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Original Article

Incidence and risk factor analysis of dysphagia after anterior cervical corpectomy and fusion: evidence from 297 patients

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Abstract: A large number of previous studies have explored the clinical and radiological outcomes of anterior cervical corpectomy and fusion (ACCF); however, dysphagia after ACCF has been ignored in previous studies and the incidence, severity, and duration of dysphagia after ACCF remains unknown at present. A total of 297 patients who underwent ACCF were included in this study, dysphagia was evaluated according to the Bazaz grading system before surgery and at each follow-up. An unpairedt-test and the Mann-Whitney U-test were used to compare the parameters of patients in both dysphagia, and non-dysphagia, groups. Ordinal logistic regression was performed to determine the risk factors of dysphagia. The incidence of dysphagia was 25.253% at one week, 20.202% at one month, 16.162% at three months, 11.111% at six months, 8.418% at 12 months, and 6.734% at the final follow-up. Results from ordinal logistic regression showed that female patients (95% CI [1.098, 2.813], *P*=0.013), long operation time (95% CI [1.075, 8.036], *P*=0.012) were associated with higher incidence of dysphagia. However, blood loss, involvement of C4-5 surgery, involvement of C5-6 surgery, kind of cages, kind of plates, and different surgeons were not found to be associated with higher incidence of dysphagia in this study. Most of the dysphagia after ACCF was mild and gradually decreased during the following months. Moderate or severe dysphagia was uncommon. Female patients and a long operation time may be associated with higher incidence of dysphagia. Future studies are needed to validate these findings.

Keywords: Dysphagia, ACCF, plate, corpectomy, deglutition, deglutition disorders, anterior cervical corpectomy and fusion

Introduction

Anterior cervical corpectomy and fusion (ACCF) has long been regarded as an effective and safe treatment method for multilevelcervical spondylotic myelopathy and ossification of posterior longitudinal ligament (OPLL) [1]. ACCF using the autogenous fibulaor iliac crest with, or without, an anterior plate was performed initially, then a titanium mesh cage combined with an anterior cervical plate has been widely applied by spinal surgeons, and new types of titanium mesh cages, polyetherketoneketone (PEKK) cages and nano-hydroxyapatite/polyamide-66 (n-HA/PA66) cages were introduced in recent years [2-6]. Many previous studies have explored the clinical and radiological outcomes of ACCF such as Neck Disability Index scores (NDI), Japanese Orthopaedic Association Scores (JOA), fusion rates, graft subsidence, C2-C7 Cobb angle, and the effectiveness compared with posterior laminoplasty or anterior cervical discectomy and fusion (ACDF) [7]. However, dysphagia (swallowing dysfunction) after ACCF has been ignored in previous studies and the incidence, severity, and duration of dysphagia after ACCF remains unknown at present even though dysphagiais reported to be associated with increased morbidity, mortality, and costs in anterior cervical fusion [8]. Serious dysphagia can even result in aspiration pneumonia, bronchospasm, dehydration, malnutrition, and asphyxia. Considering the paucity of knowledge of dysphagia after ACCF, a retrospective study specially focused on the incidence, severity, and duration of postoperative dysphagia was performed.

Materials and methods

This retrospective study was approved by the Medical Ethical Committee of West China

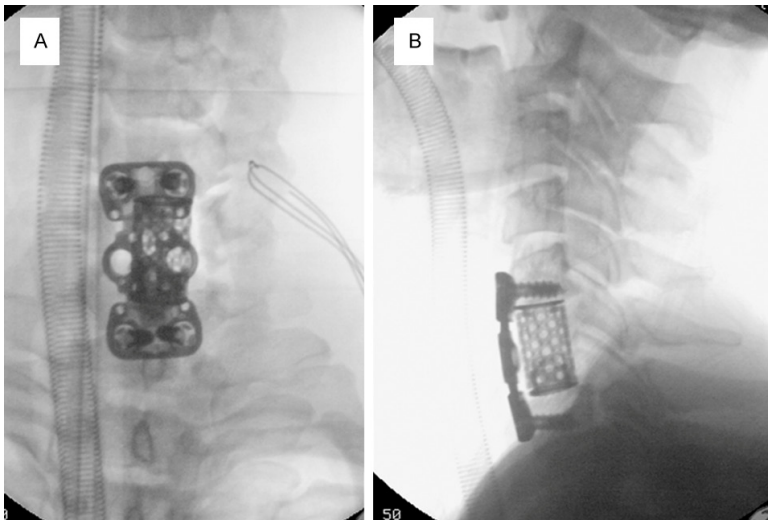

Figure 1. The anterior-posterior and lateral X-rays showed a good position of both the cages and the anterior plate.

Table 1. The Bazaz grading system for dysphagia

Severity	Liquid	Solid
0-None	None	None
1-Mild	None	Rare
2-Moderate	None or rare	Occasionally
3-Severe	None or rare	Frequent

Hospital, Sichuan University, China. All of the patients were recruited after providing informed consent to the analysis of their data.

Patient inclusion and exclusion criteria

All patients who underwent ACCF between November 2010 and November 2015 in our hospital were included in this study if they met the following inclusion and exclusion criteria.

Inclusion criteria: patients who underwent ACCF because of traumatic, degenerative, tumorous, infectious diseases, and ossification of the posterior longitudinal ligament (OPLL); operation from C3 to C7, age over 18 years; completed at least 12 months follow-up time; presented no symptom of dysphagia before surgery.

Exclusion criteria: patients with oesophageal diseases oroesophageal injuries before surgery; patients with preoperative dysphagia; patients with a history of disorders in the central nervous system such as stroke and traumatic brain injury; patients with a previous neck surgery history; patients with mental or psychological disorders such as hysteria.

The types of anterior plates, types of bone grafts, and types of cages were not limited in this study.

Surgical technique

All the surgeries were performed by senior spinal surgeons through a standard right-sided Smith-Robinson approach. After general endotracheal anaesthesia, a horizontal skin incision was performed to expose the cervical-spine with the help of fluoroscopy. When the anterior aspect of the spine was exposed by retracting the longuscolli muscle bilaterally, the operative vertebral segment was re-checked by fluoroscopy. Then the anterior longitudinal ligament, along with the anterior osteophytes, was resected, discectomy including the posterior longitudinal ligament was completed, and long shaft Caspar screws for interbody retraction were used. Arongeur was used for partly resection of vertebral bodies and then a high-speed drill was used for precise resection until the posterior cortex of the vertebrae was reached. The posterior cortex of the vertebrae, the posterior longitudinal ligament, and the posterior osteophytes were carefully removed using an appropriate rongeur. An appropriate cage (titanium mesh cage, PEKK cage, or n-HA/PA66 cage) filled with autologous bone fragments with, or without, composite synthetic bone grafting was implanted under the guidance of fluoroscopy. Anterior cervical plates of appropriate size were adopted for fixation purposes. Final fluoroscopy was conducted before the wound was closed in a layer-by-layer fashion after drainage insertion (**Figure 1**). All patients were instructed to wear an orthosis for one to three months after surgery.

Evaluations of dysphagia

Dysphagia was evaluated according to the Bazaz grading system [9] before surgery and at the each follow-up, namely one week, one

Table 2. Patient characteristics: overall, non-dysphagia group, and dysphagia-group

Group	Overall group	Non-dysphagia group	Dysphagia-group	P
Total segments	297	222	75	
C3	2	2	0	0.296
C4	40	27	13	
C5	163	125	38	
C6	84	60	24	
C7	8	8	0	
Age (y): Mean SD	49.63±12.956	49.19±13.375	50.92±11.616	0.319
Gender (Female/Male)	77/220	42/180	35/40	< 0.001
Intraoperative time (min)	203.84±14.145	200.67±12.656	213.20±14.253	< 0.001
Estimated blood loss (ml)	145.99±36.822	145.36±38.130	147.87±32.809	0.611
Length of hospital stay (d)	13.724±5.234	13.59±5.037	14.12±5.791	0.449
Titanium mesh cages	141	136	28	0.006
n-HA/PA66 cages	156	109	47	
Atlantis plate	210	150	60	0.002
Vectra-T plate	36	28	8	
PAC plate	10	9	1	
Venture plate	41	35	6	

month, three months, six months, and 12 months after surgery, and at the final follow-up time. The Bazaz grading systemis based on qualitative information provided over the telephone to determine patient perception of difficulties with liquids *versus* solids and it has been widely used in previous studies (0-None; 1-Mild; 2-Moderate; 3-Severe; as listed in **Table 1**).

Statistical analysis

All statistical analysis was performed using the statistical program SPSS version 19.0 (SPSS Inc. for Windows). The values of quantitative data were presented as mean ± standard deviation (SD). An unpairedt-test and the Mann-Whitney U-test were used to compare the parameters of patients in the dysphagia, and non-dysphagia, groups. Ordinal logistic regression was performed to determine the risk factors of dysphagia. The results were regarded significant when the *P*-values were less than 0.05.

Results

Finally 297 patients (overall group) with an average age of 49.63±12.956 years were included in this study, and among them there were 77 female patients and 220 male patients. Corpectomy segments distributions were as follows: two patients at C3, 40 patients at C4, 163 patients at C5, 84 patients at C6, and eight patients at C7. 141 titanium mesh cages and 156n-HA/PA66 cages were implanted in 297 patients while 210 Atlantis plates, 36 Vectra-T plates, 10 PAC plates, and 41 Venture plates were used for anterior plating. The average intraoperative time was 203.84±14.145 min, the average estimated blood loss was 145.99±36.822 ml, and the average length of hospital stay was 13.724±5.234 d.

75 patients suffered from dysphagia after surgery and they were defined as the dysphagia-group while the other 222 patients who did not report dysphagia were defined as the non-dysphagia group. The corpectomy segment distributions, age, estimated blood loss, and length of hospital stay were similar in the dysphagia-group and non-dysphagia group (all $P > 0.05$) while the gender, intraoperative time, types of cages and anterior plates showed significant differences between the two groups (all $P < 0.05$). The patient characteristics in the overall sample, non-dysphagia group, and dysphagia-group are summarised in **Table 2**.

According to the Bazaz grading system the total incidence of dysphagia after ACCF was 25.25% at one week, 20.20% at one month, 16.16% at three months, 11.11% at six months, 8.42 at one year, and 6.73% at the

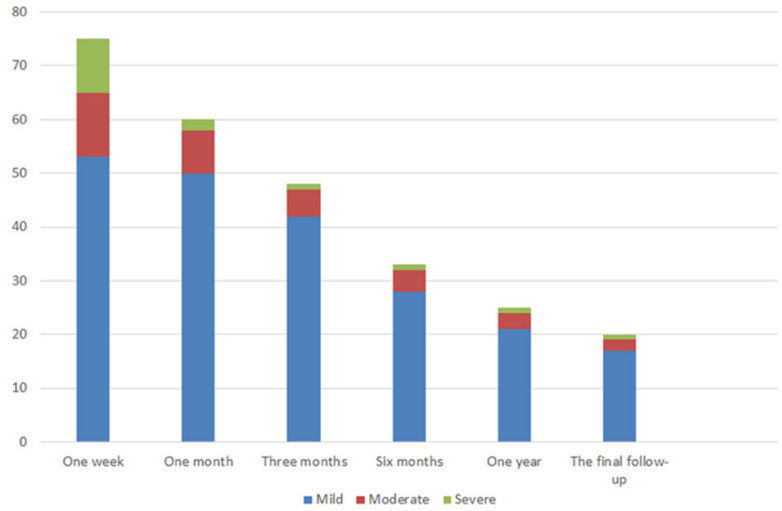

Figure 2. The number of patients suffering from mild, moderate, or severe dysphagia at each follow-up.

Table 3. The incidences and severity of dysphagia at each follow-up

Time	Mild	Moderate	Severe	Incidence
One week	53	12	10	25.253%
One month	50	8	2	20.202%
Three months	42	5	1	16.162%
Six months	28	4	1	11.111%
One year	21	3	1	8.418%
The final follow-up	17	2	1	6.734%

final follow-up. One week after surgery there were 53 patients suffering from milddysphagia, 12 patients suffered from moderate dysphagia and 10 patients suffered from severe dysphagia, however, three months after surgery, the mild dysphagia patients, moderate dysphagia patients, and severe dysphagia patient numbers decreased to 42, five, and one, respectively. Most of the dysphagia was mild to moderate, severe dysphagia was uncommon, the total incidence of dysphagia gradually decreased during the following months after surgery and at the final follow-up there was only one patient reporting severe dysphagia (**Figure 2**). The incidences and severity of dysphagia at each follow-up are listed in **Table 3**. Female patients (OR=1.370, 95% Confidence Interval [1.098, 2.813], *P*=0.013) and long operation time (OR=1.374, 95% Confidence Interval [1.075, 8.036], *P*=0.012) were significantly associated with a higher incidence of dysphagia after surgery through a multiple factors analysis by the ordinal logistic regression model, while age, blood loss, involvement of C4-5, involvement of C5-6, type of cages, type of plates, and surgeon were not found to be associated with higher incidences of dysphagiain this study (all $P > 0.05$), **Table 4**.

Discussion

ACCF has been introduced to treat multilevel cervical spondylotic myelopathy and OPLL a long time ago but previous studies did not particularly focus on the incidence of postoperative dysphagia [10]. Dysphagia has been reported to be one of the most common complications after anterior cervical surgery with possible serious secondary complications such as aspiration pneumonia, bronchospasm, dehydration, malnutrition, and asphyxia [11-14]. Joseph *et al.* examined the relationship between postoperative dysphagia and in-hospital outcomes, readmissions, and overall costs, and found that dysphagia correlates with significantly increased length of stay, 30-day readmissions, in-hospital mortality, and increased direct costs [8]. In this study 297 patients who underwent ACCF were retrospectively reviewed regarding the incidence, severity, and duration of postoperative dysphagia. In addition a multiple factors analysis using the ordinal logistic regression model was also performed in an attempt to determine the possible risk factors of dysphagia after ACCF.

In this study the total incidence of dysphagia after ACCF was 25.25% at one week, 16.16% at three months, and 6.73% at the final follow-up, and it gradually decreased during months following surgery. Most of the dysphagia was mild or moderate, severe dysphagia was uncommon: these findings are similar to the previously reported incidence of dysphagia after anterior cervical discectomy and fusion (ACDF) which often requires a less invasive

Table 4. Results of multivariate ordinal logistic regression

Variables		Estimate	OR[b]	95% Confidence Interval		*P* values
Gender	Female	1.108	1.370	1.098	2.813	0.013
	Male	0[a]				
Age	Age > mean age	-0.036	1.413	1.383	1.444	0.916
	Age < mean age	0[a]				
Operation time	Time > mean time	1.588	1.374	1.075	8.036	0.012
	Time < mean time	0[a]				
Blood loss	> mean value	-0.102	1.358	1.092	1.688	0.739
	< mean value	0[a]				
Involvement of C4-5	Yes	-0.133	1.594	1.357	1.871	0.775
	None	0[a]				
Involvement of C5-6	Yes	0.203	1.394	0.668	2.907	0.540
	None	0[a]				
Type of cages	Titanium mesh cage	-1.177	1.560	0.219	11.122	0.068
	n-HA/PA66 cage	0[a]				
Type of plates	Venture plate	-0.089	1.831	1.754	1.912	0.883
	Vectra-T plate	0.687	1.895	0.197	18.261	0.282
	PAC plate	-0.95	3.333	0.985	11.281	0.430
	Atlantis plate	0[a]				
Surgeons	Surgeon 1	-0.514	1.820	0.429	7.718	0.391
	Surgeon 2	-1.159	1.835	0.515	6.534	0.056
	Surgeon 3	-1.295	2.151	0.401	11.539	0.091
	Surgeon 4	-1.972	3.796	2.631	5.477	0.139
	Surgeon 4	-0.073	2.000	1.957	2.043	0.916
	Surgeon 5	0[a]				

[a]This parameter is set to zero because it is redundant. [b]OR, odd ratio.

operating method with a much shorter operating time compared to that for ACCF [15, 16]. Kalb *et al*. reported that the incidence of dysphagia after anterior cervical surgery was 10.8% during the first six months after operation: the presence of dysphagia in these patients decreased significantly at three and six months, and they concluded that possible risk factors included multilevel surgeries, involvement of C4-5 and C5-6, and age, but not operating time [17]. Zeng *et al*. reported the incidence of early dysphagia after anteriorcervical spine surgery was 26.9% and they found that female patients, older patients, multi-level surgery, and anterior plate type were possible risk factors for postoperative dysphagia [18]. Yu *et al*. compared the incidence of postoperative dysphagia between two surgical approaches: lateral or medial to the omohyoid muscle, and they observed no significant differences between two surgical approaches [19]. Jang *et al*. found that age and gender were not associated with postoperative dysphagia in their study [20]. In this study female patients, and long operation times, were found to be significantly associated with higher incidences of dysphagia after surgery while age, blood loss, involvement of C4-5, involvement of C5-6, type of cages, type of plates, and surgeon were not observed to correlate with higher incidences of dysphagia after ACCF. This wide variance may be attributed to a series of variations such as surgical technique, different types of anterior plates, use of glucocorticoid and bone morphogenetic protein-2 or not, the time of post-operative evaluation, and the different factors included in the multiple factor analysis. In addition, the different methods of dysphagia assessment may affect the incidence of post-operative dysphagia as there are so many different diagnosis criteria used: patient-reported dysphagia outcome measures, clinician-based outcome measures, and complementary examinations such as barium

swallowing tests, videofluoroscopic swallowing evaluation, or fibre-optic endoscopic evaluation all yield different data [21-26].

In conclusion, most of the dysphagia seen after ACCF was mild and gradually decreased during the following months. Moderate or severe dysphagia was uncommon. Female patients and a long operation time may be associated with higher incidences of dysphagia. Further research is needed to validate these findings.

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Disclosure of conflict of interest

None.

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