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How I Do It

Closure of Tracheoesophageal Fistula With Two-Layer Tracheal-Esophagoplasty and Tracheal Advancement

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INTRODUCTION

In properly selected patients, the use of a voice prosthesis placed in a surgically created tracheoesophageal fistula (TEF) is a successful and desirable method of postlaryngectomy vocal rehabilitation. The long-term success rate for tracheoesophageal speech is high, ranging from 70% to 95%.[1,2] Unfortunately, some patients develop complications that include: migration and progressive enlargement of the puncture, persistent or recurring infection of the fistula site, aspiration pneumonia, aspiration of the prosthesis, vertebral osteomyelitis, and tracheal stomal and esophageal stenosis. The overall complication rate of TEF is 20% to 72%.[3]

One common complication of TEF is chronic leakage around or through a tracheal esophageal prosthesis (TEP), which leads to chronic aspiration. This occurs in 7% to −42% of patients.[4] The TEF may enlarge, causing salivary leakage around the prosthesis, or the prosthesis may malfunction with leakage of contents through the prosthesis. If the TEF has become too large, the prosthesis can be removed, allowing spontaneous contracture, and then replaced. Alternatively, a larger diameter TEP can be placed. For a malfunctioning prosthesis, there are a variety of styles and brands that can be trialed to determine which type best suits a patient's needs. When these measures fail and leakage persists, the medical team often chooses to close the TEF and pursue an alternative method of communication.

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Only 5% of TEFs require surgical closure.[5] More than 90% respond to conservative measures.[5] Surgical closure of a TEF can be complicated by patient factors such as advanged age, medical comorbidities like diabetes and hypothyroidism, immunosuppression, infection, and mechanical trauma. Additionally, this population has often undergone chemoradiation, which further compromises wound healing.

Multiple surgical techniques have been described for the closure of TEFs, which attests to the potential difficulty of this problem. We describe a simple and highly effective technique of TEF closure with a two-layer tracheal-esophagoplasty and tracheal advancement.

The patient is an 86-year-old male who underwent a total laryngectomy and partial esophagectomy for esophageal cancer 8 years ago. He suffered persistent leaking around his TEP for over 3 years. He trialed several different brands of voice prosthesis without success, and removed his TEP for extended periods to allow spontaneous closure, also without success. He learned to use an electrolarynx and was satisfied with this mode of communication. His past medical history is significant for multiple comorbidities, including peripheral vascular disease, chronic obstructive pulmonary disease, congestive heart failure, atrial fibrillation, cardiac pacemaker, and hypertension. Because he failed more conservative measures, he was offered surgical closure of the TEF. A two-layer tracheal-esophagoplasty and tracheal advancement technique was used. The patient had an uncomplicated hospital stay, and a modified barium swallow at 1 week showed no leak or stricture, and the patient advanced to a regular diet. The senior authors have performed this operation on six patients and successfully closed their TEFs.

SURGICAL TECHNIQUE

General anesthesia is induced via an endotracheal tube through the stoma site (Fig. 1A). A 230° circumferential incision is made at the tracheo-cutaneous junction at the superior aspect of the stoma to dissect free the

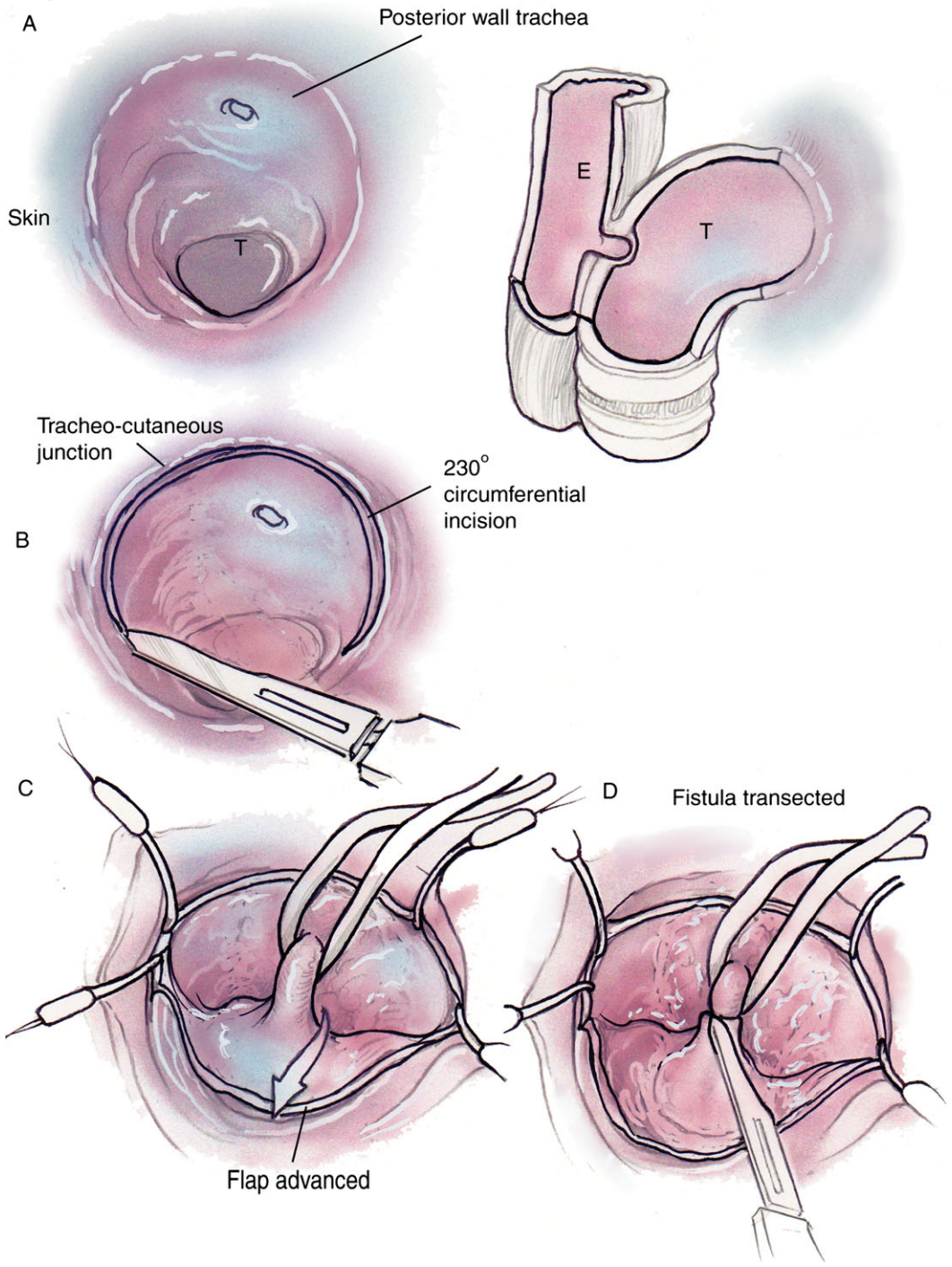

Fig. 1. Two-layer tracheal-esophagoplasty and tracheal advancement. (A) Preoperative drawing of the tracheoesophageal fistula. The superior aspect of the stoma (the posterior wall of the trachea) is to the top of the photo, and the inferior aspect of the stoma (the anterior tracheal wall) is to the bottom of the photo. The sagittal cutaway view demonstrates the relationship of the trachea to the esophagus/neopharynx. (B) A circumferential incision of approximately 230° is made at the superior aspect of the stoma at the tracheocutaneous junction. The dissection separates the posterior tracheal wall from the esophagus or neopharynx. (C) The tracheoesophageal fistula tract is isolated with a vessel loop. (D) The fistula is transected. (E) The esophageal and tracheal mucosa are imbricated. (F) To separate the closure of the tracheal and esophageal mucosa, the trachea is advanced externally and a strip of trachea is removed. (G) The stoma is matured with half-mattress sutures, and a penrose drain is placed in the lateral cervical space. (H) Healed stoma. T = trachea, E = esophagus.

posterior tracheal wall (Fig. 1B). This dissection is best started at the cartilaginous–membranous junction of the lateral trachea, which allows straightforward identification of the tracheal rings. When the appropriate plane is determined, the dissection can be extended to separate the posterior tracheal wall from the esophagus or neopharynx, taking care to preserve the lateral blood supply to the trachea. The TEF tract is isolated (Fig. 1C) and

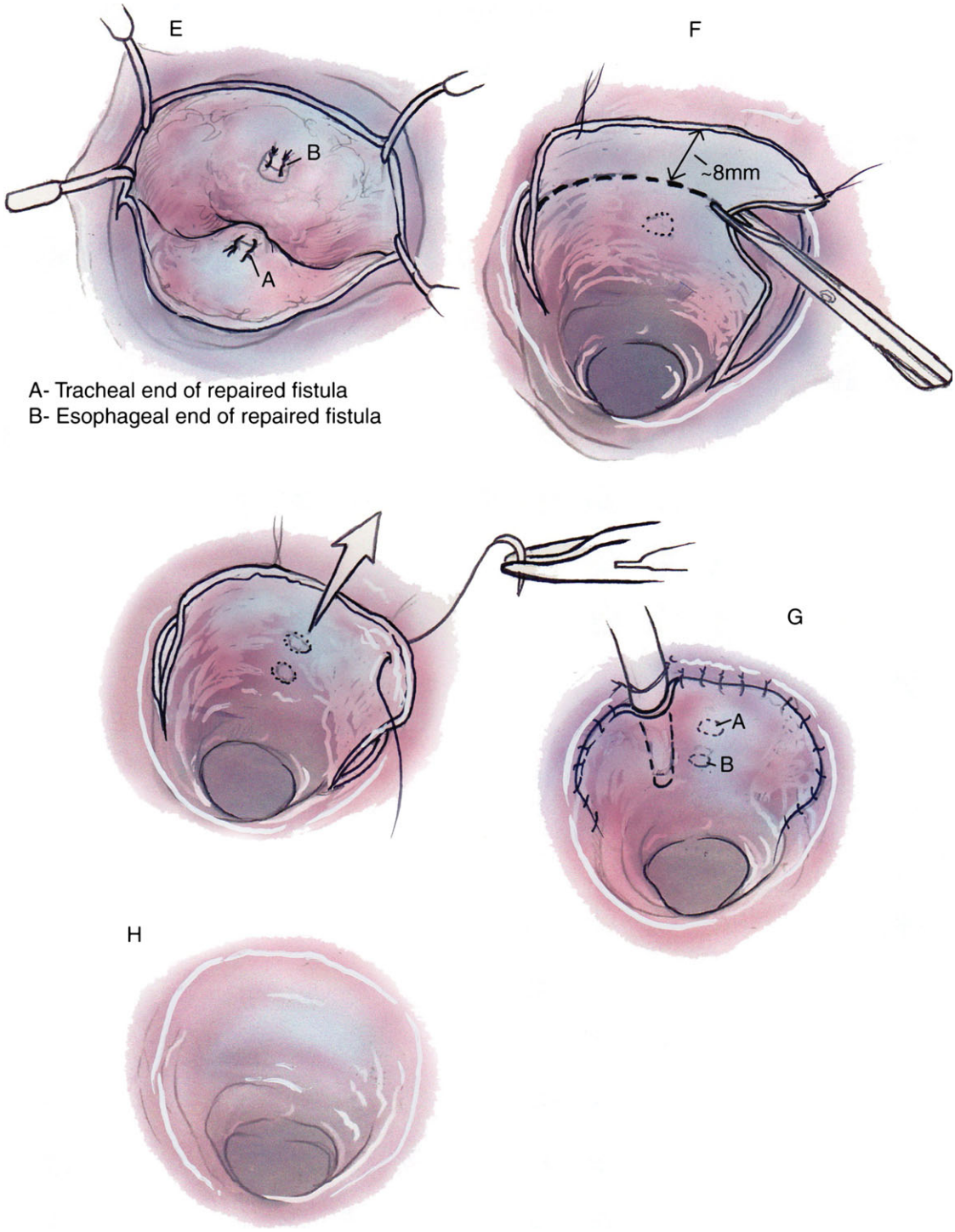

Fig. 1. Continued.

transected (Fig. 1D). The esophageal mucosa is imbricated upon itself and the tracheal mucosa is also imbricated upon itself (Fig. 1E). To separate the closure of the tracheal and esophageal mucosa, the trachea is advanced externally and an ellipse of trachea is removed (Fig. 1F). The superior aspect of the tracheal stoma is matured with half mattress sutures. A small Penrose drain is placed in the right lateral cervical space (Fig. 1G). Figure 2 shows operative photos.

DISCUSSION

There are several ways to achieve closure of an unwanted TEF (Table I). The most conservative measure is removing the TEP and allowing the fistula to contract and heal by secondary intention. This approach is successful in 53% of cases.[4] Wound healing can be stimulated by local injection of granulocyte-macrophage colony stimulating factor[6] or topical application of recombinant platelet-derived growth factor-BB (becaplermin).[7] Cauterization of

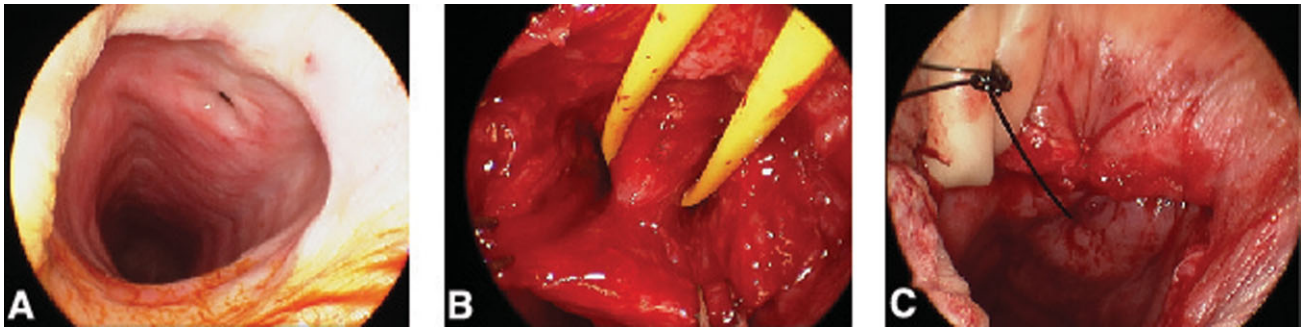

Fig. 2. Operative photos. (A) Preoperative view. (B) The tracheoesophageal fistula tract isolated with a vessel loop. (C) Postoperative photo of the repair with drain. These correspond to images in Figure 1A, C, and G.

the fistula with silver nitrate or electrocaudery[8,9] can stimulate wound contracture in an epithelialized fistula. Local injection of an augmentation filler into the fistula wall to increase the thickness and occlude the lumen has also been described; substances injected include autologous fat,[10] collagen,[11] and other synthetic materials.[12,13] A persistent TEF can also be stented with a custom prosthesis to occlude the enlarged fistula site. However, success with this option is limited.[14]

If the fistula does not respond to conservative measures, surgical closure may be necessary. Jacobs et al. described a submucosal purse-string suture that had an 80% success rate in their 20 patients.[4] Primary closure can be used for a small TEF (5–10 mm) in nonirradiated tissue. A transtracheal-stomal approach was described by Moerman.[15] He recommended a simple three-layer technique that was successful in approximately 50% of patients. Hosal and Myers described a transcervical approach that involved separation of the TEF and suturing of the fistula.[16] It must be emphasized that many persistent TEFs are found in chemoradiated patients, which present a challenging problem in wound healing. These patients may be less amenable to these straightforward options.

Koch et al. described a technique that is most similar to our technique.[17] These authors described an inverting suture of the esophagus with a cranial transposition of the trachea. All five of their patients received chemoradiation, and they reported success in four of the five patients. Our technique describes the addition of

TABLE I.
Reconstructive Options for Closure of Tracheoesophageal Fistula.

Removing prosthesis and allow healing by secondary intention	Jacobs et al.[4]
Local injection of granulocyte-macrophage colony stimulating factor	Margolin et al.[6]
Topical application of recombinant platelet-derived growth factor-BB (becaplermin)	Jakubowics and Smith[7]
Cauterization of the fistula with silver nitrate or electrocautery	Brasnu et al.,[8] Wetmore et al.[9]
Local injection of an augmentation filler.	Laccourreye et al.,[10] Remacle and Declaye,[11] Rokade et al.,[12] Lorincq et al.[13]
Submucosal purse-string suture	Jacobs et al.[4]
Custom prosthesis to occlude the enlarged fistula site	Dai et al.[14]
Primary closure–transtracheal stomal approach	Moerman et al.[15]
Primary closure–transcervical approach	Hosal and Myers[16]
An inverting suture of the esophagus with a cranial transposition of the trachea	Koch et al.[17]
Two layer tracheal-esophagoplasty and tracheal advancement	Hu et al.*
Interposition of local muscle rotation flaps	Singer et al.,[18] Remmert et al.[19]
Pedicled mediastinal pleural flap	Altorjay et al.[20]
Free flap (fasciocutaneous radial forearm free flap)	Delaere and Delsupehe[21]

*Presented technique.

both a tracheoplasty and esophagoplasty. Our technique also helps to avoid excessive cephalic trim of the tracheal wall, yet sufficiently advances the trachea externally, allowing spatial separation of the repaired perforations of the posterior tracheal and anterior esophageal walls. Another variation of this technique in patients with adequate tracheal length is to perform mobilization and resection of the trachea from the level of the preexisting tracheocutaneous junction to a point just below the plane of the previous fistula. In this procedure, the stoma requires rematuration circumferentially.

For repair of large TEFs in chemoradiated tissue, interposition of additional tissue between the esophageal and tracheal defects has been advocated. Dermal graft interpositions have been described.[4] The use of local muscle flaps, such as the sternocleidomastoid or infrahyoid myofascial flap, have the advantage of rotating vascularized tissue into the repair.[18,19] This tissue is within the chemoradiation field, and may be of dubious quality if neck dissections have been performed. A pedicled mediastinal pleural flap has been described in the thoracic literature[20] and allows use of nonirradiated vascularized tissue. Moving up to the last step of the reconstructive ladder, Delaere et al. described a fasciocutaneous radial forearm free flap.[21]

CONCLUSION

A summary of the reconstructive options for closure of TEF is shown in Table I. The two-layer tracheal-esophagoplasty and tracheal advancement is useful for TEFs that fail more conservative approaches. The advantages include good exposure, technical simplicity, low morbidity, short hospital stay, and immediate relief of leakage. This technique can be added to the menu of options for the closure of a persistent TEF.

BIBLIOGRAPHY

1. Ferrer Ramirez MJ, Gullart Domennech F, Brotons Durban S, et al. Surgical voice restoration after total laryngectomy: long-term results. *Eur Arch Otorhinolaryngol* 2001;258:463–466.
2. Op de Coul BM, Hilgers JF, Balm AJ, et al. A decade of postlaryngectomy vocal rehabilitation in 318 patients: a single institution's experience with consistent application of Provox indwelling voice prosthesis. *Arch Otolaryngol Head Neck Surg* 2000;126:1320–1328.
3. Wang RC, Bui T, Sauris E, et al. Long term problems in patients with tracheoesophageal puncture. *Arch Otolaryngol Head Neck Surg* 1991;117: 1273–1276.
4. Jacobs K, Delaere PR, Vander Poorten VM. Submocosal purse-string suture as a treatment of leakage around the indwelling voice prosthesis. *Head Neck* 2008;30:485–491.
5. Brown DH, Hilgers FJ, Irish JC, et al. Postlaryngectomy voice rehabilitation: state of the art at the millennium. *World J Surg* 2003;27:824–831.
6. Margolin G, Masucci F, Kuylenstierna R, et al. Leakage around voice prosthesis in laryngectomees: treatment with local GM-SCF. *Head Neck* 2001;23:1006–1010.
7. Jakubowics DM, Smith RV. Use of becaplermin in the closure of pharyngocutaneous fistulas. *Head Neck* 2005;27:433–438.
8. Brasnu D, Pages JC, Laccourreye O, et al. Results of the treatment of spontaneous widening of tracheoesophageal punctures after laryngeal implant. *Ann Otolarngol Chir Cervicofac* 1994;111:465–460.
9. Wetmore SJ, Johns ME, Baker SR. The Singer-Blom restoration procedure. *Arch Otolaryngol* 1981;107:674–676.
10. Laccourreye O, Papon F, Brasnu D et al. Autogenous fat injection for the incontinent tracheoesophageal puncture site. *Laryngoscope* 2002;112: 1512–1514.
11. Remacle JF, Declaye MD. Gax-collagen injection to correct an enlarged tracheoesophageal fistula for a vocal prosthesis. *Laryngoscope* 1988;98: 1350–1352.
12. Rokade AV, Mattews J, Reddy KT. Tissue augmentation using Bioplastique as a treatment of leakage around a Provox2 voice prosthesis. *J Laryngol Otol* 2003;117:80–82.
13. Lorincq BB, Lichtenberger G, Bihari A, et al. Therapy of periprosthetical leakage with tissue augmentation using Bioplastique around the implanted voice prosthesis. *Eur Arch Otorhinolaryngol* 2005;262:32–35.
14. Dai Y, Chopra SS, Kneif S, et al. Management of esophageal anastomotic leaks, perforations, and fistulae with self-expanding plastic stents. *J Thorac Cardiovasc Surg* 2011;141:1213–1217.
15. Moerman M, Vermeersch H, Hoylbrocck P. A simple surgical technique for tracheoesophageal fistula closure. *Head Neck* 1999;21:131–138.
16. Hosal SA, Myers EN. How I dit: closure of tracheoesophageal puncture site. *Head Neck* 2001;23:214–216.
17. Koch M, Aenk J, Birk S et al. Surgical closure of persistent tracheoesophageal fistulas by esophageal sutures and cranial transposition of the trachea. *Otolaryngology Head Neck Surg* 2010;143:843–844.
18. Singer MI, Hamaker RC, Blom ED. Revision procedure for the tracheoesophageal puncture. *Laryngoscope* 1989;99:761–763.
19. Remmert S, Majocco A, Gehrking E. Neurovascular infrahyoid myofascial flap. Anatomic-topographic study of innervations and vascular supply [in German]. *HNO* 1995;43:182–187.
20. Altorjay A, Mucs M, Rull M, et al. Recurrent, nonmalignant tracheoesophageal fistulas and the need for surgical improvisation. *Ann Thorac Sug* 2010;89:1789–1796.
21. Delaere PR, Delsupehe KG. Closure of persistent tracheoesophageal fistulas after removal of the voice prosthesis. *Laryngoscope* 1994;104: 494–496.