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Clinical Manifestation, Evaluation, and Rehabilitative Strategy of Dysphagia Associated With COVID-19

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Abstract: Dysphagia is the difficulty in swallowing because of the presence of certain diseases; it particularly compromises the oral and/or pharyngeal stages. In severe acute respiratory syndrome coronavirus 2 infection, neuromuscular complications, prolonged bed rest, and endotracheal intubation target different levels of the swallowing network. Thus, critically ill patients are prone to dysphagia and aspiration pneumonia. In this review, we first discuss the possible cause and pathophysiology underlying dysphagia associated with coronavirus disease 2019, including cerebrovascular events, such as stroke, encephalomyelitis, encephalopathy, peripheral neuropathy, and myositis, that may lead to the dysphagia reported as a complication associated with the coronavirus disease 2019. Next, we present some recommendations for dysphagia evaluation with modifications that would allow a safe and comprehensive assessment based on available evidence to date, including critical considerations of the appropriate use of personal protective equipment and optimization individual's noninstrumental swallowing tasks evaluation, while preserving instrumental assessments for urgent cases only. Finally, we discuss a practical managing strategy for dysphagia rehabilitation to ensure safe and efficient practice in the risks of severe acute respiratory syndrome coronavirus 2 exposure, in which swallowing therapy using newer technology, such as telerehabilitation system or wearable device, would be considered as a useful option.

Key Words: Dysphagia, Intensive Care Unit, Personal Protective Equipment

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), referred to as coronavirus disease 2019 (COVID-19), outbreak has caused 90,891,380 confirmed cases and 1,944,750 deaths globally, with Japan having 292,212 confirmed cases and 4094 deaths as of January 12, 2021. Most infected individuals (81%) confer mild disease symptoms, characterized by fever, cough, and dyspnea as the most commonly reported symptoms.[1] However, for a significant minority of patients, in particular, those older than 65 yrs, SARS-CoV-2 infection might display severe consequences, accounting for a relatively high proportion (20.3%) of patients in this age group requiring hospitalization and management in intensive care units.[1] Reports of neurologic symptoms and stroke in individuals with COVID-19 raise concerns that the neurological system is impacted negatively by this virus.[2–5] A dysphagia complication due to the cranial nerve involvement in COVID-19–infected patients has been reported recently.[6] Disuse syndrome or sarcopenia due to prolonged bed rest[7,8] or prolonged endotracheal intubation during intensive care of COVID-19 symptoms[9–11] is thought to aggravate the swallowing function. Untreated dysphagia could enhance the risk of pulmonary complications, causing aspiration pneumonia, along with induction malnutrition, causing significant weight loss and dehydration, and contributing to the high mortality rate of the disease.

In conditions of dysphagia under COVID-19 pandemic, rehabilitation programs become critical challenges. Fiberoptic endoscopic examination of swallowing (FEES) and videofluorographic swallowing study (VFSS) are criterion standards of dysphagia evaluation, which are considered aerosol-generating procedures (AGPs), defined as care practices that result in the generation of airborne particles like aerosols, and would, therefore, require wearing exceptionally high-grade personal protective equipment (PPE) by the medical staff. Because of the COVID-19 pandemic is far from being over, standard approaches to the clinical evaluation of dysphagia have to be modified as the situation demands. In addition, the current workflow of dysphagia rehabilitation needs to be modified accordingly. In this review, we first present possible causes and pathophysiology underlying dysphagia associated with COVID-19. Second, we offer some recommendations for dysphagia evaluation with modifications from conventional approaches to allow a safe and comprehensive assessment based on available evidence to date. Finally, we discuss possible strategies for managing dysphagia to ensure safe and efficient practice in the risks of SARS-CoV-2 exposure.

Clinical Manifestation Associated With Dysphagia

Although the primary manifestation is a respiratory symptom contributing to pulmonary diseases, like acute respiratory distress syndrome, COVID-19 influences other body systems. The clinical indications of dysphagia are challenged by swallowing and throat-clearing difficulties, coughing, regurgitation, heartburn sensations (reflux), and recurrent aspiration pneumonia, caused by the central nervous system aberrant-controlled neurological problems, triggered by SARS-CoV-2 infection. Viral neuroinvasion could occur by several routes: transsynaptic transfer across infected neurons, entry via the olfactory nerve, infection of vascular endothelium, or leukocyte migration across

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the blood-brain barrier, evidenced by several investigations.[3] A retrospective study by Mao et al.[2] details the neurological signs and symptoms associated with COVID-19 infection in a hospitalized population. They reported that approximately one third of hospitalized patients with COVID-19 displayed neurological signs or symptoms, that taste and smell impairments as cranial nervous manifestations of COVID-19 were observed in 5.6% and 5.1% of hospitalized patients, respectively, and that the rate of skeletal muscle injury was 10.7%.[2] Five cases of large-vessel stroke in patients SARS-CoV-2 infection were reported in New York City.[12] In a further study from 2 New York City academic hospitals, approximately 1.6% of adults with COVID-19 who visited the emergency department or were hospitalized experienced ischemic stroke, a higher rate of stroke compared with a cohort of patients with influenza.[13] According to clinical data sets collected from 125 patients from 3 major UK neuroscience bodies,[14] 77 (62%) presented with a cerebrovascular event, of whom 57 (74%) had ischemic stroke, 9 (12%) an intracerebral hemorrhage, and 1 (1%) central nervous system vasculitis. Thirty nine (31%) of 125 patients presented with altered mental status, comprising 9 (23%) patients with unspecified encephalopathy and 7 (18%) patients with encephalitis. Reportedly, nearly 35%–50% individuals develop dysphagia after their first acute ischemic stroke in the brain.[15–18] Dysphagia after stroke affects many patients in the first few hours and days after onset, with associated increased morbidity and mortality due in part to aspiration, pneumonia, and malnutrition.

In a brain autopsy of 6 patients who died from COVID-19, localized perivascular and interstitial encephalitis with neuronal cell loss were noted. In addition, axon degeneration in the dorsal motor nuclei of the vagus nerve, trigeminal nerves, nucleus tractus solitarii, dorsal raphe nuclei, and fasciculus longitudinalis medialis were observed.[19] A report from Northern Italy revealed that five patients developed Guillain-Barré syndrome after the onset of COVID-19.[4] One of five patients developed dysphagia. Emerging data indicate that COVID-19 could trigger not only Guillain-Barré syndrome but other autoimmune neurological diseases including encephalomyelitis or myositis even without systemic symptoms.[20] Evidence from an animal model of a neurogenic pathway for SARS-CoV-2 via olfactory, trigeminal nerves, and the brainstem nuclei led us to look for evidence of localized brainstem alterations.[21]

The act of swallowing is coordinated and executed by a complex neuronal network that incorporates cortical, subcortical, and brainstem structures, as well as a downstream peripheral nervous system including several cranial nerves and muscles (Fig. 1). Thus, different neurologic complications of COVID-19 might result in damage to central and peripheral parts of the swallowing neural circuits leading to dysphagia.

We reported previously the case of a patient who encountered oropharyngeal dysphagia and aspiration pneumonia after COVID-19 infection, which was initiated by the development of taste and smell impairments, as cranial nervous manifestation.[6] After treatment with a mechanical ventilator in an intensive care unit, he developed swallowing difficulty with persistent taste impairment, accompanied by high fever, general malaise, cough with expectoration, and aggravated dyspnea. The laboratory tests and chest x-ray showed re-elevated blood cell count and C-reactive protein level, as well as a further enhancement of the shadows in the field of the right lower lung (Fig. 2). In the process of recovering from SARS-CoV-2 infection, superimposed aspiration pneumonia was diagnosed. The bilateral gag reflex was absent. The FEES, VFSS, and manometry revealed impaired pharyngolaryngeal sensation, silent aspiration, and mesopharyngeal contractile dysfunction, suggesting that glossopharyngeal and vagal neuropathy was the cause of the dysphagia. This case emphasizes the significance of overlooking the neurologic involvement, concurrent dysphagia, and subsequent aspiration pneumonia in SARS-CoV-2 infection and urges for awareness of this consideration. In contrast, Spannella et al.[22] reported the case of a 95-yr-old patient who was initially diagnosed with common aspiration pneumonia; however, the condition was subsequently diagnosed as COVID-19 pneumonia during the initial spread of SARS-CoV-2.

Apart from neurologic complication, digestive symptoms are often recognized in patients with COVID-19. Of 204 patients COVID-19, 103 (51%) reported digestive symptoms, including appetite loss (81 [79%] cases), diarrhea (35 [34%] cases), and vomiting (4 [4%] cases) in Hubei province, China.[23] Digestive symptoms became more identifiable as the severity of the disease increased. In a meta-analysis of 29 studies, including 6064 patients with COVID-19, gastrointestinal symptoms were reported in 15%, with nausea, vomiting, diarrhea, and appetite loss being the three most common symptoms.[24] Notably, the appetite loss leads to malnutrition and secondary sarcopenia that increases the risk of dysphagia and aspiration pneumonia. Difficulty in interpersonal rehabilitation therapy and nutritional intervention due to the infection control render patients with COVID-19 physical decline that provoking disuse muscle atrophy. Furthermore, prolonged mechanical ventilation is likely to exacerbate swallowing difficulty because of pharyngeal and laryngeal trauma, neuromuscular weakness, reduced sensorium, gastroesophageal reflux, and/or impaired synchronization of breathing and swallowing.[9,10,25]

Chaumont et al.[26] reported four patients with encephalopathy and concurrent peripheral neuropathy with miscellaneous symptoms, including dysphagia, occurring after severe COVID-19. Neurological manifestations were detected after mechanical ventilation weaning and extubation. However, detailed findings or prognosis related to dysphagia was not described.

Transmission Route of COVID-19

SARS-CoV-2 transmission occurs via several modes, which include animal-to-human or person-to-person contact, droplet, airborne, blood-borne, contaminated object, and fecal-oral. The peak infectiousness at the time of symptom onset, or 1–2 days before symptoms begin,[27] making it difficult to monitor early infection and prevent infecting others, leads to the formation of clusters, which is the aggregation of disease cases resulting from the concentration of infected individuals. Although in Japan, confirmed instances of COVID-19 have been relatively low compared with other countries, one of the largest clusters in which approximately 130 medical professionals and patients were confirmed occurred in a rehabilitation hospital in Japan.[28]

Because COVID-19 infects the upper aerodigestive tract with the highest viral loads occurring in the nasal cavities,[29] droplets from coughing and sneezing are the source of infection. When susceptible individuals come into contact with the

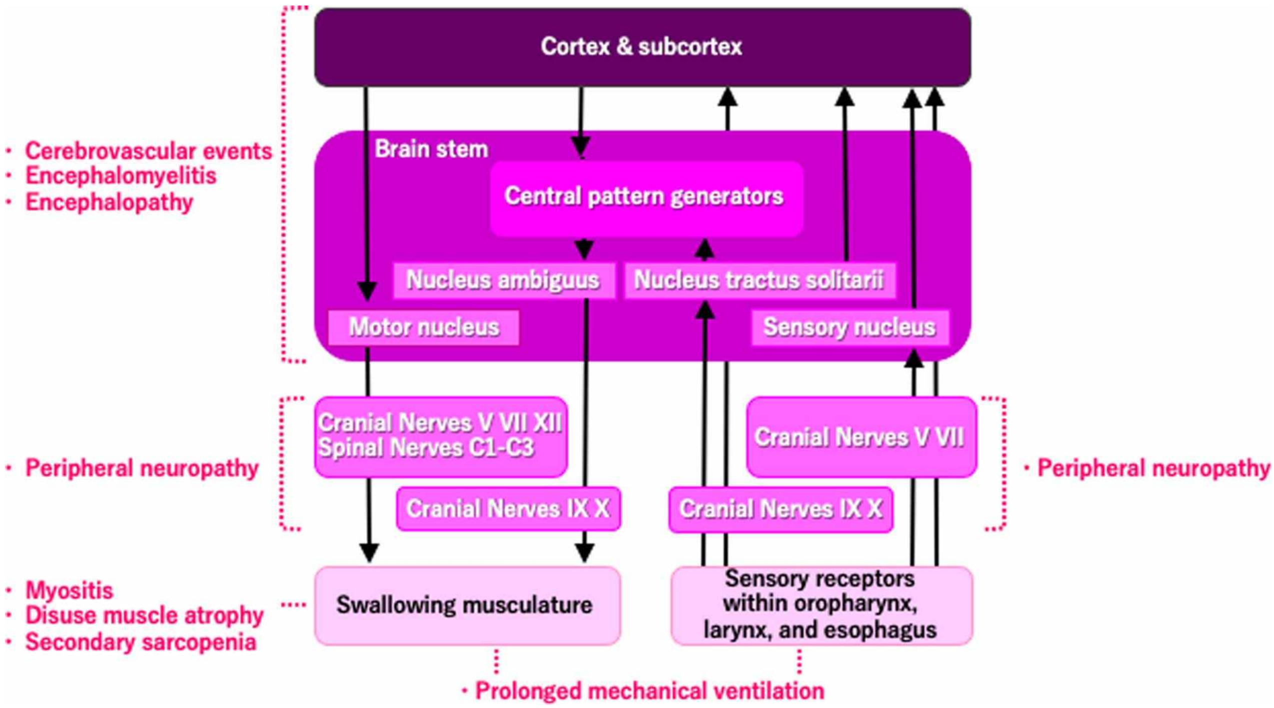

FIGURE 1. Swallowing neuronal network and COVID-19–associated complications that may lead to dysphagia. Swallowing is a dynamic process involving complex central neuronal networks throughout the cortex, subcortex, and brainstem. These central networks collaborate with the peripheral nervous system, including several cranial nerves that control sensorimotor swallowing function, to integrate muscle coordination. Cerebrovascular events, such as stroke, encephalomyelitis, encephalopathy, peripheral neuropathy, and myositis, may lead to dysphagia associated with COVID-19 as illustrated.

virus-containing body fluids (sputum, saliva, feces) from infected humans, SARS-CoV-2 could be transmitted through the oral cavity, nasal cavity, and other mucous membranes.

Because SARS-CoV-2 persists within the environment of infected individuals (e.g., household surfaces, door handles, mobile phones), when susceptible individuals come into contact with contaminated body fluid items, indirect transmission of SARS-CoV-2 could occur. Aerosols could be produced not only by coughing but also by normal breathing or talking as air passes over respiratory mucosa.[30–33] Respiratory aerosols typically consist of droplet nuclei less than 5 μm in size. SARS-CoV-2 RNA detected in air samples in hospital rooms of patients with COVID-19[34] could remain viable in aerosols for hours.[35] Therefore, unless rooms are well ventilated, aerosolized droplets could

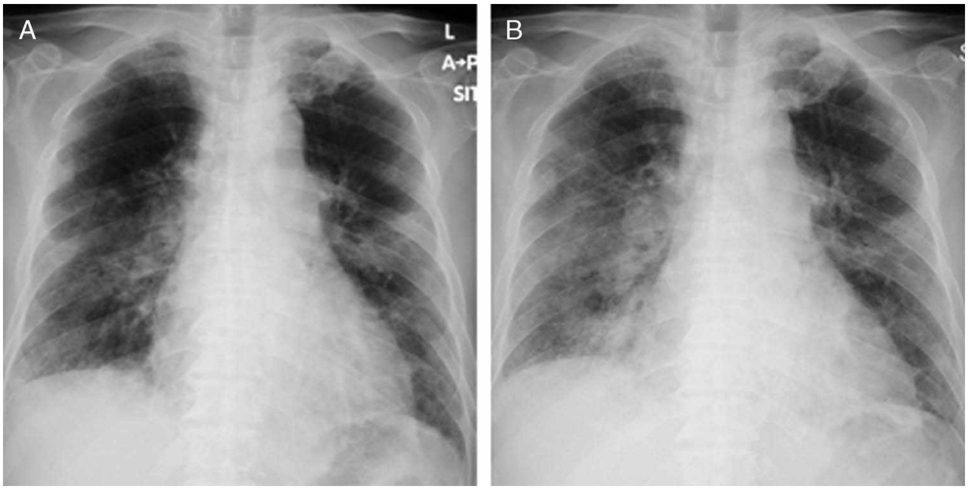

FIGURE 2. A, Chest x-ray of a patient recovering from SARS-CoV-2 infection on a day before resuming oral intake. Multifocal patchy opacities are visible in both lungs. B, A chest x-ray was taken on day 3 after resuming oral intake. Note that new enhancement of the shadows in the right lower lung field is apparent in B, suggesting superimposed aspiration pneumonia under SARS-CoV-2 infection. In general, the right lower lung lobe is the most common site of infiltrate formation due to the larger caliber and the relatively more vertical orientation of the right mainstem bronchus.

become more concentrated in an environment over time, likely to infect any person who would have an encounter.

Personal Protective Equipment

The fundamental precautions for COVID-19 pandemic infection control include hand and respiratory hygiene, the use of appropriate PPE according to risk assessment,[36] environmental cleanings, and safe waste management.[37] In the course of COVID-19 pandemic, PPE worn by healthcare professionals is critical for reducing the infection transmission in healthcare settings, mainly when AGPs are being performed.[38]

The Canadian Society of Otolaryngology–Head and Neck Surgery made the guidance.[39] Level 1 PPE includes a surgical mask, gown, gloves, and eye protection (face shield or goggles; Fig. 3A). Level 1 PPE should be used as a minimum for routine patient care and during non-AGPs in all patients. For asymptomatic and COVID-19–negative patients, the use of a gown is optional, especially when there is no risk of droplet or fluid spread. Level 2 PPE includes the use of N95 mask, eye protection preferably that seals to the face, gloves, and gown (Fig. 3B). Because of the possibility of false-negative testing in a population with a high prevalence of COVID-19, the recommendation is that level 2 PPE precautions should be followed for all AGPs in situations with a high or growing COVID-19 prevalence. Any patient who is symptomatic or COVID-19 positive scheduled for AGP should have the procedure performed in a negative pressure room while following standard operating procedures for their institution, and level 3 PPE is recommended, which consists of N95/FFP2 (or higher-level respirator), goggles, and the first layer of surgical gloves, followed by leg and foot covers, a long-sleeved, sterile water-impermeable gown, and sterile outer gloves (Fig. 3C).

The benefits of using surgical face masks are largely dependent on the parallel practice of handwashing.[40] In recent reports, the surgical mask does not have sufficient filtering ability, but the mandated face covering in the community prevented airborne transmission from asymptomatic patients by blocking atomization and preventing contact infections via viral droplet release from infected person.[41] The simultaneous implementation of face covering and social distancing was considered most optimal for minimizing transmission.

In an experiment using an aerosol generator and a breathing simulator, when a healthcare professional wore a face shield and was 46 cm far from the patient, the amount of aerosol inhaled immediately after the patient coughed was reduced by 96% with a reduction in mask surface pollution by 97%.[42] However, if the particle size of the aerosol was small, the effect of face shield was reduced, and if the exposure time was long, the effect was reduced further because the aerosol had dispersed throughout the room. Therefore, face shield is useful for reducing infection risk when used in combination with a mask when dealing with patients in close proximity, as the combination of these two PPE yields additive protective effect.

Rehabilitation workers treat numerous patients at rehabilitation centers and bedsides. In the COVID-19 pandemic, it is indispensable to make efforts not to minimize the activity of patients and, by the same token, avoid the spread of the infection. The regional epidemic characteristics should also be considered when determining the level of PPE required, especially when a patient's COVID-19 status is unknown, as, in several regions, the infections had occurred long before the

FIGURE 3. A, Minimum or standard PPE. B, Standard PPE with N95 mask and face shield. C, Full PPE.

symptoms began to show enabling clustering and escalation of the outbreak.

Dysphagia Evaluation

Evaluation should start early and with structured swallowing screening in patients at risk for dysphagia. Simple screening tests, including various water swallowing tests and the repetitive saliva swallowing test,[43] and questionnaires, such as the Eating Assessment Tool 10, are used for standard screening.[44] The repetitive saliva swallowing test assesses the patient's ability to voluntarily swallow repeatedly after being asked to swallow saliva as many times as possible for 30 secs, while deglutition was counted through palpation of the larynx. The sensitivity and specificity for aspiration were 69%–98% and 66%–93%, respectively, when the cutoff point was set at 2.[43,45] It is recommended that rapid screening with high accuracy be carried out by a trained nurse, a speech-language pathologist, an occupational therapist, or a physician.[46] An assessment using postextubation dysphagia screening[47] by a nurse in the intensive care unit is useful where speech-language pathologists, occupational therapists, or physicians might not be available. In this COVID-19 era, postextubation dysphagia screening, a validated screening tool used after extubating, is recommended for utilization as a standard procedure, according to the local intensive care unit policy.

If the initial noninstrumental patient screening fails, instrumental evaluation is the next general step. The two main diagnostic tools for identifying aspiration are FEES, which provides direct visualization of the pharynx, and VFSS, which provides real-time visualization of the oral cavity, oropharynx, laryngopharynx, and esophagus viewed on a monitor in the radiology suite. It is noteworthy that FEES and VFSS, considered as AGPs, are not recommended to be used to perform nonemergent or nonurgent COVID-19–positive or suspected cases.[9,48] Under an emergency condition, however, instrumental evaluation is unavoidable. Clinical assessment, including the full review of medical records and information from nurses and other staffs, plays a more prominent role; therefore, a thorough check on the patients' status is made before recommendation for face-to-face evaluation.

In our hospital, we performed FEES in urgent patients who were not diagnosed with COVID-19 or who tested negative twice for COVID-19 but had tested positive previously by polymerase chain reaction during the first outbreak of COVID-19 infection (April and May 2020). During this time, the scheduled FEES cases decreased (Fig. 4), and noninstrumental evaluation cases increased. Although VFSS is considered a safer option than FEES,[49] we also limited its usage for only urgent patients who were not diagnosed with COVID-19. Under this COVID-19 outbreak, it is recommended that the FEES procedure is executed with level 1 PPE for a non–COVID-19 patient and

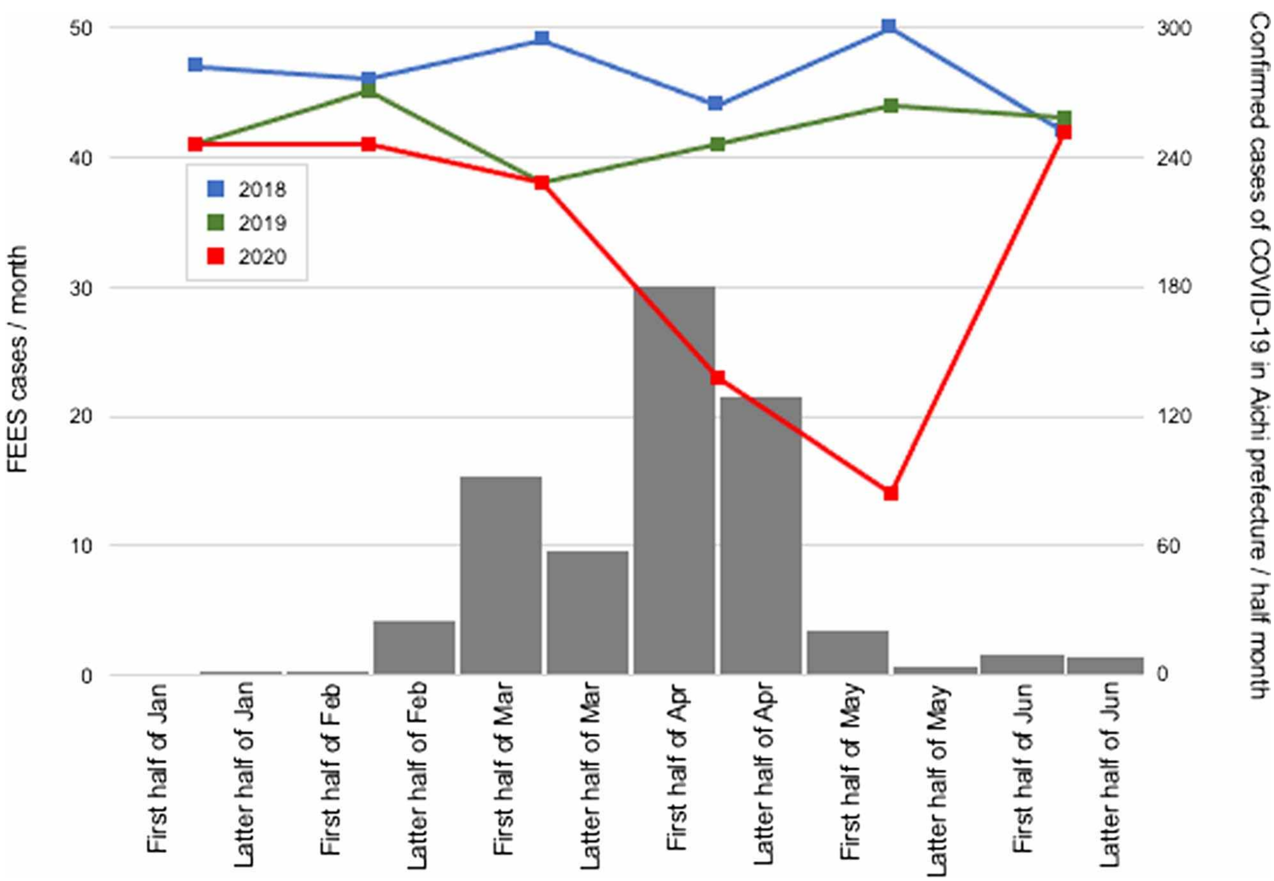

FIGURE 4. Fiberoptic endoscopic examination of swallowing cases performed in the Department of Rehabilitation, Fujita Health University Hospital, from January through June 2018, 2019, and 2020. The gray bar charts represent the confirmed cases of COVID-19 per half month in Aichi prefecture, Japan, where the Fujita Health University Hospital is located. Aichi prefecture has a population of 7.6 million.

TABLE 1. General principles and classification of AGPs in speech-language pathology service

General principles
- √ Wear a mask, gloves, gown, and face shield
- √ Not to sit face to face, but to sit side-by-side or to sit perpendicular with a patient
- √ Close contact is permitted only when necessary to observe oral mucosa, tongue, dentition, and palate.
- √ Keep the treatment room well ventilated
- √ Clean and disinfect the touched objects with alcohol (table, chair, doorknob, pencil, files, phones, keyboards, tablets, etc.) in each session

	Risk for aerosol generating: low	**Risk for aerosol generating: high**
Evaluation	Questionnaire	Water swallowing test (for those who cough frequently)
	Repetitive saliva swallowing test	Fiberoptic endoscopic examination of swallowing
		Videofluorographic swallowing study
Oral element-based exercise[a]	Range-of-motion exercise of jaw, lip, cheek, and tongue	Voice production exercise
	Tongue resistance–strengthening exercise	
	- Tongue elevation exercise	
	- Isometric progressive resistance oropharyngeal therapy	
	- Tongue rotatory lateral exercise	
	Cheek puffing exercise	
	Chewing exercise using gum covered with gauze	
	Oral motor control exercise	
Pharyngeal element-based exercise	Tongue retraction exercise	Cough exercise
	Shaker exercise	Strengthening vocal cord closure exercise
	Head raising exercise	Expiratory muscle strength training
	Jaw opening exercise	Blowing exercise
	Tongue holding swallow	
Behavior-based exercise[b] with facilitation techniques	Thermal, tactile stimulation	Tube swallowing exercise (for those who cough)
	K-point stimulation	Balloon dilation (for those who cough)
Behavior-based exercise with target-oriented methods	Mendelsohn maneuver	Supraglottic swallow, super supraglottic swallow
	Effortful swallow	Direct exercise (for those who cough frequently)
Others	Stretching of head and neck	
	Oral care	
Education	Self-training	
	Instructing patients and patient's family	

[a]Element-based exercises target the neuromuscular control, which is a prerequisite of swallowing function.
[b]Behavior-based exercises promote therapeutic learning by integrating all the activity-dependent elements to the actual swallowing behavior.

with higher PPE for a COVID-19–positive or suspected patient. In addition, FEES and VFSS could be used by shortening the examination to limit exposure to aerosolized viral particles.[49]

Ku et al.[50] introduced the workflow for swallowing studies in head and neck patients with COVID-19. According to their workflow, VFSS and FEES were performed when high fever, travel, occupation, contact and clustering phenomenon history within the last 14 days, respiratory symptoms, and/or smell/taste disturbance were not confirmed. Nonetheless, if these symptoms were confirmed, patients were divided into two groups,

FIGURE 5. Delivery of exercise program using telerehabilitation system. Left panel: A physical therapist provides exercise with instruction using the telerehabilitation system. The pulse rates and SpO_2, measured using a monitoring device, are displayed on the monitor in the therapist's room. Right panel: Patients watch the screen of tablets computers and perform the exercise according to the instruction given by the physical therapist in the assigned rehabilitation room. The SpO_2 and pulse are monitored on display during the exercise.

urgent and nonurgent. For the urgent group, VFSS and/or FEES were performed regardless of polymerase chain reaction positive or negative, but a high level of PPE was required for the polymerase chain reaction positive case.

Recent articles introduced the practical system of evaluation and diagnosis of dysphagia by using telemedicine.[49,51] In their algorithm, initial interview, screening, and clinical evaluation were performed via phone- or video-enabled encounter. If patients failed these evaluations, virtual evaluation, including mealtime observation, and trail of various consistencies were performed by speech-language pathologists, followed by the recommendation of appropriate diet and strategy. Meanwhile, the instrumental evaluation was performed only in those who were in need.[49] Telephone or other remote contact was useful and preferred for the patients who did not need urgent intervention.[9,50]

Under the current condition, where theoretically, all patients are in the gray zone of COVID-19 positive/negative, it is recommended to balance the risk of aerosolization with the benefit acquired from instrumental evaluation to choose the optimal assessment method.

Rehabilitative Strategy for Dysphagia

Appropriate treatment plan established for dysphagia treatment, according to the abnormal findings from the evaluation, is essentially the same regardless of a patient being COVID-19 positive or negative. For the COVID-19–positive patient, however, conservative management, such as diet modification and utilization of swallow strategy, is more likely to be the first choice than using active exercise directly until the COVID-19 becomes negative.[51]

When performing the swallowing exercise, clinicians need to pay special attention to the risk of aerosol generation. The consensus of AGP for swallowing exercises has not yet been achieved, except the common recognition that cough is the generation of the source of aerosol and that procedures generating cough are AGPs.[48] According to expert opinion,[52] high risks of therapeutic interventions and procedures include tracheostomy care/assessment/management, laryngectomy care/assessment/management, tongue strength therapy using Iowa Oral Performance Instrument, high-resolution manometry, pharyngeal electrical stimulation, and expiratory muscle strength training. Low risk of therapeutic interventions and procedures include surface electromyography. Swallowing compensatory and exercise therapy are regarded as the moderate risk of nonprocedural encounters.[52] Dysphagia societies, including the American Speech-Language-Hearing Association[53] and the Japanese Society of Dysphagia Rehabilitation[54] are calling medical staff attention to AGPs by classifying the risk of aerosol generation in dysphagia treatment.

Table 1 shows our university hospital's general principles and classification of AGPs. Because of the current nonconsensus opinion regarding the risk of AGPs for each swallowing exercise, hospital-based decision and its flexible exercise provision, according to emerging evidence, are required at present.

Telerehabilitation of swallowing disorders has been used in the last few decades.[55–57] This technology is being used for remote training in rehabilitation settings to rehabilitate patients with COVID-19 to reduce the risk of infection and prevent them from being isolated while minimizing the decline in functional status.[58] Our university hospital has initiated a preliminary attempt at telerehabilitation to a provide dysphagia rehabilitation program consisting of range-of-motion and muscle-strengthening exercises that improve the ability to swallow (Fig. 5). The program achieved success without any mechanical trouble and with high participant satisfaction. Accordingly, this program is highly recommended as an alternative for dysphagia rehabilitation during the COVID-19 pandemic, although the efficacy of dysphagia telerehabilitation requires further verification. Telerehabilitation systems may be available for online assessment of dysphagia.[59] Clinicians have been appointed as delegates to take responsibility for meeting this challenge of COVID-19 by identifying new methods or technologies that would allow the swallowing evaluation and treatment remotely.

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