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Tracheoesophageal puncture and the Blom-Singer prosthesis : a unique method for voice restoration following laryngectomy.

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TRACHEOESOPHAGEAL PUNCTURE AND THE BLOM-SINGER PROSTHESIS: A UNIQUE METHOD FOR VOICE RESTORATION FOLLOWING LARYNGECTOMY

By

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I. INTRODUCTION

> Since the first laryngectomy, an implantable devise or a fool-proof operation that would permit the instaneous restoration of voice has been the dream of every generation of surgeons. Unfortunately, . . the dream never quite comes to workaday reality.[1]

Until now!

Total larygnectomy can be devastating to a patient's functional and psychological well-being. Not only is the impact of having a cancer damaging, but the social isolation resulting from the loss of voice is an overwhelming experience thus the restoration of speech becomes a major priority in the rehabilitation of this population (Donegan, et al., 1981). The speech pathologist intending to provide comprehensive alaryngeal speech services to the laryngectomee must have a thorough knowledge of available rehabilitation techniques and be able to offer viable alternatives to accommodate individual patient needs. Although, at the present time, there is no totally satisfactory laryngeal substitute, some innovative surgical-prosthetic methods of voice restoration are becoming available and hold great promise for approximating the ultimate goal of easy-flowing alaryngeal phonation.

Singer and Blom (1980a) recently developed a tracheoesophageal-prosthetic technique which has been gaining wide acceptance as a preferred method for alaryngeal rehabilitation because it is a simple

[1]K. Devine, "Forward," R. Keith, *A Handbook for the Laryngectomee* (Danville, Ill.: Interstate Printers and Publishers, Inc., 1974), p. v.

surgical procedure, voice acquisition is rapid using a removable silicone valve, and the patient success rate is impressive with minimal postsurgical complications. This paper attempts to explain the procedures involved in this "major breakthrough in neoglottic reconstruction" (Donegan, et al. 1981:495) and the benefits gained through using this method for alaryngeal rehabilitation.

While esophageal voice has been the best and most preferred method of alaryngeal speech, results on the number of patients who fail to acquire proficient phonation have been discouraging. Failures to attain esophageal voice have ranged from 10 percent (Hunt, 1964) to 60 percent or greater (Martin, 1963) with average estimates at approximately one third of the laryngectomized population (Snidecor, 1968).

The lack of effective voice rehabilitation methods becomes exacerbated when one considers the growing number of treatable laryngeal cancer patients. According to recent cancer statistics, approximately 3,000 laryngectomies are performed each year; there were an estimated 10,700 new laryngeal cancer cases reported in 1981 (Silverberg, 1981). Of all cancers, Silverberg reported that laryngeal carcinoma appears to be the most curable in that over 50 percent of the patients survive after five years of being diagnosed and treated.

In light of the evidence on esophageal speech failures and laryngeal cancer statistics, the reacquisition of speech is not only an ever-increasing rehabilitation priority but an ever-increasing obstacle confronting the laryngectomee and the speech pathologist. Demands for alternative voice rehabilitation methods are therefore being placed on the speech pathologist. Until now, other therapeutic choices have been seriously limited to electronic devices and/or manual communication. With the successful development of Singer and Blom's (1980) tracheoesophageal (t-e) technique, the laryngectomee now has a viable alternative to reestablish phonation.

II. GENERAL DYNAMICS OF TRACHEOESOPHAGEAL SPEECH

Surgical removal of the larynx results in (1) the loss of the vibratory sound source generated by the vocal cords and (2) the connection of the trachea to the neck through a circular opening called a tracheostoma. This procedure prevents the passage of pulmonary air through the nose and mouth. The esophagus remains intact, allowing normal swallowing behavior. See Figures 1 and 2. A basic rehabilitation requirement following total laryngectomy is the reestablishment of a speaking method which will enable a patient to communicate with others using an alternative to the excized larynx, i.e., alaryngeal speech.

The volumes of literature discussing the limitations of present alaryngeal methods and patient factors which influence the success of one method over another indicate that the selection process can be challenging (Keith and Darley, 1979). While esophageal voice is usually the most preferred method among speech pathologists, studies have shown that a significant percentage of patients fail to achieve speech proficiency even after years of therapy (Martin, 1963). The only alternate method has been the artificial larynx. Although this method provides efficient and functional communication, annoying drawbacks exist (Blom, 1979)[2]. These include an esthetically displeasing mechanical

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[2]E. Blom, "The Artificial Larynx: Types and Modifications," eds. R. Keith and F. Darley, *Laryngectomee Rehabilitation* (Houston, Tex.: College-Hill Press Inc., 1979).

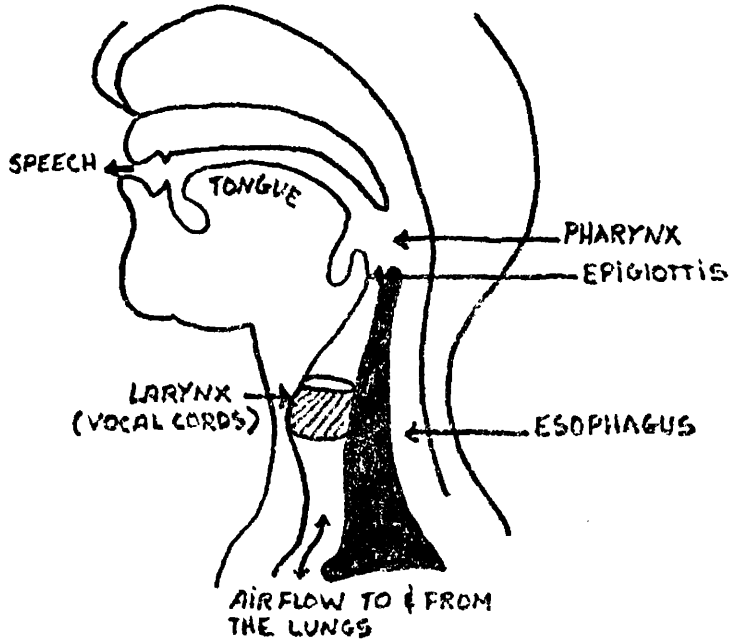

Figure 1. Normal laryngeal physiology.

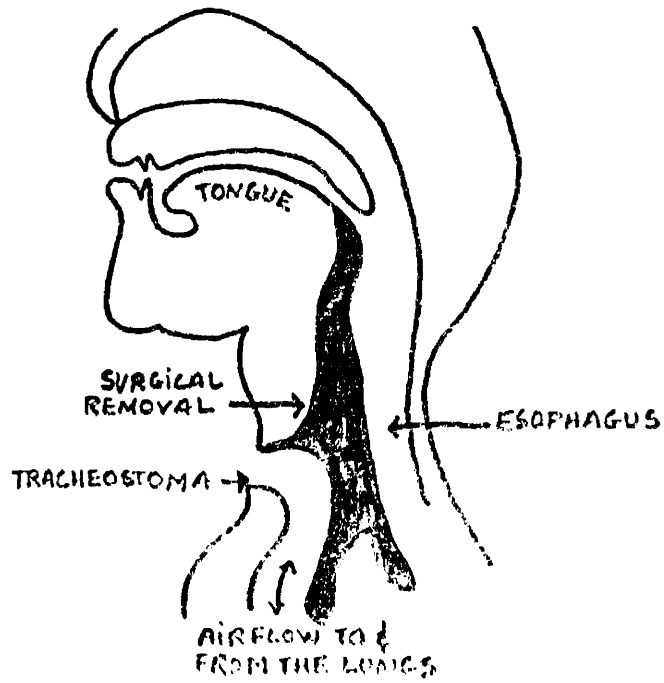

Figure 2. Laryngeal physiology following laryngectomy.

sound with a lack of inflection and the expense of instrument maintenance.

Over the past century, various innovative surgical reconstruction approaches for restoring voice in the postlaryngectomy patient have been attempted with minimal success (Blom and Singer, 1979)[3]. Because the majority of patients experience various complications--liquid aspiration, airflow track stenosis, complex surgery, elaborate prosthetic devices, and surgical risks--none of these operations have been favored among surgeons. (Interested readers are referred to the article by Blom and Singer [1979][4] which details the evolution of surgical-prosthetic techniques).

Two surgical-prosthetic techniques recently developed in the United States have been reporting impressive patient success results of between 80 to 90 percent. Panje (1981b) and Singer and Blom (1980a) have devised simple surgical procedures (the Voice Button and voice prosthesis, respectively) which create a small passageway between the trachea and esophagus. See Figure 3. Following the tracheoesophageal puncture (TEP), a small silicone one-way valved prosthesis is inserted. Upon stoma occlusion, this device allows exhaled pulmonary air to enter and vibrate the esophagus, but it precludes food and liquid aspiration. See Figures 4 and 5 for an illustration of Blom-Singer's voice prosthesis. For an illustration of Panje's Voice Button, see Figure 6. While the

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[3]E. Blom and M. Singer, "Surgical-prosthetic Approaches for Postlaryngectomy Voice Restorations," eds. R. Keith and F. Darley, *Laryngectomee Rehabilitation* (Houston, Tex.: College-Hill Press Inc., 1979).

[4]*Ibid.*

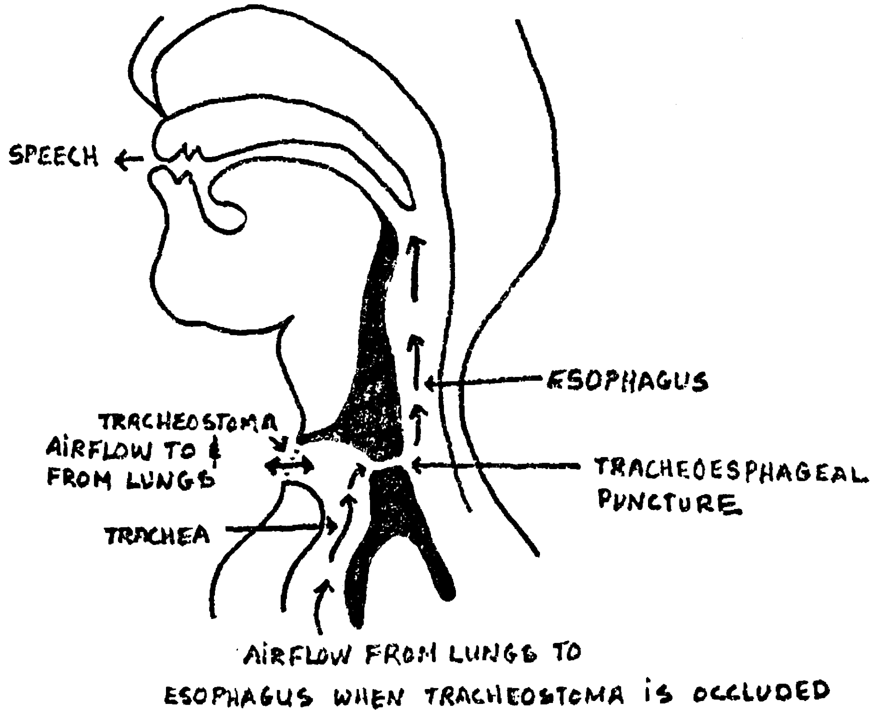

Figure 3. Tracheoesophageal tract location and airflow dynamics.

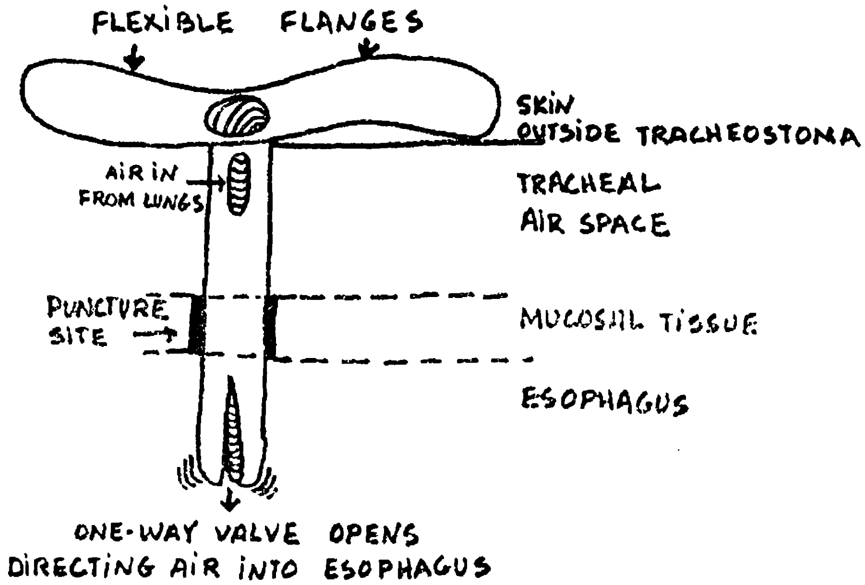

Figure 4. Blom-Singer voice prosthesis. Direction of airflow is indicated by arrows.

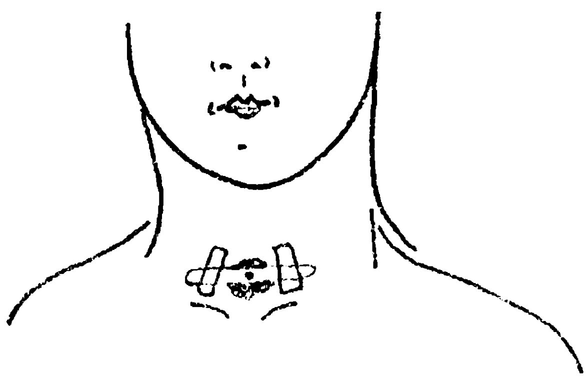

Figure 5. Blom-Singer voice prosthesis positioned in the TEP tract.

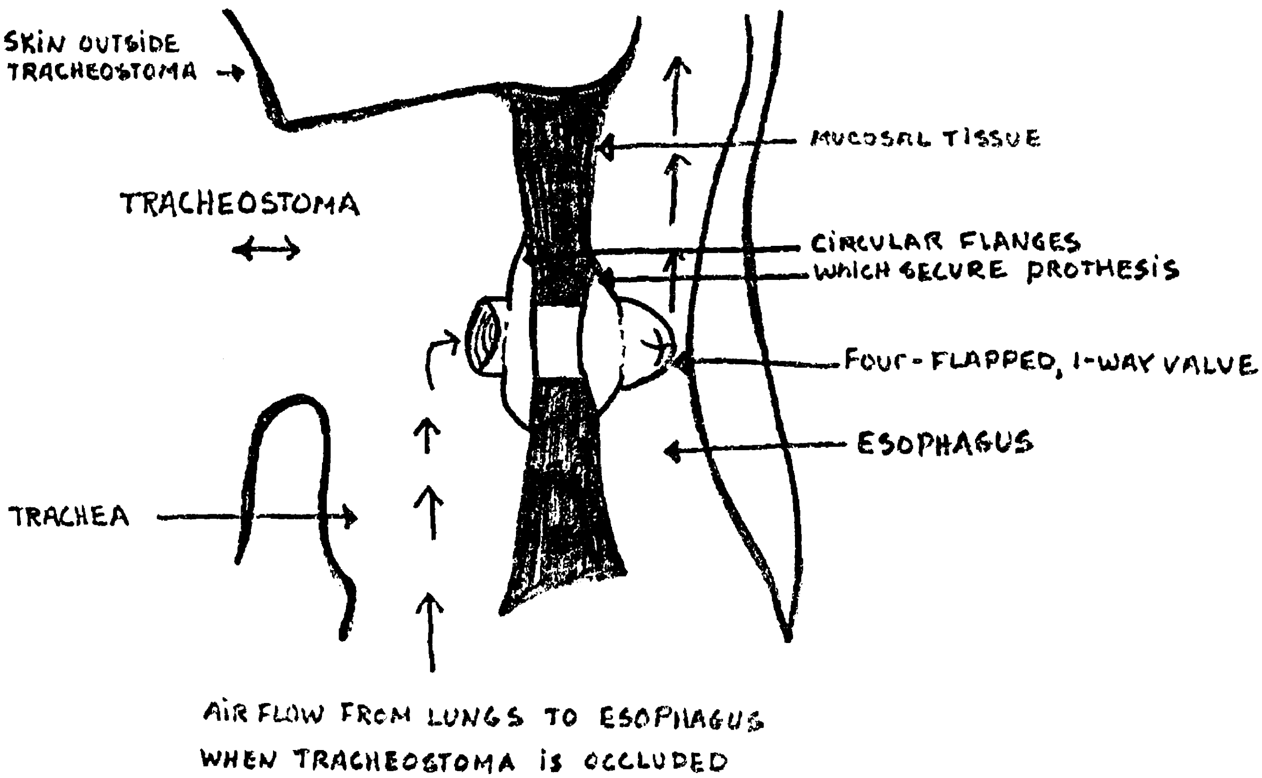

Figure 6. Panje Voice Button. A bi-flanged prosthesis which is self-contained within the tracheostoma and requires a separate inserter device to position it. In case of inhalation, the Voice Button can be retrieved by pulling on a disk attached to the prosthesis by two strings which lie outside the tracheostoma (this is not shown).

general scheme and dynamics of these techniques are highly similar, minor differences in surgical procedures, structural design of the prosthesis, and therapeutic methods exist and should be considered when choosing between various alaryngeal methods.

III. PROCEDURES FOR THE APPLICATION OF THE BLOM-SINGER PROSTHETIC DEVICE AND SUBSEQUENT VOICE RESULTS

Patient Selection Considerations and Procedures

The numerous advantages of the Blom-Singer technique for voice restoration over other methods have been enthusiastically received. See Table 1. As with any voice treatment plan, however, patient selection factors, i.e., postoperative anatomy, motivation, intelligence, etc., can markedly influence the success of rehabilitation and must be considered prior to initiating this procedure. Singer and Blom (1980b) have compiled patient selection factors which they feel are crucial for the successful reestablishment of alaryngeal voice via their technique. See Table 2.

Of particular concern in determining contraindications for their procedure, Singer and Blom (1980b) advocated using an esophageal distention test to assess the tonicity of the pharyngoesophageal (p-e) segment located superior to the intended puncture site. It long has been hypothesized that a tight p-e sphincter may be a barrier to attaining good esophageal speech (Keith and Darley, 1979). Shanks (1979)[5] recently asserted that "the most crucial area for the production of esophageal voice is the p-e segment [and that] the more serious problem is undue tension rather than laxness in this p-e area" (p. 479).

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[5]T. Shanks, Essentials for Alaryngeal Speech: Psychology and Physiology," eds. R. Keith and F. Darley, *Laryngectomee Rehabilitation* (Houston, Tex.: College-Hill Press Inc., 1979).

Table 1

Advantages of the Tracheoesophageal-Prosthetic Technique for Voice Restoration

1. The operation is technically simple, reproducible, and safe.
2. The procedure is completely reversible if unsuccessful.
3. The procedure can be used with postradiation treatment or with previous radical neck dissection.
4. The inexpensive prosthesis is easy to insert.
5. There is minimal aspiration due to the unique one-way valve design.
6. There is little stenosis of the tracheoesophageal puncture.
7. There is good patient acceptability and a high success rate (80 to 90 percent).
8. The operation produces fluent, superior esophageal speech with little therapeutic expenditures.
9. There are minimal surgical and infectious complications.

Table 2

Patient Selection Factors for the Blom-Singer Voice Restoration Technique

1. No medical contraindications; no evidence of recurrent laryngeal disease, tracheitis, or ulcerations.
2. Adequate stoma size and location; can surgically readjust stoma radius.
3. Adequate mental status; no instability or alcoholism.
4. Intact physical-sensory modalities to ensure correct prosthetic use and maintenance; no evidence of poor vision, poor visual-digital coordination, arthritis, parkinsonian tremors, or pulmonary problems.
5. Favorable passive and active air insufflation test; no evidence of pharyngeal or esophageal strictures.
6. Positive psychological motivation.
7. No occupational constraints.
8. To be used as a secondary procedure, postlaryngectomy; patient should have adequate healing of strictures, attemped esophageal speech, and completed any radiation treatment four to six weeks prior to the puncture.

Source:

M. Singer and E. Blom, "Tracheoesophageal Puncture: An Interdisciplinary Approach to Postlaryngectomy Voice Restoration" (a course presented at the American Speech and Hearing Association Convention, Detroit, Michigan, November 1980), p. 4.

A study conducted by Winans, et al. (1974) supported this hypothesis. They found that laryngectomees who were having problems with esophageal voice exhibited p-e pressures that precluded their ability to inject air low enough into the esophagus so as to produce segment vibration with minimal air force, i.e., they had too great a pressure in the p-e segment.

In that the p-e sphincter appears to function as a neoglottis in the esophageal and tracheoesophageal speaker, the tonicity of this area can be an important factor affecting the success of t-e voice production. Singer, et al. (1981) felt that a tight p-e stricture or spasm contributes to voice failures and that they can be predicted prior to instigating their procedure. They contended that a transnasal esophageal insufflation test with simultaneous videofluoroscopy should always be conducted preoperatively. This test simulates esophageal airflow, causing a p-e segment vibration. Not only do test results provide information on voice quality and airflow duration, but the simultaneous videoflows illustrate the structural dynamics of pharyngoesophageal airflow.

While negative insufflation results are a contraindicator, this is not an absolute and t-e speech can develop in many patients (Singer and Blom, 1981). It is, however, an important procedure and those patients who exhibit esophageal muscle spasms which effectively preclude airflow necessary for fluent phonation should be counselled on possible postoperative complications, i.e., greater expenditure of time, energy, frustration, and/or a pharyngeal constrictor myotomy.

Two reports have questioned the validity and reliability of the air insufflation test in predicting success or failure of the tracheo-esophageal puncture (Donnegan, et al., 1981; Panje, 1981). Interestingly, the studies reported voice fluency failures which were attributed to pharyngeal muscle spasm. While Singer and Blom (1980a) admitted to some false positives and negatives, they found that airflow constriction results "correlated well with lack of initial voice failures and the need for reeducation of the pharyngoesophageal muscles for the voice production" (p. 496).

A three-year study with 129 t-e puncture patients showed that 16 patients failed to achieve fluent speech because of pharyngoesophageal spasm (Singer, et al., 1981). All 16 patients had been identified preoperatively by transnasal esophageal insufflation. Additional assessment via transtrachael esophageal insufflation with simultaneous video fluoroscopy consistently showed the presence of a

> retropharyngeal mass, corresponding radiographically with the pharyngeal constrictors. The axial length of the mass ranged from 1 to 4 cm, and was increasingly prominent with increasing esophageal distention. The mass effectively occluded the pharynx preventing airflow for voice. With relaxation, the muscle mass was not observed and no patients reported dysphagia (Singer, et al., 1981: 500).

To demonstrate the potential for smooth esophageal airflow and fluent voice following muscle relaxation, i.e., a myotomy, Singer and Blom (1981) injected local lidocaine which effectively blocked pharyngeal constrictor innervation. In all cases (N = 14),

> effortless speech resulted, and findings from videofluoroscopy confirmed the relaxation of pharyngeal constrictor muscle. With this identification of sphincter spasm, myotomy of the pharyngeal constrictor muscles was then undertaken (Singer and Blom, 1981: 671).

Subsequent to myotomy of the cricopharyngeus and pharyngeal constrictor muscles, all 14 patients eventually acquired tracheoesophageal voice. (A few minor complications arose which precluded immediate success.)

Singer and Blom (1981) also performed eight constrictor myotomies in congruence with initial t-e puncture procedures. Candidate selection was solely based on inadequate preoperative transnasal insufflation and videofluoroscopy results. All eight patients acquired successful t-e speech following this combined approach. See Table 3.

An explanation of the air insufflation test used to evaluate pharyngeal muscle spasticity and airflow regulation is presented to help orient the speech pathologist. Technical instructions on the pharyngeal nerve plexus block and the selective constrictor myotomy are thoroughly described by Singer and Blom (1981) and will not be reiterated.

Preoperatively, the ability to tolerate esophageal distention is assessed by passing a No. 12 or No. 14 French red catheter through a nare into the esophagus to the level of the tracheostoma. Next, an examiner gently blows a steady airstream through the catheter, simulating the air source which maximally distends the esophagus and vibrates the tissue. If the catheter placement is too high, i.e., oropharynx or superior hypopharynx, a soft breathy quality will be produced. If the placement is too low or too forceful, air may enter the stomach. If this occurs, the catheter level is readjusted after an oral escape or belch is detected (Singer and Blom, 1980a).

Two conditions are evaluated during air insufflation: (1) passive, when a patient relaxes his/her oral-pharyngeal structures and (2) active, when a patient participates by saying "Ah," counting, or forming words. If sound is produced, the examiner should subjectively

Table 3

Evaluation of TEP-myotomy*

Results	No. of patients
Successes (no complications)	
Post-TEP	4
Pre-TEP based on inadequate insufflation results	8
Adjusted successes (complications corrected)	
Second myotomy of the middle pharyngeal constrictor	3
Transient esophageal aspiration	3
Minor wound infections	2
Postoperative hematoma	1
Subendocardial infarction	1
Failures (not using t-e speech)	0
Totals	
Succcesses	22
Failures	0

*N = 14 post-TEP and 8 pre-TEP.

Sources:

M. Singer and E. Blom, "Selective Myotomy for Voice Restoration After Total Laryngectomy," *Arch Otolaryngology*, 107 (1981), 672.

M. Singer, E. Blom, and R. Hamaker, "Further Experience with Voice Restoration After Total Laryngectomy," *Annals of Otology, Rhinology and Laryngology*, 90 (1981), 500-501.

note the amount of air pressure required for adequate sound production and the quality of airflow in respect to spasm and/or voice duration, i.e., aphonia, intermittent aphonia, or a squeezing tone. In addition, the examiner should have the patient describe what he/she is feeling, i.e., tension level. Because this procedure can be a tension promoting situation, the examiner should adequately educate the patient on what it will feel like and the importance of relaxation, i.e., letting the airstream passively flow through the structures.

A videofluoroscopy with a barium swallow is done simultaneously with the airflow test. Although infrequently used in alaryngeal speech rehabilitation, Blom (1979)[6] felt it was an excellent clinical tool because it provides the means to visually examine "anatomic and physiologic variables that may partly account for failure to acquire esophageal voice in some patients" (p. 182). Videoflows enable the observation of dynamic esophageal movements in conjunction with audio recordings. From these data, one can determine the location of the catheter, i.e., correct placement, and visualize the vibration and/or the reflexive contraction of the pharyngoesophageal segment.

When reviewing accumulated experience with 129 patients, Singer, et al. (1981) concluded that "the ability to tolerate pharyngoesophageal airflow for alaryngeal speech" (p. 502) has significant implications for not only t-e speakers but for conventional esophageal speakers.

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[6]E. Blom, "Radiographic and Manometric Assessment of the Patient who Fails to Acquire Esophageal Voice," eds. R. Keith and F. Darley, *Laryngectomee Rehabilitation* (Houston, Tex.: College-Hill Press Inc., 1979).

> The air-distended esophagus will stimulate pharyngeal constrictor contraction and in the laryngectomized condition, inability to relax may occur in as many as 15 to 20% of failed esophageal speakers. Selective division of the pharyngeal constrictor muscles will permit relaxation and voice acquisition will be possible for a larger number of laryngectomy patients (Singer, et al., 1981:502).[7]

Prosthetic Voice Procedures

The tracheoesophageal puncture is performed under general anesthesia. The procedure takes 10 to 20 minutes and hospitalization lasts four to seven days. The puncture site is located 3 to 5 mm inferior to the mucocutaneous junction of the tracheostoma (superior aspect). To help orient the surgeon, a fiberoptic esophagoscope with a 1-cm perforation on the beveled end is used. This device is then introduced to the level of the tracheostoma. By palpating the membraneous tracheal wall and using the translumination of light from the esophagoscope, the perforation is located and adjusted to the optimum midline position. A 14-guage intracath needle (bent to from a C-curve) is inserted through the posterior tracheal mucosa and into the perforation until it butts against the wall of the esophagoscope. Next, the needle is threaded up the esophagoscope and out the oral cavity; the distal end is attached to a No. 14 French red catheter.

While dilating the puncture with a hemostat, the catheter is drawn through the newly created hole into the oral cavity. The catheter is retrieved from the oral cavity and passed through a nare. To prevent dislodgment, a single loop is created by securing the two loose ends of the catheter with suture thread. The catheter remains in place for 24 to 48 hours until the voice prosthesis is inserted.

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[7] *Ibid.*

Postoperatively, the patient receives continuous humidification and topical application of 10 percent acetylcysteine solution. The administration of analgesics or antibiotics are unnecessary. The patient is thereafter seen by a speech pathologist for prosthetic fitting, use, and maintenance. The surgeon may be present for the initial visit--when the stent is withdrawn through the nose, and the proper prosthetic length is determined and immediately inserted into the puncture.

The silicone prosthesis has a No. 16 French diameter and comes in various lengths ranging from 2.1 to 4.3 cm. Two thin flexible flanges project from the proximal side of the prosthesis. These provide lateral retention to the skin surrounding the tracheostoma. A port, located on the inferior surface, permits exhaled pulmonary air to enter the prosthesis. At the distal end (esophageal), a razor-thin slit is designed to open with the entering air pressure, thereby conducting the airflow into the esophagus. During swallowing, this valve or slit remains closed and prevents food or liquid aspiration. Review Figure 4. Once secured, the prosthesis completely occludes the puncture, prevents liquid leak, and maintains the patency of the tract.

Upon removal of the catheter, a 3.6 cm prosthesis should be immediately inserted into the tract. A selection of adequate prosthetic length is then made. If the prosthesis is too long, it will contact the esophageal wall and push back out. If underfit, the puncture will begin to close down within three to four hours and a restent will be required to help determine correct length

Singer and Blom (1980b) have suggested using a Q-tip. The stick end of the Q-tip is gently pushed through the puncture until it butts the posterior esophageal wall. The location is marked. When the stick is withdrawn, the length is measured and 3 mm is subtracted. This is the approximate length needed. To ensure proper fit, radiopaque pictures are made of a barium paste-filled prosthesis in position.

Johns and Cantrell (1981) have used cinefluoroscopy to determine correct size. Another way to check for proper fit is to have the patient occlude his/her stoma and attempt sound. Diameter fitting is unnecessary because the mucosal tissue maintains a constant tone and naturally closes around the prosthesis, i.e., the procedure is reversible in that complete stenosis occurs upon removal.

After a correct size is chosen, double-backed colostomy tape is cut and fitted to the underside of each flange. The prosthesis is then inserted with the fingers or a bent pipe cleaner that has been inserted into the hole located between the flanges. Once in place, tincture of bensoin is applied to the top of the flanges and surrounding skin area. Paper tape is adhered over each flange and over the end of the prosthesis to help stoma occlusion.

> The patient is instructed to occlude the stoma to divert exhaled air through the voice prosthesis into the esophagus, and voice is obtained immediately. The speech pathologist instructs the patient in proper breath control, articulation, and if necessary muscle relaxation for satisfactory voice production.
>
> Although the prosthesis remains in place at all times, the patient is instructed on daily removal, cleaning, and replacement as part of his speech therapy (Singer and Blom, 1980a:532).

Singer and Blom (1980a) estimated mean treatment time to be six hours of postoperative care. A speech pathologist should see the patient at monthly intervals for at least three months. Instructions on how to insert, use, and maintain the prosthesis should be done at the initial fitting session. A list of essential equipment that the patient should have appears in the Appendix. A price list for various products also appears in the Appendix.

The voice prosthesis should be changed daily; the stoma and the tract should be cleared of any crust buildup (tweezers are useful). The silicone prosthesis cleans easily with warm, soapy water. A pipe cleaner inserted into the hole between the flanges will remove any buildup. Care should be taken not to push the pipe cleaner through the valve slit. Plaque will occasionally form; this can be eliminated by dropping the prosthesis into boiling water for 30 to 60 seconds.

The patency of the prosthesis should be continuously monitored. If the slit remains open, it is nonfunctional. Average life expectancy, with constant wear, is two months. While the prosthesis may be worn at all times, some patients prefer to remove the prosthesis before retiring and insert a catheter. This may extend prosthetic endurance. The silicone material of the prosthesis decomposes when in contact with alcohol, greasy foods, lubicants, or gels. Patients should try to avoid these ingredients as much as possible.

Troubleshooting Techniques

From accumulated patient experience, Singer and Blom (1980b) devised a list of troubleshooting ideas to assist the speech pathologist intending to provide services to t-e speakers. See Tables 4 and 5 for a review of patient results. See Table 6 for a list of troubleshooting suggestions. See also the Appendix for a description of the Blom-Singer Trachestoma Vent.

Table 4

Evaluation of TEP: Singer and Blom*

Results	No. of patients
Successes (no complications)	38
Adjusted successes (complications corrected)	
Stenosis	
TEP dilated with urethral dilators	15
Aspiration	1
Failures (not using t-e speech)	
Nonfluent speech	6
Totals	
Successes	54
Failures	6

*N = 60.

Source:

M. Singer and E. Blom, "An Endoscopic Technique for Restoration of Voice After Total Laryngectomy," *Annals of Otology, Rhinology and Laryngology*, 89 (1980a), 531.

Table 5

Evaluation of TEP: Singer, Blom, and Hamaker*

Results	No. of patients
Successes (no complications)	82
Adjusted successes (complications corrected)	
Inflammed stoma due to radiation corrected by laryngectomy tube	4
Aspiration	
1 TEP electrocautery	9
Repeated TEP electrocautery	3
Cervical subcutaneous emphysema due to inadvertent stent removal	1
Failures	
Voluntary TEP closure	
Unable to maintain prosthesis although achieved fluent speech	9
Aspiration	
Intractable, surgically closed puncture	2
Low tracheostoma	3
Nonfluent speech†	16
Totals	
Successes (with myotomy)	113
Failures	16

*N = 129.

†All patient failures were predicted by preoperative insufflation test. Fourteen of the 16 patients agreed to unilateral pharyngeal constrictor myotomy. See Table 3 for results.

Sources:

M. Singer and E. Blom, "An Endoscopic Technique for Restoration of Voice After Total Laryngectomy," *Annals of Otology, Rhinology and Laryngology*, 89 (1980a), 531.

M. Singer, E. Blom, and R. Hamaker, "Further Experience with Voice Restoration After Total Laryngectomy," *Annals of Otology, Rhinology and Laryngology*, 90 (1981), 498.

Table 6

Troubleshooting Suggestions

1. The prosthesis is upside down (air cannot enter port.)
2. The valve slit is stuck together.
3. There is excessive digital pressure or an inadequate digital seal. Readjust pressure or consider
   (a) a thumbcover to help the stoma seal.
   (b) a Blom-Singer Tracheostoma Vent with a window cut superiorly to help direct airflow through the prosthetic port.
   (c) a Blom-Singer two-way respiratory valve to eliminate the need for digital occlusion.
4. There is an inadequate prosthetic length (too long or too short). Do a videofluoroscopy to check the fit.
5. The prosthesis is too recessed in the puncture thereby causing port occlusion.
6. There is voluntary p-e spasm (too much pressure, force, and neck tension), involuntary p-e spasm, or inadequate p-e segment demonstrated by negative air insufflation and videofluoroscopy. Alternatives may include relaxation exercises or a constrictor myotomy.
7. Tissue swelling interferes with the dynamics. Readust the prosthesis so the slit is vertical; progressively turn the prosthesis to a horizontal position until sound is produced.
8. The prosthesis may be stiff. Allow body temperature to warm and soften.
9. The t-e tract has stenosed. Repuncture to open the tract.
10. The t-e tract has stretched thereby causing prosthetic dislodgment and esophageal leakage. Electrocauterization with catheter placement will reestablish the tract size.
11. The prosthesis is worn and the valve slit does not close. Replace the prosthesis.

<u>Source</u>:

M. Singer and E. Blom, "Tracheoesophageal Puncture: An Interdisciplinary Approach to Postlaryngectomy Voice Restoration" (a course presented at the American Speech and Hearing Association Convention, Detroit, Michigan, November 1980), p. 1.

To alleviate stomal occlusion problems and free the hands, Singer and Blom (1980a) developed an optimal, two-way respiratory valve to be used in conjunction with their prosthesis. The valve is composed of three parts: (1) an inner adjustable two-way respiratory diaphragm, (2) a surrounding, disposable valve casing, and (3) a custom-contoured outer housing which completely seals the stoma. While still experimental, this respiratory valve

> allows two-way airflow at the stoma for breathing and converts to a one-way inspiratory valve with increased breath pressure for voice production. Air is then diverted into the esophagus, eliminating the need for finger occlusion of the stoma. With increased respiratory demands of exercise, the valve tolerance is adjustable and the soft diaphragm will evert when expiratory pressure increases during coughing (Singer and Blom, 1980a; 530-531).

IV. THE PANJE VOICE BUTTON COMPARED TO THE BLOM-SINGER PROSTHETIC DEVICE

While the issue has not been directly researched, Panje (1981b) asserted that the

> advantages of the Voice Button compared with the Blom-Singer device are: placement is accomplished with an outpatient surgical procedure requiring no special instrumentation, the prosthesis is self-contained within the tracheostoma, it cannot be dislodged unintentionally, and no sizing is needed (p. 116).

Other differences exist between these two tracheoesophageal procedures and should be considered when choosing among various alaryngeal rehabilitation methods.

As with the Blom-Singer technique, Panje (1981a) also provided patient selection criteria for Voice Button tracheoesophageal speech: (1) total laryngectomy, (2) three- to six-months postradiation treatment, (3) stoma diameter must be greater than 1.5 cm, (4) good dexterity to insert the prosthesis and occlude the stoma, (5) good pulmonary power (no asthma or "irritable airway syndrome" (p. 7), (6) unacceptable communication skills, and (7) thin tracheoesphageal wall ($\leq$ 1 cm).

Althought Panje (1981b) felt that patient motivation, intelligence, and habits might influence the success of prosthetic voice rehabilitation, he did not include these factors as part of his selection criteria. Neither did Panje find any value in using an air insufflation test to predict patient success; he believed the test was somewhat capricious.

In order to detect patients with potentially insufficient pulmonary pressure, Panje (1981a) has instructed the clinician as follows:

> [Have] the patient blow against your occluding thumb or finger over the tracheostoma and then unexpectedly withdraw your finger. If the patient continues to wheeze and cough considerably after you remove your finger then you would consider him having a possibility of irritable airway syndrome or asthmatic bronchitis. I would not do the procedure in this type of patient (p. 1).

The assessment of t-e wall thickness is done as part of the puncture procedure. Panje, et al. (1981) stated that it is extremely important to locate the minimal point of wall thickness to ensure adequate fit of the Voice Button (≤ 1 cm). This area is usually found 1 to 1.5 cm from the upper verge of the tracheostoma. It is more inferiorly based than the puncture site suggested by Singer and Blom (1980a). Panje (1981b) advised against using the Voice Button in Blom-Singer's t-e tract because of the varying degrees of wall thickness encountered in that particular area. Perhaps that is why the Blom-Singer device requires postoperative sizing procedures.

Prior to establishing the fistula (at the time of the operation), Panje (1981b) locates and sizes the required tract length, i.e., ≤ 1 cm. This ensures a postoperative prosthetic fit (shortcutting later sizing procedures). The design of the Voice Button also negates having various prosthetic lengths. Because it is self-contained within the tracheostoma, the length between the outside stomal opening and the posterior tracheal wall does not have to be determined. Review Figure 6. Although specific prosthetic sizing is not required, the inner (esophageal) valve tips come in two lengths. Panje devised the longer type for patients who produced insufficient lung pressure necessary for long-term vocalization or demonstrated difficulty with prosthetic insertion.

Panje's (1981b) t-e procedure is performed on a surgical outpatient basis (using local anesthetics). General anesthesia or hospitalization is not required as in the Blom-Singer technique. A dilator (No. 30 or No. 40 French) is passed through the esophageal lumen until the point of maximal forward bulge of the t-e wall is located, i.e., the thinnest area. Once located, a needle is inserted perpendicular to this point and pushed through the mucosa until the dilator is contracted. After a small incision is made, a catheter (No. 14 French) is inserted through the fistula simultaneously with the extraction of the dilater. The catheter is pushed in an inferior direction toward the stomach; the upper section is cut and secured to the neck with string.

Postoperatively, a patient is advised to drink fluids with meals for two to three days and follow a five- to seven-day course of antibiotics. In approximately 10 to 14 days, the patient returns for catheter removal, voice assessment, and Voice Button insertion and maintenance techniques.

Panje (1981a) noted that it is not necessary to change the Voice Button daily (some patients have gone as long as three weeks without removing the Voice Button). By decreasing the number of removals/reinsertions, t-e site irritation can be avoided. To remove daily crust formation on the tracheal side of the prosthesis, tweezers are recommended. To clean the prosthetic lumen and valve tip, a small amount of saline solution can be injected through the device using a Dey vial. (Aspiration is minimal and nonconsequential.)

Of 40 t-e Voice Button patients, Panje, et al. (1981) reported encountering two basic problems. One is a potentially long t-e tract which prevents a good prosthetic fit. This can be avoided by locating the thinnest wall area using the technique previously described. "A second difficulty in achieving total success with the Voice Button prosthesis has been pharyngoesophageal spasm" (Panje, et al., 1981: 504).

In an earlier report of 24 patients, two demonstrated aphonia with and without the prosthesis in place (Panje, 1981b). Although one patient achieved t-e speech after heavy valium sedation, both patients eventually allowed spontaneous closure of their fistula. Four other patients demonstrated problems with sustaining fluent phonation. During voice attempts, intense straining was observed. Two of these patients have allowed the puncture to close. It appears that the straining and/or pharyngoesophageal spasm was due to inconsistent stomal capping and patient anxiety. Of the last 16 patients, only one incidence of pharyngospasm has been reported (Panje, et al., 1981).

Although the results are preliminary, Panje (1981a) found that the introductory training of t-e speech prior to prosthetic placement appears to significantly counteract later spasmatic interferences. He stated that

> insertion of the voice prosthesis before adequate development of TEF speech has been achieved can produce pharyngeal tightening and incoordinate exhalation of air that may prevent future adequate development of TEF speech (p. 504).

Postoperatively, a patient is instructed to remove the catheter three to four times daily for 30 minutes and practice t-e speech.

> With early training the patient is taught the mechanics of TE fistula speech when minimal air resistance is encountered; he learns how to manage stenting of the fistula site, and he realizes from concrete experience that the speech is produced in the pharyngo-esophageal segment (upper esophageal sphincter) and not by the voice prosthesis per se (Panje, et al., 1981;505).

Once a patient is able to produce easy speech, cover the stoma properly, and appears generally relaxed, the Voice Button is inserted. This may vary from two to six weeks. Panje, et al. (1981:505) contended that

> insertion of the voice prosthesis is not indicated if the patient cannot develop TE fistula speech, since the prosthesis will increase the pulmonary effort needed to generate esophageal speech, and thus interfere with the establishment of the muscular coordination needed for sound production.

V. CURRENT RESEARCH ON THE BLOM-SINGER TECHNIQUE FOR VOICE RESTORATION

Five separate studies have recently reported results on laryngectomees who attempted using the Blom-Singer voice restoration technique as a primary mode of communication. From these data, various complications have been realized and important therapeutic factors have been gleaned to encourage successful rehabilitation. Although problems occurred, they were generally deemed minor. Case failures appeared to be the result of individual incompatibility with this particular method, i.e., motivation, learning ability, expectations, and mental stability. Each study conclusively endorsed Blom and Singer's technique as the best method currently available for restoring speech in an alaryngeal patient.

Wetmore, Krueger, and Wesson (1981) reported a moderate 72 percent success rate with Blom-Singer speech patients. See Table 7 for evaluation results. Note the number of adjusted successes, i.e., troubleshooting procedures which corrected initial failures. The authors felt that the most frequent problem encountered was an inability to retain the prosthesis, i.e., inadvertent tract stenosis. This was usually corrected by patient reeducation. In conclusion, they stressed the importance of teamwork in patient selection and training procedures. The surgeon assesses physical factors, stoma size, eye-hand coordination, pharyngeal segment vibration, and esophageal stenosis. The speech pathologist educates the patient on the technique and assesses the speech skills, motivation, and mental status. It appears that the

Table 7

Evaluation of TEP: Wetmore, Krueger, and Wesson*

Results	No. of patients
Successes (no complications encountered)	3
Adjusted successes (complications corrected)	
TEP stenosis	
2 reoperations	1
3 reoperations	1
Tracheal mucositis	
Treated with humidifier and 10 percent acetylcysteine spray	4
Tracheostoma stenosis	
Corrected by inserting metal laryngectomy tube in stoma at night along with a catheter in TEP	1
Aspiration of prosthesis	
Learned to secure prosthesis more effectively	1
Esophageal tear	
Probably due to esophacope injury; treated with antitiotics	1
Aspiration	
Resolved by TEP cauterization	1
Failures (not using t-e speech)	
TEP stenosis	
Prosthetic dislodgment	2
Voluntary closure	
Patient noncompliance	1
Aspiration	1
Speech failure due to multiple mucosal folds occluding prosthesis	1
Totals	
Successes	13
Failures	5

*N = 18.

Source:

S. Wetmore, K. Krueger, and K. Wesson, "The Singer-Blom Speech Rehabilitation Procedure," *Laryngoscope*, 91 (1981), 1111-1114.

authors also advocated using alternate procedures to overcome obstacles which preclude successful t-e speech attainment.

In another study, Wood, et al. (1981) reported a high 93 percent patient success rate. See Table 8. The authors attributed their excellent results to four factors: (1) a single surgeon-speech pathologist team approach, (2) the format/criteria for patient selection, i.e., the most important criteria being motivation, learning capacity, and patient expectations, (3) intensive preoperative orientation of potential t-e patients, and (4) excellent speech pathology support. (Of the four reasons listed, the authors felt the latter was the most important.)

Johns and Cantrell (1981) also reported superior patient success results of 92 percent. See Table 9. The authors cited, however, some disadvantages of the Blom-Singer technique: (1) the device must remain in place at all times, i.e., problem with tract stenosis, (2) a free hand is required to occlude the stoma, and (3) the device is not self-retaining and it requires adhesives. It was also noted that, although the operation is technically simple, the amount of time and practice required for adequate prosthetic use/maintenance should not be underestimated.

> It requires the concerted efforts of the surgeon, nurse and speech pathologist to attain the success which we have described. The patients must be motivated and willing to care for themselves and for the prosthesis. . . . All failures were on early patients of this series and that may be related to patient selections. . . . The success of this procedure is directly proportional to the amount of time spent with the patient in the postoperative time (Johns and Cantrell, 1981:85).

While the points stressed above are valid, they could be regarded as general requirements rather than as major drawbacks,

Table 8

Evaluation of TEP: Wood, Tucker, Rusnov, Levine*

Results	No. of patients
Successes (no complications)	25
Adjusted successes (complications corrected)	
TEP stenosis	
1 reoperation; learned to secure prosthesis better	2
Prosthetic removal	
Due to patient's unrealistic expectations; 1 reoperation	1
Failures (not using t-e speech)	
Technical error	
Cervical cellulitis resulting from too superior TEP placement in tracheostoma. Patient refused reoperation	1
Totals	
Successes	29
Failures	1

*N = 30.

Source:

B. Wood, H. Tucker, M. Rusnov, and H. Levine, "Tracheoesophageal Puncture for Alaryngeal Voice Restoration," *Annals of Otology, Rhinology and Laryngology*, 90 (1981), 493-494.

Table 9

Evaluation of TEP: Johns and Cantrell*

Results	No. of patients
Successes (no complications)	19
Adjusted successes (complications corrected)	
TEP stenosis	
1 reoperation	4
Aspiration	
Silver nitrate cautery of TEP tract	1
Failures (not using t-e speech)	
Severe tracheitis around prosthesis due to radiation therapy	1
Neurologic disorder	
Could not tape prosthesis effectively	1
Totals	
Successes	24
Failures	2

*N = 26.

Source:

M. Johns and R. Cantrell, "Voice Restoration of the Total Laryngectomy Patient: The Singer-Blom Technique," *Otolaryngology and Heart and Neck Surgery*, 89 (1981), 85.

especially when comparing this method to others currently available such as esophageal or electrolarynx. Quality of therapy and time/effort expenditures are important determinants in any successful rehabilitation program (good esophageal speech may take months or even years to learn). From the research conducted so far, there is a strong indication that a prosthetic voice can be rapidly established with minimal frustration if patient selection and therapeutic procedures are followed correctly. Also, the development of Blom-Singer's respiratory valve appears to have alleviated the problem of manual occlusion.

Donegan, et al. (1981) reported disappointing patient success results of 56 percent. See Table 10. The authors concluded that

> the major reason for failure was patient dissatisfaction with the method of voice production, either because . . . [the patient] rejected the quality and manner of voice production or because . . . [the patient] did not have the energy and persistence that is necessary for successful outcome (p. 496).

The remaining case failures were labeled as nonfluent speech: two patients had anatomical problems and one patient exhibited pharyngo-esophageal spasm.

In comparison to other study procedures (including Singer and Blom's reports) it is apparent that the majority of voice failures could be due to (1) an ineffective preoperative format, i.e., poor patient selection criteria and orientation procedures and (2) no attempt to troubleshoot or adjust complications, i.e., pharyngeal constrictor myotomy or intensive supportive therapy.

The study conducted by Wetmore, Johns, and Baker (1981) also revealed a less than optimum success rate of 71 percent. See Table 11. In analyzing the various complications reported, one can speculate that the majority of voice failures were due to the same factors listed above.

Table 10

Evaluation of TEP: Donegan, Gluckman, Singh*

Results	No. of patients
Successes (no complications)	13
Failures (not using t-e speech)†	
Inability to manage prosthesis	7
Nonfluent speech	
Poor vocal quality created by anatomical problems	1
Pharyngeal spasm	1
Multiple pharyngeal mucosa	1
Totals	
Successes	13
Failures	10

*N = 23.

†Authors did not report any attempts to adjust complications.

Source:

O. Donegan, J. Gluckman, and J. Singh, "Limitations of the Blom-Singer Technique for Voice Restoration," *Annals of Otology, Rhinology and Laryngology*, 90 (1981), 495-496.

Table 11

Evaluation of TEP: Wetmore, Johns, and Baker*

Results	No. of patients
Successes (no complications	40
Adjusted successes (complications corrected)	
Minor aspiration	
Corrected by TEP cauterization	5
Failures (not using t-e speech)	
TEP stenosis	
Inadvertant (no reoperation attempted)	2
Voluntary due to patient noncompliance	9
Aspiration	
No attempt at TEP cauterization	2
Nonfluent speech†	5
Totals	
Successes	45
Failures	18

*N = 63.

†Authors felt that one patient evidenced esophageal spasm but refused a myotomy. No reasons for other fluency failures were presented.

Source:

S. Wetmore, M. Johns, and S. Baker, "The Singer-Blom Voice Restoration Procedure," *Arch Otolaryngology*, 107 (1981), 675-676.

While preoperative assessment and speech therapy methods appeared to be thorough, the authors neglected to address three issues: (1) why patient noncompliance was high, (2) why alternative troubleshooting techniques were not attempted, and (3) why some patients failed to attain fluency. (The authors briefly mentioned that one patient evidenced p-e spasm but refused a myotomy; however, they neglected to explain how they assessed the p-e spasm or why the patient refused the corrective procedure.)

VI. CASE STUDY PRESENTATION AND IMPLICATIONS

Observations were conducted on a laryngectomy patient who chose the Blom-Singer technique of voice restoration after many years of failure with the esophageal method. Tracheoesophageal puncture was performed by a surgeon and speech rehabilitation services were provided by Fran Lowery-Romero, M.S., Clinic Supervisor, Speech-Language Rehabilitation Section, Fitzsimons Army Medical Center, Denver, Colorado.

Background

Ed (the last name will remain anonymous), age 56, successfully underwent a total laryngectomy in 1966 at Fitzsimons Army Medical Center. Initial progress using esophageal speech was poor; Ed therefore elected to use the electrolarynx. In 1975, Ed returned to Fitzsimons desiring additional esophageal speech therapy because he was dissatisfied with the electrolarynx. Ed specifically disliked (1) listener reactions, (2) restriction of one hand, and (3) costly maintenance problems. Because of undue tenseness and excessive force, Ed never achieved proficiency and esophageal speech remained extremely dysfluent. A decision was made in 1981 to try the Blom-Singer method of voice restoration.

Evaluation of the Blom-Singer Technique

T-e puncture surgery was performed without complications; however, due to Ed's particular tissue composition surrounding his tracheostoma, considerable edema occurred. See Figures 7 through 11. Although this interfered somewhat with good prosthetic placement and stoma seal, when the clinician occluded Ed's stoma he was able to produce sound within minutes and count to 20 in one breath. Ed was encouraged to practice t-e voice with the prosthesis, but he was cautioned that, until the edema subsided, smooth speech, i.e., good stoma seal, might be difficult to attain.

To help effect a better seal, Dr. Scholl's Toe Caps were suggested. See Figure 12. It was also found that abrading the flanges with an emory board made them more adhesive and prevented accidental prosthetic dislodgment. Another potential management aid is a Flexor-Lamp, equipped with a magnifying mirror. This allows for excellent t-e tract visualization which can help puncture cleaning and prosthetic placement. It may also be used to orient the patient on stoma occlusion and respiratory coordination techniques.

A few weeks after the edematous tissue subsided, Ed was still experiencing difficulty with the t-e speech, i.e., his voice was intermittently aphonic and the pitch was high and weak indicating excessive tension. Observations revealed that (1) Ed inconsistently located the exact angle or thumb position needed to effectively occlude the stoma, (2) he had trouble coordinating respiration for t-e speech, (3) his hands were tremulous, and (4) his upper body was visibly tense and he strained to produce speech, i.e., upon inhalation his chin was up and out and upon exhalation (and stoma occlusion) his jaw jutted open and his neck tensed in an attempt to push the voice out. Interestingly, the latter tension behaviors were previously reported to have occurred

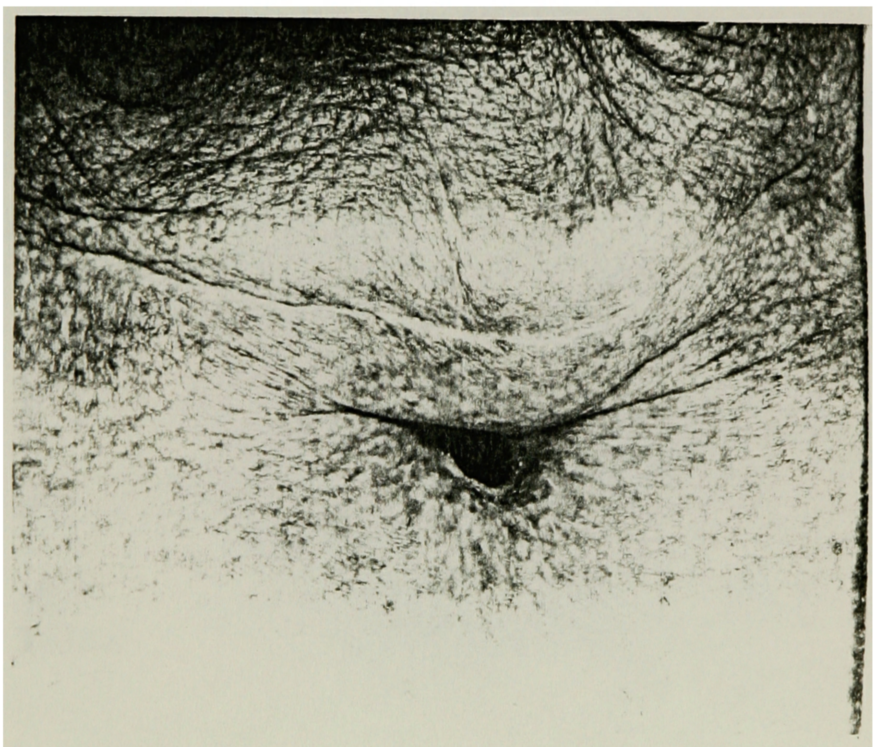

Figure 7. Edematous tissue which completely blocks the t-e puncture site.

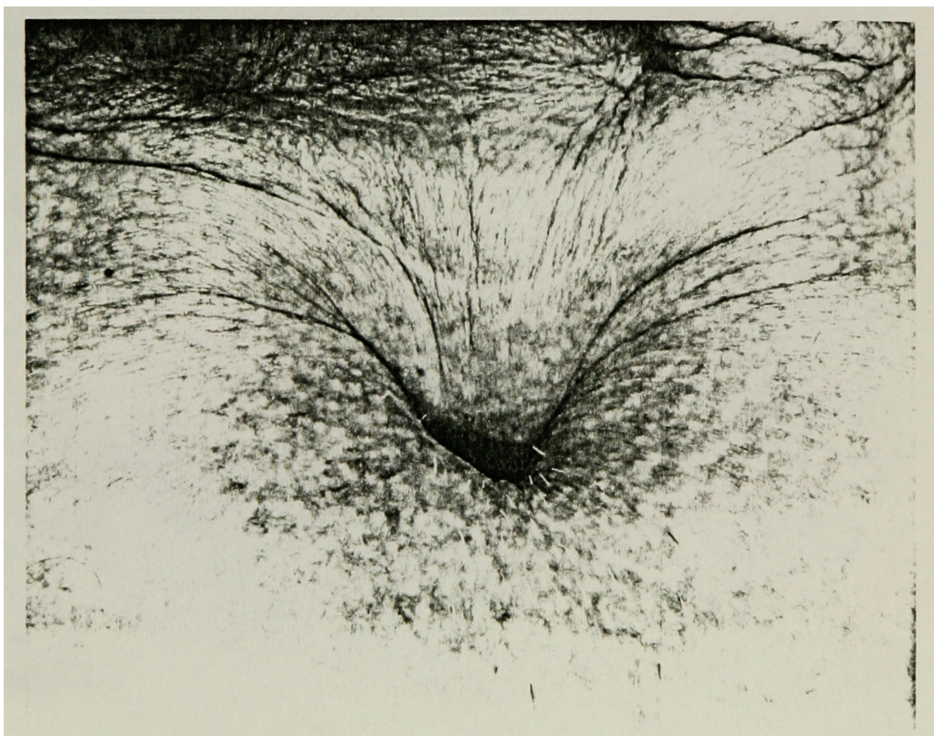

Figure 8. Upon inhalation, the tissue flap is drawn into the tracheostoma.

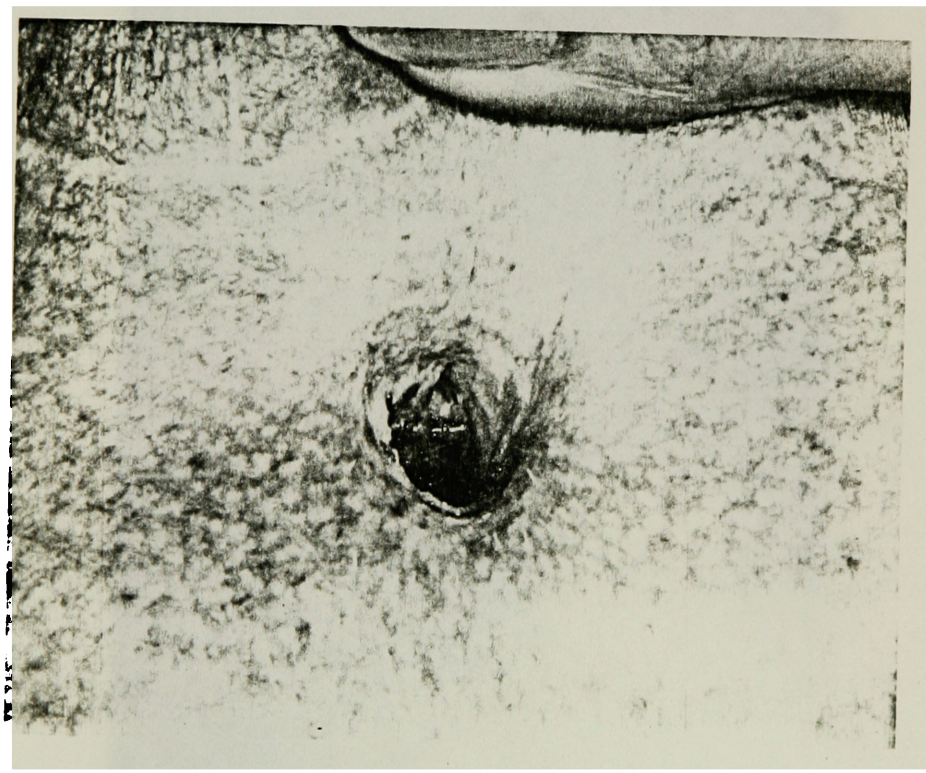

Figure 9. View of the t-e puncture when the skin flap is manually lifted.

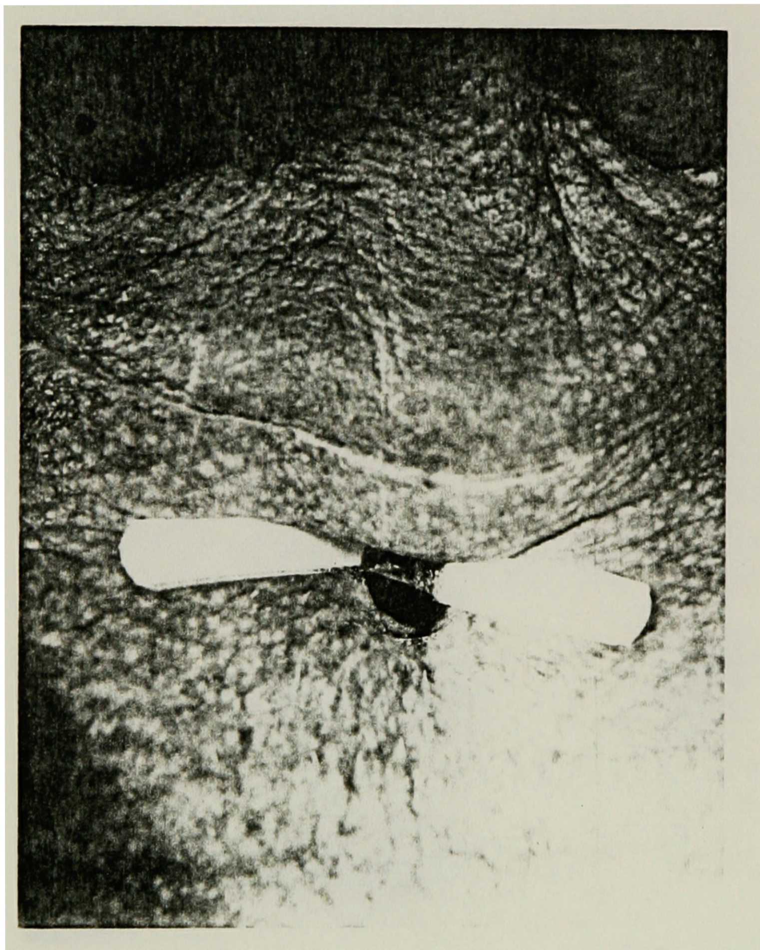

Figure 10. Edematous tissue hanging over the Blom-Singer prosthesis.

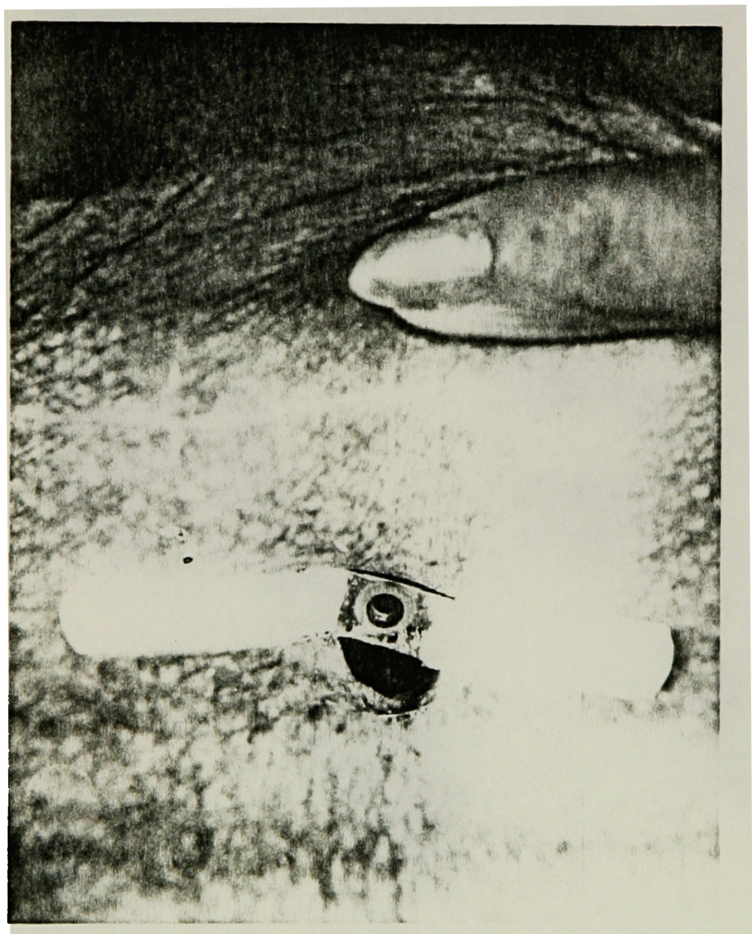

Figure 11. View of the prosthesis when the tissue flap is lifted.

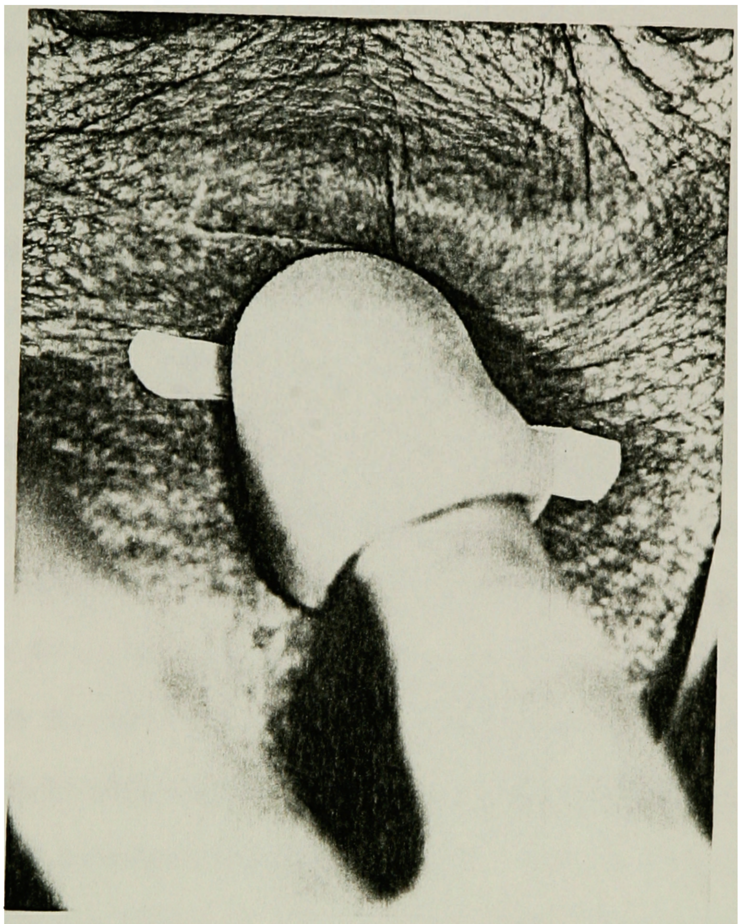

Figure 12. Stoma occlusion using a thumb cover.

when Ed was learning esophageal speech. It appears that Ed was somewhat predisposed to tension. (This potential tension problem was also identified during the air insufflation test, but it was not sufficient enough to contraindicate the t-e procedure.)

A few important behaviors were attributed to Ed's respiratory incoordination and poor t-e speech. At times, he would unnecessarily double-inject pulmonary air when attempting to speak. At other times he became confused with the whole process and would accidently produce esophageal speech, i.e., load air into the mouth while attempting to use prosthetic pulmonary air. Considering that, for the past seven years Ed had been using esophageal speech, it was hypothesized that his system needed time to readapt itself to using pulmonary power for speech.

In conclusion, it appeared that a combination of factors precluded Ed's attainment of t-e speech: (1) stoma occlusion coordination and readaption to a new mode of speech, (2) a predisposition to tension, (3) anxiety and frustration reactions because of intermittent aphonia. This caused him to push harder (force t-e speech) which in turn created more tension and subsequently more aphonia. Due to Ed's inability to achieve a smooth t-e voice, a videofluoroscopy of his prosthetic speech was performed. Results confirmed that a pharyngoesophageal spasm contributed to Ed's intermittent aphonia, therefore a pharyngeal constrictor myotomy was undertaken.

Subsequent to Ed's myotomy, tissue edema again delayed therapeutic intervention. Once this subsided (lancing was required), only a minimal change in t-e speech was observed. While p-e spasms appeared to be reduced, i.e., a somewhat lower pitch, previous incoordination problems and upper body tension and force still persisted which could be related to his less-than-optimal t-e speech. (It should also be noted that the adequacy of the myotomy was questionable and a reoperation was being considered.) To alleviate Ed's difficulty with coordinating stoma occlusion, which created tension and subsequent speech anxiety, a Blom-Singer two-way respiratory valve was ordered. Alas, the author left Fitzsimons Army Medical Center; her case followup was discontinued.

In retrospect, the problems encountered with this particular case appear to coincide with Panje, et al.'s (1981) observations of pharyngoesophageal spasms and lend support to their requirement of easy t-e speech attainment before prosthetic insertion. Ed was definitely overanxious and this interferred with smooth speech. Perhaps pharyngeal stricture and incoordinate exhalation of air could have been prevented by instructing him on easy t-e speech, stoma capping, and muscle relaxation without a prosthesis. There is a good possibility that this technique might still be beneficial. Since Ed tends to force his voice, maybe reverting to practicing t-e speech without a prosthesis, i.e., when air resistance is minimal, will encourage a more relaxed state. In addition, perhaps a viable adjunct to relaxation therapy might be the use of biofeedback equipment to encourage voluntary muscle control to help eliminate muscle tension and overall anxiety.

Even though frustrating complications delayed optimal t-e speech, Ed expressed great satisfaction with his new voice in comparison to his esophageal and electrolarynx speech; he did not want to reverse the procedure. Ed specifically felt that his t-e speech was better, i.e., more intelligible, because of (1) increased speech rate, (2) longer sentence productions, i.e., less pause time, and (3) a more acceptable voice quality and mode of production, i.e., his vocal image was improved. This last point carries an important message. Although achieving functional communication is primarily important to a laryngectomee, the impact of an asthetically displeasing voice should not be underestimated. In recognizing this issue, Cooper (1973:213) stated,

> The vocal image extensively prevails among the laryngectomized patient. . . . He compares the new sound or voice to the presurgical voice, judging the new sound for its ease, flexibility, durability and asthetic listenability. He is also concerned with how other people will accept the new sound.

Research on the characteristics of superior esophageal speakers have indicated that speech intelligibility and listener acceptability were highly correlated with (1) more rapid speech rate, (2) higher mean fundamental frequency, and (3) a greater proportion of periodic phonation versus aperiodic silence (Hoops, 1969; Shipp, 1969; Snidecor, 1968).

A recent investigation by Robbins, et al. (1981) compared two methods of alaryngeal speech (t-e and esophageal) and laryngeal speech. From their data, a discriminate analysis was conducted which identified group differences and classified group similarities based on acoustic parameter values, i.e., frequency, intensity, and temporal characteristics. Results indicated that these acoustic measures accurately defined (100% correct) an acoustic profile which categorized each mode of speech. The authors also found that "the discriminate analysis indicated that although all 3 groups are distinguished acoustically from one another, according to these particular variables, laryngeal speech and t-e speech are most alike" (Robbins, et al., 1981:13). See Table 12. Although a complete acoustic analysis comparing Ed's various modes of alaryngeal

Table 12

Results of an Acoustical Analysis of Laryngeal, t-e, and Esophageal Speakers

	Acoustic paramters	Laryngeal	t-e	Esophageal
1.	Mean maximum phonation time (vowel duration)	22 sec.	11-12 sec.	2 sec.
2.	Average reading rate (words per minute)	173 wpm	127 wpm	99 wpm
3.	Mean fundamental frequency	103 Hz	102 Hz	77 Hz
4.	Jitter ratio values (cycle-to-cycle durations)	7.74	51.35	182.45
5.	Median intensity values	69 dB/A	79 dB/A	59 dB/A
6.	Shimmer ratio values (cycle-to-cycle magnitude)	4.29	10.55	27.15

Source:

J. Robbins, H. Fisher, J. Logemann, J. Hillenbrand, and E. Blom, "A Comparative Acoustic Analysis of Laryngeal Speech, Esophageal Speech, and Speed Production After Tracheoesophageal Puncture" (paper presented at the ASHA Convention, Los Angeles, California, 1981), slides 2, 3, 8, 11, 12, 13.

speech was unobtainable, reading calculations were performed. The results supported the findings of Robbins, et al. (1981). See Table 13.

In conclusion, it appears that the important advantages of prosthetic t-e speech which allows for a more normal sound and an improved vocal image are (1) an ability to produce continuous pulmonary air thus extending the voice and increasing the speech rate, (2) a more optimal voice quality, and (3) an increase in overall intelligibility.

Table 13

Case Study Results: Average Reading Rate of Electrolarynx, Esophageal, and t-e Speech*

Communication mode	wpm
Electrolarynx	130
Esophageal	74
Tracheoesophageal (premyotomy)	112
Tracheoesophageal (postmyotomy)	116†

*The Towne-Heuer reading passage was used.

†Note the slight increase in speech flow subsequent to a pharyngeal constrictor myotomy.

VII. SUMMARY AND CONCLUSIONS

Singer and Blom (1980a) reported a new surgical prosthetic technique for voice restoration following a total laryngectomy. This method basically consists of a tracheoesophageal puncture followed 36 to 48 hours later by the insertion of a small silicone prosthesis which acts as a one-way valve. It allows pulmonary air to enter and vibrate esophageal tissue, but it prevents aspiration.

To date, various research studies have reported significant successful results; they enthusiastically endorse this procedure as a major breakthrough in alaryngeal speech because it provides communi cation skills which are comparable and usually superior to esophageal voice. Along with prompt, almost instaneous speech acquisition, a primary advantage of t-e speech is the continuous flow of pulmonary air through the esophagus which allows for a smooth, more prolonged vibration and a more rapid speech rate. It appears that acoustically, tracheoesophageal speech is most similar to laryngeal speech than any other present alaryngeal mode, i.e., electrolarynx and esophageal.

Although a few complications have been associated with this technique, in general they were deemed minor and the majority of patient failures appeared to be the result of poor patient selection criteria and orientation procedures. Four factors must be addressed preoperatively to ensure successful t-e speech: (1) patient motivation or the desire to implement this technique, (2) patient expectation, i.e., patient realizes the prosthetic maintenance duties and the potential voice complications, (3) mental stability or self-care ability, and (4) physical requirements. In addition, associated failure factors could be greatly eliminated by employing troubleshooting techniques.

One particular problem which has been identified in a small percentage of t-e patients is pharyngoesophageal spasm. In analyzing research on the relationship between p-e spasms and tracheoesophageal speech, no single factor can be attributed to resultant dysfluencies. P-e stricture appears to be caused by complex interrelated factors and, therefore, requires an eclectic approach toward prevention, i.e., an incorporation of all strategies gleaned from current research as listed below:

1. Air insufflation test to predict p-e stricture (this prepares the patient and clinician for potential fluency problems).

2. Videofluoroscopy to provide objective data and aid therapeutic success.

3. Delayed prosthetic insertion until relaxed, coordinated t-e speech is attained.

4. Intensive speech therapy services preoperatively and postoperatively.

5. Pharyngeal constrictor myotomy for patients demonstrating p-e spasm and nonfluent speech.

In addition to these procedures, a question of volitional control over the pharyngoesophageal muscle spasm needs to be addressed. Traditional voice therapy has focused on laryngeal muscle relaxation and, more recently, on biofeedback techniques to reduce vocal hyperforce or tension. These methods assume that a patient can develop volitional control over the laryngeal muscles, thus altering the voice production skills. Perhaps a tight, unyielding p-e sphincter in the laryngectomy patient might be influenced by volitional muscle control. For example, if a spasm occurs when the esophagus is distended beyond a certain degree, rather than trying to overpower the spasm (which creates more spasm), a patient could learn to internally control the airflow power or force, thereby preventing a spasmotic reaction. By learning to decrease general oral-pharyngeal tension, a more patent p-e segment might be created and allow greater mobility, i.e., open more readily, thus producing smoother vibration.

When one considers that, as early as the 1940s, two separate studies conducted by Faulkner (1940) and Greene (1947) found that esophageal spasms can be increased or decreased by suggestions which aroused emotions of anger, anxiety, happiness, etc., it is surprising that this potentially important therapeutic avenue has not produced much attention and/or quality research. As Amster (1979:235)[8] recently stated, "The potential for the application of biofeedback methodology as an aid to relaxation for the laryngectomy has not been fully realized."

In conclusion, tracheoesophageal-prosthetic speech represents a major breakthrough in alaryngeal voice restoration. In comparison to other methods, the Blom-Singer technique is by far the simplest and

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[8]W. Amster, "Advanced Stage of Teaching Alaryngeal Speech: Therapy Encounters of the Fourth Kind," eds. R. Keith and F. Darley, *Laryngectomee Rehabilitation* (Houston, Tex.: College-Hill Press Inc., 1979).

most effective method; however, it may not be appropriate for all laryngetcomees. The speech clinician and physician intending to rehabilitate this population should be well-educated on specific patient selection criteria and troubleshooting procedures.

LITERATURE CITED

Cooper, M. *Modern Techniques of Vocal Rehabilitation.* Springfield, Ill.: Charles C. Thomas, 1973.

Donegan, O., J. Gluckman, and J. Singh. "Limitations of the Blom-Singer Technique for Voice Restoration." *Annals of Otology, Rhinology and Laryngology,* 90 (1981), 495-497.

Faulkner, W. "Objective Esophageal Changes Due to Psychic Factors." *American Journal Medican Sciences,* 200 (1940), 796-803.

Greene, J. "Laryngectomy and Its Psychologic Implications." *New York State Journal of Medicine,* 47 (1947), 53-56.

Hoops, H. and J. Noll. "Relationship of Selected Acoustic Variables to Judgments of Esophageal Speech." *Journal of Communication Disorders,* 2 (1969), 1-13.

Hunt, R. "Rehabilitation of the Laryngectomee." *Laryngoscope,* 74 (1964), 382-395.

Johns, M. and R. Cantrell. "Voice Restoration of the Total Laryngectomy Patient: The Singer-Bloom Technique." *Otolaryngology and Head and Neck Surgery,* 89 (1981), 82-86.

Keith, R. *A Handbook for the Laryngectomee.* Danville, Ill.: Interstate Printers and Publishers, Inc. 1974.

Keith, R. and F. Darley. *Laryngectomee Rehabilitation.* Houston, Tex.: 1979.

Martin, H. "Rehabilitation of the Laryngectomee." *Cancer,* 16 (1963), 823-841.

Panje, W. "Panje Voice Prosthesis Procedure." Unpublished paper presented to the Otolaryngology and Maxillofacial Surgery Department, University of Iowa Hospitals and Clinics, Iowa City, Iowa, 1981a.

Panje, W. "Prosthetic Vocal Rehabilitation Following Laryngectomy: The Voice Button." *Annals of Otology, Rhinology and Laryngology,* 90 (1981b), 503-505.

Panje, W., D. VanDemark, and B. McCabe. "Voice Button Prosthesis Rehabilitation of the Laryngectomee. Additional Notes." *Annals of Otology, Rhinology and Laryngology,* 90 (1981), 503-505.

Robbins, J., H. Fisher, J. Logemann, J. Hillenbrand, and E. Blom. "A Comparative Acoustic Analysis of Laryngeal Speech, Esophageal Speech, and Speech Production After Tracheoesophageal Puncture." Paper presented at the ASHA Convention, Los Angeles, California, 1981).

Shipp, T. Frequency, Duration and Perceptual Measures in Relation to Judgments of Alaryngeal Speech and Acceptability. *Journal Speech Hearing Research*, 10 (1967), 417-427.

Silverberg, E. *Cancer Statistics, 1981*. American Cancer Society: Professional Education Publications, 1981. (Reprint from *CA--A Cancer Journal for Clinicians*.)

Singer, M. and E. Blom. "An Endoscopic Technique for Restoration of Voice After Total Laryngectomy." *Annals of Otology, Rhinology and Laryngology*, 89 (1980a), 529-533.

Singer, M. and E. Blom. "Tracheoesophageal Puncture: An Interdisciplinary Approach to Postlaryngectomy Voice Restoration." A course presented at the American Speech and Hearing Association Convention, Detroit, Michigan, November 1980b.

Singer, M. and E. Blom. "Selective Myotomy for Voice Restoration After Total Laryngectomy." *Arch Otolaryngology*, 107 (1981), 670-673.

Singer, M., E. Blom, and R. Hamaker. "Further Experience with Voice Restoration After Total Laryngectomy." *Annals of Otology, Rhinology and Laryngology*, 90 (1981), 498-502.

Snidecor, J. *Speech Rehabilitation of the Laryngectomized*. Springfield, Ill.: Charles C. Thomas, 1968.

Wetmore, S., M. Johns, and S. Baker. "The Singer-Blom Voice Restoration Procedure." *Arch Otolaryngology*, 107 (1981), 674-676.

Wetmore, S., K. Krueger, and K. Wesson. "The Singer-Blom Speech Rehabilitation Procedure." *Larynscope*, 91 (1981), 1109-1117.

Winans, C., E. Reichbach, and W. Waldrop. "Esophageal Determinants of Alaryngeal Speech." *Arch Otolaryngology*, 98 (1974), 10-14.

Wood, B., H. Tucker, M. Rusnov., and H. Levine. "Tracheoesophageal Puncture for Alaryngeal Voice Restoration." *Annals of Otology, Rhinology and Laryngology*, 90 (1981), 491-494.

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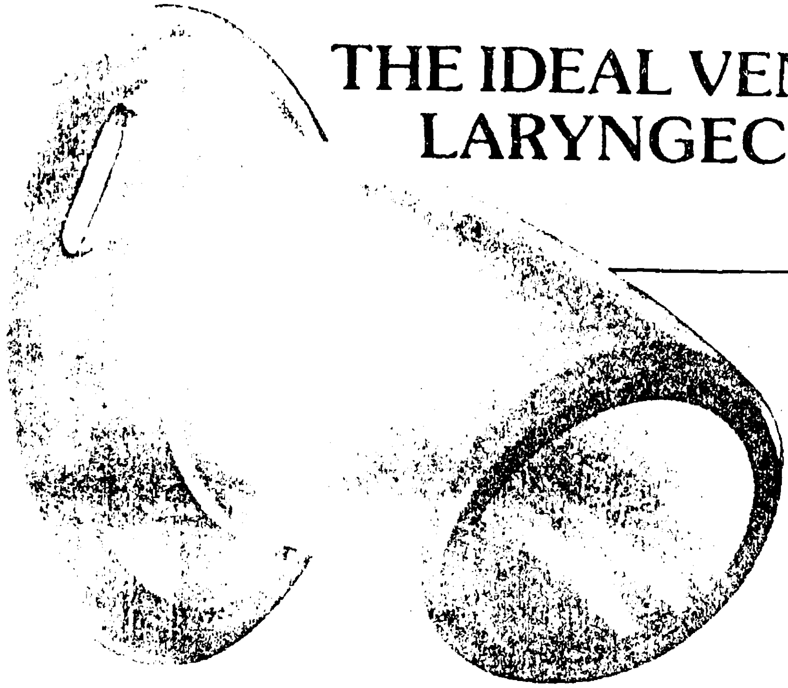

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