Chapter 50 – Voice Restoration after Total Laryngectomy

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Loss of voice is the greatest disability for most patients after total laryngectomy. Although the presence of a tracheostoma and the associated anterior neck deformity pose a cosmetic and functional deformity, it is loss of a normal speaking voice that is most debilitating to the patient, both functionally and emotionally. As a result of the severity of this disability and its effect on social interaction, efforts to rehabilitate the voice after total laryngectomy have been made almost since the first laryngectomy was performed more than a century ago.

Acoustic signals that are interpreted as voice are a complex compilation of varying frequencies created by a number of anatomic structures. The larynx is responsible for the fundamental vibratory frequency of the sound produced, as well as the associated interruptions and alterations in airflow. Airflow is created by expiratory lung volume, and the complexities of articulated speech and resonance are produced in the air passages superior to the larynx. Therefore, any means that can approximate normal vibratory airflow function proximal to the articulators has the possibility of resulting in understandable speech. All forms of speech rehabilitation after laryngectomy rely on this principle.

TYPES OF SPEECH REHABILITATION

Speech rehabilitation after total laryngectomy can be subdivided into three major categories:

1. Esophageal speech
2. Prosthetic artificial oscillators
3. Tracheopharyngeal shunts or fistulas

Esophageal Speech

Esophageal speech is a learned technique in which air is swallowed (“injected”) into the esophagus and then allowed to escape through the pharynx. Appropriate tensing of the pharyngeal walls during expiratory airflow results in vibration of the pharyngeal walls, which creates sound. Esophageal speech is typically of lower pitch than normal speech frequencies because of characteristics of the pharyngeal wall. The advantages of this technique are that it requires no surgical procedure, prosthesis, or cumbersome hand motions. However, few patients who have undergone laryngectomy are able to achieve usable esophageal speech, and fewer than one in five achieve speech acceptable for social interaction. Extensive training is required by most people, and individuals vary widely in their ability to use this training to rehabilitate their speech; nonetheless, despite recent advances it remains useful for those who are able to master it. A few patients are able to use esophageal speech as their sole speech modality, but most retain other forms of speech as a backup.

Prosthetic Oscillators

Electronic devices supplying vibration into the oral cavity will permit speech, albeit monotone and machine-like. This is clearly the easiest method to use and, for many patients, remains their sole form of speech after total laryngectomy. The devices can be divided into two types: those that cause the pharyngeal wall to vibrate and result in secondary vibration of the air column and those that cause vibrations within the oral cavity via a connecting tube (Fig. 50-1). One (and perhaps more) of the instruments available commercially can be modified to permit either vibration of the oral cavity tissues externally or entrance of vibrating air into the oral cavity. As in many other skills, speech production by these techniques is learned by experience, and patients vary widely in their ability to develop useful communication. An externally applied device will not be satisfactory in a patient whose pharynx has been reconstructed with bulky flaps or who has undergone radiotherapy because of the increased rigidity of the tissues and resistance to vibration.

Figure 50-1 Various artificial oscillators useful for patients after total laryngectomy.

Shunt Formation

The first laryngectomy performed by Billroth in 1874 is said to have included the formation of a shunt by maintaining an intact communication between the airway and pharynx. Details of the procedure are not known, but apparently maintenance of communication required a prosthesis.

The desire to create a functional shunt for voice production has led to the development of various surgical procedures since about the mid-1960s. The list of procedures is lengthy; however, the most popular surgical shunt was the Staffieri procedure.[1] In this procedure a mucosal shunt is created at the end of the trachea, and a tracheostomy tube is placed through a separate opening into the trachea. Creating a shunt large enough to permit air to escape but not so large that it results in debilitating aspiration was technically difficult, and this procedure has fallen into disuse.

In 1980 Blom and Singer first reported the use of a prosthetic one-way valve inserted through a simple puncture in the posterior tracheal wall.[2] The one-way valve permitted expired air to pass from the trachea into the esophagus but prevented retrograde passage of pharyngeal contents into the trachea (Fig. 50-2). This technique is now the standard technique of voicing in postlaryngectomy patients in the United States. A wide variety of prosthesis styles, pressures, and lengths are readily available. In Europe, the Provox prosthesis devised by Hilger and Schouwenburg is very similar to the Singer-Blom valve and used widely in Europe.[3]

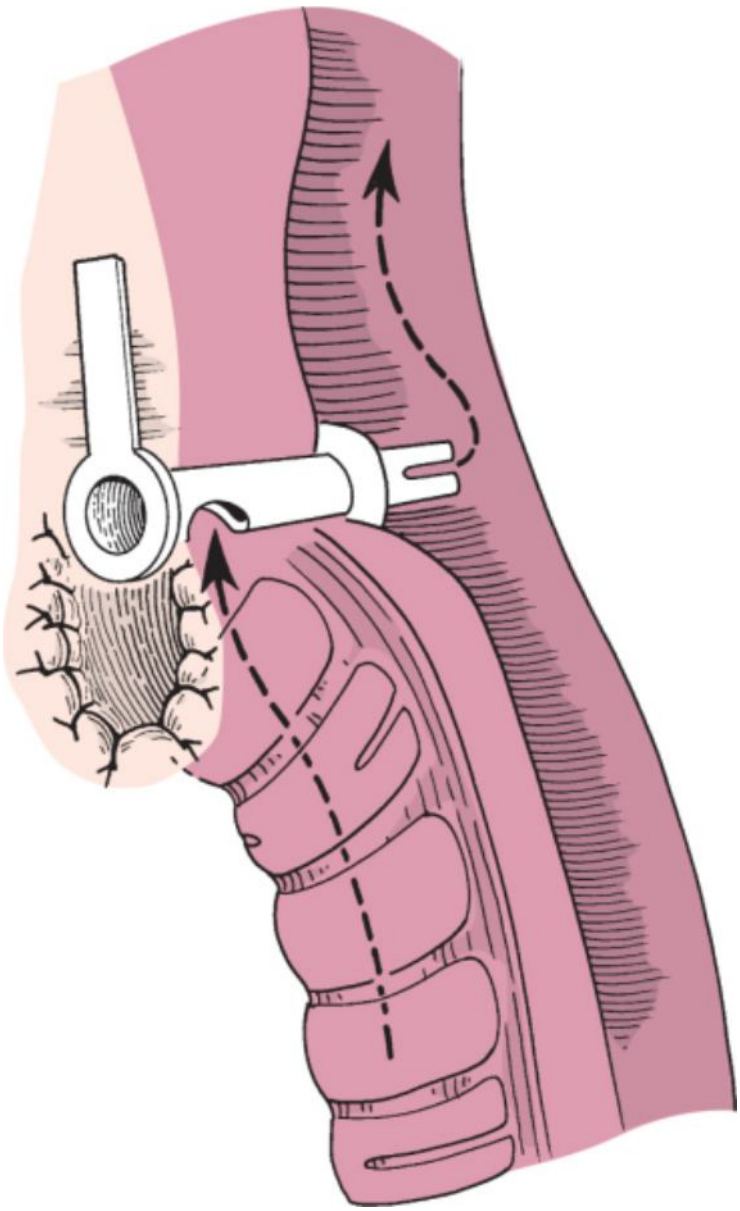

Figure 50-2 A tracheoesophageal puncture in place demonstrating the valve placed through an artificial fistula from the trachea into the cervical esophagus.
(Redrawn from Singer MI: Voice rehabilitation. In Cummings CW, Fredrickson JM, Harker LA, et al [eds]: Otolaryngology; Head and Neck Surgery. St Louis, Mosby–Year Book, 1986, p 2195.)

THE ROLE OF THE SPEECH-LANGUAGE PATHOLOGIST

The role of the speech-language pathologist (SLP) in speech rehabilitation after laryngectomy must be emphasized. Although tracheoesophageal puncture (TEP) is straightforward, use and care of the prosthesis and various techniques to assist voice production require significant patient instruction for optimal voicing. Training in postlaryngectomy speech is now an integralpart of SLP training programs. In most centers, the SLP actually inserts the prosthesis, instructs the patient in care and insertion of the prosthesis, and details the potential problems. In our practice, patient appointments are scheduled in tandem with a visit to the SLP. The SLP should be intimately involved in care of the patient from the time that the decision is made to perform a total laryngectomy, with or without TEP. The patient is informed by the SLP about possible complications such as yeast infection, discharge around the valve with aspiration, and loss of the TEP with closure of the fistula. A brochure is helpful in educating the patient and caregiver regarding TEP management (Fig. 50-3).

Figure 50-3 **A** to **D,** Photographs from patient brochure demonstrating how to insert a catheter into a tracheoesophageal puncture to maintain an intact fistula.

PATIENT SELECTION

Preoperative evaluation of a patient who is scheduled to undergo total laryngectomy or who has already undergone total laryngectomy and desires speech rehabilitation should include early consultation with the SLP. The patient should be counseled on the various means of speech production, and assessment should be made of the patient's ability to manage the TEP valve. Patients who have significant difficulty with coordination, severe arthritis of the fingers, advanced senility, or cognitive dysfunction are not good candidates for TEP placement. Patients who have previously undergone total laryngectomy and are satisfied with their current methods of speech production may not wish to proceed with TEP once the requirements for care have been explained to them. On the other hand, every patient undergoing total laryngectomy should be considered for TEP placement unless there are contraindications to its performance.

There are relatively few absolute contraindications to TEP placement aside from patient cognition and coordination. Patients with either pharyngeal or stomal stenosis after laryngectomy are not good candidates. Those with stomal stenosis should undergo stomoplasty before or at the time of performance of TEP. Voice rehabilitation with TEP is feasible in patients who have undergone gastric pull-up or jejunal free flap interposition; however, the voice is usually suboptimal.

Secondary TEP performed after delivery of radiation therapy to the stoma is contraindicated because these patients heal poorly and widening of the fistula occurs, occasionally to the point that surgical intervention for closure of the fistula becomes necessary.

PREOPERATIVE EVALUATION

Patients undergoing TEP at the time of total laryngectomy do not require any special testing. A major difficulty in the production of speech after TEP in some cases is inappropriate contraction of the pharyngeal musculature during phonation. Various intraoperative techniques have been described in an attempt to diminish this difficulty, including myotomy and myectomy, neurectomy of the pharyngeal plexus, and chemodenervation with botulinum toxin.[4] Perhaps the most important factor in preventing the problem is to ensure that the pharyngeal muscles are not reapproximated during pharyngeal closure.

The history and physical examination remain important parts of the evaluation of a patient for TEP. Additional caution is warranted if the patient has previously undergone high-dose radiation therapy to the stoma, such as those with a history of subglottic or piriform sinus cancer. Patients who have a history of difficulty swallowing should be evaluated by barium swallow. If a stricture is noted, the patient is not a candidate for TEP.

Performance of an insufflation test (insufflating air into the pharynx through a catheter placed through the nose of the patient into the pharynx) may be useful in determining whether the patient will be able to generate speech, but it is not an absolute requirement before secondary TEP.

Procedures performed secondarily can be carried out under general anesthesia with a rigid endoscope or under local anesthesia with a flexible esophagoscope. The latter technique is of particular benefit when fibrosis and scarring preclude placement of a rigid endoscope into the esophagus. If fibrosis precludes passage of a rigid endoscope and a flexible esophagoscope is not available, it is occasionally possible to use an endotracheal tube placed in the cervical esophagus and visualize the puncture site with a fiberoptic laryngoscope passed through the endotracheal tube.

TECHNIQUE

Primary Tracheoesophageal Puncture

After total laryngectomy has been performed, the inferior aspect of the trachea stoma is sewn to the skin. Several 4-0 chromic catgut sutures are placed superficially between the membranous posterior wall of the trachea and the cervical esophagus to prevent any leakage of saliva into the visceral space of the neck. A right-angled clamp is then inserted into the cervical esophagus and its point pressed anteriorly against the membranous wall of the trachea approximately 1 cm below the posterior verge (Fig. 50-4). It is very important to avoid placing the TEP too inferior because replacing the valve will be difficult to impossible. Placing the TEP too close to the mucocutaneous junction may interfere with diversion of air into the trachea because the valve may be occluded by digital pressure while phonating. Care is taken to avoid shearing the trachea from the esophagus and creating a dissection plane in the region through which the right-angled clamp and catheter will pass. Indeed, should such dissection occur, it is probably best to abort the performance of a primary TEP and plan a secondary procedure at a later date after healing.

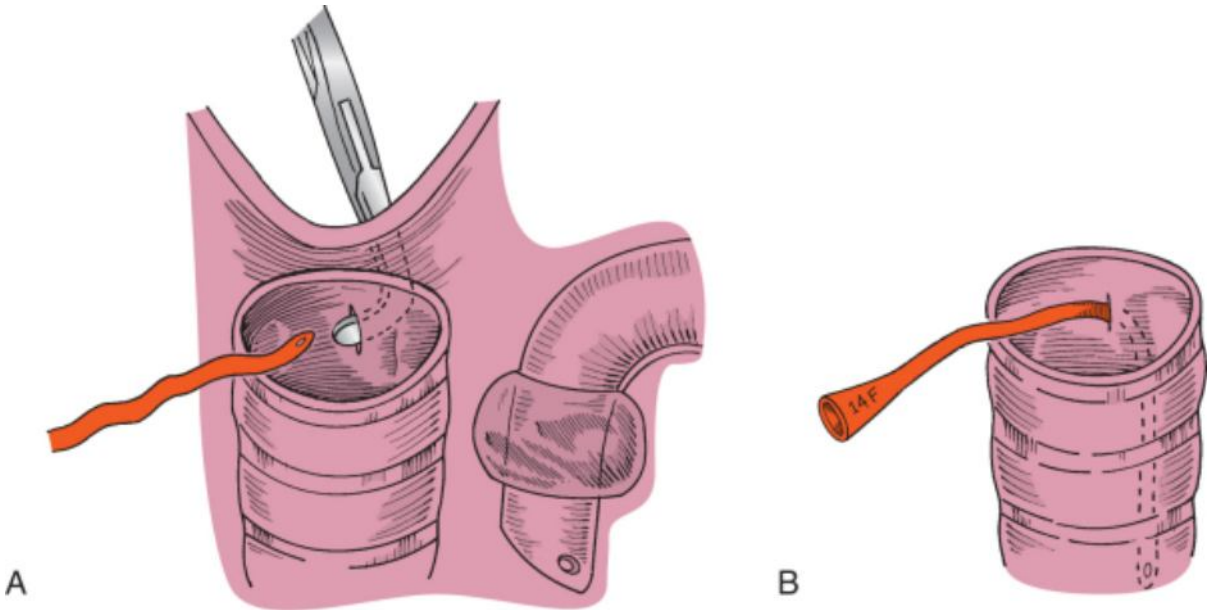

Figure 50-4 Primary tracheoesophageal puncture. A right-angled clamp is placed in the esophagus, and an incision is made in the posterior wall of the trachea over the tip of the clamp. **A,** A 14-gauge red rubber catheter is grasped and brought into the esophagus through this opening. **B,** The end of the catheter is inserted into the distal portion of the esophagus, and the catheter is secured with a suture.

A scalpel is used to incise the mucosa directly over the tip of the right-angled clamp, and the clamp is used to pull a 14-gauge red rubber catheter through the opening into the pharynx. The end of the catheter is brought out through the pharynx and then placed in the distal esophagus with forceps through the esophagoscope. A suture is used to anchor the catheter to prevent inadvertent removal during closure of the pharynx and formation of the stoma.

A myotomy should be performed to reduce postoperative muscle spasm, especially in patients with abnormal

insufflation test results. In most instances a myotomy is most easily performed posteriorly on the pharyngeal wall.

The red rubber catheter is replaced with a valve prosthesis in approximately 12 to 14 days, depending on the surgeon's impression of wound healing and patient progress.

Secondary Tracheoesophageal Puncture

This procedure is best performed with the patient under general anesthesia, although local anesthesia can be used. Recently, the use of a transnasal flexible esophagoscope has been reported to facilitate performance of the procedure under local anesthesia in the office.[5] The procedure can be performed under direct visualization with a tracheal incision, dilatation of the tract, and insertion of a catheter, or the TEP prosthesis can be inserted immediately by using a gel cap over the end of the prosthesis.[5] An alternative is to first pass a guidewire to pull the catheter into the puncture. We prefer the guidewire technique performed under general anesthesia, which is the technique described here.

Under general anesthesia, the short cervical esophagoscope is passed into the esophagus. The tip of the scope can be palpated through the stoma (Fig. 50-5). If the cervical esophagoscope cannot be passed because of fibrosis, an endotracheal tube can occasionally be placed through the mouth into the cervical esophagus and a flexible fiberoptic laryngoscope passed through it and used for endoscopic visualization. In addition, this technique helps protect the posterior esophageal wall. The position of the endoscope can also be identified by the light shining through the posterior tracheal wall. The cervical esophagoscope is turned 180 degrees so that the opening at the distal beveled end of the laryngoscope is directed anteriorly.

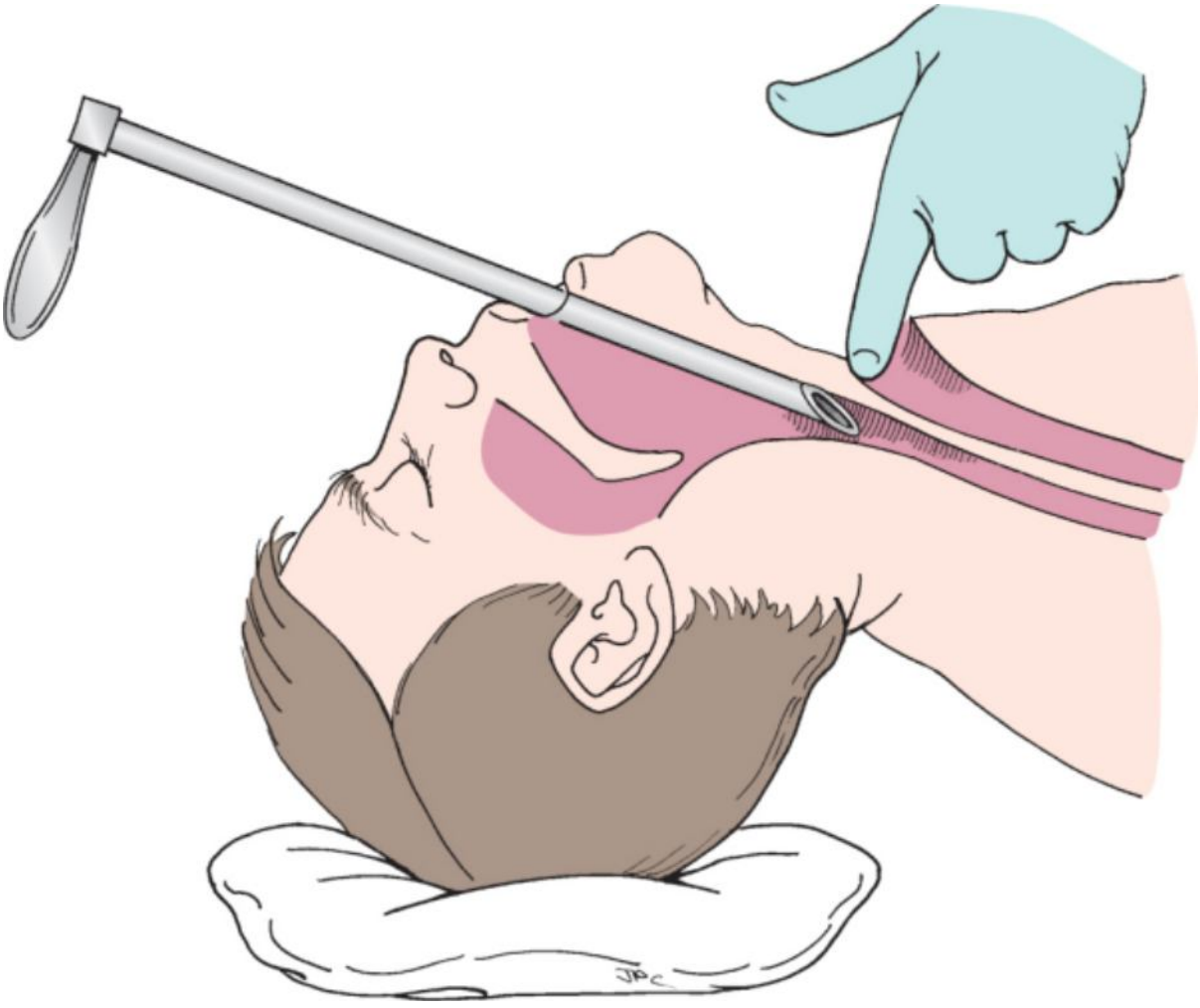

Figure 50-5 Performance of a secondary tracheoesophageal puncture. The esophagoscope is placed into the cervical esophagus and rotated so that the bevel is directed anteriorly and can be palpated with a finger placed through the laryngectomy stoma.

An 18-gauge spinal needle is then inserted through the posterior wall of the trachea at a point approximately 1 cm inferior to the posterior verge of the trachea stoma. Palpation of the open end of the esophagoscope (or endotracheal tube) will assist in placement of the needle so that its tip comes to lie within the end of the esophagoscope. Placing the needle may be difficult in patients with chronic obstructive pulmonary disease as a

result of the large anterior-to-posterior diameter of the chest. Bending the needle slightly will ease insertion (it is important to remove the stylet *before* bending the needle because it frequently cannot be removed from the needle if the needle is bent with the stylet in place) (Fig. 50-6).

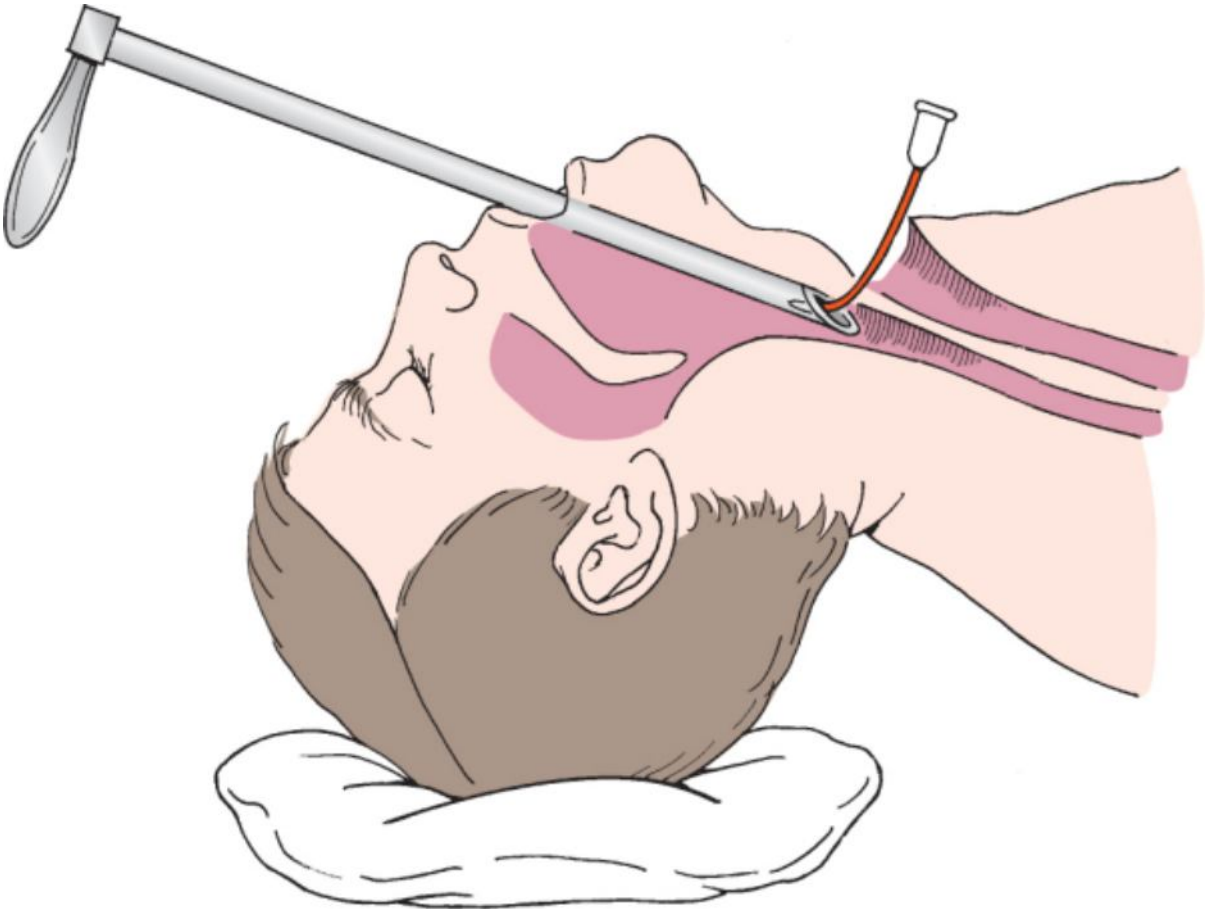

Figure 50-6 An 18-gauge spinal needle is placed through the mucosa of the posterior tracheal wall approximately 1 cm below the posterior verge, and its tip is directed into the end of the esophagoscope. It is often necessary to bend the needle slightly to ease passage of the wire.

A segment of 24-gauge stainless steel wire is then passed through the needle into the esophagoscope (Fig. 50-7). In most cases the wire must be grasped with forceps and pulled up into the esophagoscope. In other cases it will thread itself spontaneously. Eye protection must be worn to avoid inadvertent injury to the eye of personnel observing through the endoscope.

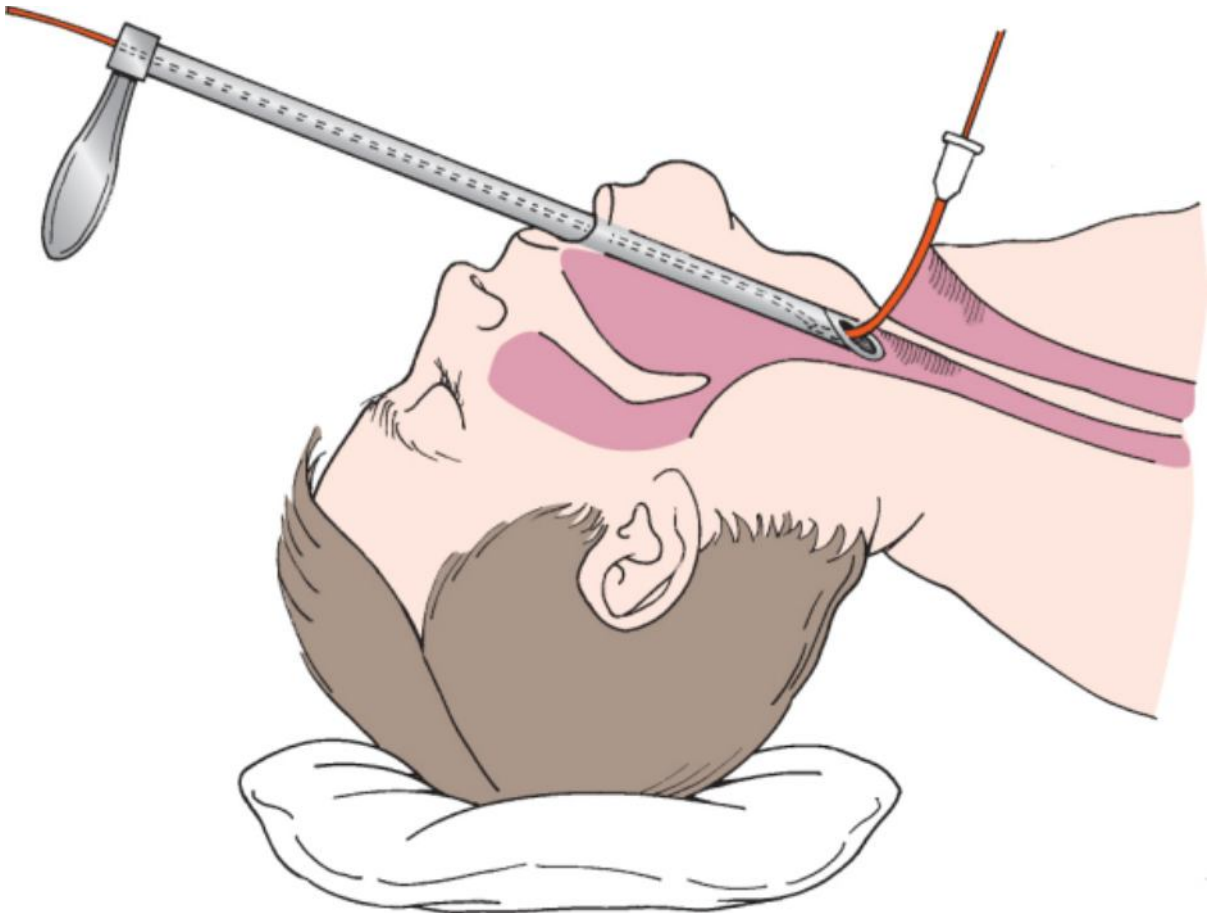

Figure 50-7 A 24-gauge wire is passed through the needle and brought out the end of the esophagoscope. Care must be taken to protect the eye of the assistant when the wire is threaded up the esophagoscope. A fiberoptic esophagoscope can also be used to retrieve the wire.

The needle is then withdrawn from the puncture site and used to puncture the end of a 14-gauge red rubber catheter. The wire is passed through the needle and thereby threaded through the end of the catheter. Care must be taken when attaching the wire to the catheter to avoid leaving a protruding end that will preclude easy passage of the catheter into the esophagus or lacerate the esophageal mucosa.

With the wire held tight, a scalpel blade is used to enlarge the opening in the tracheal mucosa (Fig. 50-8). A hemostat is attached to the wire and pulled through the incision into the esophagus (Fig. 50-9). When it is certain that the tip of the hemostat is within the lumen of the esophagus, the tips are spread so that the passage is bluntly enlarged. Failure to enlarge the fistula at thispoint is the most usual cause of difficulty in performance of the procedure. Once it has been ascertained that the opening is of sufficient diameter, the wire is used to pull the tip of the red rubber catheter through the party wall into the esophagus and out of the mouth (Figs. 50-10 and 50-11). The wire is then cut from the end of the red rubber catheter. The red rubber catheter is subsequently directed into the distal end of the esophagus by observing through the cervical esophagoscope and using long-cup forceps to direct the scope distally into the esophagus (Fig. 50-12). A knot is placed in the proximal end of the red rubber catheter to preclude regurgitation of gastric contents through the catheter. A suture is used to secure the catheter near the posterior verge of the tracheal stoma (Fig. 50-13). A plastic dressing is placed over the catheter to prevent accidental removal of it.

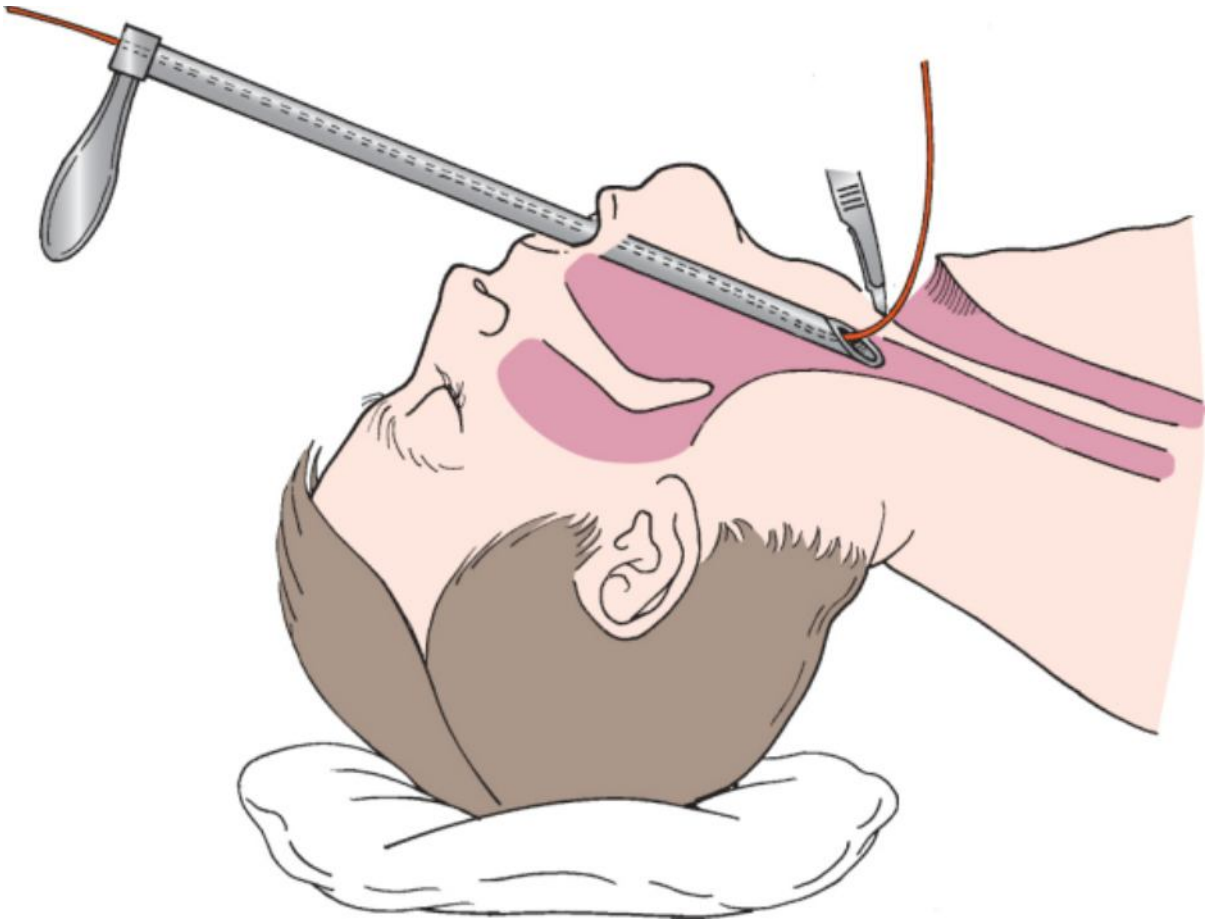

Figure 50-8 The puncture site must be enlarged slightly to facilitate passage of the red rubber catheter. This is performed by making a small incision with a knife.

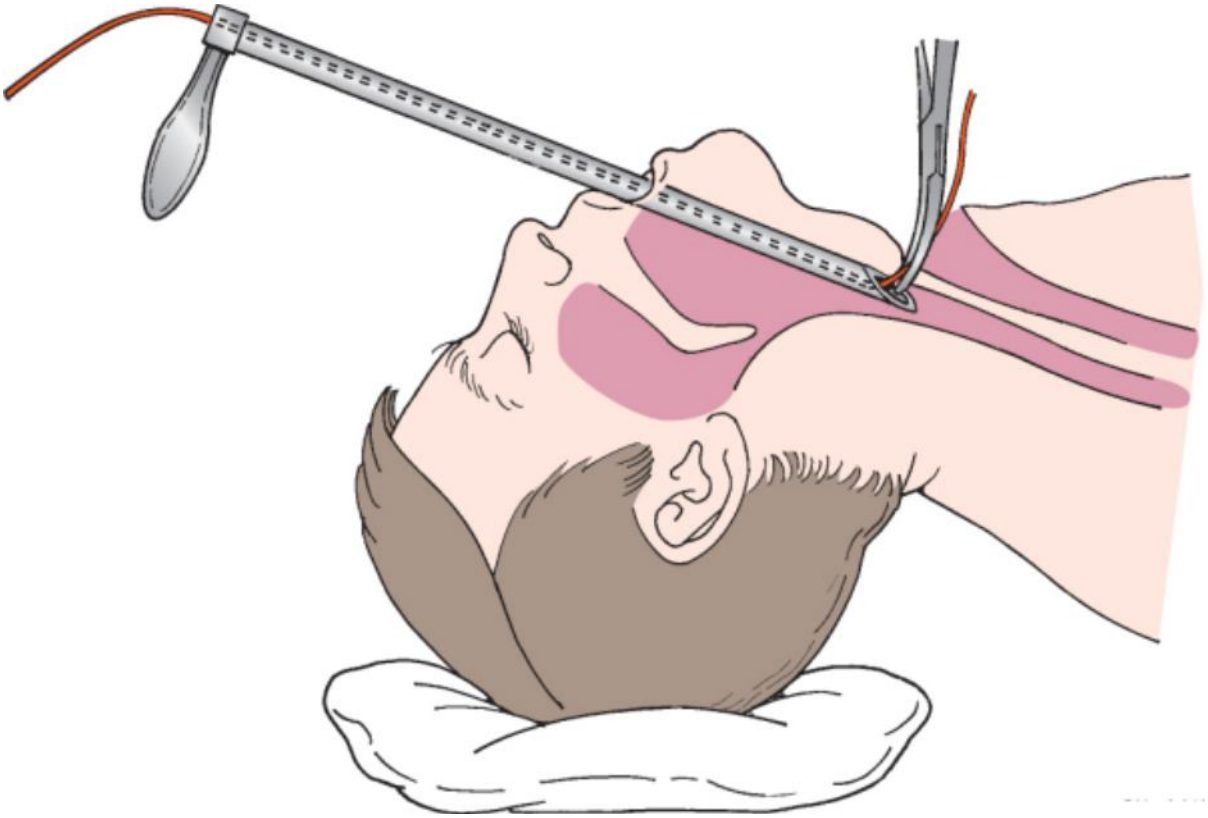

Figure 50-9 The wire is grasped with a hemostat and used to guide the hemostat into the puncture. Spreading the hemostat slightly will enlarge the fistula so that the red rubber catheter can be introduced.

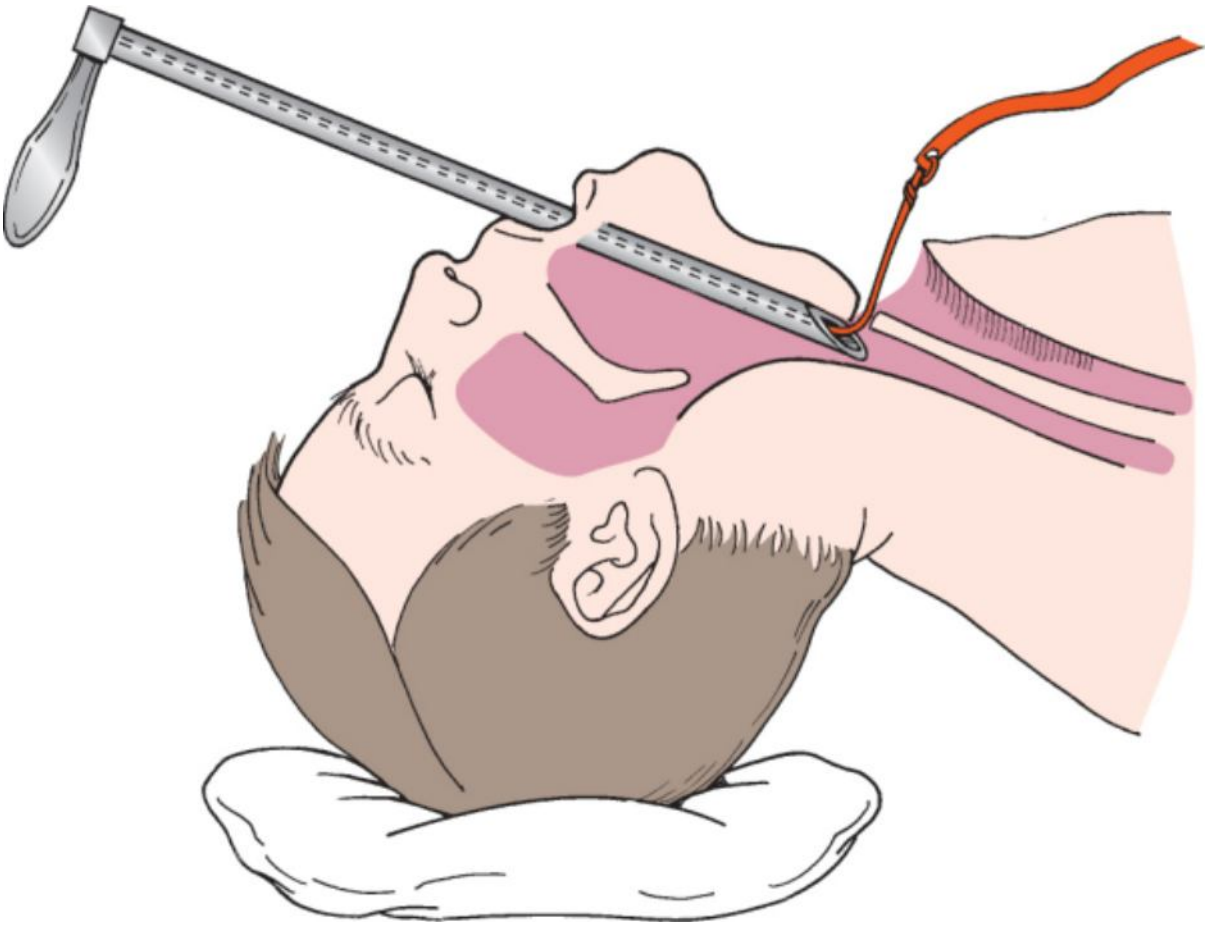

Figure 50-10 A 14-gauge red rubber catheter is attached to the wire. Care must be taken to ensure there are no protruding ends of the wire to catch on the soft tissues.

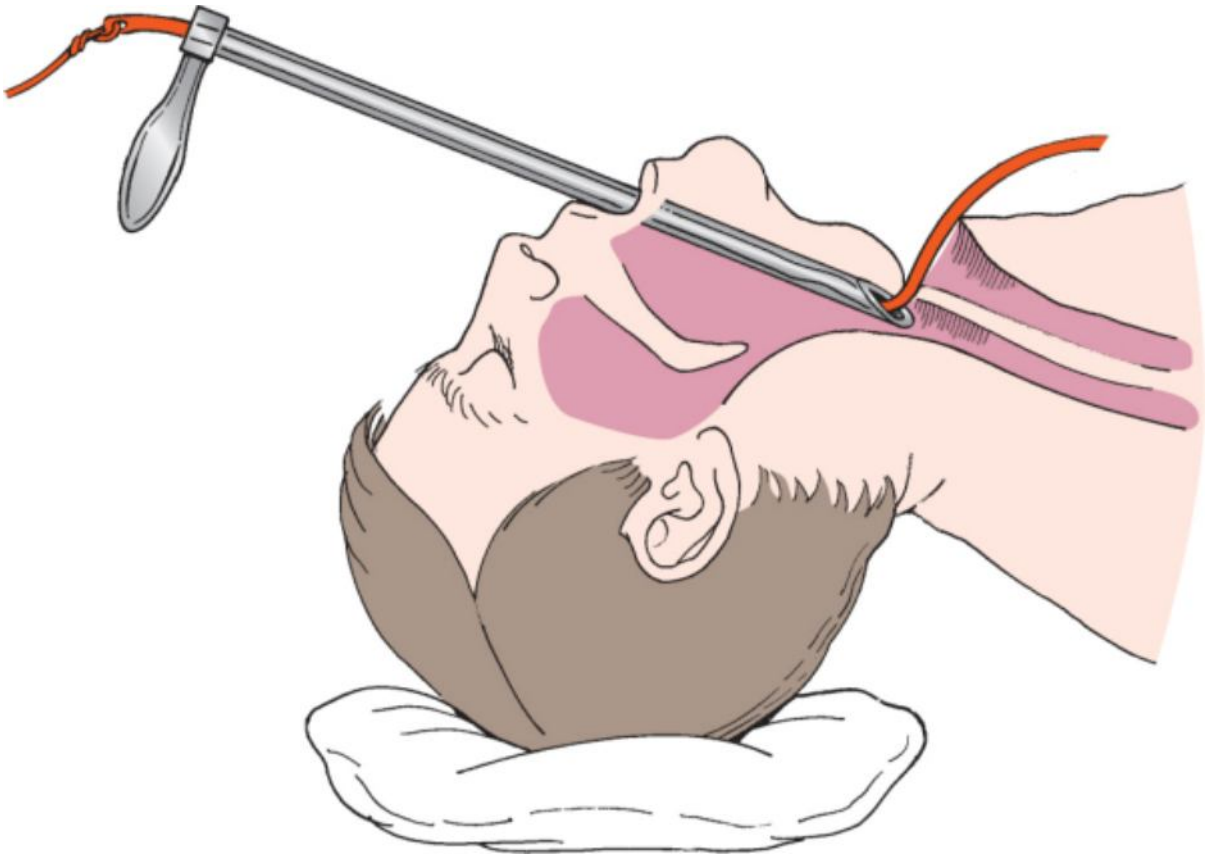

Figure 50-11 The red rubber catheter is pulled through the esophagoscope, and the wire is cut off.

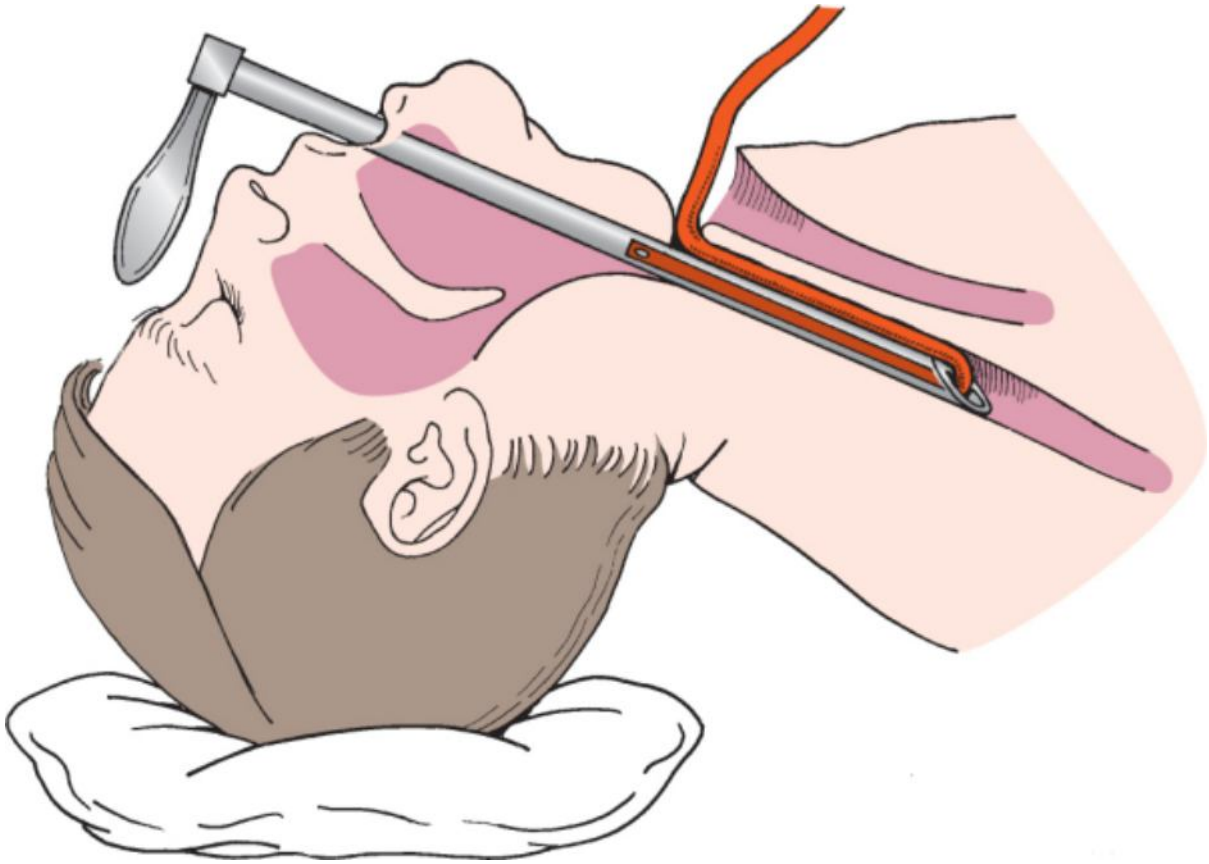

Figure 50-12 The esophagoscope is advanced into the esophageal lumen to push the end of the catheter inferiorly.

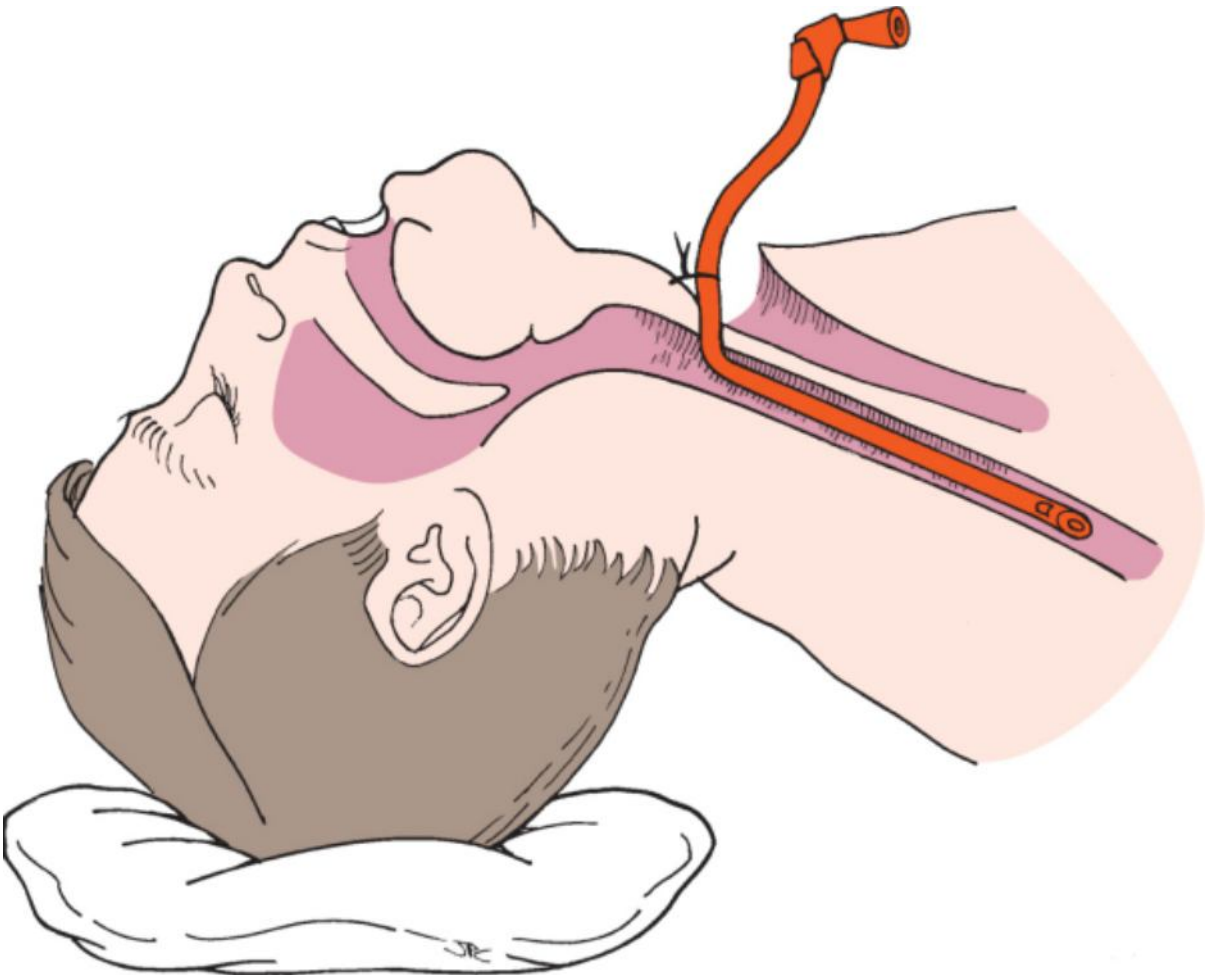

Figure 50-13 After verification of correct positioning of the catheter, a suture is used to attach the catheter to the skin of the neck to avoid inadvertent dislodgement. A knot is placed in the catheter to prevent regurgitation of gastroesophageal contents onto the patient's clothing. The catheter is fixed to the chest with a plastic dressing.

POSTOPERATIVE CARE

The red rubber catheter is removed on the 12th to 14th day for primary TEP (or the 3rd to 5th day for secondary procedures) and replaced with a TEP prosthesis (Fig. 50-14). In most instances this is performed by an SLP skilled in the management of TEP. If the stoma is too large for digital occlusion, a prosthesis can be created. Some patients are able to use a “hands-free” device that closes automatically so that digital occlusion of the stoma is not required.[6] If the contour of the neck is good, a prosthesis can be placed over the Singer-Blom valve (Fig. 50-15). This is a “flutter valve” that collapses on inspiration and closes on expiration to divert air through the Singer-Blom valve into the pharynx and oral cavity. An adhesive is applied to allow the valve to adhere to the skin. A number of factors affect successful use of these devices, such as pressure requirements, minimal expiratory restriction of airflow, and adequate dexterity and cognitive function of the patient to affixthe device. The SLP will instruct the patient in the technique of using the prosthesis and continued maintenance of the valve.

Figure 50-14 The tracheoesophageal valve in place within the puncture site.

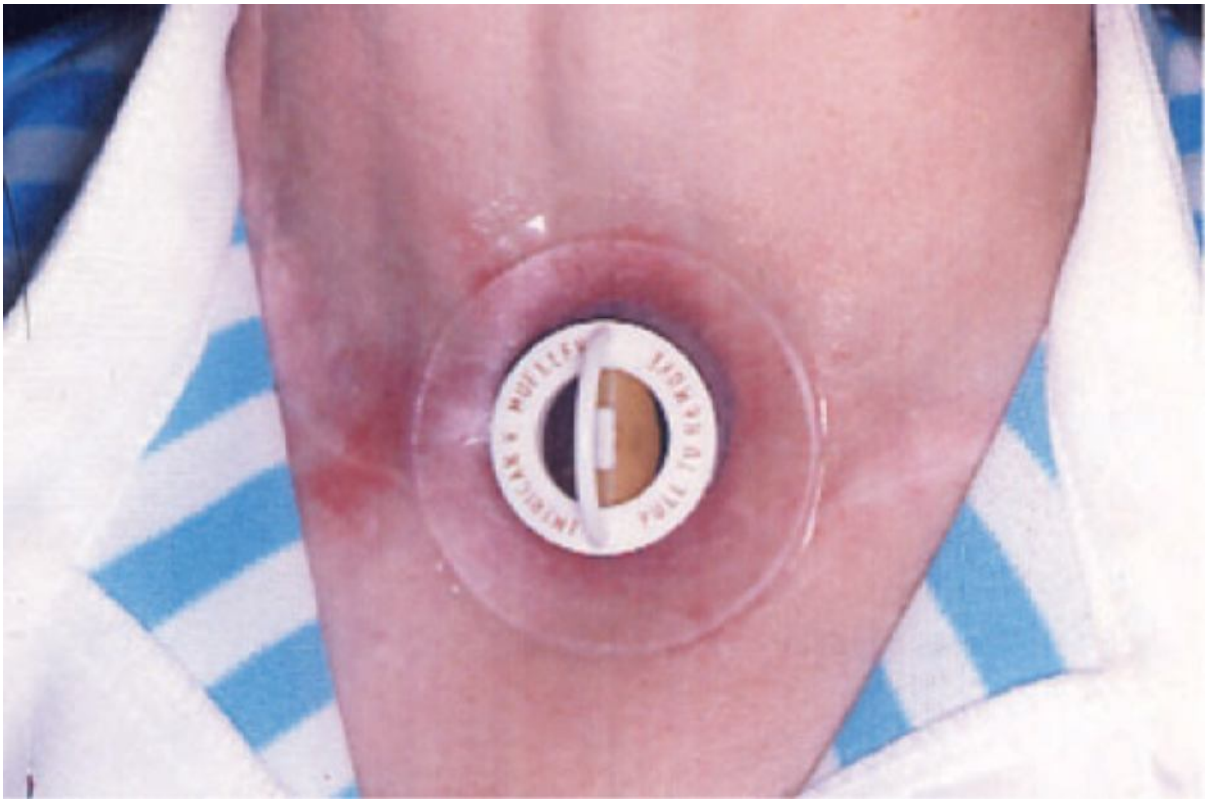

Figure 50-15 A hands-free device has a flutter valve that is fixed to the peristomal skin with adhesive.

PEARLS

- TEP is the best of the available voice restoration strategies and should be offered to nearly all patients at the time that they undergo total laryngectomy.
- A trained speech-language pathologist is required to ensure optimal rehabilitation.

- Chemodenervation of the pharyngeal muscles with botulinum toxin will assist in voicing in some patients with excessive pharyngeal muscle tension.
- An external valve to facilitate “hands-free” use of the valve can be suggested for highly selected patients.

PITFALLS

- Failure to enlarge the fistula widely enough to permit passage of the red rubber catheter leads to breakage of the wire and the need to start again.
- Performance of the procedure on a patient who is unlikely to heal, such as one who has recently received full doses of radiotherapy to the stoma or who is severely malnourished, may lead to a large fistula that requires surgical closure.
- Stomal stenosis is a contraindication to the performance of TEP. A stomoplasty must be performed first (see Chapter 72) and allowed to heal before performance of TEP.
- Stenosis of the pharynx is a relative contraindication to TEP. Treatment of the stenosis should be carried out before TEP.
- If the TEP becomes dislodged and cannot be replaced, the patient must be instructed to return quickly for replacement or the fistula may close.