Chapter

Swallowing Disorders in Patients with Stroke

Aiko Osawa and Shinichiro Maeshima

Abstract

Swallowing disturbance often causes by stroke and may predispose patients to malnutrition and dehydration, as well as increases the risk of such complications as suffocation and aspiration pneumonia. As an initial evaluation, the water swallowing test can be easily carried out, but not all of the aspiration can be excluded. Therefore, videofluorography (VF) and videoendoscopic examination (VE) of swallowing should be performed to find a safety method of oral intake for providing visualization of the pharynx and larynx dysfunction. Clinical severity scale is important because once the severity is determined, the treatment strategy is also known. Swallowing training can be divided into indirect training without food (basic training) and direct training with food (eating training). In general, it is important to select conditions and training diets that are easy to swallow and have a low risk of aspiration while using indirect training and direct training that aim at gradually improving the level of oral intake.

Keywords: stroke, dysphagia, swallowing assessment, pneumonia, videofluorography

1. Introduction

Stroke is a group of diseases associated with sudden disturbance of consciousness and motor or cognitive dysfunctions induced by cerebrovascular disorder. Pathological conditions are roughly classified into three categories according to the causes: stroke occurred due to cerebrovascular occlusion, stroke induced by rupture of small cerebral vessels, and subarachnoid hemorrhage associated with rupture of brain aneurysm, etc. According to the reports of the National Stroke Association, incidence of stroke is one person every 40 s; about 800,000 and 290,000 persons develop stroke every year in the USA [1] and Japan [2], respectively.

Medical management for stroke has changed remarkably in many ways such as rearrangement of emergency medical system, improvement of treatment methods including thrombolytic therapy and endovascular treatment of the brain, formation of medical teams in a stroke unit, and preparation of guidelines for stroke treatment, resulting in improvement of survival rate [3, 4]. More than a half of the survived patients however suffer from disabilities to a certain extent such as motor paralysis, sensory or visual impairment, cognitive disturbances including aphasia and unilateral neglect, and dysphagia, which all affect the patients' activities of daily living.

2. Incidence and features of dysphagia due to stroke

It has been reported that dysphagia is observed in 39–81% of stroke patients during the acute phase [5, 6], and the results obtained from videofluoroscopic examination of swallowing (VF) or videoendoscopic examination of swallowing (VE) may reveal that even more patients are complicated by dysphagia [7]. However, it improves promptly, most of the time, in a few days or few weeks after the onset, and sever disorders may persist until the chronic stage in about 10% of the patients [7–9]. These show how important it is, for management of stroke, to prevent aspiration pneumonia and let patients regain ability to swallow safely during the acute phase.

Pathology of dysphagia varies according to the sites of the central nervous system being affected [7, 10]. The cause of dysphagia after stroke is roughly categorized into two mechanisms: pseudobulbar palsy associated with disturbance of upper motor neurons toward nuclei in the medulla oblongata and bulbar palsy associated with lower motor neurons from nuclei in the medulla oblongata in the brain stem. In patients with pseudobulbar palsy induced by cerebrovascular events in cerebral lesions, symptoms and signs such as delayed swallowing reflex during the pharyngeal phase of swallowing, reduced laryngeal elevation, and residual food in the vallecula or pyriform sinus are observed. While in patients with bulbar palsy induced by brain stem lesions, loss of swallowing reflex and insufficient opening of the esophageal orifice are observed. In either case, patients are often complicated by disturbance of consciousness or cognitive disorder, and swallowing is also affected during the anticipatory, preparatory, and oral phases as described below.

3. Swallowing process model

There are two major systematic models known for normal swallowing dynamics (**Figure 1**). The first one is liquid swallowing model which consists of five phases including the anticipatory phase in addition to four other stages: preparatory, oral,

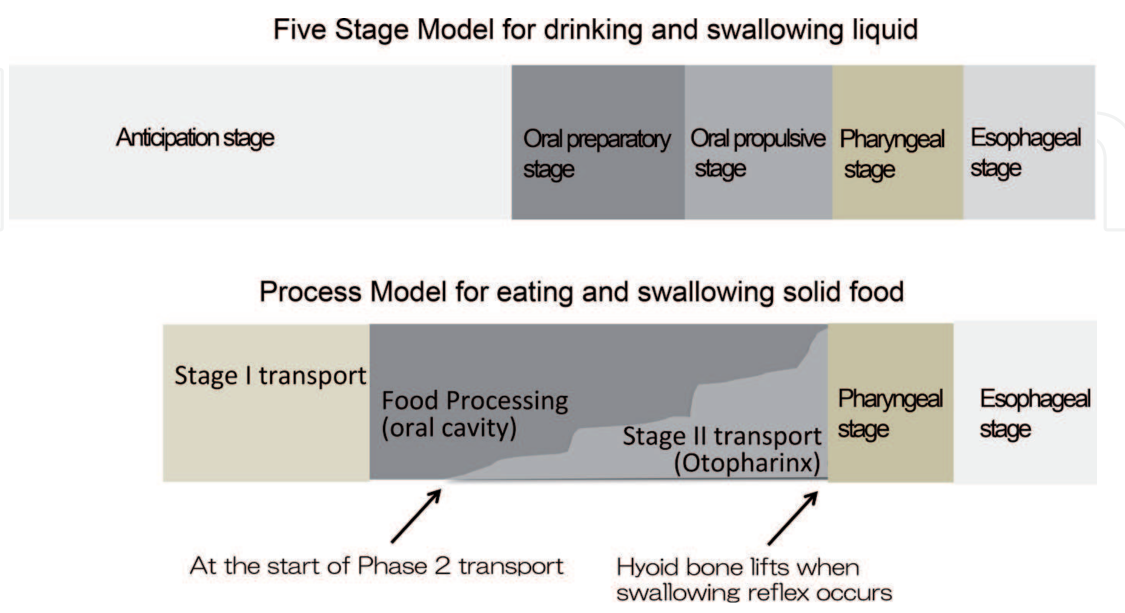

Figure 1.
Five stage and process models for swallowing. Two paradigmatic models are commonly used to describe the physiology of normal eating and swallowing: the five-stage model for drinking and swallowing liquid and the process model for eating and swallowing solid food.

pharyngeal, and esophageal phases [11]. During the anticipatory phase (recognition phase), characteristics of food are recognized, the posture and the way to eat are determined, and saliva secretion is induced. During the preparatory phase, mastication occurs to make the food easy to swallow (into a food bolus). During the oral phase, the food bolus is transferred to the pharynx by the tongue movement. The pharyngeal phase begins when the food bolus formed in the vallecula starts moving downward through the pharyngeal cavity until it reaches the esophageal orifice. This is an involuntary action which occurs unconsciously. Contraction of the suprahyoid muscle and thyrohyoid muscle induces elevation of the hyoid bone and larynx. The epiglottis descends and blocks the laryngeal aperture to prevent aspiration of the food. Along with contraction of the pharyngeal muscles, the food bolus is sent to the esophageal orifice. Once the food bolus enters the esophagus during the esophageal phase, the cricopharyngeus muscle (upper esophageal sphincter) contracts to close the esophageal orifice so that food reflux will not occur.

The second one is a process model which involves mastication [12, 13]. Solid food is transported to a molar region by the tongue (Stage I transport). The food is grounded by mastication and transported actively to the oropharynx with the tongue movement (Stage II transport). Then, a food bolus is formed. Food transport occurs repeatedly even during mastication. The bolus is formed inside the oral cavity if it is command swallow of liquid food. However, if it is chew-swallow of solid food, the bolus is formed in the area between the oropharynx and the vallecula. If the bolus contains liquid, some of it reaches the pyriform sinus before swallowing reflex begins. Thus, it is important to understand that there are two different types of swallowing dynamics before making assessments.

4. Assessment of dysphagia

In assessment of dysphagia, the cause and onset mechanism of the condition should be revealed to understand pathology. The physical findings include observation of the level of consciousness and respiratory conditions. Neurological findings (especially on trigeminal, facial, glossopharyngeal, vagus and hypoglossal nerves), the level of cognitive functions, nutritional state, dehydration status, as well as the current status and past history of pneumonia, should be assessed. In addition, food residues inside the oral cavity, furred tongue, dental caries, characteristics of saliva, denture, and gingivitis should also be examined.

There is a risk of food aspiration whenever food or fluid is put inside the mouth. Therefore, assessment of swallowing functions should be performed if possible before ingesting food. Even if meals have already been started, ask patients and families detailed questions whether or not the patients have symptoms associated with aspiration.

4.1 Interviews and observational assessments

Characteristics of dysphagia are likely to be observed in the activities of daily living. Dysphagia can be suspected by asking simple questions to patients and their families. The question items may be associated with increase of cough and sputum after meals, sputum containing food, change in voice quality after meals, pharyngeal discomfort, decreased appetite, tired feeling during meals, prolongation of meal time (over 45 min), change in the type of meals, and the way to eat, loss of weight, and fever.

4.1.1 Eating assessment tool (EAT-10)

This is a standardized questionnaire form which is easy to use [14]. The assessment using a questionnaire form consists of 10 questions regarding pleasure of eating meals, loss of weight, effort of swallowing, etc. which are evaluated by scores between 0 (no problem) and 4 (serious problem). The maximum score is 40.

4.1.2 Mann assessment of swallowing ability (MASA)

This is a highly reliable and valid assessment performed in stroke patients during the acute phase based on psychostatistic evaluations on consciousness, cooperative actions, auditory comprehension, etc. [15]. It consists of 24 items including alertness, cooperation, auditory comprehension, respiration, dyspraxia, saliva, and tongue movement, and the maximum score is 200. Allocation of scores varies according to the level of importance for each item. The risk for dysphagia or aspiration and the degree of dysphagia are evaluated by the total score to determine the food form to be recommended. No special device is required, and the assessment can be performed within 15–20 min.

4.2 Bedside swallowing assessment

The swallowing assessments are performed at the bedside after confirming that the level of alertness is satisfactory (<10) and that the patient's general condition is stable without any progression of stroke.

4.2.1 Dry swallowing

It is a basic movement to swallow saliva, demonstrating whether or not the patient is able to swallow before conducting a screening test [16].

4.2.2 Repetitive saliva swallowing test (RSST)

In this test, an examiner asks a patient to swallow saliva while palpating the hyoid bone and thyroid cartilage with the index finger and the middle finger, respectively, and counts how many times the patient swallows within 30 s [17, 18]. It is considered positive when <3.

4.2.3 Water swallowing test (WST)

The examiner asks a patient to swallow 30 ml of water at the room temperature as usual and observes how many times he/she swallows and if he/she ever gets choked [19]. It is considered positive if the patient could swallow at once without getting choked within 5 s.

4.2.4 Modified water swallowing test (MWST)

The examiner asks a patient to swallow 3 ml of cold water and observes if he/she ever gets choked and if the voice or respiratory state changes. The maximum score is 5 for this test [18, 20]. If possible, the examiner asks the patient to swallow twice more. The test can be performed up to three times, and the worst swallowing activity is evaluated. It is considered abnormal when the score is <3 (swallowing present, respiration satisfactory, choking present, and/or wet hoarseness).

4.2.5 Food test (FT)

In this test, the examiner asks a patient to ingest a tea spoon of flan (about 4 g) [18, 21]. The content of the assessment is the same as in MWST except that there is another assessment of residual food inside the oral cavity after swallowing in this test.

4.2.6 Simple swallowing provocation test (SSPT)

The examiner inserts a transnasal catheter 5 Fr into the epipharynx in the supine position and injects distilled water at room temperature to induce swallowing [22]. At first, the examiner injects 0.4 ml of distilled water and observes for 3 s. If the patient does not swallow, 2 ml is additionally injected. If no swallowing was observed within 3 s, it is considered that the patient has a risk of aspiration pneumonia.

4.3 Comprehensive clinical two-step swallowing assessment scales

There are existing clinical assessment scales which combined clinical symptoms and WST as below. Comprehensive clinical evaluations rather than simple WSTs demonstrate higher sensitivity and specificity.

4.3.1 Two-step thickened water test (TTWT)

With this method proposed by Smithard et al. [23], WSTs of 5 ml (for three times) and 30 ml are performed after obtaining clinical findings such as the alert level, trunk control, soft palate movement, and voluntary coughing.

4.3.2 Toronto Bedside Swallowing Screening Test (TOR-BSST)

This is a comprehensive WST focusing on evaluation of dysphagia of the oropharynx in addition to assessment of three items: voice quality, tongue movement, and pharyngeal sensation [24].

4.3.3 Gugging swallowing screen (GUSS)

Prior to the assessment, posture control is evaluated. An examiner assesses clinical findings including the state of consciousness, coughs (wet hoarseness), and dry swallowing (saliva swallowing) (5 points), followed by assessments of the swallowing state, presence or absence of choking or drooling, and change of voice after ingesting three food forms: semisolid, liquid, and solid (15 points) [25]. The food form is determined according to the score (20, normal food; 15–19, soft food; 10–14, dysphagia food; 0–9, indirect training).

All these tests can be easily performed to assess swallowing functions. However, not all aspirations can be detected. Simultaneous assessments using VF and WST or FT under the X-ray [26, 27] revealed that the higher the amount of fluid, the more aspirations are observed with VF, while the detection rates for choking, coughing, and wet hoarseness were not that high (**Figure 2**). In patients with decreased cognitive or physical functions and patients with brain stem lesions, silent aspiration cannot be denied even if there is no clinical finding of choking, coughing, or wet hoarseness [28]. VF and VE should be performed as much as possible in case where dysphagia is strongly suspected in physical examinations or BSA or when there is no effective strategy established for the treatment.

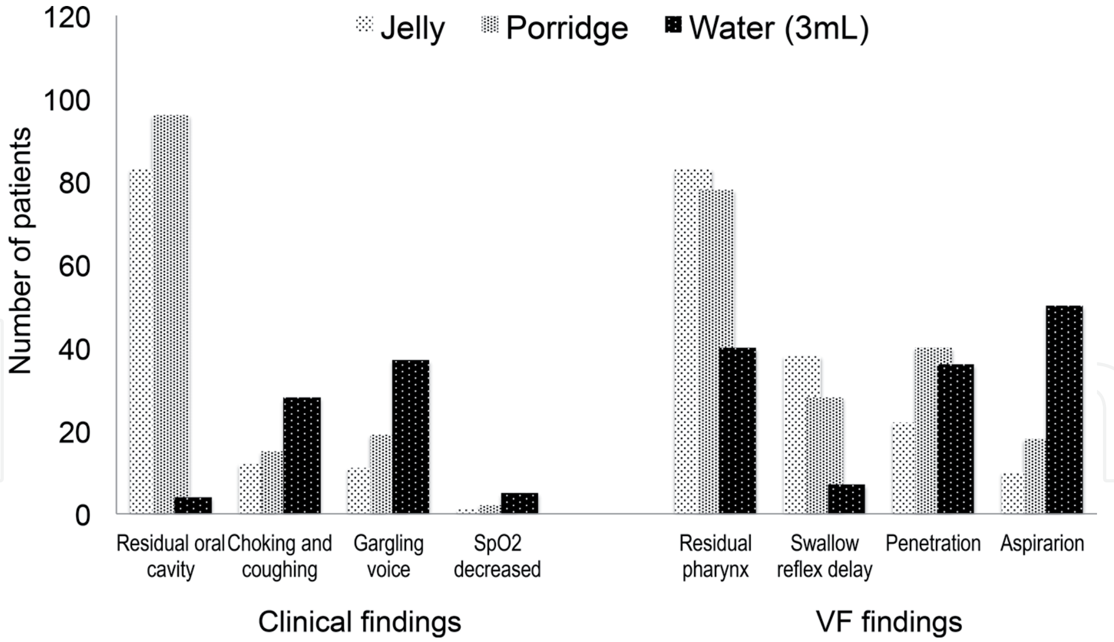

Figure 2.
Clinical and VF findings of the food test. Simultaneous assessments using VF and WST or FT under the X-ray revealed that the higher the amount of fluid, the more aspirations are observed with VF, while the detection rates for choking, coughing, and wet hoarseness were not that high.

4.4 Videoendoscopy (VE) and videofluorography (VF)

4.4.1 Videoendoscopy (VE)

Using a laryngeal fiberscope, the pharynx and larynx are primarily observed using real food (**Figure 3**). Although the moment of swallowing cannot be observed, early pharyngeal penetration of saliva or food bolus, timing of inducing swallowing reflex, pharyngeal residue, and laryngeal penetration/aspiration can be directly observed. This is a useful method which enables observation of the pharynx and larynx using actual food without irradiation. This can be used at the bedside as it does not require any large-scale devices [29].

Figure 3.
Videoendoscopy (VE). Videoendoscopy can be performed on patients at bedside.

VE can be performed without irradiation and is highly portable. In addition, it enables direct observation of mucosal and saliva conditions as well as assessment of actual meal settings. However, there is a risk of inducing pain or nasal bleeding when inserting the fiber, and it is difficult to observe oral cavity during mastication, bolus formation, and food transportation to the proximal part of the tongue; it becomes blurry at the moment of swallowing; hence, it is difficult to understand the details of laryngeal penetration/aspiration.

4.4.2 Videofluorography (VF)

Swallowing functions are assessed using an X-ray device. With this method, a patient is asked to ingest fluid (water) or solid/semisolid food (imitation food) which contain contrast medium (barium sulfate), and movement of the oral cavity, pharynx, and esophagus as well as structural abnormalities and movement of the food bolus are assessed [30]. The diagnostic value of this test is high as it can reveal formation of the food bolus and its transportation to the pharynx in the oral phase, the timing and the level of laryngeal elevation in the pharynx phase, and bolus passing at the esophageal orifice and the presence/absence or the level of aspiration (**Figure 4**). It also clarifies conditions where the risk of aspiration and pharyngeal residue is low and determines the safest food form, the method of ingestion, and the posture. Moreover, it also enables us to try various compensation methods and make detailed observations on dysphagia. Hence, this test should be considered as a gold-standard swallowing function assessment which can provide very important information to establish treatment strategy according to the findings of the observation [30].

4.4.3 Swallowing CT scan

With excellent spatial resolution (0.5 mm square) and time resolution (10 frames per second), 320 Area Detector CT (320-ADCT) enables us to precisely and quantitatively observe the swallowing movement in 3D. It presents 3D images of various organs from arbitrary directions; hence, it can precisely quantify swallowing dynamics [31, 32].

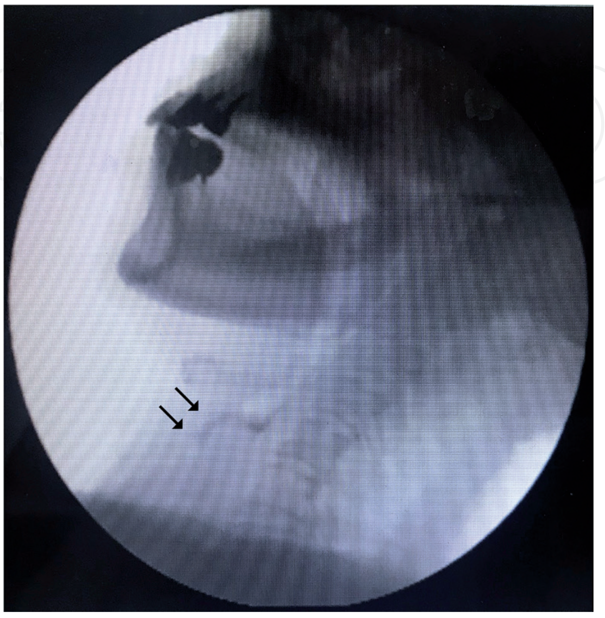

Figure 4.
Videofluorography (VF). VF shows that fluid is getting into the trachea from the larynx.

4.5 Assessment of severity in swallowing

Taking into consideration the functional diagnosis, causative disease, and general condition of the patient, the level of feeding is determined as the final overall evaluation of swallowing. Swallowing Performance Scale [33] and Functional Oral Intake Scale (FOIS) [34] are seven-level scales used in overseas countries to assess oral feeding status during the meals. While in Japan, Dysphagia Severity Scale (DSS) [35] is often used. This is a comprehensive assessment using the ordinal scale of seven levels, which can suggest a management method to a certain extent if the severity level is determined. VF and VE are not necessarily required in an evaluation using DSS. An evaluation made on clinical findings or a screening test by a highly experienced nurse can be equivalent to the evaluation made on DSS using VE [36]. Dysphagia Outcome and Severity Scale (DOSS) is a simple and easy-to-use point scale developed only to systematically evaluate the functional level of severity. With this scale, recommendations on feeding levels can be prepared based on objective evaluations [37].

5. Treatment of dysphagia

There are two types of dysphagia rehabilitation: indirect training which does not require feeding and direct training which requires feeding. For a patient with severe dysphagia, rehabilitation should be started with the indirect training, and then the direct training can be added according to the progress. Likewise, for a patient who can start rehabilitation with the direct training, the indirect training may be added if necessary [38, 39].

5.1 Indirect training

Indirect trainings which are typically used include pharyngeal cooling stimulation (ice massage), Mendelsohn maneuver with which the upper esophageal sphincter is mechanically opened by keeping the positions of the larynx and the hyoid bone elevated, blowing, supraglottic swallow (swallow while holding breath), Shaker exercise (head lift exercise), cervical anterior flexion exercise, balloon dilatation method, and pharyngeal electrical stimulation. At the same time, it is essential to conduct oral care. If a patient does not ingest food, the amount of saliva secretion decreases, and as a consequence, self-cleansing action of oral cavity with saliva decreases as well. In such cases, patients often have dry mouth covered by biofilm as seen with the furred tongue, which need to be removed by brushing. These trainings are conducted primarily by speech-language-hearing therapists and nurses. However, the concomitant use of pulmonary respiration therapy conducted by physiotherapists or trainings to improve the ability of performing daily activities conducted by occupational therapists is also very effective to prevent/relieve aspiration pneumonia and improve feeding ability. Hence, it is important to treat patients with the entire team in the rehabilitation approach for dysphagia.

5.2 Direct training

In the direct training, feeding is started as soon as safety conditions for feeding were established based on detailed evaluations. The patient is observed for 3–7 days to check if there is any sign of aspiration or pneumonia, and the meal condition is upgraded accordingly. In stroke patients, swallowing functions are likely to change according to the alert level, and facial palsy is frequently observed. As their masticatory functions have been generally decreased due to facial and lingual palsy, the patients are unable to produce a smooth and appropriately sized food bolus with adequate mastication. The poor pharyngeal clearance is likely to induce formation of food residues inside the pharynx. As the residual food may cause aspiration or suffocation, it is dangerous to offer meals which require mastication to patients with stroke in the acute phase. Therefore, it is considered safer to start feeding with a single food type such as food paste in patients suspected to have dysphagia, even if it is mild.

Once the feeding started, special attention should be paid on increase of saliva/drooling and sputum, increase of coughs, tiredness after eating meals, fever, voice change (wet hoarseness) during meals, and residual food inside the oral cavity. Aspiration can occur without choking. Therefore, if there is any sign as listed above, auscultation of the chest and vital sign assessment should be performed along with chest X-ray and blood collection, if necessary. In addition, chest CT scan should also be considered if the patient is suspected to have pneumonia in the posterior side of the lung as it is often difficult to obtain remarkable findings on chest X-ray in such cases. If aspiration pneumonia is detected in these tests, direct training should be suspended for a moment, and pneumonia should be treated immediately. Once the treatment is completed, swallowing function assessments should be performed at the bedside along with VE and VE, if necessary, to reevaluate the conditions. Special attention is required especially in elderly patients with bilateral lesions who have neurological manifestations as they are likely to develop aspiration pneumonia [40, 41].

6. Conclusions

In assessment and treatment of dysphagia, "not choking" and "safe feeding" are not necessarily the same in meaning. It is necessary to conduct the swallowing function assessments and understand the patients' conditions along with the level of consciousness and physical state. Safe feeding can be achieved in stroke patients only by selecting appropriate food materials according to their pathological conditions at the optimal timing with appropriate feeding posture and efforts.

Conflict of interest

The authors declare that they have no competing interests.

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