

Textbook of LARYNGOLOGY

Official Publication of the Association of Phonosurgeons of India

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Editor-in-Chief

Nupur Kapoor Nerurkar MBBS MS (ENT) DORL
Laryngologist and Voice Surgeon
Director
Laryngology Fellowship Program
DNB Co-ordinator
Department of ENT
Bombay Hospital and Medical Research Center
Mumbai, Maharashtra, India

Co-Editor

Amitabha Roychoudhury MBBS DLO (Hons)
DNB (Otolaryngol) DLORCS (London)
Professor and Head
Department of ENT
Vivekananda Institute of Medical Sciences
Kolkata, West Bengal, India

Foreword

Peak Woo MD FACS



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Foreword

Textbook of Laryngology, edited by Dr Nupur Kapoor Nerurkar and Dr Amitabha Roychoudhury, brings forward a textbook that is quite unique in the need for a relevant, state-of-the-art and expert-driven text on laryngology for the laryngologists and general otolaryngologists.

Dramatic advances in laryngology over the last 40 years have made larger textbooks that cover general otolaryngology, largely obsolete for the study of laryngeal disorders. Earlier, the state of the art in diagnosis and management of voice, swallow and airway disorders included subjects and approaches that would be unthinkable and were not addressed in the standard otolaryngology textbooks written for the general otolaryngologists. Today, laryngology is a recognized subspecialty. In the literature, we have seen a steady rise of laryngology papers submitted for review. According to NIH PubMed, in 1976, there were 15 articles on the search topic of vocal fold paralysis, and in 2015, there were 115 citations with the same search word. Such is one example of the proliferation of papers related to laryngeal disorders. From diagnostics to therapeutics, dramatic advances continue to pace the changes that are evolving dramatically in the specialty of laryngology. This is because quality-of-life issues related to voice, swallow, and airway continue to drive the need for expertise care in one of the most treasured of our senses, contributing to high-quality life, i.e. the need for excellence in voice, airway and swallow.

The topics and organization are comprehensive and detailed. From basic science to the future, the topics outlined are of utmost urgency in international forums in laryngology that I have had the privilege to participate in. Topics such as office diagnosis, new lasers, office procedures, new phonosurgery approaches, laryngeal reinnervation and robotic surgery are some examples of the state of the art in laryngology. This carefully edited textbook addresses each topic in detail.

A particular strength in the text is the broad focus on voice, airway and swallow issues related to laryngeal function. From treatment of voice disorders for gender reassignment to surgery for laryngeal-tracheal stenosis, the editors, Dr Nupur Kapoor Nerurkar and Dr Amitabha Roychoudhury have brought together an international group of experts in the specialty of laryngology to address each topic. Many of the experts are the leaders in the inception and the development of the treatment approaches in their chapters. Especially enticing are the chapters written by the experts from Europe, USA and India, making this a truly expert collection of chapters that contributes to the English literature in our specialty.

The editors and the contributing authors have in this collection a compendium of vital information that will be a reference tool for both the practicing laryngologists and those practitioners of otolaryngology who seek to have an up-to-date text on laryngology. For a novice, who is contemplating the subspecialty of laryngology, this textbook will serve as a 'Bible' for years to come.

Peak Woo MD FACS
Clinical Professor of Otolaryngology
Icahn School of Medicine
New York City, New York, USA

Preface

"The human voice is the most beautiful instrument of all, but it is the most difficult to play."

Richard Strauss (German Romantic Composer)

Over the past century, Laryngology has mushroomed to become a major specialty in medicine. Beginning with Manuel Garcia's discovery of mirror examination of his own larynx, diagnostics have today come a long way indeed.

The human larynx and mechanism of voice production, both in health and disease, have posed great challenges to the clinicians over centuries. The 21st century has witnessed an exponential rise in voice disorders, probably an echo of today's ever-increasing vocal demands in every walk of life. Despite extensive research by anatomists, physiologists, otolaryngologists and speech pathologists, and continued technological advancements across the globe, many conditions in laryngology remain enigmatic. The specialty of laryngology has further expanded with the incorporation of swallowing and airway disorders into its domain.

Indian laryngology has also grown by leaps and bounds over the past two decades, in tandem with the global scenario. This textbook of laryngology, published under the aegis of 'The Association of Phonosurgeons of India', is intended to be a comprehensive study material for any clinician pursuing practice and research in laryngology. It is also intended to serve as a ready-reckoner for a voice pathologist.

We sincerely thank Dr Peak Woo for writing the Foreword of our textbook. We would like to place on record our gratitude to Jaypee Brothers Medical Publishers (P) Ltd. and all our authors, who have worked tirelessly so that this textbook could be born in nine months from the conception of the idea!

**Nupur Kapoor Nerurkar
Amitabha Roychoudhury**

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A Historical Review of Laryngology

Unnikrishnan K Menon

"The more you know about the past, the better prepared you are for the future."

—Theodore Roosevelt

INTRODUCTION

Larynx: the "voice box". Laryngology: the study of this beautifully complex organ. These are facts that the present day ENT fraternity takes for granted. However, it has taken a voyage of discovery to reach these obvious conclusions. Many famous names have contributed their ingenuity and efforts to the development of this field. This chapter is a brief look at those magnificent men and their contributions.

When we think of the larynx, intuitively, we have the "internal" view in mind, viz. the vocal folds, glottis, etc. That was not always the case. The external approach to and view of the larynx predates the endoscopic view by a long margin. This could be seen as one way of classifying the history of laryngology—first, its discovery as a distinct organ and later, the history of laryngoscopy. Leading on from these would be the history of detailed studies of the vocal folds and the development of laryngeal surgery and phonosurgery.

Early Days

"The beginning is the most important part of the work."

—Plato

Awareness of the larynx as a separate organ and its probable role in voice production seems to have existed since time immemorial. The many familiar names that come up in various literature sources include Aristotle (350 BCE), credited with the first mention of the larynx in his book "Historia Animalium", and Sushruta and Charaka from India (300 BCE

and 100 BCE).¹ These were followed by the significant contributions from Claudius Galen (2nd century CE) and Ibn Sina (Avicenna) (10th century CE). The former has been proclaimed as the "Father of Laryngology".²

As students of medicine, we are well aware of the importance of diagrams and illustrations in anatomy. Needless to say, the Renaissance period in Europe made a contribution to laryngology also. Leonardo da Vinci and Michelangelo performed cadaveric dissections, followed up by illustrations and detailed descriptions of laryngeal function. Casserius, in his book titled "The Anatomy of Voice and Hearing" (1600), gave detailed artistic descriptions of the larynx, that are reportedly very accurate (Fig. 1).³

Ferrein, in 1741, gave us the term "vocal cords", comparing them to the cords of a violin, activated by contact with air column. The new name was promptly countered



Fig. 1: Cover page of the book "The Anatomy of Voice and Hearing" by Casserius (1600).

Acknowledgment: UCL Ear Institute and Action on Hearing Loss Libraries.

Clinical Evaluation in a Patient with a Voice Disorder

James P Thomas

INTRODUCTION

Clinical evaluation of the voice often consists of only two parts, history and laryngeal endoscopy. However, after eliciting a patient history, the astute laryngologist will include a middle step—listening to and documenting by audio recording the vocal capabilities of the patient before pursuing the endoscopic examination. Based on the pitch and volume where dysphonia is elicited, we have generated a vocal capabilities pattern or *vocal signature*. Utilizing this pattern during the visual examination with the endoscope and stroboscope, viewing the vocal cords at the same pitch and volume as the elicited dysphonia, more accurately identifies the pathologic cause of hoarseness.

The patient history is an important step for identifying the cause of a voice disorder and techniques for history taking are well known. After obtaining a patient history, the astute examiner though concentrates on the second and often missed portion of the laryngeal examination, eliciting hoarseness. Before describing this method of vocal testing, let us agree on some definitions.

DEFINITIONS

- Voice
- Hoarseness

Voice

“What is voice?” Sound coming out of your mouth—according to a dictionary.

Is it necessarily something made by the larynx?

Consider that a violin has a “voice.” A bow is pulled across strings, they vibrate and the air inside the wood of the violin resonates, amplifying the vibrations. We hear and recognize the sound of the violin. We recognize the voice of a violin.

Effectively, any thing that vibrates in the audible range of humans has a voice, whether the horn in a car or lips placed against a trumpet’s mouthpiece. Voice is a sound produced by vibration and amplified by resonance; no vocal cords are required.

We can tune a wire to vibrate 150 times per second and we will hear a tone. On a piano, the white key at D3 vibrates at almost 150 times a second, creating an audible vibration. The sound board of this piano resonates and amplifies the pitch, bringing into play various overtones from sound bouncing around within the cavity. For those of us not used to listening closely, we may not initially be able to describe in words the voice of this particular piano. Yet, play the same note on a guitar string and we hear the same tone, but a different voice. And most of us could separate the voice of a guitar from a piano.

Consequently, voice is vibration in the range of human hearing, made by a sound source and amplified by a resonating cavity. That is, something vibrates, usually vocal cords in a human (but it could be the supraglottis or even the esophagus in a postlaryngectomy patient). Something amplifies the sound, the pharynx. Sound is then further altered into speech. Vowels tend to be created in the pharynx and the palate, nose, tongue and mouth further alter the sound to create consonants and ultimately words and sentences.

For the diagnosis of voice disorders, it may be helpful to think of a speech line, a dividing line in the human neck at the top of the larynx. Below this line, voice is produced and above this line, voice is modified to create speech. In this chapter, our attention will be below this line (Fig. 1).

Hoarseness

For most individuals, voice is a relatively clear tone manipulated rather freely in terms of volume and pitch. We can

Principles and Essentials of Phonomicrosurgery

Peter C Baxter, Mark S Courey

INTRODUCTION

Phonomicrosurgery refers to surgeries performed on the vocal folds at high magnification which are concerned with improvement or restoration of voice quality through restoration of vocal fold function or more specifically vocal fold vibration. Special instrumentation and techniques have been developed to preserve the unique layered structures of the vocal folds while removing diseased tissue. Earlier forms of vocal fold surgery removed diseased tissue without magnification and primarily involved mucosal stripping techniques. These techniques produced unsatisfactory outcomes because the layered structure of the vocal fold mucosa was not preserved.

The surgical principles in phonomicrosurgery are based on an understanding of vocal fold physiology, which was elucidated by Hirano's cover-body theory of vocal fold vibration.¹ Understanding laryngeal physiology and anatomy is essential to achieving good voice outcomes. Technical considerations and delicate dissection are also important in obtaining optimal results. In the future, introduction of regenerative tissues may further improve results from phonomicrosurgery.

HISTORICAL CONSIDERATIONS

Earlier techniques of vocal fold surgery were developed prior to our understanding of the clinical importance of the layered structure of the vocal fold. They were often performed without magnification and without an understanding of the relevance of the mucosa. All surgeons could do was to remove the diseased tissue and/or the lesion with the surrounding mucosa. This was done primarily by grasping the tissue with a 2–4-mm cup forceps and pulling it off. This was termed the "mucosal stripping technique" and instruments were developed specifically to strip mucosa.²

Removal of the mucosal layer of the vocal fold was thought to remove diseased tissue and encourage regeneration of normal healthy mucosal layers. Subsequently, the results of this technique were unpredictable. Voice quality following mucosal stripping was often poor particularly when performed bilaterally.

Advances in the understanding of anatomy and physiology of the vocal folds led to the discovery of the special layered structure of the vocal fold. Hirano's cover-body theory demonstrated that normal vocal fold function was created by the interaction between the delicate epithelial layer and superficial lamina propria (SLP) over the vocal ligament. Widespread use of laryngeal stroboscopy allowed clinics to observe vocal fold vibration created by the intact layered structure of the mucosa. When the layered structure was removed injudiciously through surgical "stripping techniques", stroboscopy allowed the clinician to appreciate the stiffened nonvibratory nature of the regenerated tissue and to better understand why voice was not restore postoperatively. In vocal fold surgery, therefore, stroboscopy has come to serve the same purpose as the audiogram has in otologic surgery. In the same way as an audiogram is a prerequisite to middle ear surgery, stroboscopy is now a prerequisite to vocal fold surgery. Preservation and restoration of the layered structure of the mucosa is understood to be essential in restoring voice.

To accomplish this goal, contemporary laryngeal surgeons have developed smaller and more delicate instruments than cup forceps and the Loré strippers. In addition, they use magnification similar to or greater than that used in ear surgery. Finally, techniques of vocal fold microdissection have been standardized and shown in clinical series to produce reliable vocal outcomes.^{3,4}

These microdissection techniques, initially introduced originally by Bouchayer,³ were refined and studied by

Localized Inflammatory and Infective Laryngeal Disorders

PSN Murthy, Swetha Pedaprolu

INTRODUCTION

Larynx lies at the junction of upper and lower respiratory tracts but forms a major component of the airway. Hence, it is most vulnerable to infections spreading the nose, paranasal sinuses, and pharynx in general. "Laryngitis" a term used widely to describe all voice disorders need not be infective in origin all the times. The voicebox also can be affected by excessive use, abuse, or misuse of voice and can present with a change in voice. Laryngeal inflammations will result from infective, irritative, traumatic, metabolic, allergic, autoimmune, or idiopathic causes. It is also possible that many a time more than one causative factor can be responsible for the disorder. This becomes important because each of these causes need to be identified and treated to get a better outcome. Laryngitis can affect the vocal health in particular and other major functions of

the larynx such as respiration, swallowing, and protection of the lower respiratory tract.

As with any other organ, inflammatory diseases can be acute or chronic. The etiopathogenesis can be different in adults and childhood but the pathological process is edema, inflammation, and exudation in acute presentations with hypertrophy or metaplasia of the mucosa leading to structural obstructive lesions causing hoarseness of the voice. So the symptoms will be essentially same depending upon the severity, type of onset, and other systemic findings.

SYMPTOMATOLOGY

- Dysphonia or hoarseness or change in voice
- Dyspnea, stridor, and airway obstruction
- Dysphagia or laryngeal aspiration/spillover
- Odynophonia and odynophagia.

LARYNGEAL DISORDERS IN CHILDREN

The child's larynx is subjected to several infective processes because of the loose supraglottic mucosa and can present with obstructive symptoms. Hence, there is a need for preventing the infection to spread and relieving the obstruction as early as possible to lessen the morbidity.

The clinical presentations can vary from a nonobstructive laryngitis like simple laryngitis to acute epiglottitis or acute laryngotracheobronchitis (LTB) causing with severe respiratory obstruction.

NONOBSTRUCTIVE LARYNGITIS OR SIMPLE LARYNGITIS

Primarily a viral infection but also can occur secondary to upper respiratory infections, fumes or dust inhalations,

or even allergic. Most common viruses are rhinovirus, parainfluenza, or respiratory syncytial viruses but also may be associated with measles, mumps, chickenpox, whoopin cough, and influenza with mucosal damage and secondary bacterial infection by *Moraxella catarrhalis*, *Streptococcus pneumoniae*, and *Haemophilus influenzae*. The infection starts in the mucosa but also can extend to underlying muscles, perichondrium, cricoarytenoid joint. Complete recovery is the rule once the larynx is rested and rarely can cause irreversible damage to the mucosa with fibrosis and loss of the architecture and structure to present as chronic laryngitis. The child presents with hoarseness of voice, discomfort, and pain with mild or moderate degree fever. The voice can be high-pitched husky voice. The diagnosis is made by positive clinical

Assessment of a Stridulous Patient

Renuka Bradoo

INTRODUCTION

Accurate and timely evaluation is the cornerstone of management of patients with a compromised airway. The ability to quickly and comprehensively evaluate the cause of respiratory distress, the site of obstruction, and the degree of severity plays a key role in the final outcome. This is because treatment decisions will differ not only from patient to patient, but also from time to time in the same patient.

HISTORY

The real challenge in history taking in a patient with a compromised airway is to elicit as much relevant and detailed information in as short a time as possible, enabling one firstly to make a diagnosis and secondly decide how urgently does one need to intervene. This is best achieved by addressing certain specific questions rather than following the standard format of history taking. The best approach would be to ask the following questions in a sequential order:

- How severe is it?

Respiratory distress can be classified into three grades¹ depending on the demeanor of the patient.

Grade 1—"interested": The patient is tachypneic with or without an audible stridor. There is minimal flaring of nostrils as well as some retraction of subcostal or suprasternal area. He does not display any anxiety and is interested in his surroundings. He has a normal intake of food.

Grade 2—"restless": The patient is tachypneic with an audible stridor or wheeze. He shows anxiety and restlessness, refuses food and drink, is preoccupied with breathing, and is not interested in his surroundings.

Grade 3—"exhausted": This is a stage of impending respiratory failure. There may be a decreased effort at respiration and a decrease in the stridor and chest retractions. The patient is drowsy, ashen gray in color, and the skin may feel cold and clammy to touch. If immediate intervention in the form of intubation or tracheostomy is not done, the patient may give up the fight and either slip into a coma or have a cardiorespiratory arrest.²

- How much time do I have before I need to intervene? This directly correlates with the grade of distress. Patients with grade 1 distress can be subjected to a detailed evaluation with imaging and endoscopy over a period of a few days. Grade 2 patients need evaluation and intervention within the next few hours and grade 3 patients require immediate life-saving measures.
- When did it start and how did it progress? The answer to this question very often elicits a diagnosis. The age of onset very often gives a clue to the diagnosis.³ Respiratory distress at birth is seen in bilateral choanal atresia, laryngeal webs or cyst, bilateral vocal cord paresis,⁴ and in extreme cases in laryngotracheal atresia. Stridor manifesting after a few weeks, which increases gradually in intensity and then disappears after the age of 1 year suggests laryngomalacia. Biphasic stridor manifesting after 1–4 months is seen in subglottic hemangiomas.

Let us consider the following clinical scenarios with respect to the onset and progression of the symptoms. In all of these cases the diagnosis can be easily arrived at on the basis of history alone:

- A middle-aged man presents with acute inspiratory stridor since 2 days, has had hoarseness of voice since the past 2 months, and has a firm, nontender swelling in the neck—possibly laryngeal carcinoma.

Laryngeal Transplantation

Arnaud F Bewley, D Gregory Farwell

INTRODUCTION

Though not integral in sustaining life itself, the human larynx can be essential in sustaining quality of life through its essential roles in voicing and swallowing. Laryngeal transplantation offers the potential to vastly improve quality of life in patients who have suffered laryngeal trauma or oncologic laryngectomy. Decades of scientific discoveries in animal and human research culminated in two laryngeal transplantations in 1998 and 2012. Both of these were surgical successes with minimal operative morbidity and both patients noted substantial improvements in their quality of life after transplant. Despite these successes, a broader application of laryngeal transplantation has been limited, given the incomplete functional recovery achieved by these patients and the inherent morbidity of long-term immunosuppression. This chapter will summarize the scientific and ethical advances that paved the way for laryngeal transplantation, discuss the details of the two successful transplantations performed, and outline future directions that will define the field of laryngeal transplantation moving forward.

QUALITY OF LIFE AFTER LARYNGECTOMY

The loss of one's larynx via trauma or laryngectomy has a profound effect on an individual's life. Though vocal rehabilitation with an electrolarynx or trachea-esophageal puncture can allow for effective communication, these remain poor substitutes for natural voicing. Though swallowing function can normalize after laryngectomy, many patients can have protracted dysphagia secondary to pharyngeal scarring, fibrosis, or stenosis.¹ In addition, patients often suffer from anosmia, rhinorrhea, and other

more subtle disturbances related to their altered anatomy. These changes have been demonstrated through survey studies to result in a decrease in quality of life for patients who have undergone laryngectomy. A retrospective psychosocial quality of life study demonstrated significant decrease in social outings and increase in owning a pet and time spent watching television after laryngectomy, all indicative of social withdrawal.² The extent to which communication changes disrupt social roles appears to be associated with patient's long-term adjustment and patients with more disruptions in their social roles have a harder time adjusting.³ Laryngectomy has also been associated with withdrawal from conversation, perceived stigmatization because of changed voice, embarrassment because of tracheostomy, and increased anxiety and depression scores. All of these factors can result in increased depression and anxiety.⁴

Risk Acceptance of Laryngeal Transplantation

Allogenic organ transplantation has had a transformative impact on modern medicine by extending the lives of innumerable individuals who would have succumbed to organ failure. However, organ transplantation is not a panacea given the risks of surgery itself and more importantly, the risks of long-term immunosuppression. For patients with end-stage failure of life-sustaining organs like the heart, lung, or liver, this tradeoff has long been deemed acceptable. However, in the context of laryngeal transplantation, the ethical considerations are more nuanced. Balancing the risks of laryngeal transplantation surgery and long-term immunosuppression against the potential improvements in quality of life has many considerations. Several survey studies have tried to shed some