

# Esophageal perforation after anterior cervical surgery: a review of the literature for over half a century with a demonstrative case and a proposed novel algorithm

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## Abstract

**Purpose** To review relevant data for the management of esophageal perforation after anterior cervical surgery.

**Methods** A case of delayed esophageal perforation after anterior cervical surgery has been presented and the relevant literature between 1958 and 2014 was reviewed. A total of 57 papers regarding esophageal perforation following anterior cervical surgery were found and utilized in this review.

**Results** The treatment options for esophageal perforation after anterior cervical surgery were discussed and a novel management algorithm was proposed.

**Conclusion** Following anterior cervical surgery, patients should be closely followed up in the postoperative period for risk of esophageal perforation. Development of symptoms like dysphagia, pneumonia, fever, odynophagia, hoarseness, weight loss, and breathing difficulty in patients with a history of previous anterior cervical surgery should alert us for a possible esophageal injury. Review of the literature revealed that conservative treatment is advocated for early and small esophageal perforations. Surgical treatment may be considered for large esophageal defects.

**Keywords** Algorithms · Esophageal perforation · Anterior cervical surgery · Abscess · Spinal fusion

## Introduction

The anterior approach to cervical spine for treatment of spinal diseases has been well established and considered as a standard procedure, which was first introduced by Cloward and Smith-Robinson in 1958 [1, 2]. However, anterior cervical surgery is not without complications [3–5]. One serious complication of this operation is esophageal perforation [4, 6, 7].

Esophageal perforation after anterior cervical spine surgery is an uncommon, but well recognised and a potentially life-threatening complication. The incidence of esophageal injuries ranges from 0.3 to 4 % [8, 9]. Most of the perforations tend to appear preoperatively related to direct iatrogenic injury and diagnosed in the early postoperative period [5, 9, 10]. Delayed perforations usually occur due to chronic compression of prominent hardware [8, 10, 11]. The most common symptoms after esophageal perforation are dysphagia, pneumonia, fever, odynophagia, hoarseness, and breathing difficulty while less common ones are chest pain, weight loss and gastrointestinal bleeding [4, 8, 9, 12]. Asymptomatic esophageal perforations are also reported [5]. Early diagnosis and appropriate treatment of esophageal perforations are very important to prevent any morbidity and mortality.

There are various treatment strategies for esophageal perforation such as conservative treatment or surgical approaches. To date, there is no definitive treatment algorithm for esophageal perforation after anterior cervical surgery. We present a case of delayed esophageal perforation after anterior cervical surgery. We also reviewed the

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English literature between 1958 and 2014 and discussed the treatment options of esophageal perforation after anterior cervical surgery. We propose a management algorithm in esophageal perforation after anterior cervical surgery.

## Materials and methods

In this paper, the English literature was reviewed for esophageal perforation related to the anterior cervical surgery. A detailed electronic search was carried out using the medical subject headings (MeSH) term “esophageal perforation” in the MEDLINE and PubMed databases for studies published from January 1958 to December 2014. Fifty-seven papers were found to be related with esophageal perforation following anterior cervical surgery. The related papers were evaluated according to the type of anterior cervical surgery before esophageal perforation, timing of diagnosis, size of perforation, treatment option (conservative or surgical), duration and the result of treatment. A table is prepared which summarizes the reviewed cases (Table 1) [4, 5, 7–11, 13–47]. Primary suturing of esophageal defect with or without flap was considered as surgical treatment, and other surgical and endoscopic interventions like drainage of abscess, esophageal stent application were regarded as conservative surgery and not mentioned in the table. A total of 43 papers including our case were depicted in the table. Fifteen papers regarding esophageal perforation after anterior cervical surgery were not included in the table due to a lack of detailed explanation of the treatment process, patient information or treatment results. In 5 of the 43 selected papers, only those patients who had adequate information about esophageal perforation following anterior cervical surgery were included in the table.

## Case

A 40-year-old female patient had been operated 12 years ago for a C6 vertebral fracture due to a traffic accident. Following anterior surgical decompression with C6 corpectomy, stabilization and fusion of the C5–7 segment was achieved with the autogenous bone graft and anterior plate system.

The patient admitted with complaints of dysphagia and weight loss continuing for 3 months. Neurological examination revealed pain and hypoesthesia related to right C5 root dermatome. On X-ray imaging, there was a plate and screw malposition, and a solid fusion was visible between the C5 and C7 vertebral segments (Fig. 1a). On cervical magnetic resonance imaging (MRI), an adjacent level disc herniation at C4–5 level was detected. On esophagogram

with barium, anterior plate contact with esophagus was observed (Fig. 1b). Computerized tomography (CT) showed osteophytic changes between C5 and C7, and a fusion between C5 and C7 vertebrae was determined. The endoscopic examination confirmed the diagnosis of the 2-cm esophageal perforation which was caused by the cervical plate, thus the patient was operated upon these findings.

Plate invasion into esophagus was confirmed during operation (Fig. 2a), and the anterior plate was removed. The perforated part of the esophagus was primarily sutured in collaboration with thoracic surgeons. After the edges of the perforation were debrided, esophageal tear was sutured with absorbable interrupted stitches. The suturing was done in a tension-free way to avoid secondary stricture of the esophagus. There was no late stricture and no need for endoscopic dilatation after the suturing of the esophagus. A soft wound drain was placed between esophagus and the vertebrae for drainage of any esophageal leakage. The additional C4–5 discectomy and peek cage fusion were also performed due to adjacent level disease. The posterior stabilization was performed after anterior surgery. In the postoperative period, the patient was started with nasogastric (NG) feeding. Wide spectrum intravenous antibiotic treatment consisting of metronidazole, teicoplanin and meropenem was administered for 6 weeks. On the fifth postoperative day, an extensive drainage from the incision site was observed (Fig. 2b). Although the patient did not have any fever or any signs of septicemia, and was treated conservatively for 4 weeks with a drainage catheter, NG feeding and broad spectrum antibiotics, the leakage persisted. An esophageal fistula was finally discovered at the end of fourth week after several endoscopic examinations. The esophageal fistula was repaired with endoscopic plastic stent application by ENT surgeons. Conservative treatments with NG feeding and wide spectrum antibiotics were also continued. After the first postoperative day the spit discharge of the fistula draining to the skin terminated. The wound drain was removed and the patient was started with oral feeding 1 week after endoscopic stenting. NG tube was removed 2 weeks after stenting. After 4 weeks, esophageal stent was removed and a spontaneous recovery was confirmed with endoscopic examination. The patient was discharged 6 weeks after the endoscopic intervention without any dysphagia and with recovery of neurological symptoms. As of 1 year follow-up, the patient is in good condition and symptom-free; therefore no endoscopic follow-up exams were needed.

## Discussion

Esophageal perforations were classified as “early” if diagnosed within 1 month after the operation and “late” if diagnosed after the first month [48, 49]. The most delayed

**Table 1** Summary of literature review for esophageal perforation following anterior cervical surgery between 1958 and 2014

References	Number of case	Surgical procedure before esophageal perforation	Timing of diagnoses/size of perforation	Conservative treatment as a first choice (duration)	Result of conservative treatment/ timing to start oral intake	Repairing surgery/ conservative treatment (duration)	Removed fixation or fusion material during esophageal perforation treatment	Status of fusion during esophageal repair	Supplementary stabilization during esophageal perforation treatment/kind	Result of surgical treatment/ timing to start of oral intake
Benazzo et al. [13]	3	C + ACP	Early (2 days)/5 cm	NG (3 months) with ATr (10 days)	Not healed	PSI with SCM flap/ATr and NG (16 days)	No	No	No	Healed/ 16 days
		ACD + PC	Early (3 days)/3 cm	NG and ATr (30 days)	Not healed	PSI with SCM flap/jejunosomy (27 days)	No	No	No	Healed/ 27 days
		ACD + PC	Early (6 days)/3 mm	NG and ATr (38 days), HBO (3 days)	Not healed	PSI with SCM flap/NG (11 days)	No	No	No	Healed/ 11 days
		C + ABG	Late (47 days)/NA	No	–	FO: PSI/gastrostomy (NA) with ATr (NA) SO: PSI/gastrostomy (7 Months) with ATr (NA)	No	No	Yes/PS	Not healed Healed/7 Months
Whitehill et al. [15]	1	C + ABG	Late (40 days)/1 cm	No	–	PSI/gastrostomy (46 days) with ATr (NA)	ABG	No	Yes/PS	Healed/NA
		C + ABG	Late (10 weeks)/NA	No	–	PSI/NG (1 week) with ATr (2 weeks)	No	No	No	Healed (1 week)
		ACD + ABG + ACP	Late (recurrence in 6 weeks after operation)/NA	NG and ATr (6 weeks)	Healed/ 6 weeks	No	–	–	–	–
		ACD + ABG + ACP	Late (7 year)/NA	No	–	PSI/NG (1 week)	ACP	Yes	No	Healed/ 1 week
Amhaz et al. [17]	1	C + PC + ACP	Late (4 months)/NA	No	–	PSI with SCM flap/NG (1 week)	ACP	NA	No <sup>a</sup>	Healed/ 1 week
Fountas et al. [18]	1	ACD + ACP + ABG	Late (16 months)/small tear	ATr and SOI (4 days)	Healed/4 days	–	ACP	Yes	No	–
Kim et al. [11]	1	C + ACP + ABG	Late (8 years)/NA	No	–	PSI/NG (3 weeks)	Yes <sup>b</sup>	Yes	No	Healed/ 3 weeks
Ardon et al. [8]	4	ACD + ACP + ABG	Early (1 month)/NA	ATr (NA) with PN (NA)	Died	No	ACP	No	No <sup>a</sup>	–
		C + ACP + ABG	Late (6 weeks)/NA	Long-term ATr and parenteral feeding (3 months)	Healed/ 4 months	No	ACP	No	Yes/CO	–
		ACP	Late (3 months)/NA	No	–	PSI/PN and ATr (2 months)	ACP	No	Yes/PS	Healed/ 6 weeks
		C + ACP + ABG	Early (6 days)/NA	No	–	PSI with SCM flap/PN and ATr (6 weeks)	ACP	No	Yes/CO	Healed/ 6 weeks

Table 1 continued

References	Number of case	Surgical procedure before esophageal perforation	Timing of diagnoses/size of perforation	Conservative treatment as a first choice (duration)	Result of conservative treatment/ timing to start oral intake	Repairing surgery/ conservative treatment (duration)	Removed fixation or fusion material during esophageal perforation treatment	Status of fusion during esophageal repair	Supplementary stabilization during esophageal treatment/kind	Result of surgical treatment/ timing to start of oral intake
Dakwar et al. [19]	5	ACD + ACP	Late (27 months)/NA	No	–	PSt with SCM flap/NA	ACP	Yes	No <sup>a</sup>	Healed/NA
		ACD + ACP	Late (24 months)/NA	No	–	PSt with SCM flap/NA	ACP	Yes	No <sup>a</sup>	Healed/NA
		C + ACP + PC	Late (7 months)/small tear	No	–	FO: PSt with PM flap/NA	ACP	No	Yes/New ACP	Not healed
						SO: reinsertion of the PM flap (3 weeks after FO)/NA	No	No	No	Not healed
Haku et al. [20]	1					TO: recloser with RF flap (3 months after SO)/NA	ACP	No	Yes/PS	Not healed
						FthO: removing of cage (8 months after TO)/NA	PC	Yes	No	Healed/NA
		ACD + ACP	Late (6 weeks)/NA	No	–	FO: PS/NA	No	No	No	Healed/NA
						SO: recloser with SCM flap (recurrence 18 months after FO)/NA	ACP	NA	No	Healed/NA
Reid et al. [21]	4	ACD + ACP	Late (6 years)/NA	No	–	PSt with SCM flap/NA	ACP	Yes	No	Healed/NA
		C + ABG	Early (1 day)/5 × 5 mm	No	–	PSt with LCM flap/NA	ABG	No	No <sup>a</sup>	Healed/21 days
		ACP	Intraoperative/3 cm	No	–	FO: PS/NA	ACP	No	No	Not healed
						SO: recloser with PM flap (1 week after FO)/NA	No	No	Yes/ABG	Healed/2 months
		ACP	Early (NA)/NA	No	–	PSt with PM flap/NA	ACP	No	No <sup>a</sup>	Healed/135 days
		ACP	Early (2 weeks)/NA	No	–	FO: PS/SOI with ATr (NA)	ACP	No	Yes/CO	Not healed
						SO: timing is unknown	No	No	No	
						TO: timing is unknown	No	No	No	
						FthO: recloser with free omentum flap (7 months after FO)/NA	No	Yes	No	Healed/10 days
		C + ACP	Early (NA)/1 cm	SOI with Atr (2 months)	Not healed	PSt with free omentum flap/NA	ACP	NA	No	Healed/56 days

Table 1 continued

References	Number of case	Surgical procedure before esophageal perforation	Timing of diagnoses/size of perforation	Conservative treatment as a first choice (duration)	Result of conservative treatment/ timing to start oral intake	Repairing surgery/ conservative treatment (duration)	Removed fixation or fusion material during esophageal perforation treatment	Status of fusion during esophageal repair	Supplementary stabilization during esophageal treatment/kind	Result of surgical treatment/ timing to start of oral intake
Hanci et al. [22]	3	C + ACP + ABG	Late (1 year)/NA	No	–	PS/NG (NA)	ACP	Yes	No	Healed/NA
		C + ACP + ABG	Late (47 days)/NA	PN with Atr (3 days)	Not healed	PS/NG (2 weeks)	ACP	Yes	No	Healed/ 2 weeks
		C + ACP + ABG	Late (2 months)/NA	Gastrostomy (17 weeks) with antibiotics (NA)	Healed/ 17 weeks	No	ACP	No	Yes/CO	–
Phommachanh et al. [23]	5	ACD + ACP + ABG	Late (6 weeks)/NA	No	–	PS/NA	No	Yes	No	Not healed
		C + ACP	Late (7 months)/NA	No	–	Recloser with SCM flap/ NA	ACP	Yes	No	Healed/ 3 weeks
		ACP + ABG	Late (2 years)/NA	No	–	PS/NG (2 weeks)	No	No	Yes/PS	Not healed
Pichler et al. [7]	1	ACP	Late (6 years)	No	–	PS/NG (2 weeks)	No	No	–	Healed/ 9 months
		C + ACP + TC	Late (4 months)/NA	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 4 weeks
		C + ACP + ABG	Late (7 years)/NA	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 4 days
Zairi et al. [24]	1	C + ACP + TC	Late (8 years)/4 cm	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
		C + ACP + ABG	Late (11 years)/NA	PN with Atr (7 days)	Healed/ 14 days	PS/NG (2 weeks)	No	No	No	Healed/ 4 weeks
		ACP	Late (2 months)/NA	Atr (6 weeks)	Not healed	PS/NG (2 weeks)	No	No	No	Healed/ 4 weeks
Gazzeri et al. [25]	1	C + ACP + ABG	Late (11 years)/NA	PN with Atr (7 days)	Healed/ 14 days	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
		ACP	Late (2 months)/NA	Atr (6 weeks)	Not healed	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
		C + ACP + ABG	Late (9 years)/NA	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
Korovesis et al. [26]	1	C + ACP + ABG	Late (9 years)/NA	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
		C + ACP + ABG	Late (9 years)/NA	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
		C + ACP + ABG	Late (9 years)/NA	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 2 weeks
Almre et al. [28]	1	C + ACP + ABG	Late (18 years)/3 cm	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 10 days
		C + ACP + ABG	Late (18 years)/3 cm	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 10 days
		C + ACP + ABG	Late (18 years)/3 cm	No	–	PS/NG (2 weeks)	No	No	No	Healed/ 10 days

Table 1 continued

References	Number of case	Surgical procedure before esophageal perforation	Timing of diagnoses/size of perforation	Conservative treatment as a first choice (duration)	Result of conservative treatment/ timing to start oral intake	Repairing surgery/ conservative treatment (duration)	Removed fixation or fusion material during esophageal perforation treatment	Status of fusion during esophageal repair	Supplementary stabilization during esophageal treatment/kind	Result of surgical treatment/ timing to start of oral intake
Bonavina, [29]	1	ACP	Late (1 year)	No	–	PS/NG (2 weeks)	No	NA	No	Healed/NA
Lu et al. [30]	1	C + ACP + ABG	Late (9 years)/NA	No	–	PS/NA	ACP	Yes	No	Healed/10 days
Finiels et al. [31]	1	ACP	Late (9 years)/NA	No	–	PSI with SCM flap/NG (10 days) with ATr (NA)	ACP	Yes	No	Healed/NA
Kintscher et al. [32]	1	C + ACP + ABG	Early(11 days)/NA	NG (31 days), ATr (NA)	Not healed	FO: PSI with fascia lata patch/NA SO: PSI with jejunal flap (3 months after FO)/PEG (6 weeks)	ACP	No	Yes/CO	Not healed
Lucas et al. [33]	1	ACP	Late (10 years)/NA	No	–	PS/PEG (NA), ATr (NA)	ACP	Yes	No	Died
Navarro et al. [34]	2	C + ACP + ABG	Late(10 months)/NA	No	–	PSI with SCM flap/NG (NA) with ATr (NA)	ACP + ABG	No	Yes/ABG + PS	Healed/23 days
Nourbakhsh et al. [35]	1	C + ACP + ABG	Late(4 months)/NA	NG (NA), ATr (NA)	Healed/119 days	No	ACP + ABG	No	Yes/ABG + PS	–
Orlando et al. [36]	5	C + ACP + ABG	Late (3 years)/NA	No	–	PS/NA	ACP	Yes	No <sup>a</sup>	Healed/NA
		ACD + ACP	Early (10 days)/NA	NG (1 month) with ATr (1 month)	–	PS/NG (NA) with ATr (10 days)	ACP + ABG	No	CO	Healed/NA
		ACD	Late(6 months)/NA	No	Healed/NA	No	ACP	Yes	No	–
		ACD	Intraoperative/small tear	No	–	PS/NG (10 days) with ATr (5 days)	No	No	No	Healed/NA
		ACD	Early (1 day)/5 mm	No	–	PSI with SCM flap/NG (6 days) with ATr (5 days)	No	No	No	Healed/NA
		ACD	Intraoperative/NA	No	–	PS/NG (NA) with ATr (NA)	No	No	No	Healed/NA
Patel et al. [37]	3	C + ACP + ABG	Early (1 day)/NA	NG (NA) with ATr (NA)	Healed/NA	No	ACP + ABG	No	YES/PS	–
		C + ACP + ABG	Early (3 days)/NA	No	–	PSI with SCM flap/NG (3 weeks) with ATr (NA)	NA	No	No <sup>a</sup>	Healed/NA
		ACD + ACP + ABG	Early (2 days)/small tear	NG (1 week) with ATr (1 week)	Healed/NA	No	ACP	No	No	–
Sahjpal et al. [4]	1	C + ACP + ABG	Early (4 days)/NA	No	–	PSI/gastrostomy (10 weeks) with ATr (6 weeks)	No	No	No <sup>a</sup>	Healed/10 weeks

Table 1 continued

References	Number of case	Surgical procedure before esophageal perforation	Timing of diagnoses/size of perforation	Conservative treatment as a first choice (duration)	Result of conservative treatment/ timing to start oral intake	Repairing surgery/ conservative treatment (duration)	Removed fixation or fusion material during esophageal perforation treatment	Status of fusion during esophageal repair	Supplementary stabilization during esophageal perforation treatment/ kind	Result of surgical treatment/ timing to start of oral intake
Shenoy et al. [38]	2	ACD + ABG	Late (4 weeks)/NA	NG (4 weeks) with ATr (4 weeks)	Healed/NA	No	ABG	No	No	–
		ACP	Early (3 weeks)/large defect	No	–	PSI with SCM flap/NG (12 weeks) with ATr (8 weeks)	ACP	No	No	Healed/ 12 weeks
Smith et al. [39]	1	C + ACP + ABG	Late (6 weeks)/NA	TPN (10 days) with ATr (NA)	Healed/ 14 days	No	ACP	Yes	No	–
Sun et al. [40]	1	ACD + ACP + ABG	Late (37 days)/NA	NG (18 weeks) and ATr (NA)	Not healed	No	ACP	No	CO	Healed/NA
Von Rahden et al. [10]	3	ACP + ABG	Late (3.5 years)/3 cm	No	–	Reconstruction with free jejunal loop/NA	Yes	Yes	No	Healed/NA
		C + ACP	Late (2 years)/2 cm	No	–	PSI/PEG (3 weeks)	ACP	No	PS	Healed/ 3 weeks
		ACP	Late (4 years)/4 cm	No	–	PSI/ATr (2 weeks)	ACP	Yes	No <sup>a</sup>	Healed/ 2 weeks
Vrounmaets et al. [9]	2	C + ACP + ABG	Early (1 day)/3 cm	No	–	PSi/NG (7 days) with ATr (7 days)	ACP	Yes	No	Healed/ 7 days
Witwer et al. [41]	1	C + ACP + ABG	Late (10 years)/NA	NG (NA) with ATr (NA)	Not healed	PSi/NA	ACP	Yes	No	Healed/NA
Zdichavsky et al. [42]	1	C + ACP + ABG	Late (4 years)/NA	No	–	PSi with SCM flap/NA	ACP	Yes	No	Healed/NA
Kim et al. [43]	2	C + ABG + ACP	Late (10 months)/NA	No	–	PSi with SCM flap/NA	ACP	No	PS	Healed/NA
		C + ABG	Late (4 months)/NA	NG (NA) with ATr (NA)	Healed/NA	No	No	No	No	–
		C + ABG + ACP	Late (5 weeks)/NA	NG (4 months) with ATr (4 months)	Not healed	PSi with SCM flap/NA	ACP	Yes	No	Healed/NA
Guarner-Argente et al. [44]	1	ACD + ACP	Late (3 years)/NA	PEG (4 weeks) with ATr (4 weeks)	Healed (4 weeks)	No	No	Yes	No	–
Harman et al. (this study)	1	C + ABG + ACP	Late (12 years)/2 cm	No	–	PSi/NG (6 weeks) with ATr (6 weeks)	ACP	Yes	PS	Healed/ 5 weeks
De Moore et al. [45]	2	ACP	Late (2 months)/>5 cm	No	–	PSi/gastrostomy (NA) with ATr (6 weeks)	ACP	No	NO	Healed/NA
		ACP	Late (3 years)/>5 cm	No	–	PSi/gastrostomy (NA) with ATr (6 weeks)	ACP	NA	No	Healed/ 2 weeks
Kau et al. [46]	2	ACP	Late (13 years)/3 cm	No	–	PSi with submental island flap/NG (7 weeks)	ACP	Yes	No	Healed/NA
		C + ABG + ACP	Late (1 year)/large	No	–	PSi with PM flap/NG (1 month)	ACP	Yes	No	Healed/ 1 month



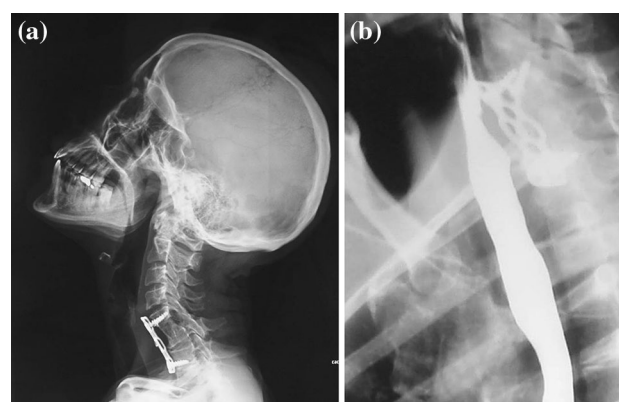
Table 1 continued

References	Number of case	Surgical procedure before esophageal perforation	Timing of diagnoses/size of perforation	Conservative treatment as a first choice (duration)	Result of conservative treatment/ timing to start oral intake	Repairing surgery/ conservative treatment (duration)	Removed fixation or fusion material during esophageal perforation treatment	Status of fusion during esophageal repair	Supplementary stabilization during esophageal treatment/kind	Result of surgical treatment/ timing to start of oral intake
Wierzbicka et al. [47]	2	ACP	Early (3 days)/NA	No	–	PSI/gastrostomy (84 days)	No	No	No	Not healed
						PSt with RF flap/NA	No	No	No	Healed/ 12 days
		ACD	Early (2 days)/NA	No	–	PSt with FA flap/NA	No	No	No	Healed/NA

*PSI* primary suturing, *SCM* sternocleidomastoideus, *PO* postoperative, *NG* nasogastric feeding, *ATr* antibiotic treatment, *HBO* hyperbaric oxygen therapy, *FO* first operation, *SO* second operation, *TO* third operation, *FthO* forth operation, *LCM* longus colli muscle, *PM* pectoralis muscle, *RF* radial forearm, *SOI* stopping oral intake, *PN* parenteral nutrition, *ACD* anterior cervical discectomy, *C* corpectomy, *ACP* anterior cervical plate, *ABG* autogenous or allogenic bone graft, *TC* titanium cage, *PS* posterior stabilization, *CO* cervical orthosis

<sup>a</sup> Posterior stabilization was attempted before esophageal perforation

<sup>b</sup> Only displaced screw removed not plate

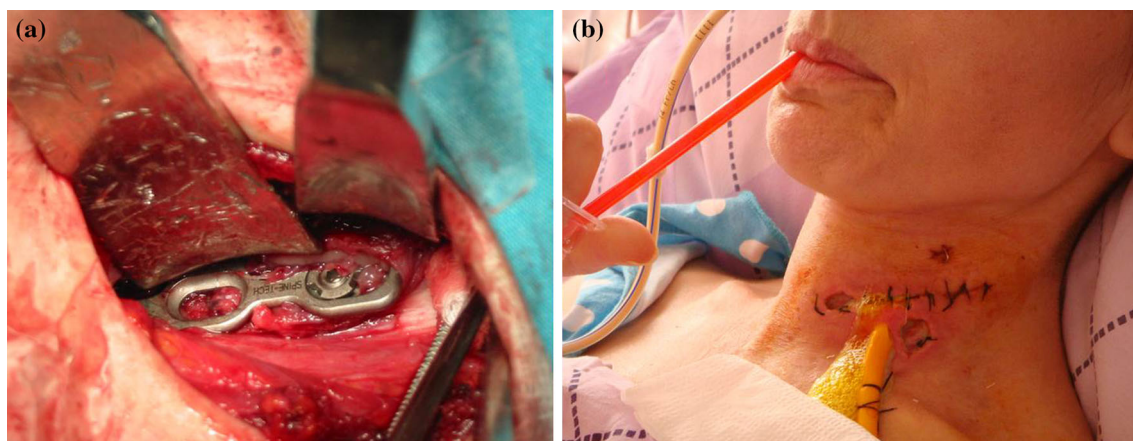


**Fig. 1** **a** Lateral X-ray film shows a solid fusion on the cervical spine and anterior implant dislocation. **b** Barium swallow, showing anterior plate contacted with esophagus

case of esophageal perforation was 18 years after anterior cervical surgery [28].

Early esophageal perforation after anterior cervical surgery is mostly caused iatrogenically due to inappropriate placement or dislodgement of sharp-toothed retractor blades in the esophagus. However, iatrogenic injury of the esophagus may be overlooked due to the narrow surgical area in anterior cervical surgery. Late esophageal perforation is mostly caused by chronic compression or contact and subsequent necrosis, abscess formation due to graft dislodgement or screw migration with or without plate failure [8, 10, 11, 13]. Reusing the same hardware for any revisional surgery when needed is not recommended because this may cause esophageal perforation due to easier plate or screw extrusion. Replacing of the hardware has been suggested to reinforce the fixators and to avoid extrusion [50]. Dislodgement of a bone graft may be easier without the use of cervical plate in anterior cervical surgery which may increase the risk of esophageal injury [15, 20]. However, an inappropriately placed cervical plate or dislodged screw and plate may also increase the risk of esophageal injury [8, 11, 13, 16, 18, 19, 21, 22]. Cervical trauma may be a predisposing factor for hardware dislodgement after surgery [51]. In some cases, even without any dislodgement of the cervical plate, chronic pressure necrosis or chronic micro-trauma caused by pressure sores of the metallic hardware may lead to esophageal perforation [22, 41]. In our case, esophageal perforation, due to dislodged anterior cervical plate, was diagnosed 12 years after the patient's anterior cervical surgery. The beginning date of anterior hardware dislodgement and the duration of migration could not be precisely estimated. Hardware dislocation may have occurred in time and chronic pressure on the esophagus due to the dislodged plate may have resulted in esophageal perforation.





**Fig. 2** **a** Intraoperative view of perforated esophagus by cervical plate. **b** Excessive drainage observed from the incision area after fluid intake

Diagnosis of esophageal complications is made by radiologic studies, endoscopic examination, and clinical evaluation. In the early postoperative period, the common symptoms such as dysphagia, pneumonia, fever, odynophagia, hoarseness, breathing difficulty, and also less common symptoms such as chest pain, and gastrointestinal bleeding should always alert the clinician for a probable esophageal perforation. A leakage from incision, swelling, redness, tenderness, crepitus around the neck, and any signs of septicaemia are also indicative of an esophageal perforation. Also, in the late postoperative period, similar symptoms and signs together with history of previous anterior cervical surgery should alert for possible esophageal injury [4, 8, 9, 12, 22]. As a rather rare cause of dysphagia and weight loss, anterior cervical hyperostosis, should be taken into consideration [52].

Radiologically, presence of air in the anterior cervical area strongly increases suspicion of esophageal injury. X-ray may show indirect signs such as subcutaneous emphysema, paravertebral air, widening of the retropharyngo-esophageal space or migrating of fixation material [5, 7, 9]. Esophagography with a contrast agent may show perforation along with its location, but has an overall false-negative rate of 10 % [53, 54]. A water-soluble contrast agent has been recommended such as gastrograffin or barium sulfate for esophagography [55]. Cervical CT and MRI which may show dislodgement of hardware or air near the paravertebral area are valuable diagnostic tools as well. CT and MRI with contrast medium may also show the detailed esophageal morphology and the presence of an abscess or its collections. The fusion of the cervical spine should be evaluated with cervical CT or X-ray to decide on supplementary fixation for revision surgery of delayed esophageal perforation. Endoscopic examination is essential both before the diagnosis and one or 2 days after the treatment. This examination directly shows the perforation site, and therefore, is a valuable diagnostic method to

assess the size of the perforation [5, 7, 24, 56]. If possible, flexible endoscopy should be preferred and endoscopic examination should be carried out carefully because of the risk for further tear [13]. In our case, the patient had been admitted with the complaints of dysphagia and weight loss for more than 3 months. There were no obvious findings of septicaemia. The X-ray and CT scan revealed dislodged hardware over the cervical vertebrae. We suspected an esophageal perforation under the light of the clinical findings, and an esophagoscopy confirmed the diagnosis.

The treatment of esophageal perforation is difficult because of the poor blood supply of esophagus, relatively thin walls compared with the intestine, and leakage of digestive secretions such as saliva [21]. Basic treatment options for cervical esophageal perforation ranges from conservative management to surgical interventions.

Conservative treatments include stopping oral intake (NPO), feeding the patient with NG tube, jejunostomy/gastrostomy or parenteral nutrition. Wide spectrum antibiotic therapy should be administered [5, 9, 10, 57]. The recommended NPO duration was for a minimum of 7 days after repair surgery. If the patient is not tolerating nasogastric feeding or requiring feeding for more than 2 weeks, she or he may be subjected to gastrostomy or jejunostomy [13, 27, 58]. In the literature, there is no specific recommendation for the duration of antibiotic treatment. But it may be extended up to 1 year if the perforation is associated with vertebral osteomyelitis [24]. The surgical treatment consists of primary suturing of the esophageal defect with or without muscle flap interpositioning, drainage of the abscess, and removal of the hardware. If there is no evidence of fusion, supplemental stabilization of the cervical spine is required [9, 10, 19, 23, 41].

There is no clear consensus on the first choice of treatment in esophageal perforation, whether surgical or conservative. Conservative treatment was suggested in case of a small (under 1 cm) and early-recognized esophageal

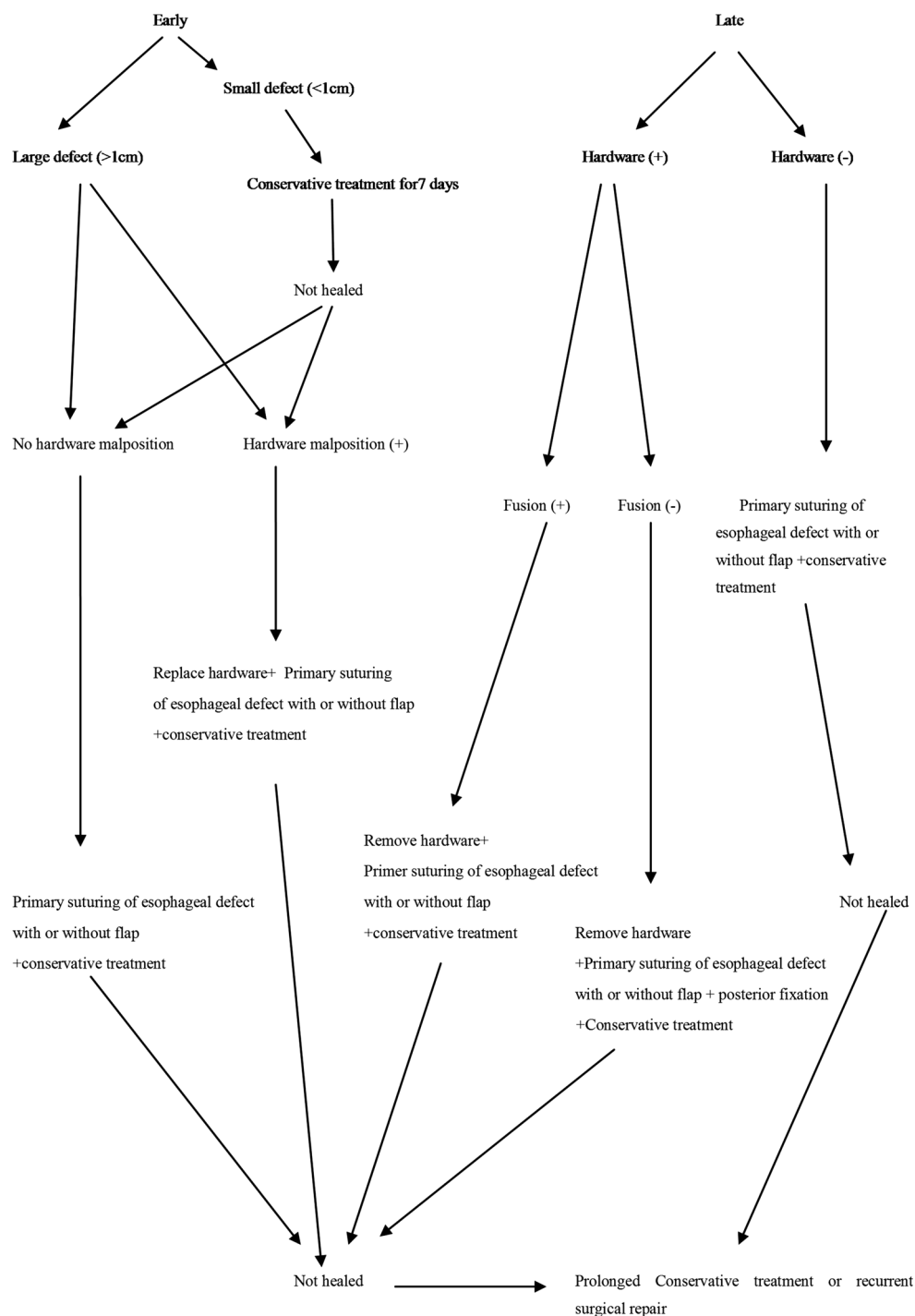
perforations with minimal symptoms and without signs of septicaemia [8, 18, 24, 27, 37, 58–60]. Surgical treatment is suggested for large (over 1 cm) esophageal perforations with more prominent symptoms [36, 37, 43, 61]. Conservative treatment should always be added to the surgical treatment.

Primary suturing of esophageal perforation should be performed after the debridement of the wound. Poorly viable or chronically inflamed margins should be carefully

removed to increase the likelihood of successful closure [27]. Absorbable interrupted or imbricating stitches may be used for suturing [13, 20]. However, primary suturing of complex esophageal injuries have a high risk for esophageal stricture and endoscopic dilatation may be required [62]. The suturing could be done in a tension-free way to avoid secondary stricture of esophagus [63].

A muscle flap may be used to reinforce the primary surgical repair of esophageal perforation, which provides a

**Fig. 3** Management algorithm of esophageal perforation due to anterior cervical surgery



layer over the esophagus and might also be suggested as a buttress [19]. This flap protects esophagus from compression or friction of the surrounding tissues around the damaged area [20]. The muscle flap is specifically useful for supporting the closure of a large esophageal defect [10, 13, 21, 24, 38, 48]. The sternocleidomastoid (SCM) muscle, which is pliable and has a great blood supply and is easy to harvest, is a very effective flap for closure of perforations [13, 34, 56]. Longus colli, sternothyroid, sternohyoid, pectoralis muscles and other tissues such as omentum and pleura may also be used for flap [7, 20, 21, 53]. In our case, we decided to do a primary suturing of the large esophageal defect (2 cm). Anterior cervical plate was removed during the surgery and a wound drain was placed between esophagus and vertebra. Conservative treatment was initiated after this surgical treatment. Due to leakage from incision area, conservative treatment was prolonged to 4 weeks rather than second surgical attempt. At the end of this period, the leakage persisted. After 4 weeks, endoscopic examination showed an esophageal fistula and it was repaired with endoscopic plastic stent application by ENT surgeons. There was no leakage after the endoscopic repair and the patient was reinstated to a soft oral diet 1 week later. The wound drain was removed 1 week after endoscopic intervention. In the literature, there is no specific recommendation for the length of time of wound drainage. We think the repetitive surgical attempt may be combined together with the prolonged conservative treatment. In the early postoperative period, if a dislodged hardware was found to cause esophageal perforation, hardware should be replaced with a new one and esophageal perforation should be sutured with or without a muscle flap. If there is no hardware malposition primary suturing of esophageal defect with or without a muscle flap should be performed. In late esophageal perforation, if there is a solid fusion on the cervical spine, hardware should be removed and esophageal perforation should be sutured with or without muscle flap. If a solid fusion of the cervical spine has not been occurred, hardware should be removed and a supplemental posterior fixation should be added together with primary esophageal repair. We established a management algorithm in esophageal perforations after anterior cervical surgery (Fig. 3).

## Conclusion

Successful management of esophageal perforations after anterior cervical surgery depends on early diagnosis and treatment. The removal of instrumentation, primary suturing of perforated area with or without a muscle flap, bypassing the esophagus with either NG feeding or gastrostomy/jejunostomy and wide spectrum antibiotic therapy

are the essential first step treatment options for this condition.

## Compliance with ethical standards

**Conflict of interest** The authors report no conflict of interest and alone are responsible for the content and the writing of the paper.

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