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Original Article

Esophageal Complications after Anterior Cervical Spine Fixation

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Abstract

Background: Esophageal perforation may occur spontaneously, may be induced by a foreign body, or may be caused by direct trauma or iatrogenically. The anterior approach to cervical spine surgery is a known etiology of esophageal injury. This study described the management of esophageal injury after cervical spine fixation.

Methods: This retrospective study included patients who experienced esophageal perforation after spinal fixation between 2008 and 2019. Patients with esophageal injury caused by causes other than spinal fixation were excluded.

Results: The study evaluated the outcomes of 11 patients who developed esophageal perforation (PEP) following anterior cervical discectomy and fusion (ACDF) for traumatic spinal fractures. The cohort comprised two females and nine males, with a mean age of 33.9 years. Esophageal injuries were identified at varying post-operative intervals, with some patients presenting significant complications like cervical abscesses and dysphagia. The causes of perforation were attributed mainly to surgical trauma and device migration, with some patients experiencing delayed presentations. Surgical intervention included esophageal closure techniques, with 82% of patients achieving successful repair. The majority were treated with muscle flaps and various methods of suture closure. The mean duration of being NPO was 33.8 days, and the average hospital stay was 45 days. Ultimately, nine patients (82%) healed completely, while two patients (18%) had complications related to their condition.

Conclusion: Esophageal injury, although uncommon in the anterior spinal approach, is still considered a life-threatening complication and requires a low threshold of suspicion from the surgeon with prompt and targeted intervention, as there are no definite guidelines for management.

KEYWORDS

Esophageal; Perforation; Cervical; Fixation, Thoracic; Muscle flap

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Introduction

Anterior cervical discectomy and fusion (ACDF) is considered safe and effective for managing cervical disc prolapse or traumatic cases [1]. The anatomical position of the esophagus, which lies directly anterior to the cervical spine, makes it vulnerable to injury during the anterior approach in cervical spine surgery [2, 3]. Esophageal perforation, although rare, is a life-threatening lesion that can lead to death in 6–34% of cases [4, 5]. Most pharyngoesophageal perforations (PEPs) in the form of perforations occur due to anterior cervical spine fixation, mainly for the treatment of trauma or discectomy and fusion, at the C5–C7

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level [6]. Iatrogenic esophageal injuries may be diagnosed intraoperatively, perioperatively, or many years postoperatively. Erosion of the hypopharynx or esophagus has been described as occurring up to 9 years postoperatively [7, 8]. Other causes of perforation include foreign bodies, trauma, and spontaneous perforations [9, 10]. Esophageal perforation can lead to deep neck space infection, airway obstruction, and descending mediastinitis. Various surgical techniques have been adopted to avoid such complications. Caution during initial exposure, along with careful retractions, has been recommended to minimize the risk of esophageal injury [2]. Additionally, positioning the retractor blades beneath the longus coli muscle can help prevent inadvertent esophageal "escape" during the procedure, further reducing the risk of injury [11]. Early perforations typically result from surgical trauma caused by sharp instruments, high-speed burrs, and retractors, while delayed injuries are more often associated with hardware failure, screw migration, or pressure from the fixation plate components [12 - 14]. Perforations in the cervical esophagus are generally considered less critical than those in the intrathoracic or intra-abdominal areas due to their slower progression to descending mediastinitis. This study aimed to report our institution's experience in managing esophageal injuries following cervical spine fixation, focusing on potential causes, presentations, and risk factors.

Patients and Methods

Design and patients

We retrospectively reviewed cases of esophageal perforation that were encountered and treated in our hospital as primary cases or were referred from other hospitals between 2008 and 2019. All patients with esophageal injury were included. Patients with esophageal injury caused by causes other than spinal fixation were excluded.

Data and outcomes

Data were collected for demographic characteristics, indication for spinal fixation, time interval of presentation, clinical course of each patient, management and outcome.

Procedures

The primary surgery was performed by a neurosurgeon performing anterior cervical discectomy and fusion via a cervical plate and screws with or without a cage or mesh. To establish the diagnosis of PEP, each patient underwent either contrast esophagogram and/or computed tomography (CT) scans to evaluate the level of perforation and its size and morphology. Magnetic resonance imaging (MRI) was performed to assess the cervical spine, prosthetic materials and mediastinum. Esophagoscopy was seldom needed. Once the diagnosis was established, oral feeding was given. Sufficient nutritional therapy was provided through a nasogastric tube (NGT) inserted under fluoroscopic guidance, percutaneous jejunostomy (PJ) or total parenteral nutrition (TPN). Broad-spectrum intravenous antibiotics were given, followed by culture and sensitivity. Daily debridement of the cervical wound was performed; if the wound was left open, irrigation with sterile normal saline and dressing was performed. A multidisciplinary team meeting, including a thoracic surgeon, a neurosurgeon, an ENT surgeon, and an anesthesiologist, was conducted to outline the management plane for every individual patient on the basis of the timing of the presentation of symptoms, the size of the fistula, the extent of the infection and the general condition of the patient.

Surgical management was performed under general anesthesia with endotracheal intubation, and patients were placed in the supine position in most cases. According to the subjective assessment of the wound infection, the degree of tissue necrosis in addition to the clinical condition of the patient and whether a muscle flap was performed, the wound was debrided, irrigated and either closed with drains or kept open for drainage. Oral feeding was started after at least 5 days of repair, and healing was confirmed via contrast esophagography.

Statistical analysis

Data are presented as numbers (%) for categorical variables and means (standard deviations) and ranges for numerical variables.

Table 1: Demographic data of the patients who presented with esophageal perforation after anterior cervical discectomy and fusion

Case	Age	Sex	Indication for ACDF	Spine Fixation Devices Used in ACDF	Clinical Presentation of PEP	Time Interval between ACDF* & Diagnosis of PEP
#1	29	F	Trauma C5-C6	Plate	Cervical Abscess	58 days
#2	32	M	Trauma C6-C7	Plate	Dysphagia	36 days
#3	21	M	Trauma C6-C7	Plate	Dysphagia, Cervical Swelling	90 days
#4	45	M	Trauma C6-C7	Plate	Cervical Swelling, Wound Discharge	4 days
#5	28	F	Trauma C5-C6	Plate + Cage	Dysphagia, Cervical Pain & Swelling	16 days
#6	37	M	Trauma C5-C6	Mesh + Plate	Fever, Cervical Pain & Swelling	58 days
#7	23	M	Trauma C6-C7	Plate	Odynophagia, Repeated Choking & Chest Infection	7 years
#8	20	M	Trauma C5-C6-C7	Plate + Bone Graft	Odynophagia, Chest Infection	26 months
#9	49	M	Trauma C6-C7	Plate + Cage	Dysphagia	288 days
#10	41	M	Trauma C5-C6-C7	Plate	Neck Subcutaneous Emphysema	51 days
#11	48	M	Trauma C4-C5-C6-C7	Plate + Cage	Cervical Abscess, Wound Discharge	12 days

ACDF: Anterior Cervical Discectomy and Fusion, PEP: Pharyngoesophageal Perforation

Results

Eleven patients were treated for esophageal perforation as a complication of ACDF for traumatic spinal fracture between 2008 and 2019. There were two females (18.18%) and nine males (81.81%), with a mean age of 33.9 ± 10.2 years (range 21–49). All patients experienced traumatic cervical spine fracture as an indication for anterior spinal fixation. The level of the injury was C5/C6 in three patients (27%), C6/C7 in five patients (46%), and multiple levels in three patients (27%). Only three patients underwent spinal fixation at our hospital, while the remaining patients were referred from other hospitals. In those three patients, esophageal injury was discovered on the 4th postoperative day in one patient (9.1%), the 24th postoperative day in another patient, and the last patient presented with dysphagia and neck swelling three months postoperatively. The demographic characteristics, spine procedure performed, time interval between the spine procedure and PEP presentation, and presenting symptoms are presented in Table 1.

On the basis of the radiographic findings and intraoperative findings, the cause of perforation was assumed (Table 2). Direct surgical trauma during the operation was thought to be the cause in two patients (18%) who presented on the 4th and 24th postoperative days. Both had continuous discharge of pus and food particles from the cervical wound. Plate decubitus was the cause of death in six patients (54%). They presented at the 16th, 24th, 36th, 51st, 58th and 90th days after spine surgery. The presentations of these patients included cervical abscess, dysphagia,

Table 2: Etiology and management of pharyngo-esophageal perforation

Case	Causes of Perforation	Route of Nutrition/Duration (Days)	Surgical Procedure	Hospital stay
#1	Screw Migration	NGT*/19	Debridement, Screw Removal, Simple Closure, SCM* Muscle Flap	27 days
#2	Plate Decubitus	NGT/16	Double-Layer Closure, SCM Muscle Flap	25 days
#3	Plate Decubitus	NGT-PJ/31	Plate & Screw Removal, Simple Closure, SCM Muscle Flap	41 days
#4	Direct Surgical Trauma	TPN/11	Double-Layer Suture Closure	25 days
#5	Plate Decubitus + Direct Surgical Trauma	TPN/23	Debridement, Plate + Cage Revision, Double-Layer Closure, Open Wound	31 days
#6	Plate Decubitus	NGT/40	Plate & Screw Removal, Double-Layer Closure, Neck Collar, SCM Muscle Flap, Open Wound	51 days
#7	Plate & Screw Migration	PJ/116	Plate and Screw Removal, Simple Closure, SCM Muscle Flap	120 days
#8	Screw Migration	PJ/39	Plate & Screw Removal, Simple Closure, SCM Muscle Flap	59 days
#9	Plate & Screw Migration	PJ/22	Plate & Screw Removal, Simple Closure, Strap Muscle Flap	39 days
#10	Plate Decubitus	TPN/31	Debridement of The Wound and Supportive Therapy, Open Wound	53 days
#11	Plate Decubitus + Direct Surgical Trauma	PJ/24	Debridement of The Wound and Supportive Therapy, Open Wound	24 days

NGT: nasogastric tube, SCM: sternocleidomastoid, PJ: percutaneous jejunostomy, TPN: total parenteral nutrition

subcutaneous emphysema and neck pain. Plate and screw migration occurred in 2 patients (18%) who presented at 288 days and 7 years from ACDF with dysphagia and odynophagia with repeated choking and chest infection, respectively. Screw migration alone occurred in 2 patients (18%). The presentations of these patients were cervical abscess and odynophagia with repeated chest infection at 58 days and 26 months, respectively. The mean period of presentation after surgery was 358.9 days (ranging from 4-2555 days).

All patients were kept NPOs. Four patients (36%) were fed via NGT, one of whom was shifted to PJ due to oropharyngeal infection, another four (36%) via PJ, and the remaining three (27%) received TPN. The mean duration of NPO was 33.8± 27.3 days (ranging from 11–120 days). A lateral longitudinal cervical incision over the medial border of the sternocleidomastoid muscle (SCM) was made in nine patients, and a cervical collar incision was made in one patient. A combination of one incision was performed in one patient. Esophageal closure was attempted in all patients by debridement of the wound and removal of all necrotic tissues and was performed successfully in only nine patients (82%). The perforation was identified and closed with synthetic, absorbable, interrupted sutures depending on the time of presentation. Recent perforations were closed with double layer sutures, whereas in old tears where severe infection and many necrotic tissues were encountered, the edges of the perforation were

approximated with loose sutures. Simple closure (approximation of edges with loose sutures) of the esophageal perforation was used in five patients (46%), and double-layer closure was used in four patients (36%). A muscle flap was used in seven out of the eleven cases (64%). The SCM was used in six patients, whereas a cervical strap muscle flap was used in one patient. The spinal plates were removed in four patients (36%) with delayed presentation in whom spinal fusion had already occurred in the postoperative period. Only two patients had their migrating screws removed. The wound was left open in four patients (36%) for daily wound care. Two patients were treated conservatively by keeping him NPO, administering TPN, IV antibiotics, and wound opening accompanied by debridement, as there was only a small string-like leak on contrast esophagography.

The outcome was complete healing in 9 patients (82%). One patient experienced esophageal stenosis postrepair and was treated with multiple settings of laser photocoagulation in collaboration with the otolaryngology department. Patients were discharged after restoration via oral feeding after confirmation of esophageal healing via contrast esophagography or chest CT with oral contrast. The mean hospital stay was 45 ± 26.5 days (ranging from 25-120 days). Two patients who died (18%) were 48- and 23-year-old males. The first patient improved after 14 days of conservative management, in which the PEP was not repaired, and his cervical wound improved, with healthy granulation tissue. However, the patient developed ventilator-associated pneumonia, sepsis and multiorgan failure and passed away 24 days after PEP diagnosis. The other patient was quadriplegic with hoarseness of voice and presented seven years after trauma and spinal fixation with odynophagia, repeated shock and recurrent chest infection. Endoscopy revealed migration of the plate and screws into the posterior wall of the esophagus (Figure 1). Surgical repair of the esophagus with an SCM flap was performed. A repeat contrast esophagogram at ten days after surgical repair revealed persistent leakage, and the patient developed severe infection with multidrug-resistant Acinetobacter. Clinical deterioration in the form of multiorgan failure and death occurred 93 days after repair.

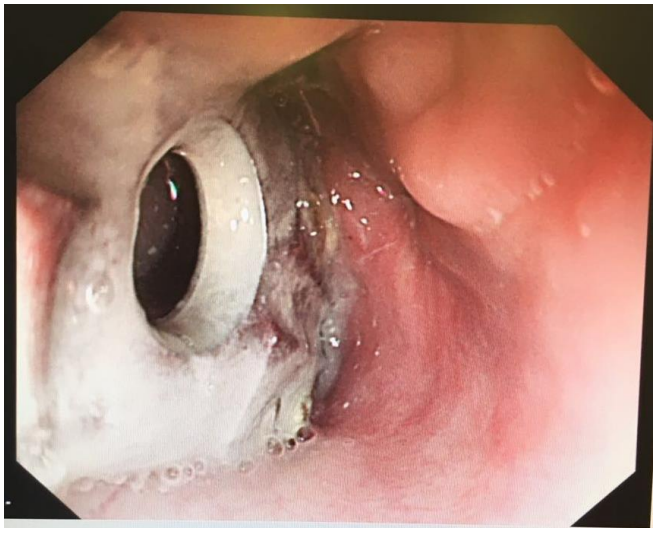

Figure 1: Endoscopic image of a patient with an esophageal perforation at C6–C7

Discussion

Esophageal perforation following anterior cervical discectomy and fusion (ACDF) is a rare but potentially life-threatening complication, associated with a poor prognosis and a mortality rate ranging from 16% to 50%, depending on the timing of diagnosis and treatment [15, 16]. This condition can lead to serious complications, such as mediastinitis, and infection of deep neck spaces. The timing of esophageal perforations may be intraoperatively, perioperatively, or even many years after surgery. Erosions of the pharyngeo-esophagus have been reported up to 9 years after spinal surgery [7, 8]. However, this incidence includes perforations sustained during surgery, which can result from traumatic exposure, ischemic necrosis due to pressure from surgical instruments, or accidental injury from these instruments. Instrument failure can expose sharp edges, leading to esophageal tears [8].

The literature indicates that most esophageal perforations are identified during surgery or early postoperative [17]. Fountas and colleagues reviewed 1,015 ACDF surgeries at their institution and reported three cases of esophageal perforation (0.3%), two of which were recognized intraoperatively. The third case was diagnosed on postoperative day two and was managed with primary repair, followed by irrigation and debridement of the mediastinum [18]. Patel and

collaborators analyzed the prevalence of esophageal perforations in 3,000 patients who underwent ACDF by five surgeons over 30 years, reporting only three cases (0.1%), all diagnosed during the immediate postoperative period.

Recently, several reports have highlighted delayed presentations of esophageal perforations. Causes such as hardware migration and irritation have been noted, with many delayed presentations occurring within the first 18 months post-surgery. However, some cases have been documented many years after the initial procedure. Gazzeri and associates [19] described a case where a screw migrated and caused a perforation 11 years after ACDF. They reported that the initial screw was removed, leading to complete expulsion into the digestive tract within just 6 days. Although uncommon, there are other cases of patients presenting years later; for example, Kim and colleagues reported an esophageal perforation developing 8 years after ACDF [20]. Lu, Tian, and Solerio noted perforations occurring 7 years postoperatively [13, 21, 22], while Woolley reported one at 5 years [23]. In our cohort, only two patients presented during the early postoperative period: one exhibited cervical swelling and was discharged on the 4th postoperative day, while the other reported dysphagia, cervical pain, and swelling 16 days after ACDF. Three additional patients had delayed presentations, occurring at 1-, 2-, and 7-years post-operation, with symptoms including repeated chest infections, odynophagia, and dysphagia.

The clinical presentation can vary significantly based on the timing and cause of the injury, and the patients can be asymptomatic or present with dysphagia, odynophagia, subcutaneous emphysema, cervical abscesses, and severe symptoms like mediastinitis, pneumonia, and septic shock [13, 24]. This necessitates a high level of suspicion for early diagnosis and prompt treatment. Yee and Terry [25] reported an asymptomatic patient who, three months post-surgery, was found to have a missing screw in the anterior cervical construct on a radiograph; further imaging revealed the screw in the intestinal tract. Similarly, Pompili and colleagues [26] described an asymptomatic patient who presented one year after the procedure with a screw that have migrated into the gastrointestinal tract. Such cases are rare, as most patients exhibit one or more symptoms related to local tissue trauma and infection.

X-rays may reveal free air, pneumothorax, pneumomediastinum, or pleural effusion, presenting indirect signs of perforation. The radiological findings may appear normal in the early phase post-procedure [27]. A contrast esophagogram can help delineate the location and extent of the fistula, although it has a false-negative rate of up to 25% [12, 28]. Contrast neck–chest CT is considered the "gold standard" for imaging due to its 92–100% sensitivity in detecting gastrointestinal fistulas, in addition to assessing spinal stability and fixation devices [27]. Endoscopy is not considered as a first-line diagnostic tool because it can exacerbate perforation; however, some authors advocate for intraoperative endoscopy to identify the perforation site [12]. In our cases, neck and chest X-rays suggested perforation in five patients; two had screw displacement, one had subcutaneous emphysema, one showed a soft tissue shadow, and one exhibited multiple air-fluid levels. Contrast CT scans of the neck and chest were performed in all patients, successfully diagnosing perforation in nine of them (90%). In one patient, who presented 51 days after ACDF with cervical subcutaneous emphysema, the CT scan was inconclusive. Esophagoscopy was performed in two patients, failing to reveal perforation in one; this patient was later diagnosed through contrast esophagography, which showed a string-like contrast leak at the hypopharynx.

The treatment of esophageal perforation remains controversial, with no clear guidelines or consensus on a treatment policy. Conservative management is recommended for small, early-recognized perforations with well-contained leaks and no signs of septicemia [29-31]. This approach includes complete prohibition of oral intake for at least 7 days, administration of broad-spectrum antibiotics, use of prokinetic agents (such as cisapride and metoclopramide), and feeding via nasogastric tube or jejunostomy.

Patients exhibiting oral thrush or whitish plaques on mucosa during endoscopy should receive antifungal treatment. Those at risk for esophageal candidiasis, including immunocompromised patients, those with HIV, and chronic proton pump inhibitor users, should also receive intravenous antifungal medications [32]. Unfortunately, approximately 20–25% of conservatively treated patients develop abscesses, with an associated mortality rate of 18% [33, 34]. Therefore, surgical intervention is often considered the gold standard for closing the perforation, controlling infection, and stabilizing the cervical spine when necessary [34]. Techniques include double-layer or imbricating sutures, reinforced with muscle flaps from the sternocleidomastoid, pectoralis major, or longus colli [35, 36]. In our cohort, repair of the perforation was attempted in all nine patients, supported by frequent wound care, broad-spectrum IV antibiotics, NPO status, and adequate feeding through alternative routes.

The implications of this study highlight significant considerations for the management of PEPs following anterior cervical discectomy and fusion. The findings underscore the importance of vigilance in monitoring for PEPs, which can present days, months, or even years after surgery, often leading to severe complications such as infections, dysphagia, and even death. The study emphasizes that surgical trauma and device migration are critical risk factors, suggesting that improved surgical techniques, such as careful retractor placement, may help reduce the incidence of these injuries. Moreover, the outcomes indicate that a multidisciplinary approach is essential for effective management, involving neurosurgeons, ENT specialists, and other healthcare professionals to tailor treatment based on individual patient needs. The high rate of successful repairs (82%) underscores the potential for positive outcomes if PEPs are identified and managed promptly. However, the mortality rate, particularly associated with complications such as ventilator-associated pneumonia and multiorgan failure, highlights the need for enhanced postoperative care and monitoring protocols. Overall, this study contributes to the understanding of PEPs in cervical spine surgery, advocating for continued research and improved clinical practices to mitigate risks and enhance patient safety.

Conclusion

As esophageal injury related to anterior cervical discectomy and fusion surgery is uncommon and may occur long after spinal surgery, a high index of suspicion plays a role in early diagnosis and consequently early initiation of appropriate treatment and better outcomes. Treatment should be tailored in each case, depending on the time from perforation to diagnosis, the morphology and the etiology of the perforation. Supportive measures, such as feeding, are as important as surgical repair.

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