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ORIGINAL ARTICLE

Risk factors for severe dysphagia in acute cervical spinal cord injury

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Study design: A retrospective, consecutive case series.
Objectives: The relationship between dysphagia and acute cervical spinal cord injury (CSCI) has been recently reported; however, the cause and mechanism of dysphagia are still not well understood. No definitive factors have yet been established according to multivariate analysis. The objective is to elucidate the incidence and risk factors of dysphagia in patients with acute CSCI.
Setting: Spinal Injuries Center, Fukuoka, Japan.
Methods: A total of 298 patients with acute CSCI, who were evaluated for neurological impairment within 3 days after injury, were reviewed. CSCI patients with tube dependence due to obvious aspiration after injury were defined as having dysphagia. The factors postulated to increase the risk for dysphagia, including the patient's age, sex, American Spinal Injury Association (ASIA) impairment scale at 3 days after injury, level of injury, tracheostomy and operative treatment, were analyzed using a multiple logistic regression model.
Results: Of 298 patients, 21 were suffering from severe dysphagia after acute CSCI (7.0%). Of these 21 patients, 12 (57%) had CSCI at the C3–C4 level. Multivariable logistic regression analysis revealed that old age (>72 years), severe ASIA impairment scale (A or B) and presence of tracheostomy were significant risk factors of dysphagia. Level of injury ⩾C3–C4 was not a significant risk factor after adjustment for several potential confounders.
Conclusion: The incidence of severe dysphagia associated with aspiration was 7%. Old age, severe paralysis and presence of tracheostomy may be the risk factors for dysphagia. The risk for dysphagia should be evaluated to prevent aspiration pneumonia.
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INTRODUCTION

Dysphagia following cervical spinal cord injury (CSCI) in the acute phase can increase the risk of pulmonary complications, which may cause life-threatening conditions.[1] Diseases of the respiratory system are the first leading primary cause of death in patients with spinal cord injury.[2] In the USA, 67.4% of these are cases of pneumonia.[2] Especially, aspiration pneumonia remains a major cause of further morbidity and mortality.[3,4]

The relationship between dysphagia and CSCI has been recently reported;[4–7] however, the cause and mechanism of dysphagia are not well understood. Although several risk factors for dysphagia such as age, tracheostomy and anterior surgery have been postulated in patients with CSCI,[4–8] no definitive factors have yet been established according to a multivariate analysis. We conducted the analysis in order to identify the risk factors of dysphagia using larger number of patients and multivariate model. The purpose of this study was to elucidate the incidence and risk factors of dysphagia in patients with acute CSCI.

PATIENTS AND METHODS

Patients

A total of 464 consecutive patients with traumatic cervical spinal injury with and without spinal cord damage were treated at our institute and were registered in our database system from January 2007 to December 2014. All patients underwent computed tomography, magnetic resonance imaging and neurological examination at admission. We retrospectively selected 298 patients based on the following criteria:[1] admission within 3 days following injury,[2] patients with paresis or paralysis,[3] patients without brain injury[4] and patients without premorbid history of swallowing disorder before trauma. Neurological impairment scale was evaluated according to American Spinal Injury Association (ASIA) impairment scale[9] by surgeons and physiotherapists. Level of injury was determined by two surgeons using computed tomography and magnetic resonance imaging. All surgeons were expert board members of the Japanese Society for Spine Surgery and Related Research, who determined the level of injury and neurological impairment by using the ASIA classification.

Medical records were individually reviewed retrospectively to evaluate condition of eating, tracheostomy due to respiratory complication and operation of CSCI. We extracted patients with tube dependence due to obvious aspiration after injury. The functional oral intake scale (FOIS)[10] was used to evaluate oral intake function (FOIS items—Level 1: Nothing by mouth, Level 2: Tube-dependent with minimal attempts of food or liquid, Level 3: Tube-dependent with consistent oral intake of food or liquid, Level 4: Total oral diet of a single consistency, Level 5: Total oral diet with multiple consistencies, but requiring special preparation or compensations, Level 6: Total oral diet with multiple consistencies without special preparation, but with specific food limitations and Level 7: Total oral diet with no restrictions). Levels 1 through 3 relate to varying degrees of non-oral feeding; levels 4 to 7 relate to varying

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degrees of oral feeding without non-oral supplementation. In this study, FOIS levels 1 through 3, whose patients were tube-dependent for nutrition due to obvious aspiration, were defined as having severe dysphagia.

This study was approved by our Institutional Review Board of Spinal Injuries Center. Some of the patients in this study were included in our previous paper, which examined the risk factors of tracheostomy between 1996 and 2010.[11]

Data analysis

We analyzed the factors postulated to increase the risk for dysphagia, including the patient's age, ASIA impairment scale (AIS) at 3 days after injury, level of injury, tracheostomy and operative treatment. Patients with dysphagia were compared with those without dysphagia. χ^2-test was used after the variables were categorized. A logistic regression model was used to compute odds ratios (ORs) and 95% confidence intervals (95% CIs) for an increased risk for dysphagia. Age was categorized into the following two groups: 72 years or less and >72 years. The cutoff value of 72 years was analyzed and selected using receiver operating characteristic curve. AIS at 3 days after injury was categorized into severe (A or B) and mild (C or D). Level of injury was categorized into the following two groups: C3–C4 or more cephalic and C4–C5 or more caudal. Treatment method was categorized into conservative treatment and operative treatment. Whether the patients received tracheotomy within a month after trauma was also categorized. The logistic regression model was adjusted for age, sex, AIS, level of injury, treatment and tracheostomy. All statistical analyses were performed using the JMP 10 statistical software package (SAS Institute Inc., Cary, NC, USA). A *P*-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the patient demographics of this study. Of the 298 patients, 21 appeared to be suffering from severe dysphagia after acute traumatic CSCI (7.0%). All of these patients experienced evident aspiration, had to stop oral intake due to aspiration and were tube-dependent temporarily for nutrition. The neurological status of each patient with dysphagia revealed that 13 of those patients were AIS A, 6 patients were AIS B and 2 patients were AIS C. Of the 21 patients, 12 (57.1%) received tracheostomy.

Of 21 patients who had severe dysphagia, 12 patients (57%) had spinal cord injury at C3–C4, 4 patients (19%) at C4–C5, 4 patients (19%) at C5–C6 and 1 patient (5%) had spinal cord injury at C6–C7.

CSCI patients with and without dysphagia were compared in Table 2. Those with dysphagia showed significantly greater age, more severe AIS, higher level of injury and presence of tracheostomy by both χ^2-tests and simple logistic regression analyses. After adjustment for potential confounding factors, multivariable logistic regression analysis revealed that age >72 years (OR: 3.71, 95% CI: 1.21–12.3, $P=0.02$), AIS A or B (OR: 8.98, 95% CI: 2.06–63.60, $P=0.008$) and presence of tracheostomy (OR: 16.41, 95% CI: 5.14–58.26, $P<0.001$) were significant risk factors for dysphagia.

Table 1 Summary of demographic data of 298 patients with cervical spinal cord injury

	Severe dysphagia[a] *(+)*	*Severe dysphagia*[a] *(−)*	*Total*
Cases (*n*)	21	277	298
Age (median (range))	73 (32–84)	63 (14–91)	64 (14–91)
Sex (male) (*n* (%))	20 (95)	236 (85)	256 (86)
Operative treatment (*n* (%))	7 (33)	92 (33)	99 (33)
Tracheostomy (*n* (%))	12 (57)	14 (5)	26 (9)
ASIA impairment scale (n *(%))*			
A	13 (62)	85 (31)	98 (33)
B	6 (29)	32 (12)	38 (13)
C	2 (10)	125 (45)	127 (43)
D	0 (0)	35 (13)	35 (12)

Abbreviations: ASIA, American Spinal Injury Association; FOIS, functional oral intake scale.
[a]Severe dysphagia: FOIS ⩽ 3.

DISCUSSION

Several previous studies[6–8] have reported that the incidence of dysphagia after CSCI was between 8.3 and 41%. Shin *et al.*[4] reported that 10 of 121 (8.3%) tetraplegic patients showed evidence of aspiration on a videofluoroscopic swallowing study. Shem *et al.*[6] reported that dysphagia was present in 12 of 29 (41%) individuals with acute tetraplegia who underwent a prospective bedside swallow evaluation. In our study, which included the greatest number of patients with acute CSCI compared with previous studies, the rate of incidence was lower than in previous reports. The reason for this is that patients with CSCI often present with varying degrees of dysphagia, which makes it difficult to set a definition for dysphagia. Our criteria for dysphagia, which was defined as patients with tube dependence for nutrition due to obvious aspiration (FOIS levels 1–3), may signify a more severe swallowing disorder than seen in other studies.

Old age was significantly related to the higher incidence of dysphagia in our study. Previous studies[6,8] also identified age as a significant risk factor. Aging itself, independent of CSCI, can increase

Table 2 Risk factors for dysphagia in acute cervical spinal cord injury

	Severe dysphagia[a]		P-*value*[b]	*Crude OR*	*Adjusted OR*
	(+) n = 21	*(−)* n = 277		*(95% CI)*	*(95% CI)*
Age (yr), n *(%)*					
⩽72	10 (48)	210 (76)		Reference	Reference
>72	11 (52)	67 (24)	0.004	3.44 (1.39–8.62)[c]	3.71 (1.21–12.3)[c]
ASIA impairment scale, n *(%)*					
C, D	2 (10)	168 (56)		Reference	Reference
A, B	19 (90)	117 (44)	<0.001	12.9 (3.67–82.52)[c]	8.98 (2.06–63.60)[c]
Level of injury, n *(%)*					
⩽C4/5	9 (43)	189 (63)		Reference	Reference
⩾C3/4	12 (57)	109 (37)	0.04	2.47 (1.01–6.26)[c]	2.57 (0.71–10.43)
Treatment, n *(%)*					
Conservative treatment	14 (67)	185 (62)		Reference	Reference
Operative treatment	7 (33)	92 (38)	0.991	1.01 (0.37–2.50)	0.78 (0.18–3.43)
Tracheostomy, n *(%)*					
Negative	9 (43)	263 (88)		Reference	Reference
Positive	12 (57)	14 (12)	<0.001	25.05 (9.19–71.71)[c]	16.41 (5.14–58.26)[c]

Abbreviations: ASIA, American Spinal Injury Association; CI, confidence interval; FOIS, functional oral intake scale; OR, odds ratio.
The logistic regression model was adjusted for age, sex, AIS, level of injury, treatment and tracheostomy.
[a]Severe dysphagia: FOIS ⩽ 3.
[b]*P*-value was calculated by the χ^2-test.
[c]$P<0.05$ by univariate or multivariate logistic analysis.

the risk for dysphagia, because changes in physiology with aging are seen in the upper esophageal sphincter and pharyngeal region, whose sensation is blunted with age.[12]

Tracheostomy was a significant risk factor for dysphagia in this study. As tracheostomy accompanied with acute respiratory failure was reported to be correlated with severe neurological impairment scale, they may be confounding factors of dysphagia.[11] Previous studies[6,8] also supported this correlation. Gross *et al.*[13] reported that the reduction of respiratory volume and subglottic pressure due to a tracheostomy tube or a thorax trauma raised the risk of aspiration. The reduction of subglottic pressure and stimulation of a tracheal cannula to larynx and esophagus may cause dysphagia of patients with tracheostomy.[14] The OR of tracheostomy was highest among significant risk factors demonstrated in this study; thus, we need to pay special attention to aspiration of patients with tracheostomy.

Our study demonstrated that severe paralysis (AIS A or B) was a significant risk factor for dysphagia. Maeda *et al.*[15] reported that the area of prevertebral hyperintensity on T2-weighted magnetic resonance imaging had a significant negative correlation with the ASIA motor score, indicating that patients who had larger prevertebral hyperintensity tended to show more severe paralysis. Therefore, swelling at the retropharyngeal space due to vertebral fracture or soft tissue damage may affect swallowing dysfunction.

Multiple logistic regression analysis revealed that level of injury $\geqslant$ C3–C4 was not a significant risk factor, whereas both χ^2-test and simple logistic regression model showed a significant difference. More than half the patients with dysphagia had a spinal injury at C3–C4 level, whereas no patient had dysphagia at C2–C3 level in our study. Seidl *et al.*[5] also showed that the number of swallowing disorders increased as the level of tetraplegia lowered with the peak of the C4 level. On the other hand, Shem *et al.*[6] reported that no relationship between dysphagia and level of injury was found to exist. Buchholz and Neumann[16] postulated changes in pharyngeal wall sensitivity as a result of separation of the rear wall of pharynx as a result of trauma and surgery. Most of the CSCI in old patients are spinal cord injury without major bone injury, and they often occur at the C3–C4 level.[17,18] Confounding factors, such as age and level of injury, should be considered although injury at C3–C4 may affect a cause of dysphagia because larynx is located just in front of C3–C4 vertebrae.

Our study showed that operation was not a significant risk factor for dysphagia. Anterior surgical approach of cervical spine has been reported to cause dysphagia.[19,20] Andrew and Sidhu[19] reported that the greatest level of swelling or change in the prevertebral soft tissues after anterior cervical surgery occurred at the mid-body of C4 with an average change of 10.7 mm. Because only 1 of 7 patients who underwent surgery underwent anterior approach for CSCI, operation might not be identified as a risk factor for dysphagia in this study.

Limitations to this study should be acknowledged. Patients with dysphagia present with varying degrees of swallowing disorders. Difficulty with food transmission through pharynx and problem of mastication, which were other symptoms of dysphagia, were not evaluated in this study, because we focused on aspiration. Also, as tube dependence due to aspiration is a very important line between life and death in clinical practice, we aimed to examine the risk factors for severe dysphagia. Because our criteria for dysphagia was FOIS levels 1–3 due to obvious aspiration, only severe swallowing disorder was defined as severe dysphagia and examined in this study. Moreover, detailed examination using videofluoroscopic examination of swallowing or videoendoscopic evaluation of swallowing would provide more accurate diagnosis of aspiration.

When we treat acute CSCI patients with these risk factors, caution is necessary to avoid aspiration. In addition to these risk factors, patients with a past history of stroke, aspiration pneumonia or chronic pulmonary disease may also require close attention and screening tests in clinical practice. Diet with special preparation, oral care, avoidance of unnecessary tracheostomy and screening for dysphagia should be performed to prevent pulmonary complications associated with dysphagia and maintain better nutritive condition. Therefore, the risk for dysphagia should be evaluated.

CONCLUSION

A total of 298 patients were retrospectively reviewed to detect risk factors for dysphagia using a multiple logistic regression model. The incidence of severe dysphagia associated with aspiration was 7%. Old age, severe paralysis and tracheostomy may be at risk for dysphagia. Risk for dysphagia should be evaluated to prevent aspiration pneumonia.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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