Influence of Experimental Palatal Plate on Mandibular Position during Continuous [n] Phonation in Complete Denture Wearers

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Abstract: The objective of this study was to clarify the influence of the thickness of a palatal plate on the mandibular position during continuous [n] phonation in complete denture wearers. Ten complete denture wearer volunteers (mean age of 76.4 years) were investigated. Two kinds of experimental palatal plates with a thickness of 3 mm and 5 mm (from the denture basal surface to the denture polished surface) were fabricated and used for each subject. The mandibular position was recorded by a K7 mandibular kinesiograph during continuous [n] phonation and at the physiologic rest position under three conditions: wearing a palatal plate with a thickness of 3.0 mm or 5.0 mm and not wearing a plate (control). These results showed that there was no statistically significant difference in the interocclusal distance during continuous [n] phonation with or without the experimental palatal plates. Furthermore, no significant difference in the interocclusal distance in the physiologic rest position was found in the above comparisons. With the limitations of this study, we concluded that the mandibular position during continuous [n] phonation in complete denture wearers was not influenced when the thickness of the palatal plates was 5 mm or less.

Key words: Palatal plate, phonetic method, interocclusal distance, continuous phonation of [n], complete denture wearers

全部床義歯装着者における実験用口蓋床の厚さが
[n] 持続発音時の下顎位に及ぼす影響

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要旨：本研究の目的は、全部床義歯装着者における実験用口蓋床の厚さが[n]持続発音時の下顎位に及ぼす影響を明らかにすることである。被験者として全部床義歯装着者10名（平均年齢76.4歳）を選択した。厚さ3.0mmと5.0mm（義歯床粘膜面から義歯床磨耗面までの距離）の2種類の実験用口蓋床を作製し、各被験者に応用した。下顎運動計測器K7を用いて、厚さ3.0mmもしくは5.0mmの口蓋床装着時および口蓋床非装着時（コントロール）の3条件で、[n]持続発音と下顎安定時の下顎位を記録した。その結果、[n]持続発音時の顎間距離では、2種類の口蓋床装着時と非装着時の間に有意差が認められなかった。下顎安定時の顎間距離においても同様に3条件間で有意な差は認められなかった。以上より、全部床義歯装着者における口蓋床の厚さが5mm以下ならば、[n]持続発音時の下顎位には影響を及ぼさない可能性が示された。

索引用語：実験用口蓋床、発音利用法、顎間距離、[n]持続発音、全部床義歯装着者
Introduction

Determination of the correct vertical dimension of occlusion is considered to be particularly important during treatment with complete dentures. Many techniques have been proposed to determine the occlusal vertical dimension (OVD) for edentulous patients, including the use of the vertical dimension of the physiological rest position\(^1\), the speaking method\(^2\), pre-extraction records\(^3, 4\), cephalometric radiographs\(^5\), and the swallowing method\(^6\). However, there is no universally accepted or completely accurate method of assessing OVD in edentulous patients\(^7, 8\).

Phonetics has been a popular guide for determining the OVD. The continuous phonation method has been studied, especially, for determining the mandibular position\(^9-12\). In clinical practice, when determining the OVD, the palate would be covered by a palatal plate, and, thus, the thickness of this plate may affect the articulatory process. However, the relationship between the thickness of a palatal plate and the mandibular position in complete denture wearers had not yet been studied in detail.

The purpose of this investigation was to evaluate the effect of experimental palatal plates on the mandibular position during continuous [n] phonation in complete denture wearers.

Materials and Methods

Subjects

Ten edentulous subjects, 7 males and 3 females, participated in this study. Their mean age was 76.4 years (ranging from 67 to 91 years). The dentures had been supplied by the Division of Removable Prosthodontics, Department of Restorative & Biomaterials Sciences, Meikai University School of Dentistry, Japan. The inclusion criteria of the subjects included the following: (1) wearing complete denture using at least six months but no longer than five years, and (2) complete denture with adequate retention, stability, support, and satisfaction. The exclusion criteria of the subjects included the following: (1) prostheses with inadequate retention, stability, or support, (2) systemic disease, (3) speech defect, and (4) temporomandibular disorders.

All participants were fully informed of the nature of the investigation, and written informed consent was obtained prior to enrollment. The experimental protocol was approved by the Ethics Committee of the Meikai University School of Dentistry (No.A 0603).

Experimental palatal plates

The dentures of all subjects were duplicated using a copy flask, irreversible hydrocolloid, and autopolymerizing resin (Fit Denture System, SHOFU Co., Kyoto, Japan). Two types of experimental palatal plates with different thicknesses were fabricated from autopolymerizing resin (Fit Denture System, SHOFU Co.). The thicknesses of the palatal plate were 3.0 mm and 5.0 mm from the denture basal surface to the denture polished surface in the hard palate area, and the margins of the palatal plate were smoothed to the lingual surface of the maxillary artificial teeth. The thickness of every palate plate was re-measured with a slide caliper (Matsui Measure, MFG. Co., Niigata, Japan) and confirmed before insertion. Occlusal interference due to the palatal plate was eliminated. The retention, stability, and posterior border of the palatal plate were also checked.

Kinesiographic assessment

The mandibular movement was measured using a kinesiograph (K 7 Evaluation System, Myotronics Research Noromed, Inc., Seattle, WA, USA). The equipment consisted of an array of sensors secured to the subject’s head that provided information on mandibular movements from the incisor point. When the mandible moved, the sensors tracked a small bar magnet attached to the labial midline surface of the lower central incisors. The kinesiograph was connected to a computerized system that records and displays spatial coordinates in the vertical and anteroposterior axes to the nearest 0.1 mm.
Research protocol

The participants were seated in upright position with their heads in a firm headrest. Each subject was instructed to keep his/her head as steady as possible during recording, facing forward, and with the Frankfort plane parallel to the ground. They were asked to pronounce the sound [n], starting from the intercuspal position (ICP), for 4s continuously at a normal conversational pitch and volume and then to return to the ICP.

Subsequently, the physiologic rest position was evaluated. After resting for a while, the subjects were asked to swallow and relax the jaw for a few minutes. Once a perfectly steady tracing of the mandibular position for 5s had been observed on the computer monitor, the rest position was then recorded, and the subjects were asked to close to the ICP.

The mandibular phonation position and physiologic rest position were measured under 3 conditions separately: without a plate (control condition) and with a plate of 3.0 mm or 5.0 mm in thickness. The recordings were repeated 4 times under each condition to obtain a mean value. Each type of palatal plate was inserted in a random sequence.

The distance between the incisal edges of maxillary and mandibular anterior teeth (interocclusal distance: IOD) in both the vertical and anteroposterior directions during continuous phonation of [n] under all three conditions was measured. Typical tracings of mandibular movement during continuous phonation of [n] are shown in Fig 1. The baseline in the figure indicates the mandibular position in the ICP. When the subject continuously phonated [n] as instructed, his/her mandible moved downward and backward from the starting point (SP) in Fig 1. The IOD during the course of the continuous phonation was measured at 4 separate points (I, II, III, and IV), where the time intervals from the starting point (SP) were 1s, 2s, 3s, and 4s, respectively. The average value of these 4 points in both the vertical and anteroposterior directions was calculated to represent the IOD of phonation. The IOD at the physiology rest position was also measured. Typical tracings of a mandibular movement are shown in Fig 2. Measurements were made with a millimeter ruler to an accuracy of 0.01 mm.

Statistical analysis

Statistical analysis of the data was performed by means of a variance analysis (ANOVA) with repeated measures and Bonferroni/Dunn. The values are presented as the mean ± standard deviation (s.d.). The significant level was set at p<0.05. Data were evaluated using statistical software (SPSS 14.0 for Windows; SPSS Inc., USA).

Results

Fig 3 shows the mean values of the vertical and an-
teroposterior direction IOD during continuous [n] phonation under three conditions. There was no significant difference among the three conditions, regardless of the axis.

Fig 4 shows the mean values of the vertical and anteroposterior interocclusal distance at the physiologic rest position under three conditions. No significant difference was found among the 3 conditions.

**Discussion**

Phonetic tests have been advocated as clinical aids in constructing oral prostheses for a long time. Silverman reported that the closest speaking space is constant throughout life and allows consistent determination of the occlusal vertical dimension (OVD). Several researchers reported that the [s] sound has been used to determine the OVD and the [m] sound has used to establish a desirable mandibular rest position. However, speaking spaces formed through sibilant sounds have wide interindividual variation and have adapted to anatomic characteristics. Gillings reported that sibilant sounds are not always reliable indicators of the closest speaking space and that additional clinical procedures may be necessary to establish a satisfactory OVD in complete denture fabrication. Thus, the character selected to determine the OVD should be one that is less influenced by the lips, teeth, and various types of prosthetic treatment.

As the characteristics between Japanese and English pronunciation are different, pronouncing the word of “sixty-six” and “Mississippi” properly is difficult for Japanese, especially elderly patients. The customary methods of using sibilant sounds to establish the OVD don’t have enough reproducibility and stability. Some studies have focused on the phonation of continuous vowels and consonants. It is admitted that the mandibular position was easily recorded during continuous phonation. Only the five vowels and [n] can be continuously phonated in Japanese pronunciation. Yamamoto et al. and Ohmori et al. found that the mandibular position during continuous phonation of [n] in 30 dentate subjects and 20 complete denture wearers was very close to the ICP in each subject and, furthermore, was more stable statistically than the physiologic rest position.

In pronouncing the consonants [t], [d], [n], or [l], the primary area of tongue palatal contact was the alveolar area, and only a small portion of the hard palate was involved. During continuous [n] phonation, the mouth is closed without tooth contact, and the expiration flows out through the nasal cavity. It is suggested that the mandibular position during continuous [n] phonation would be very slightly affected by the palate. Zhang et al. found that the mandibular position during continuous [n] phonation did not show significant change after insertion of an experimental plates with a thickness of less than 5 mm in dentate subjects. In the present study, the IOD during continuous [n] phonation in the subjects who had experimental palatal plate inserted had a slight increase in the
vertical direction and shift backwards, but there was no statistically significant difference (Fig 3). The mean values of the IOD during continuous [n] phonation were less than those of the physiologic rest position. Since there was no significant difference in vertical or anteroposterior direction with and without palatal plate of 3 and 5 mm in thickness, there was no significant influence of the experimental palatal plate on the IOD at the physiological rest position was detected in this study.

Conclusions

Within the limitations of this study, we concluded that the mandibular position during continuous [n] phonation was not affected by the experimental palatal plates in complete denture wearers.

References


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