

Rehabilitation after Total Laryngectomy

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Abstract

Comprehensive rehabilitation after total laryngectomy is more than just restoration of the voice alone. Due to central position in the upper aerodigestive tract, its removal requires rehabilitation of all three 'systems' depending on respiratory airflow, i.e. Voice, Pulmonary and Olfactory functions. Rehabilitation of speech takes preference, but pulmonary and olfactory rehabilitation require multidisciplinary team effort in order to achieve optimal results and good quality of life.

Keywords: Voice rehabilitation , Pulmonary rehabilitation, Olfactory rehabilitation.

INTRODUCTION

Total laryngectomy, although highly undesirable, is still indispensable procedure in treating advanced or recurrent cancer of the larynx and hypo pharynx. This procedure is not without consequences and results in altered respiration and loss of voice coupled with disfigurement. The larynx has important functions in olfaction and respiration and is more than just an organ of voice production. Its removal requires rehabilitation of all three 'systems' depending on respiratory air flow, i.e.

1. Vocal rehabilitation
2. Pulmonary rehabilitation
3. Olfactory rehabilitation

Perhaps loss of voice is the most distressing to the patients as they lose power of communication. So, re-establishment of an acceptable voice is critical for successful psychosocial adjustment. Rehabilitation of a laryngectomized patient requires a multidisciplinary team effort in order to achieve optimal results and good quality of life.

Vocal Rehabilitation

A lot of progress has been made in the voice rehabilitation after total laryngectomy in the past three decades. Initial efforts at restoration of voice started as early as 1873 when Billroth performed the first total laryngectomy. The artificial

larynx that team designed not only contained a tone – producing element, but also a heat and moisture exchanging membrane. The developments in the area of voice rehabilitation after total laryngectomy have been phenomenal. Voice rehabilitation options available to the postlaryngectomy patients are:

Esophageal Speech

Beginning of the 20th century saw improvement of the technique of laryngectomy, particularly the primary closure of the pharyngeal mucosa. Simultaneously in 1922, Seeman¹ first recognized that the cervical oesophagus could act as a neoglottis, and the stomach and distal oesophagus as an air reservoir. This was the beginning of the technique of esophageal speech. Esophageal speech was the mainstay of alaryngeal communication until the early 1980s and had been used as a method of voice restoration for over 100 years. It entails trapping air in the mouth or pharynx and propelling it into the esophagus. The patient can then reflux the air up through the esophagus vibrating the pharyngoesophageal segment. Pharyngoesophageal segment is a collective name for Cricopharyngeal muscle and middle and inferior constrictor.² This produces a belch-like sound that can be articulated by the tongue, lips, and teeth.³⁻⁶ The vibratory segment is located in the lower cervical region corresponding to C5 through C7. The cricopharyngeus and the inferior and middle constrictor muscles contribute to the formation of vibratory segment.

The three basic approaches to esophageal insufflation are consonant injection, glossopharyngeal press, and inhalation. All techniques are based on the pressure differential principle that air flows from areas of higher pressure to areas of lower pressure. Consonant injection involves using consonants/articulators to increase oropharyngeal air pressure, which, in turn, overrides the sphincter pressure of the PE segment, thereby insufflating the oesophagus. The glossopharyngeal press method can only be used during rest or during interphase intervals. With this method, the tongue acts as a piston, forcing air downward into the oesophagus. And finally, the inhalation method, which is negative pressure approach, involves decreasing thoracic air pressure below environmental air pressure by rapidly expanding the thorax and relaxing the PE sphincter so air insufflates the oesophagus. Users have to learn relaxation of the PE segment which is important for the air entry into the oesophagus.^{2,7}

The major disadvantage of this form of speech is that very few laryngectomees are successful users. Proficiency in esophageal speech typically requires several months of speech therapy. Speech acquisition is delayed because of the learning curve, and difficulties with pitch, rate, duration, phrasing and loudness are possible. 40 to 75 percent of laryngectomees fail to acquire functional esophageal speech. As the oesophagus can hold just 80 ml of the air and out of it only 15 ml can be used for sound production, there is need for repeated insufflation which results in such mode of speech to be being labored and of inferior quality. Esophageal speech is characterized by a low fundamental frequency, reduced mean utterance length, and a greater effort to produce it. Given these disadvantages, esophageal speech has largely been relegated to a second tier means of post laryngectomy voice rehabilitation.

It has been noticed that less than 1/3 rd of the laryngectomees are successful in functional communication.⁸ According to Stemple high motivation and work are required in achieving functional speech.² Prospective studies have challenged the historical reports of acquisition rates of 65%, readjusting the acquisition rate to 30%. However, esophageal speech has its own benefits. It is natural speech with some form of control over pitch/loudness and hands are free for greater independence for more active life style.⁶ Another advantage is that it requires no batteries or apparatus to be purchased or maintained, it does not sound mechanical, and it does not require additional surgery.

Therefore, esophageal speech is for candidates who are highly motivated to put forth the physical and emotional effort needed to produce intelligible speech.⁹ Post radiation fibrosis, pharyngeal scarring, esophageal stenosis, recurring suture line fistulae, and defects in neural innervation preclude the use of esophageal speech. In addition, some individuals are not candidates for esophageal speech due to lack of relaxation of the PE segment.²

Electronic Larynx

The second method of voice restoration is the use of electronic larynx, which is an electrically driven diaphragm or sound transducer. The first artificial larynx was developed in 1859 by Johann Cezermak. The first recipient of the device was not a laryngectomee, but an 18-year-old boy who had undergone a tracheostomy for tracheal stenosis. The artificial larynx was initially used for a Laryngectomee in 1873 when the first successful laryngectomy took place.¹⁰ There are two basic types of artificial larynges, pneumatic and electronic. In the pneumatic type, air from the lungs is diverted through a coupling device held against the stoma. Pulmonary air causes a reed within the device to vibrate. The air is transmitted through a tube directly into the oral cavity where it is articulated into speech. While the pneumatic type of artificial larynx yields better voice quality than the electronic varieties, it is cumbersome and challenging to use.¹¹ The more common type of artificial larynx is the electronic variety.⁵ This device generates sound vibrations outside the body, which are then transmitted through the tissues of the neck, cheek, or intraorally through a tube, so that they can be shaped into speech with the use of the resonating cavities and articulators.⁴ Neck placement is preferable but not always possible due to fibrosis from surgery and/or radiation. Intraoral adaptors (Fig. 1) may be used to bypass the neck and direct the tone into the oral cavity.^{3,4} Two types of electronic devices are now available in the market viz, the trans cervical or neck type (Fig. 2) and the intraoral type (Fig. 1).

The artificial laryngeal speech is generally a faster method, and does not delay or interfere with other forms of alaryngeal speech acquisition. Main advantage is immediate postoperative communication which is psychological booster to the patients. Its disadvantage is its dependence on batteries, mechanical voice quality, its conspicuous nature, and the need of hand to operate the instrument.



Fig. 1: Intraoral electronic larynx



Fig. 2: Electronic larynges for use against the neck

Prosthetic Speech

Another option for individuals who have undergone total laryngectomy is tracheoesophageal voice restoration surgery. The use of a fistula technique for voice restoration was proposed in Billroth's 1873 paper, which described the first successful laryngectomy.⁸ Many versions of the T-E fistulization followed; however, until the 1980s, either an artificial larynx or esophageal speech continued to be the primary choices for communication. T-E fistulization gained popularity after 1979 when Singer and Blom refined the procedure and prosthesis (Fig. 3). A one directional, silicone rubber shunt valve is placed in a surgically created T-E fistula (posterior wall of the trachea through the anterior wall of the oesophagus) that allows pulmonary air to travel through the prosthesis into the oesophagus where esophageal sound is generated through vibration of the pharyngoesophageal segment.^{8,11} The prosthesis also prevents the aspiration of saliva, liquid, and food into the trachea. A flap on the valve opens by positive pressure and closes by elastic recoil during exhalation.⁸ In order for speech to be produced, the stoma must be covered so that air does not escape at that point, but is forced to continue into the

oesophagus. This can be accomplished manually or with a tracheostoma valve which will occlude when sufficient air pressure has accumulated.^{2,5} Tracheoesophageal voice prostheses can be indwelling or non-indwelling. The non-indwelling prosthesis was developed initially. A flap valve design improved voicing and allowed the development of a tracheostoma valve, which eliminated the need to occlude the stoma manually. This also improved hygiene and cosmetic appeal.¹² Later, indwelling voice prosthesis was developed which could remain in place for weeks or months. In many European institutes indwelling voice prostheses were preferred since early eighties. The rationale for preference was the advantages like:

- No replacement required by patient
- Shorter learning curve and little dexterity needed for daily care
- More robust design: longer device life

Additionally, heat moisture exchangers were developed which cover the tracheostoma or are incorporated into the devices.⁸ An advantage of the non-indwelling prosthesis is that it can be inserted, removed and cleaned by the patient. Bunting¹³ noted that the duckbill prosthesis (Figs 4 and 5) is the least expensive. The prosthesis is fixed to the skin with tape and individuals must have the dexterity and cognitive ability to keep up the removal, reinsertion, and cleaning, sometimes daily. Replacement into the tracheoesophageal fistula is one of the major causes of failure. For example, if the individual does not insert the prosthesis completely into the oesophagus, it can lead to a false passage and closure of the distal end of the puncture tract. An added advantage of the indwelling prosthesis is that it can be cleaned *in situ* and does not have to be removed as frequently. Thus, it requires less dexterity, and there is no need for a tag taped to the skin which results in a better seal of the stoma during phonation. Another advantage of the indwelling voice prosthesis is that it maintains the tracheoesophageal tract and does not fall out or become dislodged as can the catheter or stent of the duckbill prosthesis (e.g. with aggressive coughing or while being cleaned).

Disadvantages of the indwelling prosthesis also include the following: it is more prone to yeast colonization which destroys its function, as microbial colonization can hold the flap valve open leading to leakage through the prosthesis; there is a need for more frequent replacement of the valve



Fig. 3: Bloom-Singer classic indwelling voice prostheses



Fig. 6: Soft valve assembly



Fig. 4: Dukbill voice prosthesis



Fig. 7: Hard valve assembly



Fig. 5: Bloom-Singer low pressure voice prostheses

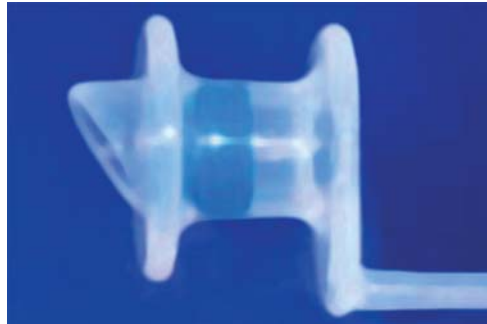


Fig. 8: Provox 1 prosthesis voice

(compounded by the higher cost); and enlargement of the fistula can result in reduced fixation and infections. Different prosthesis are available for insertion like Bloom-Singer Soft valve (Fig. 6) and Hard valve (Fig. 7) assembly, and Provox series (Figs 8 to 10).

Using the tracheostoma breathing valve is more hygienic than manual stoma occlusion. It allows for hands-free communication, and does not draw unwanted attention to the stoma (Fig. 11).



Fig. 9: Provox 2 voice prosthesis

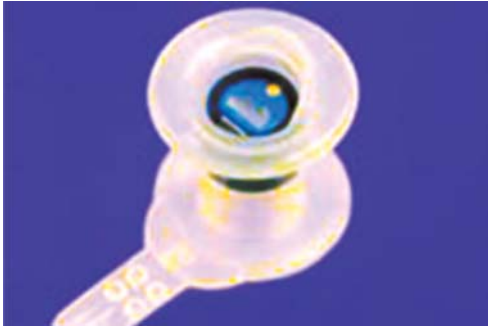


Fig. 10: Provox vega voice prosthesis candida resistant for long-life



Fig. 11: Provox hands-free speaking valve

Evaluation and Patient Selection for TE Speech Restoration

Prosthetic speech rehabilitation is presently ‘gold standard’ followed in most institutes world over. TE puncture can be undertaken at the laryngectomy, i.e. primary or at later stage known as secondary puncture. Primary insertion of the indwelling voice prosthesis is the method of choice for postlaryngectomy voice rehabilitation (level 3 evidence). Primary TE puncture offers optimal timing for voice restoration in majority of patients in multidisciplinary settings.¹⁶ It avoids a second operative procedure and allows a quicker and more successful voice restoration.¹⁷ However, there may be some situations where delayed or secondary TE puncture is necessary to avoid postoperative complications. Secondary TE puncture is considered for patients at risk of developing a fistula such as those who have severe radiation sequelae.¹⁸ Extensive pharyngeal or esophageal resection involving the retro tracheal space is a contraindication to primary TE puncture, as the risk of fistula formation is very high. Unrealistic patient expectations, poor patient motivation, manual dexterity, visual acuity, and respiratory function may compromise their ability to utilize

TE speech, and hence, are relative contraindications to TE puncture. There is apparently no significant difference in patient satisfaction on the subjective and objective assessments of voice quality in patients undergoing primary or secondary TE puncture.¹⁹

In established laryngectomies careful investigation and selection is even more critical for secondary voice restoration, in order to achieve success. Preoperative evaluation of patients considered for secondary TE puncture can be achieved by videofluoroscopy (VF). This is the most accurate method for assessing PE segment tonicity and function after laryngectomy.²⁰⁻²² Video fluoroscopy is a dynamic test with three important components; a modified barium swallow, attempted phonation, and an esophageal insufflation test. The preoperative insufflation test is an excellent preoperative indicator of postoperative TE speech production. Patients also benefit from hearing the potential quality of their TE voice after puncture. This is particularly true for patients whose pharynx has been reconstructed following pharyngolaryngectomy or pharyngolaryngo-esophagectomy. The insufflation test involves insertion of a catheter through the nose until the end is just below the PE segment. Air is channelled through the catheter to insufflate the oesophagus, simulating TE speech. Attachment of a manometer to the insufflation catheter allows measurement of pressure and constrictor tonicity within the PE segment. Tonicity, surgeon and patient choice, local services, and party-wall thickness determine the choice of speaking valve to be used. In summary, a patient who is otherwise in good health, strongly motivated, and determined to achieve voice after laryngectomy will usually succeed, provided the surgeon and speech pathologist have the knowledge and expertise to manage any problems and complications that arise.

Pulmonary Rehabilitation

After a total laryngectomy, the individual is breathing through the stoma instead of the nasal passages. Due to disconnection of the upper and lower respiratory tract as occurs after total laryngectomy conditioning of the inspired air will no longer take place. Without heat moisture exchange mechanism as provided by nasal cavities there is no warming, humidifying, or filtering of the air. Along with the focus on the voice rehabilitation, pulmonary rehabilitation and airway protection should receive equal attention. After laryngectomy considerable decrease in the

breathing resistance, leads to a shift of the ‘equal pressure point’ to more peripheral in the pulmonary tract, which could have a negative effect on pulmonary physiology. Clinically they have excessive sputum productions, coughing, and forced expektoration with frequent stoma cleaning. The heat moisture exchanger protects the airway, maintains a more natural tracheal environment, and decreases mucus production and coughing as the trachea is more protected from drying and cooling (which can cause thick or crusty mucus to form).^{11,13} Due to development of the heat and moisture exchanger (HME) restoration of the upper respiratory tract function is possible (Figs 12 and 13). During exhalation collection of heat and humidity (by condensation of water vapor) in the filter occurs and is exchanged with the breathing air. Filter has also important function of filtering dust particles from the inhaled air. HME also helps in partly reinstalling of the breathing resistance causing an upward shift of the ‘equal pressure point’ which might improve pulmonary physiology.

Clinical Studies on Positive Effects of HME’s has shown:

1. Significant reduction of pulmonary problems
 - Coughing, stoma cleaning, sputum production, forced expektoration, shortness of breath



Fig. 12: Heat moisture exchanger



Fig. 13: Provox micron

2. Significant reduction of other physical and psychosocial problems
 - Fatigue, sleep, anxiety, depression, social contacts
3. Significant improvement of quality of voice

Advantages of Immediate Postoperative HME use are:

- Airway protection and humidification without a noisy external humidifier.
- Early familiarization with stoma and HME use, and easier start with voicing.
- No problem with irregular and/or large stoma.
- Well –cared for patients, relatives and other patients in the ward.
- Lower need for regular suctioning of the mucus.
- Easy patient adaptation to resistance of HME.
- Better patient compliance with HME use : ‘self-evident’ part of postoperative care

Added benefits of using HME are retention of approximately 60% of daily water loss (500 ml) excessive loss with stomal breathing with more hygienic handling of stoma.

Olfaction Rehabilitation

There is anosmia or hyposmia after total laryngectomy because breathing in and out is via stoma as odor molecules cannot reach olfactory epithelium. Impaired olfaction leads to reduced flavor which results in reduced food enjoyment and hence reduced oral intake. The issue gets compounded in cases that are radiated as part of treatment protocol and also have reduced taste. This reduces quality of life significantly. Hilgers et al¹⁴ developed nasal airflow – inducing manoeuvre (NAIM) in which repeated extended yawning movement is performed, lowering the jaw , floor of mouth, tongue, base of tongue, and soft palate while keeping the lips securely closed. This is easily taught to the patients describing as yawning with the mouth closed, i.e. “polite yawning”. This manoeuvre induces negative pressure in the oral cavity and oropharynx, which generates nasal airflow, enabling odorous substances to reach the olfactory epithelium again. Olfactory acuity could be rehabilitated after total laryngectomy in approximately 50% of the patients by applying a NAIM procedure.¹⁴ Birgit Risberg-Berlin confirmed that the NAIM method is easy to learn and rapidly improves smell and taste. A single intervention session is sometimes sufficient, but many patients benefit from repeated training.¹⁵

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