

Risk Factors Associated with Dysphagia after Anterior Surgery in Treatment for Multilevel Cervical Disorder with Kyphosis

yongjun li

Hebei Medical University Third Affiliated Hospital

xing wei

Pekin University Aero

Bingyao Chen

Peking University

feng wang

Hebei Medical

Guangze Song

Peking University

yong shen (✉ xingtailyj@163.com)

Hebei Medical University Third Affiliated Hospital

Research article

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Abstract

Study Design: A retrospective study.

Objective: The purpose of this study was to clarify the risk factors associated with dysphagia following anterior surgery treating multilevel cervical disorder with kyphosis based on subgroup of follow-up time.

Methods: Totally, 81 patients who suffered from multilevel cervical disorder with kyphosis receiving anterior surgery from July 2018 to June 2020 were reviewed for clinical and radiological outcomes. Patients with dysphagia was defined as dysphagia group and without dysphagia as no-dysphagia group according to follow-up time (1 week, 1-month, 3-month, 6-month and 1-year after surgery). Data was performed to compare between the patients with and without dysphagia.

Results: In our study, the occurrence of dysphagia was 67.9%, 44.4%, 34.6% and 25.9% and 14.8% at the time of 1 week, 1-month, 3-month, 6-month, and 1-year after surgery, respectively. Our findings showed that a history of smoking, lower preoperative Swallowing Quality of Life (SWAL-QOL) score, post-operative Cobb angle of C2-7 and change of Cobb angle of C2-7 were associated with dysphagia within 3-month after surgery. Furthermore, a history of smoking, lower preoperative SWAL-QOL score, and post-operative Cobb angle of C2-7 were linked with dysphagia within 6-month after surgery. However, a history of smoking and lower preoperative SWAL-QOL score were found to be risk factors related with dysphagia at any follow-up.

Conclusions: In the present study, many factors were related with dysphagia during 3-month after surgery. What's more, a history of smoking and lower preoperative SWAL-QOL score were associated with dysphagia at any follow-up. We hope this article can provide a reference for spinal surgeons to predict which patients were susceptible to suffer from dysphagia after anterior surgery in treatment of multilevel cervical disorder with kyphosis.

Introduction

As with more frequently using cell phone and computer and lack of exercise, Multilevel Cervical Disorder with Kyphosis, as shown in Fig. 1 has become a common degenerative disease in clinical, which may severely affect quality of life or even lead to disability in elderly population.[1, 2] As we known, anterior surgery, not only providing sufficient decompression but also improving cervical lordosis, are widely used in treatment for cervical diseases such as multilevel Cervical Disorder with Kyphosis [1–3]. However, it is difficult to avoid some related complications like dysphagia with greater effect on patients' quality of life and psychological, varying from 1–79% morbidity reported in previous studies [4, 5]. Therefore, it is very important to identify the risks of dysphagia. Bazaz[6] mentioned that female patients, ≥ 60 years old and multiple surgeries were risk factors for dysphagia. Multilevel cervical spine and upper cervical spine surgeries was the leading factors associated with dysphagia [7]. A increasing number of articles focus on this topic, as far as we know, yet the risk factors for dysphagia remain controversial. Therefore, the aim of

this study was to explore risk factors of dysphagia based on subgroup of follow-up time following anterior cervical surgery treating multilevel cervical diseases.

Methods

Search strategy

Patients

We included 81 patients who underwent anterior cervical surgery from July 2018 to June 2020 in HeBei Medical university. We defined patients with dysphagia as dysphagia group and without dysphagia as no-dysphagia group at follow-up (1 week, 1-month, 3-month, 6-month and 1-year after surgery). The inclusion criteria for study were as follows: (1) study population must be adult patients (≥18 years old); (2) patients suffering from multilevel cervical disease including Cervical spondylotic myelopathy (CSM), Cervical spondylotic radiculopathy (CSR), Ossification of posterior longitudinal ligament (OPLL); (3) patients were diagnosed with dysphagia at follow-up according to Bazaz dysphagia score [6]; (5) patients following anterior cervical surgery including anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF); (6) Radiographic evaluation including X-ray imaging at the time of before surgery, 1 week, 1-month, 3-month, 6-month, and 1-year after surgery, preoperative computed tomography (CT) and magnetic resonance imaging (MRI) of the cervical spine must be performed. Studies were excluded if they (1) without completed data; (2) Patients treated for cervical trauma, tumor, infection, inflammation, scoliosis; (3) patients with another history of cervical surgery.

Imaging assessment

The following radiological variable were measured: angle of C2 to C7 (C2-C7) was defined as the angle formed by the inferior endplates of C2 and C7 in lateral radiographs. C2-C7 SVA is the distance from the posterosuperior corner of C7 and the vertical line from the center of the C2 body. T1 slope was measured as the angle between a horizontal line and the superior endplate of T1 on lateral radiograph.

The methods were carried out in accordance with the approved guidelines. We compared the data between dysphagia group and no-dysphagia group at follow-up. All measurement data were presented as the mean ± SD. (standard deviation) when data satisfied criteria for normality with $p > 0.05$. When data like age, Chi-square test was used for data analysis. The Kolmogorov–Smirnov test was used to verify the normal data distribution. Statistical significance levels were considered to be $p < 0.05$. All statistical analyses were carried out using SPSS, version 21.0 (SPSS Inc., Chicago, IL).

Results

1 week after surgery

At 1-week after surgery, 67.9% (55 of 81 patients) suffered from dysphagia. There was no difference in age, sex, diabetes, body mass index (BMI), disease duration, diagnoses, surgical procedure, pre- and post-operative JOA, number of fusion level, preoperative Cobb angle of C2-7, change of, pre- and post-operative T1 slope and pre- and post-operative C2 SVA in two group. However, smoker ($p=0.046$), preoperative Swallowing Quality of Life (SWAL-QOL) score ($p=0.001$), postoperative Cobb angle of C2-7 ($p=0.001$), change of Cobb angle of C2-7 ($p=0.001$), and change of C2 SVA ($p=0.031$) were found to be risk factors related with dysphagia.

1-month after surgery

28 of 81 patients (34.6%) occurred dysphagia. There was no difference in age, sex, diabetes, body mass index (BMI), disease duration, diagnoses, surgical procedure, pre- and post-operative JOA, number of fusion level, preoperative Cobb angle of C2-7, change of, pre- and post-operative T1 slope and change of, pre- and post-operative C2 SVA in two group. However, smoker ($p=0.001$), preoperative SWAL-QOL score ($p=0.001$), postoperative Cobb angle of C2-7 ($p=0.001$), and change of Cobb angle of C2-7 ($p=0.001$) were associated with increased rate of dysphagia at 1-month after surgery.

6-month after surgery

21 of 81 patients (25.9%) suffered from dysphagia. There was no difference in age, sex, diabetes, body mass index (BMI), disease duration, diagnoses, surgical procedure, pre- and post-operative JOA, number of fusion level, change of, and preoperative Cobb angle of C2-7, change of, pre- and post-operative T1 slope and change of, pre- and post-operative C2 SVA in two group. However, smoker ($p=0.001$), preoperative SWAL-QOL score ($p=0.001$), and postoperative Cobb angle of C2-7 ($p=0.008$) were associated with increased rate of dysphagia at 1-month after surgery.

1-year after surgery

21 of 81 patients (25.9%) suffered from dysphagia. There was no difference in age, sex, diabetes, body mass index (BMI), disease duration, diagnoses, surgical procedure, pre- and post-operative JOA, number of fusion level, change of, pre- and post-operative Cobb angle of C2-7, change of, pre- and post-operative T1 slope and change of, pre- and post-operative C2 SVA in two group. However, smoker ($p=0.001$) and preoperative SWAL-QOL score ($p=0.001$) were associated with increased rate of dysphagia at 1-month after surgery.

Multivariate analysis

Smoker, preoperative SWAL-QOL score, postoperative Cobb angle of C2-7 and change of Cobb angle of C2-7 were identified as risk factors of dysphagia within 3-month after surgery. At 6-month follow-up,

smoker, preoperative SWAL-QOL score, and postoperative Cobb angle of C2-7 were independent risks of dysphagia. However, only smoker and preoperative SWAL-QOL score were found to be risks of dysphagia at 1-year follow-up.

Discussion

Dysphagia is not a uncommon postoperative complication of anterior cervical surgery in the treatment of cervical diseases. Bazaz [6] performed a prospective study including 249 patients and reported the rate of postoperative dysphagia were 50.2%, 32.2%, 17.8%, and 12.5% at 1, 2, 6, and 12 months, respectively. A growing number of studies paid attention on risk factors of postoperative dysphagia and demonstrated that age, female patients, smoking, multilevel fused level, rhBMP use, perative time, type of surgical procedure, and surgical level, revision surgery, comorbidities such as diabetes and hypertension, and severe neck pain were related with increased risk of postoperative dysphagia [4, 5]. Although many scholars focused on postoperative dysphagia after anterior cervical surgery, the risk factors associated with postoperative dysphagia are controversial. To our knowledge, few studies have investigated the risk factors of postoperative dysphagia after anterior cervical surgery treating multilevel cervical disorder with kyphosis according to follow-up time.

Our findings showed that a history of smoking, lower preoperative SWAL-QOL score, post-operative Cobb angle of C2-7 and change of Cobb angle of C2-7 were associated with dysphagia within 3-month after surgery. Furthermore, a history of smoking, lower preoperative SWAL-QOL score, and post-operative Cobb angle of C2-7 were linked with dysphagia within 6-month after surgery. However, a history of smoking and lower preoperative SWAL-QOL score were found to be risk factors related with dysphagia at at any follow-up.

Thus, we perform a retrospective study to evaluate the risk factors associated with postoperative dysphagia based on subgroup of follow-up time. In the present study, 67.9%, 44.4%, 34.6%,25.9% and 14.8% at the time of 1 week, 1-month, 3-month, 6-month, and 1 -year after surgery, respectively. As Fig. 2 shown, within 1-year follow-up, the number of patients with postoperative dysphagia significantly decrease along with time but the descent gradually slowed down. Nevertheless, we did not observe a obviously stable tendency within 1-year follow-up due to our relatively short follow-up. We need a longer follow-up to assess when patients who have multilevel cervical disorder with kyphosis suffering from postoperative dysphagia after anterior cervical would significantly relieve.

In term of cervical sagittal parameters, Okano I [8] collected retrospectively data of 291 patients to identify the perioperative risk factors for dysphagia and dysphonia and suggested that preoperative C2-7 angle was not related with high morbidity, which was consistent with our result. However, Okano I did not studied on effect of postoperative C2-7 or correction of C2-7 on postoperative dysphagia. Tian [9] considered cervical sagittal parameters as factors and concluded that change of C2-7 angle played an important role in development of dysphagia in patient with or without kyphosis. Furthermore, Tian [9] demonstrated that once the dC2-C7 angle is greater than 5°, the chance of developing postoperative

dysphagia is significantly greater. Chen [10] also evaluated risk factors of the development of dysphagia following same-day combined anterior-posterior cervical spine surgeries and indicated an increment in surgical correction of C2–7 with an increasing rate of postoperative dysphagia. Actually, we partially agreed with previous conclusions [9, 10] due to the difference in character of the study population, which may lead to a slight discrepancy. In the present study, we only focused on patients with multilevel cervical disorder with kyphosis and proved that postoperative and change of C2–7 angle significantly impact dysphagia within 6 months, but not at 1-year follow-up. We definitely believed that postoperative and change of C2–7 angle were the leading driver in development of postoperative dysphagia in special patient with kyphosis at short-term follow-up. Surely, patients were not being adapted to a status that is against the esophagus caused by cervical lordosis and plate after anterior cervical surgery. Whereas, patients gradually adjust to the status that is against the esophagus. Mention above may perfectly account for our results. Park [11] believed that most patients were able to tolerate this increase in C2–7 SVA. While we also partially agree with Park's consequence. In our study, change of C2 SVA was discovered to be related with postoperative dysphagia with 1-month. After 1 month after surgery, patients may adapt to the correction of C2 SVA.

The SWAL-QOL questionnaire with lower scores indicating more frequent symptoms of dysphagia is a widely used tool to measure the degree of dysphagia [12, 13]. Because some questions are less suitable for a spinal surgical study [8]. Therefore, we adopted a 14-item questionnaire to assess symptoms frequently associated with dysphagia [14]. Vaishnav [15] firstly evaluated the relation between SWAL-QOL score and dysphagia and suggested that preoperative SWAL-QOL score was a predictive factor of dysphagia in single level ACDF. Park [11] also found preoperative dysphagia associated with poor postoperative functional swallow outcome by FOSS score. We obtained similar results with previous study [11, 15]. Our findings demonstrated that lower preoperative SWAL-QOL score implying was an independent risk of postoperative dysphagia at any follow-up in univariate and multivariate analysis, which was particularly relevant clinically because it was beneficial for spine surgeon to preoperatively distinguish those who were susceptible to postoperative dysphagia. Additionally, we are able to offer adequate preoperative preparation to minimize the degree of postoperative dysphagia.

A number of studies have shown detrimental effects of smoking on clinical outcomes of surgical treatment for spinal disorders. Riley [4] found that smoking was an independent predictor of postoperative dysphagia after anterior cervical surgery. Joaquim [5] had a similar result. In this study, the data indicated that no matter which follow-up, a history of smoking was positively related with postoperative dysphagia after anterior surgery. One plausible explanation for this result is the deleterious effects of smoking on delaying the detumescence of surrounding tissues.

There were several limitations in this study. First, this is a retrospective study from a single-center. We will conduct a prospective multi-center study in the future. Second, the small sample size of patients with postoperative dysphagia, especially at final follow-up, may induce potential biases. A larger number of patients with postoperative dysphagia were included in the further study. Third, 1-year follow-up time is

relatively short, a longer follow-up may be more significant. Fourth, we did not analyzed the degree of postoperative dysphagia based on Bazaz dysphagia score [6] because of small sample.

In conclusion, many factors including patients with a history of smoking, lower preoperative SWAL-QOL score, postoperative Cobb angle of C2-7 and change of Cobb angle of C2-7 and C2-7 SVA were related with postoperative dysphagia during 3-month after surgery. Furthermore, patients with a history of smoking and lower preoperative SWAL-QOL score were found to be risk factors of postoperative dysphagia after anterior cervical surgery at any follow-up. According to present study, we can clearly see which kind of people with kyphotic curvature and multilevel diseases more likely had postoperative dysphagia after anterior cervical surgery. We hope this article can provide a reference for spinal surgeons when facing multilevel cervical degenerative diseases. Meanwhile it is helpful for the future study on postoperative dysphagia. Further large-scale, well-designed studies are urgently needed.

Abbreviations

BMI = body mass index, JOA= Japanese Orthopedic Association, ACDF=anterior cervical discectomy and fusion, ACCF= anterior cervical corpectomy and fusion. SWAL-QOL= Swallowing Quality of Life

Declarations

Ethics approval and consent to participate:

The study was approved by the Institutional Review Board of the third hospital of Hebei Medical University before data collection and analysis. there is no need to write informed consent forms from patients because this is a retrospective study.

Consent for publication:

Not applicable.

Author Contributions:

YJL and XW was responsible for study concept, design, data extraction, data analysis, and writing the article. BYC was responsible for data extraction, screened the abstracts and reviewed the article. FW and GZS were responsible for study concept, design, and data analysis. YS was responsible for study concept, design, data analysis, and writing the article.

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Tables

Table 1

Comparison of characteristics between the two groups at 1-week after surgery

Characters	Dysphagia (n=55)	No-Dysphagia (n=26)	p
Age (years)	55.3±10.6	52.6±9.3	0.245
Sex (male/female)	28/27	14/12	0.805
Smoker (yes/no)	23/32	5/21	0.046
DM	11/44	5/21	0.935
BMI (kg/m ²),	24.2±3.1	25.0±3.2	0.541
Disease duration (months)	11.2±3.1	10.8±2.2	0.323
Diagnostic categories			
CSM	22	9	0.642
CSR	33	17	
Surgical procedure			0.675
ACDF	29	15	
ACCF	26	11	
Pre-op JOA	10.1±1.4	10.2±1.8	0.623
Post-op JOA	13.3±2.1	13.2±2.0	0.991
Number of fusion levels	3.6±0.8	3.1±0.5	0.078
Pre-op SWAL-QOL score	36.8±12.6	58.9±15.6	0.001
Pre-op Cobb angle of C2-7 (°)	1.1±2.1	0.8±2.0	0.167
Post-op Cobb angle of C2-7 (°)	15.1±3.6	12.3±2.9	0.001
Change of Cobb angle of C2-7 (°)	14.0±3.1	11.5±3.7	0.001
Pre-op T1 slope (°)	8.3±1.8	8.2±2.0	0.912
Post-op T1 slope (°)	11.3±2.0	11.5±2.3	0.867
Change of T1 slope (°)	3.0±1.8	3.3±3.2	0.765
Pre-op C2 SVA.(mm)	3.8±1.5	3.3±1.2	0.457
Post-op C2 SVA.(mm)	4.7±3.1	5.0±3.0	0.746
Change of C2 SVA.(mm)	0.9±1.3	1.7±1.4	0.031

Table 2

Comparison of characteristics between the two groups at 1-month after surgery

Characteristics	Dysphagia (n=36)	No-Dysphagia (n=45)	p
Age (years)	54.1±10.1	53.9±9.0	0.540
Sex (male/female)	17/19	25/20	0.456
Smoker (yes/no)	20/16	7/38	0.001
DM	9/27	7/38	0.289
BMI (kg/m ²),	24.4±3.4	24.9±3.6	0.725
Disease duration (months)	11.1±3.1	10.9±2.2	0.455
Diagnostic categories			
CSM	14	17	0.919
CSR	22	28	
Surgical procedure			0.842
ACDF	20	24	
ACCF	16	21	
Pre-op JOA	10.1±1.5	10.2±1.7	0.584
Post-op JOA	13.3±2.1	13.2±2.0	0.923
Number of fusion levels	3.5±0.8	3.1±0.6	0.125
Pre-op SWAL-QOL score	33.2±13.6	55.9±16.6	0.001
Pre-op Cobb angle of C2-7 (°)	1.1±2.0	0.8±2.0	0.227
Post-op Cobb angle of C2-7 (°)	15.3±3.5	12.4±2.9	0.001
Change of Cobb angle of C2-7 (°)	14.2±3.1	11.6±3.6	0.001
Pre-op T1 slope (°)	8.3±1.8	8.2±1.9	0.612
Post-op T1 slope (°)	11.3±2.0	11.5±2.3	0.767
Change of T1 slope (°)	3.0±1.8	3.3±3.2	0.513
Pre-op C2 SVA.(mm)	3.7±1.3	3.4±1.2	0.441
Post-op C2 SVA.(mm)	4.6±3.1	5.0±3.0	0.646
Change of C2 SVA.(mm)	0.9±1.3	1.7±1.4	0.038

Table 3

Comparison of characteristics between the two groups at 3-month after surgery

Characteristics	Dysphagia (n=28)	No-Dysphagia (n=53)	p
Age (years)	54.2±10.4	53.8±9.2	0.484
Sex (male/female)	15/13	27/26	0.822
Smoker (yes/no)	18/10	9/44	0.001
DM	6/22	10/43	0.783
BMI (kg/m ²),	24.4±3.2	24.9±3.8	0.625
Disease duration (months)	11.0±3.0	10.9±2.3	0.665
Diagnostic categories			
CSM	10	21	0.731
CSR	18	32	
Surgical procedure			0.401
ACDF	17	27	
ACCF	11	26	
Pre-op JOA	10.1±1.5	10.2±1.7	0.521
Post-op JOA	13.3±2.0	13.2±2.0	0.823
Number of fusion levels	3.6±0.9	3.0±0.7	0.109
Pre-op SWAL-QOL score	33.0±13.4	55.7±16.8	0.001
Pre-op Cobb angle of C2-7 (°)	1.1±2.0	0.8±2.0	0.205
Post-op Cobb angle of C2-7 (°)	15.2±3.4	12.5±3.0	0.001
Change of Cobb angle of C2-7 (°)	14.1±3.0	11.7±3.5	0.001
Pre-op T1 slope (°)	8.3±1.8	8.2±1.9	0.542
Post-op T1 slope (°)	11.4±2.0	11.4±2.3	0.923
Change of T1 slope (°)	3.1±2.0	3.2±3.1	0.756
Pre-op C2 SVA.(mm)	3.6±1.3	3.5±1.3	0.441
Post-op C2 SVA.(mm)	4.7±3.0	4.9±3.0	0.646
Change of C2 SVA.(mm)	1.1±1.4	1.4±1.5	0.058

Table 4

Comparison of characteristics between the two groups at 6-month after surgery

Characteristics	Dysphagia (n=21)	No-Dysphagia (n=60)	p
Age (years)	54.1±10.2	53.9±9.3	0.423
Sex (male/female)	10/11	32/28	0.652
Smoker (yes/no)	14/7	13/47	0.001
DM	5/16	11/49	0.751
BMI (kg/m ²),	24.5±3.1	24.8±3.6	0.875
Disease duration (months)	11.0±3.0	10.9±2.3	0.612
Diagnostic categories			
CSM	8	23	0.985
CSR	13	37	
Surgical procedure			0.836
ACDF	11	33	
ACCF	10	27	
Pre-op JOA	10.1±1.5	10.2±1.6	0.556
Post-op JOA	13.3±2.0	13.2±2.0	0.721
Number of fusion levels	3.5±0.9	3.1±0.7	0.297
Pre-op SWAL-QOL score	30.0±14.1	54.9±17.0	0.001
Pre-op Cobb angle of C2-7 (°)	1.1±2.0	0.8±2.0	0.311
Post-op Cobb angle of C2-7 (°)	14.6±3.2	13.1±3.2	0.008
Change of Cobb angle of C2-7 (°)	13.5±3.0	12.3±3.5	0.061
Pre-op T1 slope (°)	8.3±1.7	8.2±1.8	0.663
Post-op T1 slope (°)	11.3±2.1	11.4±2.2	0.871
Change of T1 slope (°)	3.0±2.0	3.2±3.0	0.451
Pre-op C2 SVA.(mm)	3.6±1.3	3.5±1.3	0.470
Post-op C2 SVA.(mm)	4.7±3.0	4.8±2.9	0.803
Change of C2 SVA.(mm)	1.1±1.4	1.3±1.6	0.181

Table 5

Comparison of characteristics between the two groups at 1-year after surgery

Characters	Dysphagia (n=12)	No-Dysphagia (n=69)	p
Age (years)	54.3±10.0	53.8±9.6	0.307
Sex (male/female)	6/6	36/33	0.889
Smoker (yes/no)	9/3	18/51	0.001
DM	3/9	13/56	0.621
BMI (kg/m ²),	24.6±3.0	24.7±3.7	0.899
Disease duration (months)	11.0±3.0	10.9±2.3	0.633
Diagnostic categories			
CSM	4	27	0.760
CSR	8	42	
Surgical procedure			0.762
ACDF	7	37	
ACCF	5	32	
Pre-op JOA	10.1±1.7	10.2±1.4	0.351
Post-op JOA	13.2±2.2	13.2±2.0	0.629
Number of fusion levels	3.4±1.0	3.2±0.8	0.405
Pre-op SWAL-QOL score	35.7±15.0	57.0±19.1	0.001
Pre-op Cobb angle of C2-7 (°)	1.1±2.1	0.8±2.0	0.255
Post-op Cobb angle of C2-7 (°)	14.0±3.0	13.5±3.3	0.051
Change of Cobb angle of C2-7 (°)	12.9±2.8	12.7±3.3	0.661
Pre-op T1 slope (°)	8.3±1.8	8.2±1.1	0.756
Post-op T1 slope (°)	11.3±2.1	11.4±2.1	0.571
Change of T1 slope (°)	3.0±2.0	3.2±3.0	0.522
Pre-op C2 SVA.(mm)	3.6±1.2	3.5±1.3	0.650
Post-op C2 SVA.(mm)	4.7±3.0	4.8±3.0	0.786
Change of C2 SVA.(mm)	1.1±1.4	1.3±1.6	0.215

Table 6

Multivariate analysis of dysphagia based on follow-up time.

<i>1-week follow-up</i>				
<i>Characters</i>	<i>p</i>	<i>OR</i>	<i>95%CI</i>	
			<i>lower</i>	<i>upper</i>
Smoker	0.020	1.237	1.056	1.478
Pre-op SWAL-QOL score	0.011	1.593	1.301	1.674
Post-op Cobb angle of C2-7 (°)	0.032	1.204	1.072	1.451
Change of Cobb angle of C2-7 (°)	0.001	1.776	1.342	2.154
<i>1-month follow-up</i>				
Smoker	0.032	1.364	1.098	1.556
Pre-op SWAL-QOL score	0.018	1.605	1.276	1.876
Post-op Cobb angle of C2-7 (°)	0.020	1.453	1.172	1.721
Change of Cobb angle of C2-7 (°)	0.001	1.802	1.412	2.206
<i>3-month follow-up</i>				
Smoker	0.019	1.231	1.008	1.453
Pre-op SWAL-QOL score	0.017	1.305	1.126	1.576
Post-op Cobb angle of C2-7 (°)	0.020	1.243	1.040	1.401
Change of Cobb angle of C2-7 (°)	0.033	1.202	1.016	1.414
<i>6-month follow-up</i>				
Smoker	0.008	1.445	1.214	1.697
Pre-op SWAL-QOL score	0.012	1.401	1.113	1.778
Post-op Cobb angle of C2-7 (°)	0.014	1.331	1.126	1.543
<i>1-year follow-up</i>				
Smoker	0.012	1.347	1.134	1.532
Pre-op SWAL-QOL score	0.006	1.754	1.375	2.163

Figures



Figure 1

a. Magnetic resonance imaging showed multilevel cervical disorder with kyphosis. 1b.X-ray showed recovery of cervical lordosis after anterior cervical surgery.

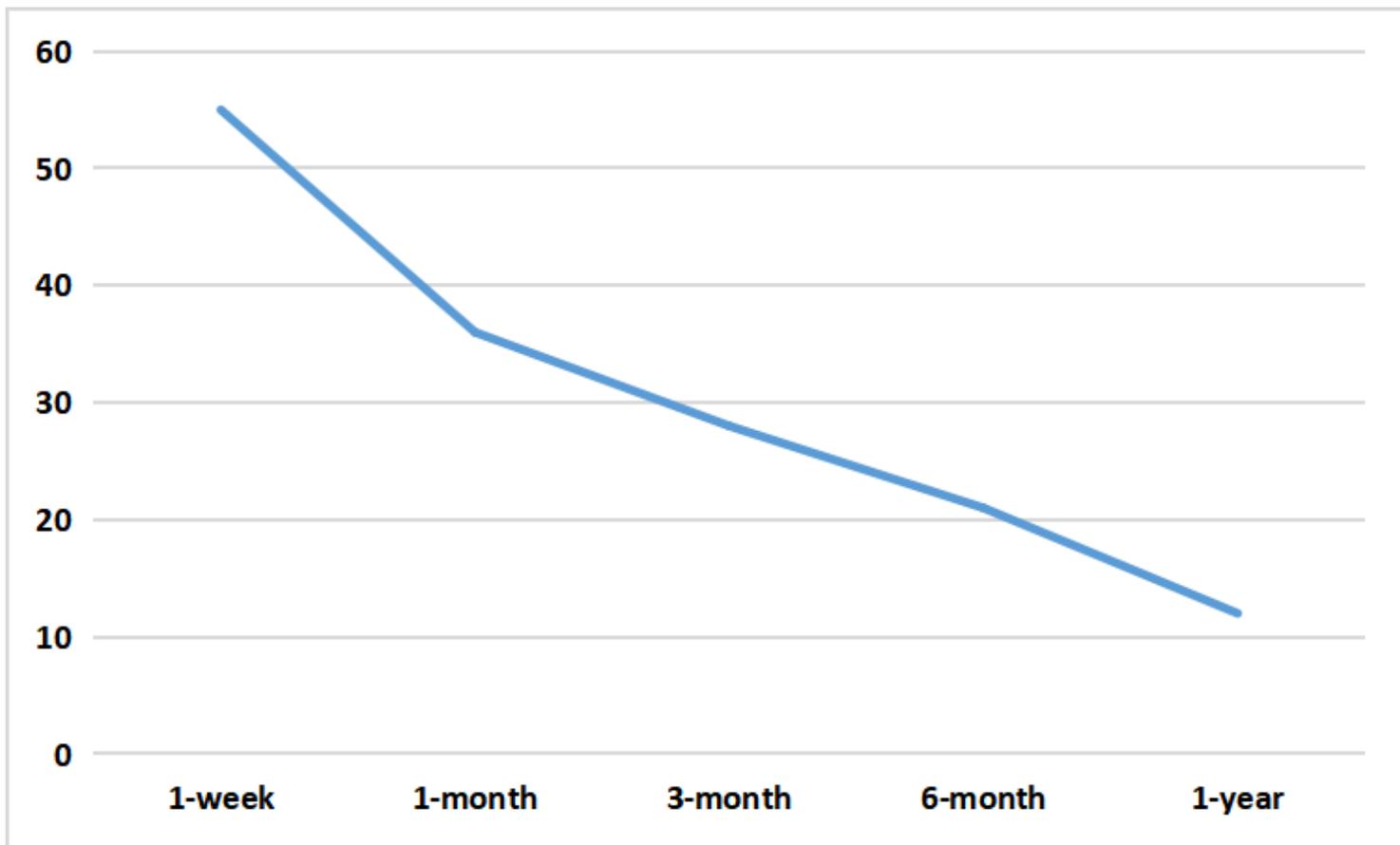


Figure 2

Relation between rate of dysphagia and follow-up time.