Paparella: Volume III: Head and Neck

Section 2: Disorders of the Head and Neck

Part 5: The Larynx, Trachea, and Esophagus

Chapter 33: Surgical Vocal Rehabilitation

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Tumors of the larynx are significant not only because they present treatment dilemmas but also because most treatment modalities require social adjustment secondary to changes in respiration, speech, and deglutition. Thus, it should be the goal of any oncologic surgeon to restore these dynamic functions after accomplishing the primary goal of tumor extirpation.

McNeil and colleagues reported in 1981 that when subjects are confronted with a conservative treatment for laryngeal carcinoma that trades off quality for quantity of life, nearly 20 per cent opt for radiation therapy with voice preservation instead of total laryngectomy - even when higher survival rates are probable with the latter procedure.

The management of laryngeal carcinoma has been marked by successes, failures, and controversy. In the USA, an estimated 11000 new cases of laryngeal cancer occur annually. Approximately 80 per cent of these patients undergo either a total or partial laryngectomy at some point in their course of treatment. During the past 125 years, the total laryngectomy as definitive therapy for advanced laryngeal carcinoma has been paralleled by the development of innovative procedures for voice restoration. The history of these procedures has also been accompanied by similar patterns of success, failure, and controversy.

History

The earliest successful total laryngectomy for laryngeal cancer is attributed to Billroth in 1873 and was reported by Gussenbauer. The patient survived the procedure by use of a diverting pharyngostome that prevented aspiration. After 21 days, an artificial larynx devised by Gussenbauer was placed in the fistula with a linking tube to the tracheostoma. The pharyngeal orifice was protected by a lid or trapdoor valve that closed with swallowing and opened for speech. In addition, a vibrating metal membrane or "tongue" was placed in the expiratory airstream for sound production. The patient's speech was audible and intelligible, but it was monotone. Within 5 months, the patient died of recurrent cancer. This was the first documented use of an artificial larynx and it is noteworthy that speech was produced in the immediate postoperative period.

Historically, prosthetic shunts were the earliest forms of voice restoration after total laryngectomy. Bottini and Casselli reported long-term survivors of laryngectomies, including one patient who effectively used an artificial larynx until her death at 89 years of age. With Gluck and Sorrenson's introduction of primary reconstruction of the pharynx in 1894, the troublesome pharyngostome was abolished. Vocal rehabilitation was then dependent on external artificial larynges or esophageal speech.

Alaryngeal Communication

Today, the three most common methods of communication used by laryngectomees are the artificial larynx, esophageal speech, and tracheoesophageal speech. Many patients complain about the hand-held electrolarynx because of the production of a mechanical sounding voice. It also uses batteries and requires that the user always carry it with him or her. In comparison, esophageal speech, which emanates from vibrations of the pharyngoesophageal mucosa, has the advantage of hands-free voice production. Tracheoesophageal puncture produces a good voice but requires an operative procedure and patient compliance. Fistula techniques have also been hindered by aspiration, local infection, stenosis, and migration of the tract. Consequently, the search for the perfect form of speech rehabilitation has persisted.

Traditionally, esophageal speech has been the most frequently advocated method of vocal rehabilitation, following which 50 per cent of patients fail to acquire functional communication. Characteristically, the voices of those who are able to use esophageal speech are limited with respect to intensity, pitch, and rate.

In 1982, Weinberg and co-workers demonstrated that airway resistance associated with esophageal and tracheoesophageal phonation is substantially greater than that for the normal larynx. Reduction of amplitude levels in esophageal speech has been attributed to low air pressure flow resulting from the limited power supply of the esophageal air reservoir. In contrast, the increased amplitude levels of tracheoesophageal voice production are possible because the pulmonary system generates and sustains greater esophageal pressures. Robbins and co-workers reported in 1984 that the characteristics of tracheoesophageal speech are more similar to laryngeal speech than to esophageal speech because of the powerful advantage of pulmonary supported air flow.

Pulmonary air also allows tracheoesophageal speakers to sustain voice production for substantially longer periods compared with esophageal speakers. The former group has access to larger air volumes (volume capacity 5000 mL), whereas the esophageal speakers are limited to esophageal volume (80 mL). However, both groups have reduced maximum phonation times relative to laryngeal speech.

The findings that tracheoesophageal speech production is acoustically more similar to laryngeal speech than is esophageal speech production have encouraged clinicians to work toward improving postlaryngectomy vocal rehabilitation.

Surgical Speech Rehabilitation

Two groups of surgical speech rehabilitation have developed: those procedures involving an internal shunt and those requiring a voice prosthesis. Both have their pros and cons and ardent disciples.

Internal Shunts

In 1958, Conley and co-workers summed up the technical difficulties associated with voice rehabilitation: "The technical problem to overcome consists of created a passageway that would permit the free flow of air from the trachea into the esophagus without the passage of food or saliva from the gullet into the trachea".

Speech rehabilitation of the laryngectomy patient was relatively unchanged until 1959 when Conley introduced the tracheoesophageal vein graft fistulization procedure. The esophageal mucosal tube was intraluminal, inferiorly based, and anastomosed to the skin above the tracheostome. Unfortunately, stenosis, tracheal contamination, and patient reluctance limited the acceptance of this technique.

In 1965, Asai and colleagues proposed a three-stage method to establish an internal shunt. A superiorly placed tracheostoma created at the time of laryngectomy was followed with secondary construction of a superior pharyngostoma in the midline hypopharynx. During the final stage, this was connected to the tracheostoma by a cervical skin tube, resulting in a long, vertical, dermal-lined internal shunt.

Asai and co-workers reported that of 72 patients, most had good phonation. However, the shunt was disrupted in ten cases and stenosis occurred in another ten cases. Aspiration pneumonia complicated two cases, for an overall complication rate of 30 per cent. Some patients were also troubled with hair growth in the tunnel.

Miller was the first to report preliminary experience with the Asai procedure in the USA. He reported excellent speech in not more than 20 per cent of his patients and confirmed a high incidence of aspiration. Other commonly reported complications included stenosis or dilatation of the shunt.

In 1969, Staffieri proposed a tracheopharyngeal shunt termed a *neoglottis phonatoria.* This technique was inspired by a report by Guttman, in which a Chicago ice man attempted suicide after losing his voice because of a total laryngectomy. He plunged an ice pick into his throat, but instead of dying, he regained the ability to speak because he accidentally pierced the esophageal wall in a way that gave him tracheoesophageal speech.

In an attempt to duplicate that case, Staffieri created a small slit in the oesophageal wall of the laryngectomized patient. He then placed a part of the esophageal wall over the top of the trachea, forming a valve that linked the trachea to the pharynx. To speak, the patient simply placed a finger of the external tracheostoma. When exhaled from the lungs, air was forced through the internal esophageal slit, allowing the pharynx to vibrate and create sounds. The valve was open only when air from the lungs forced it open. Hopefully, when food or liquid descended from the hypopharynx, the valve would remain closed.

Staffieri performed the operation on 137 patient and reported a success rate of 90 per cent with regard to voice production. Unfortunately, other investigators have not been able to duplicate Staffieri's work and have reported phonation success rates ranging from 50 to 83 per cent. There have also been reports of chronic aspiration, shunt stenosis, and serious limitations in irradiated patients.

In the USA, Sisson and co-workers, introduced Staffieri's technique. Despite following strict criteria, 25 per cent of patients experienced recurrent tumor, and only 50 per cent achieved permanent vocalization. Likewise, Leipzig's experience with neoglottic reconstruction resulted in a 13 per cent recurrence rate in the neck and a 40 per cent incidence of aspiration. Surgical closure of the neoglottis was necessary in half of these cases.

In 1972, Serafini and Arslan described a procedure in which they preserved the cricoid ring, thyroid perichondrium, hyoid bone, and suprahyoid epiglottic stump following narrow field laryngectomy to form a "neolarynx". The tracheocricoid unit was joined to the hypopharyngeal mucosal remnant, and the anterior wall was reconstructed by mobilizing the hyoid bone and epiglottis to the superior cricoid cartilage. Excellent speech results were reported in some cases, but decannulation of the airway was possible in only 20 per cent of patients, and serious chronic aspiration occurred in 30 per cent of patients. Four of 35 patients (11 per cent) experienced midline recurrences of their cancer.

Amatsu and colleagues introduced a tracheoesophageal shunt in 1977, with later modifications in 1986. The technique consists of a tracheal flap, side-to-side anastomosis of the trachea to the esophagus, bilateral esophageal constrictor muscle flaps, construction of the tracheoesophageal shunt, and reapproximation of the esophageal constrictor muscles. They reported this procedure in 16 patients, 14 of whom had speech restored. The tracheoesophageal shunt remained open without stenosis in 13 patients. Of the 14 tracheoesophageal shunt speakers, 12 had normal deglutition without aspiration.

Other efforts have included tracheohyoidopexy, an internal fistula without a prosthesis, a dermis-lined tracheoesophageal tube, a full-thickness skin tracheoesophageal fistula, extended hemilaryngectomy, triangular neoglottis, V-shaped neoglottis, and "valved" tracheoesophageal shunt.

All of these procedures use basically the same principle - diverting pulmonary air into the esophagus and allowing the cricopharyngeal muscles to act as a vibrator. Based on this principle, one may assume that the greater the diameter of the shunt or opening, the greater the pulmonary air that is available for speech production and hence the better the quality of the speech produced. However, with a greater diameter shunt, one is at greater risk for aspiration.

Prosthetic Communication Techniques

Concern with the high failure rate in neoglottic procedures stimulated new interest in laryngeal prostheses. In 1972, Taub and Spiro introduced the "VoiceBak". Their procedure created a laterally placed esophagostoma at a preselected cervical level that permitted maximum air flow activation of the pharyngoesophageal mucosa for sound production. The site was selected after preoperative insufflation of the esophagus via a catheter placed through the nose. This is now regarded as Taub's test.

The prosthesis was inserted at the fistula site by a flanged silicone tube attached to a one-way saliva valve and regulator worn on the upper chest. This unit permitted two-way air flow for normal breathing and converted to a one-way flow system to the fistula under increased pressure during speech production.

This was the first commercially available laryngeal prosthesis, but it was quite awkward, required regular mechanical maintenance, and the cost was prohibitive. In addition, because the surgical procedure could not be regularly performed on irradiated patients or after radical neck dissection, its applicability was limited.

Blom-Singer Tracheoesophageal Puncture

In 1979, Singer and Blom revolutionized the speech restoration field with their description of an endoscopic technique in which a tracheoesophageal one-way silicone valve was placed in a tracheoesophageal fistula after total laryngectomy. The prosthesis was light-weight, inexpensive, and effective. The authors reported that 90 per cent of the patients achieved fluent tracheoesophageal speech even though 72 per cent had undergone neck dissection and 63 per cent had undergone radiation therapy. Others such as Panje and Wetmore have confirmed the 90 per cent success rate as a secondary procedure. Hamaker and co-workers have described a 69 per cent fluent speech result with placement of a tracheoesophageal prosthesis at the time of laryngectomy.

Surgical Technique

The technique of endoscopic restoration employs general anesthesia and a rigid esophagoscope modified by an aperture on the distal end. The tracheal wall is perforated with a 14-gauge needle 5 mm from the mucocutaneous junction of the tracheostoma. The needle pierces the esophageal wall and enters the endoscope at the aperture. A catheter (No. 14 French) is threaded in a retrograde direction across the tracheoesophageal wall and into the pharyngoesophagus to serve as a stent for the puncture. After 48 hours, without interruption of diet or usual alaryngeal communication, the stent is replaced by the valved voice prosthesis. The horizontal distance is measured between the lumen of the esophagus and the trachea. A corresponding Blom-Singer voice prosthesis is inserted and is self-retaining by its collar. It is fixed to the skin by adhesive for additional security.

The laryngeal sphincter is stimulated by the recoil closure of the silicone valve. Sound is produced by the apposition of vibrating pharyngoesophageal membranes and the force of expired air. At the esophageal end, the slit valve opens under positive airway pressures of 30 to 60 cm of water, permitting air flow of 50 to 100 mL/second. The valve closes immediately when air flow stops. Because of its configuration, it has been descriptively termed a *duckbill.*

Preoperative Speech Evaluation

Patients who are good candidates for tracheoesophageal puncture should be motivated and mentally stable. They must have an adequate understanding of the anatomy and mechanics of the prosthesis and must demonstrate manual dexterity and visual acuity in order to care for the stoma and the prosthesis. In addition, they should not have a significant hypopharyngeal stenosis and should be able to produce speech with esophageal insufflation via a properly positioned esophageal catheter (Taub's test). With the air insufflation test, the examiner blows air passively into the esophagus via a catheter, thus eliminating any problems the patient may have with air injection into the esophagus. When the patient opens the mouth, the catheter is gently manipulated up and down the tract, and esophageal voice is produced. This allows the examiner to assess the presence of lack of a vibrating segment, the air pressure required to produce voice, and the resonance to air flow through the esophagus.

Patients must also have adequate pulmonary reserve, a good cough reflex, and overall good health, and should have a stoma of adequate depth and diameter to accept a prosthesis without airway compromise. In addition, a patient with low pulmonary flow rates should be screened, for he or she may have difficulty with the speech fistula.

Patients who undergo pharyngeal reconstruction with a skin flap or visceral transposition may effectively use tracheoesophageal phonation. The voice quality is effective for communication, although fundamental frequencies may be low secondary to the mass introduced by the flaps and lack of phonatory resistance. This is an important point because the prognosis for esophageal speech acquisition or effective artificial larynx use is relatively poor in these cases.

Voice training consists mainly of learning to diver exhaled air efficiently under increased pressures to open the valve and support tracheoesophageal air flow. Speech re-education is neither difficult nor time-consuming because the postlaryngectomy vocal tract remnants remain functional for intelligible articulation of pharyngoesophageal sound. Manual occlusion of the tracheostoma is usually learned rapidly by most patients.

Types of Prostheses

One of the drawbacks with the postlaryngectomy voice restoration procedures is the need for manual stoma occlusion. Some consider this inconvenient, non-hygienic, and socially unacceptable, since it draws attention to the laryngectomized condition. Because of this, Blom and co-workers modified their original prosthesis and introduced a simple air flow-regulated tracheostoma valve that eliminates the need for manual diversion of pulmonary air for speech. In this modification, the valve design of the duckbill has been changed. The basic tubular design remains the same but is increased in diameter from 5.3 to 6.6 mm. The slip valve has been replaced by a circular valve, which is recessed slightly into the distal end of the prosthesis. The beveled tip protrudes minimally into the esophageal lumen and provides a protective hood over the valve. A circular inner retention collar is also incorporated.

During speech, air diverted through the prosthesis opens the one-way valve. With the cessation of air flow, the hinged valve returns to its closed position and is seated against a recessed circumferential ledge to provide a seal. This design effectively eliminates regurgitation of fluids from the esophagus, and the positive pressure gradient generated within the esophagus during swallowing tends to assist valve closure. When the airway resistance of the original prosthesis is as much as four times that of the normal larynx, calculations indicate that air flow resistance of the low-pressure voice prosthesis is nearly within the range offered by the human larynx.

Individual respiratory needs during exertion are managed by substituting diaphragms of different thicknesses that effect corresponding changes in the valve compliance. With this device, the laryngectomy patient is no longer required to manually occlude the tracheostoma.

Other prostheses have been developed for tracheoesophageal speech. Panje and Groningen introduced devices intended to facilitate tracheoesophageal speech while minimizing aspiration.

Because of some problems with the Blom-Singer and the Panje prostheses in patients with tracheostomal stenosis or with a deep tracheal stoma behind prominent sternocleidomastoid muscles, Shapiro and Ramanthan developed a prosthesis that incorporated a duckbill polymeric silicone (Silastic) tube attached to a new type of tracheostoma button. The Charing Cross modification was developed because of similar complains in prosthesis fitting.

Variations of Technique

Although Blom and Singer initially reported this technique as a secondary procedure, many authors were interested in incorporating it during the time of total laryngectomy.

Maves and Lingeman cited advantages to performing a tracheoesophageal puncture at the time of total laryngectomy. The tracheoesophageal puncture does not preclude achievement of standard oncologic procedures, a second procedure can be avoided, there is no need for a nasogastric tube, and the patient's psychological state can be improved by the rapid return of vocal communication. In their series of 11 patients, satisfactory fluent, intelligible speech developed in all of them. The time from laryngectomy to the development of speech ranged from 2 to 12 weeks with an average of 5.2 weeks. Six patients were initially fitted with Panje prostheses and four with Blom-Singer prostheses. The decision as to which prostheses to use was based on the configuration of the stoma and the final position of the tracheoesophageal fistula.

Stiernberg and colleagues reported similar results, with 13 of 20 patients achieving fluent, intelligible speech after primary tracheoesophageal puncture. The authors concluded that primary tracheoesophageal puncture is a reliable procedure without an increase in morbidity.

If postoperative radiation therapy is planned, Shagets and Panje suggest introducing tracheoesophageal speech immediately following surgery without using a voice prosthesis. The patient is encouraged to experience tracheoesophageal speech before commencing radiation therapy. The catheter or stent is removed 3 days prior to the first radiation treatment, and the fistula is allowed to close. If the patient likes tracheoesophageal speech, the tracheoesophageal puncture can be easily restored 6 to 12 weeks following the completion of radiation therapy. The authors report that patients who are allowed to vocalize through a tracheoesophageal puncture prior to radiation therapy have a much higher rate of success in achieving both esophageal and tracheoesophageal puncture speech when compared with those laryngectomees who do not experience air passage through the pharyngoesophagus.

Complications

Tracheoesophageal puncture has several advantages over other techniques including (1) a midline approach that avoids potential great vessel injury, (2) decreased chances of salivary leakage into the mediastinum, (3) ease of patient compliance, and (4) lack of many external valves or devices.

In addition, using a prosthesis over an internal shunt allows for (1) maintaining the patency of the fistula tract, (2) regulating the efficiency of the shunted air from the trachea to the esophagus, and (3) preventing aspiration. Nonetheless, complications do occur, although most are minor.

Aspiration in any shunt procedure is the greatest limitation. Komorn and Staffieri devised surgical modifications to eliminate the problem. Blom and co-workers and Panje introduced prostheses with a one-way valve. However, despite these measures, some patients still experience minimal aspiration.

In a multi-institutional study, Wetmore and colleagues documented minor leakage around the voice prosthesis in 5 of 63 patients who underwent a tracheoesophageal puncture. The leakage in all of these patients was controlled by cauterization of the puncture site. McConnell and Duck noted several cases of dislodgement and aspiration of the prosthesis into the tracheobronchial tree. This was particularly true among patients using a prosthesis that did not have a flange.

Singer and colleagues noted the complications of esophageal reflux, peristomal inflammation, minor wound infections, hematoma, and cervical inflammation and emphysema. More than 10 per cent of the patients had problems with leakage of saliva or food from the fistula tract.

Surgical complications include esophageal perforation, allergic reactions to tape or to the prosthesis, and cellulitis of the peristomal area. Other reported complications include enlargement of the tracheoesophageal fistula, aspiration pneumonia, aspiration of the prosthesis, fistula migration, peristomal cellulitis or infection, paraesophageal abscess, pneumomediastinum, cervical osteomyelitis, esophageal stenosis, and creation of a false tract.

Proper fit of the prosthesis is necessary for good speech and for the prevention of complications. The length of the device and the angle at which the prosthesis enters the party wall of the trachea and esophagus are important factors. An excessively long prosthesis may damage the posterior pharyngeal wall. In addition, some prostheses may not be angled correctly or may not conform to the neck or stoma size. In this situation, tension will be placed on the fistula tract and the stoma, causing the fistula to enlarge or migrate. Esophageal stenosis or stricture may follow.

Fistula expansion is most commonly seen in irradiated tissue but can occur in nonirradiated tissue as well. If this occurs, the prosthesis should be left out or replaced with a small catheter for a few days. This usually results in contraction of the fistula. In more resistant cases, cauterization of the fistula tract may help.

Aspiration of the prosthesis can be life-threatening if the patient does not have a good cough reflex. Repeated aspiration of the prosthesis is an indication that the patient is having difficulty maintaining the stoma and fistula, and consideration should be given to permanent removal of the prosthesis.

Postoperative Speech Evaluation

In assessing quality of speech, many speech pathologists use questionnaires, videofluoroscopy, videotaped interviews, and head and neck examinations. Videofluoroscopy records the appearance of the reconstructed pharynx and upper esophagus in three stages: during the events of (10 swallowing, (2) esophageal phonation, and (3) phonation during air insufflation. Ordinary soft tissue x-ray films, xeroradiography, and CT scans or magnetic resonance imaging do not demonstrate the physiology of the neopharynx satisfactorily. The esophageal segment *must* be observed dynamically. Barium swallows should be used to detect any anatomic abnormality within the oral, pharyngeal, or esophageal phases.

Despite the obvious success of the tracheoesophageal puncture, alaryngeal speech fails to develop in a small but significant group of patients. Wetmore and colleagues found that speech never develop in 11 per cent of patients after tracheoesophageal puncture, whereas an addition 18 per cent failed to maintain tracheoesophageal speech. Many times these patients are brushed off as having lack of drive or psychological problems. Adequate evaluation of these patients' failures many times points to a physiological or anatomic cause for the failure.

In evaluating tracheoesophageal speech failure, speech assessment without a prosthesis is helpful in establishing whether problems are device-related or due to pharyngeal spasm. The clinician should then try different types of prostheses. Previous studies have demonstrated distinct differences in speech loudness, fluency, and effort related to choice of device. If speech generation difficulties continue in spite of an optimal device choice, the patient should be evaluated for pharyngeal constrictor spasm.

Singer and Blom noted an overall failure rate of 19 per cent, more than half of which they attributed to air flow-induced pharyngospasm. In their study, percutaneous nerve block of the pharyngeal plexus followed by pharyngeal myotomy led to the development of tracheoesophageal speech in almost 90 per cent of these spasmodic failures. Henley and Souliere reported a similar experience. Of 43 patients who underwent tracheoesophageal puncture, 5 had significant pharyngospasm and required pharyngeal myotomy of the inferior and middle constrictor muscles.

To understand the basis of air flow-induced pharyngospasm, one must remember the effect of a laryngectomy on the normal anatomy and physiology of the larynx. Bilateral innervation via the pharyngeal plexus causes constriction of the constrictor muscles and relaxation of the cricopharyngeus muscle; at rest the reverse is true. Kirchner and co-workers studied the effect of laryngectomy on pharyngeal physiology and found a decrease in the resting cricopharyngeal pressure coupled with evidence of uncoordinated contraction of the middle and inferior constrictor muscles. They felt that these findings were secondary to surgical damage of the motor nerve supply to the pharynx and inadequate surgical approximation of the constrictors. They further showed that good esophageal speech did not depend upon a functional upper esophageal sphincter nor upon the size or shape of the pharyngeal lumen. Surprisingly, they found the upper esophageal sphincter to be approximately 4 cm in length, thereby implying a sphincteric action by the inferior and middle constrictor muscles.

Pharyngoesophageal spasm in the postlaryngectomy patient appears to be a normal physiologic reflex that prevents gastroesophageal reflux into the larynx, but in laryngectomees it works to the disadvantage of esophageal and tracheoesophageal puncture speakers. Fortunately, tracheoesophageal spasm either does not occur or does not cause much difficulty in all laryngectomized patients. Singer and Blom identified 16 (12 per cent) of 129 patients who were unable to achieve tracheoesophageal speech because of pharyngoesophageal spasm. Fourteen of those patients underwent cricopharyngeal and constrictor muscle myotomies and eventually fluent speech developed.

Failure to produce speech may be due to the method of pharyngeal repair. Pharyngeal reconstruction usually involves suturing the anterior remnant of the pharyngeal muscles. Although the nerve supply of the pharyngeal plexus and external laryngeal nerve is often disrupted at the time of laryngectomy, videofluoroscopy clearly demonstrates that reinnervation occurs and that the degree of tone in the pharyngoesophageal segment is important in the acquisition of alaryngeal speech. Whether or not the type of mucosal closure has a bearing on the acquisition of tracheoesophageal puncture speech remains unanswered at this time. Many feel that if a conventional two-layer closure of mucosa and muscle is performed, a posteropharyngeal myotomy should be performed at the same time. Although hypotonicity may result, this is much easier to correct by digital pressure than is hypertonicity, which generally requires further surgery.

In cases of pharyngoesophageal spasm, there may be one or two hypertonic segments, and voice production will be very poor. Usually the injection of air into the esophagus is adequate, but regurgitation gives a poor uncoordinated, and ill-sustained voice. In severe cases, air injection may be so difficult that sufficient volume for voice production is impossible.

In other instances, the patient may only be able to phonate a little at a time before spasm closes the pharyngoesophageal segment completely. With a stricture, the patient is unable to inject air into the esophagus in a quantity sufficient for phonation to occur. On videofluoroscopy, the narrowing may be seen at rest but will open on swallowing a large gulp of barium and then close again. This often leaves a small amount of residual barium above the segment, resulting in an air-fluid level.

In hypotonic patients, the pharynx and esophagus dilate on swallowing, and there is rapid passage of barium. On attempted phonation, however, no true pharyngoesophageal segment develops and the voice is very weak and whispery. This situation can be corrected by digital pressure on the pharynx externally, which "creates" the pharyngoesophageal segment and allows voice production.

Discussion

Postlaryngectomy speech rehabilitation continues to intrigue head and neck surgeons. A multitude of procedures are used today, testifying to the fact that no one method is perfect. Yet data does support some basic differences between the types of speech production.

In a study comparing several parameters of tracheoesophageal speech with esophageal and normal speech. Singer and co-workers found that tracheoesophageal speakers have a better fundamental voice frequency, greater intensity, and better intelligibility in a noise environment than do esophageal speakers.

Blom and co-workers studied the time, expense, and success rates of patients attempting to acquire esophageal speech compared with those trying to acquire tracheoesophageal speech. Esophageal speech, although traditionally considered the method of choice, could be achieved by no more than half of the patients who tried to acquire it. Among those who did, the therapy time was considerable and the resultant speech proficiency was variable. It may take as long as 3 to 12 months to learn good esophageal speech. Conversely, tracheoesophageal puncture voice training can take as little as 7 to 10 days.

Patient selection is a critical part of postlaryngectomy speech rehabilitation and should include (1) no compromise of accepted surgical or adjunctive radiation treatment techniques, (2) avoidance of uncontrolled tracheal laceration, (3) minimal added inconvenience to the patient, (4) simple and inexpensive prosthetic materials, if required, (5) uncomplicated, reproducible, and consistent surgical technique, and (6) speech that is equivalent or superior to esophageal speech or the artificial larynx.

By maintaining a team approach to voice restoration and employing meticulous surgical technique and thorough postoperative evaluation, most postlaryngectomy patients should be able to achieve effective communication.