REHABILITATION MANUAL 30

DYSPHAGIA REHABILITATION MANUAL

Editor
MASAMI AKAI

NATIONAL REHABILITATION CENTER
FOR PERSONS WITH DISABILITIES
JAPAN

(WHO COLLABORATING CENTRE)

July, 2015

The National Rehabilitation Center for Persons with Disabilities was designated as the WHO Collaborating Centre for Disability Prevention and Rehabilitation in 1995.
The terms of reference are.

1 To collaborate with WHO in the development of knowledge and resources for increasing access to quality health, rehabilitation services and sports for persons with disabilities in the Western Pacific Region.
2 To support and cooperate with WHO to conduct capacity development activities and share good practice and experiences regarding disability and rehabilitation across the region.
3 To work with WHO to increase the awareness and understanding of the needs and rights of persons with disabilities.

National Rehabilitation Center for Persons with Disabilities
WHO Collaborating Centre for Disability Prevention and Rehabilitation

Rehabilitation Manual 30
Dysphagia Rehabilitation Manual
July 30,2015

Editor: Masami AKAI

Kozo Nakamura, M.D., Ph.D., President
4-1 Namiki, Tokorozawa, Saitama Prefecture 359-8555, Japan
Tel. +81-4-2995-3100
Fax. +81-4-2995-3661
E-mail whoclbc@rehab.go.jp

PREFACE

The National Rehabilitation Center for Persons with Disabilities has long been a WHO Collaborating Centre, and one of its activities in this regard is to create rehabilitation manuals that summarize the material on a range of topics in the field of rehabilitation medicine.

The subject of this particular manual is dysphagia. Ensuring sufficient nutrition through adequate eating and swallowing function is one of the linchpins of medical treatment alongside proper sleep and maintaining bodily hygiene. Only if these factors are met can the various effects of rehabilitation training be expected to become apparent. When treating persons with swallowing difficulties, the first step is to diagnose the cause or condition, after which a range of exercises should be used and the type of food provided should be tailored to enable oral intake. This manual covers these points, and therefore will be of value to a broad readership.

It is to be hoped that this manual will pave the way for the wider use of dysphagia rehabilitation in the future.

M. AKAI

EDITOR

Masami AKAI
Adviser, Research Institute,
National Rehabilitation Center for Persons with Disabilities

CONTRIBUTORS

Yasushi SUZUKI
Nobuaki KIMIJIMA
Hisako UCHIYAMA
National Rehabilitation Center for Persons with Disabilities

LLUSTRATOR

(Chapter 3)
Haruko IWASAKI
National Rehabilitation Center for Persons with Disabilities

CONTENTS

Chapter 1.
The Swallowing Mechanism and its Impairment

1. Introduction

Swallowing movements can be understood as both nutritional intake and airway-blocking movements. In healthy persons, a food bolus ingested through the mouth is transported to the stomach via the esophagus. The respiratory tract (airway), starting from the nasal cavity, intersects in the pharyngeal area with the food transport route (nutritional passage), starting from the oral cavity (Figure 1); however, if the bolus is not transported to the stomach, even if it is held up temporarily, it ultimately has only three possible exit routes: it may be vomited out of the mouth, forced back up into the nose, or spilled into the respiratory tract. Regardless of the severity of dysphagia, it carries the ever-present risk of respiratory tract obstruction, or aspiration. In healthy persons, through swallowing movements, a bolus that has traveled from the oral cavity to the pharynx is transported safely and reliably into the esophagus, passing through the pharynx while the trachea is gradually closed; in this process, the movement of the larynx plays the most important role.[1)]

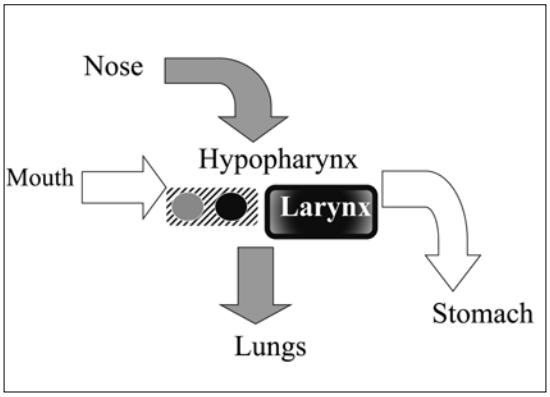


Figure 1 Intersecting food transport route and trachea

2. The Anatomy of Swallowing

The center of swallowing movements is the so-called deglutition center in the bulbar reticular formation, which is composed of dorsal solitary nuclei, ventral solitary nuclei, and ambiguous nuclei and other motor neurons. Input to this center is broadly divided into two types: input from the corticobasal ganglia further up, and sensory input from the oral cavity, pharynx, and other peripheral organs. The output from the deglutition center is projected to the muscles involved in swallowing through the ambiguous nuclei and other motor cells (Figure 2). Little is known about the deglutition center, including its localization, and it is an area of interest for researchers.

The peripheral muscles involved in swallowing movements include the masticatory, facial, suprahyoid, soft palatal, pharyngeal, infrahyoid, and intrinsic lingual muscles. Figure 3 shows the main muscles and their dominant nerves. These include almost all of the muscles of the mouth, pharynx, and larynx.

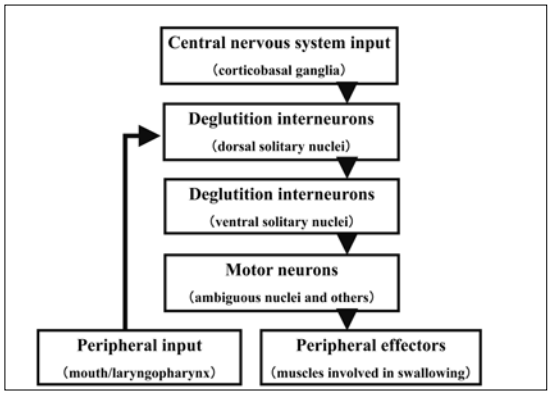


Figure 2 Mechanism of swallowing

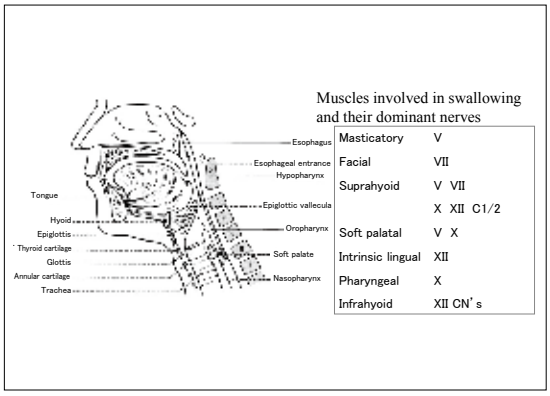


Figure 3 Organs involved in swallowing

3. The Three-stage Classification in Swallowing Research

Most of the current research on swallowing classifies the temporal process of the rapid, complex movements involved in swallowing into three stages. This classification was first proposed in 1816 by the physiologist François Magendie[2-3] in his work *Précis élémentaire de physiologie* (“An Elementary Précis of Physiology”) (Figure 4). The subsequent discovery of x-rays by Röntgen in 1885 enabled observations through radiography and fluoroscopy, allowing detailed measurements of the movements over time of the mouth, pharynx, and larynx during the passage of the bolus in the middle of 20th century.[4]

This three-stage classification has also been the subject of neurological studies, particularly those using electromyography. In 1956, Doty and Bosma[5] reported that they had triggered the swallowing reflex in dogs, monkeys, and cats by means of both tactile stimulation of the pharyngeal mucosa and electrical stimulation. The authors described the activity of the oral and pharyngeal muscles during this process (Figure 5).

Although there is still a certain amount of confusion, the current interpretation is that “phase” refers to the temporal pattern of the movement of the bolus as observed by x-ray fluoroscopy, whereas “stage” refers to the temporal pattern of the outputs in the neural mechanism of swallowing (Figure 6).

In practical terms, the oral phase constitutes the time during which lateral fluoroscopy shows a bolus that had been retained in the mouth by the tongue travels posteriorly until its leading edge passes through the faucial area. The pharyngeal phase

Figure 4 Pre’cis E’le’mentaire de Physiologie

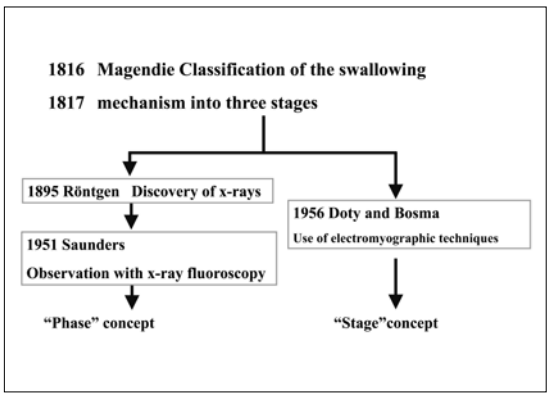


Figure 5 History of study of swallowing

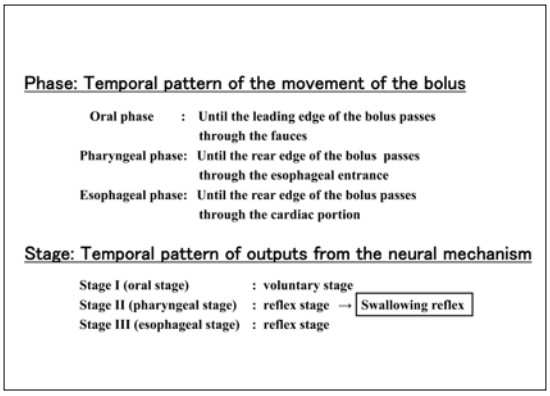


Figure 6 Swallowing phase and stage

lasts until the rear end of the bolus passes through the esophageal entrance, and the esophageal phase lasts until the bolus passes through the esophagogastric junction. Stage I of swallowing refers to the voluntary period until immediately before the swallowing reflex is triggered by the bolus being propelled posteriorly through the mouth, and Stage II begins at the start of his swallowing reflex. Stage III starts at the point when esophageal peristalsis begins as esophageal sensory receptors are stimulated by the entrance of the bolus into the esophagus.

Many researchers are continuing to work in these areas today.

4. Disjunction between Phase and Stage

Normally, when a healthy person swallows, the triggering of the swallowing reflex depends on whether or not the bolus enters the pharynx, and it may thus easily be envisaged that the start of the pharyngeal phase coincides almost exactly with the start of Stage II. The movements of each area during the reflex movements of Stage II vary depending on factors including the amount swallowed, the physical properties of the substance being swallowed, and the person's posture; however, strictly speaking, there may be a disjunction between the start of the pharyngeal phase and the start of Phase II.

In 1994, Shin[6] compared the temporal patterns of phases and stages, and explained the mechanism of dysphagia in terms of a "disjunction" between phase and stage. He stated that dysphagia is caused by a "disjunction" between swallowing stage and phase that exceeds a certain tolerable limit as a result of an abnormality of the peripheral or central nervous system, and that this "disjunction" is compensated for in the case of healthy persons (Figure 7).

The aim of dysphagia treatment is thus to restrict this (temporal) disjunction between phase and stage to within tolerable limits that are amenable to compensation.

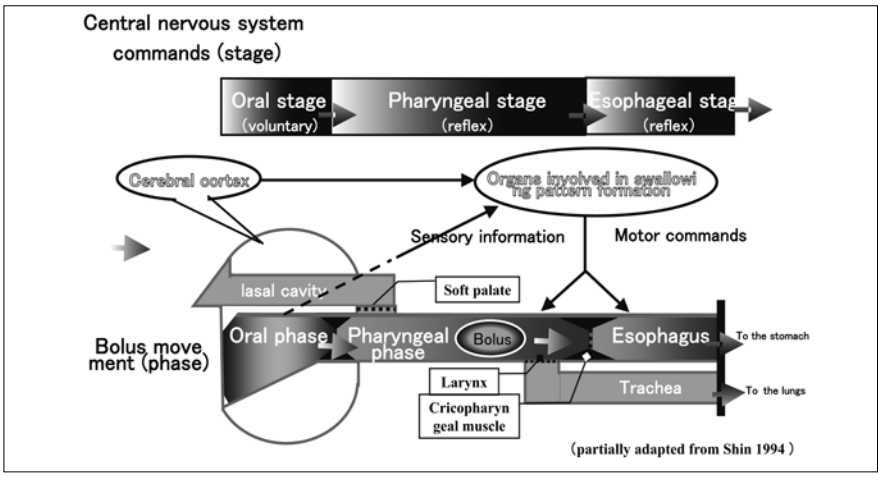


Figure 7 Relation of phase and stage

5. Types of Dysphagia

Rather than a single condition, the term "dysphagia" refers to a pathological state and its symptoms, and its diagnosis is considered in the following two stages: (i) diagnosis of the cause of the dysphagia, and (ii) diagnosis of the level at which the problem is occurring and its severity (the pathological condition) (Figure 8).

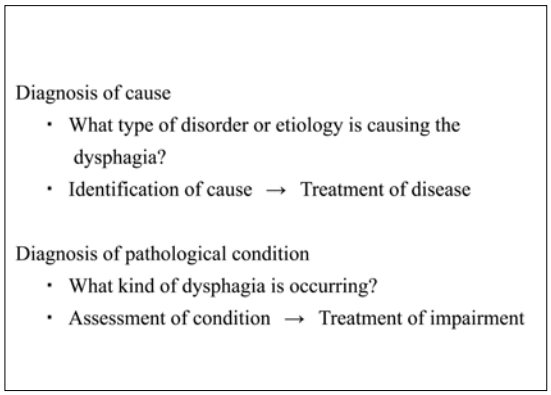


Figure 8 Diagnosis of dysphagia

1) Diagnosis of cause

Numerous different disorders can cause dysphagia. Hirano *et al*[7] divided dysphagia into static disorders and dynamic disorders, whereas Horiguchi[8] proposed that it be classified into the following three types: (i) organic dysphagia, (ii) motor disorder dysphagia, and (iii) functional dysphagia.

In these terms, Hirano *et al*.'s category of static disorders corresponds to organic dysphasia, and their category of dynamic disorders corresponds almost exactly with motor disorder dysphagia (Figure 9).

In general, medical history taking and visual examination are important in the diagnosis of the cause. Neurological conditions, including cerebrovascular disorder, will frequently already have been diagnosed; however, the investigation should start by looking for the disorders covered by organic dysphagia. For example,

elderly patients with cerebrovascular disease should not immediately be considered to have motor disorder dysphagia before the possibility of organic dysphagia has been ruled out.

If organic dysphagia can be ruled out, the possibility of motor disorder dysphagia should then be investigated. Familiarity with the various disorders themselves is required when investigating the possibility of motor disorder dysphagia, and collaboration with specialists in related disciplines, such as neurology, is also necessary.

The diagnosis of functional dysphagia is always by exclusion, and it is only diagnosed after all other causes, with the exception of acute inflammation, have been ruled out.

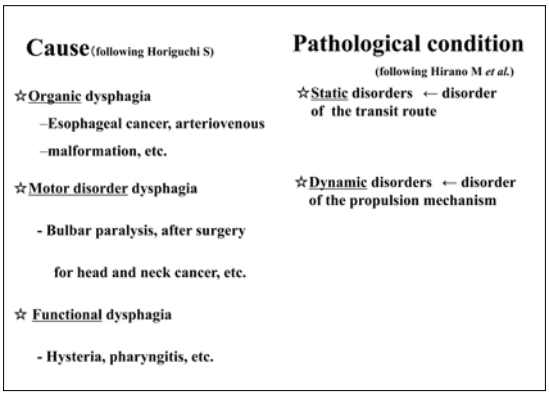


Figure 9 Types of dysphagia

2) Diagnosis of pathological condition

The second step in the diagnosis of dysphagia is diagnosis of the pathological condition, in terms of the level at which the problem is occurring and its severity. Along with the diagnosis of the cause described above, this is an important aspect of dysphagia assessment.

In organic or functional dysphagia, treating the cause takes priority over dysphagia treatment, and, in many cases, this treatment also improves the dysphagia. Motor disorder dysphagia, however, is often a complication or sequela of the cause itself, and in many cases dysphagia treatment is required in addition to treatment of the underlying condition. The choice of treatment must thus be based on the diagnosis of the pathological condition. Even if a particular disorder has been diagnosed as the cause, it is common in the clinical treatment of dysphagia to see cases in which the causative disorder has no curative therapy or in which irreversible changes may have occurred, making the diagnosis of the pathological condition more important for both treatment and assessment of the prognosis.

Pharyngo-esophagography generally provides a large amount of information that is useful for the diagnosis of pathological condition. In particular, the types of aspiration are described in the following section.

6. Types of Aspiration

Although aspiration does not occur in all patients with dysphagia, it is extremely common in patients with this condition. In Japan, aspiration is conventionally classified with reference to laryngeal elevation during Stage II (the reflex stage), and the timing of aspiration (the entrance of a swallowed substance into the airway) is classified as shown on the left-hand side of Figure 10.[7] This classification is useful for decisions such as surgical indications. In the United States and Europe, on the other hand, a speech therapy-based typology is used that classifies aspiration in terms of the point at which it occurs relative to the swallowing reflex stage, as shown on the right-hand side of Figure 10.[9] In this classification, "the swallow" refers to the swallowing reflex itself, and Figure 11 shows a simple diagram of its mechanism.

The two classification systems shown in Figure 10 correspond very closely with each other, and are described below (Figure 12).

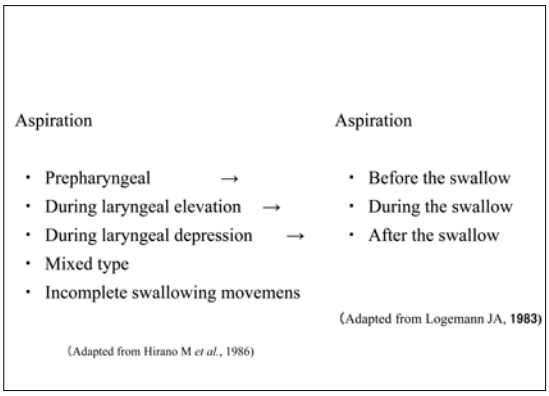


Figure 10 Types of aspiration

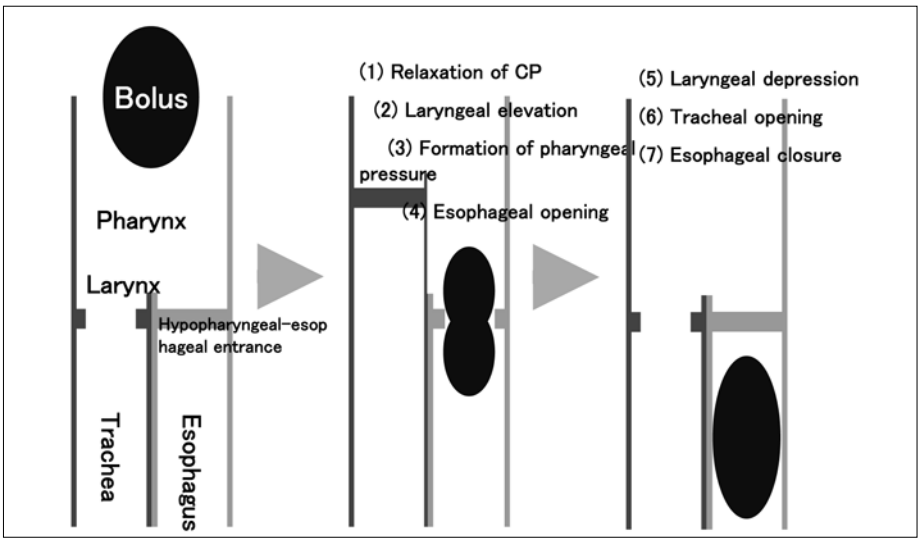


Figure 11 Swallowing reflex

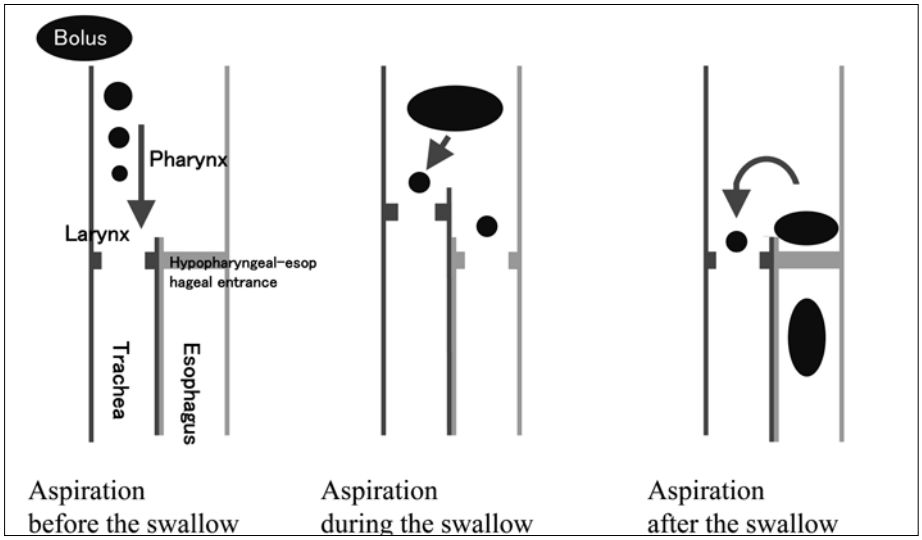


Figure 12 3 types of aspiration

1) Aspiration before the swallow

The bolus is not retained within the oral cavity but enters the pharynx or larynx before the swallowing reflex occurs (or without its occurrence), and is aspirated. It occurs in the event of poor bolus retention within the oral cavity, or the failure or delay of the swallowing reflex. These correspond to prepharyngeal aspiration, but may also include some incidences of laryngeal elevation stage aspiration.

2) Aspiration during the swallow

Aspiration during the swallowing reflex is properly described as aspiration while the larynx is elevated. This occurs as a result of impaired laryngeal elevation, failure of glottic closure, or other imperfect closure of the glottis, disturbance of perception, or if the timing of glottic closure is delayed because of brainstem damage or other causes. These correspond to aspiration during laryngeal elevation. If aspiration occurs during swallowing because of imperfect closure of the glottis caused by the delayed triggering of the swallowing reflex, it should correctly be considered aspiration before the swallow.

3) Aspiration after the swallow

Aspiration after the swallow occurs while the larynx is depressed. The bolus being transported from the oral cavity into the pharynx fails to pass through the esophageal entrance in its entirety, with part of it remaining in the pharynx. From there, it is aspirated when the airway is opened by the larynx after the end of the swallowing reflex. This may occur if the propulsive force of the bolus is weak; the cricopharyngeal muscle is insufficiently relaxed, causing increased resistance by the esophageal entrance; or the timing of cricopharyngeal muscle relaxation is poor. These correspond to aspiration during laryngeal depression.

4) Mixed-type aspiration

This type of aspiration may occur during any of the prepharyngeal stage, laryngeal elevation, or laryngeal depression.

5) Aspiration due to swallowing movement failure

This type of aspiration occurs when there is no effective (meaningful) swallowing, or no attempts or actions associated with swallowing are done.

7. Summary

This chapter as described the swallowing mechanism and its impairment. Swallowing is a precipitous, complex, and elaborate movement, and although not all its mechanisms have been identified as yet, it is vital to understand patients' swallowing movements on the basis of the above-described processes, in addition to utilizing the diagnostic and assessment methods described in the next chapter.

References

1. Suzuki Y., Horiguchi S. The role of ENT physicians in the treatment of dysphagia. MB Med Rehab. 2, 2001, p.27-33. [In Japanese]
2. Magendie F. Précis élémentaire de physiologie. Paris, Mequignon-Marvis. 2, 1816, p.58-67.
3. Suzuki Y., Yagishita S. The achievements of François Magendie in dysphagia research. J Jpn Broncho-Esophagol Soc. 53, 2002, p.313-318. [In Japanese]
4. Saunders J. B. The mechanism of deglutition (Second stage) as revealed by cine-radiography.Ann 0tol. 60. 1951. p.897-916
5. Doty R., Bosma J. F. An electromyographic analysis of reflex deglutition. J Neurophysiol. 19. 1956. p. 44-66.
6. Shin T. The neurogenic mechanism of swallowing and its abnormalities. Mimi. 40 (supplement 1), 1994, p.241-422. [In Japanese]
7. Hirano M et al. The clinical classification of aspiration and its significance: with a focus on dynamic disorders of swallowing. J Jpn Broncho-Esophagol Soc. 31, 1976, p.237-243. [In Japanese]
8. Horiguchi S. Dysphagia diagnosis. JOHNS. 14, 1998, p.1711-1714. [In Japanese]
9. Logemann J. Evaluation and Treatment of Swallowing Disorders. 2nd ed. pro-ed. Texas, 1998.

Chapter 2.
Dysphagia Diagnosis and Assessment Methods

1. Dysphagia Diagnosis by Specialists

As described above, rather than a single condition, the term "dysphagia" refers to a pathological state and its symptoms, and its diagnosis requires two stages: diagnosis of the cause of the dysphagia and assessment of the concrete symptoms indicating what kind of dysphagia is occurring (diagnosis of the pathological condition) (Figure 9). Some types of dysphagia can be improved by treating the underlying condition itself; however, in many cases, symptomatic treatment for dysphagia is required in parallel with treatment of the underlying condition. In these diagnostic processes, it is therefore essential to gather information while keeping the treatment in mind.

Ear, nose, and throat (ENT) physicians not uncommonly have to undertake these diagnoses alone; however, collaboration with doctors of other specialties is also frequently required. Points that need to be kept in mind during treatment and diagnosis by regular ENT physicians are described below.

1) Medical history, visual examination, and palpation

In the treatment of patients with dysphagia, a medical history is taken and a visual inspection and palpation are performed in line with regular ENT treatment. In many cases, it may be possible to obtain some idea about the pathological condition by asking about detailed symptoms when taking a patient's medical history, for example if they mention that food has "gone down the wrong way" while eating. Matters such as the patient's motivation to overcome dysphagia, the state of support from family members and other caregivers, and dietary preferences also provide important information for the choice of treatment methods and when setting goals. Even at this stage, it is thus necessary to think about the choice of symptomatic treatment and setting goals when taking the patient's medical history.

The main purpose of visual inspection and palpation is to observe morphological abnormalities of the oral cavity, pharynx, and larynx, and to look for neurological signs. When possible, this should be extended to encompass systemic neurological signs and posture.

2) Laryngopharyngeal endoscopy

After a general examination, the laryngopharyx should be examined with a transnasal fiber-optic endoscope. This is a familiar procedure for regular ENT physicians, and one that is indispensable in everyday clinical practice for the detection of organic and functional abnormalities of the laryngopharynx. In recent years, manufacturers have started selling fiberscopes with battery-operated light sources. These now provide sufficient illumination (compared with when they initially became available), and are highly portable for use in bedside examinations in hospitals.

Although the use of a fiber-optic endoscope in the functional evaluation of swallowing has some limitations, in addition to the detection of the abnormalities mentioned above, it does enable the observation of the swallowing dynamics for liquids and solids.

The disadvantage of this method is that the tip of the fiberscope is placed in the oropharynx and thus remains above the soft palate; the effect of this on swallowing dynamics is unclear, and it also means that nothing at all can be seen during pharyngeal contraction. With increasing experience, however, it becomes possible to predict swallowing function to some extent from what can be observed before and after pharyngeal contraction. At the same time, lateral images from pharyngo-esophagography, described in the next section, can also be conjectured.

Although it goes without saying that pharyngo-esophagography is the gold standard from the viewpoint of the amount of information that can be obtained from swallowing function tests, static and dynamic observation of the laryngopharynx with a transnasal fiber-optic endoscope is both noninvasive and simple, and therefore has an important role to play.

3) Pharyngo-esophagography

Esophagography is an essential test for the diagnosis of the pathological condition underlying dysphagia, as it provides a large amount of information. Furthermore, it constitutes the gold standard for the functional analysis of swallowing. It must always be considered, however, that patients who may be experiencing dysphagia are always at risk of aspiration during the test.

Barium sulfate solution is generally used as the contrast agent. A nonionic angiography contrast agent may also be used, although this is not covered by health insurance. In any event, currently, no contrast agent exists that is entirely safe if aspirated. If there is a risk of aspiration, (1) a weak solution of contrast agent must be used; (2) the number of tests must be kept to a minimum by using video recordings; (3) patients must be encouraged to expectorate after the test; and (4) an aspirator must be available in the room where the test is performed. If necessary, only lateral images should be acquired, as these provide far more information than do frontal images.

This test is carried out while the patient is standing; however, it may also be performed with the patient sitting down if it is difficult to maintain the standing position. Patients who cannot maintain a stable seated position must be immobilized with a restraining belt or other means to prevent them from falling off the chair during the test.

The volume of liquid contrast agent used is 5–10 ml per test. If there are problems in transferring the contrast agent from a cup into the mouth, then it may be placed in a syringe fitted with a Nelaton tube or similar device, and transferred into the patient's mouth through the tube. Depending on the requirements in settings for actual functional training, solid contrast agents such as jelly with added barium sulfate may be used in addition to liquid contrast agent.

The basic scanning directions are frontal and lateral; however, as mentioned above, should the number of scans be limited for any reason, then priority is given to lateral scans. Video recordings should be made whenever possible. If necessary, an assistant may be stationed in the x-ray room.

2. Simple Tests for Dysphagia

Thus far, we have described the initial diagnostic methods used by specialists such as ENT physicians in diagnosing dysphagia. As for all diseases and pathological conditions, suspecting the presence of dysphagia is the first step in its treatment. However, it is not always the specialists who are the first to suspect its presence; apart from family members, in many cases this will be medical staff such as attending physicians, nurses, and speech therapists who do not possess specialist skills in areas such as endoscopy. This section mainly describes screening tests for dysphagia that do not require any special tools (simple tests). Although pharyngo-esophagography and endoscopic evaluation of swallowing are the gold standard for dysphagia diagnosis, as described above, there are simple, highly sensitive tests that are also useful in regular outpatient clinics, at the bedside, and during at-home medical treatment.

1) Choking and aspiration

Although not every dysphagia patient experiences aspiration, it is one of the most important symptoms of dysphagia. The choking that is initially induced by aspiration is a symptom that is easy to assess objectively. If choking or coughing is present during meals, details such as the point at which it occurs during the meal and during swallowing, its frequency and the patient's posture at the time, and the effect of variations in food texture must either be collected during medical history taking or consciously observed when the patient is observed while eating.

Choking is a protective reflex when food or drink has entered the respiratory tract as a foreign body, and is a state that everyone experiences at some point. In itself, choking is not a pathological event. If it occurs frequently, however, it becomes a basis for suspecting dysphagia.

Although choking does suggest aspiration, the converse is not necessarily true: the absence of choking does not suggest the absence of aspiration. If hypoesthesia of the inside of the respiratory tract has developed as a result of long-term aspiration, or if the airway protection reflex has been weakened or lost, patients may not choke as a result of the invasion of the respiratory tract by a foreign substance. This is known as "silent aspiration," and in terms of the severity of dysphagia is considered a more serious condition.

2) Dry swallowing

Even when not eating, humans swallow repeatedly at regular intervals to dispose of saliva in the mouth. The action that forms the basis of this saliva disposal is known as "dry swallowing." The first thing to do before carrying out any of

these simple tests is therefore to observe whether the patient is capable of dry swallowing.

3) Repetitive saliva swallowing test

This test involves looking at the patient's ability to voluntarily swallow repeatedly, and is a simple, comparatively safe test that is highly correlated with aspiration.

The patient is placed in a resting position. After their mouth has been moistened with a drink such as cold water, the patient is instructed to swallow repeatedly and the number of swallows achieved is counted. Three or more dry swallows during a 30-s period is considered normal. The number of swallows is defined as the number of laryngeal elevations, determined through either visual observation or palpation.

4) Water swallow test

Some patients with dysphagia may find it difficult to swallow water, and this is especially pronounced in patients with static dysphagia in whom the food propulsion mechanism is impaired by cerebrovascular disturbance or neuromuscular disease. The goal of this test is thus to detect aspiration with a high degree of accuracy by having patients swallow water.

Two methods have been widely proposed: the original method, which entails swallowing 30 ml of fluid, and another that involves swallowing 3 ml of the same fluid (Table 1). In Kubota *et al.*'s original method, patients began with a trial swallow of 3 ml of fluid, after which 30 ml was used; on the other hand, Saito *et al.*[1] subsequently described a method that involves having the patients drink 3 ml of fluid and observing the state of swallowing in detail. In both methods, the swallowing process and the nature of any choking that may occur are observed.

Water-swallow test

○ **Method**

A cup containing 30 ml of water at room temperature is handed to the patient who is seated on a chair. The patient is told, "Please drink this water as you normally would." The time taken to finish drinking the water, the profile, and any episodes are measured and observed.

○ **Profiles**

1. Able to drink all the water in one gulp without choking
2. Able to drink all the water in two or more gulps without choking
3. Able to drink all the water in one gulp, but some choking occurs
4. Despite drinking the water in two or more gulps, some choking occurs
5. Frequent choking, with difficulty drinking all the water

○ **Episodes**

Sipping, holding water in the mouth while drinking, water coming out of the mouth, a tendency to force oneself to continue drinking despite choking, drinking in a cautious manner, etc.

○ **Diagnosis**

- Normal range: Completed Profile 1 within 5 s
- Suspected: Completed Profile 1 after >5 s, or Profile 2
- Abnormal: Profiles 3–5

Source: Kubota Toshio et al.: Paralytic dysphagia in cerebrovascular disorder— screening tests and their clinical application. General Rehabilitation 10, 1982, p.271-276.

Modified water-swallow test (quoted from Saito *et al.*[1])

○ **Procedure**

Three milliliters of cold water is introduced into the oral vestibule, and the patient is instructed to swallow. If the patient is successful, the patient is instructed to perform swallowing movements a further two times, and the worst swallowing activity is assessed. If the patient scores at least 4 points on the assessment criteria, a maximum of two additional attempts should be made (for a total of three attempts), and the worst assessment is recorded.

○ **Assessment criteria**

1. Failure to swallow, with choking and/or changes in breathing
2. Successful swallowing without choking, but with changes in breathing or wet hoarseness
3. Successful swallowing, but with choking and/or wet hoarseness
4. Successful swallowing with no choking or wet hoarseness
5. In addition to criterion 4, two successful additional swallows within 30 s

Source: Saito Eiichi et al. Integrated Research on Treatment and Handling of Dysphagia: General Research Report. Research Project on Aging and Health, Fiscal 1999 Health and Labour Sciences Research Grant (Chief researcher: Saito E). 1999, p.1–18. [In Japanese]

Table1 Water-swallow test

5) Swallowing provocation test (swallowing reflex test)

In this method, a narrow-diameter tube is inserted through the nose to the neighborhood of the oropharynx, a small volume of water is injected, and the time between the injection and the start of the swallowing reflex is measured. In Teramoto et al.' s original method,2) when 0.4 ml of distilled water at room temperature was injected in healthy persons, the time to the start of the swallowing reflex was 1.7 s. On the basis of this figure, a time of 3 s or more was considered abnormal. It is possible that these results may vary, however, depending on the amount injected, water temperature, and speed of injection. This test evaluates pharyngeal perceptual input and motor output without the influence of the oral phase, and is capable of evaluating the presence of silent aspiration.

6) Other simple tests

This section describes tests for which special devices are required.

(1) Percutaneous arterial oxygen saturation measurement

This test uses pulse oximetry to measure arterial blood saturation (SpO2) while eating, and to infer the occurrence of aspiration when SpO2 declines. In practice, ingestion is discontinued should SpO2 while eating decrease to <90% or decline relative to its original value at a mean rate of 3% per minute. Although aspiration itself is not assessed in this method, it is useful for the risk management of breathing during eating.

(2) Plain cervical radiography

By asking patients to swallow a small amount of contrast agent and comparing plain cervical radiographic images taken before and after this process, it is possible to confirm the presence or absence of laryngeal spillage, aspiration, and pharyngeal retention. Unlike x-ray fluoroscopy, this method does not enable dynamic observations during swallowing; however, it can be carried out easily by using regular radiographic equipment.

3. Summary

Although it may feel as if there is no more to say with regard to the basic concepts of dysphagia diagnosis and assessment, simpler and more sensitive procedures are still being published. As mentioned earlier, suspecting the presence of dysphagia is the first step in its treatment, and it is important to choose methods that are sufficiently useful in your own institution rather than being beguiled solely by novelty.

Cited References

1. Saito E et al. Integrated Research on Treatment and Handling of Dysphagia: GeneralResearch Report. Research Project on Aging and Health, Fiscal 1999 Health and Labour Sciences Research Grant (Chief researcher: Saito E). 1999, p.1–18. [In Japanese]
2. Teramoto S et al. Usefulness of simple swallowing provocation test as a screening test for swallowing function. J Jpn Respir Soc. 37, 1999, p.466-470. [In Japanese]

References

1. Horiguchi S., Suzuki Y. Screening tests in evaluating swallowing function. JMAJ. 54(1), 2011, p.31-34.
2. Fujishima I. Symptoms and screening. In: Fujishima I, ed. Dysphagia Made Easy. Osaka: Nagai Shoten, 2001, p.78-85. [In Japanese]
3. Horiguchi S. Bedside screening tests for dysphagia. In: Yumoto E, Kaga K, Ikeda, K et al., eds. Diagnosis and Treatment Practice in Otorhinolaryngology, Vol. 7: Treatment of Dysphagia. Tokyo: Bunkodo; 2002, p.20-25. [In Japanese]
4. Kubota T et al. Paralytic dysphagia in cerebrovascular disorder—screening tests and theirclinical application. Gen Rehabil. 10, 1982, p.271-276. [In Japanese]
5. Sherman B et.al. Assessment of dysphagia with the use of pulse oximetry. Dysphagia 14(3),1999, p.152-156

Chapter 3.
Approaches to Dysphagia Rehabilitation

This chapter describes points to note concerning the indirect and direct exercises and functional exercises at the bedside that are used by speech therapists at the National Rehabilitation Center for Persons with Disabilities.

During their initial interview with a patient, speech therapists

(1) Confirm the patient's general condition (ability to maintain a seated position, presence of facial paralysis);

(2) Confirm the clarity of the patient's articulation in general conversation, estimate the state of movement of the speech organs (jaw, lips, tongue, and soft palate), and confirm voice quality; and

(3) Gather information on matters such as food intake before onset (from the patient or family members).

They then carry out an in-depth assessment, create a dysphagia rehabilitation menu, and carry out rehabilitation. The point to note is that this approach is entirely focused on the patient's condition.

1. Indirect Exercises

This section describes points to note concerning the approach to posture maintenance, movement of the oral organs (speed, range of motion, accuracy), and improvement in respiratory function (with the aim of improving expectoration), with the use of illustrations.

1) Posture maintenance

Points to note to enable the adoption of a posture that enables patients to maintain a relaxed seated position in a chair or wheelchair.

Patients are seated with their hips low down and their middle and lower back in contact with the back of the chair, to avoid compression of the abdomen and chest (Figures 1-1 and 1-2). Ideally, both feet should be planted on the floor and the seat angle should be 90°; however, patients with hemiplegia may require the use of a cushion, towel, or other forms of padding to make it easier for them to maintain their posture (Figures 2-1 and 2-2). A mark is chosen so that the patient's line of sight is parallel with the floor (Figure 3). The patient is asked to breathe deeply and try to relax. The arms are allowed to hang down the sides of the chair or wheelchair (Figure 4).

The time patients spend in the seated position should gradually be increased in accordance with their capacity to do so. To relax muscle tension in the upper body, up-and-down movement of the shoulders (Figure 5) or passive anterior-posterior flexion and bilateral flexion are carried out to relax muscle tension in the shoulders and neck (Figures 6-1 and 6-2). Note: Passive movement may be dangerous if cervical vertebral lesions are present, and should only be used for patients without such lesions.

Figure 1-1. Compression of the abdomen and chest.

Figure 1-2 Posture that does not compress the abdomen or chest.

Figure 2-1 A way of maintaining the midline position

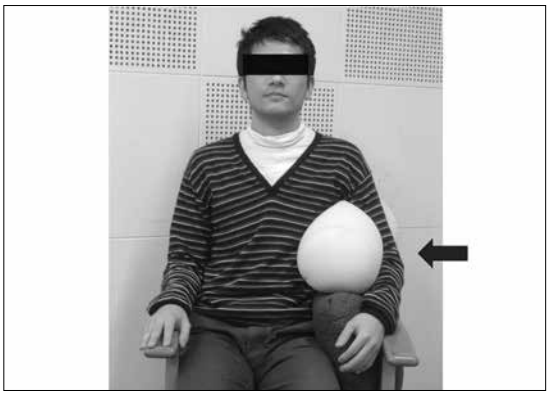


Figure 2-2 Another way of maintaining the midline position

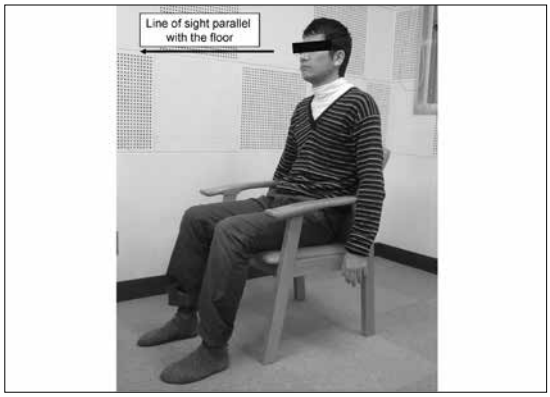


Figure 3 Setting a marker

Figure 4 Relaxation of the trunk

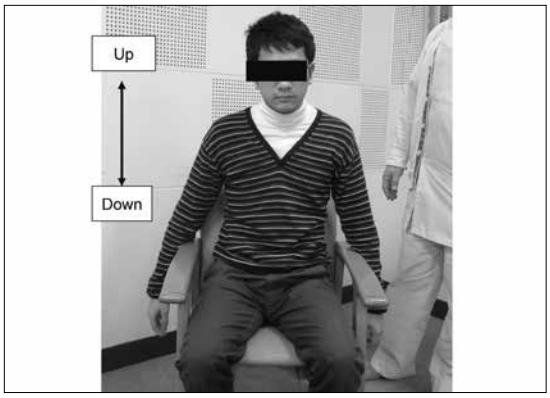


Figure 5. Relaxation of the trunk (moving both shoulders up and down)

Figure 6-1 Posterior flexion of the neck

Figure 6-2 Anterior flexion of the neck

2) Coarse movements of the oral organs

Mandibular opening and closing

Care is taken to ensure that there is no variation in size when the mouth is open, to prevent associated movements (of the neck and head), and that there is never any variation in size or speed during alternate movements (Figure 7). The temporomandibular joint is also touched to confirm its movement. When looking at the strength of mandibular opening and closing, it is also necessary to be aware of locations to be blocked. (Mandibular depression: the back of the head should be blocked as shown in Figure 8-1. Mandibular elevation: the forehead should be blocked as shown in Figure 8-2.) Mandibular opening and closing should be performed as an alternating movement with the same range of motion every day.

Figure 7. Restriction of associated movement

Figure 8-1 Blocking at the back of the head

Figure 8-2 Blocking at the forehead

Lip closure, protrusion, retraction, and rounding

If the mandible opens and closes when lip protrusion and pulling back are performed as alternating movements, patients are asked to bite on a bite block or tongue depressor to stop the mandible from moving. If the neck moves backward and forward, the therapist may instruct the patient verbally or block the movement with his or her hand (Figures 9-1 and 9-2). The patient is also asked to puff out both cheeks. If they are capable of doing this, the therapist gently taps both cheeks with his or her fingers (Figure 10). Patients who are incapable of lip closure, elevation of the back of the tongue, and elevation of the soft palate also have difficulty in puffing out their cheeks. Lip rounding is performed as if whistling or blowing on something hot to cool it.

Sticking the tongue out and pulling it back in, elevating the tip and the back of the

Figure 9-1 Preventing forward movement of the neck

Figure 9-2 Preventing backward ovement of the neck

Figure 10 Checking the maintenance of intraoral pressure

tongue, touching the corners of the mouth on each side with the tip of the tongue

The mouth is held open so that the tongue can be protruded (if the mandible opens and closes in this process, the patient is asked to bite on a bite block or tongue depressor) (Figure 11). Note is taken of the resting state while the tongue is protruded, the shape of the tongue (rolled or flat), and whether when it is pulled back into the mouth it is withdrawn as a whole, without the tip of the tongue being

elevated toward the upper front teeth (Figure 12). If the tip of the tongue is raised, assistance is provided with a tongue depressor. The patient is instructed to move the tip of the tongue to the corners of the mouth on each side while the therapist prevents the associated movement of the neck to the left or right (Figure 13).

Breathing exercises (carried out with the goal of improving expectoration)

Figure 11 Prevention of mandibular opening and closing

Figure 12 Preventing elevation of the tongue

Figure 13 Preventing sideways movement of the neck

Posture retention in the patient is confirmed (posture is arranged so that there is no compression of the abdomen or chest). They are instructed to breathe in through the nose and out through the mouth, and if assistance is required then this must be provided in time with the patient's rhythm of breathing (Figure 14).

Hard blowing, soft blowing, and other patterns are used for exhalation, with the patient attempting to vary both the intensity and length. Tissues, a party horn, or a tube may be used as convenient methods of feedback (Figure 15). The goal is to enable patients to clear their throat voluntarily so that they become able to expectorate saliva or phlegm out of their mouths.

Figure 14 Assistance with breathing

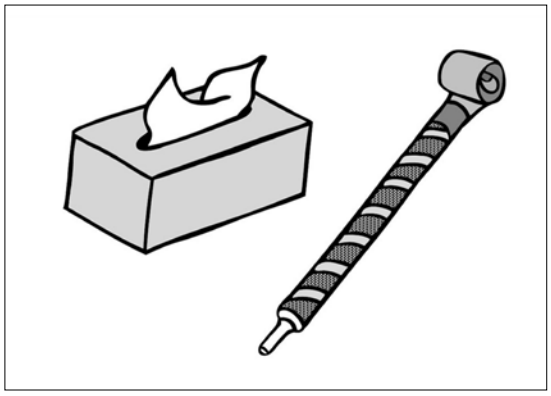


Figure 15 Some feedback techniques

Vocalization exercises

Patients are asked to read out loud and repeat meaningless words by using labial consonants (p and b), alveolar consonants (t and d), and palatal consonants (k and g) (e.g., paapaapa, taataata, kaakaaka, or baataaka) (Figure 16). This has the goal of enabling closure and opening of the lips and the smooth movement of the entire tongue. In this exercise, the therapist watches out for the omission or distortion of consonants.

Meaningless words	Consonant P−T−K	
PA−TA−KA	TA−KA−PA	KA−PA−TA
PA−TA−KE	TA−KA−PE	KA−PA−TE
PA−TA−KO	TA−KA−PO	KA−PA−TO
PA−TE−KA	TA−KE−PA	KA−PE−TA
PA−TE−KE	TA−KE−PE	KA−PE−TE
PA−TE−KO	TA−KE−PO	KA−PE−TO
PA−TO−KA	TA−KO−PA	KA−PO−TA
PA−TO−KE	TA−KO−PE	KA−PO−TE
PA−TO−KO	TA−KO−PO	KA−PO−TO
PE−TA−KA	TE−KA−PA	KE−PA−TA
PE−TA−KE	TE−KA−PE	KE−PA−TE
PE−TA−KO	TE−KA−PO	KE−PA−TO
PE−TE−KA	TE−KE−PA	KE−PE−TA
PE−TE−KE	TE−KE−PE	KE−PE−TE
PE−TE−KO	TE−KE−PO	KE−PE−TO
PE−TO−KA	TE−KO−PA	KE−PO−TA
PE−TO−KE	TE−KO−PE	KE−PO−TE
PE−TO−KO	TE−KO−PO	KE−PO−TO
PO−TA−KA	TO−KA−PA	KO−PA−TA
PO−TA−KE	TO−KA−PE	KO−PA−TE
PO−TA−KO	TO−KA−PO	KO−PA−TO
PO−TE−KA	TO−KE−PA	KO−PE−TA
PO−TE−KE	TO−KE−PE	KO−PE−TE
PO−TE−KO	TO−KE−PO	KO−PE−TO
PO−TO−KA	TO−KO−PA	KO−PO−TA
PO−TO−KE	TO−KO−PE	KO−PO−TE

Figure 16

The rehabilitation menu shown in Figure 17 can be used to create a task sheet that is given to patients to use in their own rooms, once a shared understanding has been reached with the therapist in the training room or on the ward.

Use of devices such as a mirror or a metronome as a feedback mechanism for coarse movements is required during indirect exercises. One point to note is that rather than being concerned with range of motion and speed, the emphasis should be on accuracy.

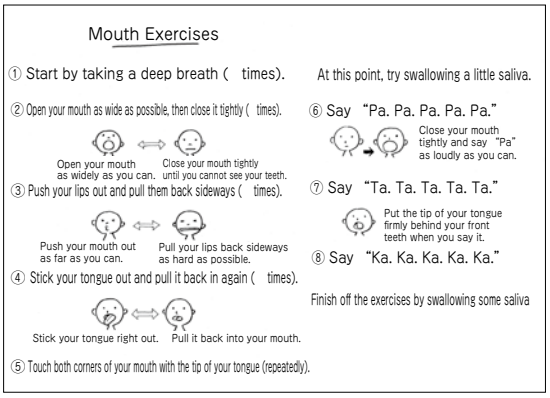


Figure 17 Coarse movements of the oral organs

Other techniques

Ice massage (Figure 18)

The trigger site for the swallowing reflex is stimulated with cold, eliciting the swallowing reflex. The cotton ball part of a frozen cotton bud is commonly used, and care is required to ensure that the thawed water does not fall into the pharynx.

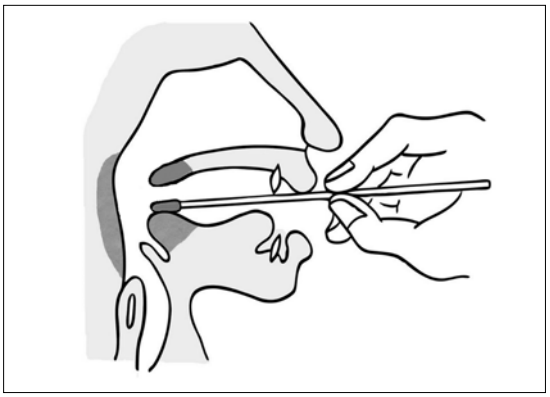


Figure 18 Ice massage

Mendelsohn maneuver (Figure 19)

This exercise uses the swallowing of saliva with the aim of improving laryngeal elevation, resulting in the expansion of the esophageal entrance. The larynx is kept elevated with assistance for several seconds after having swallowed. Great care is required in the distribution of force by the therapist when assisting with raising

the larynx. Although patients are instructed to during laryngeal elevation, patients are simultaneously instructed to hold their breath; however, many patients are able to cope with breathing, and it may be necessary to adapt the type of guidance offered.

Figure 19 The Mendelsohn maneuver

Oral care (Figure 20)

The mouth is home to numerous different strains of bacteria, and oral care is thus an essential treatment for patients. Those with silent aspiration in particular may require multiple sessions. Collaboration with nurses is indispensable as part of a team approach.

Figure 20 Oral care

2. Direct Exercises

Use of jelly and other thickening agents

Whether patients are capable of eating by themselves or whether they require assistance (including whether they can use self-help devices) must be determined. A single mouthful contains approximately 3–5 ml. Guidance is provided by talking to patients about matters such as pacing (if a rapid method of ingestion is used).

The therapist should ideally provide assistance soon after the start of oral intake

training. After several swallows and voluntary throat clearing, the patient is encouraged to vocalize to confirm voice quality. The presence or absence of wet hoarseness is evaluated on an aural scale. The total amount ingested should be determined in accordance with swallowing function, and gradually increased. When thickening agents are used, the amount used should also be adjusted gradually in accordance with the swallowing function (Figure 21). Care must also be taken to ensure that the jaw does not rise during ingestion. The patient's line of sight must be parallel to the floor (Figure 22). After oral intake training, if necessary, aspiration should be carried out as required and the performance of oral care is essential. Aspiration is performed after oral intake, and the use of red food coloring as the assessment criterion for aspiration is recommended. Patients who have been fitted with a cannula should begin by focusing on indirect exercises with the aim of weight reduction, although this depends on the type of cannula. Particular care is required when dealing with patients fitted with a cuffed cannula.

The teeth play an important role in mastication. Patients with few remaining teeth, thus affecting mastication, should be encouraged to wear dentures.

When increasing the thickness of food as the patient improves, pharyngo-esophagography is carried out and the matter must be considered by a team including the attending physician, ENT physicians, nurses, radiologists, and dieticians.

Once food can be ingested, the therapist should sit with the patient during one meal every day to watch how the patient eats, and offer advice and instruction. It is helpful to have a notepad on the table on which to write down important points.

When a patient is eating a meal together with several other patients, care must also be taken with respect to the patient's position at the table and to self-help devices. The goal is to prevent the patient from being drawn into the eating pace of the others.

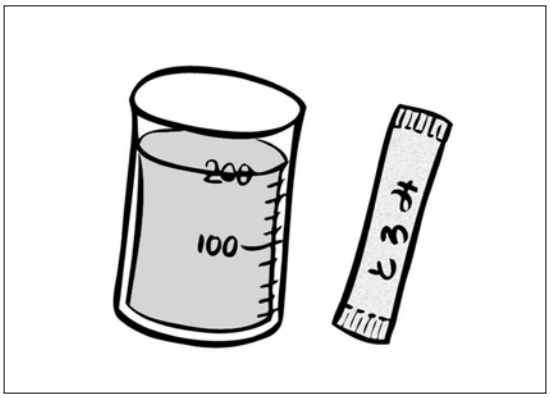


Figure 21 Thickening agent


Figure 22 Consideration of line of sight

3. Points to Note for Functional Exercises at the Bedside

When exercises are carried out on the ward, care should be taken to draw the curtains and to talk in a low voice to avoid the conversation being overheard by other patients in the same ward.

If possible, the patient should sit on the side of the bed (with both feet planted on the floor); however, if an adjustable backrest is required, the angle must be adjusted to suit the patient's condition and prevent the trunk from tilting sideways. Of course, to prevent the patient's upper body from slipping down, the knees must be propped up at an angle and measures should be taken to prevent the body from sliding toward the bottom of the bed (Figure 23). Propping up of the neck alone must be avoided, by using a towel or cushion to create an angle from the base of the shoulder blades. This is because if the neck is propped up by itself, it bends forward, restricting the range of motion of the mandible (Figure 23).

The primary consideration when carrying out both indirect and direct exercises is whether or not the patient can adopt a comfortable posture.

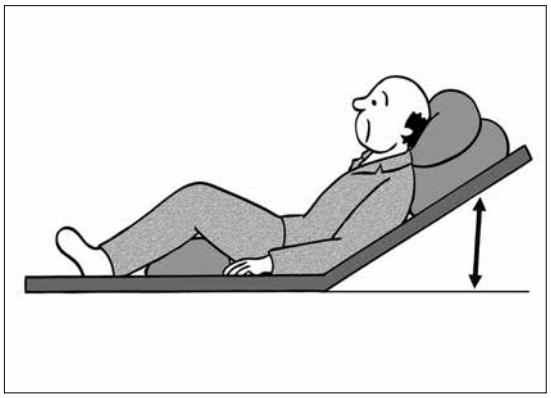


Figure 23 Arrangement of bed angle

References

1. Osamu O et al. Clinical management of dysphagia: The theory and practice of rehabilitation. 5th edition. Tokyo Ishiyaku Publishers, Inc. Tokyo, 2002. [In Japanese]
2. Murray J. Manual of eating disorder and dysphagia assessment: from medical interview to proposing an exercise plan [Japanese translation of "Manual of Dysphagia Assessment in Adults"]. 1st edition. Tokyo Ishiyaku Publishers Inc. Tokyo, 2001. [In Japanese]
3. Hirose H et al. The study of motor speech disorders for speech therapists. 2nd edition. Tokyo Ishiyaku Publishers Inc. Tokyo, 2001. [In Japanese]
4. Tetsuji Y. Dysphagia Q&A. 4th edition. Iyaku (Medicine and Drug) Journal Co., Ltd. Osaka 2008. [In Japanese]

Chapter 4.
Diets for Patients with Eating Disorder and Dysphagia

1. Introduction

What type of diet is suitable for patients with eating disorder and dysphagia?

Ideally, it should be tasty, safe, nutritionally balanced, enjoyable to eat, and differ as little as possible from the regular menu; however, it must also be able to compensate for problems with mastication and food bolus formation and minimize the risk of pharyngeal retention and aspiration. To improve or maintain dysphagia, an individually tailored approach is required. Eating is one of the greatest pleasures in life, and it is important to consider both palatability and individual preferences when endeavoring to improve patients' quality of life (QOL).

In practice, patients are assessed by means of physical signs and videofluoroscopy of swallowing (VF), and their body position and posture and the texture of their food are confirmed.

2. Conditions for Dysphagia Diets

Dysphagia diets have three main conditions:

- ○ Physical nature
- ○ Nutritional content (foods to improve or maintain nutritional status)
- ○ Palatability (foods that can be eaten with enjoyment)

Even if a food poses no physical problems, it cannot be used for training if it tastes bad. Foods that taste good but which are physically unsuitable for a particular patient are dangerous. Maintaining or improving patients' nutritional status through food is also important.

1) Physical nature

The physical nature of a foodstuff must be assessed comprehensively not only in terms of its hardness but also considering matters such as its adhesiveness, cohesiveness, and viscosity.

(1) Cohesive foods to compensate for difficulties in chewing or bolus formation.
Foods that break up are more likely to be retained in the mouth or pharynx, resulting in aspiration. (Cohesiveness)

(2) Fluids with the appropriate degree of viscosity rather than thin liquids. Foods that are too viscous, however, are not suitable as they may be retained in the mouth or pharynx. (Viscosity)

(3) Foods that form boluses that easily change shape, so they can pass through the narrow pharyngeal space without being retained. (Fluidity)

(4) Foods with a definite taste or aroma are preferable.
Water is added when foods are processed in a blender, and this may dilute their taste. Flavored sauces or other condiments may be added.

(5) Foods of a uniform density.

Chunky soups, rice porridge and other lumpy foods, or foods that contain a mixture of liquids and solids are not suitable, and caution is therefore required.

(6) Foods that are either cold or hot.

Items that are the same temperature as the skin are difficult to perceive when placed in the mouth, making it less likely that the swallowing reflex will occur.

Gelatin jelly (1.6% gelatin concentration, made from 80 g juice and 1.3 g gelatin) is the best-known food that meets all seven of these conditions. The surface of gelatin melts to form a sol at 18°C (the temperature inside the mouth), meaning that it flows while the interior remains as a gel and changes shape. Because the surface melts slightly and becomes covered in liquid, it is able to flow smoothly through the narrow pharynx. This phenomenon is seen in gelatin because at the structural level, its surface possesses hydrophilic groups while its interior possesses hydrophobic groups. The affinity between the oral and pharyngeal mucosa and food is important, and the characteristics of gelatin can be utilized effectively in this area.

Other similar ingredients include agar* and starch; however, although they do form food boluses, the physical properties of these materials still pose problems. Agar breaks up inside the mouth when chewed, meaning it is susceptible to aspiration and thus unsuitable for a dysphagia diet. Starch (as potato starch, cornstarch, or other forms) becomes more easily adsorbed and viscous as it cools. The longer the time taken to eat a meal, the colder it becomes and the more likely it is to stick to the pharynx; therefore, caution is required.

*The raw ingredient for agar is a complex polysaccharide obtained from Gelidium divaricatum and other types of red algae. It is a gel that dissolves when heated and solidifies when cooled. It is also used as a coagulating agent in culture medium.

2) Nutritional conditions

As dysphagia becomes more severe, eating takes more time and the number of foods that can easily be eaten becomes limited. Anorexia or choking may cause the amount of food intake to diminish, and this entails the risk of the development of malnutrition or dehydration due to insufficient fluid intake. It also causes a decline in the immune function and activities of daily living (ADL), leading to fears that disuse-induced functional decline may develop in terms of becoming bedridden or a diminished sphere of action. For elderly people in particular, reduced salivary secretion, periodontal disease or badly fitting dentures, and the effect of sleeping medication or antidepressants may be important factors in reducing food intake.

Depending on the severity of the disorder, tube feeding may also be used in addition to oral intake. If sufficient nutrition cannot be ensured by means of oral intake alone, it is important to carry out swallowing training while tube feeding is being used. The basic philosophy must be that oral intake is fundamental to the ingestion of food.

In light of these points, to ensure good nutritional status and improve QOL, nutritional supplementation and instruction are carried out specific to individual

circumstances while the status of food ingestion is monitored.

3) Palatability

Aspects of food related to whetting the appetite include patient preferences, appearance (presentation), aroma, temperature, and taste. Aroma, in particular, is said to account for 60% of palatability. The reaction of the cerebellum to the sight of something good to eat (induction of the desire to eat the food) acts on the various organs involved in swallowing, promoting the secretion of saliva and making the swallowing reflex more likely to occur.

In terms of temperature, a 20°C difference with the body temperature is ideal, with hot food ideally served at >60°C and cold food at <15°C.

3. Food Textures for Different Levels of Eating Disorder and Dysphagia

It is common for patients to present multiple conditions simultaneously, and the optimum food texture for patients must therefore be considered on an individual basis. Ideally, the results of VF and other tests should be taken into account when adapting a diet for a patient.

Process followed by a food bolus during ingestion and swallowing (five stages)

- ○ Recognition of food (anticipatory stage/recognition stage)
- ○ Mastication and bolus formation (preparatory stage/oral preparatory stage)
- ○ Bolus propulsion to the pharynx (oral stage)
- ○ Pharyngeal transit and passage of the bolus into the esophagus (pharyngeal stage)
- ○ Esophageal transit (esophageal stage)

1) Anticipatory stage (visiospatial agnosia, cognitive impairment, attention disorder)

Before the food enters the mouth, a process occurs that consists of becoming aware ofappetite, recognizing food, focusing attention, and actually transporting the food to the mouth.

Three levels of neural activity are involved in the anticipatory stage: appetite, arousal, and recognition. Impairment of the anticipatory stage may be affected by attention disorder and restlessness due to conditions such as dementia, impairment of consciousness, and depression, and in many cases the primary pathological state is loss of appetite or anorexia.[1)]

These are handled by offering the patient's favorite foods in an atmosphere as close to that of a family dinner as possible, to create a dietary environment in which the patient can be mentally relaxed. In this case, rather than physical properties, the emphasis is on providing meals that the patient enjoys eating to enable smooth swallowing.

The senses of taste and smell diminish with increasing age, and this can be combated by means of using food enhancements such as strong seasonings.

The method of providing food and food texture are decided with reference to the

following items. (1) Does the patient have a desire to eat, and are they aware of the food? (2) Do they maintain a seated posture while eating, and can they adjust their posture themselves? (3) Are they able to use eating utensils to feed themselves? Consideration must be given to the arrangements of utensils and dishes that can be used.

2) Preparatory stage (imperfect lip closure, poor bolus formation, early pharyngeal entry)

This stage, also called the oral preparatory stage, covers the period during which the food is carried into the mouth, until the completion of mastication and bolus formation. Trismus or masticatory disturbance, the teeth, salivary secretion, or tongue movement will prevent this process from working properly.2) Tongue movement is particularly important, as it is the tongue that is responsible for placing and retaining food over the molars, collecting the chewed food in the center of the tongue and forming it into a bolus, and preventing it from spilling into the pharynx during mastication. Hard substances are chewed and formed into a bolus by a mixture of tongue movements and viscous saliva. A decline in the capacity for mastication and bolus formation leads to food of a dangerous texture entering the pharynx, which may result in aspiration.

Any disturbance in oral function prolongs the time required for mastication, and food can be observed to fall out of the mouth or build up inside it.

Soft jelly that can be swallowed whole is suitable for compensating for a decline in mastication and bolus formation. It is important that the jelly is strongly flavored to stimulate the sensory organs inside the mouth, increasing the amount of saliva and making bolus formation easier. If masticatory capability is reduced, food that can easily be chewed with little muscular effort should be used, and its hardness increased in stages. In the case of trismus, an effective method is to slide thin slices of gelatin jelly into the mouth.

3) Oral stage (impaired propulsion)

In this stage, the bolus gathered in the center of the tongue is propelled into the pharynx. If the tongue and palate are not in close concert, or if paralysis or atrophy of the tongue is present, the bolus will not be properly transported from the mouth to the pharynx. The backrest should be adjusted so that the patient is eating at an angle of 30°–45°.

Similarly to disturbances of the preparatory phase, food should be textured to help enable the formation of boluses that are easily transportable to the larynx; a sticky texture is difficult to propel through the pharynx and should be avoided. If the flow speed of the bolus is too fast, the bolus may enter the pharynx before the swallowing reflex is triggered; therefore, slow-flowing sols must be used to avoid aspiration. Gelatin jelly liquefies and may be aspirated if too long a time is required for transport, and caution is therefore required. One possible technique is to use commercially available jellies that are resistant to liquefaction.

4) Pharyngeal stage (delayed triggering or decrease of the swallowing reflex,

incomplete laryngeal elevation, pharyngeal retention, imperfect closure of the glottis)

Actual swallowing occurs at the moment when the bolus is transported from the pharynx into the esophagus, and any disturbance at this point carries the risk of aspiration.

If the pharyngeal reflex is slow, it is important that foods slip through slowly without being too sticky. Soft gelatin jelly (1.6%–1.8% concentration) is suitable as it holds together and flows slowly during its transit through the pharynx. A homogeneous bolus is less likely to leave food residue in the pharynx.

5) Esophageal stage (gastroesophageal reflux, poor esophageal peristalsis)

In this stage, the bolus is transported into the stomach by esophageal peristalsis. The most common occurrences at this point are impaired transit and reflux. For impaired transit, soft, easily deformable foods should be chosen, and one effective method is to arrange meal times so that patients consume solids and soups alternately. In the case of reflux, care should be taken to avoid foods that decrease sphincter pressure (those containing large amounts of fat, chocolate, and alcohol), as well as coffee and tea, which promote gastric acid secretion.

4. Graded Food Textures and Their Use in Oral Intake

1) The dysphagia diet pyramid

Kanaya et al. have proposed this pyramid as a tool for gradually moving up the levels of the dysphagia diet. The different food textures and methods of proceeding with swallowing exercises for the different levels of swallowing function are indicated in terms of their degree of difficulty for ease of understanding, with six categories ranging from regular food to a dysphagia diet. The foods and dishes become progressively difficult to eat from Level 0 to Level 5. (Level 5 is nomal foofs) Depending on the type of disorder, patients may progress in either direction, from easy to difficult or the other way around.

Criteria of the dysphagia diet pyramid

Level	Severity	Texture	Other
Level 0 (initial diet)	Severe	Food that is carried smoothly through the pharynx by its weight when fed in slices (absolutely no texture or adhesiveness). Gelatin 1.6% (concentration), jelly.	Grape jelly, orange jelly
Level 1 (dysphagia diet I)	Moderate	The initial diet of jelly plus soup, juice, rice water, or similar solidified with gelatin, which is not sticky or textured when sliced and does not tend to stick to the mucosa. Gelatin 1.6% (concentration), jelly.	Pudding, salmon mousse
Level 2 (dysphagia diet II)	Moderate	The initial diet of jelly plus soup, juice, rice water, or similar solidified with gelatin, which may somewhat stickier or more textured when sliced than the foods in Level 1. Gelatin 1.6% (concentration), jelly plus fish, shellfish, and meat.	Foie gras, mousse
Level 3 (dysphagia diet III)	Mild	The foods in L2 plus foods with the texture of purée that do not break up when pressed with the tongue. Fluids are thickened. Starch, thickening agents.	Egg dishes
Level 4 (transitional diet)	Mainly masticatory impairment	Foods with a high liquid content, soft steamed foods, foods that are not cut too finely, and non-dry foods. Thicken fluids if necessary.	Soft steamed pumpkin

The Japanese Society of Dysphagia Rehabilitation has also published a Classification of Modified Diet for Dysphagic Persons in 2013, for use in settings including hospitals, institutions, and at-home medical care (Figure 1). This comprises a graded classification of foods (modified diet for dysphagic persons) and thickness.

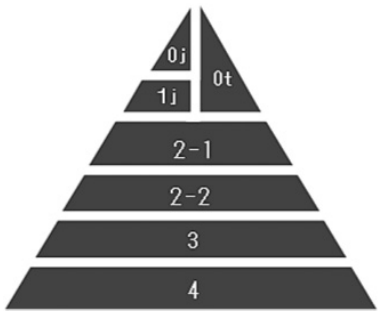


Figure1 Classification of Modified Diet for Dysphagic Persons 2013 in the Japanese Society of Dysphagia Rehabilitation
Source: Task Force of Modified Diet for Dysphagic Persons in the Japanese Society of Dysphagia Rehabilitation, 2013

Quick summary chart (food) of the Modified Diet for Dysphagic Persons 2013 in the Japanese Society of Dysphagia Rehabilitation (Partially revised)

Code		Name	Texture	Aim/features	Example foods	Masticatory ability required
0	j	Swallowing training foods 0j	Homogeneous jelly, taking account of adhesiveness, cohesiveness, and hardness. Little water separation, can be scooped up when sliced.	Assessment and training in severe cases. Small amounts can be scooped up and swallowed whole. Easily aspirated if retained. Low protein content.		(Some capacity for transport)
	t	Swallowing training foods 0t	Homogeneous thickened fluids, taking account of adhesiveness, cohesiveness, and hardness. (In principle, either moderately thick or extremely thick fluids are suitable)	Assessment and training in severe cases. Presumed to be drunk in small sips. Used if aspiration occurs when jelly is swallowed whole, or if jelly dissolves in the mouth Low protein content.		(Some capacity for transport)
1	j	Modified dysphagia diet 1 j	Homogeneous jelly, pudding, or mousse consistency, taking account of adhesiveness, cohesiveness, hardness, and water separation.	Already has the right bolus consistency outside the mouth (small amounts can be scooped up and swallowed whole). During transport, the tongue must be pressed against the palate with a certain degree of awareness. More surface texture than 0j.	Processed in a blender. Rice gruel jelly, etc.	(Some capacity for bolus retention and transport)
2	1	Modified dysphagia diet 2-1	Homogeneous, smooth purée, paste, or food processed in a blender that is not sticky and holds together well. Can be scooped up and eaten with a spoon.	Easily made into a bolus through simple oral manipulation (not susceptible to pharyngeal retention or aspiration).	Rice water or gruel the consistency of paste that contains no lumps and is of low adhesiveness.	(Capacity for bolus formation and retention by means of mandibular and tongue movements)
	2	Modified dysphagia diet 2-2	Smooth purée, paste, or food processed in a blender, including nonhomogeneous food, that is not sticky and holds together well. Can be scooped up and eaten with a spoon.		Gruels that may be somewhat inhomogeneous (lumpy), but which are still soft, with little water separation, and of low adhesiveness.	(Capacity for bolus formation and retention by means of mandibular and tongue movements)
3	Modified dysphagia diet 3		Foods that keep their shape but are easily crushed, formed into a bolus, and transported, which do not come apart in the pharynx, and are easily swallowed. No great water separation.	Can be crushed between the tongue and the palate. Requires oral manipulation during crushing and transport (or activates these functions), and mitigates the risk of aspiration.	Rice gruel or similar, taking account of water separation.	At least the capacity to crush food between the tongue and palate.
4	Modified dysphagia diet 4		Foods that are not hard, do not come apart easily, and do not easily stick to the mouth. Soft enough to be broken up with chopsticks or a spoon.	Ingredients and cooking methods selected to take account of the risk of aspiration and suffocation. Can be used for patients with no teeth, but in this case they must be crushed using the upper and lower alveolar ridges or mashed, as they are difficult to crush between the tongue and palate.	Soft rice, thick rice gruel, etc.	At least the capacity to crush food between the upper and lower alveolar ridges.

Source: Task Force of Modified Diet for Dysphagic Persons in the Japanese Society of Dysphagia Rehabilitation, 2013

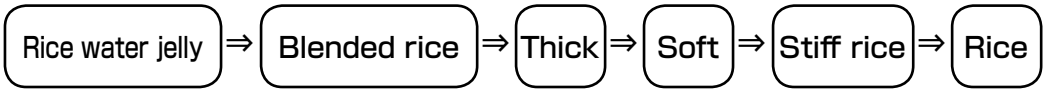
2) Grades of ease of swallowing

Although this is a generally used scale, it is not necessarily followed in this order.

(1) Staple foods

A high water content results in rapid flow into the pharynx, and the liquid in thin rice gruel may be aspirated, meaning that it may be necessary to add a thickening agent. Should a patient find that the grains of rice in rice gruel remain in the mouth and cannot swallow processing the gruel in a blender to make it smoother may make it easier to swallow.

As rice gruel cools over time, it acquires a starch-like viscosity. Water may also separate out, and care is therefore required.

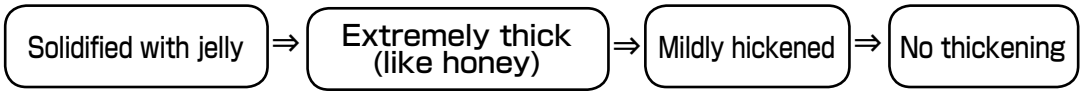


(2) Side dishes

Vegetables become softer the longer they are cooked. Vegetables other than tomatoes are hard to eat, so the focus should be on cooked or grated vegetables. Potatoes and yams easily cause choking if their water content is low, and a large volume of fluid should therefore be added.

(3) Liquids

As liquids flow rapidly, they entail a high risk of aspiration, particularly in patients with a delayed swallowing reflex. Thickeners are used to reduce the speed of flow.



5. Choice of Ingredients and Cooking Methods

1) Inappropriate ingredients (ingredients that are difficult to eat)

(1) Foods that do not soften even when cooked

Ham, mushrooms, shellfish, etc. If cooked and finely chopped, they break up and do not hold together well in the mouth.

(2) Hard foods

Nuts, sesame, dried shrimp, etc. These ingredients themselves are hard and simply break up when chewed and are easily aspirated.

(3) Thin foods

Foods that are shaped like thin sheets are prone to stick to the soft palate. Thin foods are also difficult to perceive in the mouth.

(4) High-fiber foods

Bamboo shoots, root vegetables, green vegetables, fish dishes, and other foods that are high in fiber cannot easily be bitten into pieces, and are prone to remain in the mouth.

(5) Dry foods

Bread, steamed potatoes, hard-boiled eggs, and other foods with a low water content become more viscous and harder when mixed with saliva.

(6) Sour foods

Vinegar is inherently easy to choke on. Citrus fruits and other sour foods are also prone to cause choking.

(7) Foods consisting of small pieces that do not hold together well

Minced meat cooked to dryness does not hold together in the mouth and is easily retained in the pharynx.

2) Ingredients prone to aspiration

Thin liquids (watery fluids)	Tea, miso soup, juice
Foods that break into pieces in the mouth and do not hold together well (hard foods and those with a high fiber content)	Squid, octopus, bamboo shoots, millet, etc.
Ingredients with a low water content	Bread, sponge cake, potatoes, hard-boiled eggs
Foods that easily adhere to the inside of the mouth or pharynx	Green vegetables, wafers, etc.
Very sticky foods	*Mochi* (rice cakes), *dango* (rice dumplings)
Very sour foods that easily induce choking	Pickles, citrus fruits, etc.
Nuts and seeds that easily become stuck in the larynx	Peanuts, soy beans, sesame

3) Points for cooking (cooking adaptations)

Many ingredients that are hard when raw become softer after cooking. They should be cut up across the grain, and cooked until they are sufficiently soft. Dry ingredients can have liquid or fat added to make them softer and smoother. Potatoes and eggs may have a binder added to soften them and make them hold together more easily. The savory taste of protein foods is drawn out when they are cooked at a low temperature for a long time, and this method also enables them to be cooked without excessive loss of water content.

(1) Cook food: Raw vegetables are difficult to eat, and thus should be cooked. Salads should consist of steamed or dressed dishes.

(2) Add liquid: A too low water content makes food difficult to swallow, but when too high, it can cause choking. The right amount of liquid should be added in preparing food so that it is soft and easily taken in. Liquid should be added to chopped boiled green vegetables, and they should be boiled until soft.

For example, bread can be made into French toast, and steamed fish substituted for grilled fish.

(3) Add a binder: Make mince into meatballs (with added egg) or hamburgers.

(4) Ways of cutting food: If the first one or two bites are difficult, rather than chopping food up finely, score it or make cuts at narrow intervals most of the way through. Thin foods are difficult to perceive in the mouth, so it is better to cut food to a thickness of 5–10 mm and cook it until soft. Check the direction in which the fibers run and cut them up across the grain, as this makes the cooked food easier to chew.

(5) Add fat: Adding fat (salad oil, mayonnaise, butter, cream, etc.) to food makes it smoother and easier to swallow. Generally speaking, fish or meat with a high fat content does not harden after cooking, and is easy to eat.

For example, mashed potatoes or sweet potato cakes should be served rather than steamed potatoes.

(6) Thicken: Thin liquids are the type that most easily causes choking. They should be thickened with potato starch or a commercially available thickening agent to make them easier to drink without choking. Creamy soups and other inherently thickened dishes are easy to swallow.

(7) Temperature

The temperature of food should be around 20°C above or below body temperature. This difference between body temperature and food temperature provides a stronger stimulus that is more likely to trigger the swallowing reflex. This reflex is most likely to be triggered when the pharyngeal mucosa are touched by something slightly cold. A temperature of around 10°C–15°C also feels pleasant in the mouth, thus promoting ease of eating.

4) Cooking utensils

A food processor and a blender are essential for the preparation of a dysphagia diet. The type of device used is determined by the type of ingredient and its quantity.

A food processor is frequently used for chopping and other basic preparation. It may be used to grind ingredients with a low water content, or when preparing foods of a paste consistency. A blender is used to blend ingredients or foods with a high water content. A hand blender is a useful household implement for blending small amounts. It can also be used as a food processor by removing the blade and fitting it to the container that comes as part of the set.

Figure 2 Food processor and blender

Figure 3 Handheld blender

5) Use of thickeners (thickening agents)

Thickeners are agents that can be added to foods that are difficult to swallow to thicken them, irrespective of the temperature. They can be broadly divided into three types in terms of the raw ingredients used: starch, guar gum, and xanthan gum.

Type	Characteristics
Starch	A large amount must be added. Thickens immediately. Provides stable viscosity irrespective of the type of food or drink. Uses: Good for making molded dishes such as blended foods or mousses.
Guar gum	Only a small amount is needed for thickening, but it takes time for stable viscosity to be obtained. Changes the smell of food (to the smell of guar gum). One feature is that it also thickens milk. Uses: Good for thickening soups and adding to blended foods and purées to make molded dishes.
Xanthan gum	Highly transparent, colorless and odorless, and of low adhesiveness. Suitable for thickening clear liquids and the like. It is not good for thickening milk or high-density liquid diets, although it has recently been improved. It is currently the most popular thickening agent. Uses: Ideal for thickening to a low viscosity.

In terms of points during use, the liquid may become lumpy if it is stirred too slowly or if more thickener is added once it has started to thicken. When adding more thickener, lumps can be avoided by making a fresh solution. It takes approximately 5–15 min for its physical properties to stabilize.

The Japanese Society of Dysphagia Rehabilitation has produced a graded

classification of thickness to go with its classification of modified dysphagia diets. The consistency is determined in accordance with the level of dysphagia of the concerned patient.

Japanese Society of Dysphagia Rehabilitation 2013 quick summary chart (thickness)

	Grade 1	Grade 2	Grade 3
English description	Mildly thick	Moderately thick	Extremely thick
Description of consistency (when drunk)	A thin enough consistency that "drink" is the appropriate term for its consumption. Liquids that spread out as they enter the mouth. Depending on their taste and temperature, the fact that they have been thickened may not be noticeable. Do not require much effort to swallow. Can easily be sucked up through a straw.	A clearly thick consistency that is appropriately described as "drunk". Has slow dynamics in the mouth and does not spread out immediately Easily holds together on the tongue. Resistant to being sucked up through a straw.	A thick consistency that holds together well and requires effort for its transfer, that is appropriately described as "eaten". Cannot be sucked up through a straw.
Description of nature (visual appearance)	Runs straight off a tilted spoon. Runs out immediately from between the tines of a fork. After it has been poured out of a cup, only a faint residue remains.	Runs slowly off a tilted spoon. Runs out slowly from between the tines of a fork. After it has been poured out of a cup, the inside of the cup remains covered with a thick coating.	Keeps its shape to some extent and tends not to run off a tilted spoon. Does not run out from between the tines of a fork. Cannot be poured out of a cup (drops out slowly as lumps).

Source: Task Force of Modified Diet for Dysphagic Persons in the Japanese Society of Dysphagia Rehabilitation, 2013

6. Characteristics, Types, and Methods of Use of Gelling Agents

Gelling agents have the property of solidifying liquid components, and are used in foods such as jellies and puddings. A small amount can solidify liquids, and their hardness can be adjusted by varying the amount used. Gelling agents include agar (Gelidium divaricatum), gelatin (derived from animal skin and bones), carrageenan, and pectin. These all have different properties, and are used for different purposes. In recent

years, gelling agents for making warm jellies have also come onto the market.

1) Agar

Agar coagulates at a temperature of 30°C–40°C and melts at 70°C–85°C. It thus solidifies at room temperature. It is characterized by high cohesiveness and a tendency for water to separate out; it does not dissolve in the mouth; and when it is crushed, it does not change shape while passing through the pharynx, which means caution is required. When making agar jelly, the agar is boiled to dissolve it.

2) Gelatin

Gelatin melts at 20°C–30°C. It melts at the temperature of the inside of the mouth. Moreover, as it retains water well, it has a pleasant texture when eaten. Temperature management must be taken into account because gelatin melts at room temperature. The appropriate concentration of gelatin jelly for use at the start of swallowing training is 1.6% (5 g of gelatin per 300 ml of liquid). The jelly should be soft enough to wobble when shaken. The normal gelling agent concentration is 1.5%–3.0%.

3) Carrageenan

Carrageenan is a gelling agent derived from red algae (*Gigartina tenella, Chondrus crispus*). Its physical properties are similar to those of gelatin and agar: it solidifies at room temperature, and is stable enough not to leak out. As it is tasteless and odorless, it has no effect on the flavor of other ingredients, and is extremely soft and slightly elastic.

4) Pectin

Pectin is a polysaccharide found in citrus fruits and apple skin that can be extracted in water. It gels when heated at a sugar concentration of at least 60% and pH around 3. It is used for gelling jams, jellies, yogurt, and other foods.

7. Food Standards (the dysphagia diet classification used by the Hospital of National Rehabilitation Center for Persons with Disabilities)

The dysphagia diet classification used by the National Rehabilitation Center for Persons with Disabilities includes three grades of dysphagia diet.

During VF, barium-containing jelly of four grades of hardness is used. This may be regarded as a mock food, and the classification of this jelly corresponds to the food classification and provides a guide when deciding on the food texture to use.

Category	Jelly diet I (soft)	Jelly diet II (hard)	Dysphagia I	Dysphagia II	Dysphagia III	Safe diet
Food texture	Jelly. No need for mastication or bolus formation, can be swallowed smoothly. Not retained in the larynx or pharynx.	elly, Okunos mousse, etc. No need for mastication or bolus formation, can be swallowed smoothly. Not retained in the larynx or pharynx.	Blended and thickened. Paste consistency. No solids. Soft enough to be crushed by the tongue.	Crushed and thickened soft vegetables. Mashed consistency. Very finely chopped (<3 mm), with some texture, soft enough to be crushed by the gums.	Chopped (<1 cm), no risky ingredients used. Soft enough to be chewed into pieces by the gums.	Around the size of a 500-yen coin, may be thickened. No risky ingredients used.
Staple			Smooth rice gruel	Thick rice gruel	Thick rice gruel/soft rice	Thick rice gruel/soft rice/normal rice
Energy (kcal)	Per meal 20 kcal	Per meal 150 kcal	1200	1400	1500	1600
VF test food	Water, thickened water	Very soft jelly	Soft jelly	Moderately hard jelly	Hard jelly	Cookies

Figure 4 Dysphagia diet I

Figure 5 Dysphagia diet II

Figure 6 Dysphagia diet III

Figure 7 Dysphagia diet III, II, and I (shrimp omelet)

Cited References

1. Kanaya S. Dysphagia diets for home and hospital, Tokyo Ishiyaku Publishers Inc. Tokyo, 2006. p. 73. [In Japanese]
2. Kanaya S. Dysphagia diets for home and hospital, Tokyo Ishiyaku Publishers Inc. Tokyo, 2006. p. 79. [In Japanese]

References

1. Fujitani J.. How to cook dysphagia diets. Japan Medical Planning, 1999. [In Japanese]
2. Kanaya S.Dysphagia diets for home and hospital, Tokyo Ishiyaku Publishers Inc., 2006. [In Japanese]
3. Watanabe S. Diseases of the elderly and nutrition and dietary therapy. Kenpakusha,2009. [In Japanese]
4. Japanese Society of Dysphagia Rehabilitation, ed. Japanese Society of Dysphagia Rehabilitation E-Learning Materials. Area 5. Nutrition for patients with dysphagia. Tokyo Ishiyaku Publishers, Inc., 2011. [In Japanese]
5. Yamori M. Learning dysphagia rehabilitation step by step. Nissoken, 1999. [In Japanese]
6. Fujishima I. Rehabilitation for swallowing disorders associated with stroke. 2nd edition.Tokyo Ishiyaku Publishers Inc., 1999. [In Japanese]
7. Japanese Journal of Clinical Nutrition. Nutritional care in dysphagia. Tokyo Ishiyaku Publishers Inc., 2011-9. [In Japanese]
8. Task Force of Modified Diet for Dysphagic Persons of the Japanese Society of Dysphagia Rehabilitation: The Classification of Modified Diet for Dysphagic Persons in 2013 in the Japanese Society of Dysphagia Rehabilitation.