Management of esophageal and pharyngeal perforation as complications of anterior cervical spine surgery

Moo Sung Kang, MD, Kyung Hyun Kim, MD, PhD, Jeong Yoon Park, MD, PhD, Sung Uk Kuh, MD, PhD, Dong Kyu Chin, MD, PhD, Byung Ho Jin, MD, Keun Su Kim, MD, PhD, Yong Eun Cho, MD, PhD

PII: S1878-8750(17)30304-2
DOI: 10.1016/j.wneu.2017.02.130
Reference: WNEU 5361

To appear in: World Neurosurgery

Received Date: 26 December 2016
Revised Date: 27 February 2017
Accepted Date: 28 February 2017


This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.
Management of esophageal and pharyngeal perforation as complications of anterior cervical spine surgery
Abstract

Objective. To describe our experience in treating esophageal and pharyngeal perforation after anterior cervical spine surgery.

Methods. Six patients with esophageal injury and one patient with pharyngeal injury after anterior cervical spinal surgery, managed at our department between 2000 and 2015, were retrospectively analyzed.

Results. During the study period, seven patients (six male and one female; mean age, 45 years) presented with esophageal perforation. The original anterior cervical spinal surgery was performed due to trauma in two patients and because of a degenerative cervical disorder in five. Early esophageal perforation was diagnosed in two patients, and delayed esophageal injury due to chronic irritation with the cervical implants was noted in five. Three of the five delayed perforation cases were related to cervical instrument displacement. Two patients showed no definite signs of infection, whereas five patients had various symptoms, including fever, neck pain, odynophagia, neck swelling, and upper extremity weakness. Two patients with a large defect underwent surgical repair and three with minimal perforation due to chronic irritation from the implants underwent instrument removal without direct repair of defect. Two asymptomatic patients received no intervention. Six patients with infection completely recovered from esophageal injury after treatment for a mean duration of 5.2 weeks (range, 4-8 weeks). One patient expired because of postoperative pneumonia and sepsis after implant removal.

Conclusions. Esophageal and pharyngeal injury after cervical spinal surgery may occur either directly due to spinal trauma and vigorous intraoperative retraction or due to chronic irritation with cervical implants. In cases of perforation associated with infection, various surgical modalities, including primary closure and reinforcement with a flap could be considered depending on factors such as esophageal defect size, infection severity, and timing of recognition of injury.

KEY WORDS: esophageal perforation, cervical spine, complications, revision, spine surgery
Introduction

An anterior approach to the cervical spinal cord and nerve roots is commonly used for various kinds of cervical disorders due to spondylotic, neoplastic, infectious, or traumatic causes. With this approach, the posterior neck muscle is not detached from its origin, decreasing neck pain and kyphosis. Furthermore, the use of a transverse incision decreases scarring, which is often imperceptible over the long term.

However, the potential complications of an anterior approach to the cervical spinal cord and nerve roots include respiratory distress due to retropharyngeal edema or hematoma, vertebral or carotid artery injury, vocal cord paralysis, and Horner’s syndrome. In addition, esophageal or pharyngeal perforation could be a serious complication of anterior cervical surgery. These injuries are especially grave because of the difficulty in controlling infection and uncertain subsequent deformation of cervical alignment. Although a few such cases have been reported, published information to guide spine surgeons in the management of such injuries is limited.

In this study, we analyzed seven cases of esophageal or pharyngeal perforation associated with anterior cervical surgery performed for a variety of reasons in an attempt to develop guidelines for the evaluation and management of such injuries.

Materials and Methods

We retrospectively reviewed the medical records at our institute, a tertiary spinal care center. Between 2000 and 2015, 3362 anterior cervical surgeries were performed by the authors. We assessed each case in regard to the following factors: basic demographics, length of stay, primary pathology, mechanism of injury, time to diagnosis, method of previous surgery, result of inspection tool, method of esophageal repair, removal of implant, use of drains, use of antibiotics, use of either oral/parenteral intake, reported pathogens and complications.

Results

Among the 3362 surgeries during the study period, three were diagnosed with esophagus perforation, constituting an approximate incidence of 0.09%. Additional three esophageal and one pharyngeal perforation were referred to us from other hospitals. Seven patients (six male and one female; mean age, 62.5 years [range,
21-79 years) with esophageal and pharyngeal perforation as complications of anterior cervical spinal surgery were managed at our institute. The original surgical treatment was adopted because of traumatic cervical spine fracture in two cases and because of degenerative cervical radiculomyelopathy in rest five. With regard to previous surgeries, anterior cervical corpectomy and fusion had been performed in two cases, anterior cervical discectomy and fusion had been performed in four, and arthroplasty had been performed in one. The perforation sites were at C2-5 in one case, C4/5 in one, C5/6 in two, and C6/7 in three. The general information was presented in Table 1.

Two patients with early injury were associated with intraoperative injury and trauma. One case occurred during anterior cervical discectomy and fusion (ACDF) and the other injury appeared one month after corpectomy and fusion due to the vertebral body fracture. Five delayed perforations were diagnosed 4 weeks to years postoperatively. Among these five cases, four were caused by the irritation from the displaced implant. Three had displacement of anterior plate and screws, the other had displacement of artificial disc.

Neck pain, the most common symptom, was present in 3 of the 7 cases (42%). Fever was noted in only 2 patients (28%) and odynophagia was manifested in two (28%). Wound discharge (n=1, 14%), definite subcutaneous emphysema (n=1, 14%), radiating pain in upper extremity from resultant foraminal stenosis (n=1, 14%), were also shown. One with pharyngeal perforation from plate displacement complained of hoarseness from decreased mobility of vocal cord. (Fig. 1) One patient was asymptomatic and visited our clinic at 14 years postoperatively with the incidental finding of an esophageal defect and a metallic foreign body emerging through the defect on esophagogastroduodenoscopy, performed as part of a routine health check-up. The follow-up period after diagnosis of pharyngoesophageal injury ranged from 16 months to 7 years. (Fig. 2)

Plain radiograph of the cervical spine showed subcutaneous emphysema in one early perforation, bony erosion and kyphosis in another early injury case. In four of five delayed perforation, various types of implant failure were detected with serial plain radiograph. (Fig. 3) Thickening of the retropharyngoesophageal soft tissue was only seen in four delayed perforation with infection signs. Also plain radiograph showed air-fluid level in delayed one. Contrast esophagography using gastrografin or barium was performed in four cases without definite infectious signs, and a large defect and pseudo-diverticulum was detected in one case. A chest computed tomography (CT) taken after contrast esophagography indicated a large defect site that manifested as
mediastinitis with retention of the contrast medium around the pericardium in one case. (Fig. 4) Flexible esophagoscopy was also performed in three cases and was helpful by direct visualization. Magnetic resonance imaging (MRI) showed spondylitis with an abscess in four patients, and CT of the cervical spine revealed detailed status of instrument failures and bony erosion in four. The results of diagnostic tool are presented in Table 2.

All cases of perforation were discussed with otolaryngologists and chest surgeons. For early injury cases with a large defect and concurrent infection, surgical treatment was chosen to promote healing. One patient was successfully treated with a sternocleidomastoid (SCM) muscle flap, using the sternal head of the SCM muscle, and was discharged 8 weeks after revision. In the other early perforation patient, direct suture with black silk 3-0 was not successful and the wound had to be reopened; daily iodine-povidone-soaked dressing and drainage was performed 2 weeks after revision. Contrast esophagography performed 6 weeks after revision revealed no definite leakage through the esophageal defect and wound was re-sutured.

Five delayed injury patients had minimal defect related to chronic irritation with implants. Two remnant instruments were removed surgically to reduce further damage except one total displacement of artificial disc through the digestive system at the time of diagnosis. Anterior plate located on the pharyngeal wall was removed with pharyngoscopic approach. One asymptomatic patient with metal plate exposure and a pseudocyst received no intervention and no overt infection was occurred.

The patients basically received conservative care, including intravenous antibiotics and parenteral nutrition. The average duration of treatment was 5.2 weeks, ranging from 4 weeks to 8 weeks. Treatment details were summarized in Table 3 and Fig. 5.

A variety of organisms was detected on culture, including methicillin-resistant Staphylococcus aureus (MRSA), Acinetobacter, Pseudomonas, Enterococcus, Streptococcus, and Prevotella species. Broad-spectrum intravenous antibiotics against both aerobes and anaerobes, such as ampicillin/sulbactam and piperacillin/tazobactam, were administered and vancomycin was administered for MRSA. Three patients underwent posterior instrumentation and fusion with an autologous bone graft due to the instability and kyphosis. One patient died because of uncontrolled pneumonia and septic shock after implant removal, resulting in a mortality rate of 14.2%.
Discussion

Pharyngoesophageal perforation is a rare complication of anterior cervical surgery with an incidence of 0.02-1.62%.\textsuperscript{3-6} However, this injury is frequently associated with an unfavorable outcome, with a mortality rate of up to 19%. An early diagnosis of acute perioperative esophageal injury is especially important because, with accurate and early diagnosis, mortality rates are reported to less than 7%. Whereas, a delayed diagnosis after 24 hours after injury were reported to have a higher mortality rate of up to 27-60%.\textsuperscript{7-9}

Contrast esophagography is a standard tool with which to establish a diagnosis. With this test, we highlight not only the site and size of the perforation but also the presence of pseudo-diverticulum or concurrent mediastinitis, which greatly helps determine the need for surgical repair. Water-soluble contrast media, such as gastrografin, are frequently used in the first line of screening in patients with suspected perforation due to rapid absorption and less irritation of the mediastinum. Initial contrast esophagography sometimes yields false-negative results when the study is performed immediately after injury, because of edema associated with a small perforation. The sensitivity of this study is reported to be 50-89%, and some authors advocate that a negative result should be followed by the administration of barium or thinned barium because of its superiority in enabling visualization of the mucosa.\textsuperscript{7,10,11}

Flexible esophagoscopy also can be used to provide direct visualization of the injury site, with one study reporting a sensitivity of 100% and a specificity of 83%.\textsuperscript{12} However, the role of flexible esophagoscopy has not been adequately established because air insufflation, which is a requirement during the procedure, may convert a small perforation into an overt injury and even increase contamination of the mediastinum.\textsuperscript{8,11,13}

In this study, five of seven perforations occurred at the level of C5/6 and C6/7. This may be related to the overall frequency of surgery at this level. Killian’s triangle, an area formed by the inferior constrictor pharyngeus and the cricopharyngeus muscles corresponding to the C5/6 level, is known to be vulnerable to iatrogenic retraction injury.\textsuperscript{8} A sharp dissection, the pressure of retractor blades, drilling, or even traumatic endotracheal intubation is the usual mechanism of acute injury.\textsuperscript{9,14,15} Some reports suggest that cervical fracture is an independent risk factor, and in this study, there was one case of acute injury related with traumatic cervical injury.\textsuperscript{3} Delayed esophageal injury has been described to result from chronic pressure necrosis or ischemia and be related to instrument failure.\textsuperscript{7} Previous reports suggest that the time of presentation ranges from the intraoperative period to 10 years postoperatively. In this study, there were five cases of chronic injury from
months postoperatively to 14 years postoperatively.

A key component of primary and immediate management of a pharyngoesophageal perforation is prompt diagnosis and assessment of the need for operative or nonoperative management. No standard treatment modalities have been established yet, and treatment is highly case specific. In a review article, Brinster et al suggested an algorithm of current management strategies for esophageal perforation, which is mainly based on the injury site of the esophagus, containment, and tolerability of surgical repair. However, this management algorithm is not specific to spine surgeons because it encompasses the cervical, thoracic, and abdominal parts of the esophagus and does not consider spinal instruments.

Based on our experience, we simplified a management flow chart. Asymptomatic patients without any sign of infection around the penetrating site usually recover spontaneously and do not need any treatment. We encountered one asymptomatic patient with an incidental finding of metal plate exposure during routine medical examination. Also another patient who had chronic cough and hoarseness due to pharyngeal irritation with the displaced anterior plate recovered after pharyngoscopic removal. Several authors have reported their experience with delayed pharyngoesophageal perforation with instruments failure and spontaneous healing.16-20 This spontaneous healing phenomenon could result from the small size of displaced instruments or their slow migration process.16

In patients with suspected infection, the presence of overt leakage and a pseudocyst on contrast esophagography or pharyngoesophagography should be assumed to be an indicator of the need for surgical repair. Solerio et al recommended that non-operative treatment such as the administration of intravenous broad-spectrum antibiotics and parenteral nutrition should be limited to patients with only asymptomatic and contained types of perforation, less than 1 cm in length, due to their high failure rate of up to 25%.21 In addition, serial supportive imaging and laboratory tests should be conducted considering the possibility of masking due to local edema or cellular debris. Surgical repair consists of primary closure or reinforcement with a pedicled muscle flap interposition using various cervical muscles. Primary closure consists of both mucosal layer suturing with absorbable material and muscular layer suturing with non-absorbable material. This may take a longer time to heal and is associated with a higher rate of failure or stricture than reinforcement with a flap.22 Reinforcement with a muscle flap functions as a basic physical barrier and increases antibiotic delivery via the rich vasculature. The SCM muscle is most common choice owing to its rich arterial supply and high mobility; the longus colli
muscle has been reported as an alternative.\textsuperscript{22,23} Orlando et al advocated that the type of surgical repair depends on the timing of the recognition of the laceration. Some authors suggest that severe bacterial infection and large perforations are indications for flaps.\textsuperscript{21,24} If the infection is not controlled with surgical repair, open-wound management, like povidone-iodine soaking, can be employed as a rescue modality.\textsuperscript{25}

For patients with no definite evidence of extraluminal contamination, surgical repair of perforations is not usually required. However, removal of the instrument causing irritation is carefully concerned if the perforation is suspected to result from chronic pressure of the cervical spinal instruments.

The average duration of treatment was 5.2 weeks, ranging from 4 weeks to 8 weeks in our cases. Sawyer et al reported the mean duration of treatment as $26 \pm 5$ days based on their experience with 22 cases.\textsuperscript{11} Other authors have reported durations of treatment ranging from 28 to 253 days.\textsuperscript{4,6,22,26}

In this study, one 78-year-old male patient with diabetes mellitus died 4 weeks postoperatively because of sepsis and pneumonia after revision. Culture of his cervical wound revealed super-infection with several pathogens including MRSA and \textit{Acinetobacter} species. Various species of microorganisms were reported in our culture studies. Due to the contamination from gastric contents, multiple organisms including gram-positive, gram-negative, and anaerobic organisms can be identified and parenteral antibiotics covering all these bacteria should be given. To our knowledge, there are no previous reports of large series detailing the prognostic factors, likely because of the low incidence of esophageal perforation.

**Conclusion**

Pharyngeal and esophageal injury is an uncommon complication that can potentially occur either directly due to spinal trauma and vigorous intraoperative retraction or due to chronic irritation with cervical implants. Considering the multiple factors including infection signs, defect size and timing of diagnosis, various surgical modalities, including primary closure or reinforcement with a flap, with concurrent non-operative treatment were effective in achieving successful repair. Even though it is treated thoroughly, minimizing of morbidity and mortality is still a challenge for clinicians.
References


Figure legend

Fig. 1  a plain radiograph showing instrument displacement b pharyngoscopic image showing plate over epiglottis (case no. 4)

Fig 2. a plain radiograph showing instrument displacement b esophagography performed 14 years after surgery showing direct plate exposure without infection sign c follow-up esophagography at 15 months after diagnosis of esophagus perforation still showed the same exposure of metal plate without overt infection

Fig. 3 serial plain radiographs showing instrument displacement with delayed esophageal perforation a postoperative 6 years b postoperative 8 years c postoperative 10 years d postoperative 10.5 years

Fig. 4 a Contrast esophagogram showing definite leakage with pseudocyst (arrow) b chest CT after contrast esophagram showing contrast leakage with pseudocyst (arrow) c chest CT shows mediastinal leakage

Fig. 5 Summary of diagnosis and treatment of patients
<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Age</th>
<th>Injury site</th>
<th>Timing of injury</th>
<th>Onset of symptom</th>
<th>Previous surgery</th>
<th>Preoperative diagnosis</th>
<th>Level</th>
<th>Chief complaint</th>
<th>Past history</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>43</td>
<td>esophagus</td>
<td>Early</td>
<td>1 day</td>
<td>ACDF</td>
<td>Disc herniation</td>
<td>C6/7</td>
<td>fever</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>21</td>
<td>esophagus</td>
<td>Early</td>
<td>1 month</td>
<td>ACCF</td>
<td>Fracture &amp; dislocation</td>
<td>C6/7</td>
<td>neck pain</td>
<td>none</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>61</td>
<td>esophagus</td>
<td>Delayed</td>
<td>14 years</td>
<td>ACDF</td>
<td>Fracture &amp; dislocation</td>
<td>C6/7</td>
<td>incidental finding on EGD</td>
<td>none</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>55</td>
<td>pharynx</td>
<td>Delayed</td>
<td>8 years</td>
<td>ACCF</td>
<td>Disc herniation</td>
<td>C2-5</td>
<td>odynophagia</td>
<td>none</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>52</td>
<td>esophagus</td>
<td>Delayed</td>
<td>10 years</td>
<td>Arthroplasty</td>
<td>Disc herniation</td>
<td>C5/6</td>
<td>neck pain</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>49</td>
<td>esophagus</td>
<td>Delayed</td>
<td>3 months</td>
<td>ACDF</td>
<td>Disc herniation</td>
<td>C5/6</td>
<td>odynophagia</td>
<td>none</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>79</td>
<td>esophagus</td>
<td>Delayed</td>
<td>9 months</td>
<td>ACDF</td>
<td>Disc herniation</td>
<td>C4/5</td>
<td>fever</td>
<td>DM</td>
</tr>
</tbody>
</table>
Table 2 The results of diagnostic tool

<table>
<thead>
<tr>
<th>No.</th>
<th>contrast esophagography</th>
<th>fiberoptic</th>
<th>X-ray</th>
<th>MRI</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>fistula, pseudocyst</td>
<td></td>
<td>emphysema</td>
<td>Spondylodiscitis</td>
<td>mediastinitis</td>
</tr>
<tr>
<td>2</td>
<td>fistula, pseudocyst</td>
<td>exposure of</td>
<td>bony erosion &amp; kyphosis</td>
<td>Spondylodiscitis</td>
<td>bony erosion &amp; kyphosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>allograft</td>
<td></td>
<td>Abscess</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>exposure of</td>
<td>nonspecific</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>metal plate</td>
<td></td>
<td>Spondylodiscitis</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>no definite leak</td>
<td>exposure of</td>
<td>displacement of plate and screws</td>
<td></td>
<td>nonspecific</td>
</tr>
<tr>
<td></td>
<td></td>
<td>metal plate</td>
<td></td>
<td>Abscess</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>no definite leak</td>
<td>no definite leak</td>
<td>displacement of artificial disc</td>
<td>Spondylodiscitis</td>
<td>bony erosion &amp; kyphosis</td>
</tr>
<tr>
<td>6</td>
<td>no definite leak</td>
<td>no definite leak</td>
<td>air-fluid level, soft tissue edema</td>
<td></td>
<td>soft tissue edema</td>
</tr>
<tr>
<td>7</td>
<td>no definite leak</td>
<td>no definite leak</td>
<td>displacement of screw</td>
<td>Spondylodiscitis</td>
<td>soft tissue edema</td>
</tr>
<tr>
<td>No.</td>
<td>Treatment</td>
<td>Result</td>
<td>Supplementary treatment</td>
<td>Duration feeding route</td>
<td>Bacterial culture</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------</td>
<td>--------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>1</td>
<td>Primary suture</td>
<td>Persistent leakage</td>
<td>open soaking dressing</td>
<td>6 weeks</td>
<td>Gastrostomy</td>
</tr>
<tr>
<td>2</td>
<td>SCM flap</td>
<td>Recovery</td>
<td>8 weeks</td>
<td>NG tube</td>
<td>Flomoxef + Metronidazole → Sulbacillin</td>
</tr>
<tr>
<td>3</td>
<td>Observation</td>
<td>Recovery</td>
<td>Oral</td>
<td>4 weeks</td>
<td>no growth</td>
</tr>
<tr>
<td>4</td>
<td>Removal of implant</td>
<td>Recovery</td>
<td>Oral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Conservative care</td>
<td>Recovery</td>
<td>Oral</td>
<td>4 weeks</td>
<td>no growth</td>
</tr>
<tr>
<td>6</td>
<td>Removal of implant</td>
<td>Recovery</td>
<td>4 weeks</td>
<td>NG tube</td>
<td>No growth → MRSA</td>
</tr>
<tr>
<td>7</td>
<td>Removal of implant</td>
<td>Expired</td>
<td>4 weeks</td>
<td>NG tube</td>
<td>Acinetobacter, Pseudomonas MRSA, Enterococcus Streptococcus Prevotella</td>
</tr>
</tbody>
</table>
Contrast esophagography, flexible esophagoscopy, computed tomography, magnetic resonance imaging, plain radiograph, serologic tests, bacterial culture

Instrument penetration without definite infection (n=2)
- Observation (n=1)
- Fiberoptic removal of displaced instrument (n=1)

Suspected infection (n=5)
- Definite contrast leakage (n=2)
  - Surgical repair of the esophageal defect
    - Sternocleidomastoid muscle flap
    - Primary closure
  - Minimal or no contrast leakage (n=3)
    - Surgical removal of the implant (n=2)
    - Spontaneous displacement (n=1)
Highlights

The esophageal and pharyngeal perforation after anterior cervical spine surgery is a rare but critical complication.

Favorable outcome was achieved after surgical repair of perforation in cases with definite leakage.

Without eminent perforation after passage of the instrument, the wound can be managed with only medical management.

If the infection sign is not suspected in delayed perforation, the instrument failure can be carefully observed without any intervening.
Abbreviations

ACDF : Anterior cervical discectomy and fusion

CT : Computed tomography

MRI : Magnetic resonance imaging

SCM : Sternocleidomastoid

MRSA : methicillin-resistant \textit{Staphylococcus aureus}