Correlation between Finger Length and Occlusal Vertical Dimension in Adult Sudanese Women

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Abstract

The objective of this study was to investigate the correlation between the length of each of three fingers (the index finger, 2D; ring finger, 4D; and little finger, 5D) and the occlusal vertical dimension (OVD). If such a relationship were established, it would simplify and facilitate the prediction and reestablishment of the OVD in the construction of complete dentures. The correlation between the OVD and the length of 2D or 5D has already been investigated in a number of studies. However, to our knowledge, no study has investigated the relationship between the length of 4D and the OVD. A total of 117 adult Sudanese women were enrolled in this study. The distance from tip of the finger to the second crease was measured using a digital caliper. The OVD was established based on two measurements: one from the septum of the nose to the menton of the chin; and the other from the tip of the nose (N) to the gnathion at the tip of the chin (Gn). All data were analyzed using the SPSS program. The Pearson correlation coefficient was used to determine the relationship between variables. Differences between means were determined using a paired-sample t-test. The p-value was set at 0.05. A significant correlation was found between finger length and the OVD. However, this correlation was significantly higher between 2D and the OVD based on N-Gn. The present findings indicate that 2D can be used to predict the OVD in adult Sudanese women.

Key words: Finger length — Occlusal vertical dimension — Complete denture — Sudanese

Introduction

One of the most important and complicated steps in the construction of complete dentures is determining the occlusal vertical dimension (OVD). Failure to do this accurately can have a negative effect from both a functional and esthetic point of view, and may even render the denture unwearable. A perusal of the literature will reveal that much attention has therefore been paid to how this can be done with precision, and not only in
the field of prosthodontics. Many techniques have been developed in dentulous patients, involving either pre-extraction records or post-extraction methods. The former approach has included the closest speaking space\(^{29,30}\), profile tracing\(^{12}\), lingual frenum attachment\(^{1,9}\), intra-oral tattoos, and many other methods\(^{2,31}\). In edentulous patients, other techniques have been proposed, such as the physiologic rest position\(^{14,25}\), swallowing method\(^{17,20}\), facial measurements\(^{22-24,26}\), cephalometrics\(^{27,32}\), and many others\(^{10,34}\). In edentulous patients, however, the rest position has long been the standard approach to establishing the OVD. However, the position of the mandible at rest is not constant and changes throughout life. Moreover, it may differ in the same individual at the same sitting or between sittings\(^{6,15,16,33}\). Despite advancements and improvements in technology and innovations in prosthodontics, however, a consensus remains to be reached on how best to accurately establish the OVD. Recently, many studies have investigated the hypothesis that the OVD might be predicted by the length of the fingers\(^{5,8,18,19,21}\). The aim of the present study was to determine whether there was a correlation between the length of each of three fingers (index finger, 2D; ring finger, 4D; and little finger, 5D) and the OVD as established based on two measurements in adult Sudanese women.

**Materials and Methods**

1. **Participants**

A total of 117 dentate women aged between 18 and 25 yrs (mean, 20.50 ± 1.37 yrs) were recruited from the Faculty of Dentistry at Khartoum University, Khartoum, Sudan. All the participants were healthy and had occlusal harmony (class I). The following were selected as exclusion criteria from the study: facial disfigurement; deformation of the fingers; and previous orthodontic or orthognathic surgery. Each participant was seated on a chair in an upright position with the head unsupported and instructed to bite lightly on the posterior teeth in centric occlusion.

2. **Measurements**

The distance from the tip to the root (or the second crease) of each finger was measured and recorded (Fig. 1). The OVD was established based on two measurements: 1) as the distance from the septum of the nose (Sn) to the menton (Me) on the inferior border of the chin (here, as shown in Fig. 2, a stick was placed to extend horizontally from the Me to create a line running parallel with the line of the Sn); and 2) the distance from the tip of the nose (N) to the gnathion (Gn) at the tip of the chin (Fig. 3). These two measurements were then compared to determine how well they correlated with the length of the fingers. All measurements were performed using a digital caliper (Digital Caliper, Hornady, New York, USA) by one of the authors. To establish intra-rater reliability, the measurements were recorded twice in 16 participants with a 2-week interval between measurements. The data were analyzed using the Intraclass Correlation Coefficient test (ICC). The results revealed a highly significant level of reliability and reproducibility (ICC = 0.81, p = 0.001).

3. **Statistical analysis**

Mean and standard deviations were determined for a descriptive analysis. A one-sample test was utilized to determine whether the
means of the finger lengths differed significantly from the hypothesized values (mean OVDs). A paired-sample t-test was used to determine differences between means. The Pearson correlation coefficient was used to establish correlations. All tests were performed using the Statistical Package for Social Sciences Software (SPSS V22, IBM, Chicago, USA). A p-value < 0.05 was considered significant, with a 95% confidence interval.

**Results**

The mean, range, and standard deviation are shown in Table 1. The length of 5D was the smallest (57.17 ± 4.02 mm) while that of 4D was the greatest (71.20 ± 4.06 mm). Differences in means are highlighted in Table 2. No significant difference was observed in the mean measurements of 2D and N-Gn. However, differences between the means of the

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**Table 1** Descriptive statistics of all measurements (mm)

|     | N  | Minimum | Maximum | Mean  | SD   |
|-----|----|---------|---------|-------|------|
| 2D  | 117| 56.18   | 78.28   | 68.98 | 3.72 |
| 4D  | 117| 60.49   | 83.65   | 71.20 | 4.06 |
| 5D  | 117| 48.77   | 68.38   | 57.17 | 4.02 |
| Sn-Me | 117| 55.10   | 79.74   | 65.93 | 4.66 |
| N-Gn | 117| 56.22   | 80.18   | 68.19 | 4.08 |

**Table 2** Differences between finger length and OVD (mm)

|     | Mean | SD   | p-value |
|-----|------|------|---------|
| Pair 1 | 2D–Sn-Me | 3.05 | 5.23  | .001 |
| Pair 2 | 4D–Sn-Me | 5.28 | 5.59  | .001 |
| Pair 3 | 5D–Sn-Me | −8.75 | 5.56  | .001 |
| Pair 4 | 2D–N-Gn | 0.79 | 4.41  | .054 |
| Pair 5 | 4D–N-Gn | 3.02 | 4.74  | .001 |
| Pair 6 | 5D–N-Gn | −11.01 | 4.87  | .001 |

Fig. 2 Occlusal vertical dimension measured from septum of nose to menton of chin

Fig. 3 Occlusal vertical dimension measured from tip of nose to tip of chin (gnathion)
other measurements were significant (p<0.05). Moreover, the difference between 2D and N-Gn was the smallest (0.79 mm), while the differences between 5D and Sn-Me and between 5D and N-Gn were the greatest (−8.75 and −11.01 mm, respectively). The Pearson correlation coefficient test (Table 3) revealed a highly significant positive correlation (r=0.362, p=0.001) between 2D and N-Gn, followed by between 4D and N-Gn (r=0.320, p=0.001) and between 5D and N-Gn (r=0.277, p=0.002). All correlations between finger length and Sn-Me were lower than those between finger length and N-Gn. The dispersion of finger length measurements from OVD values (65.93 and 68.19 mm) was determined using a one-sample t-test (Tables 4 and 5). While the measurements for 2D showed no significant difference from the mean values of N-Gn, they did show a significant difference (p<0.05) from the mean value of Sn-Me. However, all other measurements showed a significant difference (p<0.05) from the mean values of N-Gn and Sn-Me.

**Discussion**

Determining the correct OVD in edentulous patients is a prime consideration for any dentist, and clinical judgment still plays an important role when doing so in the construction of a complete denture. A number of methods have been proposed for establishing the OVD in the absence of pre-extraction records, some of them involving the relationships and distances between specific landmarks. Yamashita et al. used cephalometric analysis to predict lower facial height and formulated an equation that could be used within a height range of 37 and 59 mm. This equation contains many variables, however, making its application difficult in a clinical setting. In another study, Basler et al. found great variation in the accuracy of three commonly used techniques for determining the OVD (phonetics, tactile sense, and swallowing). Moreover, the OVD obtained from the rest position is not reliable because the mandible is a movable bone and, thus, the rest position is subject to change. The distance from the distal canthus of the eye to the tragus of the ear has also been suggested as an alternative in predicting the OVD. However, closeness to a vital organ (the eye) makes it difficult to measure. Therefore, finger length

| 2D | Pearson Correlation | .236* | .362*** |
|  | p-value | .010 | .001 |
|  | N | 117 | 117 |

| 4D | Pearson Correlation | .183* | .320** |
|  | p-value | .048 | .001 |
|  | N | 117 | 117 |

| 5D | Pearson Correlation | .186* | .277** |
|  | p-value | .045 | .002 |
|  | N | 117 | 117 |

** Correlation significant at 0.01 level (2-tailed).
* Correlation significant at 0.05 level (2-tailed).

| Table 3 Correlation between finger length and OVD |
| Sn-Me | N-Gn |
|---|---|
| 2D | Pearson Correlation | .236* | .362*** |
|  | p-value | .010 | .001 |
|  | N | 117 | 117 |
| 4D | Pearson Correlation | .183* | .320** |
|  | p-value | .048 | .001 |
|  | N | 117 | 117 |
| 5D | Pearson Correlation | .186* | .277** |
|  | p-value | .045 | .002 |
|  | N | 117 | 117 |

** Central dispersion of finger length and OVD (Sn-Me = 65.93) **

| t | df | p-value | Mean Difference (mm) |
|---|---|---|---|
| 2D | 8.87 | 116 | .001 | 3.05 |
| 4D | 14.05 | 116 | .001 | 5.27 |
| 5D | −23.53 | 116 | .001 | −8.76 |

** Central dispersion of finger length and OVD (N-Gn = 68.19) **

| t | df | p-value | Mean Difference (mm) |
|---|---|---|---|
| 2D | 2.30 | 116 | .054 | 0.79 |
| 4D | 8.03 | 116 | .001 | 3.01 |
| 5D | −29.61 | 116 | .001 | −11.02 |
may offer a more suitable tool for establishing the OVD as there is no temporal variation in adulthood, unlike with jaw position, and there is no danger to any vital organ. The present study was designed to determine the relationships between the length of each of three fingers (2D, 4D, and 5D) and the OVD as established based on two measurements, Sn-Me and N-Gn, in adult Sudanese women. These two distances were used to establish which showed the strongest correlation with finger length. To date, few studies have investigated the relationship between finger length and the OVD. The results of this study showed a mean value of 65.93 mm for the OVD according to the distance of Sn-Me. This is in accordance with the findings of Al-Dhaher\(^3\), who showed a mean value of 65.27 mm in a sample of Iraqi women. However, this finding is not in agreement with those of Majeed\(^9\), Miran\(^21\), Alhaj\(^4\), or Ladda\(^18\), which were 59.61 mm in Pakistani, 61.97 mm in Kurdish, 67.05 mm in Yemeni, and 56.70 mm in Indian women, respectively. The mean OVD according to N-Gn in the present study was 68.19 mm. This result is consistent with that of Nagpal\(^24\), who reported a mean value of 67.25 mm in Indian women, but differs from that of Basset\(^8\), who noted a mean value of 63.35 mm in Nepali women. It is possible that the discrepancies between these results are due to variations in the characteristics of soft tissue and topography among these different populations. In terms of finger length, the present results showed that 4D was the longest, followed by 2D and 5D. It was beyond the scope of this study to evaluate and compare these findings with those of other studies, as the main aim here was to establish the predictability of OVD, but they do agree with those of some previous studies\(^5,10\). A weak relationship was found between 2D and Sn-Me. Likewise, the relationship between 5D and Sn-Me was also weak. Although, the relationship between 2D and Sn-Me accords with the findings of Ladda\(^8\), it differs from his finding in regard to the relationship between 5D and Sn-Me. This discrepancy may due to variation in finger length among different ethnic groups. Similarly, in the present study, the relationship between 4D and Sn-Me was weak. In reviewing the literature, no data were found regarding the correlation between length of 4D and OVD. Therefore, to our knowledge, this is the first study to investigate this relationship. In the present study, the correlation between finger length and N-Gn was stronger than that with Sn-Me. The relationship between N-Gn and 2D was the strongest, followed by that with 4D and 5D. However, great variation was observed in the means of these measurements (Table 2). The difference between 2D and N-Gn was 0.79 mm, which was not statistically significant ($p = 0.054$). This suggests that the two measurements are nearly equal to each other, which in turn supports the relationship between them, strongly indicating that 2D can be used to predict the OVD as based on N-Gn. On the other hand, the difference between 4D and N-Gn was 3.02 mm. Even though this difference was still within the normal limits of interdental distance (2–4 mm), it was statistically significant. Another important finding was the highly significant difference between 5D and N-Gn ($−11.01$ mm). This result indicates that 5D may not be suitable for establishing the OVD. This suggests that measurement based on N-Gn is more reliable and better applicable to predicting the OVD\(^9\). However, it is important to bear in mind that the current study was carried out on women only. Therefore, further study employing larger sample sizes and investigating both sexes is required.

**Conclusion**

To the best of our knowledge, this is the first study to investigate the relationship between the length of 4D and the OVD. A significant correlation was observed between these measurements. However, the relationship between the length of 2D and the OVD as measured based on N-Gn was stronger and showed the least difference. Taken together, the present findings suggest that neither 5D...
nor 4D is suitable for predicting the OVD. Moreover, 2D is also not suitable for establishing the OVD as measured based on Sn-Me. However, 2D is highly recommended for predicting the OVD as measured based on N-Gn in adult Sudanese women.

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