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CLINICAL STUDY

Incidence and severity of dysphagia after anterior cervical discectomy and fusion with zero-profile spacer: prospective study with 3-years follow-up

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ABSTRACT

INTRODUCTION: Dysphagia after anterior cervical discectomy and fusion (ACDF) is a regular complication. The aim of this study was to identify risk factors for incidence and severity of dysphagia after ACDF with zero-profile spacer.

METHODS: Incidence and severity of dysphagia was evaluated preoperatively and for time of three years after ACDF (regular outpatient check-ups) – prospective study with 3-years follow-up. Severity of dysphagia was assessed subjectively using Bazaz–Yoo dysphagia score. Influence of selected factors on the incidence and severity of postoperative dysphagia was evaluated. Following statistical methods were used: Fisher's exact test, unpaired Student's t-test, one-way ANOVA and Spearman's correlation coefficient. Level of significance was defined as $p < 0.05$. Correlations between paired parameters were evaluated according to Spearman's correlation.

RESULTS: Our study included 133 patients who underwent one-, two- or three-level ACDF with zero-profile spacer in years 2013–2018. Myelopathy and GERD had significant impact on incidence and severity of pre-existing dysphagia. Risk factors for incidence of dysphagia after ACDF were number of treated segments, myelopathy, pre-existing dysphagia and surgery of C4/5 segment. Age of patients, duration of surgery and pre-existing dysphagia correlated positively very weakly to weakly with severity of dysphagia after ACDF. Number of treated segments, myelopathy, GERD and surgery of the C4/5 segment were risk factors for greater severity of postoperative dysphagia.

CONCLUSION: Risk factors for incidence and severity of pre-existing dysphagia were myelopathy and GERD. Risk factors for dysphagia incidence after ACDF were number of treated segments, pre-existing dysphagia, myelopathy and surgery of C4/5 segment *(Tab. 6, Fig. 1, Ref. 30)*. Text in PDF *www.elis.sk*

KEY WORDS: dysphagia, anterior cervical discectomy and fusion, risk factors, zero-profile spacer.

Abbreviations: ACDF – anterior cervical discectomy and fusion, AH – arterial hypertension, DM – diabetes mellitus, GERD – gastroesophageal reflux disease, nVAS – neck visual analogue scale, GSP – global sagittal profile

Introduction

Anterior cervical discectomy and fusion (ACDF), as the most common surgical procedure for degenerative disease of the cervical spine, is burdened by the occurrence of postoperative complications. Regular complication in the postoperative period is a swallowing disorder of variable severity. Published studies report a wide range of factors that affect dysphagia after ACDF: age, gender, number of treated segments, smoking, gastro-oesophageal reflux disease (GERD), arterial hypertension (AH), diabetes mellitus (DM), duration of surgery, pre-existing dysphagia, prevertebral soft tissue swelling, difference between the postoperative and preoperative C2–7 angle, endotracheal tube cuff pressure, preoperative tracheal traction exercise, cervical plate type and position, psychiatric factors, palsy of laryngeal recurrent and/or superior nerves, use of recombinant human bone morphogenetic protein, use of zero-profile spacer, steroid application, experience of surgeon, revision surgery, body mass index, blood loss, preoperative comorbidities, duration of pre-existing pain, cervical retractor type, decreasing surgical levels, improved surgical techniques, preoperative visual analogue scale, course of disease, cervical circumference, ossification of posterior longitudinal ligament, application of absorbable collagen bio-membrane during ACDF and type of surgery (cervical arthroplasty versus ACDF) (1–6). The aim of this study was to identify risk factors for the incidence and severity of swallowing disorders after ACDF with a zero-profile implant.

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Tab. 1. Bazaz - Yoo dysphagia score (adapted according to (7)).

Bazaz-Yoo dysphagia score	Subjective evaluation of the patient's swallowing disorder
None	No problems with swallowing
Mild	Sporadic swallowing problems
Moderate	Problems with swallowing in connection with a certain diet
Severe	Common problems with swallowing with most types of diet

Tab. 2. Characteristics of patients group.

Gender	Female: 91/68.4% Male: 42/31.6%
Age	Age up to 55 years: 61/45.9% Age 55 years and more: 72/54.1%
Type of surgical procedure	1-level surgery: 54/40.6% 2-level surgery: 63/47.4% 3-level surgery: 16/12.0%
Time of surgery	ACDF duration up to and including 90 minutes: 78 ACDF duration over 90 minutes: 55
Selected important comorbidities	Gastro-oesophageal reflux disease: 14/10.5% Pre-existing dysphagia: 20 / 15.0% Myelopathy: 28/21.1% Diabetes mellitus: 11/8.3% Arterial hypertension: 62/46.6% Smokers: 60/45.1%
Number of treated intervertebral discs	C3-4 level: 3/2.3% C4-5 level: 38/28.6% C5-6 level: 106/79.7% C6-7 level: 79/59.4% C7-T1 level: 3/2.3%

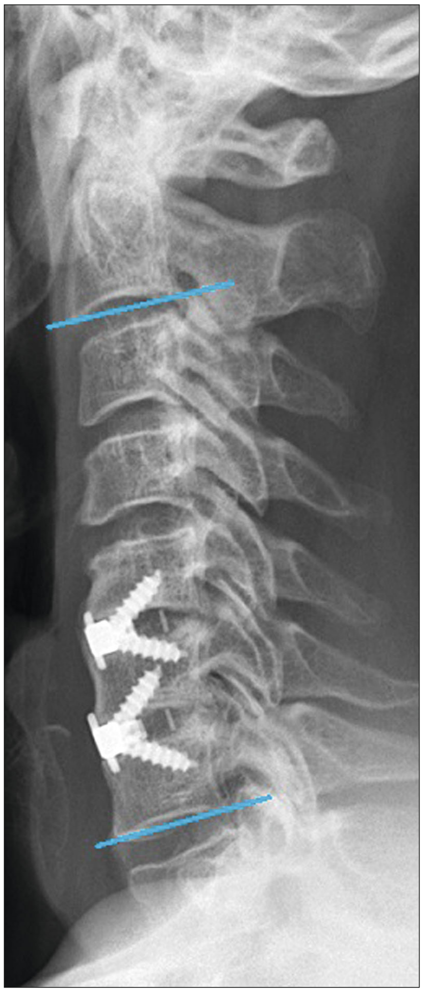

Fig. 1. The method of the GSP measuring – Cobb C2-C7 (author´s archive).

Methods

Our study included 133 patients (91 women and 42 men) who underwent one-, two- or three-level ACDF in years 2013–2018. Mean age of patients in the cohort was 52 years. A total of 228 cervical motion segments were surgically treated. In all cases, a cage Zero Profile Variable Angle (DePuy Synthes, Switzerland) cage was used to induce fusion. This zero-profile spacer is fixed in the intervertebral space by means of two divergently inserted screws. Exclusion criteria for surgery included pregnancy, contraindications of elective surgery, severe osteoporosis, cervical spine injury, inflammation and tumor of the cervical spine. Incidence and severity of dysphagia were monitored preoperatively and for time of three years after ACDF (regular outpatient check-ups – six weeks, three months, six months, one year, two years and three years). Severity of dysphagia was assessed subjectively using Bazaz–Yoo dysphagia score (Tab. 1) (7). All data were collected and recorded prospectively at the patient's admission to the hospital and in the postoperative period at outpatient check-ups or by telephone. Following parameters were recorded before surgery: age, gender, history of smoking, myelopathy verified by magnetic resonance imaging, comorbidities (DM, AH, GERD), neck visual analogue scale (nVAS), pre-existing dysphagia and global sagittal profile (GSP) before ACDF. After ACDF, these parameters were recorded: number of treated segments, level of surgery, duration of surgery and change of GSP after surgery. To determine the impact of individual factors on the incidence of swallowing disorders, patients were divided into subgroups: in terms of gender for women and

Tab. 3. Incidence of dysphagia before and after ACDF in study cohort.

Dysphagia after ACDF	Pre-existing	After 6 weeks	After 3 months	After 6 months	After 1 year	After 2 years	After 3 years
Overall incidence	20/15.0%	89/66.9%	72/54.1%	56/42.1%	47/35.3%	25/18.8%	13/9.8%
Mild	15/11.3%	77/57.9%	63/47.4%	50/37.6%	45/33.8%	24/18.0%	12/9.0 %
Moderate	5/3.7%	12/9.0%	9/6.7%	6/4.5%	2/1.5%	1/0.8%	1/0.8%
Severe	0/0%	0/0%	0/0%	0/0%	0/0%	0/0%	0/0%

Tab. 4. Risk factors for incidence of dysphagia after ACDF.

Risk factors for incidence of dysphagia after ACDF	Pre-existing dysphagia	Dysphagia after 6 weeks	Dysphagia after 3 months	Dysphagia after 6 months	Dysphagia after 1 year	Dysphagia after 2 years	Dysphagia after 3 years
Gender (male/female)	p=0.615	p=1.000	p=1.000	p=1.000	p=0.714	p=0.151	p=0.755
Age (up to 55 years, 55 years and more)	p=1.000	p=0.214	p=0.377	p=0.338	p=0.305	p=0.655	p=1.000
Number of segments	–	p=0.371	p=0.023	p=0.003	p=0.011	p=0.0003	p=0.003
Surgery of C3–4 segment	–	p=0.717	p=0.698	p=0.425	p=0.652	p=0.241	p=0.090
Surgery of C4–5 segment	–	p=0.375	p=0.159	p=0.063	p=0.102	p=0.00001	p=0.0001
Surgery of C5–6 segment	–	p=0.602	p=0.183	p=0.060	p=0.183	p=0.082	p=0.463
Surgery of C6–7 segment	–	p=0.780	p=0.366	p=0.194	p=0.222	p=0.270	p=0.565
Surgery of C7–T1 segment	–	p=0.651	p=1.000	p=0.556	p=0.568	p=1.000	p=1.000
Smoking	p=0.810	p=0.892	p=0.558	p=0.874	p=0.865	p=1.000	p=0.573
Duration of surgery (up to and including 90 min., over 90 min.)	–	p=0.493	p=0.187	p=0.424	p=0,395	p=0.123	p=0.077
GERD	p=0.002	p=0.405	p=1.000	p=1.000	p=0.299	p=0.735	p=0.637
Pre-existing dysphagia	–	p=0.582	p=0.691	p=0.209	p=0.260	p=0.050	p=0.229
Myelopathy	p=0.004	p=0.420	p=0.093	p=0.007	p=0.050	p=0.071	p=0.078
DM	p=0.112	p=0.489	p=0.615	p=0.418	p=0.568	p=0.467	p=0.326
AH	p=0.637	p=0.585	p=1.000	p=0.749	p=0.394	p=0.831	p=1.000
Change of GSP after surgery	–	p=0.712 95% CI (–2.716, 3.963)	p=0.692 95% CI (– 2.213, 3.325)	p=0.120 95% CI (– 0.601, 5.146)	p=0.675 95% CI (– 2.252, 3.469)	p=0.391 95% CI (–1.774, 4.503)	p=0.133 95% CI (–0.969, 7.248)
Neck VAS	p=0.314 95% CI (–0.469, 1.448)	p=0.350 95% CI (–0.427, 1.198)	p=0.348 95% CI (–0,338, 0.952)	p=0.064 95% CI (–0.038, 1.347)	p=0.584 95% CI (–0.543, 0.961)	p=0.896 95% CI (–0.734, 0.837)	p=0.327 95% CI (–0.480, 1.430)

men, in terms of age to patients under 55 years and 55 years and older, patients after one-, two- and three-level ACDF, according to the level of surgery (C3/4, C4/5, C5/6, C6/7 and C7/T1), for smokers and non-smokers, into subgroups according to the presence of comorbidities, pre-existing dysphagia and myelopathy and according to the duration of surgery on patients with surgery up to and including 90 minutes and surgery over 90 minutes. GSP was assessed by measuring the Cobb angle between the lower end-plate of C2 vertebral body and the lower end-plate of C7 vertebral body (Cobb C2–C7) or the lowest visualized vertebral body above C7 vertebra, but always in a particular patient (Fig. 1). Statistical analysis of results was performed using IBM® SPSS® Statistics for Windows (version 25, Armonk, New York, IBM Corporation and PAST, version 4.03, Copyright Ø. Hammer). Following statistical methods were used to evaluate the influence of observed factors on the incidence of swallowing disorders: Fisher's exact test and unpaired Student's t-test. Following methods were used to statistically evaluate the influence of observed factors on the severity of dysphagia: unpaired Student's t-test, one-way ANOVA and Spearman's correlation coefficient. Level of significance was defined as $p < 0.05$. Correlations between paired parameters were evaluated according to Spearman's correlation. Spearman's rho (R) coefficient is a statistical measure of the strength of a monotonic relationship between paired data. Positive or negative correlation was interpreted as follows: 0.00–0.19 (very weak), 0.20–0.39 (weak), 0.40–0.59 (moderate), 0.60–0.79 (strong) and 0.80–1.00 (very strong).

Results

Basic characteristics of the group of patients are given in Table 2. In the monitored group of patients, women predominated (68.4 %), the most frequently treated motion segment was C5/6 (79.7 %) and the most common was 2-level ACDF (47.4 %). The incidence of pre-existing dysphagia in the cohort was 15.0 %. In 6 weeks after ACDF, the incidence of swallowing disorders was 66.9 % with a gradual decrease of the incidence in the next follow-up period. In the period of 3 years after surgery, 9.8 % of patients reported a swallowing disorder. Mostly mild dysphagia was present throughout the follow-up period, and severe dysphagia was not reported (Tab. 3).

Gender, age of patients, duration of the surgery, smoking, DM, AH, change of GSP and nVAS had no significant impact on the incidence of dysphagia before and after ACDF. Myelopathy ($p = 0.004$) and GERD ($p = 0.002$) conditioned a higher incidence of pre-existing dysphagia. Myelopathy had a significant effect on the incidence of swallowing disorders at six months ($p = 0.007$) and one year ($p = 0.05$) after ACDF. Pre-existing dysphagia resulted in a higher incidence of swallowing disorders at two years after ACDF ($p = 0.05$). Surgery of C4/5 level had a significant effect on the incidence of dysphagia at two years ($p = 0.00001$) and

Tab. 5. Risk factors for severity of dysphagia after ACDF.

Risk factors for severity of dysphagia after ACDF	Pre-existing dysphagia	Dysphagia after 6 weeks	Dysphagia after 3 months	Dysphagia after 6 months	Dysphagia after 1 year	Dysphagia after 2 years	Dysphagia after 3 years
Gender (female/male)	p = 0.261 95% CI (–0.076, 0.277)	p = 0.561 95% CI (–0.158, 0.290)	p = 0.633 95% CI (– 0.172, 0.282)	p = 0.854 95% CI (–0.196, 0.237)	p = 0.372 95% CI (– 0.104, 0.276)	p = 0,059 95% CI (– 0.006, 0.299)	p = 0.814 95% CI (– 0.108, 0.138)
Age	R = 0.091 p = 0.297 very weak	R = 0.222 p = 0.010 weak	R = 0.183 p = 0.035 very weak	R = 0.219 p = 0.011 weak	R = 0.186 p = 0.032 very weak	R = 0.160 p = 0.066 very weak	R = 0.083 p = 0.341 very weak
Number of treated segments	–	F = 14.71 p = 1.742E-06	F = 24.51 p = 9.265E-10	F = 31.36 p = 7.705E-12	F = 11.52 p = 2.48E-05	F = 28.34 p = 6.084E-11	F = 15.77 p = 7.396E-07
Surgery of C3–4 segment	–	p = 0.012 95% CI (0.168, 1.359)	p = 0.033 95% CI (0.053, 1.269)	p = 0.063 95% CI (–0.031, 1.132)	p = 0.605 95% CI (–0.383, 0.654)	p = 0.138 95% CI (– 0.103, 0.731)	p = 5.159E-05 95% CI (0.351, 0.979)
Surgery of C4–5 segment	–	p = 0.003 95% CI (0.114, 0.560)	p = 0.0005 95% CI (0.177, 0.623)	p = 0.0002 95% CI (0.205, 0.627)	p = 0.025 95% CI (0.029, 0.413)	p = 0.002 95% CI (0.089, 0.395)	p = 0.020 95% CI (0.024, 0.271)
Surgery of C5–6 segment	–	p = 0.109 95% CI (–0.047, 0.466)	p = 0.023 95% CI (0.042, 0.557)	p = 0.005 95% CI (0.110, 0.595)	p = 0.038 95% CI (0.013, 0.447)	p = 0.026 95% CI (0.024, 0.374)	p = 0.233 95% CI (–0.056, 0.227)
Surgery of C6–7 segment	–	p = 0.166 95% CI (– 0.062, 0.358)	p = 0.031 95% CI (0.022, 0.443)	p = 0.045 95% CI (0.005, 0.407)	p = 0.072 95% CI (– 0.015, 0.341)	p = 0.113 95% CI (– 0.028, 0.261)	p = 0.677 95% CI (– 0.091, 0.140)
Surgery of C7–T1 segment	–	p = 0.218 95% CI (–0.262, 1.134)	p = 0.433 95% CI (–0.428, 0.992)	zero variance	zero variance	zero variance	zero variance
Smoking	p = 0.596 95% CI (– 0.121, 0.210)	p = 0.847 95% CI (– 0.189, 0.229)	p = 0.276 95% CI (– 0.094, 0.328)	p = 0.876 95% CI (– 0.185, 0.219)	p = 0.620 95% CI (– 0.133, 0.222)	p = 0.975 95% CI (– 0.142, 0.146)	p = 0.410 95% CI (– 0.067, 0.162)
Duration of surgery	–	R = 0.274 p = 0.001 weak	R = 0.242 p = 0.005 weak	R = 0.194 p = 0.025 very weak	R = 0.214 p = 0.013 weak	R = 0.323 p = 0.0001 weak	R = 0.247 p = 0.004 weak
GERD	p=0.0001 95% CI (0.254, 0.762)	p=0.116 95% CI (– 0.067, 0.605)	p=0.828 95% CI (– 0.306, 0.382)	p=0.820 95% CI (– 0.290, 0.366)	p=0.034 95% CI (0.023, 0.591)	p=0.394 95% CI (– 0.132, 0.334)	p=0.656 95% CI (–0.144, 0.228)
Pre-existing dysphagia	–	R = 0.089 p = 0.306 very weak	R = 0.118 p = 0.176 very weak	R = 0.202 p = 0.20 weak	R = 0.181 p = 0.037 very weak	R = 0.236 p = 0.006 weak	R = 0.153 p = 0.079 very weak
Myelopathy	p = 0.002 95% CI (0.109, 0.500)	p = 0.006 95% CI (0.102, 0.598)	p = 0.0004 95% CI (0.203, 0.697)	p = 9.495E-07 95% CI (0.361, 0.811)	p = 0.005 95% CI (0.091, 0.513)	p = 0.004 95% CI (0.079, 0.421)	p = 0.050 95% CI (3.200E-05, 0.276)
DM	p = 0.054 95% CI (–0.005, 0.586)	p = 0.057 95% CI (– 0.012, 0.734)	p = 0.090 95% CI (– 0.052, 0.706)	p = 0.122 95% CI (– 0.077, 0.647)	p = 0.564 95% CI (– 0.227, 0.415)	p = 0.523 95% CI (– 0.176, 0.344)	Zero variance
AH	p = 0.550 95% CI (– 0.115, 0.215)	p = 0.152 95% CI (– 0.058, 0.369)	p = 0.436 95% CI (– 0.128, 0.295)	p = 0.390 95% CI (– 0.114, 0.289)	p = 0.195 95% CI (– 0.060, 0.293)	p = 0.960 95% CI (– 0.140, 0.147)	p = 0.784 95% CI (– 0.099, 0.130)
Change of GSP after surgery	–	R = 0.084 p = 0.338 very weak	R = 0.065 p = 0.457 very weak	R = –0.096 p = 0.270 very weak	R = –0.048 p = 0.581 very weak	R = 0.088 p = 0.312 very weak	R = 0.144 p = 0.099 very weak
Neck VAS	R = 0.127 p = 0.145 very weak	R = 0.108 p = 0.215 very weak	R = 0.033 p = 0.410 very weak	R = 0.091 p = 0.300 very weak	R= – 0.064 p = 0.462 very weak	R = –0.012 p = 0.893 very weak	R = –0.092 p = 0.294 very weak

three years (p = 0.0001) after the procedure. Surgery of other motion segments had no significant effect on the incidence of dysphagia. The increasing number of operated segments conditioned a higher incidence of postoperative dysphagia in the period of three months and more after ACDF (Tab. 4).

Gender, surgery of C7–T1 level, smoking, DM and AH had no significant influence on the severity of swallowing disorders throughout the monitoring period (Tab. 5). The age of patients correlated mostly very weakly positively with the severity of the dysphagia. Larger number of treated segments significantly conditioned greater severity of dysphagia during the entire postoperative period. Surgery of the C4/5 segment resulted in greater severity of dysphagia throughout the postoperative period. Surgery of segments C3/4, C5/6 and C6/7 were risk factors for the severity of swallowing disorders only in some periods after ACDF (Tab. 5). Duration of surgery correlated mostly weakly positively with the severity of dysphagia. GERD had a significant impact on the severity of pre-existing dysphagia (p = 0.0001) and postoperative dysphagia in the period of 1 year (p = 0.034). Pre-existing dysphagia correlated positively mostly very weakly with the severity of postoperative dysphagia. Myelopathy had a significant impact on the severity of dysphagia before and after surgery (Tab. 5). The change of GSP after surgery and nVAS correlated very weakly with the severity of swallowing disorders.

Tab. 6. Clinical studies evaluating the incidence of dysphagia after ACDF.

Authors	Study	Number of patients	1D	1M	6W	3M	6M	1 year	2 years	3 years and more
Wang et al (3)	R	2827	20%			5%	2%	1%	0.4%	
Opsenak et al (6)	P	73			53%	33%	19%	22%		
Bazaz et al (7)	P	249		50%	32%		18%	13%		
Riley et al (9)	R	454				30%	22%		21%	
Kalb et al (10)	P	249			89%	30%	7%	0%		
Yue et al (11)	R	74	46%							35%
Lee et al (27)	P	156		49%			20%	15.4%	11%	
Olsson et al (29)	P	100								26%

Discussion

Process of the swallowing is divided into three neuro-anatomical phases – oral, pharyngeal and oesophageal. Oral phase begins with the food entry into the mouth, which is fragmented by masseter muscle and tongue. Tongue muscles, innervated by hypoglossal nerve, handle bolus of the food. Complex coordination of the soft palate, tongue movements, salivary glands and masseter muscles, including the conduction of information from chemoreceptors and mechanoreceptors in the mouth, is ensured with facial, glossopharyngeal and hypoglossal nerves. Pharyngeal phase represents involuntary coordination of muscle contractions that move bolus of the food. Critical aspects of this phase are the laryngeal elevation and the inversion of epiglottis, which prevents the food penetration into airways. Superior and recurrent laryngeal nerves provide innervation of the pharyngeal phase. Oesophageal phase begins with passage of the food bolus through the upper oesophageal sphincter and ends with the passage through the lower oesophageal sphincter. This phase is completely involuntary and is performed by the coordinated peristaltic of the oesophageal musculature. Coordination of the oesophageal phase is provided by autonomous myenteric plexus, which is under control of the vagal nerve (6, 8). Glossopharyngeal and hypoglossal nerves can be damaged during the surgical approach to the segment C3 and above, superior laryngeal nerve during the approach to C3/4 and C4/5 levels and recurrent laryngeal nerve during the approach to the segment C6 and below. Vagal nerve is naturally protected in the carotid sheath and can be damaged by excessive retraction in the whole subaxial cervical spine (8). In our study, only the surgery of the C4/5 segment at two and three years after ACDF had a significant impact on the incidence of dysphagia. Surgery of the C4/5 segment conditioned a significantly more severe swallowing disorder in the entire postoperative period. This finding may be related to the injury to superior laryngeal nerve in relevant segment. Similarly, Kalb et al reported a more frequent occurrence of dysphagia in patients after C4/5 level surgery (10). However, we have to accept the assumption that superior laryngeal nerve injury in our cohort tended to repair slowly or was permanent. Surgery of other motion segments has a significant effect on the severity of dysphagia only at some follow-up dates. Some studies consider upper-level surgery to be risky for the incidence of dysphagia (2, 3).

Published incidence of dysphagia after ACDF varies in a wide range of 0–89 % and decreases with an increasing time from the surgery (3, 6, 7, 9–11, 27, 29). In the early postoperative period, the incidence of dysphagia is about 50 % (Tab. 6). In our cohort, incidence of dysphagia six weeks after ACDF was 67 %. This finding may explain the incidence of pre-existing dysphagia at 15 %. Yue et al reported only 3 % incidence of dysphagia before ACDF (11). In our study, dysphagia after surgery persisted for a long time, in the period of three years it was still at the level of 9.8 %. In a study by Kalb et al no postoperative dysphagia was present in one year after ACDF (10). In the Wang et al study, the incidence of dysphagia was 1 % and 0.4 % at one and two years after ACDF, respectively (3). On the other hand, Yue et al reported persistent dysphagia after surgery at 35 % with a mean follow-up of 7.2 years (11). As in other studies, postoperative mild dysphagia according to the Bazaz–Yoo dysphagia score prevailed in our cohort (6, 7, 11, 12, 27). The meta-analysis of Yang et al found a low incidence of both transient and persistent dysphagia after ACDF using a zero-profile implant. Most dysphagia was mild and decreased during the following postoperative period. Severe dysphagia occurs infrequently (12, 27). Similarly, one type of zero-profile spacer with integrated plate was implanted in all patients in our cohort (Zero Profile Variable Angle). Many studies reported a lower incidence of dysphagia after implantation of a zero-profile cage compared to a cage/graft fixed with a conventional plate (13–18). Other studies have not confirmed a significant difference between both surgical modalities (19–21). Fixation of the cage with a conventional plate conditions the irritation of hypopharynx and oesophagus. In addition, the design of a conventional plate plays an important role (27). Risk factors for the incidence and severity of pre-existing dysphagia in our study were myelopathy and GERD. Swallowing disorder in GERD is a logical accompanying phenomenon (26). Frempong-Bodau et al reported a swallowing disorder before surgery in 66 % of patients with myelopathy, which was demonstrated by barium passage. They have assumed that the cause of dysphagia in myelopathy is the failure of local reflex mechanism on a preganglionic sympathetic level, due to the compression of the spinal cord (22). In our cohort, in addition to surgery of C4/5 level, also myelopathy, number of treated segments and pre-existing dysphagia had a significant impact on the incidence of postoperative dysphagia. Number of treated segments and myelopathy also had a significant effect on the severity of dysphagia after ACDF. Dysphagia after ACDF is usually persistent in patients with graphical findings of myelopathy (22). A larger number of operated segments requires a larger surgical approach, which causes greater edema of the prevertebral soft tissues. Also, surgery of several motion segments takes longer and increases the risk of injury to the hypopharynx, oesophagus and laryngeal, hypoglossal and glossopharyngeal nerves. Most studies confirmed the increasing incidence of dysphagia after anterior multilevel surgery (1–3, 7, 9, 10, 22). Pre-existing dysphagia in our study very weakly or weakly positively correlated with the severity of postoperative dysphagia. The cause of pre-existing dysphagia may be GERD, already mentioned myelopathy or extensive ventral osteophytes in the context of degenerative disease of cervical motion segments or diffuse idiopathic skeletal hyperostosis (22–26). In our cohort, age of patients and duration of ACDF did not have a significant impact on the incidence of postoperative dysphagia, but positively correlated with its severity. However, this correlation was very weak or weak. Older patients and longer duration of surgery are considered risk factors for swallowing disorders after ACDF (1–3, 10, 21, 28). Duration of surgery, of course, depends on the number of operated segments and is shorter when using a zero-profile spacer (14, 21). Longer operative time leads to more significant retraction of laryngeal nerves, hypopharynx and oesophagus, which may determine their ischemia (3, 30). In this study, smoking did not have a significant impact on the incidence and severity of dysphagia before and after ACDF. In our previous study even, smokers had significantly lower incidence of pre-existing dysphagia and dysphagia within one year after ACDF (6). However, smoking is considered a significant risk factor for incidence and recovery of swallowing disorders (3, 5, 29). Change of cervical alignment and diabetes mellitus are considered risk factors for dysphagia after ACDF (1, 3, 5). In our study, the influence of these factors was not confirmed.

Limitations of this study include a small number of enrolled patients and a short follow-up. Our study is a mono-center and only patients after implantation of one type of zero-profile spacer were included in the cohort to maintain homogeneity. In addition, presence and severity of swallowing disorder was verified only subjectively. However, video-fluoroscopic studies involve a small number of patients because only a few potential study subjects are willing to undergo radiological examination (22, 28). In addition, completion of repeated video-fluoroscopic examinations in post-operative period is time-consuming and costly. To identify risk factors for dysphagia after ACDF, multi-center studies with a large patient population and long follow-up are required.

Conclusion

Incidence of pre-existing dysphagia in our study was 15.0 %. Incidence of dysphagia six months and three years after ACDF was 66.9 % and 9.8 %, respectively. Severe dysphagia did not occur throughout the follow-up period. Myelopathy and GERD resulted in higher incidence and greater severity of pre-existing dysphagia. Risk factors for incidence of dysphagia after ACDF were myelopathy, pre-existing dysphagia, surgery of C4/5 level and a larger number of treated segments. Risk factors for severity of dysphagia after surgery were multi-level ACDF, GERD, surgery of C4/5 level and myelopathy. Age of patients, duration of surgery and pre-existing dysphagia correlated positively very weakly to weakly with the severity of dysphagia after ACDF.

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