

**CLINICAL EXPERIENCE**

# Anterior spinal hardware erosion of the pharyngoesophagus: A difficult reconstructive challenge—Our experience in nine patients

## 1 | INTRODUCTION

Pharyngoesophageal perforation (PEP) can be spontaneous, secondary to instrumentation/resection, or as a sequela of interventions such as anterior cervical discectomy and fusion (ACDF). After ACDF, PEP can either be due to intraoperative injury or hardware failure/chronic erosion.<sup>1</sup> The rate of injury has been variable in multiple studies, ranging from 0.02% to 1.62%.<sup>2,3</sup> Though the incidence of PEP is rare, complications including spinal abscesses, sepsis, mediastinitis, and osteomyelitis are devastating with reported mortality rates approaching 20%–50%.<sup>4,5</sup>

Reconstruction of these defects is challenging given the intrinsic qualities of the oesophagus as well as extrinsic patient factors such as a history of local radiation, nutritional status and other comorbidities that predispose the patient to poor wound healing. Prior studies have evaluated multiple reconstructive options, including conservative management, primary closure and a variety of different flaps (both local and free-tissue transfer). However, there are limited reports of functional outcomes after surgery. Therefore, our objective is to report our experience of the variety of reconstructive options available for PEP after an ACDF, report the need for revision surgery in many of these complex cases, and to present patients' post-operative swallowing outcomes.

## 2 | METHODS

### 2.1 | Ethical considerations

This study was approved by The University of Michigan Institutional Review Board (HUM00050982).

### 2.2 | Study design, setting, and participants

The STROBE reporting guideline was followed.

We performed a retrospective review of nine patients from 2013 to 2019 who developed PEP secondary to spinal hardware erosion confirmed on imaging or endoscopy that necessitated reconstruction at a single academic medical centre. Long-term swallowing outcomes up to 4 years were collected.

### 2.3 | Surgical approach

For each patient, multidisciplinary coordination with neurosurgery and thoracic surgery was performed. If the spine was deemed unstable after removal of anterior implants and/or instrumentation, posterior fusion by neurosurgery was performed the day prior to reconstructive surgery. For reconstruction of these pharyngoesophageal defects, we used either free tissue transfer (radial-free forearm flap [RFFF], anterolateral thigh [ALT] and parascapular [PS]), rotational flaps (sternocleidomastoid flap [SCM]), or primary closure. All patients with free tissue flaps underwent post-operative monitoring using a standardised protocol consisting of doppler, colour, turgor and capillary refill with hourly monitoring for 48 h, then every 2 h for 48 h, then every 4 h for the remainder of the hospitalisation.

### 2.4 | Data collection

Variables that were collected included age, gender, prior trach dependence, history of radiation exposure, location of hardware at time of presentation, length of hospital stay, type of drain (passive vs. suction), antibiotic duration, fistula occurrence, re-operation/re-exploration during admission, need for further procedural intervention after discharge and timing of such intervention, total follow-up time, and swallowing outcomes. Given the case numbers and the goal of this study being experiential in nature, statistical analysis was not performed.

## 3 | RESULTS

### 3.1 | Indications and operative interventions

There were nine patients included in our study population. Table 1 reports each patient's indications for ACDF, spinal surgical history, and operative neurosurgical and reconstructive intervention. Indications for ACDF ranged from prophylaxis in the setting of cervical chondrosarcoma that was resected and required post-operative radiation to cervical trauma/myelopathy. Cervical trauma was the most common indication. At presentation, six patients had both anterior and posterior hardware in place, three had only anterior hardware, and two patients

**TABLE 1** Indications for ACDF and operative interventions during reconstruction.

Patient	Indication for ACDF	Levels of spine originally intervened upon	Neurosurgical intervention	Reconstruction type
1	Cervical trauma	C3–C6	Debridement of infection in corpectomy site	Primary repair with ALT overlay
2	Cervical disc herniation	C4–T1	Removal of anterior plate and screws from C4 to T1	Primary repair without tissue overlay
3	Cervical trauma; prior attempt at repair with SCM rotational flap	C5–C7	Removal of corpectomy graft, revision anterior fusion with placement of interbody cage	Primary repair with RFFF overlay
4	Lower extremity weakness and unstable spine in the setting of larynx radiation	C5–T1	Removal of anterior plate and screws	Primary repair with ALT overlay
5	Osteomyelitis	C2–T1	Anterior hardware Removed	Primary repair without tissue overlay
6	Cervical myelopathy	C4–T1	Day prior to reconstruction-posterior fusion C4–C7; day of reconstruction-removal of anterior plate and screws. Two interbody cages left in place	Primary repair with parascapular overlay
7	Cervical trauma	C5–C7	Removal of anterior plate and screws; one interbody cage left in place	Primary repair with RFFF overlay
8	Cervical stenosis; in the setting of oropharyngeal radiation	C4–C7	Day prior to reconstruction—C5–C7 total laminectomies, C3–T2 posterior spinal fusion; day of reconstruction-removal of anterior plate and screws	Primary repair with RFFF overlay
9	Prophylactic fusion during resection of cervical chondrosarcoma in the setting of required post-operative radiation	C2–C7	Removal of anterior plate and screw	SCM rotational Flap

Abbreviations: ACDF, anterior cervical discectomy and fusion; ALT, anterolateral thigh; RFFF, radial-free forearm flap; SCM, sternocleidomastoid flap.

had interbody cages in place that were not removed as the surrounding bone had fused. All patients had their anterior hardware removed by neurosurgery during reconstructive surgery. Two patients had an unstable spine and required posterior fixation the day prior to reconstructive surgery. Reconstruction was performed with primary closure with three RFFF, two ALT and one PS free flap overlay; two primary closures without free flap overlay, and one SCM flap for carotid coverage for a patient who had a difficult intubation resulting in more significant pharyngotomy that was stented with a nasogastric tube rather than primary repair. A reconstructive algorithm for these patients is shown in Figure 1 and representative pictures are seen in Figure 2.

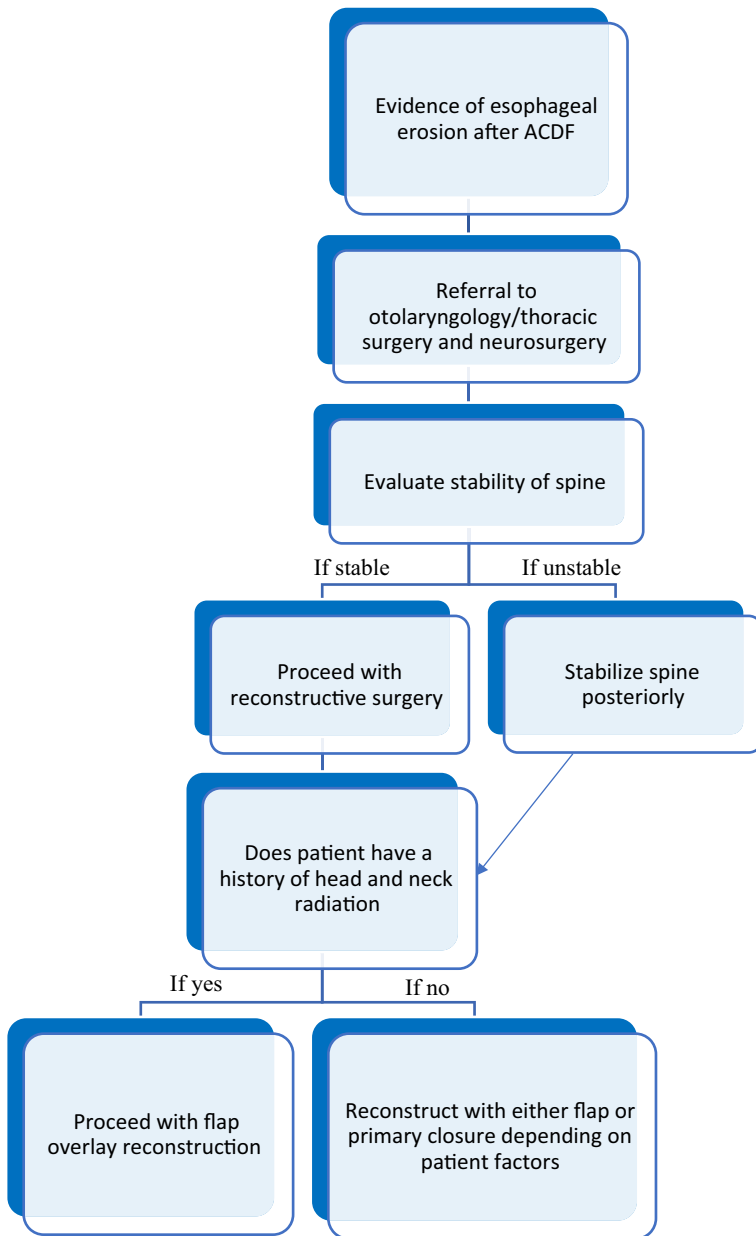
### 3.2 | Demographic and hospitalisation data

Table 2 reports demographic and post-operative details. Patients on average were 61.9 ( $\pm 14.8$ ) years old. In total, 4/9 were male, 5/9 were former smokers and 3/9 had previous exposure to head and neck radiation. The post-operative length of stay was 13.4 ( $\pm 4.6$ ) days. Culture-directed antibiotics were used for an average of 8.1 ( $\pm 8$ ) days. Suction drains were used in 7/9 patients, whereas 2 patients had solely passive drain placement. For those with suction drains, there was a requirement of subsequent red rubber catheter drain placement for wound irrigation due to a salivary leak in 6/7 that was found by

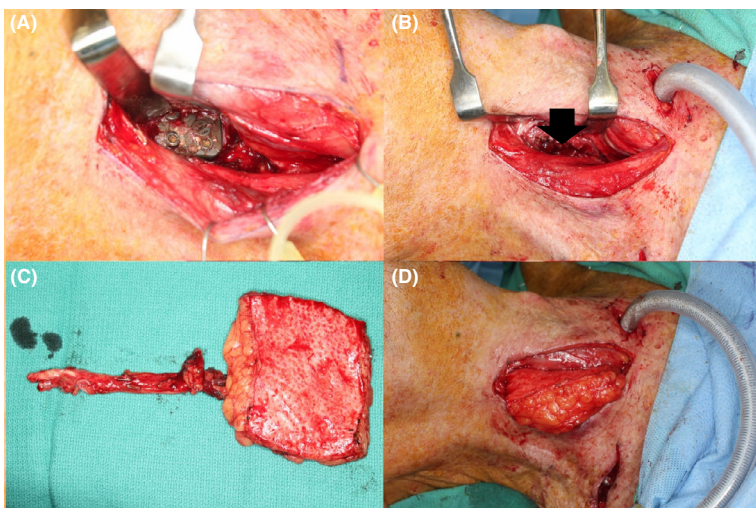
having the patient take in water dyed blue and evaluating the suction drain for blue liquid. There was a low threshold to place these passive drains to minimise the need for operative intervention, and doing so resulted in only three patients requiring operative take back for management of infection/dehiscence, with no development of recurrent fistulae.

### 3.3 | Follow-up, swallowing outcomes, additional interventions

The average follow-up time was 2.3 ( $\pm 1.8$ ) years. Eight patients were able to take all nutrition orally on average 57.6 ( $\pm 30.9$ ) days after their reconstructive surgery, whereas one patient with a history of radiation for treatment of larynx cancer used a G tube for nutrition with some oral trial. There were no restrictions to their diet, though some patients did have trouble with dry food and preferred liquids. The decision to advance to an oral diet was made in a multidisciplinary fashion utilising speech-language pathology, patient preference, physical examination, and/or swallow studies. Each patient was examined in clinic prior to this decision, and 6/8 patients were seen in conjunction with a head and neck trained speech-language pathologist. It was found that four patients had post-operative diverticula on average 179 days after reconstruction; three required endoscopic diverticulectomy.



**FIGURE 1** Reconstructive algorithm. ACDF, anterior cervical discectomy and fusion



**FIGURE 2** Intraoperative reconstructive approach. (A) Exposure of plate. (B) Primary repair of Pharyngoesophageal perforation (PEP; arrow to repair). (C) Deepithelialized anterolateral thigh flap for overlay of repair. (D) Flap sutured in place over repair.

**TABLE 2** Demographic and post-operative results

Variable	Overall n (%)
Male, n (%)	4 (44)
Age, mean (SD), years	61.9 (15)
Race, n (%)	
White	8 (89)
Other	1 (11)
Tobacco use, n (%)	
Current	0 (0)
Former	5 (56)
Never	4 (44)
Alcohol Use, n (%)	
Current	2 (22)
Former	2 (22)
Never	5 (56)
Radiation, n (%)	
Yes	3 (33)
No	6 (67)
Length of stay, mean (SD), days	13.4 (5)
Follow-up, mean (SD), months	27 (21)
Antibiotic duration, mean (SD), days	8.1 (8)
Drain requirement, n (%)	
Initial suction	7 (78)
Initial passive	2 (22)
Post-operative complications, n (%)	
SD leak	6 (67)
Diverticula	4 (44)
Need for Intervention	3 (33)
Return to OR for dehiscence/infection	2 (22)
Tracheostomy	1 (11)
Need for oesophageal dilation, n (%)	3 (33)
Final nutrition avenue, n (%)	
All nutrition orally	8 (89)
G tube with some oral trial	1 (11)
Time to oral intake, mean (SD), d	57.6 (30.9)

Abbreviations: OR, operating system; SD, Standard deviation.

Three patients also required oesophageal dilation. One patient required a tracheostomy and was subsequently decannulated.

## 4 | DISCUSSION

### 4.1 | Key findings

Management of pharyngoesophageal erosion secondary to anterior spinal hardware remains challenging. While a number of reconstructive approaches have been described, there is limited data on postoperative functional/swallowing outcomes. Here, our study demonstrates that a customised, multidisciplinary approach to reconstruction and follow-up

is key and can promote excellent wound healing and swallowing outcomes. Patients can have multiple complications including formation of diverticula, salivary leaks requiring additional intervention, and need oesophageal dilation, and it is important to counsel them on these possibilities. However, an oral diet is possible, and all but one of our patients demonstrated complete oral nutrition without supplementation regardless of reconstructive option.

### 4.2 | Comparison to prior studies

There is no single “ideal” flap, either free tissue or local, for reconstruction after PEP secondary to anterior spinal hardware. In our study, those patients who had a previous history of head and neck radiation were reconstructed with tissue flaps. The local effects of radiation are known to be detrimental to rapid dividing tissues such as mucosa, leading to poor wound healing, higher infection risks, and increased risks of complications.<sup>6</sup> However, free flap reconstruction has been shown to be effective and has high success rates in previously irradiated areas in the head and neck,<sup>7</sup> with comparable anastomotic failure rates as compared to non-irradiated fields.<sup>8</sup> It is therefore a reasonable option to reconstruct with tissue flaps in these patients with a history of radiation as the increased bulk of tissue and coverage can have a high chance of reconstructive success while also providing redundant tissue to help reduce the chance of a leak. Though there have been studies suggesting that gastro-omental flaps lead to earlier return of feeding or resolution of leak on esophagram,<sup>9</sup> these authors did not use these flaps due to the need to enter the abdomen and the subsequent potential increase in infection risk.

## 5 | CONCLUSION

A variety of reconstructive options can be used for fistula closure due to anterior spinal hardware erosion with excellent swallowing outcomes. A customised, multidisciplinary approach must be used based on indication for ACDF, stability of the spine with hardware removal, patient's previous exposure to radiation, and their extent of pharyngoesophageal erosion.

### KEYWORDS

anterior cervical disk fusion, free tissue reconstruction, multidisciplinary approach, Oesophageal perforation

### AUTHOR CONTRIBUTIONS

**Nithin S. Peddireddy:** acquisition of data, interpretation of data, draft article and revisions and final approval. **Pratyusha Yalamanchi:** interpretation of data, draft article and revisions and final approval. **Osama Kashlan:** interpretation of data, draft article and revisions and final approval. **Paul Park:** interpretation of data, draft article and revisions and final approval; **Rishi M. Reddy:** interpretation of data, draft article and revisions and final approval. **Steve B. Chinn:** interpretation of data, draft article and revisions and final approval. **Keith A. Casper:** interpretation of data, draft

article and revisions and final approval. **Kelly M. Malloy**: interpretation of data, draft article and revisions and final approval. **Chaz L. Stucken**: interpretation of data, draft article and revisions and final approval. **Mark E. P. Prince**: interpretation of data, draft article and revisions and final approval. **Andrew J. Rosko**: conception design, acquisition of data, interpretation of data, draft article and revisions and final approval. **Matthew E. Spector**: conception design, acquisition of data, interpretation of data, draft article and revisions and final approval.

## FUNDING INFORMATION

No relevant funding.

## CONFLICT OF INTEREST










The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

## PEER REVIEW

The peer review history for this article is available at <https://publons.com/publon/10.1111/coa.14025>.

## DATA AVAILABILITY STATEMENT

The data that were used are presented in the article. For any specific questions, the corresponding author can be contacted.

Nithin S. Peddireddy<sup>1</sup>   
 Pratyusha Yalamanchi<sup>1</sup>   
 Osama Kashlan<sup>2</sup>  
 Paul Park<sup>2</sup>   
 Rishindra M. Reddy<sup>3</sup>   
 Steven B. Chinn<sup>1</sup>   
 Keith A. Casper<sup>1</sup>   
 Kelly M. Malloy<sup>1</sup>   
 Chaz L. Stucken<sup>1</sup>  
 Mark E. P. Prince<sup>1</sup>  
 Andrew J. Rosko<sup>1</sup>   
 Matthew E. Spector<sup>1</sup> 

<sup>1</sup>Department of Otolaryngology-Head and Neck Surgery, University of Michigan, Ann Arbor, Michigan, USA

<sup>2</sup>Department of Neurosurgery, University of Michigan, Ann Arbor, Michigan, USA










<sup>3</sup>Section of Thoracic Surgery, Department of Surgery, University of Michigan, Ann Arbor, Michigan, USA

## Correspondence

Nithin S. Peddireddy, Department of Otolaryngology-Head & Neck Surgery Michigan Medicine, 1500 East Medical Center Drive, Ann Arbor, MI 48109, USA.

Email: [nithins@med.umich.edu](mailto:nithins@med.umich.edu)

## ORCID

Nithin S. Peddireddy  <https://orcid.org/0000-0001-5902-0047>  
 Pratyusha Yalamanchi  <https://orcid.org/0000-0003-0776-3759>  
 Paul Park  <https://orcid.org/0000-0002-0375-396X>  
 Rishindra M. Reddy  <https://orcid.org/0000-0002-4337-5051>  
 Steven B. Chinn  <https://orcid.org/0000-0003-4282-0640>  
 Keith A. Casper  <https://orcid.org/0000-0003-2878-3863>  
 Kelly M. Malloy  <https://orcid.org/0000-0002-0337-9293>  
 Andrew J. Rosko  <https://orcid.org/0000-0001-6432-5451>  
 Matthew E. Spector  <https://orcid.org/0000-0001-7646-6075>

## REFERENCES

- Halani SH, Baum GR, Riley JP, Pradilla G, Refai D, Rodts GE, et al. Esophageal perforation after anterior cervical spine surgery: a systematic review of the literature. *J Neurosurg Spine*. 2016;25(3):285–91. <https://doi.org/10.3171/2016.1.SPINE15898>
- Hershman SH, Kunkle WA, Kelly MP, Buchowski JM, Ray WZ, Bumpass DB, et al. Esophageal perforation following anterior cervical spine surgery: case report and review of the literature. *Glob Spine J*. 2017;7(1 Suppl):28S–36S. <https://doi.org/10.1177/2192568216687535>
- Eleraky MA, Llanos CSV. Cervical corpectomy: report of 185 cases and review of the literature. *J Neurosurg*. 1999;90(1 suppl):35–41.
- Orlando ER, Caroli E, Ferrante L. Management of the Cervical Esophagus and Hypopharynx Perforations Complicating Anterior Cervical Spine Surgery. *Spine*. 2003;28(15):E290–5. <https://doi.org/10.1097/01.BRS.0000087093.89889.0A>
- Sharma RR, Sethu AU, Lad SD, Turel KE, Pawar SJ. Pharyngeal perforation and spontaneous extrusion of the cervical graft with its fixation device: a late complication of C2-C3 fusion via anterior approach. *J Clin Neurosci*. 2001;8(5):464–8. <https://doi.org/10.1054/jocn.2000.0826>
- Robinson D. The hazards of surgery in irradiated tissue. *AMA Arch Surg*. 1955;71(3):410–8.
- Bourget A, Chang JTC, Wu DBS, Chang CJ, Wei FC. Free flap reconstruction in the head and neck region following radiotherapy: a cohort study identifying negative outcome predictors. *Plast Reconstr Surg*. 2011;127(5):1901–8. <https://doi.org/10.1097/PRS.0b013e31820cf216>
- Mulholland S, Boyd JB, McCabe S, Gullane P, Rotstein L, Brown D, et al. Recipient vessels in head and neck microsurgery: radiation effect and vessel access. *Plast Reconstr Surg*. 1993;92:628–32.
- Hanwright PJ, Purnell CA, Dumanian GA. Flap reconstruction for esophageal perforation complicating anterior cervical spinal fusion: an 18-year experience. *Plast Reconstr Surg - Glob Open*. 2015;3(5):1–8. <https://doi.org/10.1097/GOX.0000000000000350>

**How to cite this article:** Peddireddy NS, Yalamanchi P, Kashlan O, Park P, Reddy RM, Chinn SB, et al. Anterior spinal hardware erosion of the pharyngoesophagus: A difficult reconstructive challenge—Our experience in nine patients. *Clinical Otolaryngology*. 2023;48(2):264–8. <https://doi.org/10.1111/coa.14025>