Beds with angle indicators and head lift function contribute to appropriate positioning during eating and low incidence of pharyngeal residue

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Introduction

The presence of a pharyngeal residue, defined as the material remaining in the pharynx, is a sign of a swallowing disorder and a clinical predictor of aspiration. Healthcare professionals adjust the eating pattern and patient posture to reduce the amount of pharyngeal residue in order to prevent aspiration pneumonia. One of the effective methods for reducing the amount of pharyngeal residue is proper positioning to achieve appropriate trunk tilt and head and neck flexion angle [1]. To avoid pharyngeal residues during eating, the trunk tilt and head and neck flexion angle must match the recommended angle based on the evaluation of the swallowing function, such as video endoscopy (VE). In our previous study, beds with angle indicators and head lift function resulted in better angle as compared to conventional beds in healthy individuals [2]. Our next challenge is to investigate the reproducibility of the recommended angle and reduction of the amount of pharyngeal residue by using a bed with angle indicators and head lift function in patients with swallowing disorders during mealtimes. Performing VE, which was used to decide the recommended angle of trunk tilt and head and neck flexion, based on the evaluation of the pharyngeal residue during mealtimes is difficult due to its invasiveness. Therefore, no previous studies have compared pharyngeal residues in patients with swallowing disorders between the recommended angles and angles during eating. Recently, a newly established technique has been reported to be able to noninvasively identify pharyngeal residues during mealtimes with the use of an ultrasound device [3]. Ultrasonography is noninvasive and can be performed repeatedly. Additionally, no special diet is required during examination; thus, imaging can be performed while the patient is consuming his normal diet. Therefore, we propose to use ultrasonography to evaluate the effect of beds with angle indicators and head lift function on pharyngeal residue reduction during daily mealtimes.

The present study aimed to investigate 1) the reproducibility of the recommended trunk tilt and head and neck flexion angle by using a bed with angle indicators and head lift function in patients with swallowing disorders during

mealtimes and 2) the effect of a bed with angle indicators and head lift function on the reduction of the amount of pharyngeal residue during mealtimes.

Methods

This cross-sectional observational study was conducted in a university hospital with approximately 1,400 beds. All patients used either beds with angle indicators and head lift function (AX-72153T: SEAHONENCE Inc., Osaka, Japan) or standard beds. There were no criteria for the use of functional and standard beds. Patients were randomly allocated, irrespective of the severity of their dysphagia. Therefore, this study was an observational study with only observations made during VE assessment and feeding. We recruited patients diagnosed with a swallowing disorder by VE. The inclusion criteria were as follows: 1) patients admitted to the hospital between June and October 2023 and 2) who started oral intake after VE. The exclusion criteria were 1) patients whose oral intake was not recommended according to the VE assessment findings, 2) patients with severe dysphagia who were not medically stable, 3) patients with deteriorating general condition, 4) patients for whom the echo probe could not be applied during eating due to the presence of a neck collar or a central venous catheter, 5) patients aged <20 years, and 6) patients who had not been evaluated for swallowing ability for three types of food (staple foods, side dishes, and liquids) during swallowing assessment using VE. The bed with angle indicators and head lift function has indications of the backrest and head lift angle, whereas standard beds do not have

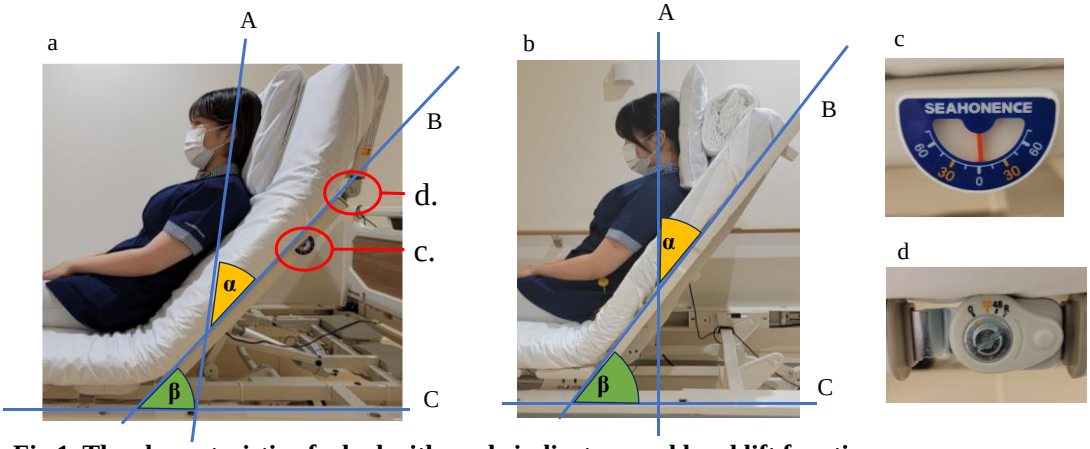

Fig 1. The characteristic of a bed with angle indicators and head lift function

a. A bed with angle indicators and head lift function
b. A bed without angle indicators and head lift function
c. An angle indicator of the backrest angle
d. An angle indicator of the head lift angle
A. A straight line connecting the top of the patient's head and the external ear canal
B. Outer edge of the backrest
C. Outer edge of the bedframe
Head and neck flexion angle was defined as the angle formed by the intersection of A and B (α).
Trunk tilt angle was defined as the angle formed by the intersection of B and C (β).

indicators of the backrest and head lift angle or a head lift function. The backrest's range of movement is 0º–80º for both beds, and the range of movement of the head lift function is 0º–30º. The trunk tilt angle was defined as the angle formed by the outer edge of the backrest and the outer edge of the bedframe. The head and neck flexion angle was defined as the angle formed by the intersection of the straight line connecting the top of the patient's head and the external ear canal and the outer edge of the backrest (Fig 1). The recommended trunk tilt angle and head and neck flexion angle and those during eating were measured using a Todai angle meter. The agreement of the recommended angle and the angle during eating were evaluated. The agreement between the recommended angle and the angle during eating was defined as only when both trunk tilt angle and head and neck flexion angle during eating matched with the recommended angle. The acceptable error margin for the trunk tilt angle was within ±5º from the recommended angles. The error margin for the head and neck flexion angle was within ±2.5º from the recommended angles. Pharyngeal residue measurements were taken during eating after the trunk tilt and head and neck flexion angles had been measured.

Pharyngeal residues of the glottis valley and right and left pisiform fossa were confirmed using a wireless ultrasound diagnostic device (iViz air: Fuji Film Medical Corporation, Tokyo, Japan). When viewing the epiglottis valley, the probe was applied transversely from just above the hyoid bone. When imaging the right pisiform fossa, the probe was applied transversely from the right side of the laryngeal ridge, whereas when imaging the left pisiform fossa, the probe was applied transversely from the left side of the laryngeal ridge (Fig. 2). Ultrasound movies were taken for 2–15 seconds to ensure that the imaging point was accurately captured. The pharyngeal residues were determined as hyper-echoic areas in the hypo-echoic areas in the

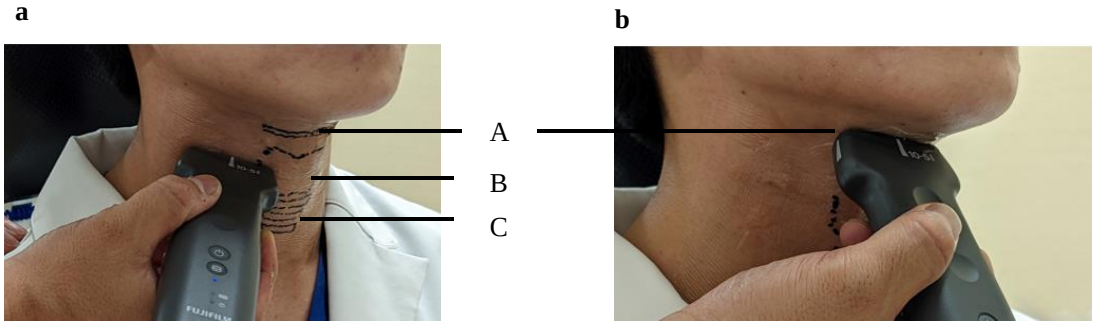

Fig 2. Echo probe location when imaging the pisiform fossa and glottis valley

a. Probe location for the imaging of the pisiform fossa

A . Hyoid bone. B . Thyroid cartilage. C . Cricoid cartilage

When observing the right pisiform fossa, the probe is applied transversely from the right side of the laryngeal ridge; when observing the left pisiform fossa, the probe is applied transversely from the left side of the laryngeal ridge.

b. Probe location for the imaging of the glottis valley

Probe is applied transversely from just above the hyoid bone.

epiglottis valley and pisiform fossa.

We compared the agreement between the recommended angle and angle at the time of eating between patients placed on the beds with angle indicators and head lift function (functional group) and patients on the standard beds (standard group). We also compared the presence of pharyngeal residue between two groups.

This study was approved by the Medical Research Ethics Review Committee of Fujita Medical College (approval number: HM23-080).

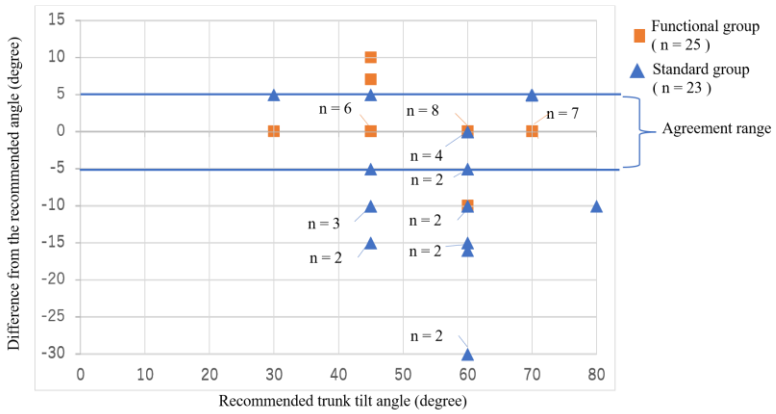

Fig 3. Difference between the recommended trunk tilt angle and trunk tilt angle at eating

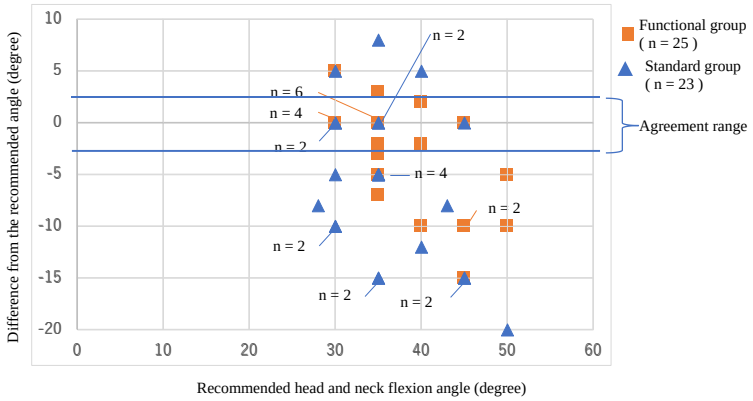

Fig 4. Difference between the recommended head and neck flexion angle and the angle at eating

Results and discussion

VE assessment was performed on 156 patients. After excluding 108 patients, 48 patients were enrolled in the study, including 25 patients assigned to the functional group and 23 patients assigned to the standard group. In the functional and standard groups, the number of men [n (%)] was 17 (68.0) and 14 (60.9), respectively. The mean age [± standard deviation (SD)] of the functional and standard groups were 76.0 ± 13.1 and 72.2 ± 14.5 years, respectively. The mean BMI (± SD) was 20.2 ± 3.9 and 18.8 ± 5.4 kg/m^2, respectively.

The agreement number between the recommended and eating angles [n (%)] was significantly greater in the functional group [14 (56.0)] than in the standard group [2 (8.7)] ($p < 0.01$). The errors between the recommended trunk tilt angle and the angle at eating differed by up to 10º and −15º in the functional and standard groups, respectively. The error ranges of the functional and standard groups were mostly within ±5º and mostly outside ± 5º. In both the functional and standard groups, the angle at eating tended to be lower than the recommended angle. The error tended to increase as the recommended angle became higher (Fig. 3). The maximum errors between the recommended head and neck flexion angle and the angle at eating were 15º and 20º in the functional and standard groups, respectively. In both the functional and standard groups, the angle at eating tended to be lower than the

recommended angle. The error tended to increase as the recommended angle became higher (Fig. 4). The errors (degrees: mean ± SD) between the recommended trunk tilt angle and the angle at eating were 0.3º ± 3.2º and −8.5º ± 9.6º. The error was significantly lower in the functional group ($p < 0.001$). Residual presence [n (%)] was significantly lower in the functional group [11 (1.8)] than in the standard group [34 (6.3)].

This investigation was the first study that showed better agreement between the recommended angle and the angle at eating patients with swallowing disorders utilizing beds with angle indicators and head lift function as compared to those patients utilizing the conventional beds. Moreover, the ultrasound images successfully showed that better agreement was effective in preventing pharyngeal residues during usual mealtimes.

In the future, we plan to develop a pharyngeal residue monitoring system embedded in a bed. We expect that the bed will be able to determine the appropriate trunk tilt and head and neck flexion angles based on information obtained by the monitoring system and will automatically adjust its posture during mealtimes. This system will contribute to safe and comfortable eating without pharyngeal residues among people with swallowing disorders.

Conclusion

The trunk tilt and head and neck flexion angle during eating is more likely to agree with the recommended angle when using a bed with angle indicators and head lift function as compared to a standard bed, resulting in a lower incidence of pharyngeal residue.

Acknowledgements

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