

ORIGINAL

A revised version of the Seirei Swallowing Questionnaire for people with cognitive decline (Swallow-10)

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Abstract : The Seirei dysphagia screening questionnaire (namely, Seirei dsq) has been used to screen for oropharyngeal dysphagia (OD). Some of the questions in the questionnaire are difficult for people with cognitive decline to answer. We selected 10 items from the Seirei dsq that could be assessed by others, such as care workers (named Swallow-10). This study aims to verify the validity of the scoring method used in Swallow-10. The dataset used in this study was the one used in the development of Seirei dsq : 50 patients with cerebrovascular disease who were diagnosed with OD, 145 patients with cerebrovascular disease who did not have OD, and 170 healthy subjects. Among the answer choices, “A” for severe symptom, “B” for mild symptom and “C” for no symptom were scored with 4, 1 and 0 points respectively. Factor analysis extracted two factors : one related to pharyngeal function and another related to oral function. In addition, the Cronbach’s alpha coefficient was 0.84. ROC analysis indicated that optimal cutoff value was 5 points, with a sensitivity of 90.0% and a specificity of 88.5%. These results suggest that Swallow-10 may be useful as an OD screening tool for subjects with cognitive decline *J. Med. Invest.* 70:231-235, February, 2023

Keywords : Dysphagia, screening questionnaire, people with cognitive decline, scoring method

INTRODUCTION

Oropharyngeal dysphagia (OD) is commonly observed in patients with post-stroke, Parkinson’s disease, and Alzheimer’s dementia, and can lead to serious complications, including malnutrition, aspiration pneumonia, and early death (1). Furthermore, the risk of developing dysphagia increases with age, even in elderly people without specific disease (2, 3). Note that although 13.7% of older people who live independently have dysphagia, many recognize it as a normal part of life and do not seek treatment because they are unaware that it is a disease (4). Low nutrition owing to dysphagia affects frail (5). Therefore, even in independent elderly individuals, it is necessary to identify early signs of decline in swallowing function and take appropriate measures.

Dysphagia can be diagnosed by screening and bedside clinical examination. If more precise examination is needed, the diagnosis can be confirmed by video-fluorography or video-endoscopy. Screening questionnaires for dysphagia do not necessarily require specialized training and can be easily used in hospitals or nursing homes, where there are no medical staff specialized in dysphagia. The EAT-10, a typical dysphagia screening questionnaire, consists of 10 questions, each of which is rated on a scale of 0 to 4 points. A total score of 3 points or more (the full score is 40 points) indicates a high probability of dysphagia (6). The Seirei dysphagia screening questionnaire (hereafter referred to as “Seirei dsq”), which consists of 15 questions, was developed by Okuma *et al.* as a screening tool for dysphagia in the recovery

process of cerebrovascular disease (7). The Seirei dsq has three answer choices for each questionnaire item, these are severe symptom “A,” mild symptom “B,” and no symptom “C” (Table 1). If any of the answers indicate a severe symptom “A”, the presence of dysphagia is suspected (hereafter abbreviated to “if there is any “A” method”). It is highly reliable and accurate and is widely used in medical and nursing care in Japan.

Because most questions in EAT-10 are based on the patient’s (subject’s) own experiences, the accuracy of screening may be reduced in patients with cognitive decline. A development study of the Japanese translation of the EAT-10 reported that 40% of 393 patients with dysphagia or suspected dysphagia could not be applied because of dementia or aphasia (8). The Seirei dsq also includes several questions that are not only difficult for patients with dementia to answer but also difficult for caregivers to assess, such as “Do you ever have the feeling of food or liquid going up into your throat from your stomach?”.

There is a need for a dysphagia screening tool that is applicable to patients with dementia and older people with cognitive decline.

We selected 10 items from Seirei dsq, which could be easily assessed by others, such as caregivers, to make it applicable to elderly people with dementia or cognitive decline, hereinafter referred to as “Swallow-10” (Table 1). Despite the reduction of five questions, the Swallow-10 has sufficiently high sensitivity and specificity for the same evaluation method as the Seirei dsq (“if there is any “A” method”) (9).

In addition, for Seirei dsq, we devised and reported a quantitative evaluation method by scoring the answer choices for each questionnaire item and setting a cutoff value for the total score instead of the conventional evaluation method (10). In that study, we demonstrated that the scoring method has the same or higher sensitivity and specificity than the conventional method “if there is any “A” method”. Moreover, the addition of mild symptom “B” to the scoring method has the potential to quantitatively

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Table 1. The Seirei dysphagia screening questionnaire and the Swallow-10

| Seirei dsq | Swallow-10 | Questionnaire items | Answer options | | |
|------------|------------|----------------------------------------------------------------------------------------------|---------------------|-------------------|-----------------|
| | | | "A" Severe symptoms | "B" Mild symptoms | "C" No symptoms |
| 1 | q1 | Have you ever been diagnosed as having pneumonia? | Many times | Once | No |
| 2 | q2 | Do you feel you are becoming thin? | Obviously | Slightly | No |
| 3 | q3 | Do you ever have difficulty when you swallow? | Many times | Sometimes | No |
| 4 | q4 | Do you ever choke during a meal? | Many times | Sometimes | No |
| 5 | q5 | Do you ever choke when swallowing liquids? | Many times | Sometimes | No |
| 6 | q6 | Do you have a rumbling throat (phlegmatic feeling) during or after meals, or at other times? | Many times | Sometimes | No |
| 7 | | Do you ever have the feeling that food is getting stuck in your throat? | Many times | Sometimes | No |
| 8 | q7 | Does it take you longer to eat a meal than before? | Obviously | Slightly | No |
| 9 | | Do you feel that it is getting difficult to eat solid foods? | Obviously | Slightly | No |
| 10 | q8 | Do you ever drop food from your mouth? | Many times | Sometimes | No |
| 11 | q9 | Do you ever have the feeling that food is remaining in your mouth? | Many times | Sometimes | No |
| 12 | | Do you ever have the feeling of food or liquid going up into your throat from your stomach? | Many times | Sometimes | No |
| 13 | | Do you ever have the feeling that food is getting stuck in your esophagus? | Many times | Sometimes | No |
| 14 | | Do you ever have difficulty sleeping because of coughing during the night? | Many times | Sometimes | No |
| 15 | q10 | Do you feel that you are getting hoarse? | Obviously | Slightly | No |

evaluate the state of reduced swallowing function before dysphagia develops. This self-administered questionnaire can be used by the general elderly population to check the status of their own swallowing function and is expected to trigger the implementation of various preventive measures.

The purpose of this study is to examine whether the Swallow-10, with five fewer questions from the Seirei dsq, has sufficient validity, reliability and accuracy when using the scoring method.

MATERIALS AND METHODS

Dataset

The dataset of the subjects collected in Seirei Mikatahara General Hospital for the development of the original Seirei dsq (7) was also used in this study. 1) 50 patients with cerebrovascular disease who had dysphagia (clinically suspected dysphagia, confirmed by video-fluorography) but were able to consume orally(37 males, 13 females ; age range, 36 – 92 years ; mean, 69 years ; median, 65 years), 2) 145 patients with cerebrovascular disease without dysphagia (88 males, 57 females ; age : 36 – 88 years, mean 69 years, median 66 years), and, 3) 170 healthy individuals (77 males, 93 females ; age : 23 – 93 years, mean 65 years, median 63 years) (7).

Analysis

First, a factor analysis was conducted to verify the structural validity of Swallow-10 as a screening tool. We chose the principal factor method for factor extraction and Promax method for factor axis rotation. Second, Cronbach’s alpha coefficient was calculated to assess reliability.

Third, the optimal cutoff value for Swallow-10 was obtained from sensitivity and specificity results using the ROC analysis method. The method of scoring the answer choices for Swallow-10 followed the previous study conducted for the Seirei dsq as follows, 4 points were given for severe symptom “A”, 1 point was given for mild symptom “B” and zero points were given for no symptom “C” (10). After the total score was calculated, the optimal cutoff value was determined based on the following criteria : the shortest distance from the upper left corner (0, 1) of

the graph of the ROC curve (hereafter referred to as ROCd) and maximum value of the sum of sensitivity and specificity minus one (Youden’s index).

SPSS Statistics ver. 24 was used for analysis.

Code of Ethics

The study was approved by the Ethical Review Committee of Tokushima Bunri University (approval no : R1-32).

RESULTS

Factor analysis

The sample adequacy of the KMO test was 0.865 (significance probability, $p < 0.01$), guaranteeing the validity of the factor analysis. For the communality of the factors, q1(pneumonia diagnosed) and q2(weight reduction) were low values (less than 0.2). To analyze the factor structure of Swallow-10, two factors were extracted. The questions with the highest factor loadings were the following five items for Factor 1, q3(difficulty in swallowing), q4(choking during meals), q5(choking on tea), q6(phlegm in the throat) and q10(hoarseness), and the following two items for Factor 2, q8(spills out of mouth) and q9(food remains in the mouth) (Table 2). To visually understand the factor structure, a distribution diagram of the factor loadings of each questionnaire item in

Table 2. Factor structure of Swallow-10 (principal Factor method Promax rotation)

| Questionnaire items | Pattern Matrix ^a | | Communalities |
|------------------------------|-----------------------------|---------|---------------|
| | Factor1 | Factor2 | |
| q1 Pneumonia diagnosed | 0.40 | -0.05 | 0.14 |
| q2 Weight reduction | 0.40 | 0.00 | 0.17 |
| q3 Difficulty in swallowing | 0.68 | 0.06 | 0.45 |
| q4 Choking during meals | 0.50 | 0.29 | 0.55 |
| q5 Choking on tea | 0.58 | 0.15 | 0.52 |
| q6 Phlegm in the throat | 0.59 | 0.06 | 0.33 |
| q7 Meals take longer | 0.34 | 0.39 | 0.41 |
| q8 Spills out of mouth | -0.15 | 0.84 | 0.40 |
| q9 Food remains in the mouth | -0.07 | 0.80 | 0.42 |
| q10 Hoarseness | 0.69 | -0.20 | 0.26 |
| Eigenvalues | 4.13 | 1.13 | |

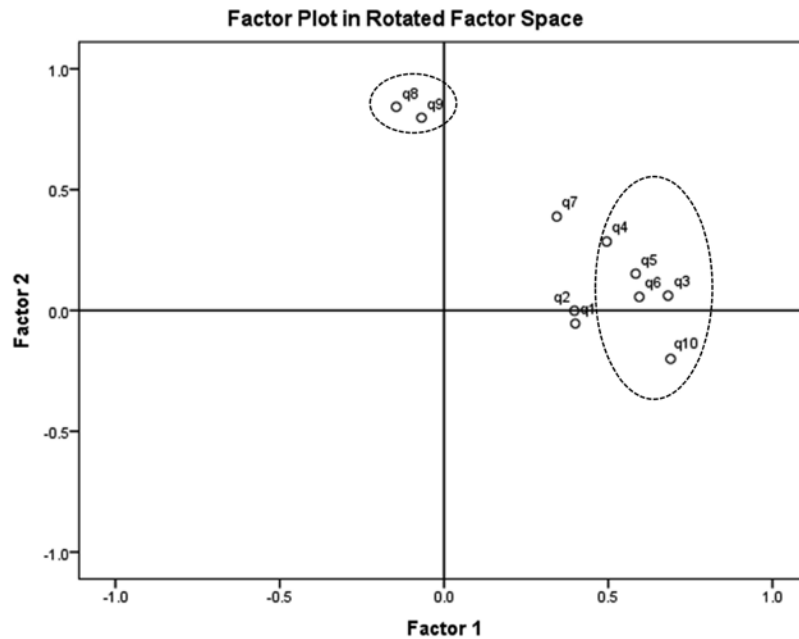


Figure 1. Factor plot in factor space after Promax rotation. The horizontal axis shows the factor loadings of factor 1, and the vertical axis shows the factor loadings of factor 2. Question items with factor loadings of 0.5 or higher are circled.

the factor space after a Promax rotation is illustrated (Figure 1).

Validation of reliability

Cronbach's alpha coefficient, used to assess the internal validity (consistency) of Swallow-10, was 0.84.

Determination of the optimal cutoff value through an ROC analysis

Table 3 shows the sensitivity, specificity, ROCd, and Youden's index values for each cutoff value. Among the conditions where the cutoff value was between 2 - 7 points, ROCd was the lowest at 0.012 and Youden's index was the highest at 0.785 when the cutoff value was 5 points. Under these conditions, sensitivity and specificity were 90.0% and 88.5%, respectively. Thus optimal cutoff value was given with 5 points. (Table 3). Figure 2 shows the ROC curve overlaid with the coordinate point when cutoff value was 5 points and the dashed line indicating ROCd (Figure 2). The areas under the curve (AUC) was 0.941.

DISCUSSION

Many elderly people are unaware that they have penetration or aspiration, or even if they are aware of them, they do not consider these issues as pathological phenomena (2, 4, 11). There is no doubt that it is even more difficult for older people with cognitive decline to be aware of them.

It has been reported that many patients with dementia present symptoms of dysphagia (12, 13), which can cause a variety of health problems. In a situation where the number of older people with dementia is currently large and will continue to increase in the future (14), if a person has not been officially diagnosed with dysphagia, its signs should not be overlooked. When targeting individuals with cognitive decline, the swallowing questionnaire should be assessed and answered by caregivers through observation. Swallow-10 considered this and excluded five items from Seirei dsq. These are four questions that are difficult for others

Table 3. Sensitivity, specificity, ROCd, and Youden's index for each cutoff value

| Cutoff value | Sensitivity | Specificity | ROCd | Youden's index |
|--------------|-------------|-------------|-------|----------------|
| 2 | 98.0 | 64.5 | 0.063 | 0.625 |
| 3 | 94.0 | 74.6 | 0.034 | 0.686 |
| 4 | 92.0 | 83.1 | 0.018 | 0.751 |
| 5 | 90.0 | 88.5 | 0.012 | 0.785 |
| 6 | 84.0 | 91.0 | 0.017 | 0.750 |
| 7 | 82.0 | 91.7 | 0.020 | 0.738 |

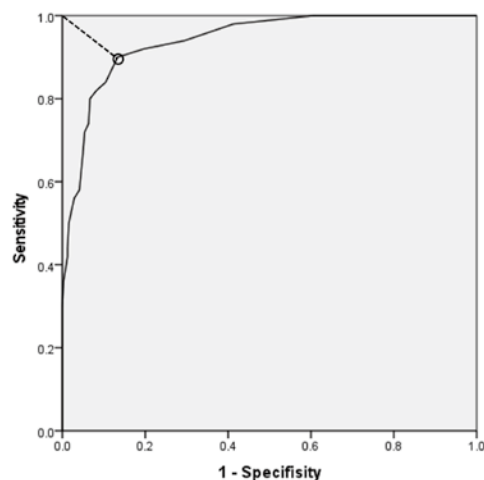


Figure 2. ROC curve
 ○ : Coordinate point with a cut-off value of 5 points
 ----- : ROCd (distance from the upper left corner point of ROC coordinates)

to evaluate, and the following question “Do you feel that it is getting difficult to eat solid foods?”, which is affected by denture wear and may overestimate the judgment regarding dysphagia (15).

Diagnostic performance, as assessed by sensitivity and specificity based on definitive diagnostic results (the gold standard) by video-fluorography or video-endoscopy, is an important requirement that screening or non-instrumental clinical assessment methods for dysphagia should have (16). During its development, Seirei dsq was assessed against the results of a confirmed diagnosis of dysphagia by video-fluorography. The assessment results have shown have high sensitivity and specificity, as well as a high Cronbach’s alpha coefficient (7). In addition, Seirei dsq correlates well with the results of the 30-ml-water-drinking test, providing necessary evidence for its use as a dysphagia screening tool (17). Furthermore, by adopting a scoring system, Seirei dsq can be evaluated quantitatively and is expected to become a tool not only for screening dysphagia but also for presumption of the state of decreased swallowing function before it leads to dysphagia (10).

In this study, we examined the evaluation method by scoring Swallow-10 in the same manner as that for Seirei dsq and obtained the results described above. When evaluating patient-reported outcome measures (PROMs), such as dysphagia screening questionnaires, the Cosmin guideline recommends that structural validity be assessed first, followed by internal consistency and cross-cultural validity or unbiasedness of measurement results (18). Using this as a reference, Swallow-10 was evaluated as a screening tool in three steps: factor analysis for structural validity, Cronbach’s alpha coefficient for internal consistency, and ROC analysis for sensitivity and specificity.

In the factor analysis for the first step, Promax rotation was applied to rotate the factor axes in order to clarify the factor interpretation and two factors were extracted. Factor 1 consists of five items including “difficulty in swallowing” and “choking on tea,” which are mainly related to the pharyngeal phase of the swallowing phases (19), and was named “pharyngeal function related factor”. Factor 2 included two items, namely, “Spills out of the mouth” and “food remains in the mouth”, which were seemed to be related to the preparatory or oral phase. Therefore, Factor 2 was named “oral function related factor”. Kawashima *et al.* reported in a survey study of community-dwelling elderly individuals using Seirei dsq that factor analysis demonstrated dysphagia could be estimated at any stage of swallowing difficulty (15). This feature of Seirei dsq and Swallow-10, which can estimate the location or stage of dysphagia, is not implemented in EAT-10.

For the second step, Cronbach’s alpha coefficient, which is an index of reliability (internal consistency), can be influenced by the number of items and tends to be lower when the number of items is small (20). Seirei dsq achieved a value of 0.85, whereas Swallow-10 achieved a value of 0.84, despite having five fewer items, indicating that the reliability of Swallow-10 is as high as that of Seirei dsq.

On the other hand, the Cosmin guidelines state that if a PROM is used in a different population than the one it was developed for, it should be reevaluated for content validity regarding the new population (18). Although Seirei dsq questionnaire was developed mainly for patients with cerebrovascular disease, it demonstrated high internal consistency in a survey study of elderly people aged 65 years and over living in the community (15). Swallow-10, which comprises the same questionnaire items as Seirei dsq, also can be applied to a wide range of subjects. However, additional studies applying Swallow-10 to community-dwelling older people and cognitively impaired subjects would be needed to further ensure this.

In our earlier paper on Swallow-10, we reported that the cutoff

value was 4 points, with 2 points for answer choice “A”, 1 point for “B”, and 0 points for “C” (9). On the other hand, in our subsequent study of scoring the Seirei dsq, the ROC analysis showed that the score for “A” should be weighted to be 4 points instead of 2 points (10). In this study, the score of “A” was set to 4 points in accordance with this report.

As a result, the optimal cutoff value of 5 points, which yielded a sensitivity of 90.0%, a specificity of 88.5%, and an AUC of 0.941, which was high enough to meet the COSMIN guideline requirement of an AUC of at least 0.70 (18).

These results may show that the Seirei dsq has sufficient screening accuracy even with missing answers to the five question items excluded by Swallow-10, but this does not mean that these items are unnecessary. One possible reason for this is that the four items excluded in the Swallow-10 are questions about the pharyngeal or oesophageal stages, and their exclusion may result in a partial loss of Seirei dsq features that estimate the site or stage of dysphagia (15). Thus the original Seirei dsq should be used in subjects who are able to answer the questions clearly.

Here, we discuss the usefulness of Swallow-10 and Seirei dsq as tools for detecting signs of dysphagia in the elderly population, whose swallowing functions tend to deteriorate with age. In the original “if there is any A method” criterion used in Seirei dsq, mild symptom “B” was ignored in the evaluation. Adding the mild symptom “B” to the total number of points would not only increase the quantitativity of the Swallow-10, but would also make people aware that their swallowing function is deteriorating for those who do not meet the cutoff value. Therefore, depending on the total score or the questionnaire item the patient answered as symptomatic, appropriate preventive measures can be taken, which may prevent people from developing dysphagia. Swallow-10, with a cutoff value of 5 points, has five levels, from 0 to 4 points. On the other hand Seirei dsq, with a cutoff value of 8 points, has eight levels, from 0 to 7 points (10). Thus, the width of the range below the cutoff value may also allow evaluation of the state of decreased swallowing function. In contrast, EAT-10 has a cutoff value of 3 points, and there are only three levels (0, 1, and 2 points) that do not meet the cutoff value, which is a somewhat narrow range for evaluating the state of decline in swallowing function. For EAT-10, it has been reported that the cutoff value should be 2 points, for which sensitivity is high with no decrease in specificity (21). In this case, there exit only two levels below the cutoff value, and the range of the scale is too narrow to assess the state of decline in swallowing function. If the swallowing questionnaire is to be used for the general population as a health checklist, Seirei dsq or Swallow-10 may be more advantageous compared with EAT-10.

LIMITATIONS AND CHALLENGES

The Swallow-10 is intended to be assessed and answered by caregivers of subjects with cognitive decline through daily observation. The results of this study are based on the dataset used in the Seirei dsq development study, which was answered by the cerebrovascular patients themselves. Additional research should be investigated whether screening results for dysphagia have high screening performance even when caregivers or family members answer the Swallow-10 on behalf of the subjects.

Furthermore, in order to widely disseminate the Swallow-10 and Seirei dsq worldwide, it must be applied in other countries besides Japan to assess cross-cultural validity or measurement unbiasedness.

CONCLUSION

The Swallow-10, which uses a score-based assessment method, achieves high sensitivity and specificity as a screening tool for dysphagia and can be applied to people requiring nursing care with reduced cognitive function. Furthermore, the results suggest that Swallow-10, together with Seirei dsq, can be used as a health checklist to alert the elderly to a decline in swallowing function.

CONFLICT OF INTERESTS

The all authors have no relevant financial and non-financial interests to disclose.

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