Low Nutrition before Injury Is a Risk Factor for Dysphagia in Older Patients with Cervical Spinal Cord Injury: Based on a Multicenter Data of 707 Patients

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Abstract:

Introduction: For older adults, dysphagia is a serious problem that can occur after spinal cord injury (SCI), but its risk factors are unclear. This study aimed to identify risk factors for dysphagia in elderly patients (≥65 years) with cervical SCI.

Methods: This multicenter study included 707 patients with cervical SCI (mean age 75.3 years). Univariate and multivariate analyses were conducted for patient characteristics and geriatric nutritional risk index (GNRI).

Results: Dysphagia occurred in 69 patients (9.8%). The significant factors were as follows: male sex (odds ratio [OR] 3.43), GNRI <92 (1.83), dementia (2.94), fracture (3.40), complete paralysis (3.61), anterior surgery (3.74), and tracheostomy (17.06). Age was not identified as a risk factor.

Conclusions: Low GNRI before injury was one of the independent risk factors for dysphagia after geriatric cervical SCI. GNRI represents the comprehensive nutritional status of the elderly and reflects feeding function and its recovery capacity.

Keywords:

dysphagia, cervical spinal cord injury, elderly patients, geriatric nutritional risk index, frailty index

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Introduction

Dysphagia is a common complication after cervical spinal cord injury (SCI), with an estimated incidence of 16%-60%[1]. The adverse consequences of dysphagia in patients with SCI include hypoxemia, chemical pneumonia, atelectasis, bronchospasm, and pneumonia; these respiratory complications primarily cause death in patients with SCI[2]. Therefore, it is important to understand and respond to dysphagia after SCI. Furthermore, dysphagia and respiratory complications increase medical costs[3,4]. Since it decreases quality of life and increases the need for nursing and caregiving, with enormous consequences for patients and providers, identifying the risk factors of dysphagia in cervical SCI is critical.

Several studies have reported the risk factors of dysphagia after SCI. For example, advanced age and tracheostomy are well-known risk factors with a significant impact on dysphagia[2,5-10]. In recent years, the demographics of SCI have shifted from young subjects injured by high-energy trauma to elderly patients injured by minor trauma[11]. Even though elderly SCI cases usually have incomplete paralysis from minor trauma[12,13], dysphagia still occurs. Incomplete cervical SCI is brought about by spinal cord compression induced by hyperextension in degenerated cervical spine (i.e., elderly patients with potentially degenerative cervical myelopathy)[14-16]. Thus, the epidemiology of this disease differs between younger and older adults. However, previous studies have dealt with cervical SCIs of all ages, limiting the number of reports that have investigated elderly dysphagia after SCI in detail.

In an aging society, cervical SCIs continue to increase as the number of elderly people increases[17-21]. It is critical to identify the risk factors of dysphagia because its prevalence is expected to increase at an accelerated rate, with advanced age being a risk factor for dysphagia after SCI[2,5,7,8,10]. Therefore, we conducted a retrospective study using a national multicenter research database[22,23] of elderly patients with cervical SCI. We analyzed patient demographics and identified risk factors for the development of dysphagia.

Materials and Methods

Patients

This study was conducted by the Japan Association of Spine Surgeons with Ambition (JASA) group. Specifically, this was a multicenter retrospective analysis of hospitalized patients aged 65 years or older who sustained cervical spinal cord and/or cervical spine injuries. The scope included 33 medical facilities between 2010 and 2020. The study protocol was approved by the Institutional Review Board (No. 3352-1) of 25 representative institutions and by each institution. Since this was a retrospective study, informed consent was not required for submission. The optout of this study was posted on the website (https://web.sapmed.ac.jp/orsurg/guide/hj0g2h00000007ax-att/pgsps60000000g3l.pdf), and we did not receive any inquiries.

A total of 1,512 eligible patients with or without surgical treatment were entered into the database[22]. Patients without SCI (American Spinal Injury Association Impairment Scale [AIS] grade E) and those with unknown paralysis grades were excluded. Additionally, patients with unknown geriatric nutritional risk index (GNRI)[24] or unknown the 5-item modified frailty index (mFI-5)[25] at injury were excluded. GNRI and mFI-5 were calculated based on data at the time of admission. The GNRI formula is as follows:

GNRI=[14.89×albumin (g/dL)]+[41.7×weight/ideal weight]

The ideal weight was calculated using the Lorentz equations as follows:

For men: height (cm)−100−[(height−150)/4]

For women: height (cm)−100−[(height−150)/2.5]

The mFI-5 is determined by counting the presence of five problems: congestive heart failure in the past 30 days, history of severe chronic obstructive pulmonary disease or pneumonia, hypertension requiring medication, diabetes mel-

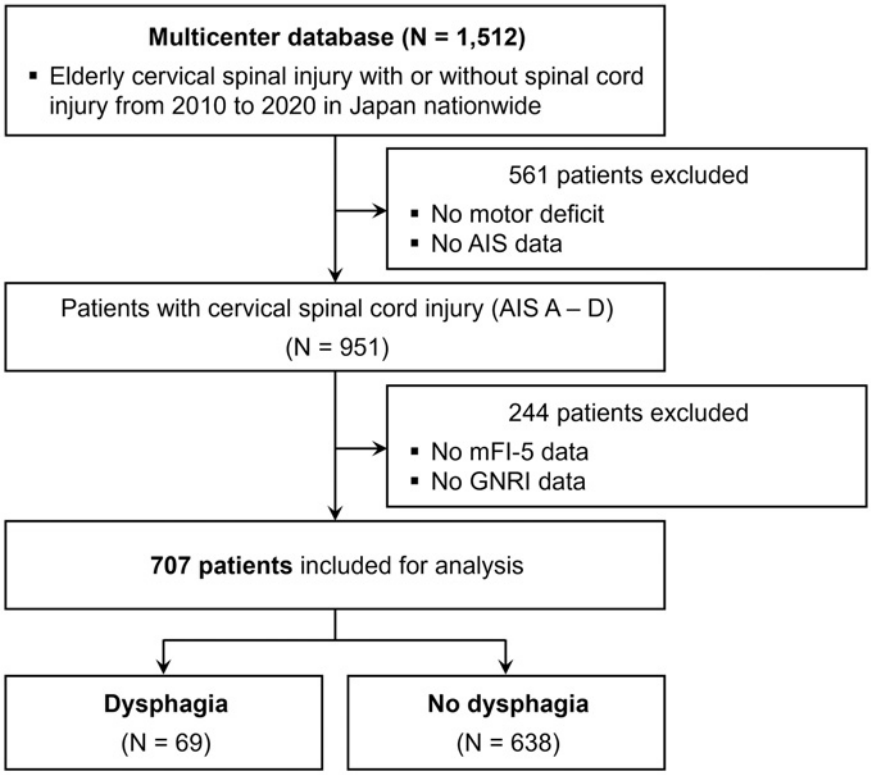

Figure 1. Patient selection flowchart.
AIS, American Spinal Injury Association impairment scale; mFI-5, 5-Item Modified Frailty Index; GNRI, geriatric nutritional risk index

litus treatment with oral agents or insulin, and nonindependent functional health status. In total, 707 patients were included in this study (Fig. 1).

Patients' demographic and operative data

The incidences of dysphagia were collected through a retrospective review of medical records. The following items were recorded from the medical record survey: presence or absence of dysphagia, age at the time of injury, sex, presence or absence of cervical spine fracture, presence or absence of cervical ossification of posterior/anterior longitudinal ligament, severity of neurological symptoms (i.e., AIS grade), concomitant injuries at the time of SCI, preexisting medical comorbidities, GNRI, mFI-5, and whether surgery, such as tracheostomy, was performed.

Statistical analysis

The data is presented as mean±standard deviation for continuous variables and as number and percentage for categorical data. Statistical analyses were performed using R version 4.2.2 (http://www.R-project.org) on Wilcoxon rank sum, Fisher's exact, and Pearson's Chi-squared tests. Statistical significance was set at $p < 0.05$. Factors with p-value <0.1 on univariate analysis were included in the multivariate regression model; odds ratios (OR) and 95% confidence intervals were calculated to identify independent predictors.

Results

The demographic data can be seen in Table 1. All 707 patients comprised a mean age of 75.3 years, 72% male, a mean GNRI of 96.9, and approximately 80% had an mFI-5 below two. Cervical fracture was seen in 38%, and paralysis was common with AIS D (35%). Moreover, 66% of patients underwent surgery, mostly via the posterior approach (3.1% underwent anterior approach).

Dysphagia occurred in 69 patients (9.8%). The following factors were identified as significant on univariate analysis: male sex, GNRI <92 (moderate nutrition-related risk), smoking, presence of ossification of anterior longitudinal ligament, fracture, complete paralysis (AIS A or B), surgical treatment, anterior surgery, and tracheostomy (Table 2). Logistic regression analysis was performed on factors with p <0.1 (including mFI-5 ≥3, dementia, concomitant head injury). The following were deemed significant: male sex (OR 3.43), GNRI <92 (1.83), dementia (2.94), fracture (3.40), complete paralysis (3.61), anterior surgery (3.74), and tracheostomy (17.06) (Table 3).

Discussion

The current study analyzed the risk factors for dysphagia development in elderly cervical SCI using a multicenter database. Surprisingly, besides several previously identified risk factors, poor nutritional status (GNRI <92) before injury

was identified as an independent risk factor for the development of dysphagia in older adults.

Table 1. Demographics.

	N=707
Age, year	75.3±6.7
Sex, male	511 (72%)
GNRI	96.9±12.2
mFI-5	
0	264 (37%)
1	302 (43%)
2	125 (18%)
3	14 (2.0%)
4	2 (0.3%)
Fracture	266 (38%)
AIS	
A	90 (13%)
B	59 (8.3%)
C	246 (35%)
D	312 (44%)
Surgical treatment	470 (66%)
Anterior surgery	22 (3.1%)
Tracheostomy	29 (4.1%)

GNRI, geriatric nutritional risk index; mFI-5, 5-Item Modified Frailty Index; AIS, American Spinal Injury Association impairment scale

The underlying mechanisms and pathophysiology of dysphagia after SCI are poorly understood despite its high prevalence[1]. Alternatively, our study identified several risk factors in previous reports. First, tracheostomy strongly increased the risk of developing dysphagia, regardless of the disease[26]. For this reason, unnecessary tracheostomies should be avoided[8]. Additionally, anterior cervical surgery is also recognized as a potential cause of dysphagia[27,28]. Hence, surgical procedures could also be a risk factor affecting dysphagia in older patients with SCI[29]. Next, dysphagia is a common symptom of dementia[30]. Patients with dementia and Alzheimer's disease, a common form of dementia, have poor oral hygiene and tooth loss[31] and exhibit signs of dysphagia even in the early disease Stages[32]. Third, men are also potentially at an increased risk because of sex differences in swallowing, possibly due to differences in anatomical and functional swallowing characteristics[33,34]; women have slower swallowing time and smaller volume per swallow than men. This physiological difference may be a risk in the pathological condition of cervical SCI. Thus, necessary medical procedures, acquired abnormalities, and individual differences are associated with dysphagia development.

Although older age has been reported as a significant risk factor for dysphagia development after cervical SCI, our study among older patients (mean age 75.3 years) found that increasing age was no longer a significant risk factor. Previ-

Table 2. Univariate Analysis.

	Dysphagia N=69	No dysphagia N=638	p-value
Age, year	76.4±6.3	75.2±6.7	0.14
Sex, male	62 (90%)	449 (70%)	**<0.001**
BMI, kg/m^2	22.1±4.3	22.3±3.6	0.17
GNRI <92	36 (52%)	188 (29%)	**<0.001**
mFI-5 ≥3	4 (5.8%)	12 (1.9%)	0.061
Smoking	24 (35%)	136 (21%)	**0.011**
Comorbidities			
Dementia	8 (12%)	34 (5.3%)	0.054
DM	24 (35%)	169 (26%)	0.14
CVD	5 (7.2%)	54 (8.5%)	0.73
Parkinson's disease	2 (2.9%)	6 (0.9%)	0.18
Cervical OPLL	21 (30%)	181 (28%)	0.72
Cervical OALL	17 (25%)	84 (13%)	**0.010**
Fracture	49 (71%)	217 (34%)	**<0.001**
AIS A or B	41 (59%)	108 (17%)	**<0.001**
Concomitant injury			
Head	14 (20%)	82 (13%)	0.087
Chest	2 (2.9%)	6 (0.9%)	0.18
Abdomen	0 (0%)	1 (0.2%)	>0.99
Surgical treatment	55 (80%)	415 (65%)	**0.014**
Anterior surgery	6 (8.7%)	16 (2.5%)	**0.015**
Tracheostomy	20 (29%)	9 (1.4%)	**<0.001**

BMI, body mass index; mFI-5, 5-Item Modified Frailty Index; GNRI, geriatric nutritional risk index; OPLL, ossification of posterior longitudinal ligament; OALL, ossification of anterior longitudinal ligament; DM, diabetes mellitus; CVD, cerebral vascular disorder; AIS, American Spinal Injury Association impairment scale

Table 3. Multivariate Analysis.

	OR	95% CI	p-value
Sex, male	3.430	1.49–9.18	**0.007**
GNRI <92	1.833	1.002–3.354	**0.048**
Dementia	2.942	1.085–7.347	**0.026**
Fracture	3.398	1.84–6.479	**<0.001**
AIS A or B	3.614	1.974–6.628	**<0.001**
Concomitant head injury	1.777	0.826–3.651	0.13
Anterior surgery	3.743	1.085–11.405	**0.026**
Tracheostomy	17.062	6.772–45.833	**<0.001**

GNRI, geriatric nutritional risk index; AIS, American Spinal Injury Association impairment scale

ously, Hayashi et al.[8] analyzed a patient population with a mean age of 64 years (range 14-91 years) and found that older age (≥72 years) was a risk factor for dysphagia. However, this does not significantly impact our study, where the mean age exceeded 72 years. Alternatively, Pattison et al.[35] reported that patients who developed dysphagia were older (84.1±8.93 vs. 79.9±8.48 years, p=0.006), with patient ages exceeding 65 years. However, that patient population did not include patients with SCI. Thus, their pathophysiology differs from that of the patients in our study. Hence, although dysphagia after cervical SCI, which can occur in all ages, is more common in the elderly than in younger patients, the impact of age on dysphagia appears to be limited in the older population (65 years and older).

In the current cohort, which is limited to elderly patients, low GNRI was identified as a risk factor for dysphagia after SCI. GNRI was developed by Bouillanne et al.[24] to measure nutritional status in the older adults and has been applied in various risk analyses in the older adults because of its usefulness. The GNRI is also useful in assessing mortality risk in older patients experiencing trauma[42-44]. The GNRI is calculated using serum albumin levels and the patient's height and weight. Serum albumin is considered a medium-to-long-term nutritional indicator because it is highly stable, the most abundant protein, and has a long half-life of 19 days[40]. Furthermore, body weight, another GNRI parameter, also has limited short-term fluctuations, with many older people experiencing ≤5% change in body weight over a 2-year period[41]. Therefore, the GNRI is a more accurate indicator of a patient's background nutritional status than their short-term condition.

The concept of "oral frailty" has recently emerged, and the oral health of the elderly has gained much attention. Oral health deterioration, especially with few remaining teeth, is associated with frailty[36]. With aging, patients suffer from dental caries, periodontal disease, and tooth loss[37]. They also experience a decline in tongue motor function and saliva production[38]. The loss of mass and strength of the swallowing muscles may also contribute to dysphagia development[39]. These factors impair the eating function of the older adults, leading to poor nutritional status and frailty. The frailty index is often used as a tool to determine the physiological reserve capacity of the older adults[25], but it is not useful for measuring the risk of developing dysphagia. Rather, nutritional status, which reflects original eating function, is highly important for estimating the risk of dysphagia development. The GNRI represents the comprehensive nutritional status of the elderly and reflects feeding function and its reserve capacity. Then, low GNRI was a significant risk factor for dysphagia in elderly patients with SCI.

An effective treatment for older patients with SCI at risk for dysphagia has not yet been identified[1]. Patients with SCI present acutely and are a difficult population to adequately assess for their background. The GNRI is a tool for assessing malnutrition-associated risks, such as mortality[24]. Thus, it can indicate nutritional status and be a useful scoring system for outcome prediction. To the best of our knowledge, we are the first to report the potential of GNRI as the risk indicator of dysphagia in geriatric patients with SCI. The GNRI should be explored further as a tool that can assist multidisciplinary teams[42] in maximizing the efficacy of treatments in geriatric patients. Assessing the GNRI and known dysphagia risk factors can enhance such interventions.

One limitation of this study is the possible underestimation of the incidence of dysphagia because of the retrospective method for reviewing medical records to determine the incidence[45]. However, patients with SCI often present with various degrees of dysphagia, making dysphagia difficult to define[8]. Because we only addressed dysphagia that required clinically intensive intervention, this study is a review of "severe" dysphagia in older patients with cervical SCI, which may be a limitation and useful clinical point of our study. This study has several other limitations. First, selection bias is possible because of the retrospective nature of this study. Second, the criteria for assessing dysphagia were inconsistent. Third, the long-term prognosis of dysphagia was unclear because of the dropout rate. Finally, the incidence of dysphagia evaluated by this study was relatively small. Nevertheless, this study still provides important insights into the incidence and risk factors for dysphagia, especially regarding low nutrition in older patients with cervical SCI.

In conclusion, this multicenter study found that a low GNRI before injury was one of the independent risk factors

for dysphagia among elderly patients with cervical SCI. Lastly, the GNRI represents the comprehensive nutritional status of the elderly and reflects feeding function and potential for recovery.

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Ethical Approval: Thirty-three health care facilities were included in the database. The study protocol was approved by the Institutional Review Board (no. 3352-1) of each of the 25 representative institutions.

Informed Consent: Informed consent was not required because this was a retrospective study. The optout of this study was posted on the website (https://web.sapmed.ac.jp/orsurg/guide/hj0g2h00000007ax-att/pgsps60000000g3l.pdf), and we did not receive any inquiries.

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