Tutorial

A Tutorial of the Current Treatment Modalities and Voice Management in Laryngeal Cancer

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Purpose: The purpose of this tutorial was to provide speech-language pathologists unfamiliar with the rehabilitation of laryngeal cancer a basic understanding of laryngeal cancer and the factors involved in the treatment of the voice.
Conclusion: This tutorial provides an overview of the types and subsites of laryngeal cancer, risk factors, stages and prognosis, and treatment options at these stages. The readers will gain the foundational knowledge necessary to work with this population and a starting point for further study. More research is needed regarding voice outcomes and the benefits of voice therapy in combination with the available laryngeal cancer treatment modalities so that we may better serve these patients.

Speech-language pathologists (SLPs) receive variable information about head and neck cancer in graduate education, continuing education, and clinical practice. New graduates or clinicians unfamiliar with this population often require specialized study to become proficient in diagnosing and treating these patients. This tutorial provides new clinicians or clinicians without a background in head and neck cancer with an overview of laryngeal cancer, current treatment modalities, and voice management in this population.

Treatment of laryngeal cancer has evolved significantly over the past 20–30 years. Prior to the 1990s, laryngeal cancer was commonly treated with a total laryngectomy with or without postoperative radiation. In the 1990s, new research emerged to support less invasive methods that allowed for organ preservation. Radiation, with or without chemotherapy, became central in the treatment of patients with laryngeal cancer, (Al-Sarraf, 2002; McGurk & Goodger, 2000). However, despite preservation of the larynx in these patients, radiation sometimes resulted in severe side effects to laryngeal function (Lazarus, 2009). Therefore, more recent research has focused on preserving function in these patients.

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Recent research on functional outcomes for patients with laryngeal cancer has largely focused on swallowing, since negative swallowing outcomes may result in life-threatening aspiration or suboptimal nutrition/hydration (Hutcheson, 2013; Lazarus, 2009). Comparatively, less has been written about voice outcomes following organ preservation protocols. However, while swallowing is often the priority, voice impacts can significantly reduce quality of life—particularly for individuals who require heavy voice usage for work. This tutorial examines current modalities as they relate to voice therapy and treatment outcomes.

Finally, although organ preservation protocols have made laryngectomies less common, total laryngectomy is still performed in particularly advanced cases, in the event of recurrence, and in the case of a nonfunctional larynx. Therefore, an overview of voice rehabilitation following total laryngectomy is provided as well.

Epidemiology

Over 500,000 new cases of head and neck squamous cell carcinoma (SCC) are reported each year worldwide (Torre et al., 2015). In the United States, laryngeal cancer is the second most common head and neck cancer, with over 13,000 new cases diagnosed annually. An estimated 99,000 people are currently living with laryngeal cancer in the United States. The median age at diagnosis is 65 years, with diagnosis more common in men than in women (at a ratio of

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5:1; National Cancer Institute Surveillance, Epidemiology, And End Results Program, n.d.). The diagnosis results in 36,000 deaths per year, with an overall 5-year survival rate of 60.7% (SEER Cancer Statistics Review; Howlader et al., 2017). However, 5-year survival rates vary depending on stage. Localized cases of laryngeal cancer (confined to the primary site) have a 5-year survival rate of 77%. When nodal spread is present, 5-year survival rate is 45%. Finally, when distant metastasis is present, 5-year survival rate is 34.3% (SEER Cancer Statistics Review; Howlader et al., 2017).

Types and Subsites

Approximately 95% of laryngeal cancers are SCC, which arise from the squamous epithelial lining of the larynx (Tamaki, Miles, Lango, Kowalski, & Zender, 2018). Other pathologies are rare in laryngeal cancer but may include adenocarcinoma, cancers of the minor salivary glands, spindle cell carcinoma, fibrosarcomas, chondrosarcomas, neuroendocrine tumors, and metastatic disease (Tamaki et al., 2018).

Cancer of the larynx can be subdivided by location into three subsites: supraglottic, glottic, and subglottic. Supraglottic cancers account for 32% of laryngeal cancers and are the most aggressive of the three (SEER Cancer Statistics Review; Howlader et al., 2017). They may involve the false vocal folds, arytenoids, and epiglottis and/or aryepiglottic folds. In supraglottic cancer, neck node metastasis is present in approximately 50% of cases on presentation. Due to the degree of nodal metastasis in this population, patients diagnosed with cancers of the supraglottis have a relatively poor 5-year overall survival rate of 40% (Tachibana et al., 2018).

Cancers of the glottis, involving the true vocal folds and/or anterior commissure, account for 51% of laryngeal cancers, making glottic cancer the most common form of laryngeal cancer (Hoffman et al., 2006). The evaluation of presenting hoarseness to diagnose the potential voice disorder often leads to an early diagnosis of glottic tumor, due to its overt nature. The glottic region is characterized by poor lymph drainage, which results in a low risk of nodal metastasis. In glottic cancer, only 20% will have neck node metastasis and 5-year overall survival rates are 60% (Tachibana et al., 2018).

Finally, primary subglottic cancers, which affect the cricoid cartilage and 5 mm of vertical space inferior to the true vocal folds, are very rare. Primary malignancy in this region accounts for only 2% of laryngeal cancer (Tamaki et al., 2018). In contrast to the predominance of SCC in other laryngeal cancer sites, subglottic cancers typically fall into one of three types: adenocarcinoma, mucoepidermoid, or adenoid cystic carcinoma. Prognosis for subglottic cancers varies depending on the type of lesion but is often poor due to difficulties with direct visualization of the region and late identification (Santoro, Turelli, & Polli, 2000).

Risk Factors

Tobacco and alcohol consumption are widely acknowledged risk factors for laryngeal cancer. However, laryngeal cancer may also occur in nonsmokers and nondrinkers. Therefore, several other risk factors have been identified. These include history of neck radiation, family history of cancer, and certain environmental/chemical exposures (Tamaki et al., 2018). Additionally, some research suggests a correlation between laryngopharyngeal reflux disease and laryngeal cancer (Dağli, Dağli, Kurtaran, Alkim, & Sahin, 2004; Lewin et al., 2003). However most studies demonstrating the correlation between laryngopharyngeal reflux and laryngeal cancer have been unable to control for other risk factors (such as alcohol and tobacco); thus, causation cannot be inferred.

Finally, while human papillomavirus (HPV) has clearly been implicated in the recent rise in oropharyngeal cancers (Chaturvedi et al., 2011), a clear link between HPV and laryngeal cancers has not been definitively demonstrated (Hernandez et al., 2014). In recent research, around 21%–25% of laryngeal cancers were found to test positive for HPV 16, 18, or 33 (Hernandez et al., 2014; Kreimer, Clifford, Boyle, & Franceschi, 2005). However, these studies have not been able to control for other risk factors, such as smoking and alcohol use; thus, it is unknown to what extent HPV contributes to the development of laryngeal cancer.

Staging and Prognosis

Staging of laryngeal cancer is performed according to the TNM system (Cancer Staging Manual by the American Joint Committee on Cancer [Amin et al., 2017]), whereby T represents tumor size, N represents number of nodes, and M represents distant metastasis. Early-stage (I, II) laryngeal cancers include T1 or T2 primarily lesions with no nodal or distant metastasis (N0, M0). Advanced-stage (III, IV) laryngeal cancers include T3 or T4 primary lesions, lesions with any nodal spread, or lesions with distant metastasis. Readers are referred to the Cancer Staging Manual for further details and a chart outlining T, N, and M at each stage. Staging is important for providers involved in rehabilitation as it guides curative management and prognosis and therefore informs pre-operative counseling and rehabilitation plans.

Clinical Presentation

Glottic tumors that form on the true vocal folds typically cause early hoarseness or voice changes and are, therefore, often identified in early stages. As a result, an SLP may be the first provider to encounter the patient. When a patient reports persistent hoarseness or vocal changes, the patient should be referred to an otolaryngologist so the larynx may be visualized and any pathology may be identified. Supraglottic and subglottic cancers that do not involve the vocal folds, typically, will not cause hoarseness, and are, therefore, often identified at later stages. Signs/symptoms, which may present with laryngeal cancer at all subsites, include persistent sore throat, chronic cough, odynophagia, ear pain, difficulty breathing, stridor (noise

on breathing), a lump in the neck, loss of appetite, and weight loss (Ward & van As-Brooks, 2014).

Management of Laryngeal Cancer

Treatment of laryngeal cancer may be definitive, concurrent, or adjuvant. Definitive treatment is intended to be the sole treatment utilized to provide a cure. With concurrent treatment, two distinct forms of treatment, that is, chemotherapy and radiation therapy, take place simultaneously. Adjuvant treatment involves administration of one treatment modality followed by another method, such as surgery followed by radiation therapy. Finally, palliative treatment may be offered in the case of malignancies for which a cure is not expected. For example, radiation may be offered with the intent of decreasing the size and functional impact of a tumor to maximize quality of life (Pfister et al., 2006).

The treatment modality selected for each patient depends heavily on not only staging but also lesion characteristics and localization, experience of the treating physician, and functional goals of the patient (Tamaki et al., 2018). The process of determining a patient's treatment plan varies across institutions. In general, the patient typically first consults with physicians who specialize in different treatment modalities to learn about the available options. Taking into account a patient's disease profile and preferences, sometimes a treatment plan may be formed at this time. For more complex cases, a tumor board composed of experts in different treatment approaches may meet to discuss the patient's case to formulate a treatment plan.

Management of Early-Stage Laryngeal Cancer

Radiation

Definitive radiation therapy has been a standard primary treatment modality for early-stage laryngeal cancer for many years. Research has demonstrated 5-year survival rates of approximately 91% for T1 glottic cancer and approximately 88% for T2 glottic cancer treated with radiotherapy (Warner et al., 2014).

Despite the high survival rates offered by radiation therapy in early laryngeal cancer, patients may experience significant early and late toxicities, which adversely impact laryngeal function. Briefly, toxic effects from radiation that may impact swallowing and/or voice include the following:

- Fibrosis: scarring and/or hardening of tissues
- Mucositis: ulceration and inflammation of the mucous membranes
- Decreased sensation
- Xerostomia: dry mouth
- Odynophagia: pain when swallowing
- Dysgeusia: taste changes
- Esophageal stricture: narrowing of the esophagus
- Trismus: reduced opening of the jaw
- Lymphedema: collection of lymph fluid that results in swelling
- Osteoradionecrosis: bone death following radiation
- Neuropathy: nerve damage (radiation-induced in this case).

Some of these effects occur early in the course of radiation and may resolve to a degree with time. Others, such as fibrosis or cranial neuropathy, take longer to develop but may be persistent and progressive. In some cases, a patient may live for years with normal laryngeal function, only to develop swallowing and/or voice problems 50–10 years postradiotherapy (Hutcheson, 2016). Collectively, these toxicities may result in poor voice and swallowing outcomes, tracheostomy tube dependence, gastrostomy tube dependence, and overall suboptimal quality of life.

Although the general focus of this review is on laryngeal cancer treatment as it relates to voice management, radiation toxicities have a disproportionate impact on swallowing function. Therefore, rehabilitation following radiation will typically focus on managing radiation-associated dysphagia. In recent years, intensity-modulated radiation therapy (IMRT) has allowed for conformal fields, so the radiation beam closely fits the area of the tumor, and decreased dosage delivered to healthy surrounding tissues, which in theory should decrease the incidence and severity of radiation toxicities. However, the larynx contains multiple interdependent structures; thus, even with improved delivery, when even one of these critical structures is impacted by radiation, significant impacts on function may occur. Management of radiation-associated dysphagia is complex and requires specialized study; thus, the reader is referred to numerous publications in this area (Hutcheson, 2013, 2016; Hutcheson et al., 2013).

Transoral Endoscopic Laser Microsurgery

A more recent alternative to radiation therapy is transoral laser microsurgery (TLM). In TLM, the surgeon resects the tumor using an endoscopic laser coupled to an operating microscope. In laryngeal cancer, it has been utilized primarily for early-stage glottic tumors, largely due to some research that demonstrates higher rates of 5-year laryngeal preservation and lower rates of complications when compared to radiation (Canis, Ihler, Martin, Matthias, & Steiner, 2015). It has been estimated to allow for both organ preservation and preservation of laryngeal function in 70%–80% of early glottic cancer cases (Silver, Beitler, Shaha, Rinaldo, & Ferlito, 2009). Additionally, TLM is easily repeated in the instance of local recurrence and is the least expensive treatment option, followed by radiation therapy (Silver et al., 2009). If adjuvant radiotherapy is not required, patients avoid radiation toxicities. Some preliminary research has even suggested TLM with or without radiation may be a viable alternative to standard chemoradiation treatment for select patients with more advanced laryngeal cancer (Canis et al., 2014; Hinni et al., 2007).

Transoral Robotic Surgery

With transoral robotic surgery (TORS), surgeons use the DaVinci surgical robot to perform transoral laser excision of the tumor. With the DaVinci surgical system, the patient's mouth is retracted and the surgeon guides a robotic surgical instrument and a three-dimensional view camera to resect and suture the site. While TORS is still a developing treatment modality for laryngeal cancer, early research suggests favorable results in both survival and functional outcomes. Currently, TORS has the strongest support for its use in supraglottic cancers (Dziegielewski, Kang, & Ozer, 2015; Mendelsohn, Remacle, Van Der Vorst, Bachy, & Lawson, 2013; Olsen et al., 2012; Ozer et al., 2013). There is also a small but growing number of studies reporting successful glottic TORS and even total laryngectomy (Kayhan, Kaya, & Sayin, 2012; Lallemant et al., 2013; Smith, Schiff, Sarta, Hans, & Brasnu, 2013). However, in general, these procedures are often prohibited by lack of access to deeper laryngeal structures due to the size and flexibility limitations of the robotic instrumentation. It has been theorized that, over time, as robotic instrumentation is improved, TORS may become as accepted as TLM due to the advantages it offers, namely, the magnified-angled three-dimensional view, instrument movements that mimic natural hand movement, and the ability to suture in deep structures (Dziegielewski et al., 2015; Ozer et al., 2013). TORS offers functional benefits as well. Previously, patients with supraglottic cancer faced the choice of extensive open surgical procedures—associated with enteral feeding, prolonged tracheostomy, and long hospital stays—or chemoradiation—associated with long-term radiation toxicities. Conversely, TORS has demonstrated overall survival rates similar to other methods, preservation of function, and avoidance of prolonged tracheostomy and enteral feeding (Mendelsohn et al., 2013).

Management of Advanced-Stage Laryngeal Cancer

Chemoradiation

Prior to the 1990s, partial or total laryngectomy via open surgery was the standard primary treatment for laryngeal cancer. Two studies—the Veterans Affairs Larynx Preservation study and the Radiation Therapy Oncology Group (RTOG) 91-11 study—are credited with supporting the shift toward organ preservation, as together, they demonstrated that primary chemoradiation is a viable alternative to extensive surgeries (Forastiere et al., 2013; Wolf et al., 1991). In 1991, the Veterans Affairs Larynx Preservation study compared overall survival outcomes of patients treated with induction chemotherapy and radiation to total laryngectomy with adjuvant radiation. Overall, the survival rates between the two groups were equal after 50 months (Wolf et al., 1991). The RTOG 91-11 study provided additional evidence that concurrent chemoradiation provided better survival outcomes than induction chemotherapy with adjuvant radiation, or radiation alone.(Forastiere et al., 2003, 2013; Wolf et al., 1991). Following the positive long-term results from RTOG 91-11, the study's treatment protocol of concomitant cisplatin and radiotherapy became the gold standard for treating advanced cancers of the larynx. With this protocol, patients receive a total of 70 gray (Gy), delivered in 35 treatments, and concurrently receive cisplatin on certain days of RT treatment.

The most common modern radiation delivery method—IMRT—delivers the maximum dosage of 70 Gy only to the tumor region, while gradually attenuating the dose delivered to surrounding healthy tissues. IMRT represents a vast improvement over radiation delivery methods prior to the 1980s, whereby 70 Gy was delivered indiscriminately to a wide field surrounding the tumor. Unfortunately, however, even with this graduated dosing, the surrounding healthy tissue will still be negatively impacted by the radiation, resulting in negative impacts to swallowing and voice function. Indeed, RTOG 91-11 reported high rates (33.3%) of severe late toxicities in patients treated with concomitant chemoradiation (Forastiere et al., 2013).

Total Laryngectomy

With a total laryngectomy, the patient's entire cartilaginous larynx is removed, including the epiglottis, the hyoid bone, the extrinsic strap muscles, and all membranous and muscular attachments. If nodal metastasis is present, radical neck dissection, in which the affected lymph nodes are removed, will also be performed. The trachea is redirected out in a surgically created stoma placed just superior to the sternal notch. With this redirection, the trachea is completely separated from the esophagus, and the stoma becomes the patient's sole airway.

Laryngeal cancer that fails to respond to chemoradiation may be treated with total laryngectomy or total laryngopharyngectomy. In some cases, a total laryngectomy may also be performed as an elective procedure when a patient's larynx is rendered nonfunctional from prior radiation. In some cases, a primary total laryngectomy may also be performed for especially advanced lesions.

The removal of the patient's larynx and redirection of airflow result in the loss of laryngeal voice, thereby making the acquisition of alaryngeal voice a high priority for these patients in rehabilitation. The separation of the trachea and esophagus, in theory, makes aspiration impossible; however, it may still occur in the presence of a fistula or a leaking tracheoesophageal prosthesis. Additionally, even if aspiration is prevented, dysphagia may still occur, particularly in patients who have had prior radiation (Arenaz Búa, Pendleton, Westin, & Rydell, 2018).

Voice Rehabilitation in Patients With Laryngeal Cancer

Voice Rehabilitation After Radiation/Chemoradiation

As previously stated, rehabilitation after radiation will generally focus on swallowing, as radiation-associated

dsyphagia can be life-threatening and significantly reduce quality of life. Pretreatment swallowing exercises have been shown to have a positive impact on swallow function and swallowing-related quality of life. This finding has prompted clinicians to implement swallowing exercises and education pretreatment in their patients (Carroll et al., 2008; Kulbersh et al., 2006). However, radiation may also induce voice changes that negatively impact quality of life and warrant management by a speech-language pathologist. Fung et al. (2005) administered the Voice-Related Quality of Life Measure to healthy volunteers, patients who underwent chemoradiation, and patients who underwent total laryngectomy. The study reported a Voice-Related Quality of Life Measure mean (*SD*) score for healthy participants ($n = 21$) of 98.0 (3.9), while patients who had received chemoradiotherapy ($n = 37$) had a mean (*SD*) score of 80.3 (20.8).

Patients with laryngeal cancer often exhibit hoarseness at pretreatment; thus, it can be difficult to determine whether a patient's poor vocal quality results from radiation or the primary damage caused by the tumor. Regardless, the end result is the same: patients with varying degrees of roughness, breathiness, and strain, as well as abnormal perturbation values when the voice is evaluated acoustically (Karlsson, Bergström, Ward, & Finizia, 2016). Radiation-associated voice changes are thought to result primarily from fibrotic stiffening of the vocal folds, inflammation of the vocal folds and adjacent soft tissue, and postradiotherapy vocal fold edema (Lau et al., 2012). Maladaptive compensatory vocal behaviors such as ventricular phonation may also contribute to diminished vocal quality (Karlsson et al., 2016). Despite the vocal changes these patients experience, several studies have reported superior voice outcomes for patients treated with radiation, as compared to TLM (Krengli et al., 2004; Oridate et al., 2009; Rydell, Schalén, Fex, & Elner, 1995).

A small number of studies have demonstrated that voice therapy improves patient-reported outcomes following radiotherapy (Karlsson et al., 2016; Karlsson, Johansson, Andréll, & Finizia, 2015; Tuomi, Andréll, & Finizia, 2014; van Gogh et al., 2006; van Gogh, Verdonck-de Leeuw, Langendijk, Kuik, & Mahieu, 2012). Some limited evidence of positive acoustic changes has also been reported (Tuomi et al., 2014; van Gogh et al., 2006, 2012). Descriptions of therapeutic exercises are somewhat general in the research, but this may be unavoidable since voice exercises typically must be individualized to best address the patient's symptoms. Generally, techniques incorporated have included diaphragmatic breathing, posture and phonation exercises, coordination of breathing and phonation, control and variation of pitch, relaxation, and vocal hygiene (Tuomi et al., 2014). Several treatment studies have referenced a protocol outlining the session-by-session progression of treatment, provided in Tuomi et al. (2014). Dosage and duration of treatment have not been consistently reported; however, positive patient-reported outcomes have been reported in little as ten 30-min sessions over a 10-week period in one study (Karlsson et al., 2015).

Overall, more research is needed in this area to clearly define the benefits and ideal timing of voice rehabilitation in this population. However, in general, the research available supports providing voice rehabilitation post-radiation to improve patient-reported outcomes.

Voice Rehabilitation After Endoscopic Surgery

TLM is currently the primary alternative to definitive radiation for patients with early-stage glottic cancer and supraglottic cancer. Several studies have compared the voice outcomes between these two treatments. Perceptually, there is some evidence to suggest TLM may result in more breathy quality of voice, whereas radiation may more commonly yield a mix of roughness, breathiness, and strain (Karlsson et al., 2016; Sjögren et al., 2008). However, when comparing overall voice outcomes following one approach versus another, the research is mixed. Some studies have found overall better voice outcomes following radiotherapy (Krengli et al., 2004; Rydell et al., 1995). By contrast, Peeters et al. (2004) found more voice-related problems following radiation than TLM but recommended surgery only for superficial tumors, where a mucosal wave is still present. Still, a meta-analysis from Cohen, Garrett, Dupont, Ossoff, and Courey (2006) found that both methods provide comparable levels of voice handicap in patients with T1 glottic cancer.

Little research is available concerning voice therapy following TLM for early glottic cancer. One study of patients treated with either radiation or TLM demonstrated improvements after voice therapy in the Voice Handicap Index, noise-to-harmonics ratio, and jitter. Therapy consisted of a maximum of 24 voice therapy sessions, with each lasting 30 min twice per week. Therapy activities were individualized based on patient needs (van Gogh et al., 2006). However, because this study also included patients treated with radiation without stratification of groups based on treatment type, the benefits of voice therapy for TLM patients cannot be determined from this study alone. Additional research on the benefits and types of voice therapy to be utilized following TLM are needed to support optimal voice outcomes in these patients.

Finally, since TORS for laryngeal cancer is still mostly confined to the supraglottic region, there is little research regarding voice outcomes and no published studies investigating voice therapy following TORS, as the preservation of the glottis may be expected to result in relative preservation of voice quality.

Voice Rehabilitation After Total Laryngectomy

The SLP is an integral member of a laryngectomy patient's team and will be significantly involved both preoperatively and postoperatively. This section provides only a brief overview of the role of the SLP with laryngectomy patients. Extensive study and training are required to competently serve this population, particularly those patients who will undergo Tracheoesophageal puncture. The reader

is referred to numerous publications on rehabilitation of the laryngectomy patient for further study.

Pre-operative Role of the SLP

During the pre-operative period, the laryngectomy patient should meet with an SLP for counseling and education. Family should be included in the pre-operative appointment to provide additional support and receive caregiver education. During this session, the SLP should obtain information about the patient's baseline functioning for speech, cognition, hand motor skills, and vision in order to make an informed presentation on the alaryngeal modes of communication available to the patient. In addition, environmental factors such as family and social support as well as vocational needs and supports should be taken into account for successful rehabilitation. Education should focus on dispelling misconceptions and alleviating fear. Specifically, most patients are chiefly concerned with the loss of voice associated with laryngectomy. Thus, the pre-operative appointment should focus on providing education on the available alaryngeal voicing options: the electrolarynx, esophageal speech, and tracheoesophageal prosthesis.

Electrolarynx

An electrolarynx is a mechanical, external sound source that the patient places either intra-orally or against the neck to create a vibratory sound signal. The electrolarynx provides an easy-to-learn means of verbal communication with minimal demands for device maintenance. As a result, this method is currently the most predominant means of alaryngeal speech worldwide, despite advances in other forms of alaryngeal speech (Xi, 2010). Even patients who choose a different form of primary alaryngeal speech are advised to own and maintain an electrolarynx as a backup or emergency form of communication (Hutcheson, 2016). The negatives of the electrolarynx are that the sound produced has an electronic quality that some speakers and listeners do not prefer, and the devices can be a costly upfront expense, depending on the patient's insurance coverage.

Esophageal Speech

With esophageal speech, the patient learns how to draw ambient air from the oral cavity into the esophagus, whereby it vibrates the pharyngoesophageal segment to generate a sound source. This method requires no maintenance; however, it can be challenging and time consuming to learn. In some studies, it has been estimated that less than 30% of patients, who attempt to learn it, actually acquire esophageal speech (Blom, Singer, & Hamaker, 1986). For a patient to become an effective esophageal speaker, an estimated 4–12 months of therapy and daily practice are required. Additionally, because the speaker does not draw air from the lungs, the speaker produces sound with less-than-ideal volume and durability. Often, esophageal speakers choose to use a portable vocal amplifier so they may be heard in noisy environments (Olszański, Gieroba, Warchoł, Morshed, & Gołabek, 2004).

TEP

In the United States, TEP is generally regarded as the gold standard for alaryngeal voice restoration after laryngectomy. With TEP, a puncture is created between the trachea and esophagus, in which a one-way prosthetic device is inserted. The patient then occludes the stoma, and exhaled air is redirected through the prosthesis whereby it travels through the esophagus to vibrate the newly created vibratory segment. When successful, TEP provides relatively quick restoration of the voice and a nonmechanical voice quality. Due to advances in technology and availability of information, patients are often familiar with TEP and may specifically request it in the pre-operative appointment. It is the SLP's role to provide all the information for and against TEP candidacy to the patient and surgeon. Given this information, the patient's surgeon ultimately makes the final decision.

For the laryngectomy patient who undergoes or wishes to undergo TEP, the SLP plays an integral and long-term role. First and foremost, the SLP will often be heavily involved in the patient's decision to undergo TEP. In recommending a TEP, the SLP considers patient psychosocial factors, medical history, oncologic history, the extent of the planned surgery/reconstruction, and any planned postoperative radiation. The SLP also makes a recommendation for timing of the TEP, which may be primary—at the time of laryngectomy—or secondary—typically 3–12 months postsurgery.

Although TEP voice is the hoped-for outcome for many patients, it requires a significant time and financial commitment from the patient and carries a risk of complications. Intact cognition and a willingness to embrace these responsibilities is a prerequisite for getting a TEP. The prosthesis must be changed regularly, as the materials comprising it degrade over time with exposure to stomach acid in the esophagus. Although earlier estimates suggested replacement may be necessary every 4–6 months, more recent estimates have suggested replacement may be required as often as every 2 months (Lewin, Baumgart, Barrow, & Hutcheson, 2017). Typically, these replacements must be done by the SLP and, thus, require an office visit. Many patients will never manage the TEP independently and thus must be able to commit to making these regular office visits for their entire lifetime. In the event of complications, further surgeries may even be required. Thus, patients must be financially stable and have access to an SLP with expertise in TEP management.

A discussion of all the elements of TEP management is beyond the scope of this review; however, one major potential complication worth discussion is enlargement of the TE fistula. Enlargement of the TE fistula leads to the inability to use the voice prosthesis, and a risk for persistent leakage around the TEP, and therefore aspiration. Several factors, such as tissue changes secondary to radiation, diabetes, smoking, nutrition, acute infection, or tumor recurrence, have been associated with causing enlargement of the fistula; however, the nature of their contribution is yet to be completely

understood (Hutcheson, Lewin, Sturgis, Kapadia, & Risser, 2011).

Postoperative Role of the SLP

Postoperatively, the SLP is responsible for placing a filtration system, providing education on stoma and filtration management, and beginning electrolarynx training.

Immediately following a laryngectomy, the patient will have a tracheostomy tube stenting open the stoma. With approval from the surgery team, the SLP will replace the tracheostomy tube with a filtration system: Most commonly, this consists of a laryngectomy tube (a soft, silicone tube) such as the Provox LaryTube and a heat and moisture exchange filter. Filtration is of utmost importance in a laryngectomy patient. In the anatomically normal upper airway, the turbinates in the nose warm, humidify, and filter the air that enters the airway. In a laryngectomy patient, the nose is completely separated from the airway and can no longer perform this function. A heat and moisture exchange filter warms, humidifies, and filters the air, preventing mucus from accumulating and hardening into an airway-obstructing mucus plug. Once established, the SLP then trains the patient and caregivers in maintenance of the filtration system.

During the postoperative period, it is best practice to issue the patient an electrolarynx and begin instruction in basic electrolarynx communication. While some patients may eventually undergo TEP, the electrolarynx will serve as a backup method of communication should the TEP begin to leak or otherwise become rendered nonfunctional. Therefore, establishing competence in electrolarynx communication is essential. Instruction at this stage focuses on appropriate placement of the device, overarticulation and phrasing, and device maintenance.

Conclusion

Treatment of patients with laryngeal cancer has undergone substantial changes over the past 20–30 years and will continue to evolve as technology improves. This tutorial provides an overview of current treatment modalities and voice management for patients with laryngeal cancer; however, regular ongoing study is necessary to appropriately serve these patients as technology and treatment advance. More research is needed regarding voice outcomes and the benefits of voice therapy following each of the available laryngeal cancer treatment modalities so that we may better serve these patients.

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