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| Description | |

Original Article

# Evaluation of a dysphagia screening system based on the Mann Assessment of Swallowing Ability (MASA) for use in dependent older adults

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**Abstract**

**Aim:** Dysphagia is common in dependent older adults. Thus, a method of evaluating eating and swallowing functions that can be used to diagnose and manage dysphagia in a simple and robust manner is required. In 2002, the Mann Assessment of Swallowing Ability (MASA) was introduced to identify dysphagia in acute-stage stroke patients. As the MASA enables easy screening, it might also be applicable to the dependent elderly if appropriate MASA cut-off values and the most useful assessment items could be determined. In the present study, we attempted to determine suitable MASA cut-off values and the most useful assessment items for predicting aspiration and pharyngeal retention in dependent older adults.

**Methods:** Using the MASA, we evaluated the eating and swallowing functions of 50 dependent elderly individuals with dysphagia. All of the patients also underwent videoendoscopic (VE)-based swallowing evaluations to detect aspiration and pharyngeal retention. The subjects' characteristics and the utility of each assessment item were compared between various groups. Using the patients' VE findings as a reference, receiver operating characteristic (ROC) curve analysis was performed to determine appropriate cut-off values for predicting aspiration and pharyngeal retention in t dependent older adults.

**Results:** The optimal MASA cut-off values for predicting aspiration and pharyngeal retention were 122 points and 151 points, respectively. Seventeen of the 24 clinical items assessed by the MASA were found to be associated with aspiration in dependent older adults.

**Conclusion:** The MASA is a useful screening tool for evaluating eating and swallowing functions in dependent older adults.

**Keywords:**

Dysphagia, Elderly, Endoscopy, ROC curve, Screening

## Introduction

Dysphagia is common in dependent older adults. It can cause aspiration pneumonia and suffocation, leading to physical and psychological problems, and negatively influence quality of life.[1–3] Dysphagia is particularly common in patients with dementia. It was estimated that 28.6% of patients with Alzheimer's disease suffer from aspiration,[4] and 52.3%–68% of nursing home residents exhibit clinical evidence of dysphagia.[5–7] In addition, the prevalence of dysphagia was reported to range from 13.8–37.6% among community-dwelling adults aged ≥65 years[8, 9].

In today's aging society, a method of evaluating eating and swallowing functions that can be used to identify and manage dysphagia in a simple and robust manner is required. Several bedside screening tests are available for detecting dysphagia.[10–15] However, these methods are often difficult to implement in dependent elderly individuals with comorbidities such as dementia or physical deterioration. No simple method of identifying dysphagia in dependent older adults has yet been established. Videofluoroscopic examination of swallowing (VF) [16] and videoendoscopic examination of swallowing (VE) [17] permit detailed investigations of dysphagia, but require special equipment and techniques. Therefore, a simple screening test for evaluating dysphagia that does not place a significant burden on the dependent elderly

and can be conducted at the bedside is desired.

In 2002, Mann examined acute-stage stroke patients and created the Mann Assessment of Swallowing Ability (MASA), a screening tool for identifying eating and swallowing disorders.[18] The tool comprises 24 clinical parameters, covering four areas: (ⅰ) "general patient examination"; (ⅱ) "oral preparation"; (ⅲ) "oral phase"; (ⅳ) and "pharyngeal phase".[18] Each assessment item is evaluated on a 5- or 10-point scale, and the maximum possible score is 200 points. For each item, a lower score indicates more severe dysphagia. It is possible to identify dysphagia or aspiration on the basis of the total score. In the abovementioned study, VF was used to provide a reference test, and the optimal MASA cut-off values for detecting dysphagia were determined in acute stroke patients. As a result, scores of <178 points and <170 points were found to be useful for identifying patients with dysphagia and aspiration, respectively. The latter cut-off point showed a sensitivity of 0.93, a specificity value of 0.63, and an area under the curve (AUC) of 0.83 for detecting aspiration in patients that had suffered acute-stage strokes.[18] Many reports have subsequently used the MASA as a method for assessing swallowing function in stroke patients.[18–20] In addition, it was reported that the MASA showed good predictive powers in patients with dysphagia who were suffering from a variety of underlying conditions.[21] However, the majority of studies for establishing

optimum cut-off values and evaluating utility and validity of each assessment item for predicting aspiration and pharyngeal retention have been carried out in patients with dysphagia caused by acute-stage stroke.[18, 22] As the MASA is easy to use, it might be suitable for use in dependent older adults individuals with comorbidities if optimal cut-off values and utility of each assessment item could be determined.

In the present study, we calculated suitable MASA cut-off values and examined the utility of each assessment item for predicting aspiration and pharyngeal retention in dependent older adults.

## Methods

### Participants and study period

We enrolled 50 dependent older adults individuals (21 men and 29 women) who had undergone VE as a result of suspected dysphagia. The participants resided at special nursing homes for the older adults (38 participants) or private nursing homes in Chiba or Tokyo (2 participants) or were receiving domiciliary care in Chiba (10 participants). Their ages ranged from 66 to 97 years (mean age: 82.58 ± 7.82 years). The participants' main underlying diseases included cerebrovascular disease (31 patients; 62.0%), cardiovascular disease (12 patients; 24.0%), respiratory disease (12 patients;

24.0%), neuromuscular disease (6 patients; 12.0%), and other diseases (12 patients; 24.0%). A total of 17 participants (34.0%) had been diagnosed with dementia. When an individual had multiple diseases, each disease was counted. All of participants were certificated of long-term care required under the Long-Term Care Insurance Act in Japan. With regard to the level of care required, 2, 5, 12, and 31 subjects had been certified as requiring level 2, level 3, level 4, and level 5 care. The study was carried out between April 2012 and June 2013.

Evaluation of eating and swallowing functions: the MASA and VE

The MASA Instruction Manual was translated into Japanese, and the same dentist carried out each evaluation.[18] Each MASA evaluation was conducted within 2 months of the VE examination. The MASA does not require specific types of food to be consumed.[18] Therefore, assessment items related to the observation of food and liquid intake were evaluated while the patients were eating their normal diets during lunch. The patients adopted their normal posture during the assessment evaluations.

All of the patients underwent VE (Pentax Endoscope FNL-10RBS®; PENTAX Corporation, Tokyo, Japan) to detect aspiration and pharyngeal retention. The VE evaluations were carried out while the patient was sitting on a chair or in a reclining wheelchair. The subjects consumed the same food and liquids during these examinations

as they did during the MASA evaluations. Three or more evaluations were carried out per meal. We defined aspiration the entry of material below the level of the true vocal folds.[17] Patients who showed aspiration were included in the aspiration group. We also evaluated whether any boluses remained in the pyriform sinus or vallecula; that is,, whether the patient showed pharyngeal retention. Any patients that exhibited pharyngeal retention that was capable of causing aspiration were included in the pharyngeal retention group. The VE data, which provided detailed information about the patients' eating and swallowing functions, were collected before the MASA evaluations were carried out.

Other index

The patients were evaluated using Functional Oral Intake Scale (FOIS) while they were consuming their normal food and liquid[23]. Cognitive function were evaluated using the Mini Mental State Examination (MMSE).[24, 25] The participants ability to carry out activities of daily living (ADL) was evaluated by Barthel Index (BI) [26].

4. Statistical analysis

The patients' characteristics and scores were compared using the Mann–Whitney *U* test or Student's *t*-test. Using the patients' VE findings as a reference, receiver operating characteristic (ROC) curve analysis[27, 28] was carried out to determine the optimal

cut-off MASA values and most useful MASA items for predicting aspiration and pharyngeal retention in dependent elderly patients. In addition, the AUC was calculated as a measure of the overall prediction accuracy of each cut-off value. Finally, the diagnostic accuracy of two cut-off values, the cut-off value for predicting aspiration obtained from the ROC curve analysis and the 170 point cut-off value that Mann reported for acute stroke patients, was compared.[18]

All statistical analyses were carried out using IBM SPSS Statistics Version 19 (IBM Japan, Tokyo, Japan). A probability level of <5% was considered statistically significant.

7. Ethical considerations

Written informed consent was obtained from all participants or their legal representatives. This study was approved by the ethics committee of Tokyo Dental College, Japan (Receipt Number 278 and 358).

## Results

1. Participants' characteristics

Based on the findings of the VE examinations, 20 and 30 patients were included in the aspiration group and non-aspiration group, respectively. In addition, 36 and 14

patients were included in the pharyngeal retention group and non-pharyngeal retention group, respectively. A total of 47 participants had MMSE scores of <20 points. Thus, many of the participants were suspected of having dementia.

The participants age; sex ratio; and MASA, FOIS, BI, and MMSE scores were compared between the groups (Table 1). The MASA, FOIS, BI, and MMSE scores of the aspiration group were significantly lower than those of the non-aspiration group (MASA and BI: $P<0.001$) (FOIS and MMSE: $P<0.05$). The mean age and MASA and BI scores of the pharyngeal retention group were significantly lower than those of the non-pharyngeal retention group (MASA: $P<0.01$) (age and BI: $P<0.05$).

2. Diagnostic accuracy of the MASA

The relationships between the sensitivity and 1-specificity of the MASA score and VE-diagnosed aspiration and pharyngeal retention can be graphically shown in the form of ROC curves (Figs. 1 and 2). The MASA showed AUC of 0.82 and 0.74 for predicting aspiration and pharyngeal retention, respectively. The point on the curve closest to the top left corner, where the true-positive rate is 100% and the false-positive rate is 0%, was used as the cut-off value. The optimal MASA cut-off values for diagnosing aspiration and pharyngeal retention were found to be 122 points and 151 points, respectively. Our findings regarding the diagnostic accuracy of the MASA are

shown in Table 2. The MASA cut-off value reported by Mann (170 points) showed sensitivity and specificity values of 0.90 and 0.33, respectively, and a positive likelihood ratio of 1.39.

3. Relationships between each MASA item and the diagnostic findings obtained with VE

The scores for each of the 24 MASA items were compared between the aspiration and non-aspiration groups, and between the pharyngeal retention and non-pharyngeal retention groups (Table 3). The scores for 17 and 9 MASA items were significantly lower in the aspiration and pharyngeal retention groups, respectively.

**Discussion**

Statistically significant differences were detected between the FOIS, BI, and MMSE scores of the aspiration and non-aspiration groups as well as between the mean age and BI scores of the pharyngeal retention and non-pharyngeal retention groups. These results suggest that patients with eating and swallowing dysfunctions are less able to perform ADL. Our findings also showed that pharyngeal retention became more common with increasing age. According to the participants' FOIS scores, the patients with aspiration were less able to consume a normal diet. However, the incidence of pharyngeal retention was not affected by dietary pattern.

A favorable consciousness level is a requirement of the MASA. In most subjects (72%), the level of alertness was high even though they had lower MMSE scores. Patients were included if they could follow the instructions spoken by the examiners. For those whose alertness was low, it was possible to assess MASA either retrospectively when the patients were fully conscious or by motion imitation.

The present study involved individuals that had undergone detailed VE examinations after showing symptoms of dysphagia in their daily lives. Therefore, our study population showed higher prevalences of VE-diagnosed aspiration and pharyngeal retention than were seen in previous studies,[4–9] which reported that aspiration and pharyngeal retention showed prevalences of 40% and 72%, respectively.

VF is the method that is most commonly used to carry out detailed examinations of dysphagia, and is considered the gold standard technique. VF was also used as a reference during the development of the MASA.[18] However, according to comparisons of the aspiration detection rates of VE and VF, VE is safer and more cost-effective, time-efficient, and sensitive than VF for evaluating swallowing safety.[29–32] In addition, VE is considered to be more useful than VF, because it can be used to evaluate eating and swallowing functions in bedridden patients.[31] The participants of the present study resided in special nursing homes for older adults or private nursing homes, or were

receiving domiciliary healthcare. The participants were also less able to carry out ADL, as shown by their BI scores. Thus, it would have been difficult to transfer many of the patients to medical facilities that had the equipment required for VF. Therefore, VE was used to provide reference data for the present study. The evaluation of oral function using VE is considered difficult.[31] However, the equipment required for VE is relatively compact and portable, which makes it possible to carry out VE at a range of locations and to evaluate swallowing function during normal mealtimes. Therefore, we considered that our use of VE to obtain reference data was a valid approach. In contrast, Mann reviewed dysphagia and aspiration using VF-derived data as a reference.[18] As we used VE-derived data as a reference, we examined pharyngeal retention instead of dysphagia in the present study, which might have weakened the associations between the VE-derived outcomes and each MASA item.

In general, there are two ways of assessing the utility of diagnostic methods: by assessing the technique's sensitivity and specificity values and by assessing its likelihood ratio.

With regard to the diagnostic accuracy of the MASA, it showed relatively high sensitivity and high specificity for detecting aspiration, together with a positive likelihood ratio of 7.5. This indicates that the MASA is useful for predicting aspiration

in dependent older adults. In the case of pharyngeal retention, the MASA showed sensitivity and specificity values of 0.72 and 0.79, respectively. However, it showed a low positive likelihood ratio of 3.37. Thus, the MASA is a useful screening method for detecting pharyngeal retention, but displays a low likelihood ratio.

Next, the diagnostic characteristics of the cut-off values obtained in the present study were compared with those of a MASA cut-off value of 170 points.[18] With regard to the diagnostic accuracy of the cut-off value for detecting aspiration obtained in the present study (122 points), it showed lower sensitivity and higher specificity values than the original cut-off value. This indicates that the use of the original cut-off value in the present study would have increased the number of false-negative diagnoses. In addition, the 170-point cut-off value had a positive likelihood ratio of 1.39,[18] which was lower than that yielded by a cut-off value of 122 points.[18] This indicates that the use of the MASA together with a cut-off value of 122 points is an accurate screening method for detecting aspiration in dependent older adults. In addition, our findings suggest that this approach results in a greater detection ability, and less overdiagnosis. Screening tools with high specificity are generally suitable for obtaining a definitive diagnosis and are considered to reduce the number of patients who require additional testing and decrease the mental and social burdens placed on patients.

As reported previously, ROC curves were used to calculate cut-off values in the present study.[18] The MASA exhibited AUC for detecting aspiration and pharyngeal retention of 0.82 and 0.74, respectively, which indicates that the cut-off values obtained in the present study resulted in sufficient accuracy according to the standards reported.[27, 28]

Based on these results, the MASA can be considered to be a useful screening method for evaluating eating and swallowing functions in dependent older adults, in whom evaluations are often carried out in the domiciliary dental care setting and it is difficult to use VF and VE equipment.

It is important to note that our participants were suffering from various comorbidities and required different levels of care, which might have influenced the cut-off values we obtained and/or their diagnostic accuracy. It will be necessary to carry out further studies, involving greater numbers of participants, that consider factors such as comorbidities, ADL, and cognitive function.

In the present study, 17 of 24 of the clinical parameters assessed by the MASA were found to be associated with aspiration, while nine of them were demonstrated to be associated with pharyngeal retention. This indicates that the clinical parameters assessed by the MASA are strongly associated with aspiration in dependent older

adults.

These eight items commonly consist of a large number of observation items not requiring the execution of instructed movements. However those related to tongue assessment require such execution to some extent. The reduction of “tongue strength” and “tongue coordination” in older adults has been noted in previous studies.[33, 34] Furthermore, an association between the swallowing function and tongue movement has been reported.[35, 36]

The importance of assessing “tongue strength” and “tongue coordination” as part of swallowing function assessment for older adults has been noted in previous studies. Furthermore, an association between their swallowing function and tongue muscle strength has been reported. In the present study, it was suggested that “oral preparation”, “oral transit”, “pharyngeal phase”, and “pharyngeal response” as items to be observed during meals, in addition to “cooperation” and “cough reflex” as patient observation items, are useful to determine conditions in the presence/absence of aspiration and pharyngeal retention. The present results show that these eight items might be useful for evaluating eating and swallowing functions dependent older adults.

In conclusion, the MASA is a useful screening method for evaluating eating and swallowing functions in dependent older adults.

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**Disclosure statement**

The authors declare no conflict of interest.

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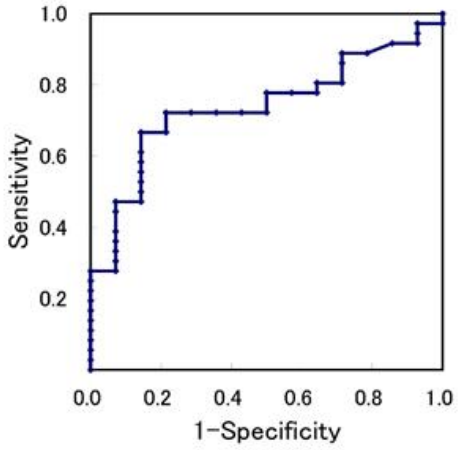
**Figs. 1 and 2**

The trade-off between sensitivity and 1-specificity of the MASA score and VE-diagnosed aspiration and pharyngeal retention can be graphically displayed in the form of ROC curves.


1.0
0.8
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Sensitivity
0.0
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0.4
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0.8
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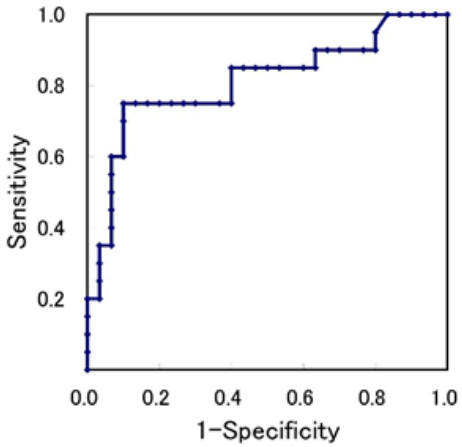


Fig. 1　ROC curve for Aspiration
(MASA compared to VE)