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REVIEW ARTICLE

A scoping review of the methods used to capture dysphagia after anterior cervical discectomy and fusion: the need for a paradigm shift

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Abstract

Objective Dysphagia is the most commonly reported complication of annterior cervical discectomy and fusion (ACDF) surgery. However, the incidence of dysphagia post-ACDF varies widely–partly attributable to differing outcome measures used to capture dysphagia. Our objective was to conduct a scoping review of the literature to quantify which dysphagia outcome measures have been employed post-ACDF and examine trends by study design, year, and location.

Methods After removing duplicates, 2396 abstracts were screened for inclusion. A total of 480 studies were eligible for full-text review. After applying exclusion criteria, data was extracted from 280 studies. We extracted the dysphagia outcome measure(s), study design (prospective vs retrospective), year, and location (country). Approximately 10% of studies were repeated for intra-rater agreement.

Results In total, 317 dysphagia outcome measures were reported in 280 studies (primarily retrospective—63%). The largest proportion of outcome measures were categorized as "unvalidated patient-reported outcome measures" (46%), largely driven by use of the popular Bazaz scale. The next most common categories were "insufficient detail" and "validated patient-reported outcome measures" (both 16%) followed by "chart review/database" (13%) and instrumental assessment (7%). Studies examining dysphagia post-ACDF steadily increased over the years and the use of validated measures increased in the past 10 years.

Conclusions This scoping review of the literature highlights that nearly half of the ACDF dysphagia literature relies on unvalidated patient-reported outcome measures. The current understanding of the mechanism, timeline, and presentation of dysphagia post-ACDF are likely limited due to the metrics that are most commonly reported in the literature.

Keywords Scoping review · Dysphagia · Swallowing · Anterior cervical discectomy fusion · ACDF · Outcome measures

Introduction

Swallowing is a complex, highly coordinated sensory-motor sequence that most people take for granted. Yet, in order to execute a safe and efficient swallow, 25 pairs of muscles controlled by five cranial nerves contract and relax in rapid succession, all intricately timed within the respiratory cycle [1]. Dysphagia (disordered swallowing) can result in food/liquid being misdirected into the respiratory tract (a process known as aspiration) and can cause pneumonia [2]. Weak and/or or poorly coordinated swallowing can result in inefficient swallowing, further contributing to aspiration risk and cause challenges with meeting nutrition and hydration needs [3, 4]. In extreme cases, patients no longer eat and drink by mouth and receive nutrition and hydration via enteral feeding. In addition to the impact on the patient's health, dysphagia is known to significantly impact quality of life

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[5], healthcare costs [6, 7], length of hospital stay [8], and caregiver burden [9]. In North America, speech language pathologists (SLPs) and otolaryngologists are the healthcare professionals typically responsible for assessing swallowing.

Dysphagia after ACDF

Dysphagia is the most commonly reported complication of anterior cervical discectomy and fusion (ACDF) surgery [10]. Dysphagia after ACDF surgery can result from post-surgical edema [11] and/or neuropraxia from nerve compression or retraction [12]. The intubation injuries are also known to increase risk of dysphagia [13]. Depending on which cervical levels are involved, the ACDF surgery places several important swallowing nerves and structures at iatrogenic risk. For example, the hypoglossal nerve is at risk at C2–C3 [14] and innervates nearly all the extrinsic and intrinsic muscles of the tongue. These muscles are critical for the formation and propulsion of the bolus. The internal branch of the superior laryngeal nerve (iSLN) is at risk near C3–4 and is responsible for sensory innervation of the laryngeal mucosa above the vocal folds [14]. The impairment of the iSLN can place an individual at risk of aspiration, given that food and liquid is not sensed entering the laryngeal vestibule. The recurrent laryngeal nerve (RLN) innervates nearly all the intrinsic laryngeal muscles and is instrumental in positioning the vocal folds for phonation and airway protection. The RLN is at risk of injury at the level of C6–C7 and also from surgical retraction [15]. Finally, many muscles that are important to swallowing are also at risk during ACDF surgery such as the pharyngeal constrictors (responsible for bolus propulsion) and the posterior digastric muscle (integral for airway protection during swallowing).

The reported incidence of dysphagia after ACDF is notoriously wide, with recent systematic reviews suggesting a range of 1–79% [16] and 0.2–87.5% [17]. While many reasons have been investigated to explain the variance in dysphagia incidence (such as time since surgery, age, sex, co-morbidities, cervical surgical level(s), surgical approach, operating room time, hardware type, use of steroids, etc.), it cannot be ignored that the choice of dysphagia metric contributes to this wide range [18–20]. Ideally, *dysphagia risk* is either identified with screening tools and patient-reported outcome measures that are psychometrically valid and/or *dysphagia is confirmed* using gold-standard instrumental assessment of swallowing. Two widely adopted techniques for visualizing swallowing are flexible endoscopic evaluation of swallowing (FEES) and videofluoroscopic swallowing studies (VFSS), also known as modified barium swallow studies (MBS). Most swallowing specialists consider the latter to be the gold-standard assessment [21]. Yet, the ACDF literature appears to rely heavily on *non-validated* patient-reported outcomes to capture dysphagia—which may challenge what is confidently known about dysphagia in this population. It is currently unknown how pervasive this issue is. Therefore, our primary goal was to conduct a scoping review of the literature to quantify which dysphagia outcome measures have been reported in the ACDF literature. Our secondary goals were to explore trends over time, by study design, and study location.

Methods

Following guidance outlined by Munn and colleagues, we determined that our research goals were aligned with a scoping review (as opposed to a systematic review) [22]. A scoping review sets out to identify patterns of evidence using an a priori review protocol; however, unlike a systematic review, it does not include a mandatory risk of bias assessment. Our goals are consistent with three of six possible purposes Munn and colleagues identified for conducting a scoping review including "to identify the types of available evidence in a given field, to clarify definitions in the literature, to identify and analyze knowledge gaps" [22]. In March 2022, we searched three medical databases (ProQuest Nursing & Allied Health, PUBMED, Scopus) using the search terms ("anterior cervical discectomy fusion") OR ("ACDF") OR ("cervical spine surgery") AND ("dysphagia"). Our goal was to locate all empirical studies published in English that reported dysphagia outcomes after planned, initial ACDF surgery. Systematic reviews, case studies, revision surgeries, non-ACDF surgeries, and trauma populations were not included. The quality of individual studies was not appraised for this review.

First, titles and abstracts were screened for exclusion. Next, the full-text versions were reviewed to confirm inclusion. Finally, data were extracted from the final set of articles. Parameters of interest included dysphagia outcome measure(s), study year, study design (retrospective vs prospective), and study location (country per final author's affiliation). When dysphagia was quantitatively reported as a complication of ACDF surgery in a given publication but a metric was not described in the methods section, studies were coded as "insufficient detail." Data analysis was conducted by trained speech language pathology (SLP) students. Approximately 10% of studies were reviewed by a second rater (SLP with 5 years clinical experience) at each step (title and abstract review, full-text review) to calculate percent exact agreement.

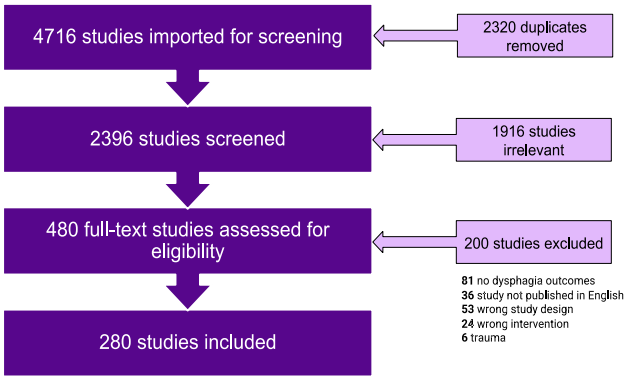

Fig. 1 Flowchart for scoping review

Results

The process of data extraction and refinement is summarized in Fig. 1. Results from our database searches were imported into *Covidence* (Veritas Health Innovation) ($n=4716$). After duplicates were removed, 2396 abstracts and titles were screened for inclusion. Percent agreement (on 200 abstract/titles) was high at this step (92.5%). Discrepancies were resolved by the first author. After screening titles and abstracts, 480 full-text studies were reviewed to confirm inclusion. A total of 200 studies were excluded for the following reasons: no dysphagia outcomes ($n=81$), study design ($n=53$), study not published in English ($n=36$), wrong intervention ($n=24$) and trauma population ($n=6$). As a result, we were able to extract parameters of interest from 280 studies. Our primary variable of interest was the number and type of dysphagia outcome measures reported, followed by secondary variables of interest including study year, study design (prospective vs retrospective), and study country. Data extraction was repeated by an experienced SLP rater in 20 studies and yielded 90% agreement. Again, discrepancies were resolved by the first author.

Outcome measures

Our review revealed that there were 317 dysphagia outcome measures reported in these 280 studies with the majority of studies reporting one outcome measure ($n=251$), with fewer studies reporting two ($n=22$), three ($n=6$), or four ($n=1$) dysphagia outcome measures. The full list of possible outcome measures (and their categorization) is presented in Table 1.

Study design

The majority of studies examining dysphagia after ACDF surgery were retrospective (177/280 = 63%). The distribution of outcome measure by study design is presented in Fig. 2a and b.

Study year

The number of studies focusing on dysphagia after ACDF surgery has been steadily increasing over the past 20 + years. Figure 3 collates the most frequent outcome measure types by 5-year age bins. Notably, validated dysphagia patient-reported outcome measures were first observed in the ACDF literature after 2011.

Study country

The majority of the studies were conducted in the USA ($n=143$), followed by China ($n=74$), Korea ($n=15$), Japan ($n=7$), Italy ($n=6$), and Germany and Canada ($n=5$). All other countries had fewer than five studies. The frequency ranking and order of top contributing countries did not change significantly when we restricted the dataset to only prospective studies.

Discussion

Dysphagia is the most common complication reported after ACDF surgery [10], yet the incidence is poorly understood. Dysphagia is a nuanced phenomenon and can be identified subjectively by the patient, quantified using validated scales, or confirmed using imaging techniques. We believe that the wide variety of methods used to identify dysphagia may be obscuring a more refined understanding of dysphagia (and risk of dysphagia) post-ACDF. Therefore, our goal was to conduct a scoping review to quantify the type of outcome measures used to identify dysphagia in the ACDF literature. Our scoping review identified 280 publications that reported dysphagia after ACDF.

As can be appreciated from Table 1, the greatest proportion of studies were classified as unvalidated patient-reported outcomes (nearly half of all outcome measures, 46%) which is largely driven by the popular use of the 'Bazaz Scale' [23]. This scale utilizes a numerical score to quantify difficulty swallowing ranging from 0 (none) to 3 (severe) for both liquids and solids. Very few methodological details are provided within the original study for how and who administers the questionnaire and why the levels of impairment are not congruent for liquids and solids. Despite its pervasive use in ACDF studies, this scale has never been validated. Indeed, recent studies have confirmed shortcomings of this

Table 1 Overall distribution of dysphagia outcome measures by category and study design

Outcome measure category	Specific dysphagia outcome measure	Prospective		Retrospective		Total	
		n	%	*n*	%	*n*	%
Instrumental assessment	Flexible endoscopic evaluation of swallowing (FEES)	6	0.05	0	0.00	6	0.02
	Videofluoroscopic swallowing study (VFSS)	9	0.07	7	0.04	16	0.05
	High-resolution pharyngeal manometry (HRM)	1	0.01	0	0.00	1	0.00
	Subtotal	16	0.12	7	0.04	23	0.07
Clinical bedside evaluation by SLP	Clinical bedside swallowing evaluation	1	0.01	1	0.01	1	0.00
	Subtotal	1	0.01	1	0.01	2	0.01
Validated patient-reported outcome/screening tool	Eating assessment tool—10 items (EAT-10)	7	0.05	4	0.02	11	0.03
	Swallowing quality of life scale (Swal-QOL)	11	0.08	10	0.05	21	0.07
	Hospital for special surgery—dysphagia dysphonia index (HSS-DDI)	3	0.02	2	0.01	5	0.02
	Dysphagia short questionnaire (DSQ)	5	0.04	0	0.00	5	0.02
	M. D. Anderson dysphagia inventory (MDADI)	4	0.03	1	0.01	5	0.02
	Dysphagia handicap index (DHI)	1	0.01	0	0.00	1	0.00
	Postoperative dysphagia, odynophagia, and voice (DOV)	0	0.00	1	0.01	1	0.00
	Dysphagia outcome severity scale	0	0.00	1	0.01	1	0.00
	Subtotal	31	0.23	19	0.10	50	0.16
Chart review/database	Chart review	0	0.00	15	0.08	15	0.05
	Database	0	0.00	27	0.15	27	0.09
	Subtotal	0	0.00	42	0.23	42	0.13
Diet-based outcomes	Functional oral intake scale	0	0.00	1	0.01	1	0.00
	National outcomes measurement system (NOMS)	0	0.00	1	0.01	1	0.00
	National dysphagia diet scale	0	0.00	1	0.01	1	0.00
	Subtotal	0	0.00	3	0.02	3	0.01
Unvalidated patient-reported outcomes	Bazaz scale (aka Bazaz–Yoo Scale)	55	0.42	62	0.34	117	0.37
	Dysphagia and Dysphonia Inventory (DDI)	1	0.01	2	0.01	3	0.01
	Dysphagia Numeric Rating Scale (DRNS)	1	0.01	1	0.01	2	0.01
	Functional Outcome Swallowing Score (FOSS)	1	0.01	1	0.01	2	0.01
	Modified Dysphagia Scoring System (MDSS)	0	0.00	1	0.01	1	0.00
	"patient report"	4	0.03	7	0.04	11	0.03
	"unique questionnaire"	2	0.02	1	0.01	3	0.01
	Visual Analog Scale (VAS)	6	0.05	2	0.01	8	0.03
	Subtotal	70	0.53	77	0.42	147	0.46
Insufficient detail	Insufficient detail	14	0.11	36	0.19	50	0.16
	Subtotal	14	0.11	36	0.19	50	0.16
Overall	Grand total	132	1.00	185	1.00	317	1.00

scale. For example, Bazaz scores do not correlate with the MD Anderson Dysphagia Inventory (MDADI)—a validated dysphagia questionnaire for head and neck cancer [20], the Bazaz scale failed to capture dysphagia in 32% of cases when compared to the validated Eating Assessment Tool (EAT-10) [24], and the Bazaz scale has significant floor and ceiling effects compared to the Hospital for Special Surgery—Dysphagia and Dysphonia Index (HSS-DDI)—a validated patient-reported outcome measure designed specifically for the ACDF population [19].

The resulting situation is that studies using the Bazaz scale may limit what is understood about dysphagia after ACDF. Large-scale, longitudinal analyses have used this scale to track the rate and presentation of dysphagia over time (despite problematic floor and ceiling effects) as the primary outcome measure for dysphagia [23, 25, 26]. Further, studies investigating innovative interventions and techniques designed to mitigate dysphagia after ACDF have relied on the Bazaz scale such as the use of intraoperative

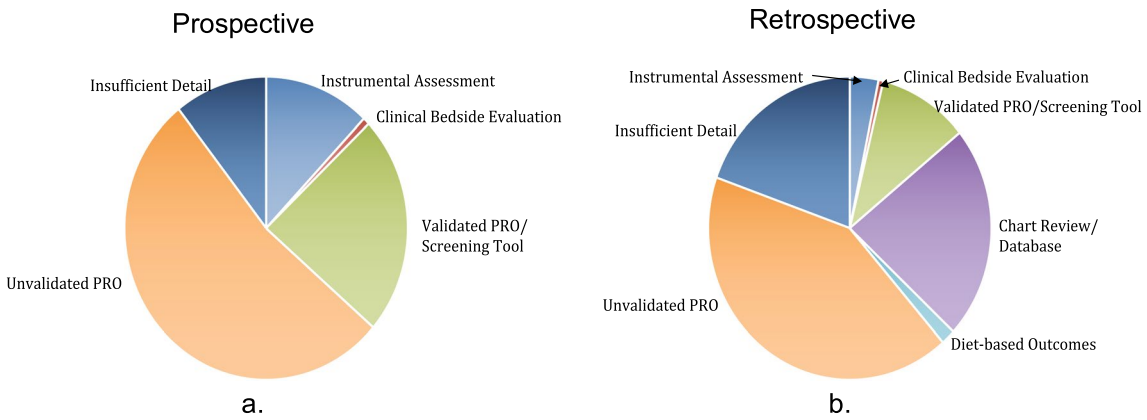

Fig. 2 Dysphagia outcome measures reported in **a** prospective and **b** retrospective studies. [PRO = patient-reported outcome]

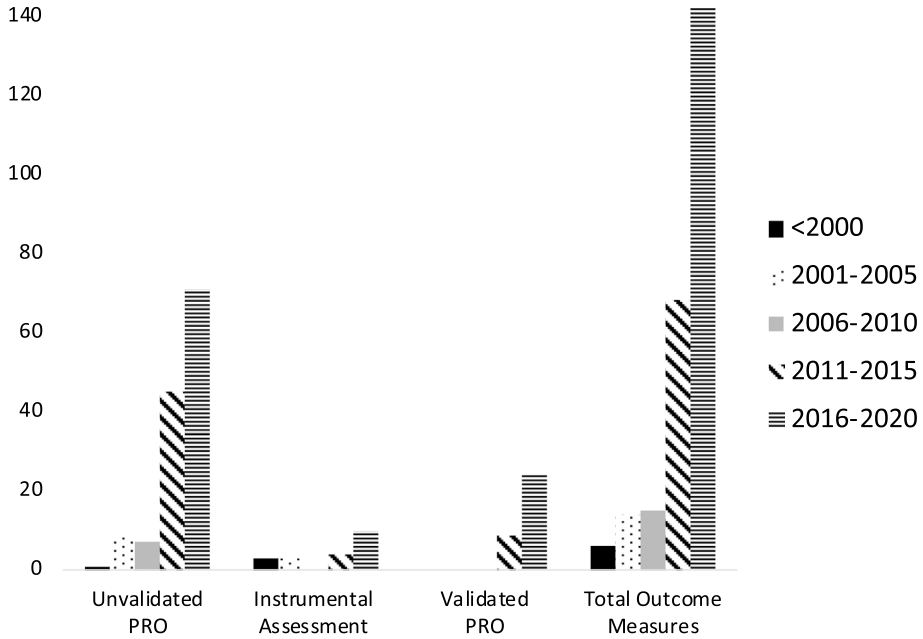

Fig. 3 Common dysphagia outcome measure categories over time. The raw number of studies is represented along the *y*-axis. [PRO = patient-reported outcome measure]

steriods [27], instrumentation type [28], and the use of pre-tracheal retraction exercises [29].

The next highest proportion of outcome measure type was equal (16%) between two categories—*nsufficient detail* and *validated patient-reported outcome measures/screening tools*. Our study raters were instructed to choose *insufficient detail* when no description was provided for how dysphagia was captured in the methods section. In these studies, authors commonly report the incidence of dysphagia in their study within the results section, with no prior details on how this was captured. Replication of these studies would not be possible with respect to dysphagia incidence. Presumably, these data rely on surgeon records and/or surgeon recall. Unfortunately, research has shown that there is poor correlation between surgeon records and patient-reported data from structured questionnaires. Edwards and colleagues documented use of surgeon records caused under-reporting of dysphagia in 80% of cases [30].

Validated patient-reported outcome measures also accounted for 16% of the studies overall. These most commonly included the Eating Assessment Tool (EAT-10) [31] and the Swallowing Quality of Life Scale (Swal-QOL) [32] both of which are designed to be used with heterogeneous patient populations. We are encouraged to see increasing uptake of new screening tools that are psychometrically appropriate for ACDF populations, including the Dysphagia Short Questionnaire (DSQ) [33] and the Hospital for Special Surgery—Dysphagia and Dysphonia Index (HSS-DDI) [34]. As noted in Fig. 3, the use of validated dysphagia metrics first appeared in 2011 and has positively and rapidly increased in the past decade.

Chart review/database outcome measures represent 13% of the overall data (exclusively in retrospective studies). This category and design of study is inherently limited (not only in ACDF) in the type of data that is gleaned; however, these studies typically yield important demographic and procedural information quantified from an impressive sample size.

Instrumental assessment accounts for 7% of all the studies that report dysphagia after ACDF surgery. Several trends emerge when we closely compiled the results of the instrumental studies in this scoping review. It appears that ACDF causes biomechanical disruptions to pharyngeal constriction/stripping [11, 35–38], hyoid bone excursion [36, 39, 40], epiglottic deflection [11, 37, 38], and upper esophageal sphincter opening [11, 36, 38, 41]. These biomechanical deficits largely explain the functional consequences observed on instrumental studies, most notably impaired swallowing efficiency (post-swallow residue) [36–38, 40, 42, 43]. Aspiration has also been documented in this population, but primarily of post-swallow residue [11, 36, 41] and/or in the acute phase [44]. VFSS has also been used to document significant pre-vertebral swelling post-ACDF [11, 36, 39, 40, 42, 44]; though, this can also be easily captured from routine lateral view radiographs.

Finally, our scoping review reveals that *diet-based outcomes* and *clinical bedside evaluations* each only represent approximately 1% of all studies that report dysphagia after ACDF.

We acknowledge several limitations of this scoping review. First, the use of a scoping review methodology meant that we did not appraise the quality of individual studies that we located. Certainly, this scoping review sets the stage for a future systematic review on this topic which would necessitate the systematic appraisal of individual study design, risk of bias and scientific rigor. Second, our review was limited to one reviewer per study, a necessary methodological decision given the sheer number of studies included; however, our excellent intra-rater agreement levels ($\geq 90\%$) minimize this limitation. Finally, our review did not gather information about dysphagia incidence which would represent an interesting follow-up analysis of the studies we have compiled. If we were to examine the incidence of dysphagia by outcome measure type, we would also need to control for timing of assessment given that dysphagia often resolves in the early post-operative period. However, to our knowledge, the evolution/resolution of dysphagia has not been prospectively analyzed using instrumental swallowing assessment and therefore represents an important area for future research.

Recommendations for the future

Based on the results of this review, we advocate for a paradigm shift in the methods used to capture dysphagia after ACDF surgery. Above all else, given the significant rates of dysphagia after ACDF surgery, we strongly advocate for collaborative clinical and research partnerships between spine surgery teams and swallowing specialists such as otolaryngologists and speech language pathologists. A post hoc review of our data revealed that only 27 of the 280 publications that examined dysphagia after ACDF included a swallowing specialist as a co-author. Next, we recommend that surgical teams discontinue the use of the Bazaz scale for screening swallowing function given the limitations discussed above [19, 24, 33]. Instead, we advocate for universal screening of swallowing at post-surgical follow-up appointments using a validated patient-reported outcome measure. The 31-item HSS-DDI [34] makes an excellent candidate for screening given that it is validated specifically for ACDF patients and provides critical information about both dysphagia and dysphonia. Scores on the HSS-DDI range from 0 to 100 (lower scores represent better function) and a >10-point reduction represents a clinically meaningful difference [45]. The EAT-10 [31] also is a strong candidate for universal screening given that it is very quick to administer (10 items) and has proposed cut points for referral for in-depth swallowing evaluation (scores ≥ 3). Early post-operative EAT-10 scores have been shown to predict long-term dysphagia symptoms in ACDF patients [46]. Then, these screening results can yield efficient and accurate referrals for instrumental swallowing assessments which we recognize are costly, time intensive, and require specialized staff and equipment. However, referrals based on universal screening at postoperative follow-up appointments should minimize the debilitating impact that dysphagia can have on health and quality of life for ACDF patients and will ensure that patients do not fall through the cracks only to end up in outpatient swallowing clinics several months later. Finally, when feasible, we strongly encourage future ACDF research designs to employ gold-standard VFSS assessments pre- and post-surgery. Expert analysis of these studies can yield nuanced continuous data on swallowing biomechanics that is likely to be sensitive to subtle differences between groups in studies aimed to reduce dysphagia post-ACDF.

Conclusion

This scoping review has revealed that the majority of studies reporting dysphagia after ACDF surgery rely on inappropriate outcome measures. Specifically, these account for nearly two-thirds of the literature we located—with unvalidated

scales making up 46% and those that lack clear methodological details regarding dysphagia diagnosis representing an additional 16%. By and far, the most pervasive tool contributing to this is the Bazaz scale. At the same time, the use of validated patient-reported outcome measures for capturing dysphagia appears to be on the rise and new, validated, ACDF-specific metrics are available for immediate use. We advocate for the inclusion of swallowing specialists (otolaryngologists and/or speech language pathologists) in both the clinical management and research of ACDF patients. Universal screening at postoperative follow-up appointments using validated patient-reported metrics will improve identification of patients at risk for significant dysphagia. This will allow for efficient and timely referrals for in-depth swallowing evaluations using instrumental imaging of swallowing and in turn minimize the debilitating effects of dysphagia on health and quality of life.

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Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

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