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Original Study

Ultrasonography to Measure Swallowing Muscle Mass and Quality in Older Patients With Sarcopenic Dysphagia

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A B S T R A C T

Background: Sarcopenic dysphagia is characterized by difficulty swallowing due to a loss of whole-body skeletal and swallowing muscle mass and function. However, no study has reported on swallowing muscle mass and quality in patients with sarcopenic dysphagia.
Objective: To compare the differences in swallowing muscle mass and quality between sarcopenic and nonsarcopenic dysphagia.
Method: A cross-sectional study was performed in 55 older patients, who had been recommended to undergo dysphagia assessment and/or rehabilitation. Sarcopenic dysphagia was diagnosed using a diagnostic algorithm for sarcopenic dysphagia. The thickness and area of tongue muscle and geniohyoid muscle (coronal plane and sagittal plane), and the echo-intensity of the tongue and geniohyoid muscles were examined by ultrasound.
Results: The study participants included 31 males and 24 females (mean age of 82 ± 7 years), with 14 having possible sarcopenic dysphagia, 22 probable sarcopenic dysphagia, and 19 without sarcopenic dysphagia. The group with sarcopenic dysphagia had a significantly lower cross-sectional area and area of brightness of the tongue muscle than that observed in the group without sarcopenic dysphagia. The most sensitive factor for identifying the presence of sarcopenic dysphagia was tongue muscle area (sensitivity, 0.389; specificity, 0.947; cut-off value, 1536.9), whereas the factor with the highest specificity was geniohyoid muscle area brightness in sagittal sections (sensitivity, 0.632; specificity, 0.806; cut-off value, 20.1). Multivariate logistic regression analysis showed that the area of the tongue muscle and its area of brightness were independent risk factors for sarcopenic dysphagia. However, geniohyoid sagittal muscle area and area of brightness showed no significant independent association with sarcopenic dysphagia.
Conclusion: Tongue muscle mass in patients with sarcopenic dysphagia was smaller than that in patients without the condition. Sarcopenic dysphagia was also associated with increased intensity of the tongue muscle.

The authors declare no conflicts of interest.

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Sarcopenic dysphagia is characterized by difficulty swallowing due to a loss of mass and function of whole-body skeletal and swallowing muscles.[1,2] Decreased skeletal muscle mass and low body mass index (BMI) are independent predictors of dysphagia in hospitalized older patients without dysphagia who have restricted oral intake after admission.[3] Therefore, sarcopenic dysphagia can be regarded as a geriatric syndrome.[2,4,5] We have developed and verified a diagnostic algorithm for sarcopenic dysphagia[6] that is a useful and easy tool for estimating the presence of sarcopenic dysphagia in clinical settings. The evaluation of swallowing muscle mass has not been established in clinical settings. Therefore, the diagnostic algorithm for sarcopenic dysphagia includes swallowing muscle strength assessed by tongue pressure, but does not include swallowing muscle mass. Age-related swallowing muscle atrophy affects the complex pathophysiology of dysphagia in patients with acute stroke.[7] Diagnosing sarcopenic dysphagia is very important, because both sarcopenia and dysphagia are common in older people, whereas some patients with stroke may develop the complication of sarcopenic dysphagia.[8,9]

Muscle mass and quality can be assessed using computed tomography, magnetic resonance imaging, or ultrasonography. However, the mass and quality of swallowing muscles has not been evaluated in sarcopenic dysphagia. Recently, ultrasonographic examination of swallowing muscle has been reported. Tamura et al showed that tongue thickness measured by ultrasound was associated with mid-arm muscle area,[10] whereas Shimizu et al reported that ultrasound examination had high reliability and validity for measuring geniohyoid muscle thickness and area.[11,12] Baba et al reported that geniohyoid muscle cross-sectional area was associated with tongue pressure, jaw-opening strength, and duration of swallowing sound.[13] Ultrasound can be used as an appropriate tool for assessing swallowing muscle mass and muscle quality in clinical settings because of its safety and accessibility. However, no study has reported swallowing muscle mass and quality in sarcopenic dysphagia.

The purpose of this study was therefore to evaluate differences in swallowing muscle mass and quality between sarcopenic dysphagia and nonsarcopenic dysphagia.

Materials and Methods

A cross-sectional study was performed in a convenient sample of patients who had been admitted to acute care hospitals, convalescent rehabilitation hospitals, long-term care hospitals, or nursing homes between October 2016 and April 2017. Patients 65 years and older recommended to undergo a dysphagia assessment and/or rehabilitation by doctors, and able to answer a questionnaire, were included in the study. Patients were excluded if their participation was deemed inappropriate by doctors because of aggravated general conditions, disturbances in consciousness, an absence of whole-body sarcopenia, and/or dementia. The Ethics Committee of the Hamamatsu City Rehabilitation Hospital approved the study. All patients provided written informed consent prior to enrollment.

Diagnostic Algorithm for Sarcopenic Dysphagia

The diagnostic algorithm for sarcopenic dysphagia divides participants into 3 categories as follows: probable sarcopenic dysphagia, possible sarcopenic dysphagia, and no sarcopenic dysphagia.[6] The diagnostic algorithm for sarcopenic dysphagia consisted of 5 steps.

1. Whole body sarcopenia (skeletal muscle strength). The cut-off values were as follows: Handgrip strength (26 kg for men and 18 kg for women) or/and usual gait speed (0.8 m/s).[14]
2. Whole body sarcopenia (skeletal muscle mass). The cut-off values for muscle mass were as follows: 2 cut-off values were used for calf circumference: 34 cm for men and 33 cm for women,[15] and 30 cm for men and 29 cm for women.[16] Conventional cut-off values of 34/33 cm were estimated from healthy older people. On the other hand, different cut-off values have been reported for older inpatients as 30/29 cm; general muscle mass (measured by dual-energy x-ray absorptiometry), 7.0 kg/m^2 for men and 5.4 kg/m^2 for women; and general muscle mass (measured by bioelectrical impedance analysis), 7.0 kg/m^2 for men and 5.7 kg/m^2 for women.[14]
3. The presence of dysphagia. The cut-off values were determined from the Food Intake Level Scales (FILS).[17] Levels < 9; levels 1 to 3 relate to various degrees of nonoral feeding; levels 4 to 6, to various degrees of oral food intake and alternative nutrition; levels 7 and 8, to various degrees of oral food intake alone; level 9, to no dietary restriction but medical considerations are given; and level 10 indicates normal oral food intake.
4. The causes of dysphagia. Patients who had a disease that was the obvious cause of the dysphagia were excluded from the study. However, patients with stroke, brain injury, neuromuscular disease, head and neck cancer, or connective tissue disease in whom the main cause of dysphagia was considered to be age-, activity-, nutrition-, invasion-, or cachexia-related sarcopenia were included.[6]
5. Swallowing muscle strength. The cut-off value was 20 kPa tongue pressure.[6]

Tongue pressure was measured using a balloon placed between the front of the palate and the tongue. The strength of the swallowing muscles was assessed using a maximum tongue pressure–measuring instrument (JMS, Hiroshima, Japan).[18] The measurements were performed once calibration of the inner-balloon pressure had been stabilized at 19.6 kPa. This calibration was performed automatically by the instrument, with the display screen showing 0.0 kPa, if the instrument was calibrated successfully. During the procedure, the participant compressed a balloon attached to the tip of the probe between the tongue and front of the hard palate using maximum voluntary effort. Tongue pressure was measured 3 times and the maximum value recorded.

Ultrasonographic Assessment for Swallowing Muscles

A portable ultrasound (M-Turbo; Fujifilm SonoSite, Tokyo, Japan) with a 5 to 15 MHz and linear- and convex-array transducer was used for the examination. The patients lay on a reclining bed at an angle of 30° and remained relaxed during the examination. The angle was set to 30° because some patients could not adopt a sitting posture and it was necessary to stabilize their posture. The ultrasonographic examination was performed by a well-trained dentist (N.O.). The thickness and area of the tongue and geniohyoid muscles (coronal plane and sagittal plane) were examined. The reliability of ultrasonographic examinations for geniohyoid muscle thickness and area has already been verified.[12] To avoid information bias, the researcher carrying out the ultrasonographic examination was blinded to the result of the diagnostic algorithm for sarcopenic dysphagia. The researcher placed the probe on 3 points of the lower chin surface: (1) the horizontal line connected at one-third of the distance from the parotid to the