Esophageal perforation after anterior cervical spine surgery

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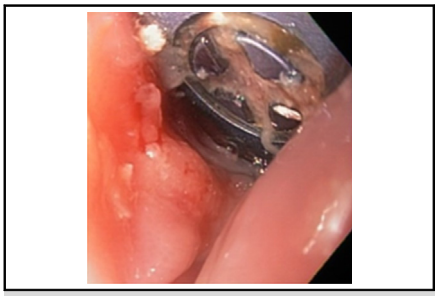
ABSTRACT

Objective: To report our updated experience in the management of esophageal perforation resulting from anterior cervical spine surgery, and to compare two wound management approaches.

Methods: This is a retrospective review of patients managed for esophageal perforations resulting from anterior cervical spine surgery (2007-2020). We examine outcomes based on 2 wound management approaches: closed (closed incision over a drain) versus open (left open to heal by secondary intention). We collected data on demographics, operative management, resolution (resumption of oral intake), time to resolution, number of procedures needed for resolution, microbiology, length of stay, and neck morbidity.

Results: A total of 13 patients were included (10 men). Median age was 52 years (range, 24-74 years). All patients underwent surgical drainage, repair, or attempted repair of perforation, hardware removal, and establishment of enteral access. Wounds were managed closed versus open (6 closed, 7 open). There were 2 early postoperative deaths due to acute respiratory distress syndrome and aspiration (open group), and 1 patient was lost to follow-up (closed group). Among the remaining 10 patients: resolution rate was 80% versus 100%, resolution in 30 days was 20% versus 100%, median number of procedures needed for resolution was 3 versus 1, and median hospital stay was 23 versus 14 days, for the closed and open groups, respectively.

Conclusions: Esophageal perforation following anterior cervical spine surgery should be managed in a multidisciplinary fashion with surgical neck drainage, primary repair when feasible, hardware removal, and establishment of enteral access. We advocate open neck wound management to decrease the time-to-resolution, number of procedures, and length of stay. (JTCVS Techniques 2024;25:208-13)



Endoscopic view of hardware eroding through the esophagus.

CENTRAL MESSAGE

Esophageal perforation following anterior cervical spine surgery is best managed surgically by drainage, hardware removal, repair when feasible, creation of enteral access, and open wound management.

PERSPECTIVE

Esophageal perforation following anterior cervical spine surgery is best managed using a multidisciplinary approach. Patients require drainage, hardware removal, repair when feasible, and durable enteral access. Compared with closed wound management over a drain, patients with open wound management are more likely to attain resolution in a shorter time, with fewer procedures and shorter hospital stays.

Esophageal perforation is a rare but well described complication of anterior cervical spine surgery (ACSS) that may present up to several years after surgery. The incidence of esophageal perforation following ACSS is estimated at 0.2 to 0.4%, with a mortality rate in the range of 16 to 50% depending on the timing of diagnosis and treatment.[1]

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Abbreviation and Acronym
ACSS = anterior cervical spine surgery

Acute perforations are related to sharp dissection during mobilization of the upper aerodigestive tract, pressure injury from retractor blades, drilling, or traumatic endotracheal intubation. Delayed perforations tend to result from chronic pressure necrosis related to instrument failure.[2]

The principles of surgical management involve hardware removal, primary closure of the esophageal or hypopharyngeal defect when feasible, and placement of a surgical feeding tube. We previously published our multidisciplinary management strategy for cervical esophageal injury following ACSS in a series of 6 patients.[3] In that article, we found that 60% of neck incisions closed at the time of initial repair developed recurrent leaks that had to be reopened to facilitate healing, and concluded that an initial open wound management approach may be advisable.

We report our updated single-center experience in the surgical management of this rare and morbid complication of ACSS by comparing outcomes based on 2 wound management approaches: closed and open.

METHODS

This study was deemed exempt by the Institutional Review Board at the University of Minnesota Medical Center. This is a retrospective review of all patients with esophageal perforations resulting from ACSS between January 1, 2007, and July 31, 2020. The surgical approach was neck drainage with primary repair of the esophageal or hypopharyngeal defect (single layer of absorbable sutures), sternocleidomastoid muscle flap interposition (if possible), anterior cervical hardware removal, and enteral nutrition support. The neck wounds were managed either by primary closure over a drain (closed approach) or packed open with wet-to-dry gauze and allowed to heal by secondary intention (open approach). The wound management strategy was neither surgeon- nor specialty-dependent, and evolved as our experience grew in the management of these patients.

The primary outcome of interest was resolution of the esophageal perforation. We defined resolution as the resumption of oral intake following the absence of a leak on radiological (esophagram) and clinical evaluation (bedside methylene blue test). There was no standard protocol for diet advancement or retesting for a leak. These decisions were made on a case-by-case basis and were guided by the patient's clinical status, the size of the defect and residual leak on serial assessments. All patients were placed on an oral diet once their leak test was found to be negative and after passing a speech and swallow evaluation. Patients were initially started on clear liquids and the consistency of their diet was gradually increased. Other end points of interest were time to resolution in days, number of procedures needed to attain resolution, length of hospital stay in days, and postoperative neck morbidity. Length of stay was the number of days between the index repair procedure at our institution and discharge. Postoperative neck morbidity was defined as the onset of dysphagia and/or vocal cord paralysis on direct laryngoscopy following the management of the esophageal perforation.

We collected information on demographics, the indication for the initial ACSS, time between the ACSS and esophageal perforation, number of interventions at the referring hospital, wound management approach (closed vs open approach), resolution, time to resolution, number of procedures needed to attain resolution, postoperative complications, length of hospital stay, and last follow-up. Descriptive statistics were used in analyzing the data.

RESULTS

Patient Population

A total of 13 patients were included in this study. Most patients were men (77%) and the median age was 52 years (range, 24-74 years). All the ACSS were performed at other institutions and all patients had cervical hardware placed at the initial procedure. Seven patients (54%) had undergone attempted repair at the referring facility before presentation. Twelve patients (92%) presented with esophageal leaks, neck abscesses, and osteomyelitis and 1 patient (8%) presented with a chronic diverticulum with exposed hardware in the esophageal lumen. The median time from ACSS to esophageal perforation was 12 months (range, 0-120 months). Only 1 patient (8%) presented within a week of their ACSS.

Surgical Management and Treatment Outcomes

All 13 patients underwent surgical drainage, repair, or attempted repair, and hardware removal at our institution (Figures 1 and 2). Sternocleidomastoid muscle interposition flaps were used in 4 patients (31%) (2 closed and 2 open approach). We placed surgical feeding tubes in 8 patients (62%); 4 patients already had enteral feeding access on arrival. Six patients (46%) had neck closure over a drain (closed approach) and 7 patients (54%) were left open to heal by secondary intention (open approach). One patient in the open approach group required vacuum assisted negative pressure wound therapy to help facilitate granulation tissue formation and healing. Two patients (15%) in the open approach group died of respiratory complications during the early postoperative period; 1 arrived in acute respiratory distress syndrome with multisystem organ failure and died shortly after surgery and the other died of aspiration. One closed-approach patient was lost to follow-up. Patient characteristics are further summarized in Table 1.

For the remaining 10 patients (5 closed and 5 open approach), Table 2 summarizes resolution, time to resolution, and number of additional procedures required for resolution. Overall resolution was 90% (9 out of 10) in a median of 13 days (range, 4-480 days). One closed approach patient never resolved, even after complete removal of a vertebral cage. All 5 patients in the closed approach group required a median of 3 procedures to achieve resolution (including 16 repeat explorations and debridements, 2 repeat hardware removals, 1 thoracotomy with decortication, and 1 Eloesser flap). None of the 5 patients in the open approach group required an additional procedure after their initial surgical intervention.

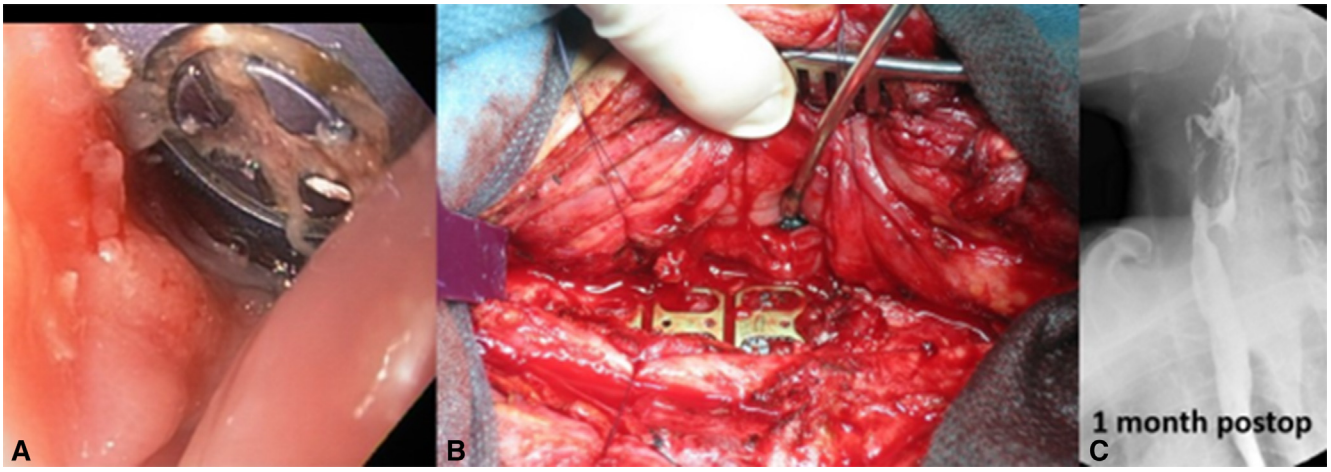

FIGURE 1. A, Cervical spine hardware eroding into the esophagus (endoscopic view). B, Cervical spine hardware exposed with anterior mobilization and exposure of the esophageal defect. C, Esophagram 1 month after repair showing good passage of oral contrast without evidence of a leak.

Two patients (20%) had vocal cord paralysis and 3 patients (30%) had symptoms of dysphagia following their procedures. These complications were successfully managed nonoperatively with speech and swallow therapy. The microbiologic findings and duration of antibiotic therapy are summarized in Table 3. Most patients had neck abscesses caused by polymicrobial organisms, and were appropriately treated with organism-specific antibiotics. Only 1 patient is on lifelong antibiotics for chronic osteomyelitis.

FIGURE 2. Esophagram showing no evidence of a leak 14 months after repair. This patient required an external fixator to maintain cervical spine stability, followed by a posterior fusion.

The median follow-up was 25 months (range, 1-144 months). One patient had a radiologic recurrence that did not require reintervention (patient on a regular diet). The overall median hospital stay was 18.5 days (range, 5-33 days). The median hospital stay for patients in the closed approach group was 23 days (range, 5-25 days) compared with 14 days (range, 11-25 days) for those in the open approach group.

Cervical Hardware Management

The cervical spine was fused in 12 patients who did not require further stabilization after hardware removal. One patient who presented within a week of ACSS had an unstable cervical spine. She underwent anterior hardware removal and replacement at the time of initial exploration and esophageal repair. She subsequently required repeat anterior hardware removal and a posterior fusion 3 months later.

Three patients had vertebral body cages in place. One patient had partial removal of the cage on our first intervention and then complete removal when he presented with an abscess recurrence. The second patient underwent partial cage removal but died of acute respiratory distress syndrome within 36 hours of the operation. The cage was not removed in the third patient. The third patient is on a regular diet but has a chronic diverticulum at the level of the cage and is on lifelong suppressive antibiotic therapy for chronic osteomyelitis.

DISCUSSION

Esophageal perforation is a rare but devastating complication of ACSS that is best managed in a multidisciplinary

TABLE 1. Patient characteristics

Patient	1	2	3	4	5	6	7	8	9	10	11	12	13
Age (y)	49	24	46	55	30	47	30	60	69	61	52	72	74
Gender	M	M	M	M	M	F	M	M	M	F	M	M	F
Indication for ACSS	DDD	TQ	TQ	TQ	TQ	DDD	TQ	DDD	TQ	DDD	Q	DDD	DDD
Time from initial surgery to diagnosis	5 mo	2 y	3 y	3 d	1 mo	6 mo	7 y	12 mo	10 mo	7 y	10 y	3 y	3 y
Operations before referral	0	3	1	1	4	0	1	1	2	0	0	1	0
No. of operations at UM (including first debridement)	3	1	9	2	8	1	1	1	1	1	1	1	1
Type of hardware	Plate	Plate	Plate	Plate	Cage	Plate	Cage	Plate	Cage	Plate	Plate	Plate	Plate
Sternocleidomastoid muscle flap	Yes	No	Yes	No	No	No	No	No	Yes	Yes	No	No	No
Wound management	Closed	Closed	Closed	Closed	Closed	Closed	Open	Open	Open	Open	Open	Open	Open
Time to resolution	97 d	12 d	16 mo	70 d	No resolution	Lost to follow-up	Died postop (ARDS)	12 d	10 d	5 d	4 d	28 d	Died postop (aspiration)

M, Male; *F*, female; *ACSS*, anterior cervical spine surgery; *DDD*, degenerative disk disease; *TQ*, trauma quadriplegia; *Q*, quadriplegia; *UM*, University of Minnesota; *ARDS*, acute respiratory distress syndrome.

fashion. Based on its rarity, available evidence on the management of this complex problem is limited to case reports and series. The principles of surgical management are to drain the neck abscess, repair the esophageal defect (if possible), remove the anterior hardware, and establish enteral access. However, thus far, there is a dearth of data in the literature to guide wound management following surgical intervention.[4-8] This is the first study that has examined the influence of a wound management approach on postoperative outcomes of esophageal perforation following ACSS. Results from our study strongly suggest that an open wound management approach should be added to the surgical management algorithm.

We found that all patients managed with an open neck wound had resolution after 1 procedure and within 30 days of presentation, whereas those who underwent closure over a drain required a median of 3 procedures to attain resolution. Additionally, only 1 patient (20%) managed with a closed neck wound had resolution within 30 days. Although this is a very rare problem and our series is small, the striking clinical difference between the study groups led us to change our management to always use an open wound approach. See Figure 3 for a graphical abstract of the study.

TABLE 2. Resolution, time to resolution, and number of procedures required by approach

Variable	Closed (n = 5)	Open (n = 5)	Total (N = 10)
Resolution	4 (80)	5 (100)	9 (90)
Time to resolution ≤30 d*	1 (20)	5 (100)	6 (60)
No. of procedures required to attain resolution*	3 (1-9)	1	1 (1-9)
No. of days to resolution*	91.5 (12-480)	10 (4-28)	13 (4-480)

Values are presented by n (%) or median (range). *One patient in the closed group never attained resolution (n = 9).

We recommend removal of the anterior hardware whenever possible. We removed the original anterior spinal hardware in all patients at the index operation for perforation (except for 1 case where the patient came to our institution after hardware removal). The median time to presentation of esophageal perforation after ACSS was 12 months and the cervical spine is usually stable at that time. Removal of anterior hardware is generally straightforward, not time-consuming, safe if the spine is stable, and feasible even in patients with sepsis. One patient had her esophageal perforation diagnosed within a week of ACSS and presented with an unstable cervical spine. We chose to replace an anterior plate; inevitably, this new plate needed removal after a few weeks and the perforation did not heal until we removed the second anterior plate and fused the spine posteriorly. We now advocate management of an unstable spine either with external fixation or with posterior fusion at the time of presentation.

The management of vertebral body cages is a challenging problem that requires individualization. Removal of a vertebral cage is a major undertaking and may not be possible at presentation. However, incomplete removal can lead to chronic osteomyelitis with incomplete resolution of the esophageal perforation. Two of our surviving patients had vertebral cages in place. One of them had eventual complete removal. However, he never healed his perforation. The second patient resumed oral intake but had a diverticulum and

TABLE 3. Summary of microbiology and antimicrobial therapy

Patient	Approach	Microbes	Antimicrobials
1	Closed	*Alpha-hemolytic streptococcus*, *Klebsiella pneumoniae*, Group D *Enterococcus*, *Pseudomonas*	Linezolid, piperacillin-tazobactam, fluconazole × 6 wk
2	Closed	*Candida albicans*, methicillin-resistant *Staphylococcus aureus*, *Eikenella corrodens*, *Enterobacter cloacae*	Linezolid, imipenem, fluconazole × 6 wk fluconazole, ciprofloxacin × 5 mo
3	Closed	*Candida albicans*, *Candida glabrata*, *Coagulase-negative Staphylococcus aureus*	Piperacillin/tazobactam, vancomycin, caspofungin × 1 mo
4	Closed	*Enterobacter cloacae*, Group D *Enterococcus*, *Actinomycetes odontolyticus*, *Granulicatella adiacens*	Ampicillin and ertapenem × 3 wk ampicillin × 6 mo
5	Closed	*Candida* sp *Alpha-hemolytic streptococcus*, Hemophillis sp Neisseria sp Coagulase-negative staph	Meropenem, linezolid, fluconazole × 1 mo, Vancomycin, caspofungin, levofloxacin × 9 mo
6	Closed	*Actinomyces* sp, *Candida albicans*, *Candida dubliniensis*	Ampicillin/sulbactam (lost to follow-up)
7	Open	*Streptococcus viridans*, B-hemolytic *Streptococcus*, *Lactobacillus*,*Rothia mucilaginosa*, *Candida glabrata*	Vancomycin, piperacillin/tazobactam, micafungin × 8 wk, then lifelong suppressive oral antibiotics
8	Open	*Cutibacterium acnes*, Diphteroids	Ampicillin/sulbactam × 2 wk
9	Open	*Streptococcus anginosus*, *Fusobacterium nucleatum*, *Parvimonas micra, Eikenella corrodens*	Ertapenem × 6 wk
10	Open	No cultures	Ampicillin/sulbactam × 4 d
11	Open	No cultures	Vancomycin, meropenem, fluconazole × 1 wk, vancomycin, ceftazidime, clindamycin, fluconazole × 2 wk
12	Open	*Streptococcus mitis*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis*, *Prevotella* sp *Saccharomyces cerevisiae*	Vancomycin, fluconazole, piperacillin/tazobactam (early death)
13	Open	*Candida albicans*, *Candida dubiliniensis*, *Peptostreptococcus Prevotella*	Piperacillin/tazobactam, vancomycin, fluconazole (early death)

possibly a persistent fistulization to the spine with chronic osteomyelitis requiring life-long suppressive antibiotics.

We do not recommend the use of stents, regardless of type in patients with esophageal perforation secondary to ACSS. Patients often do not tolerate stents because these perforations are close to the cricopharyngeus muscle. Additionally, our early experience also indicated that they are of no therapeutic value.[3]

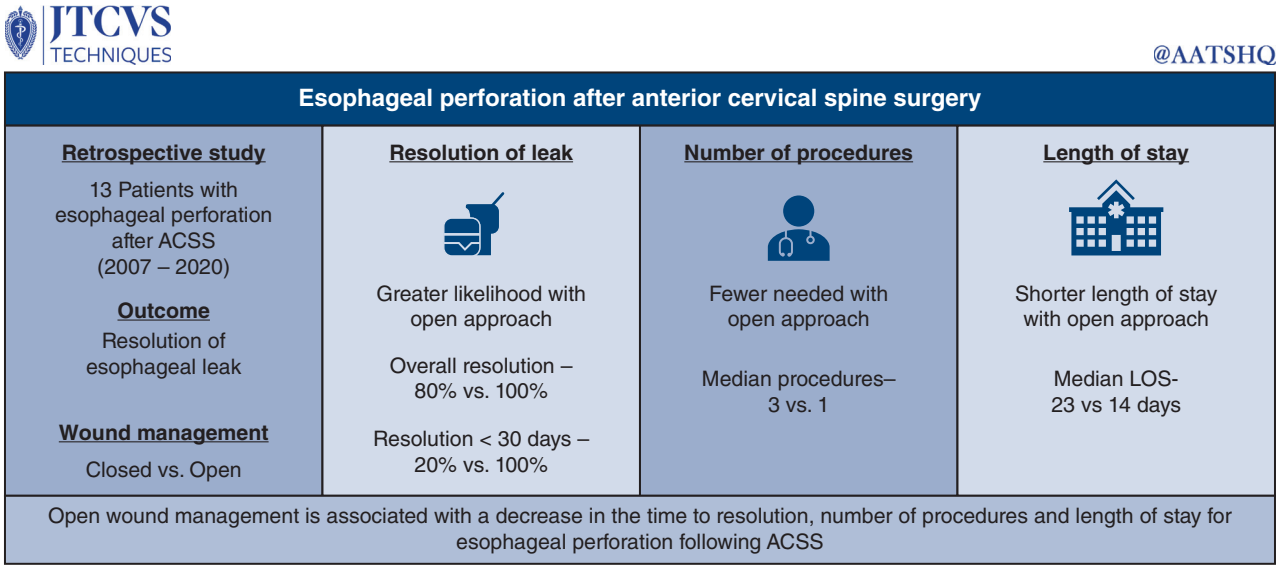

FIGURE 3. Graphical abstract. *ACSS*, Anterior cervical spine surgery; *LOS*, length of stay.

Nutrition support is an important component of recovery and establishment of enteral access was done at the time of first operation if the patient did not already have a feeding tube. Resolution is assessed with more than 1 modality. Oral methylene blue administration at the bedside is the best clinical assessment for a leak, and is particularly effective in the face of an open wound. Esophagram and swallow evaluation are other important modalities to evaluate for resolution and to guide resumption of oral intake.

The results of this study must be interpreted within the context of its limitations. This is a retrospective cohort study and by virtue of its nonrandomized design may be liable to some selection bias. It is a single-institutional study and is limited by a small sample size. In addition, we did not have a standard retesting protocol for leaks, which could have introduced some bias in our analysis. Lastly, we did not have access to short- and long-term qualitative data on outcomes and so could not assess the influence of the initial wound management approach on quality of life metrics. Despite these limitations, this study is a unique review of our institutional experience in managing a rare and complex problem.

CONCLUSIONS

We believe a multidisciplinary approach is the best way to address the difficult problem of esophageal perforation after ACSS. In particular, the team should include a spine surgeon, a head and neck surgeon, and a thoracic surgeon. Patients must undergo surgery to drain the neck abscess, remove the anterior cervical hardware, repair the esophagus (if possible), establish enteral access, and the wound should be left open. This will minimize the need for further procedures and give the patient the best chance to resolve the leak and resume oral intake. We have now implemented an institutional multidisciplinary approach to care for these patients.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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Key Words: esophageal perforation, spine surgery, wound management