A diagnostic craniometric method for determining occlusal vertical dimension

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There is no precise scientific method for determining the correct edentulous occlusal vertical dimension. This study established the proportion between the ear-eye to chin-nose distance for determining reasonable occlusal vertical dimension. Two hundred white and 400 Asian men and women participated in this study. The ear-eye and chin-nose distances were measured with a modified craniometer. The results revealed that left ear-eye distance can be used to predict chin-nose distance with reasonable accuracy. However, the algorithm for making this prediction is not the same for combinations of sex and ethnic origin. (J PROSTHET DENT 1994;71:568-74.)

The occlusal vertical dimension refers to the distance measured between two points when the occluding members are in contact, and the rest vertical dimension is defined as the distance between two selected points measured when the mandible is in the rest physiologic position.[1] Determination of the occlusal vertical dimension is one of the most important steps in making complete dentures.[2] Unfortunately there is no one precise vertical dimension.[3] Interocclusal rest space is the difference between the vertical dimension of rest (rest vertical dimension) and the vertical dimension while in occlusion (occlusal vertical dimension).[1] Although researchers have questioned the theory of constancy of the rest vertical dimension, it is still used as a starting point by most dentists.[4]

Atwood[5] found that the physiologic rest position was not consistent even in the same patients. Tallgren[6] noted that the mandibular rest position, because of its inconsistency, did not constitute a reliable reference position for assessment of occlusal vertical dimension during fabrication of complete dentures. Mohl and Drinnan[7] drew a similar conclusion, noting that the physiologic rest position should not be viewed as an unqualified, immutable, and stationary entity. The use of the Myomonitor device (Myotronics Inc., Seattle, Wash.) to accomplish a transcutaneous electrical neural stimulation (TENS)–induced relaxation of the masticatory muscles has become a popular procedure[8,9] that allegedly leads to determination of the correct occlusal vertical dimension. Rugh and Drago[10] reported that the physiologic rest position requires a state of slight contraction in certain jaw muscles. The place where minimal electromyographic activity of the masseter muscles occurs is generally at a level several millimeters open from the physiologic rest position. Williamson[11] reported similar discrepancies—that is, the TENS-induced rest position differed significantly from the physiologic rest position. More recently Dao et al.[12] found no evidence that reflex closure of the mandible could be used to establish a physiologic rest position.

Silverman[13] reported consistent results in measuring occlusal vertical dimension by phonetic methods. This technique is applicable only in class I jaw relationships.[2] Pound[14] noted that approximately 20% of the denture population has what he called an atypical "s" sound and, no matter how much the occlusal vertical dimension is increased, the anterior teeth will still remain significantly separated when "s" sounds are made. This finding highlights the importance of using other clinical guidelines besides phonetics in assessing a patient's occlusal vertical dimension.[15]

Knebelman[16] stated that in skull specimens where growth, development, and occlusion are normal, it is possible to correlate distances of craniofacial landmarks and record a measurement from the skull that may be used to help establish occlusal vertical dimension. Namely, the distance from the mesial wall of the external auditory canal to the lateral corner of the bony orbit (the ear-eye distance) is proportionately related to the distance between the most anterior undersurface part of the mandible and the nasal spine (the chin-nose distance). A craniometer devised by Knebelman[16] can be used to measure the ear-eye distance, record that measurement, and then propor-

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Table I. Pearson's product-moment correlation between chin-nose distance and left and right ear-eye distance

Group	Left ear-eye	Right ear-eye
White men ($N = 100$)	0.75	0.75
White women ($N = 100$)	0.87	0.87
Asian men ($N = 200$)	0.64	0.64
Asian women ($N = 200$)	0.60	0.57

All correlations are significant, $p < 0.0001$.

tionately adjust it so that it can then be used for edentulous patients to guide closure of the mandible to occlusal vertical dimension when the jaw relationship is recorded. This device may also be useful in situations where vertical dimension has been lost because of faulty eruption of teeth or when teeth have been extracted but not replaced. This study assessed the relationship between the ear-eye to chin-nose distance and determined the usefulness of ear-eye distance in predicting chin-nose distance for ascertaining occlusal vertical dimension in human subjects.

MATERIAL AND METHODS

The craniometer (Craniometrics, Inc., Wynnewood, Pa.) (Fig. 1) was modified by connecting spirit levels to the inferior surface of the nasal spine plate and the outside surface of the long arm according to the technique of Salig et al.[17] These modifications ensure that the craniometer is appropriately positioned vertically and horizontally during recording of occlusal vertical dimension for greater reliability in repeated measurements.

Pilot study

A pilot study was conducted. The craniometer was used by two assessors in 25 adult white men who were 20 to 30 years of age. The patients were selected from those who had a definite centric stop with their natural dentition so as to eliminate possible changes in the vertical dimension itself. These patients had not undergone major orthodontic treatment or suffered posterior bite collapse as a result of loss of teeth, and they did not have an excessive amount of soft tissue under the chin.

The ear-eye and chin-nose distances were measured by the craniometer when the patient closed to centric occlusion. The external auditory canal tip of the craniometer was placed into the meatus of the external auditory canal. It was inserted perpendicularly to the sagittal plane of the skull. With this tip fitted into the meatus, the orbital tip was positioned at the lateral border of the ocular orbit. The head was adjusted in an upright unsupported position with the bubble in the middle of the spirit level (Fig. 2). Ear-eye measurements were recorded for both the left and right sides. The craniometer was then placed between the undersurface of the mandible and the nasal spine with firm pressure when the maxillary jaw was occluded, and the

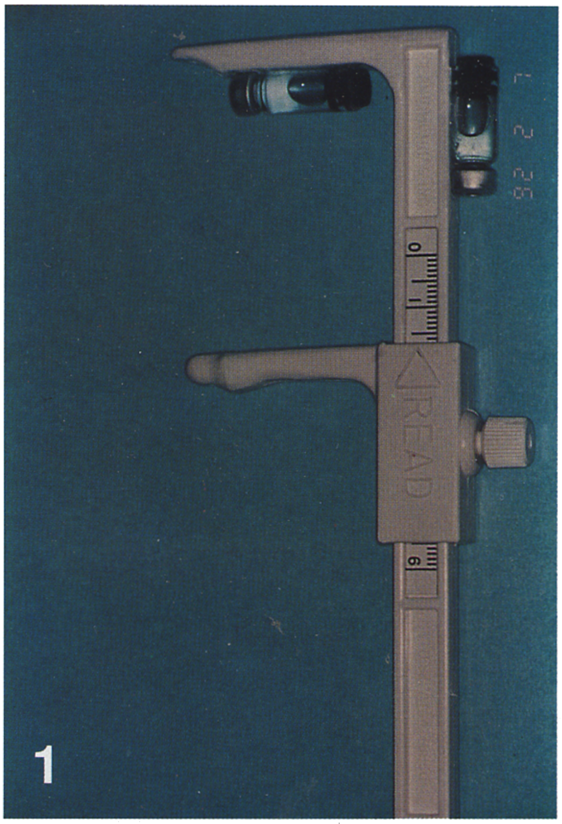

Fig. 1. Craniometer modified by connecting spirit levels to inferior surface of nasal spine plate and outside surface of long arm.

chin-nose distance was measured and recorded at the midline of the face (Fig. 3). To assess the reliability of both ear-eye and chin-nose distances, measurements were independently obtained by two assessors for all patients. Assessor 2 repeated the measurement process in the same way as assessor 1.

Pearson's product-moment correlation coefficient was used to compute interrater reliabilities for the three measurements. The correlations ranged from 0.92 to 0.96.

Main study

Patients selected included 100 white men and 100 white women and 200 Asian men and 200 Asian women, all of whom ranged in age from 20 to 30 years. Persons with class III occlusion were excluded. A large number of patients from each group were used to establish a stable estimate for subsequent regression analyses. Ear-eye distances and chin-nose distance were measured with the procedures described in the pilot study. One assessor was used to collect all data.

RESULTS

The data were examined for the four possible combinations of sex and ethnic origin. The correlations between

Fig. 2. Head adjusted in upright unsupported position with bubble in middle of spirit level.

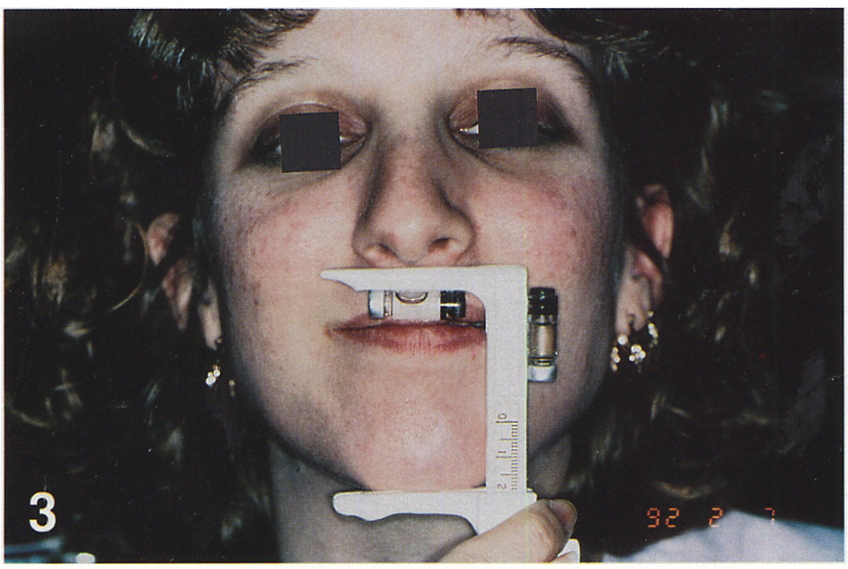

Fig. 3. Measurement of chin-nose distance.

chin-nose distances and ear-eye distances are presented in Table I. Regression analyses with the use of left ear-eye distance to predict chin-nose distance are summarized in Table II. Within a 0.95 confidence interval, predicted chin-nose distance for the groups measured at the mean ear-eye distance varied by approximately 0.8 to 1.0 mm (Figs. 4 through 7).

DISCUSSION

The results showed that left ear-eye distance can be used to predict chin-nose distance with reasonable accuracy. However, the algorithm for making this prediction is not the same for combinations of sex and ethnic origin.

Measurement of anatomic landmarks of the face has been a controversial method of recording occlusal vertical dimension. The Willis device[18] is designed to measure the distance from the lower border of the septum of the nose to the lower border of the chin and the distance from the outer canthus of the eye to the corner of the relaxed lip with the teeth in occlusion. In theory these measurements should be equal. However, the asymmetry of faces makes the value of average measurements with these anatomic landmarks questionable.

On a two-dimensional drawing it is easy to take measurements with accuracy. But two different clinicians may rarely agree on a patient's measurements to within a few millimeters. Therefore, for the sake of accuracy of measurement in this study, it was important to apply firm pressure when the instrument was making contact with the base of the nose and with the undersurface of the chin. The data indicate that the measurements were reliable. How-

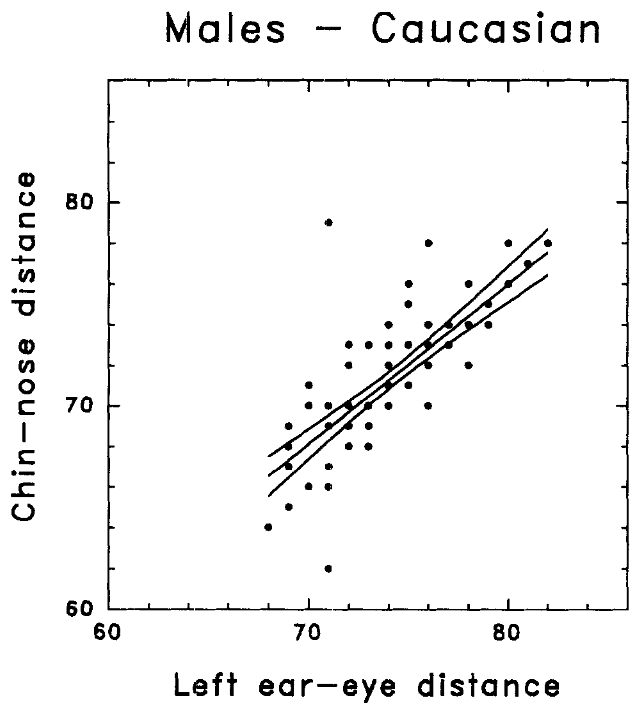

Fig. 4. Regression of ear-eye distance on chin-nose distance for white men, including 95% confidence limits.

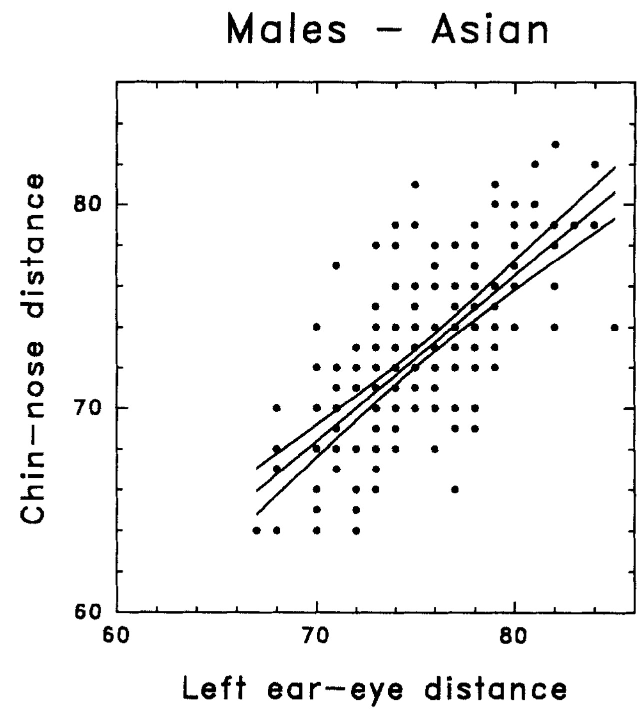

Fig. 6. Regression of ear-eye distance on chin-nose distance for Asian men, including 95% confidence limits.

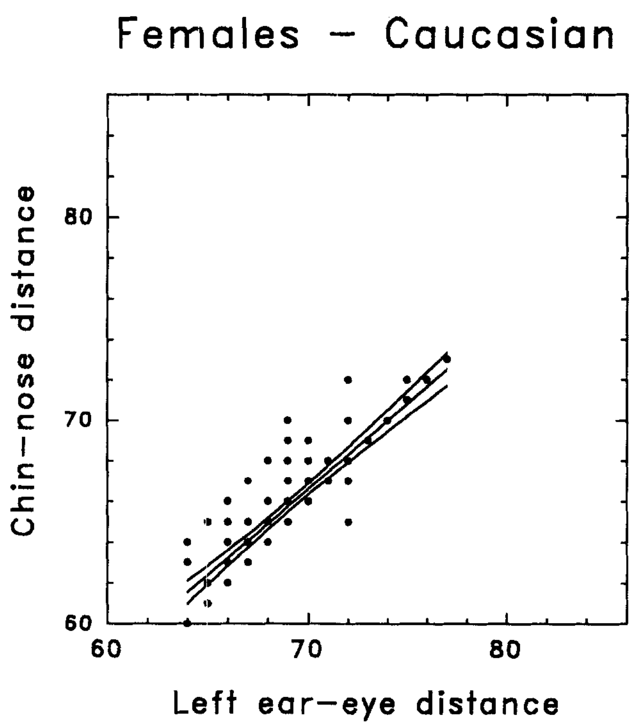

Fig. 5. Regression of ear-eye distance on chin-nose distance for white women, including 95% confidence limits.

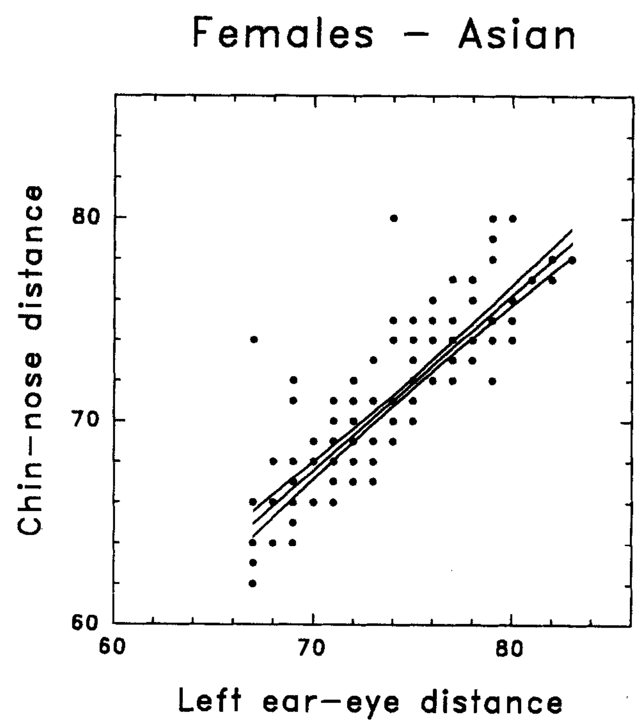

Fig. 7. Regression of ear-eye distance on chin-nose distance for Asian women, including 95% confidence limits.

ever, the extent to which the reliability is affected by subcutaneous adipose tissue is unknown.

CLINICAL IMPLICATIONS

In complete removable prosthodontic treatment, an absence of space between the tuberosities and the retromolar pads may not be noticed until interocclusal records are being made (Fig. 8). At that time, if the dentist fails to cover the retromolar pads with the mandible denture (Fig. 9) or increases the vertical dimension of occlusion to create more posterior space, the ultimate result will be compromised.

The solution is to perform a tuberosity reduction, wait

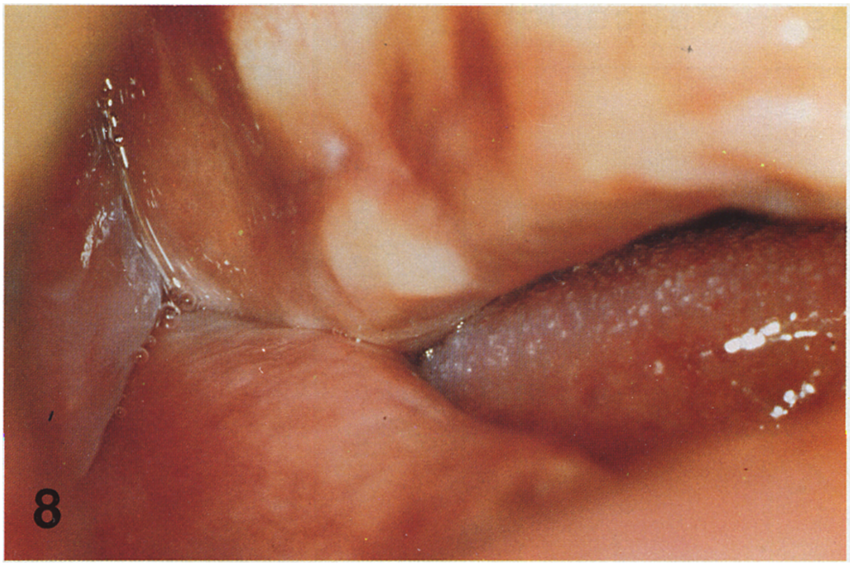

Fig. 8. Absence of space between tuberosity and retromolar pad.

Fig. 9. Dentist failed to cover retromolar pads with mandibular denture.

Table II. Regression of left ear-eye distance on chin-nose distance

Group	*F* ratio	R square	Regression parameters: Beta	Regression parameters: Intercept
White men (*N* = 100)	126.76	0.56	0.786767	13.048800
White women (*N* = 200)	312.65	0.76	0.843762	7.551326
Asian men (*N* = 100)	138.80	0.41	0.685761	21.721857
Asian women (*N* = 200)	112.68	0.36	0.684000	19.876400

For all F ratios, $p < 0.0001$.

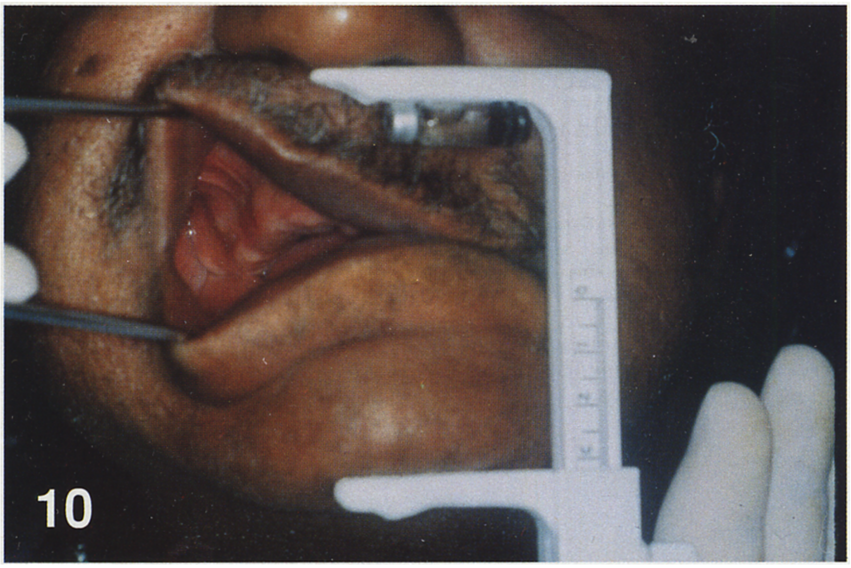

Fig. 10. Ability to see enough space between tuberosity and retromolar pad with this diagnostic craniometric method.

for healing to occur, and remake the maxillary final impression. Therefore it is very important to acquire thorough diagnostic information before treatment is begun.

The data in this study suggest that dentists measure an ear-eye distance with the modified craniometer, as described previously, then multiply this measurement by the beta value and add the intercept value from Table II for the appropriate combination of sex and ethnic origin. The resulting value should be a good approximation of the correct chin-nose distance and a good starting point for determining the vertical dimension of occlusion. This procedure may be especially useful for students or for those making otherwise subjective measurements of vertical dimension.

The modified craniometer could also be valuable for determining the vertical dimension of occlusion in patients who have poor neuromuscular control as a result of increasing age or disease. In addition, this procedure may be of diagnostic value in determining whether preprosthetic surgery is indicated when large tuberosities exist, as with patients who have symptoms of the combination syndrome. Unexpected difficulties resulting from a lack of space between the tuberosities and the retromolar pads (Fig. 10) may prolong treatment and detract from the patient's esteem for the dentist's knowledge and ability.

SUMMARY AND CONCLUSION

There is still no precise scientific method of determining correct occlusal vertical dimension. However, a diagnostic method from this investigation can be used as a guide to formulate an accurate treatment plan and prognosis. Potential problems can be identified early and explained to the patient.

The results obtained indicate the following.

1. Predicting chin-nose distance for occlusal vertical dimension is not a simple matter of subtracting a constant from an ear-eye measurement.
2. Left ear-eye distance can be used to predict chin-nose distance with reasonable accuracy. However, the algorithm for making this prediction is not the same for combinations of sex and ethnic origin.
3. This diagnostic measurement device can be used as an additional aid to existing physiologic measurements, so that absence of adequate interridge distances can be predicted.

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