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Original Article

Effectiveness and applicability of a specialized evaluation exercise-chair in posture adjustment for swallowing

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ABSTRACT

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Aim: To evaluate the effectiveness of a newly-developed evaluation exercise-chair, Swallow Chair (SC), in terms of simplicity, applicability, and comfort for dysphagic patients, in comparison with a bed for adjusting posture.

Methods: The subjects were three dysphagic patients who underwent videofluoroscopy (VFSS) and the effectiveness of the combined posture of reclining with rotation of the trunk and head for safe swallowing was evaluated. The recommended posture was adjusted and video-recorded under two conditions—using the SC or using a bed—during swallowing training, and the posture was then analyzed and compared. The evaluation criteria included the following: items necessary for posture adjustment and their number (simplicity), time required for posture adjustment (ease of use), and level of fatigue and pain experienced by the patient (comfort).

Results: In all patients, SC required fewer items and less time for posture adjustment and caused lower subjective fatigue and pain compared with using the bed. The compensatory posture recommended in the evaluation was adjusted properly during swallowing training and meal consumption using the SC and all patients improved their posture along with food type and meal frequency.

Conclusions: The SC is a simple, easy-to-use, and comfortable device for posture adjustment during evaluation, training, and meal consumption.

Key words: posture adjustment, simplicity, comfort, swallowing, deglutition

Introduction

Posture adjustment is considered to be an effective compensatory method and is used for various types of dysphagic patients. It ameliorated aspiration in 77% of patients with dysphagia according to Rasley et al., and in 81% of such patients according to Logemann et al., thus emphasizing the effectiveness of posture adjustment [1, 2]. Selection of an optimal technique for adjusting posture may help prevent aspiration and pharyngeal residue, and repeated practice of swallowing in a posture that has been confirmed to be safe is a valid training method and helps patients to resume oral intake at an earlier stage [3].

Swallowing performance in a selected posture is usually verified using videofluoroscopic swallowing study (VFSS) and/or videoendoscopy (VE) [1, 2, 4−6]. It is also important to reproduce the selected posture during swallowing training and meal consumption.

In practice, however, even if the optimal posture is selected after a thorough examination, it cannot be adjusted properly in clinical applications for the following three reasons.

1. Complexity of tasks: Clinicians frequently require multiple items such as pillows and towels to adjust the patient's posture in bed. Because they use

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Swallow Chair was co-developed by the authors and Tomei Brace Co., Ltd. The authors received several prototypes of Swallow Chair for this research from Tomei Brace, but did not receive any fees for promotional materials or research funding from the company.

various items depending on availability in the clinic, the postures achieved may not always be the same; furthermore, the reproducibility of the postures cannot be checked.

2. Awkwardness of tasks: Cumbersome tasks waste time and hinder accurate adjustment to the recommended posture.

3. Issues related to patient fatigue or discomfort: The use of pillows and towels available on site may result in an uncomfortable or unstable posture. Therefore, the patients may suffer from fatigue and pain in the neck, shoulders, or hips over time.

To overcome these issues, the authors developed an evaluation exercise chair, Swallow Chair (SC), which can be used consistently throughout evaluation, training, and meal consumption and ensures reproducibility of the recommended posture as well as simplicity, ease of use, and comfort. The SC (Fig. 2) is mobile with built-in caster-wheels designed for use in a VFSS room, hospital ward, or training room. It is equipped with reclining and tilting functions for making single posture adjustments, such as reclining

posture combining reclining, right rotation of trunk, left rotation of head

Present issues

Optimal posture selected after thorough evaluation cannot be adjusted properly in clinical applications.

complexity	awkwardness	pain/fatigue
many pillows and towels	long time	pain and fatigue in shoulders and hips

Development of a specialized evaluation-exercise-chair 'Swallow Chair'

simple	ease-to-use	comfort
adjustable with accessories	rapid adjustment	reduction of pain and fatigue

Figure 1. Development of a specialized evaluation exercise-chair for swallowing, "Swallow Chair", to overcome the present issues in posture adjustment.
To overcome the complexity, long time required, fatigue and pain, the authors developed a specialized evaluation exercise-chair, "Swallow Chair", which enables reproducible adjustment of posture with simplicity, ease of use, and comfort.

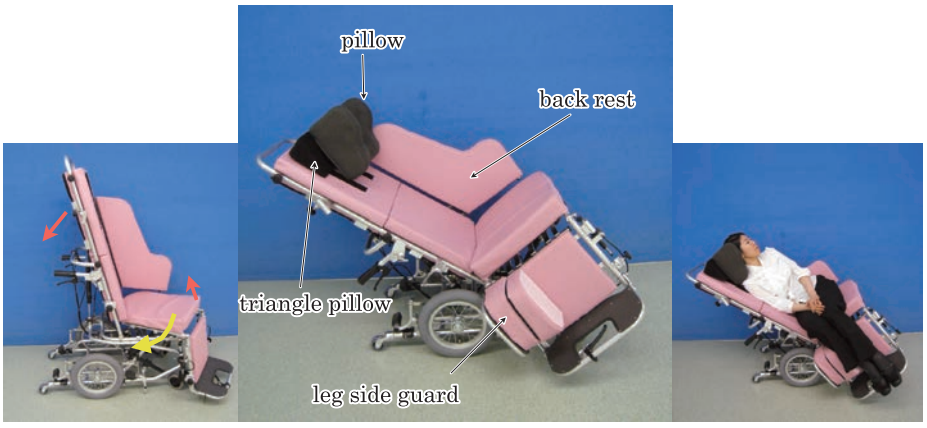

Figure 2. The developed Swallow Chair (SC).
Left: The chair is equipped with reclining and tilting functions (red arrow). The seat can be rotated by 30, 60, and 90 degrees.
Middle/right: Posture combining reclining by 30 degrees, rotation of the trunk to the right, and rotation of the head to the left. There is a pillow to hold the head and neck securely, triangle pillows, a back rest to provide back and hip stability, and leg guards to support the lower extremities. These accessories help to achieve rapid, accurate and stable adjustment of posture.

and head rotation, with comfort and ease. The reclining angle can be adjusted in 1-degree steps using the built-in inclinometer. The seat can also be rotated by 30, 60, and 90 degrees, which enables the patients to lie in a lateral recumbent position with comfort and ease and with a high level of reproducibility. These features enable adjustment to the optimal posture, such as reclining combined with trunk rotation [7]. In addition, the SC has a pillow to hold the head and neck securely, triangle pillows, and a back rest to provide back and hip stability, and leg guards to support the lower extremities. These accessories help to achieve accurate and stable adjustment of the selected posture. Moreover, the chair frame and pipes are specifically designed to be suitable for X-ray VFSS.

This study examined the effectiveness of the newly-developed SC for posture adjustment for dysphagic patients by comparing the adjustment of compensatory posture on a bed or on the SC, in terms of simplicity, ease of use, and comfort.

Methods

This study was approved by the Ethics Committee of our University (No. 11−211).

Three dysphagic patients, for whom the effectiveness of the posture of reclining with rotation of the trunk and head was confirmed by VFSS, were enrolled in this study.

Case 1: A 62-year-old male with left medullary stroke began undergoing intervention for dysphagia at 3 days post-stroke. At the initial evaluation, he was conscious, with no paralysis of the upper and lower extremities and normal cognitive function (34 points on Raven's Colored Progressive Matrices; RCPM). His repetitive saliva swallowing test (RSST) index was 1 [8, 9]. The modified water swallowing test (MWST) was not administered [10]. His functional severity score as evaluated by the Dysphagia Severity Scale (DSS) was 2 [11]. He was dependent on a nasogastric tube to meet all nutritional and hydrational needs. Diagnostic findings by VFSS at 14 days post-

Table 1. Profile and course of three cases.

Case		1	2	3
age/gender		62-year-old male	66-year-old male	70-year-old male
disease		medullary stroke left lateral medullary syndrome	medullary stroke right medulla/cerebellum	acute pneumonia, sepsis
initial evaluation	neurological neuropsychological finding	conscious no paralysis of extremities normal cognition	conscious left side paralysis: SIAS 43444 normal cognition	conscious no paralysis of extremities normal cognition
	diet type	NG tube	G tube	NG tube
	swallowing severity by DSS	2	2	1
course until start of direct training		3-days intervention started 14-days VFSS: 45° reclining with right trunk rotation and head left rotation were selected as the optimal position and direct training using jelly was initiated in this posture	101-days intervention started 117-days VFSS: 45° reclining with left trunk rotation and head right rotation were selected as the optimal position and direct training using jelly was initiated in this posture	51-days intervention started 69-days VFSS: 45° reclining with left trunk rotation and head right rotation were selected as the optimal position and direct training using thick liquid was initiated in this posture
course afterwards		30-days reclining degree changes from 45 to 60 and chopped food with thickened soup started 39-days adjustment changed to only reclining with 60 degrees 45-days mechanical soft diet with sitting upright 60-days normal diet with sitting upright	138-days rice gruel was added in direct training in the abovementioned posture	30-days paste food started in above mentioned posture at one time/day 83-days reclining degree changes from 45 to 60 (45° reclining with left trunk rotation and head right rotation) 90-days paste food, three times/ day

DSS, Dysphagia Severity Scale; SIAS, Stroke Impairment Assessment Set; NG tube, nasogastric; G tube, gastrostomy tube.

Table 2. Evaluation criteria.

Criteria	Measurement	Evaluation
items	items necessary for posture adjustment and number	simplicity
time	time required for posture adjustment	ease of use
fatigue	self-rated on a scale of 1 to 10	comfort
pain	self-rated on a scale of 1 to 10	comfort

Both methods on SC and bed were rated three times for each patient, and the average with SD was calculated.

stroke showed a large amount of pharyngeal residue after the intake of 2 ml of nectar-thick liquid in a 45° reclining position. However, in a 45° reclining position combined with rotation of the trunk to the right and head to the left, the bolus was transported to the right pyriform sinus to the right upper esophageal sphincter (UES), leaving negligible amounts of residue. Therefore, this posture (45° reclining + right trunk rotation + left head rotation) was selected as the optimal swallowing posture for this patient. Direct training using jelly was initiated in this posture.

Case 2: A 66-year-old male with brainstem infarction (right medulla and cerebellum) began undergoing intervention for dysphagia at 101 days post-stroke. At the initial evaluation, the patient was conscious and exhibited left hemiparesis (Stroke Impairment Assessment Set; SIAS 43444). His cognitive function was normal (27 points on RCPM). Saliva retention in the pharynx and a wet voice were observed. His RSST index was 2, and the MWST was not administered. His functional severity score, as evaluated by the DSS, was 2. He was dependent on a gastrostomy tube to meet all nutritional and hydrational needs. VFSS at 117 days post-stroke showed aspiration with the intake of 2 ml of nectar-thick liquid in the 45° reclining position. However, with the trunk rotated to the left and head rotated to the right in the same position, the bolus was transported from the left pyriform sinus to the left UES without aspiration. Therefore, this posture (45° reclining + left trunk rotation + right head rotation) was considered to be the optimal swallowing posture and direct training using jelly was initiated in this position.

Case 3: A 70-year-old male with acute pneumonia began undergoing intervention for dysphagia 51 days after onset. At the initial evaluation, the patient was conscious, with no paralysis of upper and lower extremities and normal cognitive function (25 points on RCPM). His RSST index was 2 and the MWST index was 3a. His functional severity score, as evaluated by the DSS, was 2. He was dependent on a nasogastric tube to meet all nutritional and hydrational needs. VFSS at 59 days after onset showed a minimal bolus flow through the UES with the intake of 2 ml of nectar-thick liquid in the 45° reclining position. In the same reclining position combined with the head rotated to the left, a small amount of bolus passed through the UES but a large amount of pharyngeal residue remained. Then the trunk was additionally rotated to the left while keeping the reclining posture and right head rotation, and in this posture, the bolus was transported to the left side of the pharynx and passed through the left UES, leaving negligible amounts of residue. Therefore, this posture (45° reclining + left trunk rotation + right head rotation) was selected as the optimal swallowing posture for this patient. Direct training using thick liquid was initiated.

The optimal combined postures recommended on the basis of the VFSS examination were adjusted under two conditions: adjusted on a bed (hereafter, "conventional method") and on the SC (hereafter, "SC method") by the attending speech-language pathologist (SLP) during direct training in all three cases. These direct training sessions by the conventional method and by the SC method were video-recorded and other SLPs analyzed the video. The evaluation criteria included the following: items necessary for posture adjustment and number (simplicity), time required for posture adjustment (ease of use), and degree of fatigue and pain experienced by the patient (comfort). Both methods were rated three times for each patient, and the average rate was calculated. The time required for posture adjustment was measured using a stop-watch. The degree of fatigue and pain was self-rated by the patients on a scale of 1 to 10.

Results

The results for each patient are shown in Table 3. Figure 3 shows specific examples of the posture adjusted by the conventional method and by the SC method. For Case 1, the item required for posture adjustment was one pillow, the time required for posture adjustment was 85 ± 4 s, and the score for fatigue and pain was 0 by the SC method. However, by the conventional method, three pillows and three towels were required for posture adjustment, which took 132 ± 23 s, and the score for fatigue and pain was 7.0 and 3.0, respectively. For Case 2, the items required

Table 3. Results of measurements.

	Case 1		Case 2		Case 3	
	SC	Conventional	SC	Conventional	SC	Conventional
number of items	1 pillow	3 pillows 3 towels	1 pillow 1 towel	5 pillows 4 towels	2 towels	5 pillows/1 blanket 6 towels
time (sec)	85±4	132±23	62±9	174±24	102±7	230±16
fatigue	0	7.0	0	2.7	3.0	5.0
pain	0	3.0	0.3	3.3	0	0

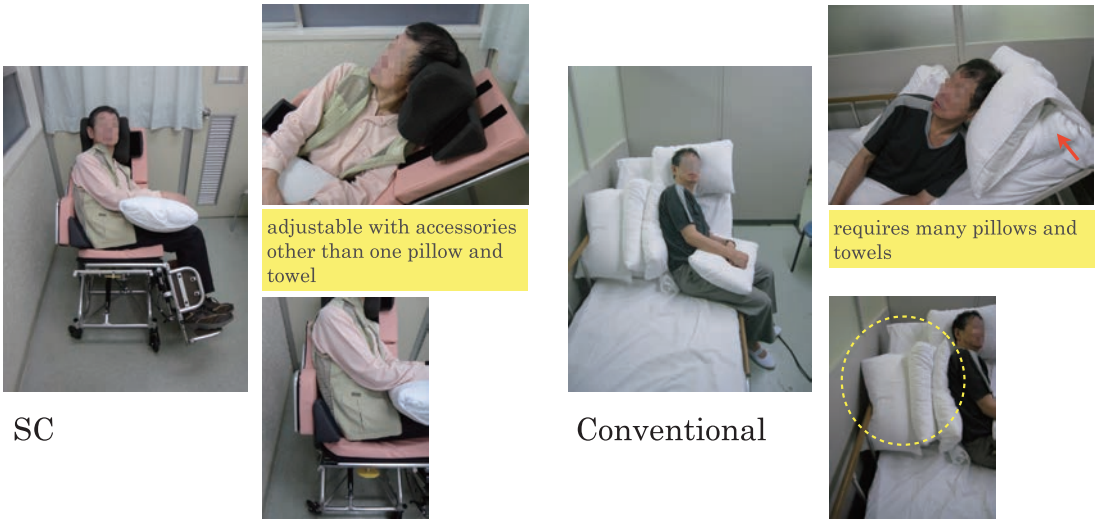

Figure 3. Specific examples of postural adjustment using the SC or a bed.
The posture combining reclining by 30 degrees, left rotation of the trunk, and right rotation of the head was compared using the SC (left) or a bed (right). The items required for posture adjustment were one pillow and one towel when using the SC, compared with five pillows and four towels when using the bed.

for posture adjustment were one pillow and one towel, the time required for posture adjustment was 62 ± 9 s, and the score for fatigue and pain was 0 and 0.3, respectively, by the SC method. However, by the conventional method, five pillows and four towels were required for posture adjustment, which took 172 ± 24 s, and the score for fatigue and pain was 2.7 and 3.3, respectively. For Case 3, the items required for posture adjustment were two towels, the time required for posture adjustment was 102 ± 7 s, and the score for pain and fatigue was 3.0 and 0, respectively by the SC method. By the conventional method, posture adjustment required one blanket, five pillows, and six towels and 230 ± 16 s, while the score for fatigue and pain was 5.0 and 0, respectively. Taken together, the SC method required fewer items and shorter time with a lower degree of pain and fatigue compared with the conventional method.

Optimal posture adjustment and food type for the direct training and meal consumption were reassessed during the course of intervention using VFSS and VE. All patients showed an improvement in posture and/or food type and meal frequency (Table 1).

Discussion

Posture adjustment is a useful compensatory technique in swallowing rehabilitation. Repeated swallowing in a safe and efficient position is known to improve neuromuscular function, leading to early recovery of swallowing ability in patients with dysphagia [3]. Therefore, it is important to identify the posture that prevents aspiration and enhances the safety of swallowing for each patient. It is also worth emphasizing the use of a recommended posture while swallowing during training and meal consumption. We developed the Swallow Chair, which can be used during examination, rehabilitation, and meal consumption and ensures reproduction of the recommended posture with simplicity, ease, and comfort.

In this study, we compared the number of items necessary for the posture adjustment, time required, and degree of pain and fatigue when the posture was

adjusted on a bed or on the SC. In all the patients, the number of items was fewer and the time required for posture adjustment was shorter, and subjective fatigue and pain were lower by the SC method than by the conventional method.

In the clinical setting, complexity, excessive time required, fatigue/pain issues, and poor reproducibility are common problems associated with posture adjustment. Combined postures involving reclining and rotation of the trunk and head, such as those used in this study, are particularly difficult to accomplish when the adjustment is performed on a bed. Patients often complain about fatigue or pain in the shoulders and hips, making this adjustment impractical. However, the SC makes posture adjustment simple, easy to use, and comfortable.

This study has some limitations. The SLP involved was aware of the purpose of the study, which may have introduced some bias. In addition, we did not verify posture reproducibility because of the difficulty of clinically measuring postural angles in the combined posture. Despite these limitations, the advantages of the SC are evident. With the SC, it is possible to monitor the reclining angle and specify the rotation angle of the seat. In addition, the SC comes with various accessories that support the posture of each individual patient (e.g., pillows), thus theoretically enabling highly accurate posture adjustment. Moreover, the SC can be used during examination, training, and meal consumption. Conventionally, different devices are used for posture adjustment for each circumstance: a special chair is used during VFSS, a wheelchair is used during treatment, and a bed is used during meal consumption; this makes it difficult to evaluate whether the posture is adjusted in the same manner in different situations. The SC enables the recommended posture to be achieved directly in treatment and meal consumption (Fig 4).

The simple operation by the SC with its accessories reduced the time required for posture adjustment. Since the optimal posture should be decided quickly in the evaluation setting, the SC is useful for quickly achieving the intended posture, which also leaves more time for exercising in the treatment setting and reduces the workload on nurses in a ward.

Comfort is also important in the clinical setting. The SC provides head and trunk stability and prevents fatigue and pain, enabling a posture to be maintained for longer. A stable and comfortable posture expands the application of direct exercise. Because of these advantages, the SC could be continuously used by all patients in this study, resulting in rapid improvement in food type and meal frequency during the intervention.

In conclusion, the SC is a simple, easy-to-use, and comfortable device for reproducibly adjusting posture during evaluation, training, and meal consumption in dysphagic patients. The SC was demonstrated to be effective for swallowing rehabilitation.

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Figure 4. Consistency of posture throughout evaluation, treatment, and meal consumption.
The SC provides consistent posture adjustment: the posture recommended by VFSS can be adjusted reproducibly during treatment and meal consumption.
Videofluoroscopic image (right), Posture adjustment in VFSS (middle), Posture adjustment in meal consumption (right).

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