

Original Article

Determining occlusal plane with the mandibular labial frenum as the anterior reference point.

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Abstract

Statement of problem: The oral care of elderly people is important, especially in an aging society. It is critical for rehabilitation of oral function with fixed or removable dentures when dentists facing the edentulous patient. The appropriate occlusal plane and establishment of the vertical maxillomandibular relations can meet the functional and esthetic demands for fixed or removable dentures.

Purpose: The purpose of this study was to measure the distances between the mandibular labial frenum and the incisal edge of the lower central incisor in a cohort of patients in order to use the average values of those distances as anterior reference points for determining mandibular occlusal planes.

Material and Methods: Casts collected from the participating patients including the clear landmarks of the mandibular labial frenum and the mesioincisal edge of the lower right central incisor were measured with a digital vernier caliper by only one clinician.

Results: The mean distances between the attachment of the mandibular labial frenum and the mesioincisal edge of the lower right central incisor in the male, female and all subjects were 12.0 ± 1.4 mm, 11.4 ± 1.1 mm and 11.3 ± 1.2 mm, respectively.

Conclusions: Collecting the records of healthy adults with no obvious teeth wear could help to determine the vertical dimensions of mandibular occlusal planes and the positioning lower anterior artificial teeth when dealing with full mouth rehabilitation.

Key words: lower central incisor, mandibular labial frenum, occlusal plane, vertical dimension

Introduction

The importance of long-term oral care for elderly people is increasing, especially in aging societies. According to a 2014 study by Wang¹, the prevalence of edentulism among individuals aged more than 65 years old in Taiwan was 24.3%. Hence, it is critical that dentists have an efficient and accurate means of reconstructing the occlusion when faced with fully edentulous elderly patients. Whenever fixed or removable dentures are

applied, an adequate occlusal plane is the key to success for full mouth rehabilitation. Specifically, the level of the occlusal plane created with the dentures should be as close as possible to the plane that was previously occupied by the natural teeth². At such level, the occlusal plane of the dentures will allow the tongue and cheek muscles to function normally. Furthermore, a well-designed prosthesis is important for good esthetics, i.e., the level of the occlusal plane can affect the proportion of the teeth displayed when smiling^{3,4}.

There are many methods for determining the occlusal plane⁵. The most commonly used method is utilizing non-mobile anatomical landmarks to achieve reasonable estimates of the upper and lower occlusal planes⁵. The level of the upper occlusal plane can be determined using the interpupillary line and the ala-tragus line. However^{6,7}, there is little information regarding what anterior reference point to use in determining the lower occlusal plane. The anterior anatomical landmarks of the mandible are the labial frenum, lingual frenum and vestibule⁸. The labial frenum is typically more visible than the lingual frenum in the mouth.

The labial frenum is a thin sheet of tissue that attaches to the center of the lower lip and between the lower two central incisors⁹. It is quite notable, and its location can be accurately recorded. In the edentulous condition, it attaches to the labial aspect of the lower ridge at the midline. This anatomical landmark can be used for the proper positioning of lower anterior teeth in their original position and to establish the level of the lower occlusal plane in full mouth rehabilitation patients.

The goal of this study was to measure the distance between the mandibular labial frenum and the mesioincisal edge of the lower central incisor in order to obtain objective data for clinicians.

Materials and methods

The present study was conducted in the Department of Prosthodontics of Shin Kong Wu Ho-Su Memorial Hospital in Taipei, Taiwan. The Ethics Committee of Shin Kong Wu Ho-Su Memorial Hospital approved the research protocol. The study involved the 52 mandibular stone casts which were obtained with alginate impressions in stock tray from 26 male patients and 26 female patients of the prosthodontic department of Shin Kong Wu Ho-Su Memorial Hospital. The included

stone casts should have the clear landmarks of the mandibular labial frenum and the incisal edges of the lower central incisors. The stone casts, which were made from 2014~2017, were selected for this study according to various inclusion/exclusion criteria.

The inclusion criteria were that the patient had to be aged from 21 to 25 years old and had to have a Class I dental relationship. The age criterion was due to the fact that the average eruption age of the lower third molar is 17-21 years old. Meanwhile, the average root completion age of the lower third molar is 18-25 years old. When the root of the lower third molar is completed, the individual in question is considered to have complete dentition¹⁰. The exclusion criteria were having dental prostheses; having teeth with excessive attrition, wear, supraeruption, or mobility; or receiving orthodontic treatment and labial frenectomy.

Point markings were made on each mandibular stone cast using a ball point pen marker. One point was marked at the mesioincisal angle of the right mandibular central incisors, and another point was marked on the attachment of the labial frenum. The occlusal plane of each of the casts was made parallel to the horizontal plane using a cast paralleling device on a Ney dental surveyor.

Each mandibular stone cast was placed on the cast holder of the dental surveyor, then the paralleling metal plate fixed to the surveying arm perpendicularly was lowered and adjusted to establish contact with the plate in at least three widely divergent points, one anteriorly and two posteriorly, on both sides (Fig. 1).

After the occlusal plane was orientated, the surveying arm with analyzing rod was lowered until the tip of the analyzing rod contacted the mark on the superior attachment of the labial frenum (Fig. 2). The value was then recorded by using the digital vernier caliper directly (Fig. 3).

The second value could then be recorded when the analyzing rod was elevated to the marking point on the mesioincisal edge (Fig. 4). The distance between the superior attachment of the mandibular labial frenum and mesioincisal edge of the lower central incisor could then be calculated from the subtraction of those two values (Table 1). The distance values for the casts were statistically analyzed with SPSS24 for MAC. The mean and the standard deviation (SD) of the measurements for all the subjects were calculated and statistically analyzed.

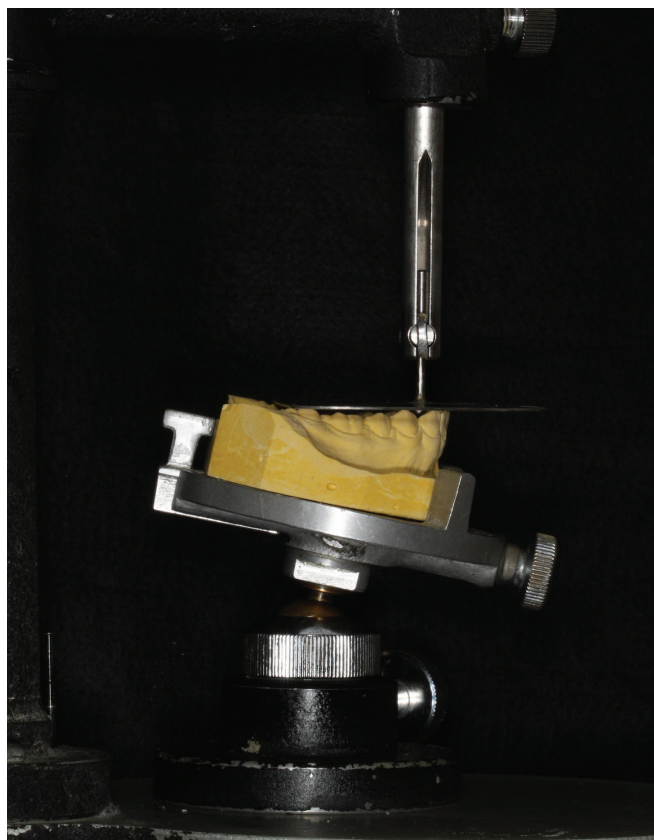


Figure 1. Cast paralleling device used to orient the cast on the surveyor.

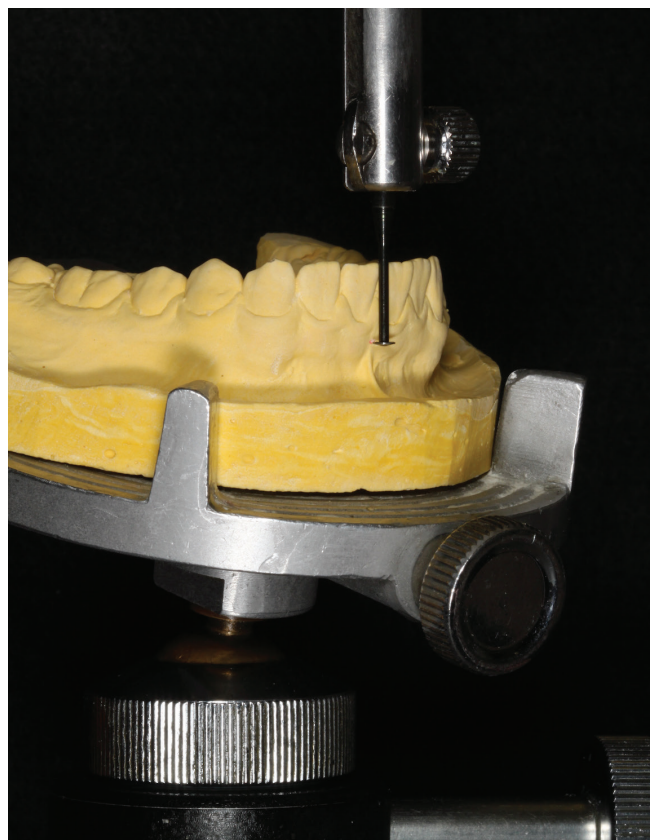


Figure 2. Analyzing rod contacting the superior attachment of the mandibular labial frenum.

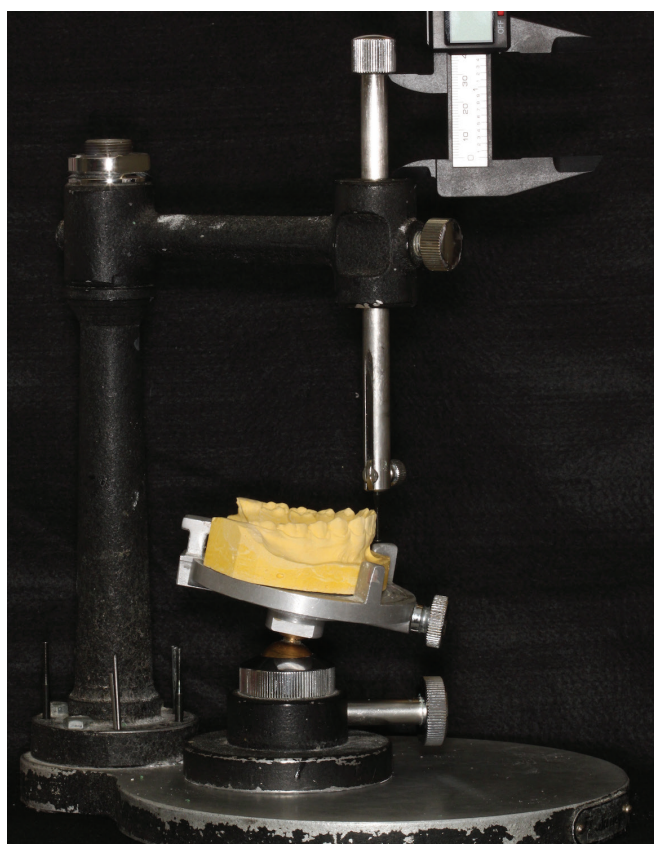


Figure 3. The distance between the two points on the vertical spindle of the surveyor was measured by a digital vernier caliper at the level of superior attachment of the mandibular labial frenum.

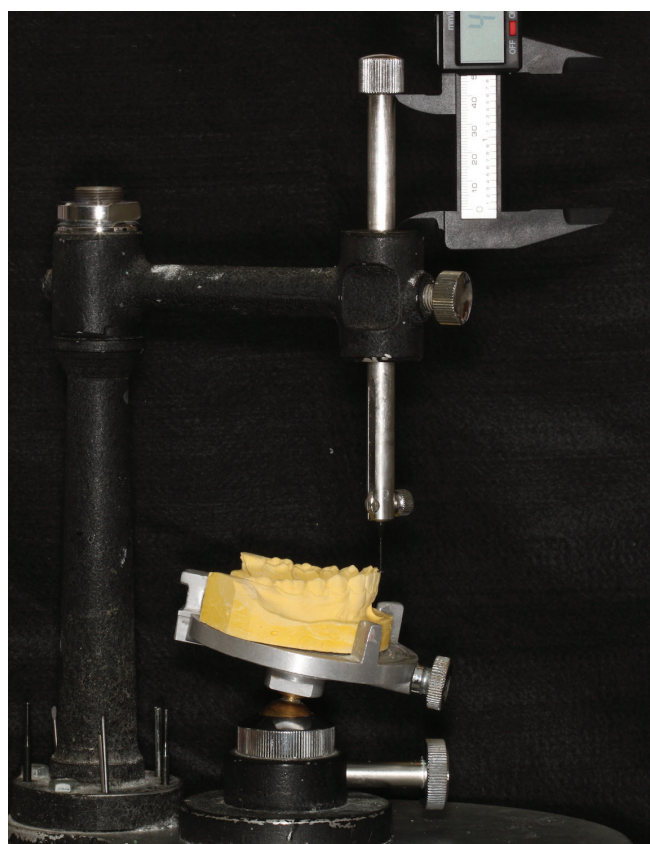


Figure 4. The distance between the two points on the vertical spindle of the surveyor was measured by a digital vernier caliper at the level of mesioincisal edge of the lower central incisor.

Table 1. Master table of values

MALE				FEMALE			
Patient No.	Model (in mm)	Patient No.	Model (in mm)	Patient No.	Model (in mm)	Patient No.	Model (in mm)
1	10.5	14	11.2	1	11.1	14	13.0
2	10.8	15	12.8	2	9.0	15	9.2
3	11.0	16	12.8	3	9.6	16	10.6
4	12.5	17	13.4	4	10.3	17	10.3
5	12.0	18	9.9	5	10	18	11.9
6	10.3	19	14.0	6	13.1	19	12.1
7	12.3	20	13.0	7	11.2	20	12.6
8	9.5	21	14.6	8	12.1	21	11.5
9	11.6	22	11.9	9	12.2	22	10.5
10	12.5	23	13.6	10	11.8	23	9.7
11	13.0	24	13.5	11	11.5	24	11.8
12	10.7	25	11.8	12	11.4	25	11.3
13	10.7	26	12.0	13	13.5	26	11.1

Results

The distances between the superior attachment of the mandibular labial frenum (MLF) and the mesioincisal edge of lower central incisor (LCI) in the male and female subjects are listed in Table 1. The distance from the MLF to the LCI in all of the subjects ranged from 9.0 to 14.6 mm, with mean ($\pm$ SD) of 11.3 ± 1.2 mm. In the male patients, ranged from 9.5 to 14.6 mm, with a mean ($\pm$ SD) of 12.0 ± 1.4 mm, as in the female patients, ranged from 9 to 13.5 mm, with a mean ($\pm$ SD) of 11.4 ± 1.1 mm (Table 2).

Table 2. Mean values and Standard deviation values (Mean $\pm$ SD)

	Total	Male	Female
Mean $\pm$ SD (in mm)	11.3 ± 1.2	12.0 ± 1.4	11.4 ± 1.1

Discussion

An adequate occlusal plane can fulfill esthetic demands, improve chewing efficiency and maintain the stability between the tongue and cheek; therefore, setting-up a reasonable occlusal plane is important for full mouth rehabilitation. However, when dealing with a patient on fully edentulous ridges or posterior teeth loss with remaining lower anterior teeth, it is hard to achieve a reliable occlusal plane. It is especially difficult to do so when a patient has supraerupted anterior

teeth or even combination syndrome. In short, it is frequently a challenge for dentists to accurately determine the anterior occlusal plane.

There are many measurement methods used to determine the appropriate occlusal vertical dimension, including the mechanical, physiological and esthetic approaches. However, the level of the occlusal plane is most commonly determined based on anatomical landmarks¹¹. Hence, pre-extraction records are often used to measure the occlusal plane⁵. The level of the upper occlusal plane can be obtained from hamular notch-incisive papilla¹² or the interpupillary line combined with the alar-tragus line.⁸ With respect to the mandibular occlusal plane orientation, the retromolar pad is often used as a posterior reference point¹³. The retromolar pad is relatively stable, even when the ridge severely resorbed. Meanwhile, many researchers have also surveyed various anterior reference points, including the lateral border of the tongue¹⁴, the commissure of the lips¹¹, the buccinator groove¹¹ and the mucolabial reflection¹⁵. However, there is much variation in anatomical landmarks, such that in comparison, the mandibular frenum is relatively stable.

The frenum is divided into the labial frenum and the lingual frenum. Many studies have used the lower lingual frenum as a landmark. But it was found that the superior attachment could be bundles not a single frenum. It is therefore difficult

to define the superior attachment. Furthermore, if the dentist wants to check the occlusal plane in the mouth, this frenum is difficult to distinguish when wax-denture is inserted. By comparison, the labial frenum is relatively easy to measure and mostly consists of a single frenum. As such, if the clinician takes an impression carefully, this anatomical mark can be easily measured.

Various methods used to measure the distances between two anatomical landmarks have been presented in previous studies. Among the most common, the first consists of using a divider to measure two given marks and then transferring the marks to a white sheet¹⁶. The distance between the carbon marks is then obtained using a digital vernier caliper. The shortcomings of this approach are that it does not orient the occlusal plane and that errors may occur when transferring the marking points to the white sheet. The second method consists of placing the study cast on the surveyed table, and then orienting the occlusal plane so that it is parallel with the horizontal plane¹⁷. After the occlusal plane orientation, a surveying arm with analyzing rod is lowered until the tip of the analyzing rod contacts the mark on the superior attachment of the labial frenum. A horizontal mark is then made with a ball point pen marker on the vertical arm of the surveyor where it meets the horizontal arm. Similarly, a second horizontal mark is made on the vertical arm of the surveyor where it meets the horizontal arm, when the tip of the analyzing rod is made to contact the mark on the mesioincisal angle of the central incisors. However, this second method also has one disadvantage, which is that the marking on the vertical arm can also be in error. As such, the present study used a modified version of the second method to prevent such errors when collecting the measurement data.

In the present study, the subjects were Taiwanese, and according to the data collected, the distances ranged from 9.5 to 14.6 mm, with a mean ($\pm$ SD) of 12.0 ± 1.4 mm in the male patients, and from 9.0 to 13.5 mm, with mean ($\pm$ SD) of 11.4 ± 1.1 mm in the female patients. These data are valuable to clinicians when making the wax rim before the vertical dimension appointment. Moreover, the method used in the present study is reliable. This is because when the resulting denture is delivered, the dentist can still use the digital vernier caliper to check the occlusal plane. It is thus efficient to use the mandibular labial frenum as the anterior reference point when determining a

reasonable occlusal plane.

The anterior teeth not only have functional needs but also esthetic demands. The upper anterior reference point is superior to the lower one. The upper teeth disclosed could be affect the older or younger, but the muscle tone decreases with age and also having teeth wear the lower teeth disclosed will increase. Hence, the important of the lower teeth increases over time. However, pre-extraction records alone cannot be effectively used to determine the level of the occlusal plane; rather, they need to be used in combination with another method to determine the appropriate occlusal plane.

Although previous studies measured the distance between the mandibular lingual frenum and lower central incisor, the results of this study can still be compared with those of previous ones.

In the study by Bissasu¹⁷, the results showed the reliable measurement of the distance between the anterior attachment of the lingual frenum and the incisal edges of the mandibular incisors. The results also showed a mean vertical distance of 10.26 mm in a Syrian population (consisting of nine males and nine females). In the study by Rahman et al.,¹⁸ the mean vertical distance between the anterior attachment of the

lingual frenum and the incisal edges of the mandibular central incisors was 10.7 mm in males and 10.9 mm; in females in an Iraqi population (consisting of fifteen males and fifteen females).

In the study by Parimala and Prithviraj¹⁹, the mean vertical distance between the anterior attachment of the lingual frenum and the mesioincisal edges of mandibular central incisors was 12.3 mm in males and 11.9 mm in females in an Indian population (consisting of fifty-six males and forty-four females).

In the study by Balasubramanian et al.,¹⁶ the mean distance between the anterior attachment of the lingual frenum and the mesioincisal edges of the mandibular central incisors was 14.5 mm in a south Indian population (consisting of fifty-six males and forty-four females).

In the study by Mahboub et al.,²⁰ the mean vertical distance between the anterior attachment of the lingual frenum and the mesioincisal edges of the mandibular central incisors was 15.42 ± 0.97 mm in males and 13.28 ± 1.57 mm in females in an Iranian population (consisting of twenty males and twenty females).

All of these studies adopted the aforementioned

second method, with the exception of the Balasubramanian et al. study. Overall, their reported values ranged from 10.26 mm to 15.42 mm. The mean vertical distance for all the subjects in the present study, meanwhile, was 11.3 mm. This value was similar to those reported in the previous studies.

The advantage of the present study's measurement method is that it is relatively easy to perform, the reason being that the labial frenum is easy to distinguish and the line between the labial frenum and incisal edge of the lower central incisors is more perpendicular to horizontal plane than the lingual frenum. This may, in turn, save on orientation set-up time and the results of the method can be checked chair-side.

Conclusion

The following conclusions were drawn from this study:

1. The distances between the attachment of the mandibular labial frenum and mesioincisal edge of the lower central incisors in the male, female, and all subjects ranged from 9.5 to 14.6 mm, with a mean ($\pm$ SD) of 12.0 ± 1.4 mm; from 9 to 13.5 mm, with a mean ($\pm$ SD) of 11.4 ± 1.1 mm; and from 9 to 14.6 mm, with a mean ($\pm$ SD) of 11.3 ± 1.2 mm, respectively.
2. Collecting the records of healthy adults with no obvious teeth wear could help to determine the vertical dimensions of mandibular occlusal planes and thus be used in their rehabilitation. The objective results of this study could thus help clinicians to efficiently determine the occlusal plane when dealing with full mouth rehabilitation.
3. The results of this study can be used in positioning lower anterior artificial teeth.

Clinical implication

For full mouth rehabilitation, the importance of obtaining a reasonable occlusal plane level is paramount. Using the mandibular labial frenum as an anterior reference point for determining the occlusal plane level is easy to do, and the results can be re-checked chair-side.

Conflicts of interest

All the authors state that they have no potential sources of conflict of interest.

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