes of voice disorders, the anatomy and physiology of voice production, pathologies of the vocal mechanism, and an extensive array of evaluation and management approaches.

Changes made to this edition focus on enhancements to instruction and learning, including use of "Call Out" boxes throughout the text to highlight cases, encourage additional thought, and suggest additional readings. There are full color figures and illustrations to enhance learning and understanding of the material as well as a companion website with additional content, including videos of laryngeal pathologies and instructional PowerPoint lectures. In addition to updated references throughout the text to reflect the current state of clinical research in evaluation and treatment of voice disorders, we introduce a new chapter describing the SLP's responsibilities with artificial airways and mechanical ventilation, and an expanded voice therapy chapter, which includes new evidence-based management approaches.

The advances in our field in the past thirty-five years have been extraordinary. However, when one studies the history of our specialty, it is remarkable how much of our past remains constant in terms of assessment and treatment. As an example, with all the available technology to aid in voice evaluation, we would submit that the skilled patient interview remains the most important part of the voice assessment. In the same vein, many of the therapy techniques that we currently use maintain their foundations in skills that were practiced centuries ago to enhance the singing and speaking voices. The advances in our knowledge have significantly enhanced the diagnostic process and have helped confirm whether our chosen treatments are truly effective.

The authors of this text have been privileged to provide clinical services to those with voice disorders, and to contribute to the research for the many aspects of voice production. While we have had the opportunity to work in interdisciplinary clinical voice centers, side-by-side with our laryngology partners, we fully understand that voice therapy is needed and provided in practically every setting in which speech-language pathologists work. This text is designed to help prepare all clinicians to evaluate and treat voice disorders, and is not limited to only those who specialize in the area of voice. This unique and eclectic population of patients encompasses all ages, across the lifespan, and represents etiologies arising from medical, environmental, social, psychological, and occupational threats to vocal health. Our patients may include typical voice users, occupational voice users, elite vocal performers, individuals with head and neck cancer, and others who suffer with upper airway symptoms. Each patient provides us with a unique diagnostic dilemma: How do we best return the voice to optimal condition?

This text is organized to systematically build the knowledge base and clinical skills necessary to successfully answer this question. We seek to organize, explain, and illustrate the comprehensive hierarchy of knowledge necessary to manage the many types of voice disorders. **Chapter 1** begins with an entertaining history of voice disorders from its ancient foundations to the present. This information clarifies the role speech-language pathologists play in the care of voice-disordered patients and introduces the interdisciplinary background that has permeated our history of successful voice therapy.

The progressive development of essential clinical knowledge areas begins in **Chapter 2,** the anatomy and physiology of voice production. Understanding the structure and function of the laryngeal mechanism is an essential basis for evaluating phonatory function, for examining the larynx and vocal folds, for recognizing the impact of abnormal changes or adaptations on voice production, and for sharing information with our physician partners-in-care. Using enhanced illustrations, this sixth edition updates the descriptions of the three subsystems of voice production, respiration, phonation, and resonance, and expands the discussion of vocal fold histology and DNA microarray gene expression analysis.

Chapter 3 provides a thorough update on the common etiologies of voice disorders, including behavioral, medical, and personality-related etiologies. Common factors associated with the cause and maintenance of voice disorders are discussed in order to understand best options for treatment planning.

Chapter 4 presents the pathologies of the laryngeal mechanism, which are organized according to the *Classification Manual for Voice Disorders-I* developed by Special Interest Division 3 (Voice and Voice Disorders) of the American Speech-Language-Hearing Association (2006). The pathologies are presented in eight major groups: (1) Structural pathologies; (2) Inflammatory conditions; (3) Trauma or injury; (4) Systemic conditions affecting voice; (5) Aerodigestive conditions affective voice; (6) Psychiatric or psychological disorders affecting voice; (7) Neurologic voice disorders and; (8) Other disorders of voice. Many of the pathologies are illustrated with color plates.

Chapters 5 and 6 discuss the objectives and procedures of a systematic diagnostic voice evaluation. Chapter 5 introduces traditional evaluation techniques, including the patient interview, audio-perceptual judgments, patient self-assessment, determining the cause(s) and maintaining factor(s) of the voice disorder, and educating the patient about these findings to establish a collaborative management plan based on these clinical data. Chapter 6 provides a state-of-the-art overview of the instrumental measures that comprise a comprehensive voice assessment, including the scientific principles that underlie their development, application, and interpretation. In addition to standard measures of acoustics, aerodynamics, electromyography, and stroboscopy, this edition explains the utility of high-speed digital imaging and videokymography tools. The appendix includes instrumental measurement norms and a helpful glossary of terms.

Knowledge of anatomy and physiology, pathologies, etiologies, and the diagnostic process have prepared the reader for **Chapter 7**, which explores an array of voice therapy approaches following the orientations of hygienic, symptomatic, psychogenic, physiologic, and eclectic treatments. Using frequent patient cases to illustrate major insights about voice treatment that we have each gathered from our 30-plus years of clinical experience, we orient the reader to the theories, selection criteria, and clinical methods for specific voice management principles. This treatment framework is appropriate for common, yet diverse, voice complaints due to a variety of laryngeal pathologies and vocal dysfunctions. Finally, we highlight the current clinical evidence that supports popular treatments used in voice therapy.

Because of the exceptional concerns of voice performers, **Chapter 8** introduces the factors that influence clinical management approaches for this artistic population, such as personalities, temperament, performance routines and schedule, and other special considerations needed for their care and treatment. The chapter defines the roles of the expanded interdisciplinary team and identifies the affiliate organizations that represent and support voice performers. In addition to traditional voice therapy considerations, the chapter also discusses nontraditional alternative treatments that are popular with this population.

Chapter 9, "Rehabilitation of the Laryngectomized Patient," serves as a stand-alone manual on the management of this special patient population. This chapter reflects the current "best practice" in voice rehabilitation or restoration in head and neck cancer patients. By outlining the complementary roles of the interdisciplinary treatment team, we understand the multiple management goals: cure the disease, select optimal communication methods, ensure safe swallowing, and address any associated physical, social, and emotional changes that affect each patient. The chapter also contains photographs of the latest communication and airway management devices currently on the market.

Finally, new to this text is **Chapter 10,** written by Tammy Wigginton and Mark Finfrock titled, "Artificial Airway and Mechanical Ventilation." It has been our experience that our colleagues who teach voice disorders are often tasked with also teaching information related to the speech-language pathologist's role in treating tracheostomy and ventilator-dependent patients. With the knowledge that there are limited teaching resources related to this area for our field, these authors, a speech-language pathologist and a respiratory therapist respectively, have prepared an excellent chapter that provides an overview of the basics of the artificial airway, and the dynamics of mechanical ventilation, as it applies to the practice of speech-language pathology.

Over the past four decades, our chosen specialty of clinical voice pathology has expanded greatly within the field of communication disorders. Nonetheless, this sixth edition of our text retains its original purpose: *to provide students and clinicians with a strong foundation of basic voice science infused with a deep clinical understanding of the best methods for assessing and treating voice disorders*. We hope that you, the reader, will find this text clear, informative, and a worthwhile addition to your professional library.

Text development requires a team, and we are deeply indebted to our team, Angie Singh, Kalie Koscielak, and Valerie Johns, for encouraging and supporting this sixth edition, and to Linda Shapiro, Lori Asbury, and Jessica Bristow on the production side of the text preparation. In addition, we wish to thank our students and colleagues who have suggested ways to improve the text with each new writing. As always, we are most appreciative for the support of our families. Finally, it is our patients who have taught us so much about what is important in the care of their voices, and to whom we are greatly indebted.

Joseph C. Stemple,
Nelson Roy, and
Bernice K. Klaben

Contributors

Mark R. Finfrock, RRT-NPS
Registered Respiratory Therapist
Neonatal Pediatric Specialist
University of Kentucky
Children's Hospital
Lexington, Kentucky
Chapter 10

Tammy L. Wigginton, MS, CCC-SLP, BCS-S
Senior Clinical Speech Language Pathologist
Specialist in Swallowing Disorders
University of Kentucky
Voice and Swallow Clinic
Lexington, Kentucky
Chapter 10

2

Anatomy and Physiology

Knowledge of the anatomy and physiology of the laryngeal mechanism is paramount to understanding voice disorders, and is a foundation for examining the larynx, evaluating phonatory function, and recognizing the impact of abnormal changes or adaptations on voice production. A solid understanding of the normal structure and function of the larynx is the basis for interpreting evaluative findings and developing appropriate voice treatment plans.

ANATOMY

The larynx is essentially a cartilaginous tube that connects inferiorly to the respiratory system, (trachea and lungs), and superiorly to the vocal tract and oral cavity. This orientation in the body is important because it exploits the interactive relationship between these three subsystems of speech: the pulmonary power supply, the laryngeal valve, and the supraglottic vocal tract resonator. When considering the "vocal mechanism," it is common to emphasize the complex and intricate structures of the larynx and vocal folds, but this limited perspective is flawed if it fails to include the broader contributions of subglottic breath support and supraglottic vocal tract resonance. Indeed, vocal function of the larynx relies heavily on the integration of this three-part system: respiration, phonation, and vocal tract resonance (Figure 2–1).

The lungs function as the power supply by providing aerodynamic (subglottal) tracheal pressure that blows the vocal folds apart and sets them into vibration. This vocal fold oscillation provides the sound source for phonation. As the tissues open and close in repeated cycles, the vocal folds modulate subglottal pressure and transglottal flow as short pulses of sound energy. The vocal tract serves as the resonating cavity, which shapes and filters the

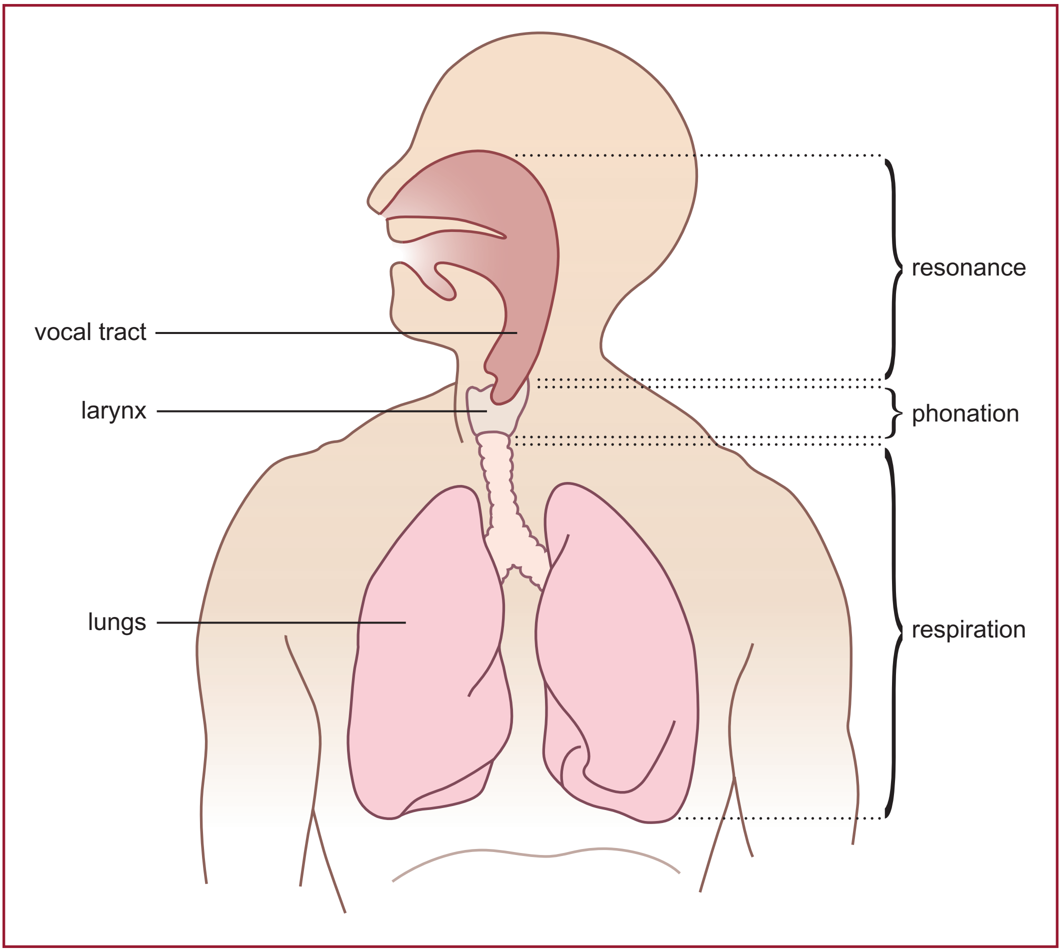

FIGURE 2–1. Orientation of the larynx in the body, at the juncture between the subglottic trachea and lungs and the supraglottic pharyngeal and oral cavities. These structures form the three subsystems of voice: respiration, phonation, and resonance.

acoustic energy to produce the sound we recognize as human voice.[1–7]

Differential diagnosis of voice disorders requires careful assessment of these three components. Obviously, laryngeal health and vocal function will influence the quality of voice production, but respiratory support and supraglottic resonance will also affect the speech product. For example, adequate or insufficient lung pressure can either maximize or limit vocal fold vibration, respectively. A patient with weak or compromised lung capacity may be unable to generate sufficient subglottal pressure required to produce normal vocal loudness or quality. Similarly, altering the shape and size of the vocal tract can either improve or diminish vocal resonance by enhancing or constricting the phonatory sound source generated by the vocal folds. The loss of either of the subglottal or supraglottal contributions could violate the potential for normal voice quality.[6–7] Indeed, the resulting voice product radiated from the lips is a truly interactive result of these subsystems: respiration, phonation, and resonance.

The Laryngeal Valve

The larynx consists of a complex arrangement of cartilages, muscles, connective tissues, and mucosa that allows wide degrees of variation in position, movement, and tension to support three basic functions: airway preservation (opening) for ventilation, airway protection (closing) to block or repel environmental infiltrates, and phonation (vocal fold vibration) for communication and singing. The laryngeal valve achieves these three functions through three levels of "folds" that are best appreciated from an endoscopic view of the larynx (Figure 2–2). Endoscopy permits visualization of internal structures from outside of the body, and it is this view of the larynx that often forms the basis of clinical judgments related to the normalcy of anatomical structure and physiological function. This view of the endolarynx (and surrounding anatomy) shows the vocal folds in their fully open position (A) or closed position (B), and also illustrates the location of each of the three sets of folds (from most superior to most inferior):

1. Aryepiglottic folds connect the anterior attachment of the epiglottis cartilage to the arytenoid cartilages to form the superior border of the circular laryngeal column (Figure 2–3). The upper rim of the larynx is formed by the aryepiglottic folds, which are strong fibrous membranes that connect the lateral walls of the epiglottis to the left and right arytenoid cartilage complexes. When the epiglottis cartilage folds posteriorly and inferiorly over the laryngeal vestibule, it separates the pharynx from the larynx and offers the first line of defense for preserving the airway.[1,2,8,9]
2. Ventricular (or false) folds lie superior and parallel to the true vocal folds just above the ventricles. The ventricular folds form the second sphincter. They are not normally active during phonation but may become hyperfunctional or more prominent during effortful speech production, or extreme vegetative closure. The ventricular folds are directly superior to the ventricles, which function as variable pockets of space above the true vocal folds. The ventricular folds form a "double layer" of medial closure, if needed. The principal function of this sphincter is to increase intrathoracic pressure by blocking the outflow of air from the lungs. For example, the ventricular folds compress tightly during rapid contraction of the thoracic muscles (eg, coughing or sneezing) or for longer durations when building up subglottic pressure to stabilize the thorax during certain physical tasks (eg, lifting, emesis, childbirth, or defecation). The ventricular folds also assist in airway protection during swallowing.[1,2,8,9]
3. True vocal folds open for breathing, close for airway protection, and vibrate to produce sound. The third and final layer of this folding mechanism is the true vocal folds. For speech communication, the vocal folds provide a vibrating source for phonation. They also close tightly for nonspeech and vegetative tasks, such as coughing, throat clearing,

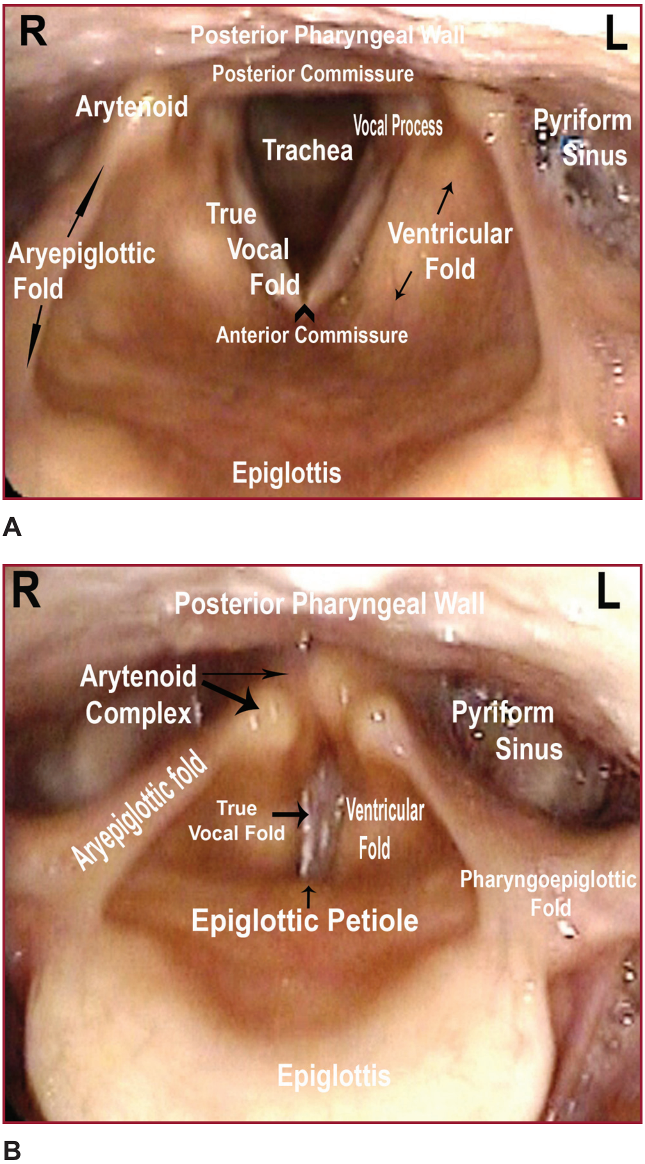

FIGURE 2–2. Endoscopic view of the larynx and surrounding structures as observed from above with the vocal folds in the fully open (**A**), and closed (**B**) positions. R = right, L = left.

and grunting, by functioning as a variable valve, modulating airflow as it passes through the vibrating vocal folds during phonation, closing off the trachea and lungs from foods and liquids during swallowing actions, and providing resistance to increased abdominal pressure during effortful activities. The angles of true vocal fold closure are multidimensional and include the potential for valving in both hori-

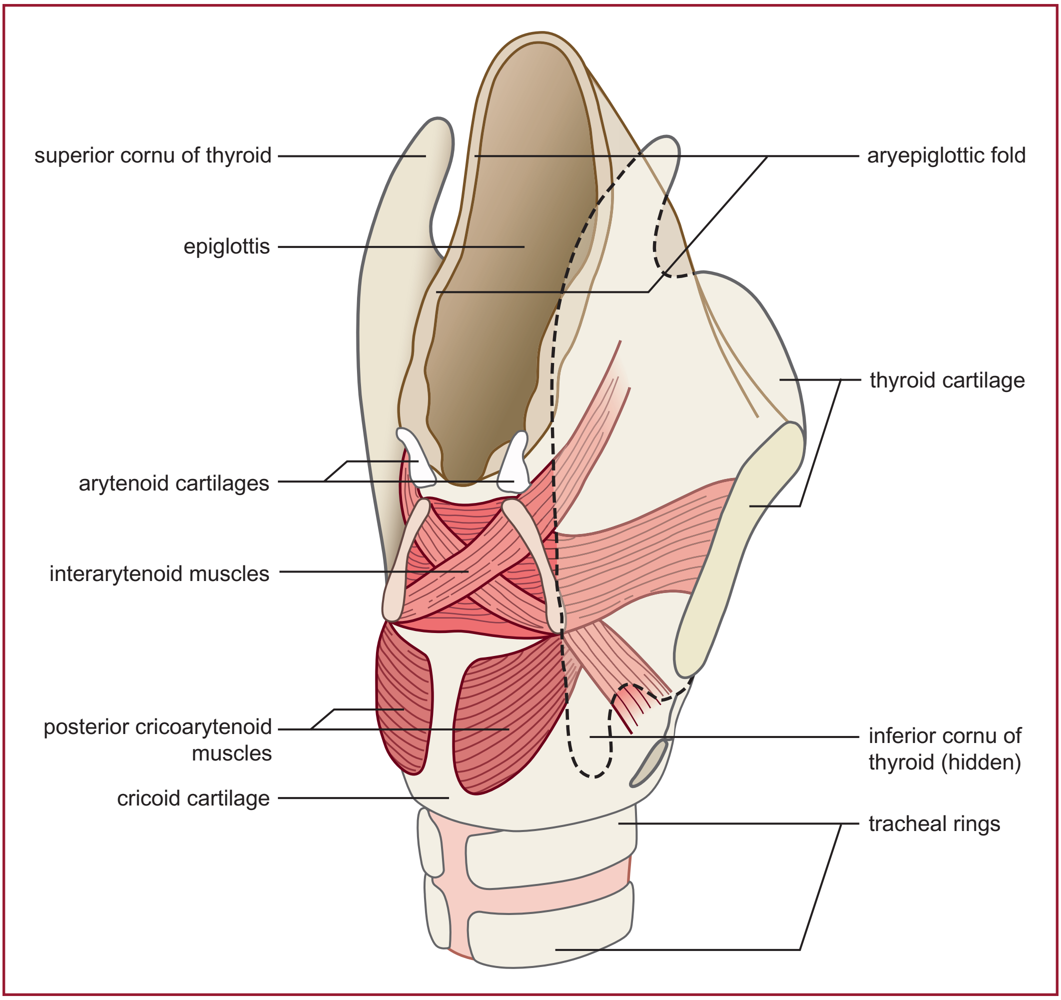

FIGURE 2–3. Oblique view of the larynx.

zontal and vertical planes, depending on the variable shape, tension, and compression of the medial edge. Communicative maneuvers include narrow and rapid opening and closing gestures to produce momentary phonetic contrasts for voiced and voiceless speech sounds, as well as sustained vocal fold closing to produce vibration for phonation.[1,2,8,9]

All three of these folding structures—the epiglottis, ventricular folds, and true vocal folds—exhibit variable shape, tension, and position to accomplish these communicative and vegetative functions in the body. Together, these three levels of airway preservation and protection perform constant adjustments in the airway aperture (Figure 2–4).

Respiration for Phonation

Vocal fold vibration is the sound source that produces phonation and provides the speech signal. Phonation relies on the pulmonary respiratory power, sup-

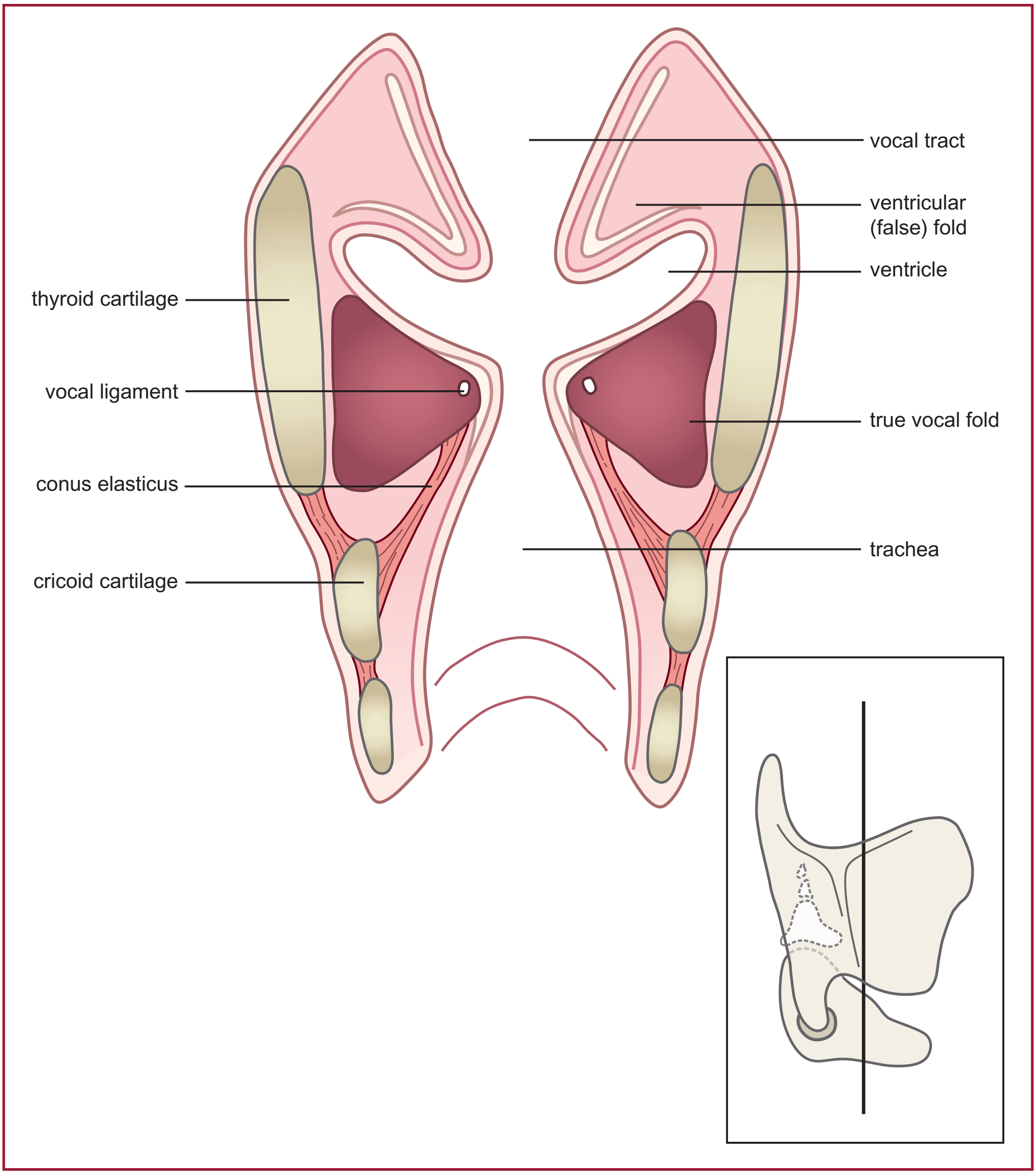

FIGURE 2–4. Coronal view of the ventricular and true vocal folds. (insert: Coronal plane of Figure 2–5).

ported by the abdominal and thoracic musculature. The lungs are housed within the rib cage in the thorax and separated from the viscera (digestive organs in the abdomen) by a large, dome-shaped muscle called the diaphragm. The bottoms of the lungs are attached to the top of the diaphragm by a double-walled pleural lining. During inhalation, the diaphragm contracts (flattening downward in the body), compressing the viscera, and simultaneously pulling the lungs downward, thereby expanding the lung volume. As this lung volume expands, air is drawn passively into the lungs. During exhalation, the diaphragm relaxes and rises back up to its resting position, as passive elastic recoil pushes air out of the lungs and upward through the vocal folds and vocal tract. During quiet exhalation, the vocal folds are abducted (opened) in the paramedian position (approximately 60% of the full glottal aperture), so no sound is generated. To exhale for speech, however, the vocal folds adduct (close) at midline, constricting the airflow stream as it exits the lungs. This aerodynamic breath stream builds up pressure below the adducted vocal folds until they are blown apart and set into oscillation, creating the vibratory sound source of phonation.[10–12] Without this airflow, no sustained phonatory sound source can be achieved. The interactive relationship between the subglottal air pressure buildup and transglottal airflow rate passing through the vibrating vocal fold valve influences the overall pitch, loudness, and quality of phonation.[4,5,10–14]

VOCAL TRACT RESONANCE

As sound waves generated by the vocal folds travel through the supraglottic air column into the pharynx, oral and nasal cavities, and across articulatory structures such as the velum, hard palate, tongue, and teeth, the excitation of air molecules within this space creates a phenomenon called resonance. Resonance occurs when sound is reinforced or prolonged as acoustic waveforms reflect off another structure. The model of acoustic energy (phonation) traveling through a filter (vocal tract) modified in variable shape, size, and constriction characteristics (articulatory gestures) is the basis for Fant's *Acoustic Theory of Speech Production*.[15] This theory underlies our understanding of the three components of the acoustic speech product: *glottal sound source* provided by the vibrating vocal folds, coupled with the supraglottic contributions of *vocal tract filtering*, and *resonant characteristics*.[15,16]

The fluctuating dimensions of the vocal tract cross-sectional area, cavity shape, and points of articulatory contact (eg, tongue, teeth, and lips), each have a direct influence on the quality and strength of the acoustic product radiated from the lips, and perceived by listeners. The sound of vocal fold vibration without the supraglottic resonating cavity (for example, in intraoperative conditions or in excised larynx studies) reveals a flat, atonal buzz, devoid of any "ring" and completely unrecognizable as human voice. The contribution of this resonating filter is essential to creating the perceptual attributes of voice, including pitch, loudness, nasality, and quality. Manipulating resonance characteristics by changing the vocal tract shape and oral posturing has been the study of vocal pedagogues, actors, and singers for several centuries.[5,7,11,13–16] Modifying resonance has also been applied directly to voice treatment methods for disordered speakers and professional voice users.[17–20]

STRUCTURAL SUPPORT FOR THE LARYNX

Hyoid Bone

The larynx is composed of a complex system of mucosa, connective tissues, muscles, and cartilages, all suspended from a single semicircular bone, the hyoid. The hyoid bone marks the superior border of the laryngeal complex of muscles and cartilage. It articulates with the superior cornu of the thyroid cartilage and attaches to the thyroid through the thyrohyoid membrane. Although the hyoid serves as the muscular attachment for many extrinsic muscles of the larynx, it is notable as the sole bone in the body that does not articulate with any other bone. This has an important benefit clinically because chronic elevation of the hyoid can reflect excessive tension of the muscular sling that supports the larynx. Speech-language pathologists and vocal pedagogues may palpate the neck to assess hyoid positioning and monitor vocal tension in patients or performers (Figure 2–5).[1,2,9,10]

Laryngeal Cartilages

There are nine laryngeal cartilages that extend from just below the hyoid bone superiorly to the first tracheal ring inferiorly. Together, these cartilages attach to muscles and connective tissues to form the surrounding columnar housing for the vocal folds. The three largest cartilages are (from most superior to inferior) the epiglottis, thyroid, and cricoid. Additionally, there are three smaller pairs of cartilages that form the posterior wall of the laryngeal column; they are (from most inferior to superior)

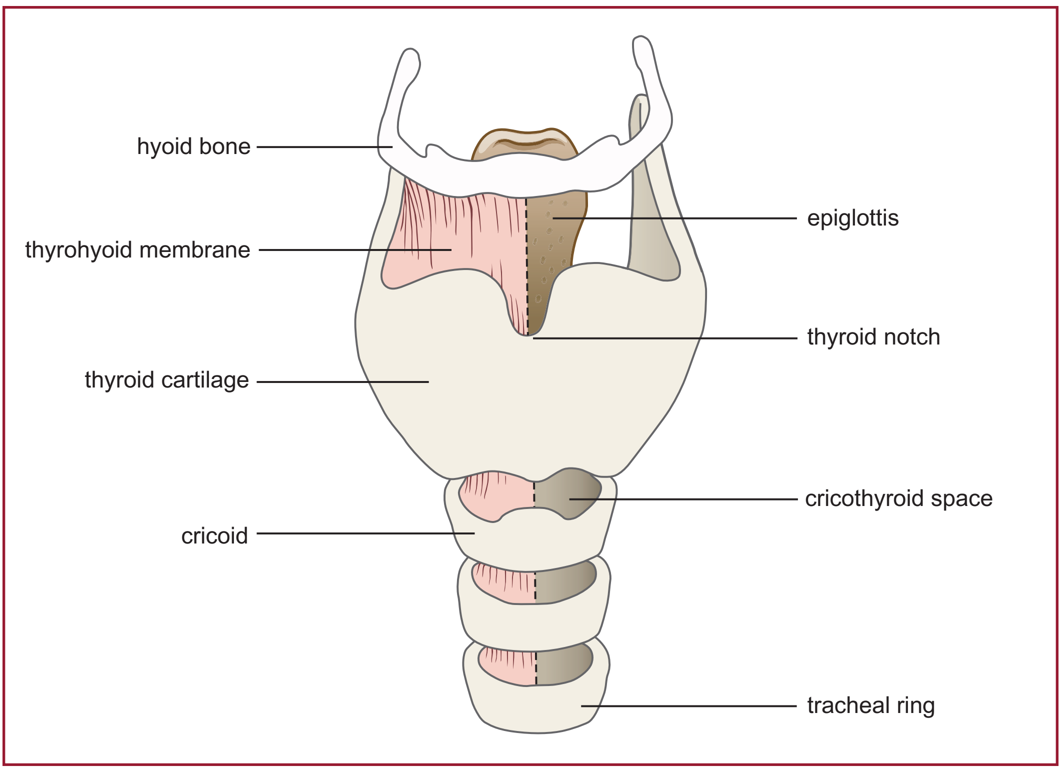

FIGURE 2–5. Anterior view of the hyoid bone and laryngeal cartilages.

the arytenoid, corniculate, and cuneiform cartilages.

Epiglottis

The epiglottis cartilage is shaped like a long leaf, with its narrow base (petiole) attached to the inner portion of the anterior rim of the thyroid cartilage. This attachment allows the blade of the epiglottis cartilage to fold along its midline and move forward and back, closing down inferiorly and posteriorly over the laryngeal vestibule. Although the position of the epiglottis may influence vocal tract resonant properties, the epiglottis normally has no direct role in phonation or communication. Its primary role is airway protection, as it forms the top level of the three tiers of a sphincteric folding mechanism to divert particles of food or liquid away from the glottis during swallowing. Unlike other laryngeal cartilages, the epiglottis is composed of elastic cartilage and, therefore, does not ossify, or harden, with age. This composition is important because this structure must remain flexible throughout life to allow a pliable free edge to assist in closing the airway (Figures 2–6 and 2–7).[1,2,9,10]

Thyroid

The thyroid cartilage is a three-sided saddle-shaped curve that creates the anterior border of the airway column. The thyroid cartilage attaches the true

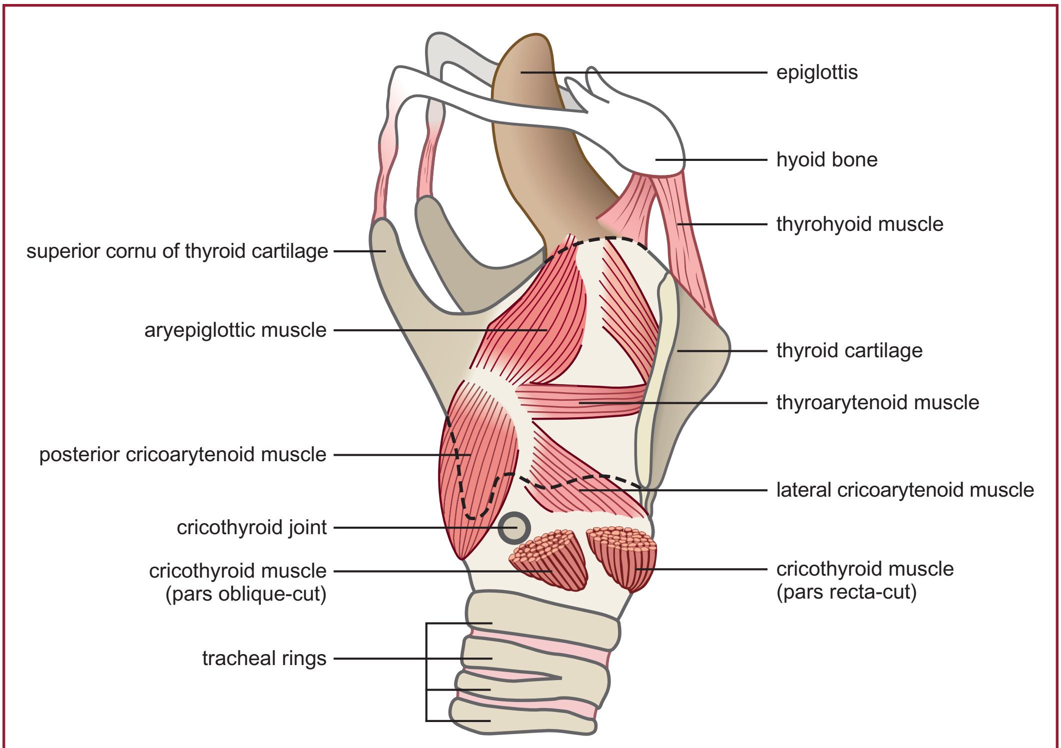

FIGURE 2–6. Lateral view of the larynx.

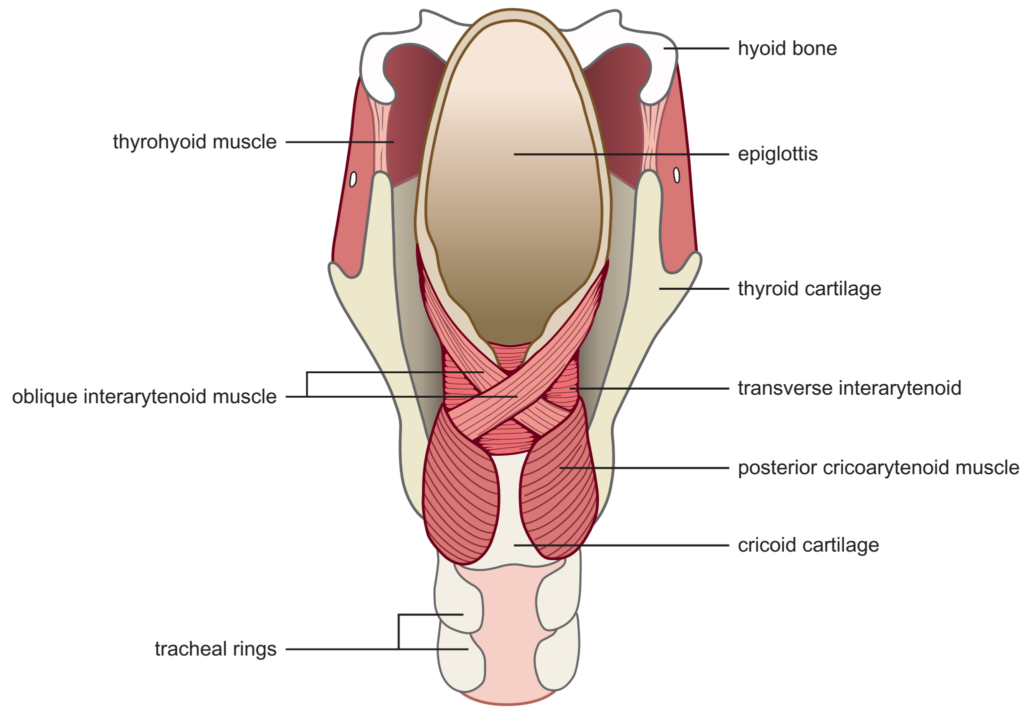

FIGURE 2–7. Posterior view of the larynx.

vocal folds to the internal rim of the anterior curve. Posteriorly are two superior cornu, or "horns" that extend upward to articulate with the hyoid bone, and two inferior cornu that articulate with the cricoid cartilage below it.[1,2,9,10] The thyroid is composed of hyaline cartilage that ossifies and limits flexibility with age.[21] The lateral walls form quadrilateral plates, called laminae, that attach at the anterior midline in a thyroid notch or prominence. In newborns, these laminae form a curve of about 130°, and the angle becomes more acute with age. A fully matured thyroid angle will be more acute for adult males (90°) than for adult females (110°).[9] In males, the thyroid notch will become more prominent anteriorly, resulting in the characteristic male "Adam's apple." This thyroid notch can be seen or palpated at the front of the neck. Clinically, malposition or aberrant movement of the thyroid notch can signal extrinsic laryngeal muscle hyperfunction, or voice misuse.[18–20]

Cricoid

Below the thyroid cartilage is the cricoid, another hyaline cartilage. It is the only circular cartilage and its shape is described as a "signet ring," with a narrow anterior curve and broad posterior back.

The cricoid sits above the first tracheal ring and provides a stable round entry to the pulmonary airway. The cricoid has two sets of paired facets, or flat surfaces that articulate with the thyroid

Call-Out Box 2–1

In clinical circles, it is quite common for patients to complain of pain and/or discomfort in specific regions of the laryngeal framework. This pain is often a symptom of overactivity of the extrinsic laryngeal muscles. This overactivity may be causal, concomitant, or a consequence of the persistent dysphonia. In fact, during the diagnostic session, many clinicians will palpate the larynx to identify the location and extent of muscle tenderness and pain (see Chapter 5). These sites typically include the major horns of the hyoid bone (bilaterally), within the thyrohyoid space, and over the superior cornu of the thyroid cartilage. Try to identify these sites on your own larynx, and then recruit some of your fellow students, (or friends) and see if you can identify these anatomical landmarks/sites across a variety of larynges. This exercise will help you to appreciate the variation in larynges across people of different genders and body types.

and arytenoid cartilages. The cricothyroid joints connect the lateral facets of the cricoid to the inferior cornu of the thyroid cartilage above it, thus allowing the thyroid cartilage to rock forward from its vertical position. The convex facets on top of the posterior cricoid rim are where the concave pyramidal bases of the paired arytenoid cartilages rest to form the cricoarytenoid joint.[1,2,9,10] Both the cricothyroid and cricoarytenoid joints are lined with a synovial membrane, which provides a connective tissue cushion supplied with secretions for lubrication, blood supply, adipose cells, and lymph tissue. Both articular joint surfaces and the synovial joint membranes do display normal age-related deterioration, although no gender differences have been noted (Figure 2–8).[21–22]

Arytenoids, Corniculates, and Cuneiforms

The three-paired cartilages are the arytenoid, corniculate, and cuneiform cartilages. The arytenoid cartilages are pyramid-shaped, with three quasitriangular surfaces: the anterior, lateral, and medial sides. The arytenoids have a pointed apex on top and a concave base. The anterior points of the arytenoid base project farther forward than the lateral and median sides to form the vocal processes. The bilateral vocal processes form the cartilaginous portions of the vocal fold, and are the posterior points of attachment for the membranous left and right true vocal folds. The arytenoids are composed of hyaline cartilage, except for these vocal processes, which have elastin cartilage at their tips. The lateral arytenoid angles are called the muscular processes because two different intrinsic laryngeal muscles attach in separate locations. When these muscles contract, they move the bilateral vocal processes laterally, to open (abduct), or medially to close (adduct), the vocal folds. The medial arytenoid angle faces its arytenoid pair, forming an even surface for midline glottic closure (Figure 2–9).[1,2,9,10]

The base of the arytenoid cartilage is a concave cylinder, allowing it to articulate smoothly with the convex superior surface of the posterior cricoid cartilage. The arytenoid base fits neatly over the posterior cricoid similar to an empty half cylinder resting over a rounded bar. The movement of the