

Review article

Pharyngeal perforations after anterior cervical spinal procedures: A systematic review

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ABSTRACT

Background: Digestive system perforations after anterior cervical spine surgery (ACSS), if left untreated, are life-threatening. These injuries are often categorized as pharyngoesophageal. Although the pharynx and esophagus are continuations of each other, they are two distinct anatomical structures. There is limited experience in managing patients with pharyngeal injuries after ACSS.

Methods: Using PRISMA guidelines, a PubMed search was conducted on the iatrogenic pharyngeal perforations after ACSS for the treatment of disc herniation and degenerative cervical myeloradiculopathy.

Results: A total of 12 patients met our inclusion criteria. Eleven were from published studies, and one was our patient (2 female and 10 male, mean age = 56.25 years, range: 31–82 years). Clinical symptoms of patients with iatrogenic pharyngeal perforation after ACSS varied depending on whether the cases present early or late after surgery. Although clinical symptoms suggested a pharynx or esophageal injury, definitive diagnosis was challenging. All cases diagnosed either early or late after ACSS underwent surgical repair treatment, except for one case managed conservatively with antibiotics and nasogastric feeding. The overall outcome was favorable for all patients. However, the postoperative follow-up duration was not specified in two cases. In the remaining 10 cases, postoperative follow-up durations were generally short and varied significantly (mean = 4.87 months, median = 1.75 months, range: 1 week–24 months).

Conclusion: Iatrogenic pharyngeal injuries resulting from ACSS are extremely rare. They are relatively straightforward to diagnose and can be managed with a multidisciplinary approach. However, their long-term prognosis remains unknown.

Abbreviations: ACSS, anterior cervical spine surgery; DCM, degenerative cervical myeloradiculopathy; PRISMA, preferred reporting items for systematic reviews and meta-analyses; CT, computed tomography.

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1. Introduction

Digestive system perforations after anterior cervical spine surgery, if left untreated, can be life-threatening, leading to complications such as feeding and breathing difficulties, cervical abscess, mediastinitis, and sepsis [1,2]. These injuries are often categorized as pharyngoesophageal or simply esophageal injuries [3–8]. A study analyzing more than 3000 anterior cervical spine surgeries conducted over a 30-year period found an iatrogenic esophageal perforation rate of 0.1 % [9]. Another two-center retrospective study reviewing 1475 anterior cervical spine surgeries over a nine-year period reported an iatrogenic pharyngoesophageal perforation rate of 0.2 % [10]. The use of the term “pharyngoesophageal” creates anatomopathological confusion. Although the pharynx and esophagus are continuations of each other, they are two distinct anatomical structures.

However, digestive tract perforations, where the anatomical site of injury is specifically identified as the pharynx, have been reported much less frequently in the medical literature than esophageal perforations. The anatomical locations and morphological structures of the pharynx and esophagus are well-defined. The laryngopharynx (hypopharynx), which is susceptible to injury in anterior cervical spinal procedures, extends from the upper borderline of the epiglottis to the lower level of the cricoid cartilage and is located at the C4–C6 vertebral levels [11]. Below the lower border of the cricoid cartilage, the digestive system continues as the cervical esophagus. Unlike other parts of the digestive tract, the wall of the pharynx consists mainly of external circular and internal longitudinal muscle layers, whereas the esophagus has the opposite arrangement [11]. The pharynx is 1.5–5 cm wide depending on the cervical level, whereas the esophagus has a slit-like lumen when empty [11].

There is limited comprehensive experience in managing patients with pharyngeal injuries after anterior cervical spinal surgical approaches, largely due to scarce publications on the subject. While human error is inevitable, it is crucial to minimize and effectively manage it. The purpose of this systematic review study is to provide information that will help identify key factors for improving patient outcomes in cases of iatrogenic pharyngeal injuries resulting from anterior cervical spinal approaches in the treatment of disc herniation and degenerative cervical myeloradiculopathy (DCM).

2. Methods

This study investigated the clinical features, treatments, outcomes, and prognosis of iatrogenic pharyngeal injuries in anterior cervical spine surgeries performed for disc herniations or degenerative cervical myeloradiculopathies (DCMs). Using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines, a comprehensive PubMed search was conducted on March 20, 2024, using the following query:

(((((Pharyngoesophageal perforation) OR (pharyngoesophageal injury)) OR (pharyngeal injury)) OR (pharyngeal perforation)) OR (pharynx injury)) OR (pharynx perforation)) AND (((anterior cervical spine surgery) OR (discectomy)) OR (corpectomy))

Only cases of iatrogenic pharyngeal injuries resulting from anterior cervical spine surgeries such as discectomy or corpectomy, with or without implants, aimed at treating cervical disc herniations and DCM were included in the study. The exclusion criteria encompassed cervical trauma cases, tumors, posterior cervical spine surgeries, isolated esophageal perforations, pharyngeal injuries due to

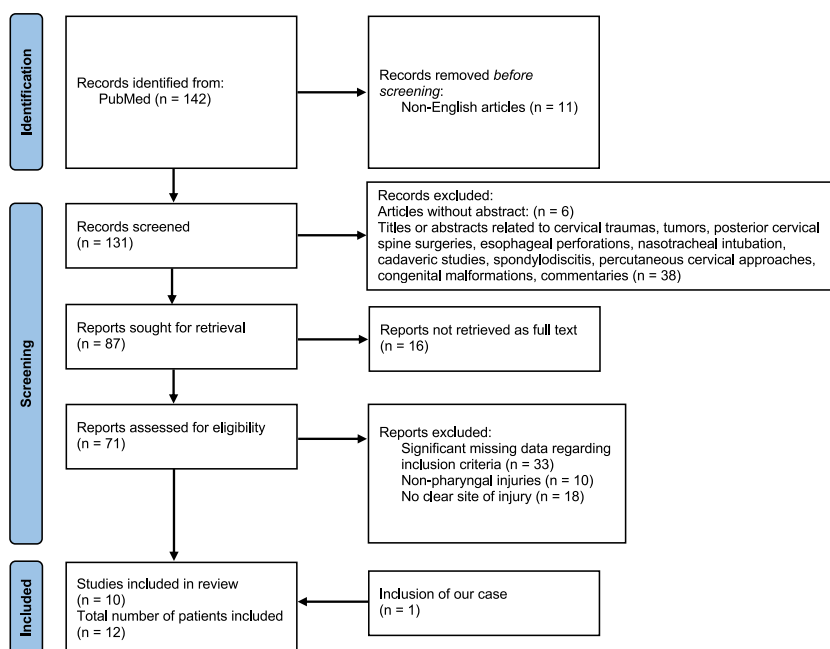


Fig. 1. Flow chart showing identification and inclusion of studies.

nasotracheal intubation, percutaneous cervical approaches, and congenital malformations. There was no time restriction on the studies screened, but those not published in English or whose full text was unavailable were excluded. Inclusion criteria specifically omitted studies that lacked sufficient data for analysis or did not explicitly identify the injury site as the pharynx, referring instead to a generalized “esophagopharyngeal” area. The process for identification and inclusion of studies is illustrated in Fig. 1. Informed consent was obtained from our patient included in this review. This study was not registered with PROSPERO. Ethics committee approval was not required for this retrospective study, as it solely analyzed events of interest that had already occurred or been published.

3. Results

3.1. Demographic characteristics of studies and patients

A total of 12 patients met our inclusion criteria [1,2,12–19]. Eleven were from published studies, and one was our patient (Table 1, Figs. 2 and 3). All previously reported studies were either case reports or case series published after the beginning of the 21st century. Of these studies, only five were published in journals specifically dedicated to neurosurgery, while the others appeared in journals focusing on otolaryngology, spine, or clinical neuroscience. Among the patients, two were female and 10 were male, with an average age of 56.25 years (ranging from 31 to 82 years). Seven patients diagnosed with a herniated disc underwent anterior cervical discectomy and fusion surgery, where implants were used. In one patient, a pharyngeal injury was identified during the exposure phase of the surgery, leading to the repair of the defect and the postponement of the discectomy to a later date. The remaining four cases, including our own, which were diagnosed with DCM or spinal stenosis, underwent multiple cervical discectomies or corpectomy, followed by fusion using implants.

3.2. Clinical manifestations

Clinical symptoms of iatrogenic pharyngeal injury from anterior cervical spinal surgery in patients with degenerative myelod- adiculopathy varied depending on whether the cases present early or late after surgery. Therefore, we categorized the cases into three groups based on the timing of injury discovery: “intraoperative” (noticed during the surgery), “early” (presented within the first 30 days post-surgery), and “delayed” (presented more than one month later). In one patient, the pharynx injury was detected intra-operatively [1]. Symptoms of pharyngeal injury manifested in the early period in six cases. In one of these cases, difficulty in breathing, neck swelling, and cracking on palpation were observed 1 h post-surgery [13]. In the remaining five cases, including our case, symptoms including anterior neck swelling, dysphagia, dysphonia, pharyngocutaneous fistula, odynophagia, and/or sore throat appeared on the second day post-surgery [12,15,16,18]. In five of the 12 patients, symptoms appeared at a delayed period after anterior spinal surgery, namely, 7.5 years later, on average (range 4–10 years) [2,14,17,19]. The symptoms in these delayed cases typically persisted and included dysphagia, coughing and choking during swallowing, odynophagia, neck pain, and/or dysphonia, with difficulties predominantly occurring with liquids rather than solids.

3.3. Diagnosis

Although clinical symptoms can suggest a pharynx or esophageal injury, definitive diagnosis is challenging. Non-contrast computed tomography (CT) revealed free air in the soft tissue of the neck in three patients, including our own. In one case, free air was also visible over the muscles adjacent to the posterior wall of the pharynx. Esophagography using oral barium contrast material diagnosed a pharyngotracheal fistula in one patient, detected pseudodiverticula in another, and showed barium extravasation from the pharynx in a third case. CT scans with oral iohexol contrast revealed leakage from the pharynx in two cases. Rigid or flexible esophagoscopy was instrumental in directly visualizing the pharyngeal defect and implant materials through the defect site in five cases. In one patient, while direct esophagoscopy failed to locate the injury, the diagnosis was made through esophagography with oral barium contrast.

3.4. Treatment

All cases diagnosed either early or late after anterior spinal surgery underwent surgical treatment, except for one case managed conservatively with antibiotics and nasogastric feeding. Surgical treatments using anterior cervical or transoral approaches, with or without the help of an endoscope, were often performed in collaboration with an otolaryngologist or thoracic surgeon. In some cases, primary closure of the injury site, for example, with stitches using 4/0 monocryl, was sufficient. However, in three patients, the repair of the defect site was further reinforced with a myofascial flap. In addition to repairing the pharyngeal injury sites in two cases, implants inserted during the initial anterior cervical decompression surgeries were removed. Postoperatively, 10 out of 12 patients received nutrition via a nasogastric tube for periods ranging from 7 to 45 days, while two were able to eat orally. Intravenous broad-spectrum antibiotic and antifungal treatments were also administered to the patients.

3.5. Complications and outcomes

The overall outcome was favorable for all patients. However, the postoperative follow-up duration was not specified in two cases. In the remaining 10 cases, postoperative follow-up durations were generally short and varied significantly (mean = 4.87 months, median = 1.75 months, range: 1 week–24 months). One patient required blind esophageal dilatation due to persistent dysphagia after

Table 1

Characteristics of iatrogenic pharyngeal injuries from anterior cervical spine surgeries for disc herniations or degenerative cervical myeloradiculopathies (Those studies whose full text was unavailable were excluded).

Author Year	No	Age Sex	Primary diagnosis	Initial surgery	Time to diagnosis	Level	Diagnosis of injury	Anatomic injury site	Symptoms	Repairing surgery	Outcome Follow up (mo.)
Orlando et al. [1] 2003	1	54 F	Disc herniation	Discectomy (postponed)	Early	C4- C5	Intraoperatively	Hypo-pharynx	None	Primary defect suturing	Good 2
Woolley et al. [2] 2005	1	55 M	Disc herniation & ankylosing spondylitis	ACDF with implants	Delayed	C6- C7	Barium swallow	Hypo-pharynx	Sore throat, intermittent dysphagia and bad taste, halitosis	None. Conservatively with antibiotics and nasogastric feeds	Good ?
Rath et al. [13] 2010	1	72 M	Disc herniation	Discectomy & artificial disc implant	Early	C3- C5	Laryngoscopy and CT with oral contrast	Hypo-pharynx	Breathing difficulty, neck swelling, crackling on palpation	Anterior approach, debridement and repair of the defect	Good 3
Kuo et al. [14] 2010	1	58 F	DCM	ACDF with implants	Delayed	C4- C7	Barium esophagography Esophagoscopy	Pharyngo- esophageal junction	Coughing, choking when swallowing, Pharyngo-tracheal fistula	Removal of implant and primary defect suturing	Good 3
Wierzbicka et al. [15] 2013	1	56 M	Disc herniation	Discectomy	Early	?	Clinical only	Hypo-pharynx	Pharyngo-cutaneous fistula, sepsis	Anterior approach, Primary defect suturing & forearm flap	Good 1
Aslier et al. [16] 2015	1	31 M	Disc herniation	ACDF with implants	Early	C3- C4	Esophagoscopy	Pharynx	Odynophagia, Dysphagia, sore throat	Anterior approach, primary defect suturing & pedicled myofascial flap	Good 24
Kang et al. [17] 2017	1	55 M	Disc herniation	ACDF with implants	Delayed	C2- C5	Esophagoscopy	Pharynx	Odynophagia	Anterior approach, removal of implant	Good 0.25
Ozbek et al. [18] 2021	1	52 M	Disc herniation	ACDF with implants	Early	C3- C6	CT with oral and IV contrast	Hypo-pharynx	Pharyngo-cutaneous fistula	Anterior approach, primary defect suturing	Good 12
Armocida et al. [12] 2022	1	56 M	Disc herniation	ACDF with implants	Early	C4- C5	Esophagoscopy	Hypo-pharynx	Neck swelling, dysphagia, dysphonia	Transoral endoscopic, primary defect suturing	Good 1
Yahanda et al. [19] 2022	2	52 M	Spinal stenosis & ankylosing spondylitis	ACDF with implants	Delayed	C2- C5	CT	Pharynx	Dysphagia, neck pain	Anterior approach, primary defect suturing & implant removal	Good ?
		82 M	DCM	ACDF with implants	Delayed	C4- C7	CT	Pharynx	Dysphagia, dysphonia	Anterior approach, primary defect suturing & implant removal	Good 1.5
Our case 2024	1	52 M	DCM	Corpectomy& fusion with implants	Early	C4- C5	CT, Esophagoscopy	Hypo-pharynx	Pharyngo-cutaneous fistula	Transoral endoscopic, primary defect suturing & pedicled myofascial flap	Good 1

*Number of patients meeting the inclusion criteria. DCM: Degenerative cervical myeloradiculopathy, ACDF: Anterior cervical discectomy with fusion, CT: Computed tomography, mo.: month, F: female, M: male.

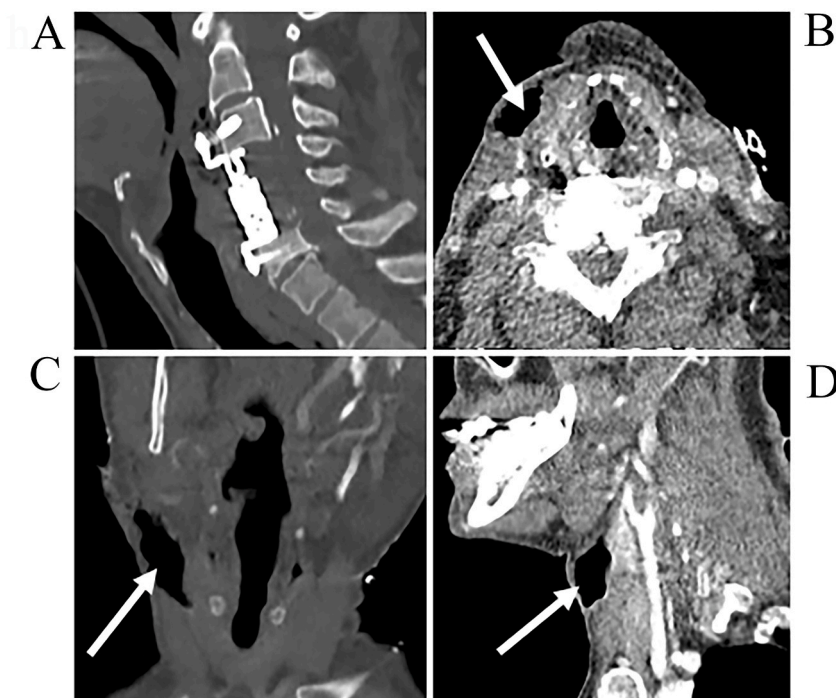


Fig. 2. Postoperative computed tomography images showing the implant (A) and subcutaneous air in axial (B), coronal (C), and sagittal (D) views.

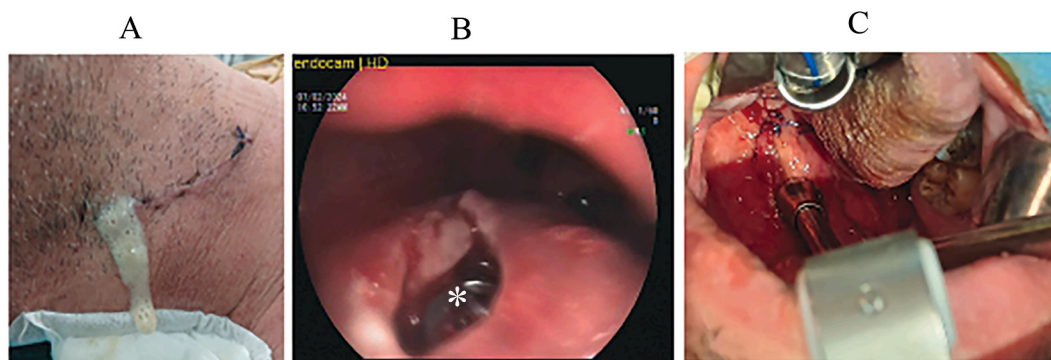


Fig. 3. Salivary discharge from pharyngocutaneous fistula resulting from pharyngeal perforation (A), esophagoscopic view of the perforated pharynx (B, asterisk), and transoral surgical repair of the injury (C,).

repair surgery. In another patient, a pseudopharyngocoele developed at the surgery site, but this was resolved with the application of an external pressure bandage for 4 days. In another patient, a follow-up barium study at three months post-surgery confirmed a sealed-off leak without evidence of a recurrent fistula.

4. Discussion

This study showed that iatrogenic pharynx injuries, although very rare, can occur in both the early or delayed periods following anterior cervical surgical procedures for the treatment of disc herniation and degenerative cervical myeloradiculopathy (DCM). One notable finding in this review is that, except for one case, pharyngeal injury was not detected during surgery. Although pharyngeal injuries are generally not detected during surgery; their diagnosis post-surgery is relatively straightforward, primarily due to symptoms such as dysphagia, and they can be treated effectively with a multidisciplinary approach. Although early outcomes after repair surgery are generally favorable, long-term follow-up results remain poorly understood. It should also be noted that if an injury to the digestive system is detected after anterior cervical spine surgeries, the injury site should be specifically determined as the pharynx or esophagus, which are different anatomical structures, in order to avoid anatomical confusion and plan appropriate treatment.

Reports indicate that anterior cervical procedures in the surgical treatment of DCM have more complications than posterior cervical

procedures [20]. The increased risk associated with anterior approaches to the cervical spine can be attributed to potential injuries to major structures of the vascular, neural, endocrine, respiratory, and digestive systems, including the carotid artery, vertebral artery, internal jugular vein, vagus nerve, hypoglossal nerve, cervical sympathetic trunk, accessory nerve, thyroid gland, parathyroid gland, larynx, trachea, pharynx, and esophagus [21–23]. Although pharynx and esophageal injuries are extremely rare following anterior cervical interventions for the treatment of cervical disc herniation or DCM, if overlooked and untreated, they are nearly always fatal [24].

The incidence of esophageal and pharyngeal perforations following cervical surgical interventions varies significantly across studies, largely due to differences in study design, scope, and methodology. However, the rates of pharyngeal or esophageal injuries are typically higher after surgeries for cervical tumors or trauma compared to those observed following procedures for cervical disc herniation or degenerative cervical myelopathy (DCM) [24]. Gaudinez et al. [6] reported 44 cases of esophageal perforation (1.49 %) in 2946 cases of cervical trauma. Lu et al. [25] reported 6 cases of esophageal injury in 1045 cases of anterior cervical surgery with unspecified diagnoses over a 10-year period; 5 of the cases with esophageal injuries were transferred from other centers. Thus, the incidence of esophageal injury in their series was 0.09 %. In a nationwide study, Marquez-Lara et al. [26] reported 11 cases of esophageal perforation (0.005 %) in 213,318 cases of elective anterior or posterior cervical spinal surgery for degenerative pathologies over a 9-year period. Interestingly, in their case population, esophageal perforation was statistically significantly more common in patients who underwent cervical total disc replacement. Newhouse et al. [27] conducted a survey of esophageal perforation cases after anterior cervical surgery within the cervical spine research societies and concluded that at least 22 cases of esophageal perforation occurred in 10,000 cases (0.22 %). Romano et al. [28] reported that only one case of esophageal injury (0.009 %) was encountered in 10,416 discectomies performed in 257 hospitals in one year. In summary, although there is a significant difference between the scope and methods of these studies, the frequency of esophageal perforation after cervical surgical interventions varies between 0.005 % and 1.49 %.

However, data on pharyngeal perforation after cervical surgical interventions are less reported. Tew et al. [29] reported one case (0.2 %) of pharyngeal injury in 500 anterior cervical surgical procedures over an 8-year period. In other words, according to the study by Tew et al., pharyngeal injury may occur in approximately 1 in 2500 anterior surgical procedures. However, Orlando et al. [1] reported a lower incidence of pharyngeal perforation. They identified 2 cases of pharyngeal injuries (0.18 %) and 3 cases of esophageal injuries (0.27 %) in 1075 anterior cervical surgeries over a 38-year period.

Although the causes of pharyngeal perforation in anterior cervical discectomy or corpectomy surgery for DCM are often unclear, they are predictable. Potential etiological factors include pressure or perforation due to instrumentation, dislocation of the graft, blunt trauma from retraction of the pharynx and esophagus, intubation for anesthesia, and anatomical variations of the patient [24]. The cause of pharyngeal perforation, particularly in delayed cases, may be related to ischemia due to the compression of the implant on the pharynx wall and the thickness of the pharyngeal wall. Indeed, an increase in the anterior-posterior distance of the retroparavertebral space, caused by prevertebral soft tissue edema due to surgical intervention, may lead to pressure and ischemia in the pharyngeal wall [30]. A cadaveric study identified individual differences in the thickness and size of the submucosal elastic laminae of the pharyngeal wall [31]. Another cadaveric study reported that the posterior pharyngoesophageal wall is thinnest in the median region at the level of the cricoid cartilage [32]. In another cadaveric study, the authors concluded that attention to the microsurgical anatomy of the anterior cervical fascial planes when performing an approach to the prevertebral space is vital to minimize iatrogenic damage to surrounding structures [33].

The potential causes of medical errors and harm are numerous and include inadequate training, time pressure, lack of equipment, physical and psychological factors, administrative problems, staff shortages, communication failures, anatomical variations in patients, and flawed reasoning [34,35]. The infrequent occurrence of serious surgical errors, automated processing of routine tasks, and use of heuristic methods may lead healthcare providers to oversimplify the situations, thereby overlooking the inherent possibility of iatrogenic pharyngeal or esophageal injuries. The most important element in reducing human error and managing it effectively when it occurs is maintaining situational awareness and employing analytical thinking.

The reports included in this review do not specify whether the surgeries were performed by trainees or specialists, making it difficult to determine whether the experience or training level of the surgeon affects the incidence of pharyngeal injuries. It is only noted that the operation in our case was performed by a specialist with the assistance of a neurosurgery resident. While some studies suggest that surgeries performed by surgical trainees under supervision yield results comparable to those performed by fully trained surgeons, others indicate a higher risk of serious complications, reoperations, and infections, as well as longer hospital stays, in surgeries performed by trainees [35].

The present study aligns with previous research in showing that while endoscopy of the hypopharynx and esophagus is the preferred method for diagnosing dysphagic patients, traditional barium radiography or videofluoroscopy is more effective in diagnosing pharyngeal injuries [36]. Management of patients with pharyngeal or esophageal perforations should be handled by a multidisciplinary team, including neurosurgeons, spine surgeons, orthopedists, gastroenterologists, otolaryngologists, head and neck surgeons, thoracic surgeons, and intensive care unit physicians and should be tailored to individual patients. The impact of conservative treatment occasionally applied to asymptomatic cases with small perforations is challenging to assess due to the rarity of such cases. Conservative treatment may include parenteral nutrition or feeding via nasogastric tube, jejunostomy, or percutaneous endoscopic gastrostomy, followed by long-term intravenous broad-spectrum antibiotic therapy and close observation [24]. Indeed, surgical treatment, which can be performed via a transoral route using an endoscope or through an anterior cervical spinal approach, is highly recommended [12,19,37]. This includes primary closure with sutures, reinforcement using muscles such as the longus coli, sternocleidomastoid, or latissimus dorsi, or an omental free flap, followed by feeding via nasogastric tube or gastrostomy and administration of broad-spectrum nutrition antibiotics until the injured area has completely healed [14,16,24].

The most common complications following pharyngeal reconstruction include strictures, pharyngocutaneous fistulas, and diverticula [38,39]. Postoperative strictures in the hypopharynx are rare, typically occurring in circumferential repair areas or distal repair zones where the hypopharynx is narrower. These strictures can obstruct the lumen and facilitate the formation of diverticula and pharyngocutaneous fistulas. Consequently, temporary or ongoing dilations may be necessary to maintain the patency of the digestive canal in the presence of strictures. Pharyngocutaneous fistulas, on the other hand, can result in feeding tube dependency, strictures, and the need for additional surgeries. While the use of negative pressure dressing systems to manage fistulas has been described, their application in the neck region is challenging. Salivary bypass stent or tubes have also been proposed as a supportive measure. Ultimately, the most effective strategy to prevent strictures and fistulas is meticulous surgical technique to avoid pharyngeal injury.

The timing for initiating oral feeding in patients following hypopharyngeal reconstruction varies significantly. Most surgeons recommend a waiting period of 7–10 days before commencing oral intake, provided there is no evidence of a pharyngocutaneous fistula [38,39]. Some researchers advocate for the routine use of contrast esophagrams, utilizing gastrografin or barium, to detect occult fistulas prior to reintroducing an oral diet. The presence of pharyngocutaneous fistulas markedly extends hospitalization, necessitates alternative feeding methods such as nasogastric tubes, parenteral nutrition, or gastrostomy tubes, and can delay the resumption of oral feeding by several weeks or even months. The hospital stay is significantly longer in patients with free extravasation of contrast material beyond the pharyngeal wall and contamination of adjacent structures, including the mediastinum or neck, compared with patients without significant contrast extravasation from the perforation site [40].

4.1. Limitations

Even if the PRISMA guidelines are followed, selection bias or publication bias may be present in any review study. Our understanding of iatrogenic pharyngeal injuries resulting from anterior cervical surgeries for the treatment of disc herniation and DCM is based on a limited number of published cases with favorable outcomes. It is widely recognized that cases with poor outcomes are often underreported. It is also possible that some patients may have recovered spontaneously without detection or may have died without a diagnosis.

5. Conclusion

Iatrogenic pharyngeal injuries resulting from anterior cervical surgical procedures for the treatment of disc herniation and DCM are extremely rare. They are relatively straightforward to diagnose and can be managed with a multidisciplinary approach. However, their long-term prognosis remains unknown.

CRediT authorship contribution statement

Baha Eldin Adam: Writing – review & editing, Data curation. **Osman Kılıç:** Writing – review & editing, Data curation. **Selma Bozcan:** Writing – review & editing, Data curation. **Mehmet Ali Kahraman:** Writing – review & editing, Data curation. **Abdullah Talha Şimşek:** Writing – review & editing, Data curation. **Fatih Çalış:** Writing – review & editing, Data curation. **Ahmet Mutlu:** Writing – review & editing, Data curation. **Naci Balak:** Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Ethical issues

Ethics committee approval was not required for this retrospective study, as it solely analyzed events of interest that had already occurred or been published. The review study was conducted in accordance with the Declaration of Helsinki for experiments involving human participants. Although all data was anonymized, informed consent was obtained from the patient.

Generative artificial intelligence

No generative artificial intelligence (AI) or AI-powered technologies were used in the writing process.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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