Relationship between Swallowing Function, and Functional and Nutritional Status in Hospitalized Elderly Individuals

Yoshitoshi Kuroda*

Department of Rehabilitation, St. Francis Hospital, 9-20 Komine-machi, Nagasaki city 852-8125, Japan

Abstract: Dysphagia is highly prevalent among hospitalized elderly individuals. However, the underlying mechanism of this condition remains to be elucidated. The primary objective of this study was to investigate the relationship between swallowing function, and functional and nutritional status in hospitalized elderly individuals. The subjects consisted of 113 patients with a mean age of 86.4 years. Those who had Parkinson's disease and a cerebrovascular accident within 6 months, or malignancy were excluded. Swallowing measures included a graded water swallowing test and food intake level scale; functional measures included a physical dependency scale and a comprehension scale; and nutritional measures included serum albumin levels, mid-upper arm circumference, and calf circumference. Both of the swallowing measures had significant correlations with the functional and nutritional measures but not with age, suggesting that dysphagia in this clinical population is related to functional dependency and malnutrition. Given that sarcopenia is exacerbated by disease, inactivity and malnutrition, the result of the present study is possibly explained using the concept of sarcopenia involving the swallowing muscle mass and its function.

Keywords: Dysphagia, elderly, sarcopenia, dependency, malnutrition.

INTRODUCTION

Dysphagia is a common condition among the elderly [1, 2]. The prevalence of dysphagia has been reported to be especially high among hospitalized elderly individuals [3, 4]. Why are older people more likely to experience swallowing dysfunction than younger people? One possible reason for this phenomenon is that the prevalence of diseases that can cause dysphagia (e.g. cerebrovascular diseases and Parkinson's disease) increases with age. However, in acute geriatric settings, it is not uncommon to observe elderly patients developing dysphagia even though they do not have a disease that directly causes swallowing impairment. This may be because the elderly have a diminished functional reserve (the resilient ability of the body to adapt to physiological stress) in swallowing, making them more susceptible to dysphagia [5, 6] and implying that a wide variety of stressors such as acute illness can induce dysphagia in the elderly. However, based on this assumption, the dysphagia symptoms should theoretically cease after removal of such stressors, which is inconsistent with our anecdotal clinical observation that some elderly patients without disease that can directly cause dysphagia presented with persistent swallowing impairment even after the acute illness was successfully treated. We therefore think that the reason for prevalence of dysphagia in hospitalized elderly individuals remains to be elucidated.

It is well-known that the hospitalized elderly are prone to functional decline [7, 8]. Although the most prominent changes resulting from hospitalization were reduction of muscle mass and its function, its influence on the swallowing function has not been sufficiently investigated. It is also well-known that malnutrition is highly prevalent among hospitalized elderly individuals [9]. Although a few researchers have advocated that protein-energy malnutrition may cause or worsen dysphagia [10, 11], there is no sufficient evidence that malnutritioncan cause dysphagia [12]. Given that functional decline and malnutrition are common conditions among hospitalized elderly individuals, it is reasonable to assume that each of these conditions may affect swallowing function. However, the relationship between swallowing function, and functional and nutritional status are unclear.

The last two decades have seen an increase concern regarding sarcopenia in the elderly population. The term sarcopenia was coined by Rosenberg in 1989 [13] and describes the age-related loss of muscle mass and function [14]. Since then, the prevalence, causes, and consequences of sarcopenia have been investigated [15-17]; however, there is still a lack of consensus over whether it is a process of normative aging or a disease state [18]. Although some researchers use the term to describe the age-related loss of muscle mass and function in an otherwise healthy individual (i.e. primary sarcopenia), others use the term more broadly, encompassing the muscle changes related to disease, inactivity, and malnutrition (i.e., secondary sarcopenia) [19]. In dysphagia research, several researchers have considered that at least part of the decline in the swallowing capacity in

*Address correspondence to this author at the Department of Rehabilitation, St. Francis Hospital, 9-20 Komine-Machi, Nagasaki City 852-8125, Japan;
Tel: +81-95-846-1888; Fax: +81-95-845-7600;
E-mail: kuroda@athena.ocn.ne.jp

E-ISSN: 2311-1917/14

the elderly may be related to the general loss of muscle mass and strength [20-22], although they seem use the term sarcopenia according to the former definition (i.e. primary sarcopenia). More recently, there have been attempts to apply the broad definition of sarcopenia (including secondary sarcopenia) to explain the mechanism underlying the dysphagia observed in the elderly [23, 24]. Although there is still a lack of consensus on the definition and feasible diagnostic methods, sarcopenia may be a useful concept to explore the underlying mechanism of dysphagia in hospitalized elderly individuals, considering that the framework of secondary sarcopenia can incorporate the possible effects of functional and nutritional decline on swallowing function.

The primary purpose of this study was to investigate the relationship between dysphagia, and functional and nutritional status in hospitalized elderly individuals. A secondary purpose was to discuss the underlying mechanism of dysphagia in this population using the concept of secondary sarcopenia.

METHODS

The primary subjects were 133 patients aged 65 years or older, who were admitted to St. Francis Hospital for acute care, and underwent swallowing and nutritional assessment for the presence of oral intake difficulty between April 2012 and October 2013. Those who had Parkinson's disease (n = 10), a cerebrovascular accident within 6 months (n = 6), or malignancy (n = 4) were excluded, leaving 113 patients (45 men and 68 women) in the study. The mean (± SD) age was 86.4 ± 6.2 years, ranging from 66-100 years. The primary diagnosis on admission included pneumonia and other respiratory diseases (n = 80), digestive diseases (n = 6), cardiac diseases (n = 5), renal diseases (n = 5), and others (n = 17). Of the 113 patients, 76 (67.3%) were reported to have dementia according to their medical records.

Swallowing measures included a graded water swallowing test (GWST) and food intake level scale (FILS). GWST consisted of 2, 3, and 5 mL of water intake in a graded manner. The patient starts with a spoonful of 2 mL of plain water, and proceeds to 3 mL and then to 5 mL of plain water. The trial is rated as “fail”and discontinued when the subject shows a major sign of difficulty (cough or dyspnea). When the subject shows a minor sign (wetvoice or multiple swallows), the trial is repeated once and them discontinued if the patient shows a major or minor sign. When the plain water trial is failed, the test is continued with the same amount of thickened water (nectar consistency), using the same scheme. According to the combined test results of both materials, the performance is scored as follows: 0, fail in 2 mL of thickened water; 1, fail in 2 mL of plain water but pass in the same amount of thickened water; 2, pass in 2 mL of plain water; 3, fail in 3 mL of plain water but pass in the same amount of thickened water; 4, pass in 3 mL of plain water; 5, fail in 5 mL of plain water but pass in the same amount of thickened water; 6, pass in 5 mL of plain water. To examine the reproducibility of the GWST, 20 patients with suspected dysphagia (10 men and 10 women) with a mean (±SD) age of 84.8 ± 7.3 years underwent the GWST twice by the same speech and language therapist within 2 weeks. The mean (± SD) days between the first and second tests were 4.4 ± 3.8 days. The Spearman rank correlation coefficient between the first and second tests was 0.73.

The FILS is a 10-point observer-rating scale for assessing the severity of dysphagia [25]. This scale rates the condition of dysphagia by examining to what degree patients take food orally on a daily basis. The FILS score ranges from 1 (no oral intake, and no swallowing training) to 10 (normal oral food intake). The reliability and validity of the FILS are reported elsewhere [25].

Functional measures included a physical dependency scale and comprehension scale. The physical dependency scale is a 7-point observer-rating scale, scored as follows: 0, bedridden and unable to change posture in bed without assistance; 1, bedridden but able to change posture without assistance; 2, uses a wheelchair with assistance; 3, uses a wheelchair without assistance; 4, basically independent but likely to be in bed during the daytime; 5, basically independent and likely to be out of bed during the daytime; 6 almost independent and able to going out into the neighborhood; 7, almost independent and able to go out using public transportation. This dependency scale was developed by using the criteria for evaluating the independence of disabled elderly persons in performing activities of daily living which had been introduced by the Ministry of Health, Labor, and Welfare in Japan in 1992. The comprehension scale is a 5-point observer-rating scale, scored as follows; 0, not possible at all; 1, almost impossible; 2, possible only in routine conditions; 3, possible in most of the daily conditions; 4, possible, but difficult in unfamiliar conditions; 5, no problem at all. Inter-rater reliability of this observational scale, using the correlation coefficient, was reported to be 0.71 [26].

Nutritional measures included mid-upper arm circumference (MUAC), calf circumference (CC), and serum albumin levels. MUAC was measured at the midpoint between the tip of the acromion process and the tip of the olecranon process of the left arm. CC was measured by moving the tape measure to obtain the maximal circumference of the left leg. All the anthropometric measurements were performed by the single speech and language therapist.

Statistical analyses were performed using Student's-*t* test and Mann-Whitney *U* test for comparison of means, χ^2 test for independence, and Spearman's rank correlation for correlational analysis. Statistically significance was set at $p = 0.05$.

RESULTS

Basic Subject Characteristics and Gender Differences

The basic subject characteristics are shown in Table **1**. Of the 113 patients, 72 (63.7%) did not pass the GWST (i.e., scored below 6). Seventy-three patients (64.6%) were bedridden and unable to change posture without assistance. The mean (± SD) values of MUAC and CC were 19.9 ± 3.2 cm and 24.2 ± 3.5 cm, respectively. According to the Japanese Anthropometric Reference Data [27], the number (percentage) of the subjects who had values below 2SD of the mean of the corresponding normative samples, stratified by age and gender, were 23 (17.3%) for MUAC and 37 (27.8%) for CC. The mean (± SD) serum albumin level was 2.7 ± 0.5 g/dL. When the conventional cutoff point of 3.5 g/dL for the nutritional screening was applied, 110 subjects (97.3%) were determined to have a nutritional risk. With regard to gender differences, the women were significantly older ($p < 0.001$), scored lower on the comprehension scale ($p = 0.002$), and had a lower CC ($p = 0.013$) than the men; however, there were no significant differences in the both swallowing measures, the physical dependency scale, MUAC, and albumin levels.

Comparison of those with and without Dementia

There were 76 subjects with dementia (27 men and 49 women) and 37 subjects without dementia (17 men and 20 women). The gender distribution between the two groups was not significantly different by a χ^2 test ($p = 0.888$). The comparisons of the other variables are shown in Table **2**. The subjects with dementia were significantly older ($p = 0.015$) and scored lower in the FILS ($p = 0.035$), physical dependency scale ($p = 0.003$), and comprehension scale ($p < 0.001$) but did not differ in the GWST, MUAC, CC, or serum albumin levels.

Correlational Analysis between the Variables

Age had significant negative correlations with thephysical dependency scale ($r_s = -0.21$, $p = 0.028$), comprehension scale ($r_s = -0.26$. $p = 0.005$), MUAC ($r_s = -0.26$, $p = 0.005$) and CC ($rs = -0.26$, $p = 0.006$) but not with the GWST ($r_s = -0.03$, $p = 0.746$), FILS ($r_s = -0.16$, $p = 0.088$), or serum albumin ($r_s = 0.03$, $p = 0.733$). The correlation coefficients between the other variables are shown in Table **3**. GWST had significant correlations with FILS ($r_s = 0.63$, $p < 0.001$), the physical dependency scale ($r_s = 0.50$, $p < 0.001$), the comprehension scale ($r_s = 0.37$, $p < 0.001$), MUAC ($r_s = 0.36$, $p < 0.001$), CC ($r_s = 0.39$, $p < 0.001$), and albumin levels ($r_s = 0.35$, $p <0.001$). FILS had significant correlations with the physical dependency scale ($r_s = 0.62$, $p < 0.001$), the comprehension scale ($r_s = 0.49$, $p < 0.001$), MUAC ($r_s = 0.31$, $p < 0.001$), CC ($r_s = 0.38$, p

Table 1: Basic Characteristics of the Subjects

	Total (n = 113)	Men (n = 45)	Women (n = 68)	p Value
Age (years)	86.4 ± 6.2	83.1 ± 6.2	88.6 ± 5.1	0.000
GWST (0–6)	3.9 ± 2.1	3.9 ± 2.1	3.8 ± 2.2	0.937
FILS (1–10)	5.0 ± 1.8	5.0 ± 1.9	5.1 ± 1.8	0.674
Dependency (0–7)	0.9 ± 1.4	1.3 ± 1.8	0.6 ± 1.1	0.064
Comprehension (0–5)	2.3 ± 1.2	2.6 ± 1.2	2.0 ± 1.2	0.002
MUAC (cm)	19.9 ± 3.2	20.5 ± 2.4	19.5 ± 3.6	0.092
CC (cm)	24.2 ± 3.5	25.2 ± 3.4	23.5 ± 3.5	0.013
Albumin (g/dL)	2.7 ± 0.5	2.7 ± 0.5	2.8 ± 0.5	0.382

Results are shown as mean ±SD.
Abbreviations: CC, calf circumference; FILS: food intake level scale; GWST, graded water swallowing test; MUAC, mid-upper arm circumference.

Table 2: Comparison of Subjects with and without Dementia

	Dementia (n = 76)	Non-dementia (n =37)	p Value
Age (years)	87.4 ± 5.4	84.4 ± 7.2	0.015
GWST (0–6)	3.8 ± 2.1	3.9 ± 2.2	0.726
FILS (1–10)	4.8 ± 1.7	5.5 ± 1.9	0.035
Dependency (0–7)	0.6 ± 1.2	1.5 ± 1.8	0.003
Comprehension (0–5)	1.9 ± 0.9	2.9 ± 1.4	0.000
MUAC (cm)	20.1 ± 3.2	19.5 ± 3.2	0.354
CC (cm)	24.1 ± 3.7	24.2 ± 3.2	0.933
Albumin (g/dL)	2.7 ± 0.5	2.7 ± 0.6	0.675

Results are shown as mean ±SD.
Abbreviations: CC, calf circumference; FILS: food intake level scale; GWST, graded water swallowing test; MUAC, mid-upper arm circumference.

Table 3: Correlation Coefficients between the Variables

	FILS	Dependency	Comprehension	MUAC	CC	Albumin
GWST	0.63*	0.50*	0.37*	0.36*	0.39*	0.35*
FILS		0.62*	0.49*	0.31*	0.38*	0.40*
Dependency			0.66*	0.27*	0.50*	0.31*
Comprehension				0.11	0.38*	0.21*
MUAC					0.74*	0.25*
CC						0.33*

Abbreviations: CC, calf circumference; FILS: food intake level scale; GWST, graded water swallowing test; MUAC, mid-upper arm circumference.
*p< 0.05.

< 0.001), and albumin levels (r_s = 0.40, p < 0.001). In general, the swallowing measures had significant moderate correlations with functional measures and significant and relatively weak correlations with nutritional measures. With regard to the relationship between the functional and nutritional measures, the physical dependency scale had significant correlations with the comprehension scale (r_s = 0.66. p < 0.001), MUAC (r_s = 0.27, p = 0.004), CC (r_s = 0.50, p < 0.001), and albumin levels (r_s = 0.31, p < 0.001), whereas the comprehension scale had significant correlations with CC (r_s = 0.38, p < 0.001) and albumin levels (r_s = 0.21, p = 0.027) but not with MUAC (r_s = 0.11, p = 0.265).

DISCUSSION

Subject Characteristics and Gender differences

The majority of the subjects were functionally dependent. In addition, many of the subjects were thin and almost all were at risk for protein-energy malnutrition. Regarding gender, there were no significant differences in either swallowing measure, suggesting that gender had no significant influence on swallowing function. However, the female subjects were significantly older, and had lower comprehension ability and CC than the male subjects, suggesting that women tended to preserve their swallowing function despite their relatively declined conditions.

Impact of Dementia

Of the 113 subjects, 76 (67.3%) were reported to have dementia. This prevalence was substantially higher than that reported in other acute settings [28, 29], although a direct comparison was impossible because of the methodological differences. There were no significant differences in gender, GWST, MUAC, CC, or serum albumin levels between those with and without dementia. However, those with dementia were significantly older and scored lower in the FILS, the physical dependency scale, and the comprehension scale compared with those without dementia. Of note, the presence of dementia was associated with lower FILS. It is known that patients with advanced dementia have a wide range of eating problems, including swallowing or chewing problems, refusal to eat, and persistently reduced oral intake [30]. Considering that the GWST reflects oropharyngeal swallowing impairment in a test setting whereas the FILS reflects the daily performance in oral food intake, the eating problems associated with dementia may be more related to the latter (i.e. the ability of taking food orally on a daily basis). On the other hand, the GWST scores in those with dementia were almost equal to those without dementia despite their decreased function in the other measurements, suggesting that dementia itself was not significantly related to the oropharyngeal swallowing impairment measured by the GWST.

Impact of Age

Age had significant weak negative correlations with the functional measures and the anthropometrics but not with the swallowing measures or serum albumin levels. The association between older age and lower values in anthropometrics was consistent with the data described in a normative sample [27]. In the present study, aging itself had no significant association with symptomatic dysphagia. Although previous studies have demonstrated that older age is associated with a decreased swallowing function, most of them used instrumental testing sensitive to a minor decline that may not present overt symptoms [5, 31, 32].

Relationship between Swallowing Function, and Functional and Nutritional Status

Both of the swallowing measures had significant correlations with the functional measures, suggesting that the swallowing disorder in hospitalized elderly individuals is related to functional dependency, especially physical dependency, which was consistent with our previous study reporting the association between oral intake difficulty and bedridden status in hospitalized elderly individuals with pneumonia [33]. The reason for this association remains to be elucidated. One may consider this association to be attributable to the effects of deconditioning resulting from illness, since the majority of the subjects in the present study were bedridden. However, to our knowledge, there is no evidence that deconditioning itself can cause dysphagia.

The swallowing measures also had a significant relationship with the nutritional measures, suggesting that the swallowing disorder was related not only to functional dependency but also to malnutrition. The results of the present study are partly inconsistent with our previous study reporting a significant relationship of the swallowing function with MUAC but not with physical activity or serum albumin levels [34]. One possible reason for this partly conflicting result may lie in the differences in the characteristics of the subjects between the two studies; the percentage of completely bedridden subjects in the present study was 64.6%, whereas that in the previous study was 25.5%. Given that the subjects of the present study were more physically dependent than the subjects of the previous study, it may be that a significant relationship between swallowing function and functional dependency is observed only when the patients' functional decline reaches a certain level (e.g. near bedridden status).

Sarcopenia as a Possible Explanation for the Relationship between Swallowing Function, and Functional and Nutritional Status

Most of the subjects of this study presented with dysphagia; however, the direct cause of the symptom was difficult to identify in most of the cases because those who had a cerebrovascular accident within 6 months or Parkinson's disease, which are frequent causes of dysphagia, were excluded. In addition, the presence of dementia was not associated with swallowing impairment measured by the GWST. What, then, was the major cause of dysphagia in the present subjects? The significant relationship between swallowing function and functional and nutritional status observed in the present study suggests that functional dependency and malnutrition can contribute to the occurrence of dysphagia or vice versa. However, the weak or moderate correlations between them do not allow us to speculate that deconditioning or malnutrition is directly related to the presence of dysphagia.

Sarcopenia is the age-related loss of muscle mass and function [14]. Although a detailed evaluation of muscle mass and function was not done the present study, the extremely low mean values in MUAC and CC as well as in the physical dependency scale suggests that many of the subjects were sarcopenic. Given that sarcopenia is exacerbated by disease, inactivity, and malnutrition [19], the association between dysphagia, and functional dependency and malnutrition observed in the present study may be explained by the concept of sarcopenia. Recent studies have demonstrated an age-related loss of muscle mass in the swallowing muscles [35, 36]. It is therefore hypothesized that elderly patients are likely to have a substantially diminished functional reserve in swallowing due to preexisting sarcopenia or other possible causes, making the exacerbation of sarcopenia from disease, inactivity, and malnutrition more likely. Although there is still no consensus on the definition of sarcopenia, the concept of secondary sarcopenia may be useful for exploring the underlying mechanism of dysphagia in hospitalized elderly individuals. Thus, we have come to a tentative conclusion that development of dysphagia in hospitalized elderly individuals is at least partly attributable to the exacerbation of sarcopenia involving the swallowing muscle mass and its function. In addition, there is also a possibility that dysphagia may exacerbate sarcopenia by reduced oral intake.

The present study has some methodological limitations. First, the swallowing muscle mass and its function were not measured, which is thought to be an essential area of study examining the relationship between sarcopenia and dysphagia. Second, a detailed assessment of swallowing impairment, including its history and possible latent cause, was not done. Third, the cross-sectional design did not allow conclusions about causality. Additional studies are required to elucidate this significant health condition in the elderly.

In conclusion, the results of present study suggested the possible presence of sarcopenic dysphagia in hospitalized elderly individuals.

REFERRENCES

[1] Kwashima K, Motohashi Y, Fujishima I. Prevalence of dysphagia among community-dwelling elderly individuals as estimated using a questionnaire for dysphagia screening. Dysphagia 2004; 19: 266-71. http://dx.doi.org/10.1007/s00455-004-0013-6

[2] Chen PH, Golub JS, Hapner ER, Johns MM. Prevalence of perceived dysphagia and quality-of-life impairment in a geriatric population. Dysphagia 2009; 24: 1-6. http://dx.doi.org/10.1007/s00455-008-9156-1

[3] Cabre M, Serra-prat M, Palomera E, Almirall J, Pallares R, Clavé P. Prevalence and prognostic implications of dysphagia in elderly patients with pneumonia. Age Aging 2010; 39: 39-45. http://dx.doi.org/10.1093/ageing/afp100

[4] Silveira Guijarro LI, Domingo Garcia V, Montero Fernandez N, Osunadel Pozo CM, Alvarez Nebreda L, Serra-Rexach JA. Oropharyngeal dysphagia in elderly inpatients in a unit of convalescence. Nutri Hosp 2011; 26: 501-10.

[5] Logemenn JL, Pauloski BR, Rademarker AW, Colangelo LA, Kahrilas PJ, Smith CH. Temporal and biomechanical characteristics of oropharyngeal swallow in younger and older men. J Speech Lang Hear Res 2000: 43: 1264-74.

[6] Ney D, Weiss J, Kind A, Robbins J. Senescent swallowing: impact, strategy and interventions. Nuti Clin Pract 2009; 24: 395-413. http://dx.doi.org/10.1177/0884533609332005

[7] Harper CM, Lyles YM. Physiology and complications of bed rest. J Am Geriatr Soc1988; 36: 1047-54.

[8] Creditor MC. Hazard of hospitalization of the elderly. Ann Intern Med 1993; 118: 219-23. http://dx.doi.org/10.7326/0003-4819-118-3-199302010-00011

[9] Kaiser MJ, Bauer JM, Ramsch C, *et al*. Frequency of malnutrition in older adults: a multinational perspective using the mini nutritional assessment. J Am Geriatr Soc 2010; 58: 1745-8. http://dx.doi.org/10.1111/j.1532-5415.2010.03016.x

[10] Veldee MS. Peth LD. Can protein-calorie malnutrition cause dysphagia? Dysphagia 1992; 7: 86-101. http://dx.doi.org/10.1007/BF02493439

[11] Hudson HM, Daubert CR, Mills RH The interdependency of protein-energy malnutrition, aging, and dysphagia. Dysphagia 2000; 15: 31-8. http://dx.doi.org/10.1007/s004559910007

[12] Cooper P, Gates S, Darzins P. Does malnutrition cause dysphagia? Nutr Diet 2005; 62: 1. http://dx.doi.org/10.1111/j.1747-0080.2005.tb00011.x

[13] Rosenberg IH. Summary comments. Am J Clin Nutr 1989; 50: 1231-3.

[14] Rosenberg IH. Sarcopenia: Origins and clinical relevance. J Nutr 1997; 127: 990S-1.

[15] Morley JE, Baumgartiner RN, Roubenoff R, Mayer J, Nair KS. Sarcopenia. J Lab Clin Med 2001; 137: 231-43. http://dx.doi.org/10.1067/mlc.2001.113504

[16] Marcell TJ. Sarcopenia: causes, consequences, and preventions. J Gerontol A Biol Sci Med Sci 2003; 58: M911-6. http://dx.doi.org/10.1093/gerona/58.10.M911

[17] Rubenoff R. Saecopenia: effects on body composition and function. J Gerontol A Biol Sci Med Sci 58: 1012-7. http://dx.doi.org/10.1093/gerona/58.11.M1012

[18] Mitchell WK, Williams J, Atherton P, Larvin M, Lund J, Narici M. Sarcopenia, dynapenia, and the impact of advancing age on human skeletal muscle size and strength; a quantitative review. Front Physiol 2013; 3: Article 260.

[19] Cruz-jentoft AJ, Baeyens JP, Bauer JM, *et al*. Sarcopenia: European consensus on definition and diagnosis: report of the European working group on sarcopenia in older people. Age Ageing 2010; 39: 412-23. http://dx.doi.org/10.1093/ageing/afq034

[20] Robbins JR, Bridges AD, Tayler A. Oral, pharyngeal and esophageal motor function in aging. GI Motility Online 2006; doi:10.1038/gimo39.

[21] Robbins JR, Levin R, Wood J, Roecker EB, Luschei E. Age effects on lingual pressure generation as a risk factor for dysphagia. J Gerintol A Biol Sci Med Sci 50: M257-62.

[22] Nicosa MA, Hind JA, Roecker EB, *et al*. Age effects on the temporal evolution of isometric and swallowing pressure. J Gerontol A Biol Sci Med Sci 55: M634-40.

[23] Wakabayashi H, Fujimoto A. Dysphagia due to sarcopenia: potential and practice of rehabilitation nutrition. 2012. Ishiyaku, Tokyo. (Japanese)

[24] Wakabayashi H. Presbyphagia and sarcopenic dysphagia: association between aging, sarcopenia, and deglutition disorders. J Frailty Aging (in press).

[25] Kunieda K, Ohno T, Fujishima I, Hojo K, Morita T. Reliability and validity of a tool to measure the severity of dysphagia: the food intake level scale. J Pain Symptom Manage 2013; 46: 201-6. http://dx.doi.org/10.1016/j.jpainsymman.2012.07.020

[26] Kuroda Y, Kuroda R. The relationship between verbal communication and observed psychological status in aphasia: preliminary findings. Aphasiology 2005; 19: 849-59. http://dx.doi.org/10.1080/02687030500225951

[27] Hosoya N, Okada T, Muto Y, *et al*. Japanese anthropometric reference data 2001 (JARD 2001). Jpn J Nutr Assess 2002; 19(Suppl): 1-81. (Japanese)

[28] Lyketsos CG, Sheppard JM, Rabins PV. Dementia in elderly persons in a general hospital. Am J Psychiat 2000; 157: 704-7.
http://dx.doi.org/10.1176/appi.ajp.157.5.704

[29] Sampson EL, Blanchard MR, Jones L, Tookman A, King M. Dementia in the acute hospital: perspective cohort study of prevalence and mortality. Br J Psychiatry 2009; 105: 61-6.
http://dx.doi.org/10.1192/bjp.bp.108.055335

[30] Mitchell SL, Teno JM, Kiely DK, *et al*. The clinical course of advanced dementia. N Eng J Med 2009; 361: 1529-38.
http://dx.doi.org/10.1056/NEJMoa0902234

[31] Robbins J, Hamilton JW, Lof GL, Kempster GB. Oropharyngeal swallowing in normal adults of different ages. Gastroenterology 1992; 103: 823-9.

[32] Shaker E, Pen J, Podvrsan B, *et al*. Effect of aging and bolus variables on pharyngeal and upper esophageal sphincter motor function. Am J Physiol 1993; 264: G427-432.

[33] Kuroda Y. Oral intake difficulty in hospitalized older persons with pneumonia: a preliminary report. J Am Geriatr Soc 2010; 58: 1606-7.
http://dx.doi.org/10.1111/j.1532-5415.2010.02990.x

[34] Kuroda Y, Kuroda R. Relationship between thinness and swallowing function in Japanese older adults: implications for sarcopenic dysphagia. J Am Geriatr Soc 2012; 60: 1785-6.
http://dx.doi.org/10.1111/j.1532-5415.2012.04123.x

[35] Tamura F, Kikutani T, Tohara T, Yoshida M, Yaegaki K. Tongue thickness relates to nutritional status in the elderly. Dysphagia 2012; 27: 556-61.
http://dx.doi.org/10.1007/s00455-012-9407-z

[36] Feng X, Todd T, Lintzenich CR, *et al*. Aging-related genihyoid muscle atrophy is related to aspiration status is healthy older adults. J Gerontol A Biol Sci Med Sci 2013; 68: 853-60.
http://dx.doi.org/10.1093/gerona/gls225

Received on 15-01-2014 Accepted on 24-02-2014 Published on 27-03-2014

DOI: http://dx.doi.org/10.12970/2311-1917.2014.02.01.3