Chapter 41

DELAYED TREATMENT OF PHARYNGOESOPHAGEAL TRAUMA

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INTRODUCTION

The majority of publications on pharyngoesophageal reconstruction are derived from reviews on aerodigestive tract malignancy, chronic inflammatory disease, and caustic ingestion. This lack of published data specifically addressing delayed reconstruction of pharyngoesophageal trauma does not undermine the value of this topic. Although the information is being extrapolated to posttraumatic reconstruction, the management principles do not change. Reconstruction in this region has proven to be surgically challenging and condemned to high rates of complications regardless of the etiology. When applying the utility of these reconstructive options and their associated morbidity and mortality in the setting of a posttraumatic reconstruction, one must consider the markedly different tissue characteristics between these patient populations. The healing capacity is compromised in patients with prior head and neck irradiation, malignancy, and multiple comorbidities, which is why much of the literature focuses on reconstruction using pedicled or free flap grafts. Although there is no data that substantiates that healing capacity is compromised in the head and neck trauma patient, it may be prudent to manage them with equivalent assiduousness.

The patient being referred for delayed management of pharyngoesophageal trauma will either need pharyngoesophageal reconstruction after an esophageal or pharyngeal diversion, or the patient will have developed a complication, such as a stricture formation, a pharyngocutaneous fistula, or a tracheoesophageal fistula. This chapter will be a review of how to manage these complications and the surgical options for reconstruction, including the various muscle flaps that can be used during the primary or secondary reconstruction of pharyngoesophageal defects.

PHARYNGOESOPHAGEAL STRICTURES

Pharyngoesophageal strictures typically present with an insidious onset of progressive dysphagia over the course of days or even years. Patients with a history of neck trauma and progressive dysphagia should be evaluated for stricture formation starting with a contrast esophagram. If this indicates a narrowing or obstruction, an esophagoscopy is warranted. The goal is not only to diagnose the stricture, but also to rule out malignancy with a biopsy and to characterize the stricture by location and length. All of these features are factored into the treatment plan, which incorporates dilation by various different methods, or resection and reconstruction.

Multiple techniques are used in pharyngoesophageal reconstruction to reduce the incidence of strictures. Circumferential defects are prone to stricture formation.[1,2] Consequently, stricture formation can be reduced by preserving at least one strip of intact pharyngeal mucosa and spatulating the anastomosis.[2] If the pharyngeal mucosa cannot be preserved, modifying the anastomotic shape from linear to oblique may also decrease stricture formation.[1] Following these basic principles when repairing an acute pharyngoesophageal injury or revising a delayed pharyngoesophageal injury may prevent the complication of stricture formation.

For those strictures that are short and still contain a patent lumen, dilation is the primary treatment. Dilation comes in many forms, from endoscopic balloon dilation under intravenous sedation to fluoroscopy-guided balloon dilation over guidewires to bougie dilators under general anesthesia. There are strictures that are more responsive to dilation, whereas others are more recalcitrant. Some strictures respond with only one dilation, but the majority of strictures require multiple dilations that range up to 23 dilations regardless of methodology.[3–6] In an extensive review of >1,800 dilations using Savary-Gilliard dilators and fluoroscopic guidance, Piotet et al[3] listed the following factors that generally resulted in failed dilation:

- prior irradiation,
- prior caustic ingestion,
- transmural involvement of the esophageal wall,
- circumferential stenosis, and
- stricture length >3 cm.

Pharyngeal strictures did not respond as well to dilation, but typically need to be treated with laser lysis rather than dilation alone.[3] Patients who responded particularly well are those with webs, most resolving after one dilation and a maximum of two dilations to achieve success.[3] Successfully treated dilations can be expected to achieve normal or near-normal swallowing function.[3–6] Dilations are generally safe, and minor complications include pain and bleeding.[3] The most significant and immediate complication is perforation and, although rare, is potentially serious if it leads to infection or sepsis. The incidence of perforation ranges from 0% to 2%, despite some patients undergoing as many as 23 dilations.[3–6] An increased number of

dilations does not result in an increased risk of perforation, but neoplastic strictures do lend themselves to increased risk of perforation, as well as massive bleeding.[3] As a first-line treatment for thin, short, and easily accessible strictures, dilation is likely to be successful, resulting in favorable functional outcomes and minimal complications.

Despite the bougie dilation technique being extremely safe, well-tolerated, and effective, there is a movement toward using balloon dilation. There are several advantages of balloon dilation over bougie dilation. First, the force of the balloon is applied radially, rather than radially and longitudinally by the bougie dilators. Second, the balloon dilation can be performed with sedation rather than requiring general anesthesia. The balloon guidewires and catheters may be introduced through tortuous strictures that would otherwise be difficult for a bougie dilator to pass through. Third, but not necessarily applicable to this discussion, esophageal stents can be deployed simultaneously with the dilation procedure.[4,5] Esophageal stents are not indicated for benign strictures, and they have been implicated in the evolution of fistulas.[7,8] The disadvantages of using the balloon dilation technique are the lack of feedback with increasing resistance and the expense of using single-use dilators. Ultimately, the technique does not change the outcomes in regard to risks and success.

Patients who fail multiple dilations or who suffer from complete stenosis may require surgical intervention. Short segments can be resected and reanastomosed, whereas longer or more tortuous segments may require resection and reconstruction with a fasciocutaneous or enteric flap reconstruction. Unfortunately, this extensive and morbid procedure is still prone to recurrent strictures.[9] Harlak and colleagues[9] reported on 28 esophageal reconstructions of chronic caustic strictures using gastric transposition. To their credit, there were no leaks or fistulas; and, although the rate of postoperative strictures was 46%, all of these responded favorably to serial dilations.[9] There was a metaanalysis on enteric flap reconstruction for long-gap esophageal atresia by Gallo et al[1] that specifically looked at jejunal transfer, colon interposition, and gastric transposition procedures. The survival rates for colon interposition and gastric transposition are similar, ranging from 90% to 96% and anastomotic stricture formation ranging from 16% to 17%. The anastomotic leaks are higher for the gastric pull-up (24% vs 17%) and likely secondary to the increased anastomotic tension. The stricture rate of jejunal transfer is highest at 50%, and anastomotic leakage ranged from 26% to 50% in this metaanalysis. Aside from the immediate complications, the long-term morbidity of these reconstructive options should also be considered. Compared with the gastric transposition, the colon transposition has a higher rate of long-term gastrointestinal complaints (40% vs 35%) and dysphagia, but less respiratory complaints (7% vs 10%). The increased rate of dysphagia with the colon transposition may be a result of colon redundancy and the absence of peristalsis. This increased rate of respiratory complaints with the gastric transposition is likely because the bulk of the stomach in the chest impairs respiration.[1] Because the morbidity associated with reconstruction of esophageal strictures is significant, only those patients with severe symptoms and who are unresponsive to dilation should be considered for this procedure.

TRACHEOESOPHAGEAL FISTULAS

Patients with penetrating neck trauma may develop a tracheoesophageal fistula as a result of massive pharyngoesophageal tissue loss, impaired blood flow, or pressure necrosis from long-term intubation. In reports on tracheoesophageal fistula repair, laryngotracheal trauma is identified as the source in 0% to 17% of patients.[7,8,10] The majority of nonmalignant fistulas are from prolonged mechanical ventilation and pressure necrosis on the tracheal wall evolving into a fistula, but other etiologies include caustic injection, prior esophageal surgery, granulomatous infections, and indwelling stents.[7,8,10,11] The diagnosis of a tracheoesophageal fistula is typically delayed by days or weeks, especially for patients who are intubated or have medical complications.[12] The most likely presentation of a tracheoesophageal fistula is pneumonia or sepsis.[12] Patients with recurring pneumonia, cough or sepsis, and a history of prolonged intubation or penetrating neck trauma should be evaluated for a tracheoesophageal fistula and confirmed with panendoscopy.

Although these complications occur infrequently, once a complication such as a fistula manifests, it rarely resolves spontaneously[12] and often requires multiple surgeries before successful reconstruction is achieved.[7,8,10] Many patients undergo multiple attempts at repair and often require two or three stages to successfully close a fistula. Of 35 patients with nonmalignant tracheoesophageal fistulas, 56 separate operations using standard approaches and methods were performed to attempt closure, and 8 of those patients had already had previous attempts at repair.[7] Even in the setting of nonmalignant etiologies, the recurrent tracheoesophageal fistula rate in this series was 8.6% (three patients).[7]

With an appreciation for the high rate of recurrence, optimizing the patient prior to repair of the tracheoesophageal fistula is paramount. The preconstruction workup for a tracheoesophageal fistula should include panendoscopy to assess the site of the fistula to identify the relationship to the vocal cords, carina, and orifice of the tracheostomy. In addition, panendoscopy should identify the location and length of tracheal stenosis and also identify any inflammation or injury to the tracheal wall at the level of the cuff.[10,12] For small fistulas or situations wherein the fistula is difficult to localize, a small amount of methylene blue can be placed into the esophagus and visualized as it passes into the trachea.[10] Many patients with tracheoesophageal fistulas have an associated laryngeal or tracheal stenosis or an infection around the tracheostomy, and failure to identify and correct these prior to intervention is thought to contribute to recurrence of fistulas.[12] Preferably, patients are weaned from the ventilator so that positive pressure through an inflated cuff does not cause additional pressure on the reconstructed portion of the trachea and esophagus.[10] If the patient cannot be weaned, then a high-volume, low-pressure cuff should be used and positioned below the level of the fistula.[10,12] Additional measures to prevent the enlargement of the tracheoesophageal fistula include removal of any transnasal feeding or nasogastric tube, and meticulous suctioning of oral secretions above the cuff. Final preoperative planning may utilize computed tomography and/or contrast esophagrams at the discretion of the surgeon.[10]

The described methods of reconstruction of tracheoesophageal fistulas include division and primary repair, resection and reconstruction and esophageal diversion that should be used selectively because there is an increased morbidity and mortality associated with it.[12] At the very least, most reconstructive surgeons advocate the interposition of a soft-tissue or pedicled muscular flap, such as the sternocleidomastoid or strap muscle between the trachea and esophagus, to separate suture lines and prevent fistula recurrence.[7,8,10] In a report on nonmalignant tracheoesophageal fistulas, Muniappan et al[8] reported a 97% success rate using only local tissue flaps (primarily a pedicled strap muscle) and affirmed that this approach is sufficient for repair of nonmalignant tracheoesophageal fistulas without stenosis or circumferential injury. In a similar study, 24 of 26 patients with tracheoesophageal fistulas were successfully managed utilizing only division and primary repair with an interposition graft.[10] Part of the success of using such a straightforward approach can be attributed to the meticulous preoperative preparation. Nearly all patients were weaned from the ventilator prior to reconstruction and had gastrostomy tubes placed to promote healing of the trachea and esophagus. Patients were nutritionally optimized, and serial panendoscopies were performed to debride necrotic tissue and map the location and size of the fistula.[10] These results emphasize the importance of a thorough preoperative workup and patience in optimizing the patient prior to reconstruction.

Another approach to repairing tracheoesophageal fistulas is resection and reanastomosis. The primary indications for utilizing this approach are

- wide fistula defined as >3 cm,
- circumferential tracheal injury, or
- presence of stenotic segments involving the trachea or the esophagus.[8]

In an earlier report on 38 patients undergoing single-stage tracheoesophageal reconstruction managed mostly with resection and reanastomosis, the mortality rate reached 10.9% and the fistula recurrence rate was 7.8%.[11] A direct comparison between the division and repair technique versus the resection and anastomosis technique reveals that resection may have more favorable outcomes. Macchiarini et al[12] managed 32 patients with postintubation tracheoesophageal fistulas with no perioperative mortality and observed a statistically significant reduction in complication rate from 38% down to 7% and excellent long-term results from 65% to 93% using resection and anastomosis versus division and repair or diversion ($p = 0.036$). In the setting of postintubation tracheoesophageal fistulas, whereby the viability of the adjacent tissue bed has been compromised by pressure necrosis, resection and reanastomosis result in better outcomes.

Closure of the trachea or esophagus, whether it involves division and primary repair or resection and reanastomosis, follows the same reconstructive principles. The approach is generally via a low-collar incision with the occasional cervicomediastinal approach if access is required or combined with an endoscopic approach. The repair of the trachea and esophagus can be staged starting with repair of the trachea first, esophageal diversion second, and esophageal reanastomosis later.[7] A tension-free closure should be achieved, and division of the thyrohyoid and/or supralaryngeal membranes may be necessary to accomplish this critical step.[12] Prior to closure, a meticulous debridement of necrotic tissue should be completed.[12] The trachea can be closed in a single layer with absorbable 4-0 sutures, whereas the esophagus is closed in two layers also with 4-0 absorbable sutures, thus avoiding juxtaposition of suture lines

between the trachea and esophagus.[8,10,12] If there is a need for additional soft tissue to close the esophageal defect beyond what is available as a local pedicled flap, or if there is concern about impaired vascular blood flow to the wound bed, the surgeon should consider either staging the esophageal closure or using a regional pedicled flap (eg, the pectoralis major myocutaneous flap or a microvascular free flap).

Successful repair of a tracheoesophageal fistula is challenging for any surgeon. The high recurrence rate has been reduced with the use of pedicled local and regional flap interpositions, as well as with the technique of resection and reanastomosis. Regardless of the technique and use of flaps, the preoperative preparation of the patient is paramount to ensure the highest likelihood of success.

PHARYNGOESOPHAGEAL RECONSTRUCTION

Pharyngoesophageal reconstruction in the posttraumatic setting comes in many forms, such as reversing a staged pharyngostomy or resecting a lengthy pharyngeal stenosis. The complications, techniques, and approaches for pharyngoesophageal reconstruction in the posttraumatic setting are similar to what is reported pertaining to malignancy, and there is direct application to the patient requiring delayed reconstruction of pharyngoesophageal trauma. The reconstruction of pharyngoesophageal defects entails primary repair, local muscle flap interposition or onlay, fasciocutaneous free flap grafts, and enteric transfers or transposition. There are advantages and disadvantages to each reconstructive option that should be considered and individually applied to the patient and the defect being reconstructed (Exhibit 41-1).

When primary repair of a pharyngoesophageal defect cannot be achieved, there are several options for reconstruction beginning with local regional flaps, such as the pectoralis major myocutaneous flap. It is a robust flap with a reliable blood supply, and it can be performed without microvascular anastomosis. This flap is applied as an onlay graft, rather than inset into the defect. In this capacity, it is serving to reinforce the pharyngeal defect with an additional layer of muscle and fascia. In contrast, the free flap grafts are inset into the defect. This technique effectively doubles the length of closure and lends itself to increased risk of anastomotic leak, fistula, and stricture formation. Clark et al[13] specifically compared the results of hypopharyngeal reconstruction using a pectoralis major myocutaneous flap versus free flap reconstruction on 153 patients with hypopharyngeal malignancy. The overall early and late morbidity rates were lower when a pectoralis major myocutaneous flap (60% and 20%, respectively) was used to reconstruct defects as opposed to free flap reconstruction (78% and 27%, respectively).[13] This is likely biased by the partial pharyngoesophageal defects that are amenable to reconstruction with a pectoralis major myocutaneous flap compared with the more substantial circumferential defects that required a free flap graft. Free flap grafts were used in these circumferential defects, whereas the pectoralis major myocutaneous flap was used exclusively in partial pharyngeal defects.[13] In addition to the favorable morbidity rates with the pectoralis major myocutaneous flap, the rates of fistula and stricture formation, length of stay, and time to oral intake were not statistically significant from the free flaps.[13] These excellent results support the safety and utility of the pectoralis major myocutaneous flap for use in partial pharyngoesophageal defects. A majority of the literature supports the use of the pectoralis major myocutaneous flap for primary partial pharyngeal reconstruction, revision pharyngeal reconstruction, and complications such as pharyngocutaneous fistula.[13–16]

In the setting of a circumferential pharyngoesophageal defect or a revision reconstruction, a free flap is indicated. The two workhorses in fasciocutaneous free flaps are (1) the radial forearm free flap and (2) the anterolateral thigh flap. In a side-by-side comparison of hypopharyngeal reconstruction using the radial forearm free flap and the anterolateral thigh flap, there is consensus that the anterolateral thigh flap is superior. Although the radial forearm free flap boasts a thin, pliable, and reliable flap, it lacks an apparently essential fascial layer that reduces the risk of anastomotic leak and fistula formation. This rate of fistula formation is 4 to 5 times higher than the anterolateral thigh flap and in some studies also results in a higher rate of stenosis formation.[13,15] If a patient is fortunate enough to avoid the morbidity of a fistula or a stricture, the swallowing and voice outcomes are roughly similar between the two fasciocutaneous flaps.[13,15] Additional advantages and disadvantages of each of these flaps are listed in Exhibit 41-1.

An enteric flap is indicated for reconstruction of those pharyngoesophageal defects that are long or low enough. Pharyngoesophageal reconstruction using the gastric transposition has a perioperative morbidity between 31% and 55% and a perioperative mortality of 5% to 15%.[17–23] The jejunal transfer perioperative morbidity is just as high at 40% to 57%, mostly due to a 7% to 31% rate of fistula formation and a 15% rate of stricture formation. The perioperative mortality, however, is nearly half at a rate of 1% to 9%.[23–28] In a

EXHIBIT 41-1

ADVANTAGES AND DISADVANTAGES OF SELECTED FLAPS

PECTORALIS FLAP

Advantages

- harvest can be performed simultaneously
- does not increase length of surgery
- does not require a separate reconstructive team or free flap surgeon
- no requirement for postoperative flap monitoring
- robust peripheral vascularity

Disadvantages

- shoulder dysfunction
- suboptimal speech outcomes
- excessive bulk
- poor cosmesis
- difficulty closing skin incisions

RADIAL FOREARM FREE FLAP

Advantages

- simultaneous harvest
- straightforward inset
- reliable, large-caliber vascular pedicle
- minimal functional morbidity of donor site
- low perioperative morbidity
- shorter hospital stay than enteric flaps
- better speech and swallow outcomes over enteric flaps
- lower esophageal stenosis rate compared with anterolateral thigh flap

Disadvantages

- minimum of three suture lines required for closure
- additional time for microvascular anastomosis and preparation of donor vessels
- poor donor site cosmesis
- additional skin graft required to close donor site
- higher fistula rate compared with anterolateral thigh flap

ANTEROLATERAL THIGH FLAP

Advantages

- simultaneous harvest
- straightforward inset
- minimal functional morbidity of donor site
- primary closure of donor site (thin patients)
- low perioperative morbidity
- shorter hospital stay than enteric flaps
- additional fascia and vastus lateralis offer additional layers of closure
- ability to harvest a second skin paddle based off of separate perforators
- better speech and swallow outcomes over enteric flaps

Disadvantages

- minimum of three suture lines required for closure
- additional time for microvascular anastomosis and preparation of donor vessels
- poor cosmesis at donor site
- limited utility in obese patients
  - flap too thick
  - unable to close donor site

GASTRIC TRANSPOSITION

Advantages

- single, nonlinear pharyngoesophageal anastomosis
- best suited for inferiorly based defects

Disadvantages

- access to abdominal and thoracic compartments
- increased anastomotic leaks
- high donor site morbidity
  - ileus
  - ventral hernia
- increased rate of fistula formation
- increased early total morbidity
- long-term respiratory complaints

JEJUNAL TRANSFER

Advantages

- simultaneous harvest
- dual, nonlinear anastomosis
- reliable vascular supply
- well-matched diameter
- ample length of graft
- single-stage reconstruction

Disadvantages

- significant donor site morbidity
  - ileus
  - small bowel obstruction
  - ventral hernia
- increased length on ventilator, hospital, and intensive care unit
- inferior voice and swallowing outcomes
- chronic dysphagia

series comparing methods of reconstruction, gastric transposition has a much higher morbidity rate (86% vs 48%), manifested with an increased rate of hypocalcemia, flap-related complications, and increased length of stay.[13] On the flip side, fasciocutaneous free flaps had twice the rate of pharyngocutaneous fistula formation compared with the gastric transposition (36% vs 18%), specifically due to a 53% fistula rate for the radial forearm free flap, whereas the anterolateral thigh flap fistula rate was only 9%.[13] In a report comparing the outcomes of 57 circumferential pharyngoesophageal reconstructions with free jejunal transfer versus anterolateral thigh flap, Yu et al[29] concluded that the anterolateral thigh flap is a superior flap. The total flap loss (6% vs 4%) and stricture rate (19% vs 15%) was higher with the jejunal transfer, and the speech and swallow outcomes were significantly worse ($p < 0.01$) than the anterolateral thigh flap.[29] The anterolateral thigh flap did, however, have an increased fistula rate of 8% versus 3% for the jejunal transfer. In a subsequent retrospective review on the use of the anterolateral thigh flap for 114 partial and circumferential pharyngoesophageal defects, the fistula rate was the same (9%), regardless of the type of defect, whereas the stricture formation was dependent on whether there was a circumferential or partial pharyngeal defect (9% and 2%, respectively).[2] One of the few articles that included reconstruction of 10 nonmalignant pharyngoesophageal defects using a jejunal transfer reported a minimal number of complications: 1 stricture, 1 fistula, and 1 flap failure.[30] Of course the sample size is small, but the rates of complications may be more applicable to this discussion on traumatic pharyngoesophageal reconstruction. Overall, the morbidity associated with enteric flaps is much greater than fasciocutaneous free flaps, but they are less prone to fistula formation than the fasciocutaneous flaps.

The most commonly used free flaps for pharyngoesophageal reconstruction are radial forearm free flap, anterolateral thigh flap, free jejunal transfer, and gastric transposition. If there is a partial defect that cannot be closed primarily, then the pectoralis major myocutaneous free flap is a reliable flap with equivalent outcomes to the fasciocutaneous free flap grafts. In general, fasciocutaneous free flaps are preferred as the first-line reconstructive option for circumferential defects, reserving the enteric free flaps for revision cases, long segment reconstructions, or inferiorly based defects. The anterolateral thigh flap has become the preferred fasciocutaneous flap because it has a lower fistula rate, with lower donor site morbidity while maintaining comparable swallowing and speech results compared with the radial forearm free flap. Disadvantages of the anterolateral thigh flap are related the patient's body habitus: excessive flap thickness and difficulty in closing the donor site in obese patients. The advantages over radial forearm free flap are the second fascial layer that is given credit for the decreased fistula rates, and the option for harvesting a second skin paddle. Of the enteric flaps, the free jejunal transfer is preferred over the gastric transposition. Advantages to the free jejunal transfer over the gastric transposition are the markedly lower morbidity and mortality rates. Despite the theoretical advantage of the peristaltic activity of the jejunal graft improving swallowing function, this flap has disappointing results. In fact, it is the dyssynchrony between the pharynx, esophagus, and jejunal flap that directly results in dysphagia.

OUTCOMES

The overall morbidity and complication rates associated with reconstruction of pharyngoesophageal defects are moving targets because of the highly variable etiology for the defects (malignancy vs postintubation fistula), the size and location of the defects (partial vs circumferential), and the methods used to reconstruct the defects (local pedicled flaps vs free flap grafts). The most common complications reported from pharyngoesophageal reconstruction are listed in Exhibit 41-2.

In a series by Muniappan et al[8] reporting their 35-year experience of constructing 74 nonmalignant tracheoesophageal fistulas using primarily resection and reanastomosis and interposition pedicled muscle flaps, the rate of recurrent fistula was 8%, recurrent tracheal stenosis was 2.7%, and the rate of wound complications was 15%.[8] The overall perioperative morbidity rate in their report was 56%, and the only identified variable that increased the mortality and morbidity rates was, not surprisingly, a repair requiring a transthoracic approach.[8] In another series of 32 patients with nonmalignant tracheoesophageal fistulas, Macchiarini et al[12] reported a slightly lower overall complication rate of 22%, which included 1 recurrent tracheoesophageal fistula (3%), 2 delayed tracheal stenosis (6%), 2 chronic dysphagia (6%), and 2 recurrent laryngeal nerve palsy (6%). Macchiarini et al[12] compared the results of surgical technique using division of the tracheoesophageal fistula and primary repair versus resection and reanastomosis. They reported that the complications fell from 38% to 7% ($p = 0.036$), and the long-term results improved from 65% to 93% ($p = 0.4$) when using the resection and reanastomosis method.[12] In another series of treating nonmalignant tracheoesophageal fistulas in 34 patients, Shen et al[7]

EXHIBIT 41-2

COMPLICATIONS ASSOCIATED WITH PHARYNGOESOPHAGEAL RECONSTRUCTION

Fistula
Stricture/stenosis
Chyle leak
Recurrent laryngeal nerve palsy
Wound infection
Chronic dysphagia
Aspiration

reported a complication rate of 54%. There were an additional 10 operations on eight different patients to treat their postoperative complications, and these included tracheostomy (4), neck exploration for bleeding (4), esophageal diversion (1), and pleurodesis for chylothorax (1). Unfortunately, univariate logistic regression analysis failed to identify any variable that influenced the morbidity rates, including

- etiology of fistula,
- location of fistula,
- fistula size,
- prior treatments, or
- use of muscle flaps.[7]

Although these factors did not apparently influence the outcomes, there are some noteworthy differences when compared with other reviews. The relative percentage of fistulas resulting from prolonged intubation in the study by Shen et al is markedly lower than in other reports.[7,8,10–12] Also, a majority of Shen et al's patients required some form of thoracotomy or laparotomy to access and repair the fistula, as opposed to a predominantly transcervical approach used in the other reports.[7,8,10–12] Thus, a surgeon can expect a perioperative morbidity rate approaching 30% to 50% with repairing tracheoesophageal fistulas and can anticipate that many patients may require revision or staged surgery.

In a more substantial reconstruction (eg, partial or circumferential pharyngoesophageal defects), the morbidity and mortality are higher than that seen in tracheoesophageal fistulas. There is a definite increase in fistula formation when primary closure is attempted rather than an interposition free flap or onlay pectoralis major myocutaneous free flap.[14,16] When comparing the fistula rates, in the retrospective review by Patel et al[16] of 359 patients undergoing salvage laryngectomy, the overall pharyngocutaneous fistula rate was 26%.[16] There was a higher incidence of fistula formation seen in salvage laryngectomy repairs with primary closure (34%) versus interposed free flap (25%, $p = 0.07$) and pectoralis major myocutaneous flap onlay (15%, $p = 0.02$).[16] Not only is the fistula formation more likely with a primary closure compared with using flaps, but also the duration of the fistula nearly doubled at 14 weeks.[16] Clark et al[13] reported a comprehensive retrospective review of the complications associated with hypopharyngeal reconstruction. The most common complications and associated rates are hypocalcemia (45%), pharyngocutaneous fistula (33%), wound complications (25%), and stricture (15%).[13] Circumferential defects were specifically associated with an increased risk of hypocalcemia, strictures, and late complications.[13] In contrast, pharyngocutaneous fistula formation was higher in patients with partial hypopharyngeal defects compared with circumferential defects (38% vs 28%) regardless of the method of reconstruction.[13] The authors hypothesize that this increased rate of pharyngocutaneous fistula formation may be because of the devascularization of the remaining pharyngeal mucosa, the increased number of suture lines, and the increased use of pedicled flaps.[13] When isolating the statistics to patients without prior irradiation, the postoperative morbidity rate was 71%, and the fistula rate was 26%.[13] Again, this data is being extrapolated from studies on patients with prior irradiation and compromised wound healing; but, nonetheless, it is apparent that, despite the method of reconstruction or the type of defect, there is considerable morbidity associated with pharyngoesophageal reconstruction.

When considering the use of a free flap for reconstruction of a pharyngoesophageal defect, the surgeon should consider the perioperative morbidity associated with different flaps and functional outcomes. The overall free flap failure rate averages from 0% to 10%, and complications include

- partial flap necrosis,
- wound infection,
- pharyngocutaneous fistula,
- stricture,
- chyle leak, and
- considerable donor site morbidity (eg, hematoma, seroma, delayed wound healing, and wound infection).[2,13–15,29,30]

Lewin et al[31] compared pharyngoesophageal reconstruction using jejunal transfers to anterolateral thigh flaps. They reported a roughly equivalent number of complications (29% and 30%) and a similar pattern of complications between the two flaps. Likewise, Yu et al[29] reported no statistically different pharyn-

gocutaneous fistula rate between free jejunal transfer and anterolateral thigh flaps (3% and 8%) in the reconstruction of pharyngoesophageal defects. When comparing gastric transposition to fasciocutaneous free flaps, gastric transposition had an increased rate of complications, and was independently predictive of both wound complications and fistula formation.[13] Frequently, the pharyngoesophageal defect and the patient characteristics dictate the type of free flap that is used for reconstruction. However, there are subtle differences between the free flaps that may persuade a reconstructive surgeon to choose one over the other.

The mortality rate associated with pharyngoesophageal reconstruction ranges from 0% to 10%.[1,2,7,10–13,29,31] There are several reports with no perioperative mortality despite the use of complex reconstructive techniques on high-risk patients.[29,31] In contrast, the mortality rate for repair of benign tracheoesophageal fistulas was 5.7% in one series.[7] Despite the etiology or the method of reconstruction, procedures or surgeries involving the pharyngoesophageal region have a significant risk of mortality.

The swallowing function and return to oral diet are somewhat dependent on the type of pharyngoesophageal defect and the type of reconstruction. For the repair of nonmalignant tracheoesophageal fistulas, most patients are expected to resume an oral diet regardless of the method of repair, and are spared from chronic dysphagia because reconstruction usually does not require the use of insensate and functionally inanimate pedicled or free flap grafts. Indeed, 75% to 83% of patients are reported to have resumed a full oral diet, and failures are due to chronic aspiration, esophageal discontinuity, or persistent tracheoesophageal fistula.[7,8,10] In the setting of laryngopharyngeal reconstruction after salvage laryngectomy, the fasciocutaneous flaps are considered to have better swallowing outcomes than enteric free flap grafts. In theory, the swallowing function with free jejunal transfers should be enhanced by peristaltic movement, but modified barium swallow studies have shown that the peristalsis is not synchronized with swallowing and may, in fact, lead to dysphagia and regurgitation.[31] Dysphagia is not only problematic in free jejunal transfers, but it is also an issue for fasciocutaneous reconstruction for the same reasons: disordered motility and impaired bolus transit through the neopharyngeal conduit.[31] In the review by Clark et al[13] of circumferential pharyngoesophageal reconstruction, 93% of patients were able to maintain an oral diet, and only 16% of patients required a gastrostomy for total or partial nutrition.[13] Patients with anterolateral thigh flap reconstruction have a higher chance of maintaining their nutrition by mouth compared with those with a free jejunal transfer.[2,29,31,32] However, one study demonstrated that patients with a free jejunal transfer who maintain an oral diet are twice as likely to be on a full, unmodified diet compared with patients with an anterolateral thigh flap.[31] Thus, there is a slight benefit with the fasciocutaneous flap for obtaining an oral diet, but that diet may be likely modified rather than being a full, regular diet.

Assessing the outcome for speech and airway is more challenging because many of the studies report outcomes on postlaryngectomy patients that are generating speech through a tracheoesophageal puncture. Again, the speech outcomes favor fasciocutaneous flaps over enteric flaps.[29,31] In the population of patients undergoing nonmalignant tracheoesophageal fistula repair, most patients can expect to have good-to-excellent speech, and 70% to 75% of patients should be tracheostomy independent.[7,8,10] Failures may be due to inadequate glottic airway, esophageal strictures, tracheal stenosis, vocal cord dysfunction, or respiratory insufficiency.[8]

SUMMARY

Posttraumatic pharyngoesophageal reconstruction may come in many different forms, such as a stricture, a tracheaesophageal fistula, or a pharyngocutaneous fistula. There is no uncertainty about the high rate of recurrence, complications, and morbidity associated with these entities. Strictures can be dilated using bougie or balloon dilation and may require repeat dilation to maintain adequate swallowing function. Patients who fail dilation therapy or who have unfavorable strictures may require surgical intervention with resection and reconstruction. Tracheoesophageal fistulas, on the other hand, always require surgical repair because they are notoriously persistent. Regardless of the method of repair, reconstructive surgeons universally agree that interposing muscle flaps, either local or regional, are a critical step in the successful repair of tracheoesophageal fistulas. Pharyngoesophageal reconstruction either for pharyngocutaneous fistula or pharyngostomy relies on the same principles applied for any head and neck reconstruction. The reconstructive surgeon should have multiple reconstructive options, including

- the pectoralis major myocutaneous flap,
- the radial forearm free flap,
- the anterolateral thigh flap,
- the jejunal transfer, and
- the gastric transposition.

This is not an exhaustive list of all the free tissue transfer options, but these flaps are the most preferred flaps utilized in pharyngoesophageal reconstruction. Each of the flaps offers advantages over the other, which must be weighed against their inherent disadvantages. The approach should be systematic, fastidious, and comprehensive when applying the same indoctrinated reconstructive principles that are used for all head and neck reconstruction.

CASE PRESENTATION

Case Study 41-1

Presentation

A 44-year-old female, at a foreign medical facility, had an iatrogenic esophageal transection during a thyroidectomy that was complicated by a temporary pharyngocutaneous fistula and required a percutaneous endoscopic gastrostomy tube for alimentation. On examination, the patient had no residual fistula and was unable to swallow any liquids or solids without immediate regurgitation.

Preoperative Workup/Radiology

Esophagogastroduodenoscopy confirmed stenosis of the esophagus. Anterograde and retrograde contrast studies revealed a 4-cm proximal esophageal blind pouch (Figure 41-1). The retrograde contrast demonstrated the presence of an intact distal esophagus of indeterminate length (Figure 41-2).

Operation

The plan was to approach the esophageal discontinuity using a combined anterograde and retrograde endoscopic approach. If continuity could not be established through an endoscopic approach, the procedure would be converted to an open approach. In the operating suite, the otolaryngology team advance a rigid esophagoscope to the distal portion of the blind pouch. Gastroenterology approached the discontinuity from a retrograde manner via the patient's PEG (percutaneous endoscopic gastrostomy) tube. Insertion of the rigid esophagoscope allowed for delineation of the proximal portion of the esophagus and provided transluminal illumination to guide gastroenterology's retrograde approach through the PEG site (Figure 41-3). An esophageal microforcep was used to puncture through the proximal end of the esophagus and advanced into the distal portion of the esophagus. A guidewire was then advanced from the flexible endoscope into the esophageal lumen where the wire was grasped with the microforceps, pulled proximally, and

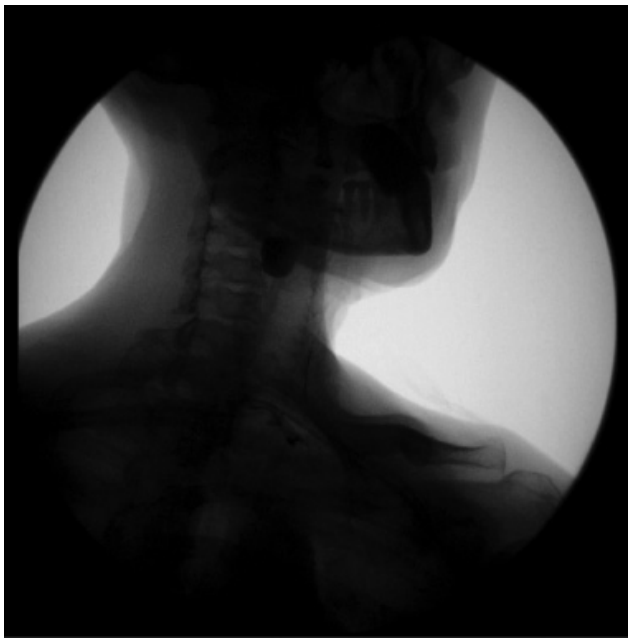

Figure 41-1. Upper gastrointestinal series showing pooling of contrast material in the proximal esophagus.

Figure 41-2. Upper gastrointestinal series showing dilation of distal esophagus with filling of contrast material.

Figure 41-3. Fluoroscopic view of the stenosed space within the esophageal lumen.

then pulled out through the oral cavity. Serial dilations were performed using both balloons and bougie dilators.

Complications

The procedure was completed without complications, signs of perforation, extensive bleeding, or airway compromise. The patient was discharged from the hospital the following day without complaints or signs of perforation. The patient requires intermittent esophageal dilations and continues to have improvement in swallowing function.

Lessons Learned

Although this case presents a novel approach to an esophageal stenosis, it still underscores the principles of a systematic, preoperative evaluation utilizing imaging and endoscopy. Fortunately, the esophageal stenosis was amenable to repair with a combined anterograde and retrograde endoscopic approach, rather than requiring an open repair. Had an endoscopic approach not been feasible, the same reconstructive options in an open approach discussed in this chapter would have applied.

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