International and Multicenter Prospective Controlled Study of Dysphagia After Anterior Cervical Spine Surgery

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BACKGROUND: In the context of anterior approach to the cervical spine, dysphagia is a common complication and still without a clear distinction of risk factors.

OBJECTIVE: To analyze the risk factors of dysphagia after cervical spine surgery.

METHODS: Multicenter prospective study evaluated patients who underwent anterior cervical spine surgery for degenerative pathologies, studying surgical, anesthesia, base disease, and radiological variables (preoperatively, 24 hours, 1 and 3 weeks, and 6 months after surgery), with control group matched. Postoperative dysphagia was assessed by Swallowing Satisfaction Index and Swallowing Questionnaire; besides, based on multiple logistic regression model, a risk factor analysis correlation was applied.

RESULTS: In total, 233 cervical patients were evaluated; most common level approached was C5-C6 (71.8%). All showed same decreasing trade for dysphagia incidence—with more cases on cervical group ($P < .05$); severe cases were rare. At postoperative day 1, identified risk factors were approach to C3-C4 (4.11, $P < .01$), loss of preoperative cervical lordosis (2.26, $P < .01$), intubation attempts ≥2 (3.10, $P < .01$), and left side approach (1.85, $P = .02$); at day 7, body mass index ≥30 (2.29, $P = .02$), C3-C4 (3.42, $P < .01$), and length of surgery ≥90 minutes (2.97, $P = .005$); and at day 21, C3-C4 were kept as a risk factor (3.62, $P < .01$).

CONCLUSION: A high incidence level of dysphagia was identified, having a clear decreasing trending (number of cases and severity) through postoperative time points; considering possible risk factors, strongest correlation was the approach at the C3-C4 level—statistically significant at the 24 hours, 7 days, and 21 days assessment.

KEY WORDS: Cervical spine surgery, Dysphagia, Risk factors

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Postoperative dysphagia is a common complication after anterior approach to the cervical spine.[1,2] It has a broad range of incidence, varying from 1% to 79%, with different factors involving the patient, surgeon, surgery, and others,[3,4] having the displacement of the esophagus with retractors as one of the intraoperative risk factors for dysphagia.[5]

Patient-related dysphagia factors are high body mass index (BMI), diabetes mellitus, hypertension, smoking, alcoholism, depression, and anxiety.[6,7] Ultimately, the processes involving anesthesia, the cervical disease, and the surgical steps during spinal exposure were considered as influencers on swallowing during the postoperative period.[8-10] There are several classifications for

ABBREVIATIONS: SQ, Swallowing Questionnaire; **SSI,** Swallowing Satisfaction Index.

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postoperative dysphagia regarding its intensity—mild to severe, time of duration, and clinical presentation.[11,12] A prospective, multicentric study on risk factors for dysphagia to analyze and promote a uniform comprehension with standardized scales is essential for further knowledge of subsequent prevention and management strategies.

The article aims to analyze the risk factors of dysphagia after anterior cervical spine surgery by a prospective multicentric design using a validated and standard scale.

METHODS

Study Design

A multicenter prospective study was performed—6 centers: Argentina, Brazil, Mexico, Colombia, and Chile. This study was approved by local Ethics Committees—CAAE Number 50485615.7.0000.5341.

Eligibility of the Patients

The inclusion criteria were symptomatic patients older than 18 years who underwent anterior cervical spine surgery for degenerative spine pathologies. The control group included patients who underwent lumbar spine surgeries for degenerative disease, to evaluate deeply the effect of the intubation itself on dysphagia—once others, which can be involved in dysphagia as risk factors, were already focused specific in literature, besides making possible an adequate pairing and matching processes. The degenerative pathologies observed in both were disk herniation, stenosis, and spondylolisthesis. The patients were included after agreeing to participate in this study and signing an informed consent.

The exclusion criteria were gastroesophageal reflux disease, prolonged use of endotracheal tube, cervical spine trauma, previous neck or cervical spine surgery, presence of dysphagia in the preoperative period, and diagnosis of neurological disorders associated with dysphagia.

Variables Analyzed

Variables from patients, surgery, anesthesia, and related to the disease were analyzed.

Patient Variables

The patient variables studied included age, sex, weight, height, BMI, smoking history, and the occurrence of comorbidities (eg: systemic arterial hypertension, diabetes mellitus, chronic obstructive pulmonary disease, rheumatoid arthritis, and cancer history).

Psychological evaluation of anxiety and depression were performed by 2 five-graded questions about the presence of (1) anxiety and (2) sadness or depression in the past 30 days. The answers were presented in a "Likert scale" of never, hardly, perhaps, frequently, and always.[13]

Surgical Variables

Several surgical details (nonrandomized surgeon choices preferences) were recorded including left-sided or right-sided Smith-Robinson approach; usage of a deep self-retractor, number, and level of discectomies and/or corpectomies; use of mesh or titanium cylinder; and the application of an intervertebral device or cervical plate. The length of the surgery, total bleeding volume, and the usage of postoperative neck brace were also recorded. All immediate postoperative motor deficits were recorded.

Anesthesiologic Variables

Anesthesiologic information included American Society of Anesthesiologists score, number of intubation attempts, tube size, presence of difficult airway, and transoperative release of tube cuff pressure.

Radiology

Radiological features included level(s) of the disease, presence of anterior vertebral osteophytes (>2 mm), cranial center of gravity C7 sagittal vertical axis—distance between a plumb line from cranial center of gravity, and the posterosuperior corner of C7[14] and C2-C7 Cobb angle.

Dysphagia Assessment

Dysphagia was assessed through the Swallowing Satisfaction Index (SSI) and the Swallowing Questionnaire (SQ) that was modified from the Bazaz classification[15]—converting this initial qualitative scale method into a detailed quantitative scoring system, adding more frequency options and examples of dysphagia situations possibly experienced by patients.

The SSI consisted in a five-point graded question about satisfaction with swallowing. The patient was classified as Swallowing satisfied if the SSI had an answer graded 4 and 5 and swallowing dissatisfaction, on the contrary, occurred when the grade was 1, 2, or 3.

The SQ consists in five-point graded questions which scored dysphagia as light, moderate, or severe based on which kind of food the patient choked (Table 1). The patient was classified as having light, moderate, or severe dysphagia, if the SQ was graded 1, 2, or 3.

Investigators applied the questionnaires during the preoperative time and postoperative 24 hours, 1 week, 3 weeks, and 6 months. At the 6-month postoperative follow-up evaluation, the 3 questionnaires were applied. At 6 months, if the SSI had an answer graded 1, 2, or 3, the patient was oriented to perform an otolaryngology examination, video fluoroscopic swallow, and fiberoptic endoscopic evaluation (Figure 1).

Follow-up

The final patient follow-up was 6 months after surgical intervention (sequential time points during this interval).

Blinding

Patient data were uploaded to an encrypted database using ID number without the name. The questionnaires were applied by a masked evaluator, and the database uploader was also blinded.

Theory/Calculation

Means and SD were used to summarize continuous data which were then compared at baseline using t tests. Categorical variables were expressed as counts and percentages. Baseline differences between groups were assessed by χ^2 or Fisher exact tests when needed.

Sample size was calculated considering immediate postoperative dysphagia prevalence as 30% with a 7% error and incidence of 5% 6-month dysphagia considering a 3.5% error. With these data, the suggested sample size was 210 patients.

To evaluate differences between groups, we conducted an analysis of covariance with adjustments for baseline measurements. The results were presented with mean ± SD at 95% CIs. The significance level of this study was set at a = 0.05. Data were analyzed using SPSS version 22.0 (IBM).

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TABLE 1. Swallowing Questionnaire

Swallowing questionnaire					
Symptoms	**Always**	**Often**	**Sometimes**	**Hardly ever**	**Never**
Choking when you eat solid food (ie, bread, meat) Mild dysphagia	1	2	3	4	5
Choking when you eat fewer solid foods (soft foods or grains such as shakes, pasta, cereals, rice, beans) Moderate dysphagia	1	2	3	4	5
Choking when you swallow liquids Severe dysphagia	1	2	3	4	5
Coughing when you eat	1	2	3	4	5
Having excess saliva	1	2	3	4	5
Having to clear your throat	1	2	3	4	5
Food sticking in your throat	1	2	3	4	5
Food sticking in your mouth	1	2	3	4	5

RESULTS

Baseline Characteristics

A total number of 233 patients composed the cervical spine group (cervical) and 158 patients the lumbar spine group (control). Baseline characteristics were similar in age, sex, and BMI (Table 2). Analyzing anesthesia procedures, the American Society of Anesthesiologist 2 score was most prevalent for both. Intubation attempts equal or more than twice were also similar, 17.2% for cervical and 16.2% for lumbar patients (Table 1). The cervical spine level approached was C5-C6 (71.8%), C6-C7 (37.6%), C4-C5 (36.5%), C3-C4 (12.9%), and C7-T1 (1.2%). The control group had as common levels L4-L5 (56.2%) and L5-S1 (55.2%). Both groups had a similar total number of levels, 1 or 2 levels compromised 86% of the cases. The length of surgical intervention was similar between the groups, with a mean of 112 ± 46.9 hours for the cervical group and 137 ± 54.9 hours for the lumbar group. Lumbar spine cases showed significantly greater

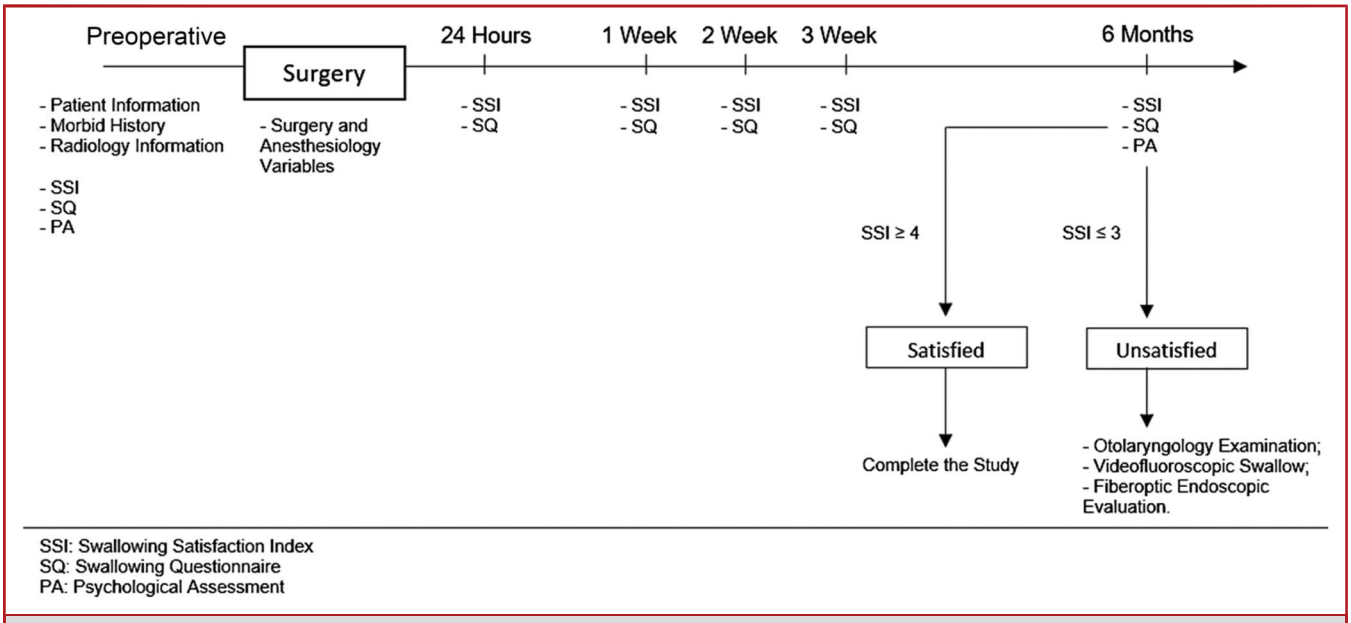

FIGURE 1. *Flowchart of the dysphagia assessment in patients who underwent cervical and lumbar spine surgery.*

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TABLE 2. Baseline Characteristics

Characteristics	Cervical (n = 233)	Lumbar (n = 158)	P
Age, y	52.1 ± 11.9	51.8 ± 15.2	.85
Male sex, no. (%)	118.8 (51.8)	82.2 (52.4)	>.99
BMI, kg/m^2	26.3 ± 4.2	27.2 ± 4.2	.17
History of, no. (%)			
Hypertension	76 (32.9)	46 (29.5)	.64
Diabetes mellitus	25 (10.6)	29 (18.1)	.16
Pulmonary disease	3 (1.2)	2 (1.0)	>.99
Coronary artery disease	0 (0.0)	6 (2.9)	.26
Cancer	6 (2.4)	3 (1.9)	>.99
Smoking	41 (17.6)	27 (17.1)	>.99
Anxiety	2.7 ± 1.3	2.6 ± 1.2	.54
Depression	1 (1-2)	1.5 (1-3)	.69
ASA score, no. (%)		.60	
1	71 (30.6)	54 (34.3)	
2	142 (61.3)	84 (53.3)	
≥3	19 (8.3)	20 (12.4)	
Level of the disease, no. (%)			
C3-C4	30 (12.9)		
C4-C5	85 (36.5)		
C5-C6	167 (71.8)		
C6-C7	87.6 (37.6)		
C7-T1	3 (1.2)		
L2-L3		17 (10.5)	
L3-L4		32 (20.0)	
L4-L5		89 (56.2)	
L5-S1		87 (55.2)	
Number of surgical levels, no. (%)			.14
1	115 (49.4)	93 (59.0)	
2	88 (37.6)	42 (26.7)	
≥3	30 (13.0)	23 (14.3)	
Tube diameter, no. (%)			.09
6 and 6.5	17 (7.1)	9 (5.8)	
7 and 7.5	134 (57.6)	81 (51.4)	
≥8	82 (35.3)	68 (42.9)	
Intubation attempts ≥2, no. (%)	40 (17.2)	26 (16.2)	.52
Length of surgery, h	112 ± 46.9	137 ± 54.9	.05
Volume bleeding, mm	91 ± 79.6	312 ± 96.2	<.001

ASA, American Society of Anesthesiologists; BMI, body mass index.
Data are presented as mean ± SD, median (IQR, P25-P75), or counts (percentages)

blood loss than the cervical group (312 ± 96.2 vs 91 ± 79.6 mL; $P < .001$) (Table 2).

Incidence of Dysphagia in Cervical and Lumbar Spine Patients

The incidence of swallowing dissatisfaction in cervical spine patients decreased progressively during the postoperative assessment of 1, 7, 21, and 180 days. The control group had an extensively lower incidence on day 1 after surgery with a similar reduction of dysphagia on days 7 and 21 (Figure 2). The otolaryngology examination, video fluoroscopic swallow, and fiberoptic endoscopic evaluation were performed in the 6 cases with dysphagia 6 months after surgery, being all normal.

Intensity of Dysphagia in Cervical Spine Patients

Mild dysphagia was the most frequent type at all time points (Figure 3). Severe dysphagia had a lower incidence, from 16 cases on day 1, 7 cases on day 7, 5 cases on day 21, to 3 cases at 6 months.

Coughing and Food Sticking in Cervical Spine Patients

Coughing and sticking in the throat and in the mouth are frequent symptoms in patients who reported dysphagia. Coughing was the complaint of 72 (30.9%) patients on postoperative day 1, 29 (12.4%) on day 7, 19 (8.2%) on day 27, and 4 (2.0%) at the 6-month assessment (Figure 4). The incidence of sticking in the throat and month has diminished over timeline.

Risk Factors for Dysphagia

To evaluate the strength of association between selected variables and the occurrence of dysphagia at 24 hours (Table 3), 1 week (Table 4), and 3 weeks (Table 5) after surgery, the data correlation was tested based on the odds ratio (95% CI) and adjusted by a multiple logistic regression model.

For a total number of 233 patients, 117 of whom considered dysphagic and 116 nondysphagic, first postoperative days, adjusted data showed the following risk factors: approach to C3-C4 (4.11, $P < .01$), loss of preoperative cervical lordosis (2.26, $P < .01$), intubation attempts ≥2 (3.10, $P < .01$), and left side approach (1.85, $P = .02$).

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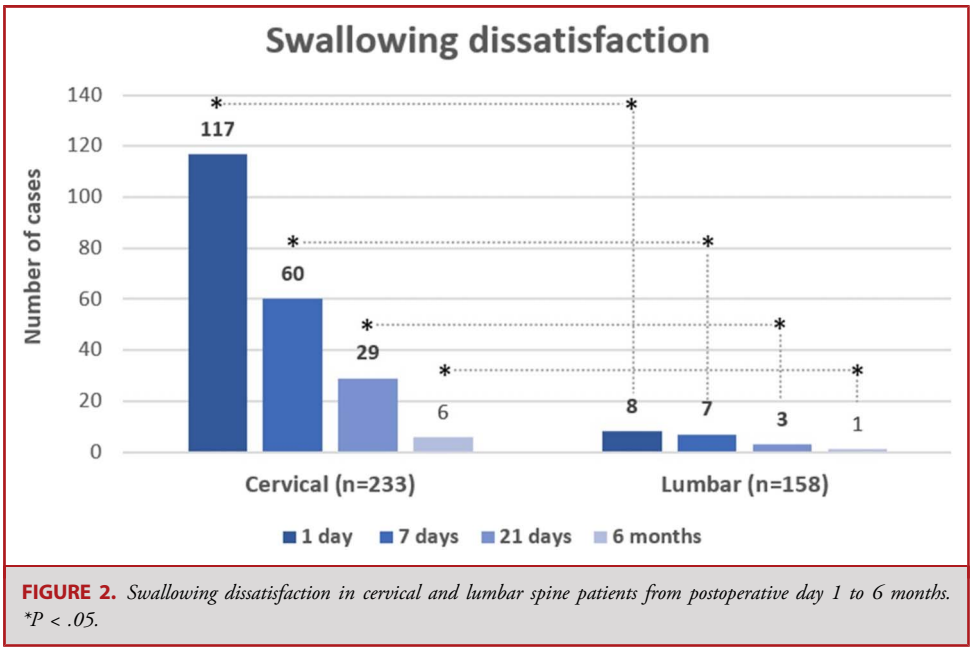

FIGURE 2. *Swallowing dissatisfaction in cervical and lumbar spine patients from postoperative day 1 to 6 months. *P < .05.*

Maintaining the total number of 233 patients, for postoperative day 7, a total of 173 were considered nondysphagic and 60 dysphagic; the approach to C5-C6 seemed as a protective factor (0.28, $P < .01$). Adjusted data presented associations, as follows, for risk factors: BMI ≥ 30 (2.29, $P = .02$), approach to C3-C4 (3.42, $P < .01$), and length of surgery ≥90 min (2.97, $P = .005$).

Considering the 21st day for postoperative evaluation, having 29 patients as dysphagic and 204 as nondysphagic, adjusted data

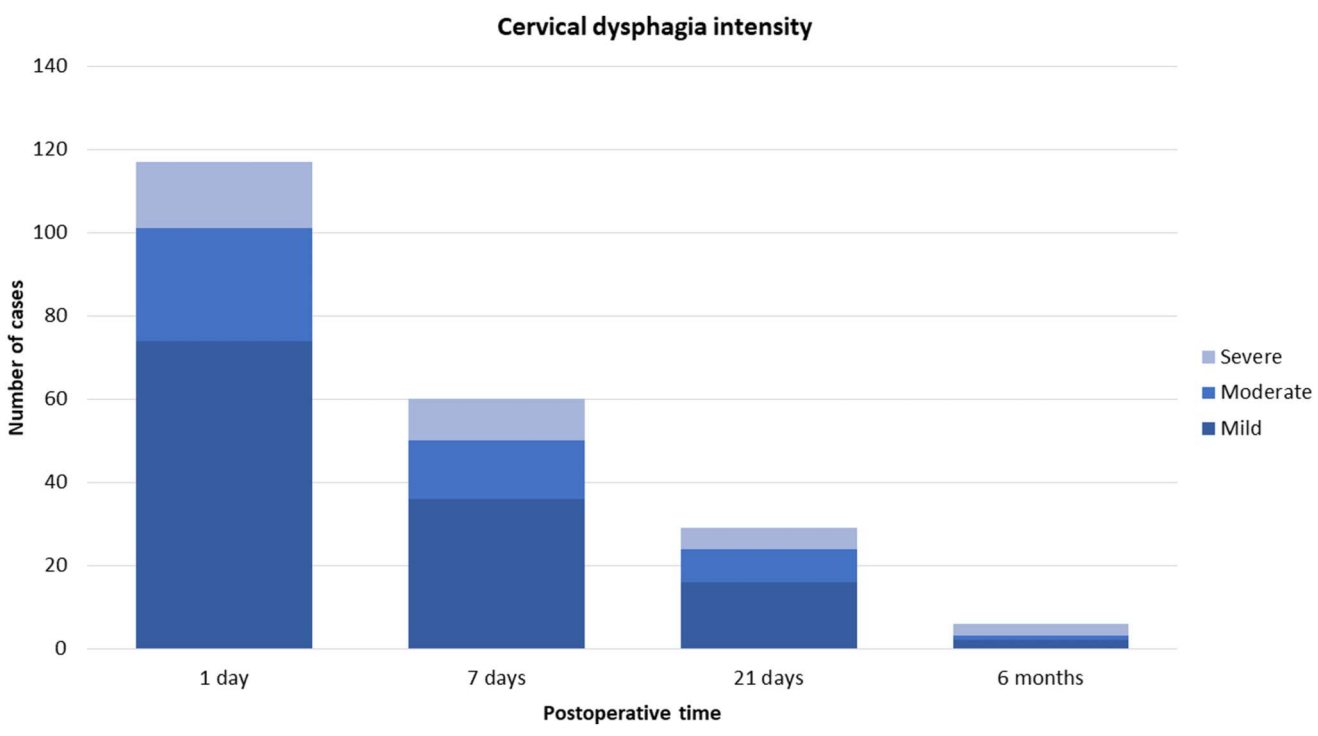

FIGURE 3. *Severe, moderate, and mild intensity dysphagia in cervical spine patients.*

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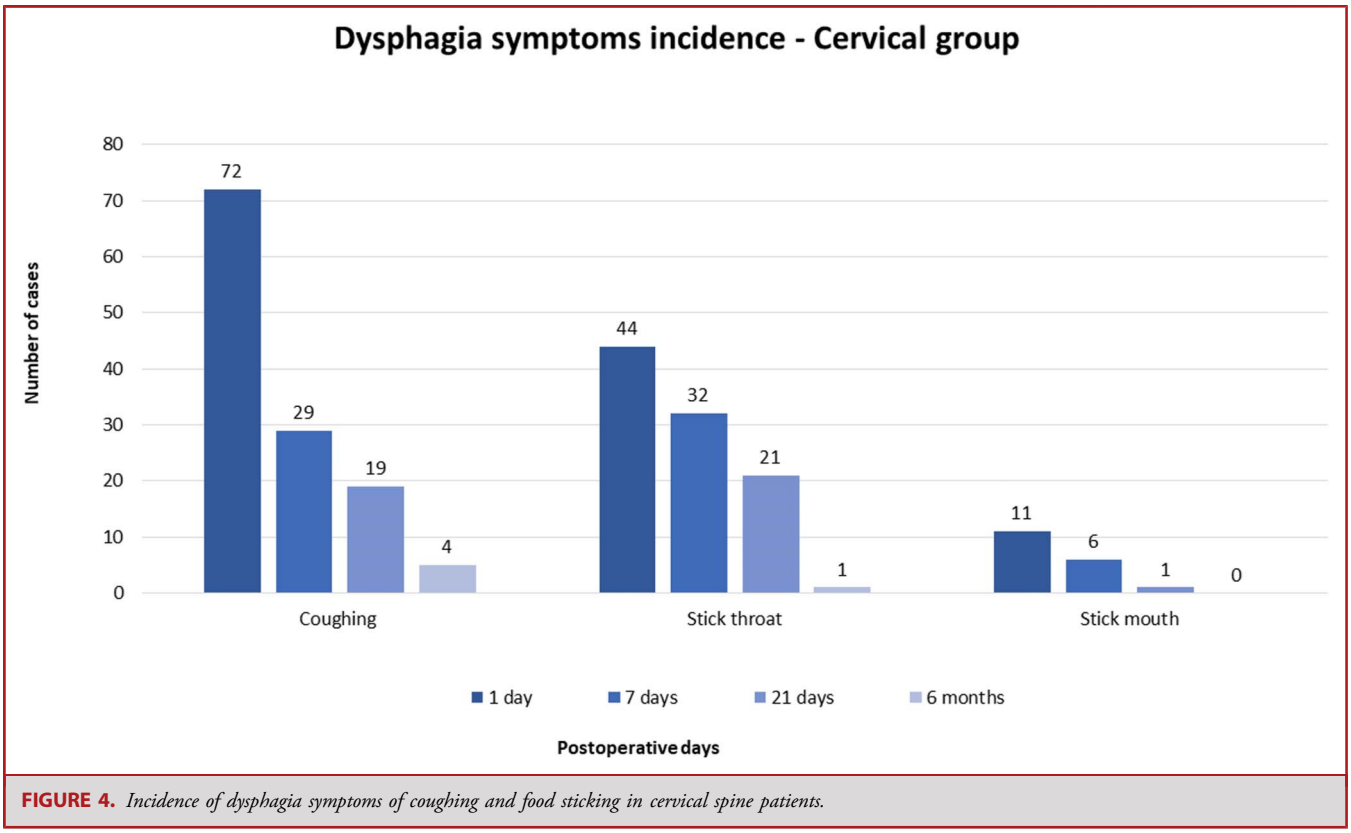

FIGURE 4. *Incidence of dysphagia symptoms of coughing and food sticking in cervical spine patients.*

pointed out the C3-C4 level as a risk factor (3.62, $P < .01$). None of the others showed statistical significance.

DISCUSSION

The present article showed that 50.2% (n = 117) of the dysphagia rates occurred in the first 24 hours after anterior cervical approach. The dysphagia incidence was progressively reduced to 2.6% (n = 6) at the 6-months\ evaluation. The literature reported a wide range of percentages of dysphagia, from 1% to 79%.[5,15] The strongest correlation with dysphagia was the approach to the C3-C4 level, observed at the 24 hours, 7 days, and 21 days assessment after surgery.

The anterior cervical approach Smith-Robinson technique is a classical and widely used, associated with successful results in the treatment of a variety of pathologies.[16] Considering the intensity of dysphagia in cervical spine patients, our study demonstrated that mild dysphagia was the most frequent type observed. The decreasing incidence was observed over the postoperative time—from 50.2% for the first day to 2.6% at 180 postoperative days. Those observations were also described in the literature.[17,18] There is still uncertainty around when the major problems with dysphagia subside. Our results suggest 6 months as a reasonable cut-off point, whereas others considered the dysphagia symptoms to last 1 to 2 years after surgery.[19]

The dysphagia intensity is important due to natural history and prognosis: As mild cases are usually self-limited, severe ones can have a considerable effect on the quality of life.[11] A prospective cohort study showed 7% of severe cases at 1 month postoperatively[17]; however, differently, our data showed 2.1% at 3 weeks. Both studies presented a similar improvement of dysphagia in the first 6 months with a lower number of cases as 0.3% at 24 months postoperatively and 1.3% at 6 months in this study.[17]

There is no unanimous and reliable questionnaire to assess dysphagia after anterior spine surgery.[20] The Bazaz classification of dysphagia is frequently applied, which categorizes the severity based on the frequency of symptoms and food viscosities.[15] Others are the Eating assessment tool,[21] the Dysphagia Short Questionnaire,[22] and the Swallow Quality-of-Life Questionnaire.[23,24] We combined the Bazaz classification and the SSI to capture broader information on dysphagia: clinical diagnosis, severity, and the impact on the quality of life. It is also important to point out that many authors, differently from here, did not inquire directly from patients regarding coughing and/or food sticking as possible postoperative dysphagia symptoms, showing diverging results.[25]

The identification of risk factors for dysphagia is essential to take actions to prevent it.[5,8] The literature shows an increased risk of dysphagia in the following variables: female sex,[26] more than

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TABLE 3. Swallow Satisfaction Index on Day 1 (n = 233)

Characteristics	S n = 116	NS n = 117	Crude OR (95%CI)	Crude P	Adjusted Or (95%CI)	Adjusted P
Age ≥60, y	37 (31.9)	30 (25.6)	0.74 (0.42-1.30)	.29	0.73 (0.41-1.30)	.28
Female sex	78 (67.2)	72 (61.5)	0.78 (0.45-1.33)	.36	0.73 (0.42-1.27)	.27
BMI ≥ 30, kg/m^2	16 (13.8)	24 (20.5)	1.61 (0.80-3.22)	.17	1.51 (0.75-3.05)	.25
Diabetes mellitus	10 (8.6)	12 (10.3)	1.21 (0.50-2.92)	.67	1.15 (0.46-2.89)	.77
Smoking	27 (23.3)	27 (23.1)	0.99 (0.54-1.82)	.97	0.95 (0.51-1.78)	.88
Anxiety	56 (48.3)	70 (59.8)	1.59 (0.95-2.68)	.07	1.65 (0.96-2.81)	.07
Depression	23 (19.8)	29 (24.8)	1.33 (0.72-2.48)	.36	1.38 (0.72-2.64)	.33
ASA score ≥3	15 (12.9)	12 (10.3)	0.77 (0.34-1.72)	.52	0.74 (0.31-1.77)	.50
Level of the disease						
C3-C4	8 (6.9)	25 (21.4)	3.67 (1.58-8.53)	.001	4.11 (1.71-9.86)	<.01
C4-C5	45 (38.8)	37 (31.6)	0.73 (0.42-1.25)	.25	0.77 (0.44-2.94)	.36
C5-C6	82 (70.7)	80 (68.4)	0.90 (0.51-1.57)	.70	0.82 (0.46-1.46)	.50
C6-C7	39 (33.6)	49 (41.9)	1.42 (0.84-2.42)	.19	1.31 (0.75-2.30)	.34
Preoperative distance CCGC7 ≥20 (mm)	56 (48.3)	53 (46.1)	0.92 (0.55-1.54)	.74	0.80 (0.46-1.37)	.41
Osteophytes anterior cervical	53 (45.7)	53 (45.3)	0.98 (0.59-1.65)	.95	0.90 (0.52-1.59)	.73
Preoperative cervical lordosis ≥15 (degree)	76 (66.7)	54 (46.6)	2.30 (1.35-3.91)	.002	2.26 (1.29-3.95)	<.01
Number of surgical levels ≥3	11 (9.5%)	18 (15.4)	1.74 (0.78-3.85)	.17	1.59 (0.68-7.78)	.28
Tube diameter ≥8	34 (29.3)	47 (40.9)	1.67 (0.97-2.88)	.06	1.57 (0.86-2.84)	1.40
Intubation attempts ≥2	12 (10.3)	27 (23.1)	2.60 (1.24-5.43)	.008	3.10 (1.43-6.70)	<.01
Left side of approach	55 (47.4)	71 (60.7)	1.71 (1.02-2.88)	.04	1.85 (1.07-3.19)	.02
Corpectomy performed (%)	5 (4.3)	11 (9.4)	2.30 (0.77-6.85)	.12	2.77 (0.91-8.46)	.07
Cervical plate used (%)	57 (49.1)	44 (37.6)	0.62 (0.37-1.05)	.07	0.58 (0.33-1.00)	.05
Length of surgery ≥90 h	83 (71.6)	75 (64.1)	0.71 (0.40-1.23)	.22	0.72 (0.41-1.28)	.27
Volume bleeding ≥60 mL	58 (50.0)	44 (37.6)	0.60 (0.37-1.05)	.07	0.56 (0.32-0.90)	.06
Neck brace, d	54 (46.6)	72 (61.5)	1.84 (1.09-3.09)	.02	0.66 (0.95-2.84)	.21

ASA, American Society of Anesthesiologists; BMI, body mass index; NS, not satisfied (swallow index ≤3); OR, odds ratio; *P*, statistical significance; S, satisfied (swallow index ≥4). Data are presented as mean ± SD or counts (percentages).

three-level surgery,[8] revision surgeries,[6] use of cervical plate,[11] patients older than 60 years,[26] smoking,[6] and long duration of pain before surgical intervention.[20] We could not identify those as risk factors probably because of different patient selection and disparities in methods for dysphagia evaluation. Higher disparity and divergence are observed when a revision is performed to analyze the cause-effect correlation.[10] For example, some articles identified the female sex as a potential risk factor for dysphagia,[26] and others, on the contrary, did not.[18] Table 6 summarized the risk factors for dysphagia after applying a multiple logistic regression model on days 1, 7, and 21 after surgery.

The present article showed that the C3-C4 level is an independent factor for dysphagia at 24 hours, 7, and 21 days postoperatively ($P < .01$). The same observation was made by Lee et al.[17] The reasons are the higher manipulation and retraction of soft tissues to gain access to the higher cervical levels, increasing the risk of superior laryngeal nerve damage.[27] Interestingly, a protective effect was observed at the postoperative evaluation on

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TABLE 4. Swallow Satisfaction Index on Day 7 (n = 233)

Characteristics	S n = 173	NS n = 60	Crude OR (95%CI)	Crude P	Adjusted OR (95%CI)	Adjusted P
Age ≥60, y	49 (28.3)	18 (30.0)	1.08 (0.57-2.06)	.80	0.74 (0.41-1.33)	.32
Female sex	113 (65.3)	37 (61.7)	0.85 (0.46-1.57)	.61	0.72 (0.42-1.27)	.62
BMI ≥ 30, kg/m^2	24 (13.9)	16 (26.7)	2.26 (1.10-4.62)	.02	2.29 (1.11-4.72)	.02
Diabetes mellitus	14 (8.1)	8 (13.3)	1.75 (0.69-4.40)	.25	1.46 (0.56-3.85)	.44
Smoking	41 (23.7)	13 (21.7)	0.89 (0.44-1.80)	.74	0.76 (0.37-1.59)	.47
Anxiety	94 (54.3)	32 (53.3)	0.96 (0.53-1.73)	.89	1.64 (0.96-2.81)	.07
Depression	37 (21.4)	15 (25.0)	1.25 (0.62-2.44)	.56	1.38 (0.72-2.63)	.33
ASA score ≥3	22 (12.7)	5 (8.3)	0.62 (0.22-1.73)	.34	0.47 (0.16-1.40)	.18
Level of the disease						
C3-C4	17 (9.8)	16 (26.7)	3.34 (1.56-7.14)	<.01	3.42 (1.55-7.56)	<.01
C4-C5	56 (32.4)	26 (43.3)	1.60 (0.87-2.92)	.12	1.82 (0.97-3.41)	.06
C5-C6	133 (76.9)	29 (48.3)	0.28 (0.15-0.52)	<.01	0.27 (0.15-0.53)	<.01
C6-C7	68 (39.3)	20 (33.3)	0.77 (0.42-1.43)	.41	0.82 (0.43-1.56)	.54
Preoperative distance CCGC7 ≥20 (mm)	79 (45.9)	30 (50.8)	1.21 (0.67-2.20)	.51	1.23 (0.67-2.27)	.50
Osteophytes anterior cervical	79 (45.7)	27 (45.0)	0.97 (0.54-1.76)	.92	0.87 (0.46-1.66)	.68
Preoperative cervical lordosis ≥15 (degree)	96 (56.1)	34 (57.6)	1.06 (0.58-1.93)	.84	1.13 (0.60-2.13)	.69
Number of surgical levels ≥3	19 (11.0)	10 (16.7)	1.62 (0.70-3.71)	.26	2.06 (0.83-5.14)	.12
Tube diameter ≥8	60 (34.7)	21 (36.2)	1.07 (0.57-1.99)	.83	0.94 (0.48-1.84)	.85
Intubation attempts ≥2	34 (16.7)	5 (17.2)	1.04 (0.37-2.92)	.93	1.08 (0.38-3.10)	.88
Left side of approach	96 (55.5)	30 (50.0)	0.80 (0.44-1.44)	.46	0.87 (0.47-1.60)	.65
Corpectomy performed (%)	13 (7.5)	3 (5.0)	0.64 (0.18-2.36)	.49	0.63 (0.17-2.63)	.50
Cervical plate used (%)	72 (41.6)	29 (48.3)	1.31 (0.73-2.37)	.36	1.51 (0.81-2.81)	.19
Length of surgery ≥90 h	108 (62.4)	50 (83.3)	3.00 (1.43-6.34)	.002	2.97 (1.39-6.32)	.005
Volume bleeding ≥60 mL	103 (59.5)	36 (60.0)	1.02 (0.56-1.86)	.95	1.04 (0.56-1.92)	.91
Neck brace, d	94 (54.3)	32 (53.3)	0.96 (0.53-1.73)	.89	0.83 (0.44-1.55)	.56

ASA, American Society of Anesthesiologists; BMI, body mass index; NS, not satisfied (swallow index ≤3); OR, odds ratio; *P*, statistical significance; S, satisfied (swallow index ≥4). Data are presented as mean ± SD or counts (percentages).

days 7 and 21, for patients who had discectomy at the C5-C6 level. The protection could be explained because the C5-C6 level is the most frequent level affected by the degenerative disease and the surgeon becomes confident because the anatomy is well-known, with minimal requirements for much traction.[28]

Cervical curvatures and angles can be related to the onset of dysphagia.[18] Our study found that the loss of preoperative cervical lordosis was a risk factor in the early postoperative assessment ($P < .01$). The same was found by Tian et al,[29] with a higher occurrence of dysphagia when the difference, considering postoperative less preoperative C2-C7 angles, was greater than 5° to 9°. A possible reason for the increased risk of dysphagia is the cervical angle correction to gain lordosis and the need for higher surgical manipulation and soft tissue dissection.

The pathophysiology of dysphagia is probably multifactorial, related to the pathology,[23,26] surgery,[27] patient characteristics,[4] postsurgical edema in the early postoperative period,[17] the amount of scar in the later recovery period (1 and 2 years),[17] and the complex anatomy and innervation of the oropharynx.[6] Taking it all together, the need for a more rostral cervical approach includes most of those components.

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TABLE 5. Swallow Satisfaction Index on Day 21 (n = 233)

Characteristics	S n = 204	NS n = 29	Crude OR (95%CI)	Crude P	Adjusted OR (95%CI)	Adjusted P
Age ≥60, y	59 (28.9)	8 (27.6)	0.94 (0.39-2.23)	.88	1.08 (0.56-2.08)	.81
Female sex	130 (63.7)	20 (69.0)	1.26 (0.55-2.92)	.58	0.89 (0.47-1.66)	.71
BMI ≥ 30, kg/m^2	35 (17.2)	5 (17.2)	1.00 (0.36-2.81)	.99	1.01 (0.36-2.84)	.99
Diabetes mellitus	19 (9.3)	3 (10.3)	1.12 (0.31-4.06)	.86	1.11 (0.29-4.21)	.88
Smoking	45 (22.1)	9 (31.0)	1.59 (0.68-3.73)	.30	1.61 (0.68-3.84)	.28
Anxiety	109 (53.4)	17 (58.6)	1.23 (0.56-2.71)	.60	0.93 (0.51-1.72)	.82
Depression	43 (21.1)	9 (31.0)	1.68 (0.72-3.96)	.24	1.11 (0.54-2.29)	.78
ASA score ≥3	26 (12.7)	1 (3.4)	0.24 (0.03-1.87)	.96	0.21 (0.03-1.72)	.15
Level of the disease						
C3-C4	24 (11.8)	9 (31.0)	3.37 (1.38-8.26)	.01	3.62 (1.43-9.17)	<.01
C4-C5	73 (35.8)	9 (31.0)	0.80 (0.35-1.86)	.61	0.81 (0.34-1.89)	.62
C5-C6	148 (72.5)	14 (48.3)	0.35 (0.16-0.78)	.01	0.34 (0.15-0.76)	<.01
C6-C7	78 (38.2)	10 (34.5)	0.85 (0.38-1.92)	.69	0.81 (0.35-1.89)	.62
Preoperative distance CCGC7 ≥20 (mm)	91 (45.0)	18 (62.1)	1.99 (0.90-4.44)	.08	2.05 (0.91-4.63)	.08
Osteophytes anterior cervical	92 (45.1)	14 (48.3)	1.13 (0.52-2.48)	.74	1.10 (0.48-2.53)	.81
Preoperative cervical lordosis ≥15 (degree)	114 (56.7)	16 (55.2)	0.93 (0.43-2.06)	.87	0.88 (0.39-1.97)	.75
Number of surgical levels ≥3	25 (12.3)	4 (13.8)	1.14 (0.37-3.57)	.81	1.15 (0.34-3.85)	.83
Tube diameter ≥8	70 (34.3)	11 (40.7)	1.32 (0.58-2.99)	.51	1.42 (0.59-3.47)	.43
Intubation attempts ≥2	34 (16.7)	5 (17.2)	1.04 (0.37-2.92)	.93	1.08 (0.38-3.10)	.88
Left side of approach	110 (53.9)	16 (55.2)	1.05 (0.48-2.30)	.89	1.08 (0.49-2.40)	.84
Corpectomy performed (%)	13 (7.5)	3 (5.0)	0.64 (0.18-2.36)	.49	0.63 (0.17-2.63)	.50
Cervical plate used (%)	89 (43.6)	12 (41.4)	0.91 (0.41-2.00)	.81	0.88 (0.39-1.97)	.75
Length of surgery ≥90 h	136 (66.7)	22 (75.9)	1.57 (0.64-3.86)	.31	1.61 (0.65-3.99)	.30
Volume bleeding ≥60 mL	120 (58.8)	19 (65.5)	1.33 (0.59-3.00)	.48	1.39 (0.61-3.17)	.44
Neck brace, d	112 (54.9)	14 (48.3)	0.76 (0.35-1.67)	.50	0.78 (0.35-1.74)	.54

ASA, American Society of Anesthesiologists; BMI, body mass index; NS, not satisfied (swallow index ≤3); OR, odds ratio; *P*, statistical significance; S, satisfied (swallow index ≥4). Data are presented as mean ± SD or counts (percentages).

Limitations

Considering the group of later dysphagia cases (6 months on), the analysis of risk factors correlation was not possible, once taking the study design, having a nonsignificant number of cases for deep and valid conclusions. Another limitation affecting our analysis is that there were relatively fewer multilevel and complex cervical spine cases in this study. At the same time, this is also the strength because the population selected is representative of most patients in whom cervical surgery is usually performed.

CONCLUSION

In a multicenter international study of 233 patients with primarily 1 to 2 level cervical pathology, a 50.2% incidence of dysphagia was reported in the first 24 hours after the anterior cervical approach and progressively diminished to 2.6% (n = 6) at the 6-month evaluation. The patients who complained of dysphagia at the last evaluation had normal results of the otolaryngology examination, video fluoroscopic swallow, and fiberoptic

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TABLE 6. Risk Factors for Dysphagia After Applying a Multiple Logistic Regression Model on Days 1, 7, and 21 After Surgery

Risk factor	Significance correlation at postoperative evaluation
Surgical approach to C3-C4 level	Day 1, 7, and 21
Loss of preoperative cervical lordosis	Day 1
Intubation attempts ≥ 2	Day 1
Left side approach	Day 1
BMI ≥ 30	Day 7
Length of surgery ≥90 h	Day 7

BMI, body mass index.

endoscopy. The strongest correlation with dysphagia was the approach at the C3-C4 level, which was statistically significant at the 24 hours, 7 days, and 21 days assessment.

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