Original Article

Association of sarcopenia with swallowing problems, related to nutrition and activities of daily living of elderly individuals

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Abstract. [Purpose] The purpose of the current study was to clarify problems associated with swallowing, related to nutrition and activities of daily living (ADL), in elderly individuals with sarcopenia. [Subjects and Methods] Seventy-seven subjects were assigned to a sarcopenia or a non-sarcopenia group according to a definition used by the European Working Group on Sarcopenia in Older People. Analyses were conducted including and excluding subjects with a central nervous system disorders in order to focus on the influence of sarcopenia. The swallowing ability, ADL, and nutrition levels were compared between the 2 groups. [Results] Swallowing function as well as ADL and nutrition levels were significantly lower in the sarcopenia group than in the non-sarcopenia group. [Conclusion] It is important to include dimensions of swallowing, nutrition, and ADL in the assessment and treatment of swallowing problems in elderly individuals with sarcopenia.
Key words: Elderly, Dysphagia, Sarcopenia

INTRODUCTION

Rehabilitation provides essential services in the comprehensive management of a wide range of swallowing problems, including physical difficulty, processing food in the mouth, dysphagia, psychosocially based eating disorders, dysfunction related to cognitive impairments, surgical intervention, and neurological impairments. Aging has also been found to affect swallowing ability. Recently, skeletal muscle problems have become prevalent among aging humans, namely sarcopenia. Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength, with a risk of adverse outcomes such as physical disability, poor quality of life, and death[1]. Sarcopenia is considered 'primary' (or age-related) when no other cause is evident except for aging itself, and it is considered 'secondary' when one or more other causes are evident[1]. Secondary sarcopenia includes activity-related, disease-related, and nutrition-related sarcopenia. Activity-related sarcopenia can result from bed rest, a sedentary lifestyle, deconditioning, or zero gravity conditions[1]. Disease-related sarcopenia is associated with advanced organ failure (heart, lung, liver, kidney, and brain), inflammatory disease, malignancy, or endocrine disease[1]. Nutrition-related sarcopenia results from inadequate dietary intake of energy and/or protein, as well as malabsorption, gastrointestinal disorders, or use of medications that cause anorexia[1]. Thus, sarcopenia and loss of swallowing muscle function among elderly individuals are characterized by multiple factors. The purpose of the current study was to clarify problems associated with swallowing, related to nutrition and activities of daily living (ADL), in elderly individuals with sarcopenia.

SUBJECTS AND METHODS

Participants aged 65 over, who were living in a Geriatric Health Services Facility in Mie prefecture of Japan, were included in the current study. Participants who received nutrition by gastrostomy tube were excluded from this study, and all participants had oral feeding ability. The subjects were 77 elderly individuals (11 men and 66 women) aged 86.5 ± 5.7 years. This study was approved by the ethics committee of the Geriatric Health Services Facility KIRARI, and all prospective participants completed an informed consent

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process prior to study entry.

Participants were assigned to a sarcopenia or a non-sarcopenia group according to a definition used by the European Working Group on Sarcopenia in Older People (EWGSOP)[1]. The proposed diagnostic criteria require the presence of low muscle mass plus low muscle strength or low physical performance.

In the present study, muscle mass was measured via bioelectrical impedance analysis (BIA) using a body composition analyzer (BC-108, TANITA, Japan). The muscle mass of the 4 limbs on the BIA scan was defined as the appendicular skeletal muscle mass (ASM), and the skeletal muscle mass index (SMI) was defined as ASM/height^2 (kg/m^2)[1]. SMI values lower than 2 standard deviations below the mean values of young male and female reference groups were classified as low muscle mass (cut off values: the men, <8.87 kg/m^2; women, <6.42 kg/m^2)[1]. If BIA was not available, muscle mass was measured by determining the calf circumference (cut off value: <31 cm for both sexes)[2, 3]. This method was used for participants who were unable to stand or who had implanted pacemakers.

Muscle strength was assessed after evaluating the handgrip strength, which was measured using a digital grip strength dynamometer (5401, Takei Scientific Instruments, Japan). Handgrip strength values in the lowest quartile were classified as low muscle strength (cut off values: men, <30 kg; women, <20 kg)[1].

Physical performance was assessed by evaluating participant's usual gait speed. Participants were instructed to walk over an 11-meter straight course at their usual speed. Usual gait speed was derived from the time (in seconds) spent walking over the middle 5meters (from the 3-meter line to the 8-meter line). Usual gait speed values in the lowest quartile were classified as low physical performance (cut off value: ≤0.8 m/s for each sex). If participants could not walk, they were classified as having low physical performance.

In the present study, swallowing function was assessed using the following eight assessment tools: the dysphagia severity scale (DSS)[4], the repetitive saliva swallowing Test (RSST)[5, 6], thyroid position (T-position)[7], genio-thyroid distance (GT)[7], thyroid-sternum distance (TS)[7], genio-sternum grade (GS grade)[7], neck circumference (NC)[8], and maximum phonation time (MPT)[9]. The DSS is a 7-point ordinal scale, on which lower scores indicate greater swallowing dysfunction. The RSST is intended to check a patient's ability to voluntarily swallow repeatedly, which is highly correlated with aspiration. Three or more dry swallows within 30 seconds is considered normal. The GT is the distance from the genio to the thyroid during neck extension. TS is the distance from the thyroid to the sternum during neck extension. GT and TS are measured using a tape measure when the neck is stretched to the maximum extension position, and T-position is calculated as GT/(GT + TS). The GS grade is a classification of the ability to hold the neck in flexion in a supine position. The GS grade is a 4-point ordinal scale, on which lower scores indicate greater loss of suprahyoid and infrahyoid muscle strength. Neck circumference was measured using a tape measure with the tape measure placed between the thyroid cartilage and cricoid cartilage. The MPT is the longest time for a person to

Table 1. Demographic and anthropometric values of the participants

	Sarcopenia group (n=44)	non-Sarcopenia group (n=33)
Gender		
Male	4	7
Female	40	26
Age (years)	85.7±5.7	86.9±5.7
Care Level	3.0±1.3	2.2±1.1*
Height (cm)	146.6±7.9	150.2±7.5
Weight (kg)	40.9±8.0	48.4±7.2**

Mann-Whitney U test *$p<0.05$, **$p<0.01$

phonate a vowel, typically /a/.

Nutrition assessment tools included the Mini Nutritional Assessment-Short Form (MNA-SF)[10] and the Body Mass Index (BMI)[11]. The MNA-SF is composed of the following 6-domains: anthropometric measurement (BMI and weight loss), global assessment (motility), dietary questionnaire (food intake), and health assessment (acute diseases and neurological problems). Scores for all domains are summed and range from 0–14. Scores from 11–14 indicate a normal nutritional status, scores from 8–11 indicate malnutrition risk, and scores <7 indicate malnutrition, meaning that the individual should undergo further clinical evaluation for malnutrition. BMI was calculated as kg/m^2.

ADL was assessed using the Functional Independence Measure (FIM)[12]. The FIM consists of 13 mobility items and 5 communication and social cognition items. Subject ADL performance is assessed on a scale of 1–7. A total score of 126 points indicates full independence, and the lowest possible score of 18 points indicates total assistance is required.

Analyses were conducted including and excluding subjects with a medical history of central nervous system disorders, because we wanted to distinguish between dysphagia due to central nervous system disorder and dysphagia due to sarcopenia.

The sarcopenia group was compared with the non-sarcopenia group using the Mann-Whitney U test and the computer software, PASW ver. 18.0 for Mac. The level of significance was chosen as 0.05.

RESULTS

Table 1 shows the demographics of the study participants. Forty-four of the 77 participants were in the sarcopenia group. The care level required for the sarcopenia group was higher than that required by the non-sarcopenia group. The weight of the sarcopenia group was lower than that of the non-sarcopenia group. No significant differences in age and height were found between the 2 groups.

Table 2 summarizes the swallowing, nutrition, and ADL factors of the sarcopenia and non-sarcopenia groups. Generally, each swallowing factor of the sarcopenia group was lower than that of the non-sarcopenia group. Significant differences were found in DSS, RSST, GT, TS, and GS grade

Table 2. Sarcopenia group and non-sarcopenia group outcomes

	Sarcopenia group (n=44)	non-Sarcopenia group (n=33)
Swallowing Factor		
DSS	4.9±1.6	5.8±0.7**
RSST	1.4±1.1	2.7±1.4**
T-position	0.45±0.05	0.45±0.05
GT	5.7±1.4	6.5±1.1*
TS	6.9±1.8	7.8±1.7*
GS grade	2.8±1.1	3.7±0.5**
NC	34.5±3.7	34.1±2.4
MPT	7.9±4.4	9.5±3.4
Nutrition Factor		
MNA-SF	9.1±1.8	10.5±1.5**
BMI	19.3±4.8	21.5±3.2*
ADL Factor		
FIM Motor	52.8±25.1	71.6±22.3**
FIM Cognitive	23.6±9.1	27.3±6.3*
FIM Total	76.4±32.3	98.8±25.2**

Mann-Whitney U test *p<0.05, **p<0.01 T-position: Thyroid position, GT: Genion-Thyroid distance, TS: Thyroid-Sternum distance
DSS: Dysphagia Severity Scale, RSST: Repetitive Saliva Swallowing Test, GS grade: Genion-Sternum grade, NC: Neck Circumference, MPT: Maximum Phonation Time

Table 3. Comparison of outcomes after excluding subjects with central nervous system disorders

	Sarcopenia group (n=33)	non-Sarcopenia group (n=26)
Swallowing Factor		
DSS	5.4±1.2	5.9±0.6*
RSST	1.6±1.1	2.8±1.4**
T-position	0.45±0.04	0.46±0.05
GT	6.0±1.4	6.5±1.0
TS	7.4±1.5	7.8±1.4
GS grade	3.1±0.9	3.8±0.5**
NC	34.2±3.6	34.2±2.6
MPT	8.8±4.2	9.9±3.4
Nutrition Factor		
MNA-SF	9.2±1.9	10.6±1.5**
BMI	19.7±5.4	21.2±3.2
ADL Factor		
FIM Motor	61.0±21.4	74.8±22.6*
FIM Cognitive	26.2±7.2	26.8±6.7
FIM Total	87.2±26.1	101.6±26.4*

Mann-Whitney U test *p<0.05, **p<0.01
DSS: Dysphagia Severity Scale, RSST: Repetitive Saliva Swallowing Test, T-position: Thyroid position, GT: Genion-Thyroid distance, TS: Thyroid-Sternum distance, GS grade: Genion-Sternum grade, NC: Neck Circumference, MPT: Maximum Phonation Time

between the 2 groups. Regarding nutrition, the MNA-SF and BMI of the sarcopenia group were significantly lower than those of the non-sarcopenia group. Each ADL factor (FIM motor, FIM cognitive, and FIM total) of the sarcopenia group was significantly lower than that of the non-sarcopenia group.

Table 3 summarizes the outcomes except of participants with a central nervous system disorder. When participants with a central nervous system disorder were excluded, the DSS, RSST, and GS grade of the sarcopenia group was significantly lower than those of the non-sarcopenia group. Furthermore, the MNA-SF, FIM motor, and FIM total values of the sarcopenia group were significantly lower than those of the non-sarcopenia group.

DISCUSSION

Seventy-seven elderly adults aged 86.5 ± 5.7 years in a Geriatric Health Services Facility were assigned to a sarcopenia group or a non-sarcopenia group based on a definition used by the EWGSOP. As a consequence, 57.1% of the participants were classified as having sarcopenia. As there was no significant difference in the mean age between the 2 groups, we should be aware that more than half of elderly individuals aged >85 years may have sarcopenia in Geriatric Health Services Facilities in Japan. In addition, it was identified that a significantly higher care level was required for the sarcopenia group. The weight of the sarcopenia group was lower than that of the non-sarcopenia group, even after excluding the influence of height, since there was no signifi-

cant difference between the mean heights of the 2 groups. These results indicate that we should consider the state of sarcopenia in elderly individuals with low body weight since they require higher levels of institutionalized care in Geriatric Health Services Facilities.

The differences in swallowing function between the sarcopenia and non-sarcopenia groups were investigated. The severity of dysphagia, swallowing performance, and the strength of the hyoid muscles were evaluated using the DSS, RSST, and GS grade, respectively. The sarcopenia group showed a significant reduction in swallowing function. Compared with the non-sarcopenia group similar results were obtained when subjects with central nervous system disabilities were excluded. Furthermore, clear differences were found between the two groups in the mean GS grade and RSST. Thus, we consider these values are important for evaluating swallowing function decline in those with sarcopenia. We also think that GS grade and RSST are useful as preventive assessments for the elderly, as well as walking velocity[13, 14].

Presbyphagia[15–18] which is induced by muscle weakness associated with aging, has been reported to account for swallowing function decline. According to the definition of presbyphagia, occipital vestibular closure in dysphagia, failure of bolus transfer by the tongue, and delays in the movement of the hyoid bone are associated with sarcopenia of the lingual, suprahyoid, and pharyngeal constrictor muscles.

TS and GT, which are used to evaluate the larynx position, were significantly shorter in the sarcopenia group. However, the differences were not significant when the subjects with

central nervous system disabilities were excluded. It is known that the larynx position changes with aging. In addition, the usefulness of TS and GT has been demonstrated for the determination of dysphagia due to abnormal muscle tone of the surrounding neck muscles and abnormal posture in hemiplegic subjects[7]. Thus, TS and GT are useful for the detection of swallowing disorders in individuals with central nervous system disease; however, it seems to be unreliable for the detection of swallowing function decline when descent of the larynx occurs due to aging.

In the sarcopenia group, the MNA-SF nutritional assessment was significantly lower even after excluding those with central nervous system disorders. Thus, food intake was possibly reduced owing to decreased swallowing function, resulting in malnutrition in elderly individuals with sarcopenia. However, malnutrition for some reason might lead to sarcopenia following swallowing function decline. The present study found that swallowing function and nutrition are important factors for the comprehensive assessment and treatment of sarcopenia. Furthermore, the mean MNA-SF score of the non-sarcopenia group was lower, and it was classified at the malnutrition level according to Rubenstein LZ et al[10]. The present results should make us aware that it is possible for people without sarcopenia to become malnourished and develop degraded swallowing and sarcopenia.

The FIM total and FIM motor scores, as indices of ADL, were significantly lower in the sarcopenia group, and the result was similar after excluding those with central nervous system disabilities. From these results, we consider that elderly individuals with low ADL scores should be suspected of having sarcopenia, and that evaluation of ADL indirectly indicates many problems caused by sarcopenia such as malnutrition or swallowing function decline.

In conclusion, swallowing function as well as nutrition and ADL levels were significantly diminished in the sarcopenia group compared with the non-sarcopenia group. From these results, we conclude that it is important to include dimensions of swallowing, nutrition, and ADL in the assessment and treatment of swallowing problems in elderly individuals with sarcopenia. A limitation of the present study was the cohort study design in a single-facility. Thus, more research is needed using multiple facilities and a larger population to clarify the swallowing problems of elderly individuals requiring care for sarcopenia.

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