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Communication after laryngectomy

Irena Hočevar-Boltežar and Miha Žargi

Department of Otorhinolaryngology and Cervicofacial Surgery, University Medical Center, Ljubljana, Slovenia

Background. *Laryngectomy is the mode of treatment of the patients with advanced laryngeal and hypopharyngeal cancer. It affects many important functions, including speech.*
Patients and methods. *Various alaryngeal speech modes are available so that no laryngectomee should be left without a means of communication.*
Results. *There is a variety of artificial devices, including electronic ones that produce their own battery driven sound. Alternatively, the patient can learn a new form of voicing using a muscular segment of the upper esophagus as a source of sound (esophageal speech). A puncture can be created surgically through the esophageal wall and a prosthesis placed in it to divert pulmonary air into the esophagus and through the same muscular segment to produce sound.*
Conclusions. *Many factors influence the choice of an alternative to be used with a particular patient. In Slovenia, esophageal speech is the most frequently used alaryngeal speech mode.*

Key words: laryngeal neoplasms; laryngectomy; speech, alaryngeal; speech, esophageal

Epidemiology and etiology of laryngeal and hypopharyngeal cancer

Laryngeal and hypopharyngeal cancers are quite common in Slovenia. In 1995 they represented 1.9 % of all new malignant diseases in Slovenia. The incidence of laryngeal cancer was 9.1/100.000 inhabitants in men, and 0.5/100.000 inhabitants in women. The incidence of hypopharyngeal cancer was 4.5/100.000 inhabitants in men, and 0.3/100.000 inhabitants in women. In 55 % of patients with laryngeal cancer and only 12 % of patients with hypopharyngeal cancer, the disease was discovered in a localized stage. In all other patients, the malignant disease was in an advanced stage and required more aggressive treatment.[1]

Laryngeal and hypopharyngeal cancers usually occur in men aged 50-65 years with a long history of tobacco consumption frequently associated with alcohol abuse. The alcohol-related nutritional deficiencies could be involved in the etiology of these cancers.[1,2] As a result, the patients often present with notable co-morbidities. In addition, the socio-

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Correspondence to: Irena Hočevar-Boltežar, MD, PhD, Department of Otorhinolaryngology and Cervicofacial Surgery, Zaloška 2, SI-1000 Ljubljana, Slovenia. Phone: +386 1 522 24 65; Fax: +386 1 52 24 815; E-mail: irena.hocevar-boltezar@guest.arnes.si

cultural level is rather poor in the majority of cases. This particular characteristic of laryngeal and hypopharyngeal cancer patients explains the delay in diagnosis and the problems linked to treatment compliance.

Laryngectomy and its consequences

Laryngectomy is a surgical procedure usually reserved for patients with advanced laryngeal or hypopharyngeal carcinoma or patients who fail radiation treatment.[3] Loosing the larynx means adapting to a living without some basics that characterize us as human. Respiration and speech are altered for ever; swallowing needs to be re-learned; smell and taste are attenuated; lifting, straining and coughing (all of which are dependent on a closed glottis) are compromised. Although there are numerous potential problems (emotional, psychological, physical, economic, social, surgical, and communicative), the inability to speak is considered the greatest of the difficulties the patient is faced by.[4]

Voice restoration after laryngectomy

After the removal of the larynx, the patient no longer has a source of sound for speaking. Currently, there are two categories of sound restoration: alternative "natural" sound sources and mechanical speech aids. The former category utilizes esophageal and tracheoesophageal speech, whereas the latter an electronic artificial larynx.[5]

Esophageal speech (ES)

ES traditionally has been the dominant approach to laryngeal speech rehabilitation. Some retrospective studies demonstrated a range of success from 12 % to 97 %.[6-11] In 1982, Gates *et al*. published the results from the first prospective investigation of ES acquisition, which showed that 26 % of their laryngectomy study group were able to acquire ES.[6] In a more recent prospective study, Hillman *et al*. found that only 6 % of their patients developed usable ES.[12]

ES is produced by compressing the air into the esophagus; the released air vibrates the pharyngeal-esophageal segment and produces the esophageal tone used for speech. The sound produced enters the oral cavity where it is articulated and shaped into words.

Generally, there are three primary methods used to teach esophageal speech: consonant injection, glossopharyngeal press, and inhalation. Regardless the method used, the goals are for the patient to be able to impound rapidly the air into the esophagus, expel it from there in a controlled manner, and produce fluent ES. Esophageal speakers have a much lower air reservoir (less than 100 cm^3) than is available to laryngeal speakers from the lungs (even > 5 litres). The small air supply will limit the esophageal speaker's ability to produce long utterances on a single charge of air.

The advantages of the ES are:

- The sound of ES is more natural and closer to the laryngeal voice.
- ES requires no dependence on mechanical instrument.
- The patient is able to achieve some measure of pitch and loudness control, and good esophageal speakers are able to vary these dynamically during speech.
- Both hands are free during speech.

ES has also some disadvantages:

- ES must be learnt and may take a long time to master it. Some patients may never learn to produce functional ES even after much effort.
- A person's ability to articulate clearly must be good, otherwise the intelligibility of ES may be poor.
- The patient may have difficulty being heard above back-ground noise.[5]

Tracheoesophageal speech (TES)

The tracheoesophageal puncture method, coupled with the use of the voice prosthesis, was introduced by Singer and Bloom in 1980.[13] The surgery may be performed at the time of the laryngectomy (primary procedure), or it may be performed at a later date (secondary procedure). Early studies, focused on carefully selected groups of patients who underwent the insertion of a prosthesis as a secondary procedure, reported success rates ranging from 56% to 93 %.[14-16] More recent studies, which have focused on the insertion of a prosthesis as a primary procedure, have reported acquisition rates ranging from 30 % to 93 %.[17-19]

In this approach, a small, silicone, valved prosthesis is inserted into a surgically created midline tracheoesophageal fistula. The uni-directional valved prosthesis is designed to maintain tract patency and protect against aspiration. The patient can divert pulmonary air from the trachea (by occluding the tracheostoma with a finger) through the prosthesis, thereby creating a sound in the pharyngoesophageal segment. The air pressures required to force open the slit of the valve range between 2 and 25 cm H_2O and depend on the rate of airflow from the lungs and the type of the device used.[20] Some patients may have considerable difficulty producing the pressures. In these cases, a lower resistance prosthesis is suitable. Special valves are available to avoid manual occlusion of the stoma. These valves close automatically when greater than normal thoracic pressures are present as when the patient wishes to produce speech.

There are still contraindications in the selection of patients for the prosthesis insertion: inability to care for the stoma, poor manual dexterity, a stenotic stoma, poor eyesight, esophageal stenosis, and poor patient's motivation.

The advantages of TES are:

- This technique can provide the most rapid restoration of nearly normal speech in most of the laryngectomized patients.
- TES is smooth and fluent because of the availability of pulmonary air.
- Loudness and pitch variation is possible.
- The approach is feasible in most of the laryngectomized patients and is also reversible if so desired.

The disadvantages of TES are:

- The insertion of the voice prosthesis requires another surgical procedure if not done together with the laryngectomy.
- Occasional aspiration due to poorly seated prosthesis, or poorly functioning prosthesis is possible.
- A buildup of candida deposits requires frequent cleaning.
- The functioning period of the prosthesis is limited.[5,21]

Artificial larynx (AL)

Previous reports of AL use among laryngectomy patients vary in many aspects. The estimates of AL use range from 5 % to 66 %.[6,22,23] This device uses electric power to drive a vibrator that provides the sound source. It generates a sound with approximately the same frequency as is the fundamental laryngeal frequency. One type of the device consists of a tube that delivers sound from the vibrator to the mouth. the sound is then articulated in the normal way. Another version consists of a hand held vibrator that is designed to deliver the sound through the skin when placed on the neck. Until recent years, the AL was considered to be the method of choice only for those patients who were unable to learn ES. Clinical experience has demonstrated that AL actually may be helpful in the acquisition of ES. AL may serve as a communication bridge until ES or TES training is initiated. Recent studies from the USA report that a majority of laryngectomees use AL – 55 %.[12]

The advantages of AL:

- It is easy to learn how to use it.

- AL provides adequate volume to be heard in noisy places.
- Volume and pitch control is possible.
- The speech with AL is intelligible when properly used.

Speech with AL has some disadvantages:

- AL has a noisy electronic sound that attracts attention.
- The neck type device cannot be used in the patients with heavily scarred neck.
- Moderate initial purchase cost and occasional additional cost for repair.
- AL requires very clear articulation to assure intelligibility.[5,21]

Characteristics of alaryngeal speech

Fundamental frequency (F0)

Most electronic speech aids have a manually adjustable F0. These are typically set to a low pitch for a male voice (about 100 Hz) and to a higher one for a female voice (about 200 Hz). Some have a variable frequency adjustment.

The F0 of the ES is usually lower than the average laryngeal F0. The results of different studies range from 57 Hz to 136 Hz.[24,25] The reasons for such a variety of the results are probably different measuring instruments used in different speech samples.

The F0 in TES is reported to be closer to normal laryngeal speakers, at least for male speakers, and ranges from 72 Hz to 134 Hz.[24,26] Some authors measured higher F0 in TES than in ES.[27]

Vocal intensity(VI)

The level of VI in users of AL is typical of normal laryngeal speakers during normal conversation or reading, ranging between 75 and 85 dB. The intensity range is somewhat reduced.[28] The intensity of the electronic vibrator is largely determinated by the design of the instrument.

The intensity of ES is usually lower in overall loudness than normal. The range of VI that esophageal speakers are able to produce is much lower than the intensity range of normal speakers (about 10 dB vs. 30 dB).[29]

The intensity of TES appears to be only slightly lower than the levels produced by laryngeal speakers. In some speakers, variation of intensity may be greater than normal.[30]

Temporal characteristics

There are little data on the temporal characteristics of speech with an AL. The few studies available indicate that reading rates are slower when using an AL compared to normal phonation or TES.[28] We might expect longer reading times because of the need for precise articulation to maintain an acceptable level of intelligibility.

In general, the patients using ES read slower than normal laryngeal speakers. Their reading rates are about 60-70 % of the rate of a normal speaker. They spend 30-45 % of their reading time in silence because they need to recharge air supply more frequently. They have a much shorter phonation time, typically less than 6 s, which is no doubt due to a small volume of air in the esophagus.[24,29,30]

Patients using TES also read at a slower rate than normal speakers but faster than esophageal speakers. Their slower rate may be due to difficulties in controlling the pharyngoesophageal segment and the need to articulate precisely. These speakers spend about 10-30 % of their reading time in silence. Their phonation time is longer than in esophageal speakers – about 12 s, but shorter than in normal speakers (in average 15-20 s).[24,29,30]

Intelligibility

Few studies have compared all three forms of alaryngeal speech. The intelligibility of speakers using AL ranges between 30 and 90 %. The average intelligibility is reported to be

about 60 %. The major cause of relatively low intelligibility is the failure to maintain the voicing distinction. Voiceless consonants tend to sound like voiced consonants.

The intelligibility of ES varies considerably, but in general, it is somewhat higher than in AL users. The average is about 70 %. Most of the deficiencies committed by esophageal speakers were voicing errors. Like in users of an AL, voiceless consonants were perceived as voiced.

TES also show considerable variation in intelligibility, but in general, they produce the most intelligible speech of the three forms of alaryngeal speech. The patients using TES do not have to use any structures in the vocal tract to insufflate the pharyngo-esophageal segment; therefore, they can maintain their normal (or develop near normal) patterns of articulation and more normal flow of speech.[31-33]

Speech rehabilitation after laryngectomy in Slovenia

According to a study performed in a group of members of an Association of laryngectomized subjects in Slovenia, 62 % of the subjects use ES, 8 % use TES, and 9 % of subjects use AL in every-day communication. About 18 % of 113 subjects who answered the questionnaire communicate using pseudo-whisper or writing. Only 2 % of subjects use AL and ES or TES. The laryngectomees assessed their satisfaction with their mode of communication using longitudinal analogue scale – 85 %.[34]

The results differ from the studies performed in the USA or Australia. Hillman et al. report that only relatively small percentages of laryngectomees developed usable ES (6 %) or remained nonvocal (8 %), and that a majority of the patients ended up as users of AL (55 %) or TES (31 %).[12] In Australia, the mode of communication after laryngectomy is about the same: 5.2 % patients use ES, 50 % AL, and 31.6 % TES.[35]

The reason for the difference in communication mode is a good access to speech therapy in Slovenia. Patients start learning ES two or three weeks after the surgery. The Association of laryngectomized subjects organizes free courses for better communication skills twice a year. Perry and Shaw report on very low referral rate to speech pathology in Australia.[35] In Slovenia, the voice prosthesis is inserted only in the patients who cannot learn ES.

Many factors influence the choice of the mode of speech rehabilitation in a particular patient. For a successful rehabilitation, a team approach is necessary. A team of professionals (ENT surgeon, phoniatrician, speech therapist, psychologist) meets the patient before laryngectomy to explain him/her the possibilities of voice restoration after the surgery. The rehabilitation is started as soon as the wounds are healed and continues in the following years. The whole team and the patient are aware that only a successful speech rehabilitation enables a good quality of life after laryngectomy.

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