

# Clinical Advantages of Eating Positions of the Mid-Neck on Swallowing Function

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**Abstract.** [Purpose] There is an established theory that slightly flexed neck positions are ideal for all patients with swallowing disorders. However, we noted that this theory needs further study of the effects of the mid-neck positions on the extended line from the trunk on swallowing function. [Subjects and Methods] Examinations were made using video fluorography (VF) recording of 10 swallowing disorder patients without aspiration in the upright seated position, and another 10 in the reclining position. We edited the recordings to obtain frame-by-frame static images, and examined time and extents of oral and the pharyngeal transits, and laryngeal elevation, using two-dimensional image analysis software. [Results] The results show there was a significantly longer oral transit time and a shorter pharyngeal transit time in the reclining position group compared to the upright seated group. However, there was no significant difference in either laryngeal transit time or the extent of laryngeal elevation. [Conclusions] The results suggest that apart from the uniform application of a slightly flexed neck position for all patients, the mid-neck angle adjustment is useful for making fine adjustment of oral and pharyngeal transit times in order to secure safe bolus transit in rehabilitation strategies.

**Key words:** Swallowing disorders, Neck, Rehabilitation

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## INTRODUCTION

There are increasing numbers of patients with eating and swallowing disorders associated with various diseases and aging. Eating and swallowing disorders may induce fatal diseases or disorders, such as aspiration pneumonia and asphyxia, which are the fourth biggest cause of death in Japan. There are three major therapeutic strategies for eating and swallowing disorders, namely, rehabilitation therapies including functional training and eating training, surgery, and substitution methods involving nasogastric tubes and gastrostomy. Rehabilitation can be conducted for most patients, however, its efficacy varies, and depending on the efficacy, other strategies may be needed. One of the measures for making an objective assessment in the design of therapeutic strategies is video fluorography (VF). VF images help medical professionals to identify the functions and organs affected, and to determine the necessary treatment items for each patient, such as an appropriate eating position and food bolus volume.

There are two determining elements of eating positions, neck angles and trunk angles. For neck angles, a slightly flexed neck position contributes prevention of aspiration by relaxing hyoid muscles, and creating an appropriate angle with the pharynx and the trachea. With regard to trunk angles, a reclining position is also effective at preventing aspiration facilitating bolus transit under gravity, and

anatomical positioning of the trachea above the esophagus. Some studies have reported that slightly flexed neck positions should be used for all patients<sup>1-3)</sup>, and trunk angles should be determined by taking account of a patient's condition<sup>3-6)</sup>. However, no studies have ever assessed the effects of the mid-neck position<sup>7)</sup> on the extended line from the trunk.

Apart from the established merit of slightly flexed neck positions, this study examined the effects of eating positions, with the mid-neck position on the extended line from the trunk, on oral and pharyngeal bolus transit and laryngeal movement using VF-based kinetic analyses, to determine eating positions for rehabilitation strategies for eating and swallowing disorder patients.

## SUBJECTS AND METHOD

We examined lateral VF images of 10 patients with eating and swallowing disorders in the upright seated position (aged  $68.50 \pm 13.35$ ), and those of 10 patients in the reclining position (aged  $78.40 \pm 11.14$ ). The subjects were chosen from among 204 outpatients of the Eating and Swallowing Department of a University hospital. In the selection process, due to privacy considerations, we used duplicate VF images, data blind except for age, and ID numbers. First, 88 patients without aspiration throughout the entire swallowing purposes were selected by naked-eye observation of the VF images. Subsequently, 20 patients were chosen from

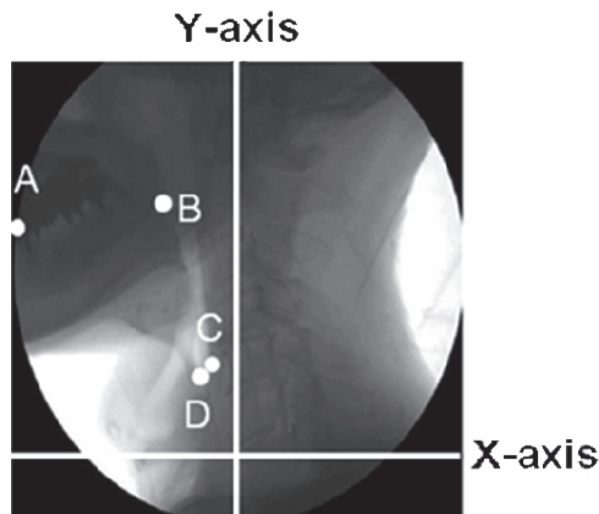


Fig. 1. Upright seated position

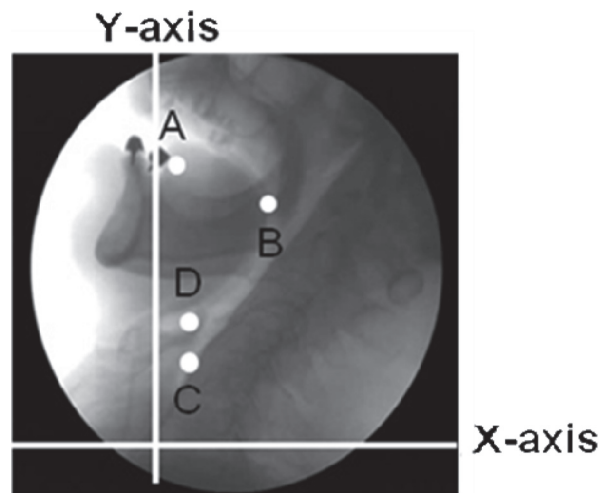


Fig. 2. Reclining position

among them who satisfied the following five conditions; (a) a jelly medium was used for the VF examination, (b) a high-quality recording was obtained, (c) there was no indwelling tube nor cannula, (d) the region could be observed without overlapping images of the neck or humeral articulation, and (e) the recording was of the first VF examination. In order to divide the 20 patients by eating position, we adopted the following procedures. The reference lines passing through the anterior-inferior corner of the seventh cervical vertebra horizontally and vertically were defined as the X-axis and Y-axis, respectively. Our definition of the upright seated position was a position with the base of the tongue (B) plotted on the left side of the Y-axis (Fig. 1), and that of the reclining position was a position with the base of the tongue on the right side of the Y-axis (Fig. 2). The measurement of the reclining angles was impracticable without the top of the head, which is the moving axis in joint range of motion, appearing in the images.

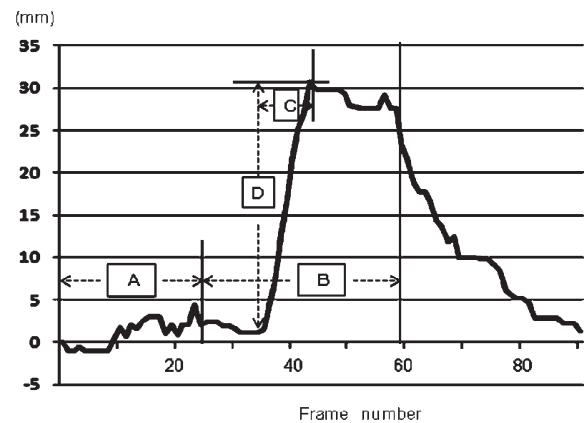


Fig. 3. Time and the extent (ID 4403 in the upright seated position)

The VF recordings of the 20 subjects differed in duration and the number of swallowings due to individual differences in eating and swallowing function.

The images of the first jelly administration of the first VF examination were used. The VF recordings were captured at 30 frames per second. Using two-dimensional image analysis software, DIPP-Motion Pro™D (DITECT CO., LTD., 1-8 Nanpeidai-cho, Shibuya-ku, Tokyo, 150-0036, Japan), we edited the recordings to obtain frame-by-frame static images and at the same time we manually plotted four coordinate points: (A) bolus head, (B) the base of the tongue, (C) the lower end of the pharynx, and (D) the upper end of the larynx (Figs. 1, 2). We digitized the data acquired and plotted them on a line graph (Fig. 3).

We analyzed oral transit time, pharyngeal transit time, laryngeal elevation time and laryngeal elevation extent using the Mann-Whitney test, with a 5% significance level.

The subjects were fully informed about the experiment, and the study received prior approval from the Ethical Committee of Nagasaki University Graduate School of Biomedical Sciences.

## RESULTS

The means and standard deviations of the oral transit times were  $0.24 \pm 0.31$  seconds in the upright seated position group and  $1.08 \pm 0.86$  seconds in the reclining position group, and there was a significant difference between the two patient groups ( $p=0.009$ ).

The means and standard deviations of the pharyngeal transit times were  $1.07 \pm 0.18$  seconds in the upright seated position group and  $0.82 \pm 0.26$  seconds in the reclining position group, and there was a significant difference between the two patient groups ( $p=0.028$ ).

The means and standard deviations of the laryngeal elevation times were  $0.32 \pm 0.13$  seconds in the upright seated position group and  $0.39 \pm 0.23$  seconds in the reclining position group, without significant difference between the two patient groups ( $p=0.43$ ).

The means and standard deviations of the laryngeal

**Table 1.** Item comparison of the upright seated position group and reclining position groups

Items	Upright	Reclining
Oral transit time	0.24 ± 0.31sec	1.08 ± 0.86sec**
Pharyngeal transit time	1.07 ± 0.18sec	0.82 ± 0.26sec*
Laryngeal elevation time	0.32 ± 0.13sec	0.39 ± 0.23sec
Laryngeal elevation extent	29.24 ± 6.88mm	28.16 ± 8.08mm

\*\*p<0.01, \*p<0.05, Mean ± SD

elevation extents were 29.24 ± 6.88 mm in the upright seated position group and 28.16 ± 8.08 mm in the reclining position group, without significant difference between the two patient groups (p=0.75) (Table 1).

## DISCUSSION

The purpose of our study was to examine the effects of oral and pharyngeal food bolus transit and laryngeal movement in relation to mid-neck position on the extended line from the trunk to verify the established theory that regardless of trunk angle, neck angle should be kept in a slightly flexed position. A further aim was to help to establish the ideal eating positions for eating and swallowing rehabilitation.

Pharyngeal transit time was shortened by reclining the trunk angle from 90 degrees (upright seated position). This result is in agreement with previous studies<sup>3-6)</sup> which reported that reclining trunk angles have positive effects on food bolus and pharyngeal transit. Trunk angle had a significant effect on pharyngeal transit time. However, it did not significantly affect the laryngeal movement time and the elevation extent. This demonstrates that in laryngeal movement, the subjects had no clear functional disorder since there was no aspiration with the jelly medium. Hata, et al.<sup>8)</sup> videofluorographically recorded bolus transit from the middle part of the tongue to the pharynx and measured its velocity using a videotimer counter and three kinds of examination medium: jelly, thick porridge, and thickened water. They concluded that regardless of the trunk angle, the transit time of thick water was the shortest followed by jelly and thick porridge. The corresponding author of the present study et al.<sup>9)</sup> measured the laryngeal movement times of healthy adults drinking water at room temperature with their necks flexed at 20 degrees and extended at 10 degrees. The laryngeal movement time of neck extension was significantly longer than that of neck flexion. In the present study, we found no significant change related to trunk angle in laryngeal elevation time, however, the fact that the laryngeal elevation time was longer in the reclining position group suggests that setting mid-neck positions on the extended line from the trunk has little effect on laryngeal movements when subjects swallow amorphous objects such as thickened water, or the neck is not set in extended to over-extended positions.

The most important achievement of our study is that we were able to demonstrate a significant difference in the oral transit time of jelly from the oral cavity to the base of the

tongue. It was shorter in the upright seated position group, whereas it was longer in the reclining position group. There was a significant difference between the two groups. Haseda et al.<sup>10)</sup> examined the correlation between swallowing disorder grades and neck extension angles both in an upright seated position group and a bed-back rest group. They found a significant difference in the upright seated position group, but not in the latter. Castell et al.<sup>11)</sup> explained that the neck is extended, oral positive pressure is more likely to be maintained, meaning it would take more time to create negative pressure. Longmann<sup>5)</sup> pointed out that slow backward inclination of the neck is effective for patients with difficulties with tongue control and bolus transit. Our study also suggests that setting a mid-neck position on the extended line from the reclining position leads to slow speed bolus transit, stabilization of the neck by the extended backrest of VF-test chair, and ideal muscle length. In addition, some improved oral functions such as velopharyngeal function, cooperativeness of swallowing, and breathing for safe eating and swallowing were confirmed.

In our study, the effects of trunk angle change from upright to reclining on remained the same. However, the prolongation of bolus transit time was found in the position with the mid-neck reclined, as opposed to the position with the mid-neck upright seated. In rehabilitation for eating and swallowing disorders, the angle setting has played an effective role in the fine adjustment of the oral transit time of patients incapable of voluntary oral function control due to oral function disorders caused by aging, swallowing disorder, disturbance of consciousness, or dementia. Consequently, we conclude that mid-neck angle adjustment is effective for fine adjustment of oral transit time as well as bolus velocity.

The establishment of basic data for determining the eating position of swallowing disorder patients would be beneficial for further research into the possible setup effects of the neck, trunk, pelvic girdle, legs<sup>12)</sup> and arms on eating and swallowing function and its risks.

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The authors declare that they have no conflict of interest.

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