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Dysphagia after cervical spine surgery: a review of risk factors and preventative measures

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Dysphagia is a regular occurrence after cervical spine surgery, and the development of dysphagia postoperatively is associated with worsened quality of life for patients. Despite the frequency and negative implications of this adverse outcome, there is no clear consensus for defining dysphagia within the spinal literature. Numerous patient-reported outcomes questionnaires are currently used to elucidate the presence and severity of postoperative dysphagia, several of which are not validated instruments. This variability in reporting creates difficulty when trying to determine the prevalence of dysphagia and any potential mitigating factors. In the current review, the authors discuss the causes of postoperative dysphagia after cervical spine surgery, metrics for evaluating postoperative dysphagia, risk factors for the development of this adverse outcome, and strategies for preventing its development. Readers will be able to use this information to improve patient outcomes after cervical spine surgery.

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Dysphagia is a common adverse outcome after cervical spine surgery. Fluoroscopic swallow studies demonstrate that persistent difficulty in swallowing after anterior cervical spine surgery is due to pharyngeal weakness secondary to tissue dissection and retraction during surgery.[1] Its presence in the postoperative period has been shown to negatively impact quality of life for patients.[2] Moreover, postoperative dysphagia after anterior cervical spine surgery has been shown to significantly increase hospital length of stay, in-hospital mortality, direct costs, and 30-day readmission rates.[3] Despite the prevalence of dysphagia and its detrimental impact on patients, metrics for quantifying and strategies for alleviating dysphagia are not well defined in the literature. The aim of this review was to discuss the existing literature on dysphagia after cervical spine surgery, including dysphagia assessment tools, postoperative incidence, risk factors, and strategies for mitigation of postoperative dysphagia.

Swallowing in the General Population

Normal swallowing is described in 3 phases.[4] It begins with the oral preparatory phase, during which food is prepared to be swallowed. The food is chewed and mixed with saliva to provide mechanical and chemical softening. A cohesive bolus of food is then propelled toward the pharynx under the pressure of the tongue contacting the hard palate. The next phase of swallowing is the pharyngeal phase, during which the tongue propels the food bolus into the pharynx. The tongue retracts to the posterior pharyngeal wall, the airway closes, the pharyngeal muscles contract, and the upper esophageal sphincter opens. The final stage of swallowing is the esophageal phase, wherein a peristaltic wave of contraction moves the food bolus through the esophagus.

With normal aging, decreased muscle mass can negatively impact swallowing. The tongue creates less force during the oral phase of swallowing, thus allowing for impaired clearing of food boluses.[4] Muscles of mastication also weaken with age, resulting in decreased mechanical softening of food. Furthermore, geriatric patients have decreased physiological salivary production that is often worsened by medication side effects. This results in less chemical digestion during the oral phase of swallowing, as well as less lubrication to propagate food boluses in all 3 phases of swallowing.[4]

Dysphagia may occur in any of the 3 normal phases of swallowing. It is common in the general population.

ABBREVIATIONS ACDF = anterior cervical discectomy and fusion; DSQ = Dysphagia Short Questionnaire; EAT-10 = Eating Assessment Tool; HSS-DDI = Hospital for Special Surgery Dysphagia and Dysphonia Inventory; IV = intravenous; MCID = minimum clinically important difference; MDADI = MD Anderson Dysphagia Inventory; SWAL-QOL = Swallowing Quality of Life questionnaire.

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TABLE 1. Dysphagia after cervical spine surgery

Tool	Format	Scoring	Validated?	Notes
Bazaz dysphagia score[6]	Patient swallowing questionnaire (scored none to severe)	Greater frequency of swallowing difficulty indicates more severe dysphagia	No	Did not correlate w/ DSQ, MDADI, or EQ-5D quality-of-life scores[13]
MDADI[7]	20 items (scored 1–5)	Lower score indicates worse quality of life; MCID = 6	Yes	
SWAL-QOL[9]	44 items (scored 1–5)	Lower score indicates worse quality of life; MCID = 8	Yes	
EAT-10[10]	10 items (5-point Likert scale)	Score ≥3 indicates clinically significant dysphagia	Yes	Excellent internal consistency, test-retest reproducibility, & criterion-based validity;[11] correlated w/ pharyngeal constriction ratio[1]
DSQ[13]	5 weighted items (scored 0–18)	Score ≥4 indicates dysphagia	Yes	Correlated w/ MDADI (r = 0.59) & showed good reproducibility[13]
Dysphagia Disability Index[14]	23 items (each graded as 0, 2, or 4)	Score >30 indicates dysphagia	Yes	
HSS-DDI[15]	31 items (5-point Likert scale)	Lower score indicates lower severity of dysphagia & dysphonia; MCID = 10	Yes	High internal reliability (α = 0.97) & high intraclass correlation coefficient (0.80)[15]
Hyodo-Komagane score[16]	Swallowing study	Total score >3 indicates dysphagia	Yes	

In a cross-sectional study of 947 adult patients who presented to their primary care physician for any nonurgent cause, 22.6% reported dysphagia symptoms that occurred a minimum of several times per month.[5] Of these patients, 46.3% had not discussed these symptoms with a physician. Despite the prevalence of dysphagia in the general population, patients undergoing cervical spine surgery are rarely screened for it.

Dysphagia Assessment Tools

There are several assessment tools for determining the presence and severity of dysphagia after cervical spine surgery (Table 1). Although fluoroscopic and endoscopic evaluation methods remain the gold standard for quantifying and qualifying dysphagia, these modalities are time consuming, invasive, and do not readily consider the subjective nature of patient symptoms. Patient questionnaires are noninvasive but may also be time consuming or misrepresentative. Numerous instruments have been developed for various purposes or populations; some of these have been validated and some have not.

To date, the Bazaz dysphagia score is the most commonly cited dysphagia questionnaire in the spine surgery literature.[6] Although simple in design, it has not been validated. Patients are asked about the severity of their dysphagia with liquid and solid foods, which are scored from "none" to "severe."

The MD Anderson Dysphagia Inventory (MDADI)[7] is often regarded as the historical gold standard among dysphagia questionnaires; however, it is burdensome to administer and score. It was designed to assess dysphagia-related quality of life in patients with head and neck cancer. It incorporates 3 domains (emotional, functional, and physical), as well as 1 global question. There are 20 items to evaluate, with 2 questions being scored contrary to the others. The scores can range from 20 to 100, with a lower score indicating worse quality of life.[7] Okano et al.[8] determined that the minimum clinically important difference (MCID) for the MDADI is 6.

The Swallowing Quality of Life questionnaire (SWAL-QOL) is a symptom-specific outcome instrument designed to assess quality of life and outcomes in patients with oropharyngeal dysphagia.[9] SWAL-QOL uses a 5-point scale, with different instructions for the patient in different sections of the survey. The instrument consists of 44 items and can be cumbersome to complete. A lower score indicates worse quality of life, and the MCID has been defined as a change of 8 points.[8,9]

The Eating Assessment Tool (EAT-10) is a validated measurement of postoperative dysphagia that takes less than 2 minutes to complete.[10] A higher score indicates a higher self-perception of dysphagia. Ten items are scored on a 5-point Likert scale to assess severity of dysphagia, where a score of 3 or higher indicates clinically significant dysphagia. EAT-10 displays excellent internal consistency, test-retest reproducibility, and criterion-based validity.[11] Fluoroscopic studies have demonstrated that the pharyngeal constriction ratio is correlated with EAT-10 ($p < 0.0125$).[1] Furthermore, in a prospective study of 100 consecutive patients conducted over 1 year, 176 instances of clinically significant dysphagia (EAT-10 score ≥ 3) were noted, 57 (32%) of which were classified as "none" on the Bazaz classification.[12] In the study, EAT-10 demonstrated excellent internal reliability ($\alpha = 0.95$).

The Dysphagia Short Questionnaire (DSQ) is a validated series of 5 questions that are weighted differently on the basis of how they are thought to impact dysphagia. It was designed on the basis of expert opinion of otolaryngologists.[13] With a scale of 0 to 18 points, a score of 4 or higher is consistent with dysphagia. In a prospective validation study, DSQ correlated with MDADI (r = 0.59)

and showed good reproducibility. The Bazaz score did not correlate with DSQ, MDADI, or EQ-5D quality-of-life scores.[13]

The Dysphagia Disability Index[14] contains 23 questions, each graded with a score of 0, 2, or 4 points. A score > 30 is consistent with dysphagia. Given the number of questions, the survey can be time consuming to complete.

The Hospital for Special Surgery Dysphagia and Dysphonia Inventory (HSS-DDI) is a validated instrument for quantifying dysphagia and dysphonia after cervical spine surgery.[15] The internal reliability is high ($\alpha = 0.97$) and the intraclass correlation coefficient is 0.80, meaning raters tend to provide similar scores. However, the survey includes 31 items graded on a 5-point Likert scale and is therefore burdensome to complete. Despite this, the initial authors indicated an average time for administration of 2 minutes 25 seconds. A lower score on HSS-DDI indicates lower severity of dysphagia and dysphonia, and MCID was defined as a change of 10 points.[8,15]

Finally, the Hyodo-Komagane score is a validated endoscopic swallowing study that uses blue-dyed water.[16] Four parameters are assessed on the basis of fluid mobility through the oropharynx. Dysphagia is defined as a total score > 3.

Incidence of Dysphagia After Cervical Spine Surgery

The reported incidence of dysphagia after cervical spine surgery varies significantly on the basis of how dysphagia is defined and the time interval since the index operation. Rihn et al.[17] prospectively compared patients who underwent anterior cervical spine surgery with a control group of patients who underwent lumbar spine surgery. The authors found that the incidence and severity of dysphagia were higher in the cervical group at 2 and 6 weeks postoperatively. At 12 weeks postoperatively, the severity of dysphagia remained higher in the cervical group and the incidence was insignificantly higher in this group ($p = 0.06$), demonstrating the typical time course for symptom improvement after anterior cervical spine surgery.

Bazaz Dysphagia Score

As previously discussed, the Bazaz dysphagia score is the most frequently cited index for determining rates of dysphagia in the spinal literature. When graded on the basis of the Bazaz questionnaire, the incidence of dysphagia after anterior cervical spinal surgery is 20%–83% within 2 weeks postoperatively, 54.0%–59.6% at 1 month, 10.2%–26% at 6 weeks, 33.6% at 2 months, 5.4%–8% at 3 months, 2.4%–18.6% at 6 months, 1.1%–15.2% at 12 months, and 0.4%–13.6% at 24 months.[17–21] Olsson et al.[22] used the Bazaz dysphagia score to assess a cross-sectional cohort of 100 patients at an average follow-up of 33 months postoperatively. The rate of dysphagia was 26%. Rare and mild dysphagia were reported by 2% and 7% of patients, respectively. Moderate dysphagia was reported by 12% patients, and severe dysphagia was reported by 5% of patients. The prevalence of persistent dysphagia after anterior cervical discectomy and fusion (ACDF) was 23% in primary cases.

Radcliff et al.[23] used the Bazaz dysphagia score to prospectively determine dysphagia rates in 85 patients who underwent posterior cervical surgery. Baseline dysphagia was present in 12% (10/85) of patients. The incidence of new dysphagia was 10/85 (12%) at 2 weeks, 8/85 (9%) at 6 weeks, 13/85 (15%) at 12 weeks, and 5/85 (6%) at 24 weeks. The incidence of new dysphagia was significantly less than that after anterior cervical surgery at 2 weeks ($p < 0.001$) and 6 weeks ($p < 0.001$) but not 12 weeks ($p > 0.99$) postoperatively. The incidence of dysphagia after posterior cervical surgery was significantly higher than that of lumbar surgery at 6 weeks ($p = 0.02$) and 12 weeks ($p < 0.01$) postoperatively.[23]

Eating Assessment Tool

Using EAT-10 scores in a prospective study, Ohba et al.[16] found that 34% of patients had dysphagia in the first 2 weeks postoperatively after anterior cervical surgery and that 25.5% of patients still had persistent dysphagia 1 year postoperatively. Among the 8.5% of patients who had dysphagia preoperatively, there was a significant positive correlation with postoperative dysphagia. In a similar study, Haller et al.[24] prospectively examined 56 patients preoperatively and at least 1 year postoperatively. Among these, 21 patients (38%) had EAT-10 scores ≥ 3. Patients who reported no long-term dysphagia had a mean EAT-10 score of 6.9 during their immediate postoperative recovery, whereas patients with long-term symptoms had a mean score of 18.1 immediately postoperatively ($p < 0.01$).

Dysphagia Disability Index

Kalb et al.[14] used the Dysphagia Disability Index to retrospectively examine rates of dysphagia after anterior cervical spine surgery in 249 patients. During the first 6 months after surgery, 27 (10.8%) patients developed dysphagia. Among these patients, the prevalence rates of dysphagia at 6 weeks, 3 months, and 6 months postoperatively were 88.8%, 29.6%, and 7.4%, respectively. By 12 months, dysphagia had resolved in all cases.

Smith-Hammond et al.[25] used the same index to prospectively investigate rates of dysphagia in 83 patients who underwent anterior cervical, posterior cervical, or posterior lumbar spine surgical procedures. The authors found significantly higher rates of dysphagia for anterior cervical patients after surgery relative to preoperative scores ($p < 0.01$). Higher rates of postoperative dysphagia compared with preoperative status for posterior cervical ($p = 0.06$) and posterior lumbar ($p = 0.09$) patients were not statistically significant.

Patient-Reported Dysphagia

Riley et al.[2] retrospectively investigated 454 patients after anterior cervical spine surgery. Dysphagia was defined as any patient description of swallowing difficulty. The incidence rates of new complaints of dysphagia were 29.8%, 6.9%, and 6.6% at 3, 6, and 24 months, respectively. Tervonen et al.[26] also used patient-reported dysphagia symptoms to prospectively study patients after anterior cervical spine surgery. Sixty-nine percent of 50 patients reported

dysphagia at the immediate postoperative visit, and 21% of patients had dysphagia between 3 and 9 months postoperatively.[26]

Risk Factors for Dysphagia After Cervical Spine Surgery

Multiple studies have attempted to identify risk factors for the development of dysphagia after cervical spine surgery. Although some risk factors are well elucidated, others remain controversial with multiple studies demonstrating conflicting results.

Operative Factors

The most commonly noted risk factors for the development of dysphagia after cervical spine surgery are a greater number of surgical levels and longer operative time.[2,11,14,17–19,27–31] Three-level surgical procedures cause dysphagia rates nearly twice those of 1- or 2-level anterior cervical surgical procedures.[31]

The prevertebral tissue is thinnest at the upper cervical levels, and postoperative tissue swelling at these levels can contribute to dysphagia. Surgical procedures, including those performed at C4 and above, are most commonly associated with postoperative dysphagia,[20,28,30,32] although one study noted the highest rates with surgical procedures at C4–5 and C5–6.[14]

In addition to greater operative time and more involved levels causing dysphagia, larger endotracheal tube size,[18] use of intraoperative bone morphogenetic protein,[31] use of an anterior cervical plating system,[18,27] and revision anterior cervical surgery[19,22,30] have all been noted to cause postoperative dysphagia after spinal surgery.

Patient Factors

Patient-specific factors also play a role in the development of postoperative dysphagia. Patients with a higher level of preoperative comorbidities are at greater risk of postoperative dysphagia after cervical spine surgery.[11,31,33] Specific comorbidities associated with postoperative dysphagia include diabetes mellitus,[18,20] obstructive sleep apnea,[11] asthma,[11] and higher body mass index.[20] In addition, smokers[16,20,22] and patients on preoperative opiates[30] are also at higher risk for postoperative dysphagia.

The data with regard to the impact of age and sex on postoperative dysphagia rates are conflicting. Most studies associate age > 55–60 years with increased risk of postoperative dysphagia after spinal surgery,[14,16,20,25,27,31,33] but other studies have found that younger age was predictive for the development of postoperative dysphagia.[11,29] Similarly, female sex is more commonly reported as a risk factor for the development of dysphagia,[11,19,20,27] but other studies have either found that male sex is associated with dysphagia[29,31] or that sex does not influence the rates of postoperative dysphagia.[17,22,34]

Multiple studies have shown that worse preoperative quality-of-life scores, including higher visual analog scale,[20] Oswestry Disability Index,[20] and Neck Disability Index[30] scores and lower Short Form-36[33] scores are predictive of the development of postoperative dysphagia.

Radiographic Factors

Spinal sagittal alignment has been noted as a risk factor for the development of postoperative dysphagia after cervical spine surgery. Ohba et al.[16] determined that a preoperative kyphotic angle at C3–4 and C4–5 and a change in the kyphotic angle at C4–5 were independent predictors of persistent dysphagia 1 year after cervical spinal surgery. Other authors have noted that greater preoperative C2–7 angle[20,30] or postoperative increase of C2–7 angle > 5°[17] were predictive of developing postoperative dysphagia.

Multiple studies have shown that the presence of postoperative prevertebral soft-tissue swelling does not correlate with the presence of postoperative dysphagia.[32,35] However, preoperative esophageal distance from the spine of < 5 mm has been associated with postoperative dysphagia.[27]

Cumulative Data

Li et al.[27] prospectively analyzed 158 patients who underwent anterior cervical spine surgery. Forty-four patients developed dysphagia postoperatively when graded on the basis of the Bazaz dysphagia score. Logistic regression analysis determined that age > 60 years, female sex, placement of a cervical plate, esophageal distance from the spine < 5 mm preoperatively, and surgery with 3 operative segments were all independent risk factors for the development of postoperative dysphagia. On the basis of these data, a predictive algorithm was created to determine the risk of postoperative dysphagia for patients undergoing anterior cervical spine surgery. The area under the receiver operating characteristic curve was 0.872, indicating high classification accuracy.

Strategies for Mitigating Dysphagia After Cervical Spine Surgery

Numerous studies have evaluated potential strategies for mitigating the risk of dysphagia after cervical spine surgery, including intraoperative medication, esophageal and endotracheal manipulation, cervical plate design, surgery selection, and multimodal methods. Many of these studies were prospective randomized trials; however, the data remain heterogenous, and dysphagia remains prevalent even in treatment groups.

Intraoperative Medication

Intraoperative steroid administration is a well-studied strategy for decreasing dysphagia rates after cervical spine surgery. Most data demonstrated that both local and intravenous (IV) intraoperative steroid administration are associated with lower rates of dysphagia in the early to intermediate follow-up period. Some data show less radiographic swelling with local steroid use, but the clinical results are largely similar between both steroid administration techniques.

Okano et al.[30] retrospectively studied 291 patients and found that intraoperative topical steroid use was an independent protective factor against low dysphagia subcomponent score on HSS-DDI at 4 weeks postoperatively, but there was no difference with steroid use at 4- to 6-month

follow-ups. Koreckij and colleagues[36] retrospectively studied 44 patients who underwent multilevel ACDF and found that both Bazaz and EAT-10 scores had improved at 6 weeks and 3 months postoperatively when local steroids were used. Although prevertebral soft-tissue swelling in the steroid group was slightly lower on initial postoperative radiography ($p = 0.07$), this was no longer evident at 6 weeks.[36] In a prospective double-blind randomized controlled trial, Curto and Edwards[37] found that local steroid administration significantly reduced the incidence of dysphagia and severe dysphagia in terms of Bazaz and EAT-10 scores on postoperative day 4, but there were no significant long-term differences in the rates of dysphagia between the control and the steroid groups.[37] In contrast, Haws et al.[38] also performed a prospective randomized controlled trial of local steroid administration and found no difference in the dysphagia rates between groups based on SWAL-QOL score.

Cui et al.[39] performed a double-blind randomized controlled trial of perioperative steroid administration in 64 patients who underwent anterior cervical spine surgery. Patients who received perioperative IV steroids reported significantly better dysphagia in terms of both the Bazaz and DSQ scores at most time points through 6 months postoperatively. On subgroup analysis, patients who underwent multilevel fusion benefited significantly from corticosteroids in terms of both dysphagia scores, whereas those who underwent single-level procedures did not. There were no short-term wound complications or infections, and length of stay and fusion rates were comparable.

Jenkins et al.[40] performed a prospective single-blind randomized controlled trial of 75 patients who received local steroid administration, IV steroid administration, or no steroid administration intraoperatively. At 2 weeks postoperatively, the local steroid cohort showed significantly lower prevalence of severe dysphagia based on EAT-10 score compared with the control and IV steroid groups. However, both steroid groups had significantly less severe dysphagia when compared with the control group at 6-week and 3-month follow-ups. At 1 year postoperatively, both steroid groups had significantly reduced dysphagia rates compared with the control group.

One double-blind randomized controlled trial involving 111 patients compared local bupivacaine administration to placebo. Villavicencio et al.[41] found no difference between the bupivacaine and control groups with regard to dysphagia rates after anterior cervical spine surgery in terms of the SWAL-QOL scores.

Endotracheal and Esophageal Manipulation

Multiple randomized controlled trials have investigated endotracheal cuff deflation and reinflation after intraoperative esophageal retractor systems have been placed in an attempt to mitigate postoperative dysphagia. According to the literature, patients report less severe sore throat at 24 hours postoperatively when the cuff is reinflated to 20 mm Hg, but there are otherwise no differences in the rates of dysphagia.[42,43] Similarly, when the cuff is reinflated to 15 mm Hg, there are no differences in the rates of postoperative dysphagia.[44]

Intraoperative esophageal retraction has been found to be significantly greater during anterior cervical surgery at the C5–6 level than the C3–4 level.[45] Furthermore, significantly greater esophageal pressures have been recorded during single-level ACDF compared with single-level disc arthroplasty. The highest mean pressure was recorded at the C5–6 level during insertion of 3-level plates.[45] Despite these findings, Papavero et al.[46] found no correlation between the force of esophageal retraction and the occurrence of postoperative dysphagia in their prospective study of 92 patients who underwent anterior cervical spine surgery. In contrast, Mendoza-Lattes et al.[47] found that patients with dysphagia had a significantly higher average intraoperative esophageal intraluminal pressure, as well as a significantly lower average esophageal mucosal perfusion rate, than asymptomatic patients. However, only 17 patients were included in the study.

In a prospective randomized controlled trial of 102 patients, Chen et al.[48] compared those who underwent tracheoesophageal traction exercises for 3 days preoperatively with those who did not. In the first 3 weeks after operation, the Bazaz dysphagia scores of the patients who underwent 2- to 4-level anterior cervical surgical procedures were better in the traction group than the control group. However, at 6 weeks and later follow-up evaluations, there were no differences in the rates of dysphagia.

Cervical Plate Design

Multiple studies have investigated slimmer plate design as a factor for mitigating postoperative dysphagia after anterior cervical spine surgery. The Zephir plate (Medtronic Sofamor Danek, Inc.; width 15 mm, thickness 1.6 mm) showed no benefit with regard to dysphagia rates compared with the Codman plate (Johnson & Johnson Inc.; width 17.58 mm, thickness 2.69 mm).[49] However, the Zephir plate had lower rates of dysphagia than the Atlantis plate (Medtronic Sofamor Danek, Inc.; width 25 mm, thickness 2.5 mm) at all follow-up periods through 2 years postoperatively.[50]

ACDF Versus Arthroplasty

Comparisons of dysphagia rates in patients who underwent ACDF and disc arthroplasty are well documented in the spinal literature. Most studies demonstrate similar rates of dysphagia between these cohorts in the immediate postoperative period, but patients who undergo ACDF frequently show higher rates of chronic dysphagia than patients who undergo disc arthroplasty. Smucker et al.[51] noted similar rates of short-term dysphagia between ACDF and disc arthroplasty patients but found significantly worse Bazaz dysphagia scores at ≥ 5 years of follow-up in patients who underwent ACDF. McAfee and colleagues[52] also reported similar Bazaz dysphagia scores at short-term follow-up between ACDF and disc arthroplasty patients but worsened dysphagia at the 3- and 12-month follow-up evaluations in the ACDF cohort. Skeppholm and Olerud[53] found no differences in dysphagia rates between their ACDF and disc arthroplasty cohorts through 2 years of follow-up, whereas patients treated with ACDF had significantly higher rates of dysphagia. Tian and Yu[34] noted higher rates of dysphagia after posterior cervical

spine surgery when compared with disc arthroplasty at 1-year follow-up, but they also reported worse Bazaz dysphagia scores in ACDF patients than both posterior cervical and disc arthroplasty patients. In contrast to the aforementioned studies, Yang et al.[54] noted worsened dysphagia rates in ACDF patients as early as 1 week postoperatively when compared with those of disc arthroplasty patients, and this continued throughout all follow-up intervals.

Multimodal Strategies for Dysphagia Mitigation

Grasso et al.[55] prospectively studied 35 patients who underwent a combined dysphagia mitigation strategy of intraoperative endotracheal cuff deflation and reinflation to 20 mm Hg, local steroid administration, and reduced esophageal retraction, and this cohort was compared with 35 control patients. The rates of postoperative dysphagia were lower in the intervention group during both the short-term and long-term follow-up periods.

Conclusions

Dysphagia after cervical spine surgery is prevalent and can negatively impact quality of life of patients. Use of validated dysphagia scales that are easy to administer and score, such as EAT-10, are necessary to better elucidate the risk factors for the development of postoperative dysphagia, as well as preventative measures. Multilevel surgery with long operative times, female sex, older age, use of an anterior cervical plate, and revision surgery are all significant risk factors for the development of dysphagia after cervical spine surgery. Intraoperative steroid administration, use of disc arthroplasty, and preoperative tracheoesophageal traction help to mitigate postoperative dysphagia. Future studies are warranted to continue to better define the risk factors and preventative measures for dysphagia after cervical spine surgery.

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Author Contributions

Conception and design: all authors. Acquisition of data: Potts, Alentado. Analysis and interpretation of data: Potts, Alentado. Drafting the article: Potts, Alentado. Critically revising the article: all authors. Reviewed submitted version of manuscript: Alentado, Bisson. Approved the final version of the manuscript on behalf of all authors: Potts. Study supervision: Potts.

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