

Tracheoesophageal Puncture Outcomes and Predictors of Success in Laryngectomised Patients

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Abstract

Introduction: Prosthetic voice restoration has been widely used for vocal rehabilitation in laryngectomised patients. The objectives of this study were to examine success rates, predictors of success and complications for our patients who had undergone tracheoesophageal punctures (TEPs) and voice prosthesis placement after laryngectomy. To our knowledge, this is the first analysis of the use and complications of TEPs in Singapore. **Patients and Methods:** Thirty-eight patients seen in our centre were analysed in this retrospective case review. Factors analysed included voice quality with age, timing of insertion, type of closure, use of radiotherapy, regular maintenance and attendance at our clinic. Twenty-eight had undergone primary TEP surgery and 10 had undergone secondary TEP surgery for voice restoration after laryngectomy for cancer. Thirty-five patients had primary closure of the pharynx with 13 vertical, 19 horizontal and 3 T-shaped closures. The other 3 patients required reconstructive surgery. Thirty-five patients had radiotherapy. A numerical assessment of voice production was made of patients immediately and at 6 months post-insertion. A review of the complications was also done. **Results:** TEPs provided a fair to good voice in 74% of our laryngectomees. Patients who attended the voice restoration clinics and who regularly cleaned their prostheses were found to have statistically better voices ($P = 0.044$ and $P = 0.002$, respectively). Patients less than 60 years old had better results, as did patients with horizontal or T-shaped closures; however, these were not statistically significant. Secondary TEPs provided fair/good voices in 90% of cases compared to 68% of primary TEPs. Voice quality during radiotherapy was diminished but recovered at 6 months post-radiotherapy. The commonest complications noted included crusting (seen in 40% of cohort), candida infections and leaks which were seen in 16% of our patients. There was no mortality attributable to the use of TEPs in our study.

Ann Acad Med Singapore 2000; 29:452-6

Key words: Total laryngectomy, Tracheoesophageal puncture, Voice prosthesis, Voice restoration

Introduction

Laryngectomised patients have been shown to have significant physical and psychosocial problems. These relate not only to respiratory symptoms but also psychological symptoms such as sleep disturbance, fatigue, social isolation and distress.¹ The primary goal in rehabilitation for these patients is to return the patient as close as possible to his preoperative psychosocial state.² Achieving this depends significantly on the patient's ability to communicate effectively.² The traditional method of voice rehabilitation is oesophageal speech, use of an artificial robotic sounding electrolarynx or a combination of these methods.² Oesophageal speech is, however, unsuccessful in 35% to 70% of patients.³ Tracheoesophageal puncture (TEP) with prosthetic placement has been shown to be

successful and safe^{2,4-6} becoming the most frequently recommended choice of speech rehabilitation amongst laryngectomees.⁶ Vocal rehabilitation is also generally achieved in 52% to 93% of these patients.^{2,7-15} A review of some of the international studies done on TEPs is summarised in Table I. The use of postoperative radiation has not been shown to increase the complication rate¹⁶ nor has it been shown to adversely influence eventual voice quality postoperatively.^{11,12}

The first prostheses which were first developed by Singer and Blom¹⁷ maintain the puncture with a one-way valve which allows air to flow from trachea to oesophagus for voice production but prevents oesophageal leakage during swallowing.

These punctures may be made at the time of total

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TABLE I: REVIEW OF MAJOR TRACHEOESOPHAGEAL PUNCTURE (TEP) STUDIES DONE

Izdebski et al, 1994 ⁸	Retrospective	San Francisco, USA	95 patients	92% successful (defined as can communicate with TEP)
Wong et al, 1997 ⁹	Retrospective	Hong Kong	153 patients	52% functional speech
Geraghty et al, 1996 ⁶	Retrospective	Chicago, USA	40 patients	66% successful
Silverman et al, 1994 ¹⁰	Retrospective	Montreal, Quebec	46 patients	60% patients satisfied; no difference between radiotherapy (RT) and non-RT group
Kao et al, 1994 ¹¹	Retrospective	Philadelphia, USA	136 patients	93% for primary TEPs; 83% for secondary TEPs; postoperative RT does not increase complication rate
Hilgers et al, 1993 ¹⁶	Retrospective	Amsterdam, The Netherlands	132 patients	92% successful; RT had no effect on complication rate
Gerwin et al, 1993 ¹²	Retrospective	Alabama, USA	24 patients	60% excellent; 5% fair
Clevens et al, 1993 ¹³	Prospective	Michigan, USA	21 patients	75% fluent
St Guily et al, 1992 ¹⁴	Prospective	Paris, France	41 patients	73% daily use with good voice
Maniglia et al, 1989 ¹⁵	Retrospective	Cleveland, Ohio	95 patients	85% of primary TEPs; 69% of secondary TEPs successful

laryngectomy (primary TEP) or as a secondary procedure³ after wound healing from surgery and radiotherapy have occurred (secondary TEP). Primary insertions have also not been shown to significantly alter the voice quality nor are they associated with any added morbidity.¹¹

We have been using this method of voice rehabilitation routinely since 1993. We place both the indwelling and non-indwelling catheters as both primary and secondary procedures and we follow these patients in a specially designated voice restoration clinic^{18,19} where rehabilitation is taught by our doctors, speech therapists and nurses.

The most common complications in the literature include crusting with salivary leakage through or around the valve, candida infestation, deterioration of the prosthesis, granulation tissue formation, stomal stenosis,²⁰ aspiration and dysphagia.^{6,21-23}

Assessment of the prosthetic voice in the literature is highly subjective with some authors using parameters such as intelligibility, loudness, pitch, telephone intelligibility^{4,7} and others just using simple intelligibility on a point scale.²

A review of the literature also did not show any studies comparing pharyngeal closure techniques or age of patient with voice quality.

Aims

The aims of this study were to examine and establish short (less than 6 months) and longer term success rates, predictors of success and complications for our patients who had undergone TEPs post-laryngectomy. We also wanted to assess the effect of radiotherapy on voice production and to see if there was any difference with different laryngeal closures intraoperatively or timing of puncture insertion.

Subjects and Methods

A retrospective analysis of the data was performed on a total of 38 patients who had total phonatory laryngectomy and TEP with prosthetic placement from December 1993 at the Department of Otolaryngology, Tan Tock Seng Hospital. All the patients were followed up for at least 6 months post-placement at our voice restoration clinic.

A numerical assessment of tabulating and rating voice production was used as shown below:

- 0 no voice
- 1 poor voice
- 2 poor but occasionally fair
- 3 fair voice
- 4 fair but occasionally good
- 5 good

The assessment was done by both the speech therapists and ENT surgeons. Good voice was recorded when the patient was able to speak fluently with good intelligibility and volume. Poor voice was recorded if the patient had a voice but was not understood and lacked the above factors.

We also identified from the patients' notes the site of surgery, the type of reconstruction and timing of radiotherapy.

We also assessed the complications seen, their management and eventual outcome.

Data Analysis

Statistical analysis was performed using SPSS for Windows (v9.0). The level of significance (alpha) was pre-determined at 0.05. Non-parametric tests were used to test for association with the dependent variable, voice quality. Voice quality was also assumed to be on a continuous scale. The Mann-Whitney U test was used to analyse voice quality among dichotomous variables. For clinic attendance

and regular maintenance, the Kruskal Wallis test was used instead. For continuous variables like age, the Spearman Correlation was used to test for association with voice quality.

Results

Out of the 38 patients, only 1 was female. The mean age of the patients was 63.5 years with a range of 40 to 81 years. Twenty-eight had undergone primary TEP surgery with the remaining 10 having had secondary restoration at an average insertion time of 4.9 months with a range of 3 to 8 months. Thirty-five patients had primary closure of the pharynx with 13 vertical, 19 horizontal and 3 T-shaped closures. Of the remaining 3 patients, 2 required pectoralis major pedicled flaps and 1 required a free jejunal flap.

Thirty-five patients had radiotherapy with 27 having only postoperative radiotherapy, 3 having both pre- and postoperative therapy and 5 patients with only preoperative therapy (these were radiation failures which required salvage surgery).

Evaluation of the data revealed that TEPs provide a fair to good voice (i.e. point scale 3, 4 or 5) in 74% of our patients at 6 months follow-up (Table II). Patients less than 60 years old also had better results (overall voice rating average 3.66) compared with those above 60. Between the ages of 60 to 69, the overall voice rating was 3.13 and between ages 70 to 79, the overall voice rating was 3.50. Patients above the age of 80 fared the worst, with overall voice rating being only 1.5 (Table III). Secondary TEPs provided fair to good voices in 90% of cases compared to 68% of primary TEPs (Table II). Primary closure of the pharynx with horizontal (overall voice rating 3.68) or T-shaped closures (overall voice rating 3.67) appeared to have better voice production compared to vertical closures (overall voice rating 3.00), but even these were much better than closure with a flap (overall voice rating 2.00) (Table IV). Voice quality was also found to be diminished during radiotherapy (overall voice rating 2.05) but recovered at 6 months post radiotherapy (3.10). Patients with no radiotherapy were noted to have an overall voice rating of 3.7 which was slightly higher than those with only pre- and postoperative radiotherapy (voice rating 3.2 and 3.4, respectively). Patients with both pre- and postoperative radiotherapy were noted to have an overall voice rating of only 2.6 (Table V). These parameters were, however, not significant predictors of voice quality.

An analysis of the attendance at our voice restoration clinic, however, showed that patients who attended regularly had statistically significant better voices compared to those who did not do so (median voice 5 as compared to 3) ($P = 0.044$). The overall voice rating of our regular attendees (which accounted for 48% of our cohort) was 4.13 as compared to 2.4 for our occasional attendees (18% of cohort). Patients who cleaned and maintained their prostheses were also shown to have statistically better voices (median voice 5 as compared to 1) ($P = 0.002$) (Tables VI and VII). The patients who cleaned meticulously (which accounted for 37% of the total cohort) had overall voice ratings of 4.27 compared to 1.89 for patients who rarely cleaned their prostheses (29% of cohort). Statistical analyses of the different variables with their associated P values are shown in Table VIII.

A list of the complications were also noted; of which, the most common was crusting of the prosthesis. There was no mortality associated with the use of TEPs (Table IX).

Discussion

TEPs has previously been shown to be a useful means of voice production in laryngectomees.^{2,6,7} Primary TEPs

TABLE III: AGE DIVISION AND VOICE PRODUCTION

Age (y)	No. (% of study population)	Overall voice
<60	15 (40)	3.66
60 to 69	15 (40)	3.13
70 to 79	6 (15)	3.50
>80	2 (5)	1.50

TABLE IV: PHARYNGEAL CLOSURE AND VOICE PRODUCTION

Type	No. (% of study population)	Overall voice
Vertical	13 (34)	3.00
Horizontal	19 (50)	3.68
T-shaped	3 (8)	3.67
Flap	3 (8)	2.00

TABLE V: RADIOTHERAPY (RT) AND VOICE PRODUCTION

Type of RT	No. (% of population)	Overall voice
Postoperative only	27 (71)	3.4
Preoperative only	5 (13)	3.2
Pre- and postoperative	3 (8)	2.6
No RT	3 (8)	3.7

TABLE II: PRIMARY/SECONDARY TRACHEOESOPHAGEAL PUNCTURE (TEP) AND VOICE PRODUCTION

Type	Voice 0	Voice 1	Voice 2	Voice 3	Voice 4	Voice 5	Overall voice
Primary (28 patients)	7% (2)	18% (5)	7% (2)	18% (5)	14% (4)	36% (10)	3.21
Secondary (10 patients)	0% (0)	10% (1)	0% (0)	50% (5)	0% (0)	40% (4)	3.60

TABLE VI: CLINIC ATTENDANCE AND VOICE PRODUCTION

	No. of patients (%)	Overall voice
0 (rarely attends)	7 (18)	2.4
1 (sometimes attends)	13 (34)	2.75
2 (always attends)	18 (48)	4.13

TABLE VII: PROSTHESIS MAINTENANCE AND VOICE PRODUCTION

	No. of patients (%)	Overall voice
0 (rarely cleans)	11 (29)	1.89
1 (sometimes cleans)	13 (34)	4.2
2 (always cleans)	14 (37)	4.27

TABLE IX: COMPLICATIONS OF TRACHEOESOPHAGEAL PUNCTURE (TEP) USE

Complications	No. (% of population)
Early crusting of prosthesis	15 (40)
Early candida (<3 months)	6 (16)
Early leaks	6 (16)
Embedded/migrated prosthesis	6 (16)
Extrusion	6 (16)
Hypertonic PE segment	4 (10)
Overhang	4 (10)
Aspirated prosthesis	3 (8)
Aspiration pneumonia with admission	3 (8)
Airway compromise	2 (5)
Painful articulation	1 (2.5)
Persistent fistula requiring surgery	1 (2.5)
Dysphagia	1 (2.5)

have the advantage of only requiring one surgery and with it the reduction in costs and patient inconvenience. Patients are also able to have early onset of voice. Advantages of the secondary placement may include better candidate selection (with the use of the Taub insufflation test to test the articulatory and vibratory segments of the upper airway) and complete recovery from surgery and radiotherapy. Care has to be taken in the use of the prosthesis during early wound healing and radiotherapy as digital pressure can affect the prosthesis position and function.

To our knowledge, this study is the first published analysis of the use and complications of TEPs in Singapore. The above results suggest that secondary procedures especially in younger patients with horizontal/T-shaped pharyngeal closures may produce better results. These may be in part related to increased motivation, better manual dexterity, coordination and visual acuity in the younger population together with better patient selection afforded by the delay in placement. These, however, were shown to be not statistically significant.

As shown in the literature previously,²⁴ apart from a temporary deterioration of voice during radiotherapy, the

TABLE VIII: PARAMETERS VERSUS VOICE PRODUCTION

	Median	Minimum	Maximum	P value
Tracheoesophageal puncture				
1	3.5	0	5	0.63
2	3	1	5	
Chinese				
Yes	3	0	5	0.09
No	5	3	5	
Closure H				
Yes	4	1	5	0.976
No	3	0	5	
Closure T				
Yes	3	3	5	0.822
No	3	0	5	
Closure V				
Yes	3	0	5	0.725
No	4	0	5	
Preoperative radiotherapy (RT)				
Yes	3.5	0	5	0.682
No	3	0	5	
Postoperative RT				
Yes	3	0	5	0.738
No	4.5	1	5	
Flap				
Yes	3	0	5	0.261
No	3.5	0	5	
Candida infection				
Yes	3.5	1	5	0.895
No	3.5	0	5	
Clinic attendance				
0	3	0	5	0.044*
1	3	0	5	
2	5	1	5	
Prosthesis maintenance				
0	1	0	4	0.002*
1	4.5	3	5	
2	5	1	5	
Age [#]	r = -0.2			0.228

Note: All *P* values are from Mann-Whitney U test unless otherwise stated

* *P* values are from Kruskal Wallis test

[#] For age, Spearman Correlation was used

role of radiotherapy was also not shown to be statistically significant in predicting voice quality.

The two factors which were shown to statistically improve voice quality were regular attendance at our voice restoration clinic and regular maintenance of the prostheses (*P* = 0.044 and *P* = 0.002). This might reflect the necessary patient motivation and combined team care required to ensure good voice.

The retrospective nature of this study makes this analysis a bit more difficult. Other factors such as education, motivation and support systems were also not evaluated. The rating system applied (as with the rest of the literature)

is subjective and captures the patient's voice only during the consultation. We feel that having a team consensus on the voice quality would probably be the most objective assessment of voice. We have since incorporated this scoring system in our vocal rehabilitation clinic.

The varied but potentially fatal complications seen with this procedure illustrate the need to inform and educate patients about the potential hazards and the need for close follow-up. The most common complication seen was early crusting of the prosthesis which was noted in 40% of our patients. Patients were taught how to maintain the prosthesis by using pipettes and brushes with anti-fungal solutions. Reflux therapy is also sometimes instituted in cases of excessive crusting and short prosthesis life. Other complications seen included leaks both through and around the prosthesis. Leaks through the prosthesis were treated by replacing the prosthesis, whilst leaks around the prosthesis were treated by a purse-string suture or by leaving the prosthesis out for a length of time to allow natural closure. Only 1 patient required surgical closure with first a sternocleidomastoid muscle flap then a 3-layered closure using a fascial graft. Embedded or migrated prostheses are probably due to the use of excessive digital pressure or that of the wrong technique of occluding the stoma. Patients were assessed and taught the technique of proper stomal occlusion which is that of allowing the stoma to rise to the occluding digit. Excessive granulation can be treated by silver nitrate cautery or diathermy.

Conclusion

TEPs provide a fair to good voice in 74% of our patients. Our findings show that regular follow up at our clinic together with proper maintenance of the prostheses help produce better voice. With proper patient education and close follow-up to prevent and manage complications, the TEP with prosthesis placement is a safe and effective method of voice rehabilitation in the laryngectomised patient.

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