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COMPARING THE EFFICACY OF VOICE RESTORATION SPEAKING OPTIONS FOLLOWING LARYNGECTOMY

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The objective of this research paper is to identify the efficacy of speech rehabilitation options after total laryngectomy by comparing the currently available alaryngeal speaking techniques, with increased focus on tracheoesophageal puncture. It will begin by supplementing readers with information regarding normal anatomy and physiology required for speech production, types of laryngeal cancers, anatomical changes resulting from laryngeal cancers, and treatment options that can be implemented in order to help preserve the ability to speak. Next, there will be descriptions of the current available alaryngeal speaking options for laryngectomized patients. The advantages and disadvantages of these options will be compared and contrasted. Additional emphasis will be placed on tracheoesophageal puncture with supporting research that lends credence to the preferred use of this speech rehabilitation option over others in a higher number of patients following total laryngectomy. In conclusion, an overview pertaining to speech-language pathologist's (SLPs) roles working with laryngectomized patients will be presented.

Typical Process for Speech

In order to understand abnormal and alternative speech after laryngectomy, it is imperative to become aware of the natural anatomical and physiological functioning necessary for typical speech production. Production of voice and speech is a natural part of human existence, allowing functional communication to occur on a regular basis. Having the ability to maintain this necessary function is often taken for granted. When head and neck cancer develops, interruptions to natural speaking may occur, causing drastic changes in a person's life (Keith & Thomas, 1996). Speaking is a dynamic process that involves proper coordination between specific structures and their functions

in order to create adequate speech. Reviewing the importance of anatomical structures and the breath support needed to produce speech assists in the understanding of how the changes following laryngectomy affect a person's ability to speak (Keith & Thomas, 1996).

There are four primary systems required for sufficient speech production that include the respiratory system, the phonatory system, the resonatory system, and the articulatory system (Seikel, King, & Drumright, 2005). In order to produce voice, the human body relies on a continuum of adequate breath support within the lungs that travels through the phonatory system. Major structures that make up the respiratory system include the lungs, diaphragm, rib cage, and trachea, where airflow is initiated for a speech act (Seikel et al, 2005). Natural speech is accomplished by the source of energy and the source of voice which include respiration and phonation (Seikel et al., 2005). Speaking is initiated when air travels from the lungs up through the trachea, positioned anterior to the esophagus. It then reaches the phonatory system, which is made up of the larynx. The larynx is a musculo-cartilaginous structure that lies superior to the trachea. It contains the cricoid cartilage, thyroid cartilage, epiglottis cartilages, and paired arytenoids, corniculate, and cuneiform cartilages (Seikel et al., 2005). Within the larynx are the vocal folds, which are bands of mucous membrane, connective tissue, and muscle that allow for adduction and abduction needed for proper voicing (Seikel et al., 2005). As the air reaches the upper portion of the trachea it continues through the larynx, setting the vocal folds into vibration where the air is converted into voice. The voicing source is then routed through the pharyngeal cavity to the oral cavity where it is shaped into speech sounds by oral articulators (Seikel et al., 2005). Interaction between airflow and laryngeal

structures is crucial for transmission of speech. When this natural process is interrupted due to anatomical and physiological change from head and neck cancer, the resulting factors can be detrimental (Thomas & Keith, 1998).

Head and Neck Cancer

Diagnosis of cancer within or near the laryngeal structures can contribute to life-changing affects that negatively impact a person's ability to communicate. When cancerous cells develop within the larynx, near the larynx, or on the voice box, it is known laryngeal cancer (ASHA, 2013). Laryngeal cancer makes up approximately 2-5% of all diagnosed cancers and occurs in twice as many men than women between the ages of 50-70 (ASHA, 2013). Heavy smoking and drinking, exposure to chemicals, poor eating habits, weakened immune system, and acid reflux are primary causes of carcinoma (ASHA, 2013). Cancer can develop in different regions of the larynx, which may be located within the true vocal folds, areas above the vocal folds, or areas below the vocal cords (Groher & Crary, 2010).

Treatment options geared towards the elimination of cancer cells or tumors depend largely on the size, location, and timing of diagnosis. Radiotherapy, chemotherapy, and surgical removal are all treatment options after the diagnosis of laryngeal cancer (Thomas & Keith, 2005). Radiation therapy is commonly used when the size of the tumor is small and detected early. For more advanced cancer when the tumor is large, chemotherapy is generally the treatment administered (Thomas & Keith, 2005). Patients may undergo radiation therapy and chemotherapy simultaneously depending upon how advanced the cancer is, the size, and location (Thomas & Keith, 2005). If the patient does not respond to these two treatment methods or if the cancer is life

threatening, surgical operation, known as laryngectomy, is necessary. The location and extent of the tumor determines the type of laryngectomy selected varying from minor reconstruction to complete reconstruction of the larynx.

The primary objective in head and neck cancer treatment is the attempt to preserve adequate breathing, swallowing, and voicing when feasible (Thomas & Keith, 2005). Two surgical procedures that preserve normal breathing, swallowing, and lung-powered speech include cordectomy and partial laryngectomy (Thomas & Keith, 2005). Cordectomy is the removal of one vocal fold and partial laryngectomy is the removal of cancerous tissue surrounding the larynx (Thomas & Keith, 2005). Changes in the quality of voice and swallowing abilities are typical following this type of surgery.

When cancer resides in regions above the true vocal folds, supraglottic laryngeal surgery is performed. Although regular breathing and speaking is preserved, negative effects on swallowing may occur. Removal of one side of the larynx causing major changes in voice and swallowing is known as hemilaryngectomy (Thomas & Keith, 2005). More extensive surgeries that result in the loss of lung-powered speech that now rely on a permanent tracheostomy in which breath supply is obtained through a hole in the neck include near-total laryngectomy and total laryngectomy (Thomas & Keith, 2005).

Reconstruction After Laryngectomy

Education prior to surgery pertaining to the anatomical changes of the laryngeal structure is a fundamental role of SLPs (ASHA, 2013). The different types of laryngeal surgeries vary in the extent of reconstruction. Although partial laryngectomies preserve anatomical structures and functions required for speech production, secondary side

effects may occur, including alterations in voice, swallowing, and breathing (Thomas & Keith, 2005).

Complete reconstruction of the larynx following total laryngectomy requires extensive surgery resulting in multiple consequential factors. Complete removal of the larynx involves major anatomical changes including separation between the trachea and esophagus (Xi, Li, Gui, & Huang, 2010). This separation is also performed during near-total laryngectomy procedures. There is a loss of the voicing source needed for speech due to separation of the oral cavity from the trachea and respiratory passageway. The surgical procedure applied to generate respiratory support is known as a tracheostomy (Seikel et al., 2005). The trachea is adjusted or shifted, and ends at a circular opening in the neck, known as the stoma (Seikel et al., 2005). Therefore, natural airflow through the nose and mouth is no longer available; the stoma supplies the air for breath support. Normal breathing relies on the nose and mouth to act as natural humidifiers during inhalation. Due to the loss of the natural air filters, the air that enters the trachea directly from the stoma is no longer being filtered, which can cause irritation and excessive phlegm (Hallers et al., 2005). Addition problems that result from a permanent tracheostomy include loss of smell, swallowing difficulties, altered taste, poor cough, lung function changes, and lifelong functional and psychological consequences (Bozec et al, 2009).

Quality of Life Following Laryngectomy

Diagnosis of laryngeal cancer resulting in laryngectomy ultimately changes a person's life. Reconstruction of anatomical and physiological functions directly impact physical abilities, but it is also important to keep in mind the secondary issues that result

from the procedure. Part of being a competent professional while working with individuals who have had laryngectomies is the ability to become receptive to the concerns and challenges that will result following surgery. Noonan and Hegarty (2010) conducted a study that reflected personal experiences of patients who had undergone total laryngectomy and the resulting challenges with functional and psychological well-being. Patients reported that both physical and psychological difficulties arose after laryngectomy that negatively affected daily life (Noonan & Hegarty, 2010). Another study viewed similar aspects pertaining to the quality of life of laryngectomy patients emphasizing awareness of characteristics that can manifest themselves in the areas of physical capacities, psychological effects, social effects, stigma, and feelings of solitude (Babin et al., 2011).

Although consequences of near-total and total laryngectomy include loss of natural voice and speech, physical, emotional, and psychological changes, several alaryngeal speech options are available for these populations in the endeavor to improve the patients' quality of life.

Alternative Voice Restoration Methods

Research regarding speech alternatives after laryngectomy is continually being implemented as new products for laryngectomies are introduced based on the research findings. Much has changed since the origination of speech restoration techniques (Kapila et al., 2011). Over the past few decades, new developments of alternative speaking options for this population have emerged. The three most common current types of voice rehabilitation following total laryngectomy include esophageal speech, artificial larynx, and tracheoesophageal puncture (Xi et al., 2009). All three types are unique in

their own way; therefore, education pertaining to functional requirements needed for each treatment option is necessary to enhance overall success for voice restoration. Comparing alaryngeal voice rehabilitation options by using supported research will allow readers to identify current advantages and disadvantages of each. Choosing an alternative speaking option after laryngectomy is not the same for every patient (Farrand & Duncan, 2007). Professionals must be competent in understanding each method as well as having the ability to identify which method is appropriate for each patient (Babin et al., 2011). Most patients desire the opportunity to learn a new type of functional speech technique subsequent to laryngectomy to improve quality of life (Farrand & Duncan, 2007). The following information regarding the three most popular types of alaryngeal voice restoration options will provide a clear picture pertaining to characteristics needed for each method.

Esophageal Speech

Esophageal speech was the initial alaryngeal speaking option and is a method that is currently being utilized (Elmiyeh et al., 2010). This method requires a person to inhale air through the mouth and hold it in the throat. The air is then released causing vibrations in the pharyngoesophageal segment. The pharynx, mouth, and articulators resonate the air allowing the production of sounds (Elmiyeh et al., 2010). There are three different methods that can be used to inhale air when implementing the esophageal speech approach. They are the swallowing method, the inhalation method, and the injection method (Kazi et al., 2006). The swallowing method is initiated by swallowing air into the esophagus prior to producing speech. The inhalation method works by creating negative pressure within the esophagus by quickly inhaling air from the stoma into the lungs.

Drops in negative pressure cause the air from the mouth and nose to be drawn into the esophagus (Kazi et al., 2006). The last method, injection, requires the tongue to push against the hard and soft palate while simultaneously closing off the nasal cavities in order to transfer air into the pharyngeal cavity (Kazi at al., 2006). Proper coordination between the inhalation and release of air can be a difficult task to learn. Advantages are that a person does not have to rely on an external battery powered device to produce speech and it is hands free. Learning to utilize proficient esophageal speech is challenging requiring a significant amount of practice and therapy. Sayed et al. (2011) reported that approximately 40-74% of patients who attempt esophageal speech fail to adequately learn and utilize this method. Due to the decreased ability to control speaking parameters, voicing characteristics are often described as breathy, rough, low pitched, with reduced intensity (Elmiyeh et al., 2010).

Globek, Staijner-Katusic, Musuric, Horga, and Liker (2004) compared acoustic and pronunciation speech parameters across three alaryngeal speaking groups that included fundamental frequency, maximum phonation time, jitter, shimmer, and intensity. Duration of speech between two pauses was also compared and measured between groups, which included the number of syllables produced, maximum number of syllables produced, and articulation rate (Globek et al, 2004). Results demonstrated that esophageal speakers scored the worst across all parameters when compared to the other two alaryngeal speaking groups and normal speakers (Globek et al., 2004). When comparing this method to the electrolarynx and tracheoesophageal puncture, research has demonstrated that esophageal speakers have decreased intelligibility, speech quality, success rate, and they require more training (Xi et al., 2010). Characteristics that improve

the success rate of esophageal speakers include adequate esophageal structure allowing vibrations to occur, understanding proper instructions on how speech is achieved, and motivation to continuously practice. Extended cancers to the pharynx and esophagus that require surgical attention will impact a person's ability to use this method (Thomas & Keith, 2005).

Electrolarynx

The second voice restoration technique that emerged following the development of esophageal speech was the electrolarynx, also known as an artificial larynx (Thomas & Keith, 2005). An artificial larynx is an instrument that allows laryngectomy patients to transform an initially generated tone into sound that is articulated into speech with his or her tongue, lips, teeth, hard palate, and soft palate (Thomas & Keith, 2005). There are two different ways a person can produce speech using this method, which include an oral electronic hand-held device that is battery operated or a pneumatic device that is operated using air from the lungs (Keith & Thomas, 1996). The electronic battery-powered device generates sound by use of a vibrating membrane and can be a neck type or an oral type (Keith & Thomas, 1996). The neck type involves holding the device against the neck near the floor of the mouth where vibrating tones are transmitted through the skin. This tone is turned into voice once it reaches the pharynx and mouth, allowing the patient to manipulate and shape sounds into speech using the oral articulators. Another possible option is to use a small plastic tube that is connected to the artificial larynx that is placed into the mouth. The tone is produced and goes directly into the mouth (Kazi et al., 2006). The second method is accomplished by using air from the lungs. With a pneumatic artificial larynx, one end of a tube is placed in the mouth while the other end is connected

to an instrument that closes off the stoma (Keith & Thomas, 1996). Air produced in the lungs travels through the trachea, out through the tube covering the stoma, and into the mouth. Exhalation causes a rubber diaphragm to create a tone that is then articulated within the mouth (Keith & Thomas, 1996). The electrolarynx is a reliable option for those who need an easy learning method for alaryngeal speech, while still having the ability to use relatively intelligible speech (Sayed et al., 2011). Although this method seems like an optimal choice pertaining to ease of use, it does have its disadvantages (Kazi et al., 2006). Common complaints include the unrealistic mechanical sound that is produced, cost for batteries, and the manual dexterity that is required as the device is being utilized (Kazi et al., 2006). Comparisons of alaryngeal voice and speech parameters between groups have shown that patients utilizing an electro-acoustical aid demonstrate the best perturbation measures, which include jitter and shimmer, the highest intensity measures, and adequate fundamental frequency. Maximum phonation time was significantly lower compared to the other groups (Globek et al., 2004). Difficulties with motor movements of the hands impact the ability to properly utilize this device. Other considerations a patient must keep in mind are the costs towards the device as well as the un-natural mechanical sound that the device emits.

Tracheoesophageal Puncture with Voice Prostheses

The newest and most popular voice restoration option is the tracheoesophageal puncture (TEP), which will be the main focus of the remainder of the paper. TEP is a surgical procedure in which a hole or fistula is created between the posterior trachea and anterior esophageal wall (Kapila et al., 2011). A silicone voice prosthesis also known as a shunt valve is then inserted into the fistula, which allows lung-

powered air to be transmitted from the lungs to the esophagus while simultaneously blocking liquid or food from entering from the esophagus into the lungs. In order to transfer air from the trachea through the prosthesis, the stoma located in the middle of the neck must be covered. As the air from the lungs passes through the prosthesis and enters the esophagus, it causes vibrations along the esophageal walls that create the sound or voice needed for speech (Keith & Thomas, 1996).

The tracheoesophageal puncture procedure can be performed at the time of the laryngectomy known as primary surgery, or at a later time following surgery, which is secondary surgery. Primary surgery is often recommended unless extensive radiation therapy has been performed increasing the risk of tissue damage, which may lead to unwanted fistulas (Bozec et al., 2010). Benefits of primary surgery include allowing patients the opportunity to quickly begin speech rehabilitation and reduce the length of recovery time by getting the operations completed simultaneously. As mentioned above, some patients are required to wait a few months before undergoing a TEP due to radiation therapy in order to attain overall success using the prosthesis. Whether or not a primary or secondary procedure is performed, the advantage results in lung-powered speech (Elmiyeh at el., 2010). Once surgery has been completed a proper shunt valve must be placed within the fistula. Proper fittings require measuring the dimensions of the puncture and choosing an appropriate voice prosthesis that matches the fistula measurements in order to attain a tight fit. There are two types of fittings that can be performed, which include a form fit and a force fit (Hallers at el., 2005). The form fit has two flanges, one on each side of the shunt valve so that once inserted, there will be a flange on the esophageal wall and one flange on the tracheal wall. The flange is a circular

flap that seals itself against the esophageal and tracheal wall to prevent food and liquid from entering through the prosthesis. The force fit includes prosthesis with a wider shaft than the fistula, relying on friction to maintain stabilization (Hallers at al, 2005).

This technique requires practice utilizing the hand to properly occlude the stoma in order for the air to be transferred through the prosthesis. Other important factors include phonatory effort, wall thickness, durability, and cost of the prosthesis (Kapila, et al., 2011). Since lung-powered speech is reserved and used for this method, prior measurements pertaining to how well a person can utilize this air are crucial for adequate voice and speech. Patient motivation also plays an important part when deciding if the laryngectomee wants to take the role of caring for the device or getting professional assistance for prosthesis maintenance. Tracheoesophageal voice prostheses are divided into two categories, indwelling and non-indwelling. Non-indwelling devices are those that can be removed and changed by the patient without the need for professional assistance while an indwelling voice prosthesis requires a medical professional to remove and replace the device (Elmiyeh et al., 2010). Although the non-indwelling voice prosthesis is less expensive and is able to be maintained by the patient, it requires a higher frequency of replacements (Elmiyeh et al., 2010).

A great deal of research has been carried out pertaining to positive outcomes for TEP and voice prosthesis users pertaining to quality of speech. Successful speech restoration has been the primary goal for patients following a laryngectomy, but increased attempts have been focused on ways to create alaryngeal speech that is close to normal. Globek et al. (2004) compared voice and speech parameters of alaryngeal groups to normal voice and speech groups and found TEP with voice prosthesis to be closer to normal voice

in the following parameters: maximum phonation, fundamental frequency, jitter, speech rate, and articulation rate. Another study found that overall speakers using TEP acquire higher intelligibility ratings, higher patient satisfaction ratings, higher quality of life ratings, and higher long-term success ratings when compared to esophageal and electrolarynx groups (Xi et al., 2010).

Besides voice and speech restoration after laryngectomy, success rates for functional outcomes have also been represented through research. For example, Bozec et al. (2010) compared functional outcomes for 103 TEP users six months after surgery and found that 86% of patients were satisfied with deglutition and oral diet and success rates of voice prosthesis restoration were 82% (Bozec et al., 2010). Studying the entire realm of consequential factors following laryngectomy provides a broad overview on the overall quality of life for the patients.

The TEP and voice prosthesis has remained a popular option for the past few decades particularly due to increased outcome measures pertaining to voice and speech production (Kapila at el, 2011). Although research has promoted this type of voice rehabilitation, it is important to understand the complications that often occur when using this device. The majority of the problems that arise when using TEP are from the voice prosthesis itself (Bozec et al, 2010). The most common reported problem is due to leakage through or around the prosthesis (Bozec et al., 2010). A person with a TEP is usually well aware when the prosthesis is leaking because coughing during or after swallowing due to water entering the airway occurs. Leakage through the prosthesis is most likely caused by a faulty valve, debris blocking the valve, slight distortion, or lifespan of the valve (Kapila et al., 2011, p. 102). Leakage around the prosthesis is

typically caused by a prosthesis which is too long, allowing it to move back and forth (Kapila et al., 2011, p. 102). A study conducted by Bozec, et al. (2010) compared functional outcomes of patients using prosthetic voice restoration. This was done by identifying short and long-term complications in order to predict success of using tracheoesophageal voice in the areas of oral diet, speech intelligibility, and lifetime of voice prosthesis. This study indicated that the life-span for an initial prosthesis is commonly up to 7 months, and lasts longer than subsequent prostheses which usually last between 3 to 6 months (Bozec et al., 2010).

Most shunt valves are made of silicone rubber, which are prone to colonization of bacteria. Biofilm adhesion and yeast can accumulate on the prosthesis causing the valve to malfunction. This formulation of bacteria or yeast along the prosthesis causes prosthesis dysfunction and eventually causes leaking either through or around valve (Hallers et al., 2005). Another problem that may occur is during the initial sizing of a shunt valve. Fistula measurements must be obtained in order for proper shunt fitting. Although the shunt valve's dimensions may originally fit the fistula's dimensions, wall thinning, atrophy, or tissue reactions may adversely affect the size, again causing leakage (Hallers et al., 2005). In some cases, shunt valves have been known to fall out or get dislodged. If the prosthesis comes out, it is imperative that a catheter is placed in the fistula. An open fistula is unsafe because saliva, liquid, or food will enter through the hole and continue down from the trachea into the lungs causing aspiration. The longer the fistula is open, the higher the chance it will close, which would require the need for a subsequent surgery (Keith & Thomas, 1996).

Numerous products have been introduced in the attempt to increase the quality of life for patients who rely on the use of stoma occlusion by hand. An automatic stoma valve (ASV) also known as hands-free speech, is a valve that covers the stoma and automatically closes when speaking is initiated (Op de Coul et al., 2005). The advantage of using an ASV is that the hand is no longer needed to close off the stoma. Another useful product recognized as the heat moisture exchanger (HME) is usually combined with automatic speaking valves used to reduce trachea irritation and phlegm production by warming, moisturizing, and filtering inhaled air (Kapila et. al, 2011). Tracheostoma and heat moisture exchange filters are fixated to the skin by use of self-adhesive strips, tape, or a secondary option of using a device such as a stoma button with flanges (Hallers et al., 2005). Problems with fixation between the valve and skin along with the increased air pressure needed for voicing can negatively impact patient's motivation to use the valve (Hallers et al., 2005). Prior considerations must be made between professionals and the patient when deciding whether or not a tracheoesophageal puncture is the best voice restoration option. Characteristics such as motivation, manual dexterity, visual acuity, and respiratory functions place patients at a higher advantage for success for this method (Elmiyeh et al., 2010).

Comparing Alaryngeal Voice Restoration Methods

Currently esophageal speech, electrolarynx, and tracheoesophageal puncture are the most commonly used methods of alaryngeal speech rehabilitation following laryngectomy. Among the three alaryngeal voice restoration methods, electrolarynx and tracheoesophageal puncture have a much higher success rate than esophageal speech intelligibility and speech quality of tracheoesophageal puncture is higher than esophageal

and electrolarynx methods, and patient satisfaction and quality of life is better in TEP group (Xi, 2010).

Overall, current research promotes the use of tracheoesophageal puncture with voice prosthesis as being the gold standard compared to the other alaryngeal speaking options. There are many concerns that must be taken into account in order to successfully implement this technique, which include identifying problems that the patients may experience with his or her voice prostheses.

Choosing an Alaryngeal Speech Option

Evidence has shown that patients who desire an undemanding method for voice restoration would benefit from the artificial larynx if there is the willingness to accept the mechanical sounding voice. Esophageal and tracheoesophageal speech require more motivation, training, and practice prior to becoming a proficient speaker. Esophageal speech, which is currently the most challenging technique to learn, is reported to be the least successful alaryngeal speaking option compared to the other groups (Xi et al., 2009).

Farrand and Duncan (2007) applied questionnaires with personal ratings of quality of life measures to laryngectomees using various speech methods, concluding that that there were not many widespread differences between the voice restoration groups. The researchers pointed out that individuals using TEP had higher ratings on voice perception; additionally, TEP and electrolarynx users demonstrated higher ratings than esophageal speech regarding pain (Farrand & Duncan, 2007). Although TEP users reported better voice perception, they did not demonstrate better scores across all areas pertaining to a better quality of life when compared to esophageal and electrolarynx

speakers (Farrand & Duncan, 2007). For example, when it came to mental health and socialization, no significant difference between groups emerged and patients reported that they were satisfied with the alaryngeal option they were utilizing (Farrand &Duncan, 2007). Different limitations were reported between the alaryngeal groups, yet the resulting scores for the quality of life dimensions were not significant (Farrand & Duncan, 2007). It is important to include a broad range of measurements, not just voice perception, in order to understand whether or not there is a true difference between alaryngeal voice restoration methods and quality of life (Farrand & Duncan, 2007). Voice parameters are important aspects that impact a person's quality of life, but other health characteristics such as energy, emotional problems, and physical functioning need to be taken into account as well. This study reviewed personal feelings towards a broad range of characteristics following laryngectomy, with few differences across groups besides voice perception and intelligibility (Farrand & Duncan, 2007). Overall, this study demonstrated that although one aspect of life is better for one group than for the others, it does not necessarily suggest an overall better quality of life (Farrand & Duncan, 2007). Research comparing quality of life regarding various voice restoration methods must include not only voice and speech parameters but also physical, emotional, and social aspects that are also involved in the rehabilitation process (Farrand & Duncan, 2007). Every patient is different, therefore it is the professional's job to assist in voice restoration decision-making following laryngectomy.

Roles of Speech-Language Pathologists

Advanced stages of laryngeal cancer have major impacts on an individual's life physically and emotionally. Realizing that consequences of total laryngectomy include

inability to produce natural speech is only one of several life-altering changes that the patients experience (Babin et al., 2011).

SLPs play a major role in educating patients regarding the types of voice rehabilitation options that are available post-surgery including educating the patient and family members prior to surgery, during surgery, and after surgery (ASHA, 2013). Before surgery, patients should be informed about the typical speech and voice process compared to alterations that will be made during surgery. SLPs will assess the communication abilities prior to surgery and provide detailed information about the different treatment options available (ASHA, 2013). Informative material should be provided so patients and significant others become aware of issues regarding life management after laryngectomy and current alaryngeal rehabilitation options (Thomas & Keith, 2005). Once the voice restoration method is chosen and is ready to be implemented, SLPs take the role of teaching the patient how to properly use the alaryngeal speech option whether it is esophageal, electrolarynx, or tracheoesopheal puncture (Miller, 1990). Prior to surgical voice restoration, the SLP works with a multidisciplinary team to determine if this voice restoration is suitable for the patient (Miller, 1990). Once TEP surgery has been completed, SLPs conduct a prostheses fitting, provide safety and care education about the prosthesis, teach patients skills to produce adequate voice with the device, and replace the prosthesis when necessary (Miller, 1990).

Future Considerations

Gains in voice rehabilitation have improved over the years and now allow laryngectomy patients to decide on different methods of producing speech (Kapila et al., 2011). Research is constantly being conducted on furthering enhancements with current

products to improve the quality of life for this population. Patients continue to experience various complications even when voice rehabilitation is initiated. Although tracheoesophageal puncture with prosthesis has demonstrated high success rates for laryngectomy patients, there are complications related to the voice prosthesis. Future considerations pertaining to improving products that will decrease complications, specifically after tracheoesophageal puncture and prosthesis surgery should be implemented (Xi et al., 2009). With the silicone device being susceptible to yeast and bacteria, a common reported problem is leakage around or through the valve increasing the need for replacement (Elmiyeh et al., 2010). More research needs to be conducted to improve quality of the voice prosthesis in order to reduce the amount of replacements needed by patients by increasing the lifetime length of the device (Xi et al., 2009). Future research should also focus on ways to improve the success of hands free speech. Stoma valves are being used**,** but a decreased success rate due to fixation difficulties remains problematic (Hallers et al., 2005).

Conclusion

The primary goal when working with patients post laryngectomy is to provide appropriate treatment options that will optimize the quality of life by giving every person a new voice. Understanding the anatomical and physiological processes needed for normal voice and speech production facilitates awareness of the underlying consequences that emerge once the natural process is interrupted.

Laryngeal cancer that results in laryngectomy severely impacts a person's life physically, socially, and emotionally. Focus has been towards providing these patients with the treatment option of successfully acquiring an alternative speaking method as

well as living a high quality life. Over the past few decades, improvements on a broad range of parameters from quality of speech to overall functional outcomes have been implemented**,** given the various voice restoration treatment options. Laryngeal cancer causes devastation to those diagnosed, especially if the entire larynx must be surgically removed resulting in loss of voice. This paper has provided an overview of the currently available voice restoration alternatives following laryngectomy along with the concurrent advantages and disadvantages.

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