VOICE RESTORATION FOLLOWING TOTAL LARYNGECTOMY BY TRACHEOESOPHAGEAL PROSTHESIS: INITIAL EXPERIENCE AT KING HUSSEIN MEDICAL CENTER

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ABSTRACT

Objective: This study presents preliminary results of using a tracheoesophageal prosthesis for voice restoration following total laryngectomy at King Hussein Medical Center. Our measures include patients' satisfaction, and perceptual ratings by family members, clinicians as well as the mean life time of the prosthesis.

Methods: Patients included twelve laryngectomees two months to 15 years following total laryngectomy. A tracheoesophageal puncture was placed in each patient, followed by fitting with voice prosthesis. Tracheoesophageal prosthesis speakers were asked to rate their satisfaction with their new speech on a 10-point rating scale, while a close family member was asked to judge the three parameters of patients' everyday speech as good, fair, or poor. Audiorecordings of tracheoesophageal prosthesis speech were rated by a panel of 24 students in a speech pathology undergraduate training program according to general intelligibility and six other parameters of voice on a 7-point rating scale.

Results: Our entire cohort was able to phonate and speak immediately after the insertion of the tracheoesophageal prosthesis with minimal training. All patients reported high satisfaction with their new speech and were quite cooperative during regular visits and follow ups for trouble shooting. The only factor that affected the patients' satisfaction was the need to use one hand to close the stoma. The primary complication was leakage through the prosthesis due to fungal infections. Most family members rated the quality, loudness, and intelligibility of tracheoesophageal prosthesis speech as fair to good. Listeners' ratings of quality, pitch, and prosody of tracheoesophageal prosthesis speech were relatively low, while their ratings of rate, articulation accuracy, and general intelligibility were higher.

Conclusion: Although the quality of tracheoesophageal speech was not good, speech rate, articulation, and general intelligibility were near normal. Tracheo-esophageal speech was highly accepted by Jordanian laryngectomees and their families. This is very significant, because other forms of voice restoration have not been acceptable to most Jordanian patients.

Key words: Laryngectomy, Tracheoesophageal prosthesis, Intelligibility, Voice quality.

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Introduction

Communication options for laryngectomized patients include electrolarynx, esophageal speech, and tracheal puncture with voice prosthesis. The electrolarynx is a handheld pulse generator that is battery-powered. Tone is introduced by placing the

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diaphragm of the device against the tissues of the neck. Sound is then transmitted into the oral cavity where the patient articulates the "metallic" sound into speech. Esophageal speech is produced when the upper esophageal sphincter enabled by the constrictor muscles vibrate as a function of air that is forced from the oral cavity through the sphincter and then brought back up to the oral cavity for articulation into speech. The major disadvantage of using elctrolarynx is its mechanical-sounding voice.[1] Esophageal speech is characterized by limited short air supply (around 80 cc), limited number of words spoken per minute, very low pitch (around 65 Hz), reduced loudness, hoarse rough quality, and significantly less intelligibility than normal laryngeal speech.[2,3] Esophageal voice training can be time consuming.[4] It has been estimated that only a maximum of 50% of laryngectomized persons learn this technique[5] as compared to 90% success rate with the tracheoesophageal speech.[6-8] Our experience with Jordanian patients has been that they rarely accept either the electrolarynx or esophageal speech. Some have even strongly requested a laryngeal transplant.

Prosthetic restoration of voice uses exhaled air to power esophageal speech and has become the preferred means of voice rehabilitation after laryngectomy in most of the world.[9-15] A one-way valve silicone prosthesis[9] is placed between the trachea to the esophagus. When the tracheostoma is occluded during exhalation, using either a finger or a hands-free stoma valve, air is shunted into the esophagus and the resulting vibration of the pharynx produces sound. Because it uses exhaled air, it is intuitive and easily learned, and phrase lengths are near normal. In contrast, traditional esophageal speech requires the patient learn to inject air into the esophagus.

Reports in the literature indicate that tracheoesophageal (TE) speech is more acceptable[10-14,16-19] and more intelligible than esophageal speech,[2,20-24] although it has similar quality.[2,15] Compared to esophageal speech, prosthetic speech produces longer phonation time and increased number of words per breath,[15,25-27] increased loudness,[22,27,28] and has better acoustic parameters.[23,25,29] TE speech is not normal, as it is low pitched,[30,31] hoarse, and strained,[18,32,33] However, TE speech has been rated as more similar to normal speech than either esophageal or electrolarynx speech.[27,28,34-36] This resemblance to normal speech in timing and intelligibility was attributed to the direct supply of the lungs as the air-stream source (around 3000 cc) during speaking.[22,37]

Prior to our study, voice prostheses had not been available to patients in Jordan. Therefore, when the valve became available in Jordan, we wished to investigate its efficacy and acceptance in our patient population. This study was to assess quality and intelligibility of tracheoesophageal speech in postlaryngectomy patients at King Hussein Medical Center (KHMC), and to determine patients' satisfaction with this form of voice rehabilitation.

Methods

Twelve male Jordanian patients (Table I) underwent secondary tracheoesophageal puncture two weeks to 15 years after laryngectomy. Eight patients had also received radiotherapy. A bronchoscope was passed through the mouth and positioned so that the distal lumen was against the posterior tracheal wall, just inside the superior margin of the tracheostoma. A puncture was made through the posterior wall of the trachea and into the esophagus at this point and a 16 French Catheter was inserted through this puncture site. Seven to ten days later, a 16 French Blom & Singer® nonindwelling low- pressure voice prosthesis (Inhealth Technologies) was inserted into the TE fistula. The appropriate tracheoesophageal prosthesis (TEP) size was selected by using a standard sizing device, and the prosthesis was inserted by a special inserting device after dilatation of the fistula by an 18 French dilator.

Patients were instructed in how to occlude the tracheostoma during exhalation to produce speech. They were also instructed on how to clean and take care of the prosthesis, and were seen periodically as needed for assistance in maintenance and disinfection of the prosthesis. All of our patients were put on long-term anti-fungal medications, since the literature indicates a high incidence of fungal colonization. The initial fistula puncturing and prosthesis insertion were done for the first four cases by an American visiting team (Woodson G, Lundy D). However, further replacements and trouble shootings for these four cases were done by Jordanian staff.

When healing was established around the fistula, usually within four to six weeks, the non-indwelling TEP was usually replaced with an indwelling prosthesis. All TEP speakers were routinely followed up for possible complications, and the prostheses were replaced whenever indicated, usually, due to Candida infection and leakage through or around the prosthesis. Complications, timing of insertion, and replacement, and reasons of prosthesis replacement were recorded for each case.

Each patient was asked to rate his satisfaction with his speech on a 10-point equal-appearing interval scale, with one as very dissatisfied, and 10 as very satisfied. A family member of each TEP speaker was

asked to judge the overall voice quality, loudness, and intelligibility, as 'good', 'fair', or 'poor'.

Computer-based high-quality audio-recordings were obtained from all twelve subjects as they read aloud a standard passage. A sample of free conversation was included in the recordings. These audio-recordings were auditory-perceptually rated by each of the 24 senior undergraduate students of speech pathology according to quality, pitch, prosody, loudness, speaking rate, articulatory clarity, and general intelligibility on a 7-point equal-appearing interval scale.

Ratings were performed by undergraduate students as prior investigators, Cullinan *et al*[20] did not find significant differences in rankings of intelligibility of readings and discourse samples made by experienced vs. inexperienced listeners.

Results

The cohort of this study (Table I) composed of twelve male Jordanian laryngectomees, who ranged in age between 36 and 74 years (61.25 + 10.01 years). All patients had refused esophageal speech or electrolaynx use. Four patients were illiterate, while the rest had an education that ranged from junior high school to postgraduate diploma. Four of them were able to go back to their work while the rest were retired.

The 12 patients of this study were fitted with a total of 41 prostheses during the past 19 months after the technique was introduced at KHMC. The average life of the Indwelling prostheses was 4.2 months (range 1- 11 months, SD= 3.2). The main reason for replacement was leaking through the TEP due to fungal contamination that prevented complete closure of the esophageal shutter. Accidental dislodgement of the prosthesis occurred three times with patients using the non-indwelling and only once with the Indwelling prosthesis. The latter patient received radiotherapy before laryngectomy. Other complications (Table II) included formation of granulation tissue around the prosthesis, which occurred in one case, and required surgical excision. Extended pachyderma under and around the tracheal flange of the prosthesis occurred in two cases. This was resolved by replacing the prostheses with a longer one in one patient, while, in the second patient, the prosthesis was taken out and an 18 French catheter was placed to keep the fistula open for one week before another longer prosthesis was placed. Three patients had a strained voice, presumably due to pharyngeal constrictor spasm. These patients were also noted to have emotional lability. Speech was improved with counseling and continued training, without the need for further surgical intervention. In three patients the tracheostoma gradually stenosed, and required stoma revision. Two of these patients still use a stoma tube at night to maintain patency of the stoma.

All members of our cohort showed high acceptability of their TEP speech. A median rating of eight was obtained on the 10-point rating scale (Table III). As shown in Table IV, most family members rated voice quality, loudness, and intelligibility as 'fair' to 'good'. Listeners' ratings of general intelligibility and other voice parameters are shown in Table V. Their ratings were lower for quality, pitch, and prosody, and relatively high for rate, articulation accuracy, and general intelligibility.

Table I. Subjects of the study (all males)

	Age	Time since laryngectomy	Duration of TEP before study	Previous means of communication	Radio Therapy sessions	Education level
AA	61	5.4 years	9 months	Buccal speech	33	Lawyer
EA	61	2.5 years	1.5 years	Electrolarynx	None	Illiterate
AB	57	1 year	11 months	Non-vocal	none	Illiterate
FF	69	16.5 years	1 years	Buccal speech	30	High school
SR	51	1.9 years	6 months	Buccal speech	35	High school
FR	61	4.5 years	1.6 years	Electrolarynx	32	University degree
HM	66	1.2 years	4 months	Esophageal speech	25	Illiterate
JA	36	1.9 years	1.6 years	Buccal speech	none	High school
RA	74	3.10 years	7 months	Electrolarynx	30	High school
MM	67	2.3 years	1.3 years	Esophageal speech	30	M. Sc. engineering
MH	63	2.1 years	1.6 years	Buccal speech	35	Junior high school
MJ	69	1.7 years	1 year	Buccal speech	none	Illiterate

Table II. Frequent complications

	Complications
AA	Excessive pachyderma around fistula; leak through prosthesis
EA	Excessive pachyderma around fistula; occasional leak through prosthesis
AB	Stoma narrowing (operated); Fistula downward migration
FF	Leak through prosthesis; mild strained voice.
SR	Repeated leak through prosthesis.
FR	Repeated leak around prosthesis.
HM	Stoma narrowing (operated); still on tracheostoma tube
JA	Repeated fungus infections during early stages.
RA	Mild strained voice; occasional leak through prosthesis.
MH	Stoma narrowing (operated); Repeated fungus infections during early stages.
MJ	Mild strained voice

Table III. Self ratings of patient's satisfaction with their TEP speech on a 10 point scale, where '1' as very dissatisfied, and '10' as very satisfied

	N	Minimum	Maximum	Median	Mean	SD
Self-rating	12	7	10	8	8.58	1.08

Table IV. Family member's ratings of TE speech

	Good	Fair	Poor
Quality	3	8	1
Loudness	6	6	-
Intelligibility	9	3	-

Table V. Listeners' audio-perceptual ratings of tape-recorded TEP speech on a 7-point scale, with '1' as very poor and '7' as very good

	Minimum	Maximum	Mean	Median	Standard Deviation
Quality	1	6	3.19	3	1.10
Pitch	1	7	3.71	4	1.23
Prosody	2	7	4.01	4	1.32
Loudness	2	7	4.21	4	1.18
Rate	2	7	5.14	5	1.26
Articulation Clarity	2	7	5.54	6	1.28
Intelligibility	2	7	5.66	6	1.31

Discussion

The 100% success rate of KHMC patients with TE speech compares favorably to the success reported by other studies.[6-8] Patient satisfaction, listeners' ratings of most acoustical characteristics, and general intelligibility of the present cohort, as well as frequent complications and prosthesis mean life, are in agreement with the published literature.[6-8,16-24,32,33]

Despite the high acceptance and quality of TEP speech, complications required frequent replacements in some patients. Another factor that limited satisfaction in some patients was the need to use one hand to close the stoma during speech. Only one patient (AA) was able to own a 'hands-free tracheostoma valve'.

The small sample size precludes a statistically significant correlation of patient satisfaction and the voice quality with other factors, such as prior radiotherapy and age of the patient. The two cases with superior voice quality did not receive radiotherapy. One of them was the youngest of the group (JA, 36 years old) and his speech was rated by listeners as the highest in all seven parameters.

Complications:

Candida infection requiring prosthesis replacement was frequent, despite anti-fungal treatment. Only three patients had voice strain suggestive of pharyngeal constrictor spasm, even though pharyngeal myotomy had not been performed during

laryngectomy in any of the patients. Voices improved with therapy in all three patients and none required subsequent myotomy or Botulinum injection. The reasons for the lower than reported incidence of spasm in our population are not clear; however our sample size is small.

Conclusion

Our 19-month experience with tracheoesophageal speech is in general agreement with previously published reports of the safety and efficacy of success rates for tracheoesophageal speech. Our findings are particularly significant in light of the low acceptance rates by our patient population for other forms of speech restoration. Our patients and their families reported high satisfaction and were pleased with this technique. Although the quality of TEP speech was rated as relatively poor, other parameters of voice were rated as fair to good. Complications and the need for frequent replacement of the prosthesis were minimal and tolerated by our cohort.

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