



Lessons on Laryngectomy: The Basics

With contributions from Kelly Salmon SLPD, CCC-SLP, BCS-S, CLT-LANA

Introduction: This resource is designed to give you a basic working knowledge of the anatomic changes that occur as a result of a total laryngectomy surgical procedure as well as to provide an overview of the fundamental changes in breathing, communication, and swallowing that are present post-total laryngectomy. Please refer to the web resources, as cited, for illustrations of the anatomy discussed within this document.

Anatomic Changes Post-Total Laryngectomy:

Detailed illustrations of the anatomy pre- and post-total laryngectomy can be accessed and downloaded free of charge on InHealth Technology's website, within the Resources section. These resources are useful for both clinician and patient/family education. You can also use them to follow-along with the descriptions of the anatomic changes in the following paragraphs.

Educational Materials:

https://www.inhealth.com/category_s/72.htm

Illustration of Anatomy Pre-Laryngectomy

<http://www.inhealth.com/v/vspfiles/pdf/sketchpad/Pre-Laryngectomy.pdf>

Illustration of Anatomy Post-Laryngectomy

<http://www.inhealth.com/v/vspfiles/pdf/sketchpad/Post-Laryngectomy.pdf>

We should begin this discussion by briefly talking about who undergoes a total laryngectomy. Typically, it is recommended that individuals with advanced-stage laryngeal cancer undergo total laryngectomy as the definitive treatment for their cancer. Individuals who unsuccessfully undergo chemoradiation with the intent of curing their laryngeal cancer may also ultimately have a salvage TL if the CRT was not successful in curing the disease. In addition, individuals who have previously been treated for head and neck cancer that then have recurrent disease that further compromises their laryngeal function may also undergo a TL. Finally, some individuals undergo a functional laryngectomy. This is when a TL is performed in the absence of active disease. This could be an individual who has a diagnosis of dysfunctional larynx - rendering their larynx non-function for breathing, speaking, and/or swallowing - either due to the late effects of previous head and neck cancer treatment, or in some cases due to profound dysphagia as a result of a neurologic insult.

When considering the anatomic changes resulting from total laryngectomy, it is first important to appreciate the structures involved in the processes of speech, voice, respiration, and swallowing. In the illustration showing the typical anatomy pre-laryngectomy, we should pay attention to several features. Most notably, in the normal system, there is a distinct relationship between our respiratory system and our upper gastrointestinal tract involved in the process of deglutition, or swallowing.



Lessons on Laryngectomy: The Basics

Normal human anatomy consists of a shared space, also known as the pharynx, to allow for the efficient exchange of air between the upper respiratory tract (consisting of the nasal passages, naso-, oro-, and hypopharynx) and the lower respiratory tract (trachea, bronchi, and lungs) for the purposes of sustaining adequate ventilation and to allow for the production of voice. In addition, the process of deglutition is accomplished via transport of foods and liquids from the oral cavity to the esophagus by way of the pharynx.

The relationship between the airway and the pharynx is complex in that we must be able to adequately protect our airway during the process of swallowing in order to prevent food and liquid from entering into our airways. When this process is working as it should, it is very efficient and largely successful. Granted, we all have something 'go down the wrong pipe' on occasion, but otherwise our swallowing system is highly effective and accurate nearly all the time.

In the illustration of the normal anatomy, pay attention to the area within the dotted lines, labeled as larynx. It is the structures within this box that are removed during a total laryngectomy procedure. The structures that are removed include the: the hyoid bone, the epiglottis, the vocal folds (true and false), the thyroid and cricoid cartilages, and a few rings of the tracheal cartilage.

In addition, a total laryngectomy procedure may also include removal of a portion of the pharyngeal wall (pharyngectomy), neck dissection (usually bilateral), or a partial or total thyroidectomy. In some more advanced cases, partial or total glossectomy may also be part of the surgical resection depending on the spread of the disease. For detailed information regarding the total laryngectomy procedure, I would encourage you to review the Iowa Head and Neck Protocols on total laryngectomy, available online at: <https://medicine.uiowa.edu/iowaprotocols/total-laryngectomy>.

Let's next review the typical presentation of the anatomy post-total laryngectomy (refer to the InHealth illustration of post-laryngectomy anatomy). The most important thing to take note of is the surgical separation of the airway and the pharynx/esophagus. The separation of these structures will result in significant changes in breathing, communication, and swallowing moving forward. These changes will be described in further detail in the following paragraphs.

In addition to these broad anatomic changes, we must also take into consideration whether the pharyngeal defect left after removal of the larynx is closed using a primary closure technique, where there is enough native tissue remaining to reconstruct the pharynx versus reconstruction of the pharynx to achieve closure via the harvesting of tissue from another area of the body - most commonly the thigh, but sometimes from the chest (pectoralis), the forearm, the shoulder (scapula), or intestine (jejunum). The type of closure will have an impact on swallowing function and may also impact candidacy for tracheoesophageal puncture in the future.



Lessons on Laryngectomy: The Basics

Finally, it is important to consider additional tissue changes that may occur if the individual undergoes radiation treatment following their total laryngectomy. Individuals may experience both acute- and later radiation associated toxicities such as xerostomia, mucositis, edema, pain, lymphedema and fibrosis. The tissue changes can impact success with both communication and swallowing function.

Changes in the Respiratory System:

When it comes to the respiratory system, let's refer to the illustration on page 5 of this InHealth resource: https://www.inhealth.com/v/vspfiles/pdf/brochures/Total_Laryngectomy_Brochure.pdf.

In the illustration, we can see that during exhalation, airflow typically travels from the lower respiratory system (again, the lungs, bronchi, and trachea) through the vocal folds, and upwards through the upper respiratory tract, including the pharynx (the hypo-, oro-, and nasopharynx) and the nasal cavity. It is this outflow of air that allows for the production of voice through creating vibration of the true vocal folds, to allow us to cough, clear our throat, blow our nose, or blow out a candle.

For the process of inspiration, we can trace the airflow in the opposite direction. Air from the ambient environment is inhaled through the nasal passages, where it undergoes a process of filtration by the mucous membranes and cilia that line the tortuous nasal passages. As the air continues to move through the nasopharynx, oro- and hypopharynx, it is also humidified (moisture in the pharynx is added to the inhaled air) and it is heated, or warmed to near-body temperature (~98 degrees) so that it is optimized for delivery to the lungs. Keep this information in mind as we talk about respiration after TL.

Following TL, the lower respiratory tract, the trachea specifically, ends at the neck, where it forms a stoma, or opening, along the inferior portion of the anterior neck. All air exchange will now bypass the upper respiratory tract and inhalation and exhalation will occur directly from the ambient environment directly through the trachea and into the lungs. As you can imagine, loss of airflow through the upper airway on its way to the lungs can have far-reaching effects. Without the upper airway filtering, humidifying, and warming the air before it reaches the lungs, there can be significant irritation of the trachea and the lungs which then leads to an increase in mucous production and potentially airway infections.

Thankfully, there are products available to individuals post-TL to help restore the homeostasis of the lower respiratory tract. Heat and moisture exchange devices, or HMEs, are cassettes with foam filters they help to take on the functions that would normally be accomplished by the nasal cavity and the pharynx. The foam inserts within the HMEs are treated with a calcium chloride (salt) solution and function to filter the inspired air and to trap heat and moisture on exhalation so that the air that is subsequently inhaled will be filtered, humidified, and warmed much closer to body temperature (Ackerstaff et al., 2003; Bień et al., 2010). As a result, we are able to achieve a state of healthy mucous production and clearance which promotes overall pulmonary health (Bień et al., 2010). HMEs can, and ideally should, be used starting in the immediate post-operative phase. There are several options for placement of an HME -- they can be fitted within laryngectomy tubes (LaryTubes), laryngectomy buttons (LaryButtons), or within an adhesive housing.



Lessons on Laryngectomy: The Basics

Effects of Total Laryngectomy on Communication Function

Please refer to the illustrations contained within InHealth's Total Laryngectomy Brochure for this section (https://www.inhealth.com/v/vspfiles/pdf/brochures/Total_Laryngectomy_Brochure.pdf).

When it comes to total laryngectomy and removal of the larynx, the loss of the voice (as the patient knows it) and the ability to communicate with ease is often challenged. Fortunately, there are several methods of voice restoration available to the individual post-TL.

The immediate postoperative phase:

In the acute postoperative phase, communication may occur via low-tech means of alternative communication. For example, individuals may communicate their needs using writing (pencil & paper, dry erase boards, Boogie boards), gesturing, mouthing words, a basic communication board, or through use of a text-to-speech app on their smartphone or tablet.

Next steps: The Electrolarynx/Artificial Larynx

Typically, the first tool used for voice restoration, as soon as 1-2 days postoperatively in most cases, is an electrolarynx (EL), or artificial larynx (AL). The EL functions as a sound source to replace the sound created by the vibration of the vocal folds during normal phonation. It can be positioned along the lateral neck, the submental space, on the cheek, or within the mouth using an intraoral adapter. Immediately postoperatively, the most common placement is via use of an intraoral adapter or on the cheek as the incisions within the anterior and lateral neck are still fresh and in the early stages of healing. Over time, EL training focuses on three core practice areas: a) consistent and accurate placement of the device, b) on/off timing of the sound source, and c) training the patient in articulation strategies and compensations such as overarticulation and phrasing. Many individuals become quite proficient in communicating with an EL; however, for many others, the 'unnatural' sound quality of the EL is off-putting, or their anatomy makes it difficult to become intelligible through use of the EL. It should be noted that individuals who have had a TL should always have an EL on hand, even if it serves as a backup to other methods of communication such as esophageal speech or tracheoesophageal speech.

Esophageal Speech

Next, we have esophageal speech. Esophageal speech is the most "low tech" of the post-TL communication options; however, it can be the most difficult for many individuals to learn to become proficient. In some, their anatomy will not allow for adequate injection of air into the esophagus by using the back of the tongue to push the air into the neopharynx and esophagus.



Lessons on Laryngectomy: The Basics

When done successfully, esophageal speech sounds very much like tracheoesophageal voicing achieved with a voice prosthesis; however, it tends to be much more “choppy” due to the frequent need to push more air into the esophagus. An easy way to mimic the esophageal speech experience is to see if you can belch on command. The process to belch on command is very similar to what we instruct a laryngectomee to do. Anecdotally, I have found that if individuals report that they were never able to belch on command prior to surgery, then tend to have a very difficult time achieving esophageal speech.

Tracheoesophageal Voice Prosthesis

Finally, we have tracheoesophageal voicing, which is achieved through diversion of air from the trachea into the esophagus through a voice prosthetic that works as a one-way diverter valve. Voice prostheses can be placed in a primary fashion, meaning that they are placed at the same time as the total laryngectomy procedure, or in a secondary fashion where they are placed as a secondary procedure, typically occurring approximately 3+ months post-operatively. Most facilities puncture in a secondary fashion in order to allow for a full candidacy work-up prior to deciding to proceed with the puncture procedure. During these candidacy assessments, completed by the SLP, an individual’s cancer history, surgical history, medical history, swallowing status, and psychosocial support system, and financial means are evaluated and discussed. Even if a patient meets the candidacy criteria, it is ultimately up to the patient to decide whether or not they would like to proceed with placement of the voice prosthesis.

Voice prostheses are often considered the “goal” or the “gold standard” for many individuals going into TL surgery. Their H&N surgeons will often show videos of past patients who are successful VP users in the pre-operative phase. As a result, many individuals hang their hopes on a voice prosthesis solving their communication difficulties. However, as the SLP, it is our role to evaluate candidacy in order to prepare the patients for the possibility of non-success with the voice prosthesis. For some individuals, voice prostheses can be amazing when they work as intended and an ongoing (and expensive) problem-solving challenge for others.

Swallowing Post-Total Laryngectomy

Please refer to the illustrations contained within InHealth’s Total Laryngectomy Brochure for this section (https://www.inhealth.com/v/vspfiles/pdf/brochures/Total_Laryngectomy_Brochure.pdf).

When we think of TL, swallowing function does not always come to mind first. Most SLPs learn, or hear, that swallowing function should be “normal” after laryngectomy, that “laryngectomees” cannot aspirate after their surgery, and that dysphagia is a rare complication post-laryngectomy. Let’s address each of these myths in turn. . .



Lessons on Laryngectomy: The Basics

1) For many clinicians and patients, the expectation is that swallow function will be relatively “normal” after surgery. Unfortunately, this is not always the case, for several reasons. Swallowing efficiency is often affected post-TL, with estimates of dysphagia ranging from 17-70% (Balfe et al., 1982; Maclean et al., 2008). Common causes for dysphagia post-TL are disorders that impact pharyngeal clearance, such as: a) reduced pharyngeal pressures, b) stricture, c) structural difference such as pseudoepiglottitis or pseudodiverticulum, d) issues within the P-E segment, and e) xerostomia.

2) When it comes to aspiration, individuals can experience aspiration post-TL, contrary to the usual thought process. There are two main conditions under which an individual can experience aspiration post-TL. The first situation is in the presence of a fistula. Fistulas are common in individuals post-TL, particularly in those undergoing reconstruction with free flap harvests, or those treated previously with radiation or chemoradiation therapy. The other scenario in which an individual post-TL can experience aspiration is with malfunction of a voice prosthesis. With voice prosthesis malfunction, there is typically leakage of liquid through or around the prosthesis directly into the airway.

3) Dysphagia can be quite common post-TL due to the structural and functional impairments mentioned previously (Landera et al., 2010). Dysphagia is a common complaint in individuals post-laryngectomy particularly when the defect has been reconstructed via harvesting of tissue from another part of the body. The key is that the flap tissue is used to create a new pharynx, or neopharynx. The neopharynx is constructed using tissue that is harvested from elsewhere and is therefore is not sensate or able to produce pharyngeal contraction as the native musculature of the pharynx was able to do pre-operatively. When explaining the function of the neopharynx, it can be described as adynamic, meaning that there is no movement in this area. Instead, it acts as a tube, or a funnel to assist with the transport of the food and liquid into the esophagus in a purely passive manner. As a result, patients will commonly report feelings of food ‘getting stuck’ in the throat. In the absence of structural barriers, patients often need to use compensatory strategies such as alternating solids and liquids, taking small bites, or adding extra moisture to their food (extra sauce, extra gravy, extra butter/mayo, etc.) in order to facilitate passage through the nasopharynx.

4) Gastroesophageal reflux can be a common complaint in individuals post-total laryngectomy. According to Mannelli et al (2018), up to 40% of individuals post-total laryngectomy experienced a pathological number of reflux episodes in the upright position. The impact of reflux can be significant in individuals post-laryngectomy, particularly when it comes to the potential formation of fistulas post-operatively and the device life of tracheoesophageal voice prostheses (Graville et al., 2019; Lorenz et al., 2010). Management of gastroesophageal reflux in individuals post-total laryngectomy mirrors traditional management through behavioral strategies and medications.



Lessons on Laryngectomy: The Basics

References

- Ackerstaff, A. H., Fuller, D., Irvin, M., MacCracken, E., Gaziano, J., & Stachowiak, L. (2003). Multicenter study assessing effects of heat and moisture exchanger use on respiratory symptoms and voice quality in laryngectomized individuals. *Otolaryngology -- Head and Neck Surgery*, *129*(6), 705-712.
- Balfe, D. M., Koehler, R. E., Setzen, M., Weyman, P. J., Baron, R. L., & Ogura, J. H. (1982). Barium examination of the esophagus after total laryngectomy. *Radiology*, *143*, 501-508.
- Bieñ, S., Okła, S., van As-Brooks, C., & Ackerstaff, A. (2010). The effect of a heat and moisture exchanger (Provox® HME) on pulmonary protection after total laryngectomy: A randomized controlled study. *European Archives of Oto-Rhino-Laryngology*, *267*(3), 429-435. doi:10.1007/s00405-009-1018-4
- Graville, D. J., Palmer, A. D., & Bolognone, R. K. (2019). Voice restoration with the tracheoesophageal voice prosthesis: The current state of the art. In *Clinical care and rehabilitation in head and neck cancer* (pp. 163-187). Springer.
- Landera, M. A., Lundy, D. S., & Sullivan, P. A. (2010). Dysphagia after total laryngectomy. *SIG 13 Perspectives on Swallowing and Swallowing Disorders (Dysphagia)*, *19*(2), 39-44. doi:10.1044/sasd19.2.39
- Lorenz, K. J. M. D., Grieser, L., Ehrhart, T., & Maier, H. M. D. (2010). Role of reflux in tracheoesophageal fistula problems After Laryngectomy. *The Annals of Otology, Rhinology & Laryngology*, *119*(11), 719-728.
- Maclea, J., Cotton, S., & Perry, A. (2008). Post-laryngectomy: It's hard to swallow. An Australian study of prevalence and self-reports of swallowing function after total laryngectomy. *Dysphagia*, *24*(2), 172-179.
- Mannelli, G., Santoro, R., Segala, F., Surrenti, E., & Gallo, O. (2018). Gastro-pharyngeal reflux and total laryngectomy. Increasing knowledge about its management. *American Journal of Otolaryngology*, *39*(2), 127-132. doi:<https://doi.org/10.1016/j.amjoto.2017.12.010>