TOTAL LARYNGECTOMY

Assessment and Management of Respiration, Swallowing, and Alaryngeal Voice

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FOREWORD

There are moments in life that redefine our sense of identity and purpose, but few that challenge the way in which we navigate our environment like a laryngectomy. The loss of one's larynx is an experience that forces an individual to find new ways to connect with the world. It is a singular journey of survival that can only be understood by those who share this path.

For those who have undergone laryngectomy, may this book serve as a guide toward a future filled with accomplishment, purpose, and opportunity.

For clinicians, may this book serve as a resource that allows us to do better and be better for those in our care.

For all of us, may this book serve as a source of strength and encouragement, proving that life after laryngectomy is not an end but a new beginning filled with hope, resilience, and inspiration.

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PREFACE

For many years, clinical education regarding the assessment and management of patients with total laryngectomy has been akin to the storytelling practices used in ancient cultures—through word-of-mouth. The first total laryngectomy was performed in 1873 by Theodor Billroth, but it was not until almost 70 years later that rehabilitation options for alaryngeal voicing became available. Over the past few decades, researchers worldwide have contributed to the growing body of evidence that highlights the sensitive and unique needs of total laryngectomees across functional and psychosocial domains.

Despite scientific progress, the absence of education specific to total laryngectomees in graduate-level didactics, medical residency training, and nursing school curriculums persists. Unfortunately, this dearth in education can leave practitioners feeling wholly unprepared to provide specialized care to total laryngectomees. Discourse between clinical practitioners has been the *sine qua non* of clinical education in total laryngectomy care. Discussions focused on the practical use of research findings, combined with experiential learning (essentially, through trial and error), have been central to how health practitioners develop clinical expertise with total laryngectomees.

Throughout my career, I have had the privilege to learn from, collaborate with, and pontificate alongside great leaders in the field. A frequently asked question in our conversations about the care of patients with total laryngectomy has been, "Why isn't there a book on this?" Although book chapters have been authored by esteemed clinician-scientists regarding respiration, swallowing, and voicing after total laryngectomy, it has been over 30 years since a comprehensive textbook on total laryngectomy care intended for a clinical audience has been published. This textbook is a culmination of updated research, comprehensive assessment techniques, innovative management, and modern approaches to tackling complex challenges. From providing foundational knowledge of "the basics" to discussing novel management strategies, this textbook embodies the collective clinical wisdom and scientific insights from experts in the field of head and neck cancers.

With the aim of closing the literary gap over the past three decades, this textbook on total laryngectomy care is intended to be used in a variety of ways:

- An off-the-shelf resource to assist with troubleshooting complex cases in the clinic setting
- A supplementary reference for didactic education in graduate, medical, and nursing school curriculums
- A guidebook to support learning about total laryngectomy care in clinical training throughout internships, externships, residences, fellowships, and ongoing clinical practice

Through this textbook, the knowledge that was once word-of-mouth has now evolved onto paper. The words, concepts, and intentions within this textbook reflect what many clinicians hold true—bettering the care of our patients by bettering ourselves through knowledge.

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1

PARTIAL LARYNGECTOMY AND TOTAL LARYNGECTOMY SURGERIES

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Introduction

In 1873, Austrian surgeon Theodore Billroth performed the first documented total laryngectomy on a patient with laryngeal cancer. The surgery consisted of significant bleeding, awakening from the anesthetic, and patient death seven months afterward. Since that time, immense strides have been made in revolutionizing surgery for laryngeal cancer, starting in the early 20th century with American surgeon George Washington Crile, who is credited with introducing the radical neck dissection as an important step during the total laryngectomy (Ceachir et al., 2014). In more recent decades, newer treatment modalities have been introduced, including classical or endoscopic CO2 laser surgery, transoral robotic laryngectomy, partial laryngectomy, and multimodal therapy including radiation and chemotherapy.

In 1991, the Veterans Affairs Larynx trial first demonstrated the role for nonsurgical larynx preservation in treatment of laryngeal cancer with induction chemotherapy and definitive radiation therapy (Wolf et al., 1991). The option to preserve the larynx with equivalent survival led researchers to study important functional outcomes following laryngeal cancer treatment, such as speech and swallowing (Cosetti & Schantz, 2008; Forastiere et al., 2003; Hoffman et al., 2006; Rzepakowska et al., 2021). Nevertheless, partial and total laryngectomy procedures continue to be a relevant primary treatment modality for many patients with larynx cancer, and importantly total laryngectomy remains the treatment modality of choice for salvage cases that have failed chemoradiation.

Partial Laryngectomy

Partial laryngectomy surgery is often considered when the tumor size and patient health allow for a more limited surgery.

However, the decision to do a partial laryngectomy is a complicated one and must be well thought-out. It is important to consider the patient's goals when it comes to swallowing ability, voice quality, and duration of therapy. Conservative laryngeal surgeries allow for organ preservation, and in turn, conservation of some of the functions of the larynx, without compromising oncologic outcome (Thomas et al., 1994; Thomas et al., 2012). To accomplish this balance, however, surgeons must have a comprehensive understanding of the indications for these procedures and whether a patient is an appropriate surgical candidate prior to performing conservative laryngeal surgeries.

Conservative laryngeal surgeries, also referred to as partial laryngectomies, allow for treatment of early glottic and supraglottic cancers. This is heavily dependent upon the tumor location and involvement of surrounding structures. In the traditional setting, these conservative laryngeal surgeries are performed via an open approach involving trans-cervical exposure, resection, and reconstruction. With the advances in endoscopic and laser surgery, many early glottic and supraglottic tumors are now being treated with transoral laser microsurgery. Open partial laryngectomies, however, remain a critical surgical tool for patients that cannot be exposed endoscopically and for tumors that cannot be accessed with microsurgical techniques.

Accurate preoperative assessment of tumor characteristics and patient functional capacity is critical in deciding whether a patient is a candidate for partial laryngectomy, and in turn, which type of partial laryngectomy should be utilized. Preoperative voice assessment, indirect laryngoscopy, and direct laryngoscopy assist in understanding the patient's voice impairments, mobility of the vocal folds and arytenoids, endolaryngeal spread of the tumor, and depth of invasion (Figure 1–1). One essential component of the preoperative clinical evaluation is assessing vocal fold movement as this will dictate whether a patient is a candidate for conservative laryngeal sur-

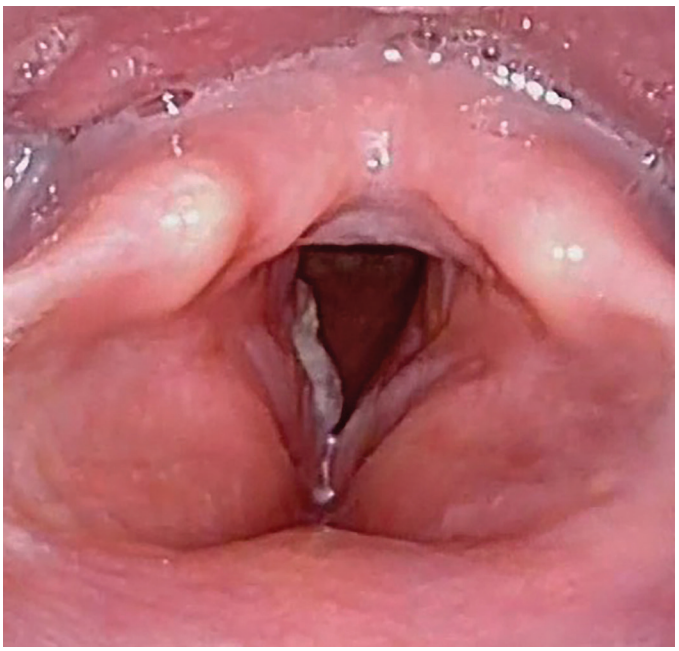

Figure 1–1. Endoscopic evaluation of laryngeal cancer.

gery. Vocal fold mobility can be impaired for various anatomic reasons; glottic and supraglottic tumors can have different effects on vocal cord mobility and arytenoid mobility (Kirchner, 1977). During the preoperative evaluation, surgeons must distinguish vocal fold fixation from arytenoid fixation, as arytenoid fixation can imply cricoarytenoid joint invasion which is a contraindication to partial laryngectomy (Iwai, 1975). Although endoscopic evaluation is a key element in understanding the three-dimensional larynx and anatomic structures that are involved by cancer, preoperative imaging studies are instrumental in understanding the subglottic extent of these tumors that are occasionally difficult to appreciate endoscopically (Figure 1–2). Thyroid cartilage and cricoid cartilage invasion are also important to evaluate in imaging studies.

In addition to the comprehensive assessment of tumor extent, the patient's functional capacity should be evaluated. Beyond the typical assessment of a patient's ability to tolerate general anesthesia, particular attention to a patient's pulmonary reserve is employed when considering a partial laryngectomy. These patients must tolerate some degree of aspiration after surgery, and thus, poor pulmonary function is a relative contraindication to these procedures (Demir, 2016). Importantly, the rate of aspiration varies between the different conservative laryngeal surgeries (Rademaker et al., 1993). The best approach to assessing a patient's pulmonary status prior to partial laryngectomy remains controversial. Some surgeons argue for the routine use of pulmonary function tests (Beckhardt et al., 1994), whereas others utilize their clinical evaluation based on history and physical exam. For example, some surgeons consider patients a poor candidate for partial laryngectomy if they cannot walk up two flights of states without experiencing shortness of breath (Johnson, 2008).

Lastly, patients' and their family's ability and willingness to participate in the postoperative care and rehabilitation should also be considered. Timely voice and swallowing rehabilitation are critical for patients who undergo partial laryngectomies. Additionally, temporary tracheostomy use is a common occurrence during partial laryngectomy

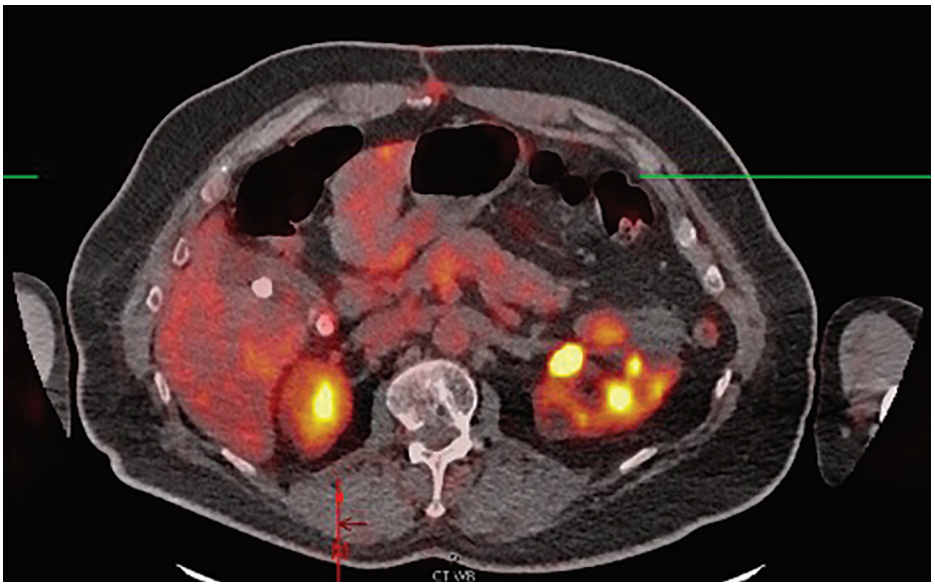

Figure 1–2. PET/CT imaging for the evaluation of laryngeal cancer.

for both airway management and limiting postoperative aspiration. Patients and families will need to engage in intensive postoperative rehabilitation and, potentially, prolonged tracheostomy care to ensure optimal functional outcomes.

Vertical Partial Laryngectomy

The vertical partial laryngectomy (VPL) is an approach focused on lesions originating at the glottic level and is defined by the removal of a portion or the entirety of a vocal fold along with the thyroid cartilage as the deep margin. A vertical transection through the thyroid cartilage is employed to allow for efficient access to the endolarynx. The extent of resection can vary from the simple excision of one vocal fold to as much as five-eighths of the larynx. In its simplest form, removal of one vocal fold can be performed via a midline thyrotomy incision. The term vertical hemilaryngectomy is used to described removal of at least one half of the larynx (Eibling, 2008) (Figure 1–3). Several variations to this procedure have been described with the most extensive resection involving both true vocal folds and one arytenoid.

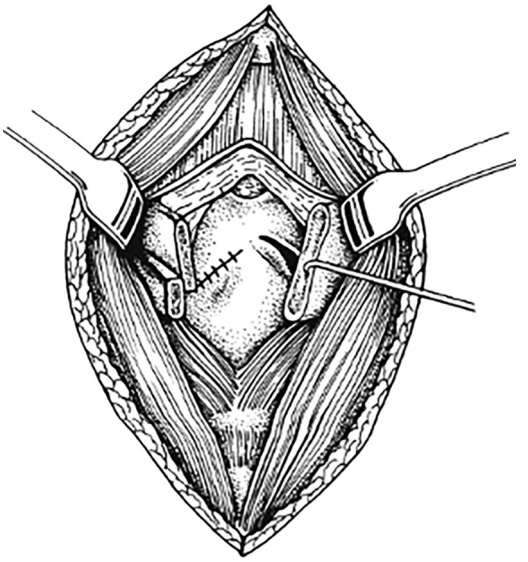

Figure 1–3. Standard hemilaryngectomy. Resection of a tumor involving the anterior portion of the left vocal fold (cross-hatch marks). *Source:* From *The Larynx, Volume I* (pp. 1–932) by Behrman, A. Copyright © 2009 Plural Publishing, Inc. All rights reserved.

Indications and Contraindications of Vertical Partial Laryngectomy

The VPL is a valuable tool for surgeons when patients have tumors that are too large for transoral laser microsurgery and too small for a total laryngectomy. The types of lesions that VPL is commonly utilized for include exophytic T1 cancers of the true vocal folds that involve the anterior commissure or vocal process, cancers of the vocal fold that invade the vocalis muscle but not the thyroid cartilage, and T2 cancers with some extent above or below the vocal fold (Eibling, 2008). Additionally, this procedure can be an appropriate salvage surgery for patients who have persistent tumor burden of the true vocal folds after radiation therapy (Yiotakis et al., 2003). The frontolateral vertical hemilaryngectomy is the most commonly performed vertical partial laryngectomy and is suited for bulky tumors involving the anterior commissure or anterior component of the opposite true vocal fold (Norris, 1958). Contrastingly, the posterolateral vertical hemilaryngectomy is an extension of the vertical hemilaryngectomy for cancers that extend posteriorly to involve the arytenoid mucosa (Som, 1951).

Contraindications for this surgical approach are based on previously reported oncologic outcomes and the rates of local recurrence. This surgical approach should not be considered in patients with extensive cricoid invasion as this is not resected in the standard VPL. Additionally, subglottic extension can be associated with cricoid cartilage invasion, and thus, should caution surgeons toward using this approach (Glanz, 1984). Subglottic extension of no more than 5 mm posteriorly, and 10 mm

anteriorly, is considered feasible by VPL, which is based on reported high local failure rates for subglottic extent beyond these values (Laccourreye et al., 1991). It should be noted that an extended vertical partial laryngectomy, with resection of the superior border of the cricoid cartilage, has been described but carries a higher risk of complications (Biller & Lawson, 1986). Additionally, a relative contraindication for VPL is vocal fold immobility. If vocal fold fixation is secondary to cricoarytenoid invasion VPL should not be performed, whereas, if immobility is secondary to a bulky tumor or superficial thyroarytenoid invasion VPL can be considered feasible (Eibling, 2008; Kirchner, 1977). Based on the reported oncologic results in the literature, vertical partial laryngectomy should not be considered for T3 or T4 glottic carcinoma (Kirchner, 1977).

Operative Technique of Vertical Partial Laryngectomy

The first surgical steps for the vertical partial laryngectomy often involve endoscopic evaluation of the tumor and airway securement with a tracheostomy. A horizontal skin incision is made, taking care to avoid the tracheostomy. After skin flaps are raised inferiorly and superiorly, the thyroid cartilage is exposed. A vertical incision is made in the perichondrium extending from the thyroid notch to the inferior border of the thyroid cartilage. Perichondrial flaps are elevated with the attached strap muscles, with care taken to preserve as much perichondrium as possible. There are a variety of techniques describing the extent of thyroid cartilage that is resected. This will vary with the tumor size and endolaryngeal extent. In the standard vertical hemilaryngectomy, a posterior 3-mm wide strip is preserved on the ipsilateral thyroid cartilage. A midline thyrotomy is made with a saw, drill, or knife, depending on the calcification of the thyroid cartilage. Superiorly, a cut is made along the superior border of the thyroid cartilage and inferiorly a cut is made just above the cricoid cartilage. Care is taken to make the midline thyrotomy at the midline for lesions not crossing the anterior commissure (or 2–3 mm beyond the tumors crossing the anterior commissure). The larynx is entered by cutting through the petiole of the epiglottis. The thyroid cartilages are retracted to open the larynx like a book and expose the lesion. Posteriorly, sharp mucosal cuts are then made through the vocal process or around the arytenoid, depending on the posterior extent of the tumor. The specimen is then removed and oriented for pathologic analysis. Hemostasis is obtained and reconstruction is performed utilizing a variety of reconstructive techniques including strap muscle flaps, false vocal fold mucosal flaps, imbrication laryngoplasty, or epiglottic laryngoplasty (Biacabe et al., 1998; Olsen & DeSanto, 1990; Tucker et al., 1979). The skin is closed over a drain, and a nasogastric tube is placed.

Advantages and Disadvantages of Vertical Partial Laryngectomy

A disadvantage of this technique is that it involves "blind" entry into the larynx and, thus, precise initial entry into the larynx is difficult (Laccourreye et al., 1991). This differs from endoscopic approaches to the larynx that provide surgeons with direct microscopic visualization of gross margins. Contrary to transoral laser microsurgery in which most resections heal by secondary intention, an advantage of this approach is that a variety of reconstructive techniques are available. Postoperatively, patients should expect some degree of permanent hoarseness. However, this can vary depending on the reconstructive technique. More significant hoarseness is observed when no reconstructive technique is employed (Liu et al., 1986). The techniques that have resulted in the greatest vocal function include free mucosal grafts and the epiglottic laryngoplasty, which involves the undermining and transposition of the epiglottis to reconstruct the