# Comparative Evaluation between Different Facial Anthropometric Measurements with the Mesiodistal Width of the Maxillary Anterior Teeth: An Observational Study

**Dr. Shreya M. Kukreja[1], Dr. N. A. Pande[2]**

[1]Postgraduate Student, Department of Prosthodontics, Ranjeet Deshmukh Dental College and Research Centre, Nagpur 440019
Email: *shreyakukreja14[at]gmail.com*

[2]Professor & Head of Department, Department of Prosthodontics, Ranjeet Deshmukh Dental College and Research Centre, Nagpur 440019
Email: *neelampande112[at]gmail.com*

**Abstract:** *Background: The face is the most prominent and expressive feature of the human body, playing a key role in determining social acceptance. With shifting demographics, such as increased life expectancy and a growing elderly population, there is a rising emphasis on geriatric dental care. One of the most challenging aspects of complete denture prosthodontics is selecting appropriately sized maxillary anterior teeth when pre-extraction records are unavailable. Therefore, this study aims to explore the precise relationship between various facial anthropometric measurements and the combined width of the maxillary six anterior teeth. Materials & Methods: This observational study was conducted in 30 healthy dentate subjects, out of the 30 subjects, 15 (50%) were males and 15 (50%) were females. Inter-canthal distance, inter-pupillary distance, inter-commisural width, inter-alar width were measured using a digital vernier caliper. All the results were analyzed by statistical software, STATA, version 10.1, 2011 by StataCorp, Texas (USA). Results: There is a strong and statistically significant correlation between the mesiodistal width of the maxillary anterior teeth and several facial anthropometric measurements. Conclusion: Inter-canthal distance, inter-pupillary distance, inter-commisural width, inter-alar width can be used as the anatomical landmark to select the maxillary anterior teeth in the absence of the pre-extraction records.*

**Keywords:** Anterior teeth selection, esthetics, interalar width, intercanine distance, intercommissural width

## 1. Introduction

In complete denture prosthodontics, aesthetics is very important. The prosthodontist must carefully combine art and science in the selection and positioning of teeth in order to create a harmonious smile. Therefore, selecting teeth for an edentulous patient becomes a crucial component of making a complete denture.[1]

According to the Dentogenic Restorations, to guarantee a suitable denture that is pleasant for the user, it must exhibit the sex, personality, and age attributes of the user. It is known that the size, shape, and color of the teeth must be in harmony with the surrounding oral and facial structures. Selecting and aligning replacement teeth to proper proportions facilitates a natural and esthetic appearance. [2]During the selection of the maxillary anterior teeth for a complete removable denture, the mesiodistal width of the upper anterior teeth is considered by some as a harder aspect to be established than their length.[3] When no pre-extraction records of the natural teeth such as casts or photographs are available, selecting the proper anterior teeth size can be difficult.[4]Therefore a systematic approach is needed in such situations; consequently, several anatomic measurements have been suggested including bizygomatic width, intercommissural width, interalar width, and interpupillary distance. [5-6]

The analysis revealed that both inner canthal distance and inter-alar distance could serve as alternative predictors for estimating the inter-canine width of the maxillary six anterior teeth, by multiplying specific ratios of 1.61 and 1.45, respectively.[7] Additionally, another study indicated a stable relationship between interpupillary distance and the width of the maxillary central incisors. Since interpupillary distance remains consistent once an individual's growth is complete, it can be used as a reliable reference for determining the width of maxillary anterior teeth.[8,9]

This research is based on the principle that artificial anterior teeth should mirror the natural predecessors in both position and physical characteristics, including size and shape. To explore this, we conducted a study examining the relationship between different facial anthropometric methods and the dimensions of natural anterior teeth, aiming to provide insights that could guide more accurate dental prosthetics. [10]

## 2. Materials and Methods

The study was conducted to compare and evaluate the relationship between different facial anthropometric measurements with the mesiodistal width of the maxillary anterior teeth.

A total of 30 dentulous individuals were chosen for this study. The sample comprised 15 males and 15 females ranging in age from 20 to 30 years. The sample was grouped by gender to estimate the impact of this component on the correlations between measurements.

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**Selection of individuals was based on the following criteria:**

**Inclusion criteria:**
1) Subjects who had no missing maxillary anterior teeth and 1st premolars;
2) No interdental spacing or crowding;
3) No dental caries or any other therapy which alter the tooth to-tooth relation;
4) No facial asymmetry.

**Exclusion criteria:**
1) Apparent loss of tooth structure due to caries, fracture, attrition or restorations;
2) Teeth restored to correct interdental spacing or malformations;
3) Evidence of any dental irregularities like crowding, malformed teeth, microdontia or macrodontia;
4) Asymmetric face especially any surgical correction of orbital structures;
5) Presence of any restorations on the maxillary anterior teeth and patients who have undertaken orthodontic treatment.

Approval for the study was obtained from Institutional Ethics Committee. The subjects provided written informed consent.

**Determination of the Intermedial canthal distance (MCW), Interpupillary width (IPW), Intercommisural width (ICW), Interalar width (IAW) and inter-canine width (ICnW)**

The material used for this study are illustrated in Figure 1. Participants were seated comfortably in a dental chair, upright and relaxed, with their heads resting against the headrest. Total 5 measurements were taken amongst these 4 were extraoral and 1 was an intraoral measurement. The Intermedial canthal distance (MCW), Interpupillary width (IPW), Intercommisural width (ICW), Interalar width (IAW) and inter-canine width (ICnW) were measured using a digital vernier caliper. The Intermedial canthal distance (MCW) was measured from the medial angle of one palpebral fissure to the medial angle of the other, as shown in Figure 2. The Interalar width (IAW) was determined by measuring the widest external point of the nose using the caliper, ensuring the measuring tips just touched the outer surface of the nose Figure 3. For interpupillary distance (IPW), participants were seated upright and asked to look straight ahead. The measurement was taken from the center of one pupil to the other using a digital vernier calliper, as shown in Figure 4. The inter-canine width (ICnW) was measured using the internal jaws of the digital vernier caliper as depicted in Figure 5.

The beaks of the internal jaws of the digital caliper will be placed in the labial embrasures on the distal surfaces of the right and left canine. The long axis of the vernier caliper will be held parallel to the incisal edges and also the internal and external jaws of the digital caliper will be positioned perpendicular to the long axis of the tooth. The locking screw will be tightened to ensure no movement while recording the width. The width will be recorded in millimeters.
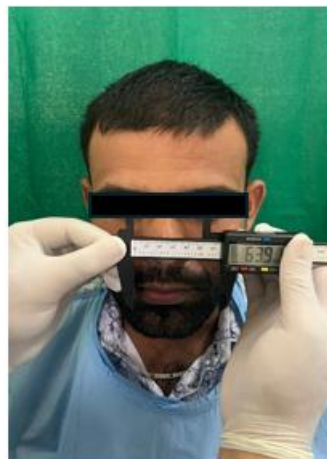

**Figure 1**
Digital vernier Calliper


**Figure 2**
Intermedial canthal distance (MCW)


**Figure 3**
Interalar width (IAW)


**Figure 4**
Interpupillary width (IPW)


**Figure 5**
Inter-canine width (ICnW)

## 3. Results

The correlation of the mesiodistal width (MDW) of the maxillary anterior teeth with various facial anthropometric measurements was calculated using Pearson's correlation coefficient (r). As per table 1,2,3 and 4 all four parameters showed a **very strong, positive, and statistically significant correlation** with the mesiodistal width of the maxillary anterior teeth ($p < 0.0001$). It is evident that all four facial parameters are strongly related to the mesiodistal width of the maxillary anterior teeth. Among these, **Inter Canthal Width (MCW)** showed the highest correlation coefficient (r = 0.9876), indicating an almost perfect positive relationship with the mesiodistal width of the teeth.

**Table 1**

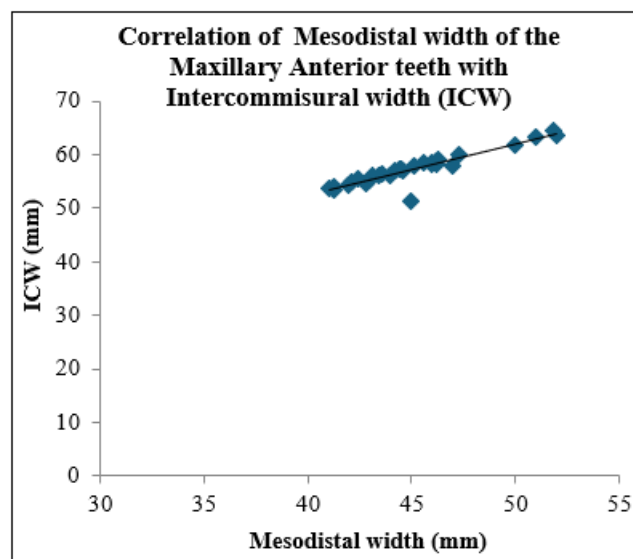| Correlation of Mesodistal width of the Maxillary Anterior teeth with the four parameters | | | |
|---|---|---|---|
| Parameters | r | P value | Interpretation |
| Inter canthal width (MCW) | 0.9876 | 0.0001 | Positive, Very strong and Significant correlation with Mesodistal width |
| Inter pupillary width (IPW) | 0.9731 | 0.0001 | Positive, Very strong and Significant correlation with Mesodistal width |
| Inter commisural width (ICW) | 0.9223 | 0.0001 | Positive, Very strong and Significant correlation with Mesodistal width |
| Inter alar width (IAW) | 0.9790 | 0.0001 | Positive, Very strong and Significant correlation with Mesodistal width |

As per graph 1, 2 3 and 4 it depicts the correlation between the mesodistal width of the maxillary anterior teeth and inter-canthal distance, inter-pupillary distance, inter-commisural width, inter-alar width demonstrates a positive, very strong, and statistically significant relationship.
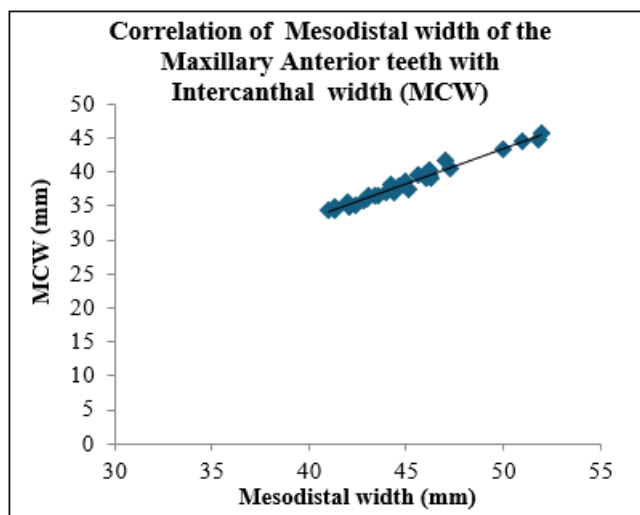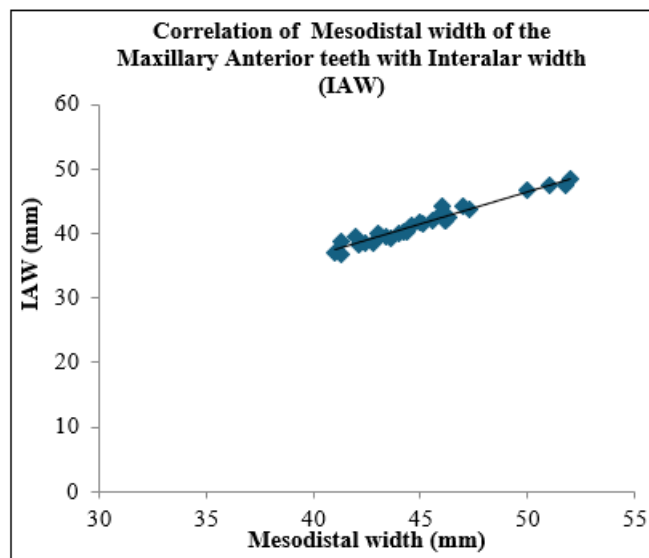


**Graph 1**
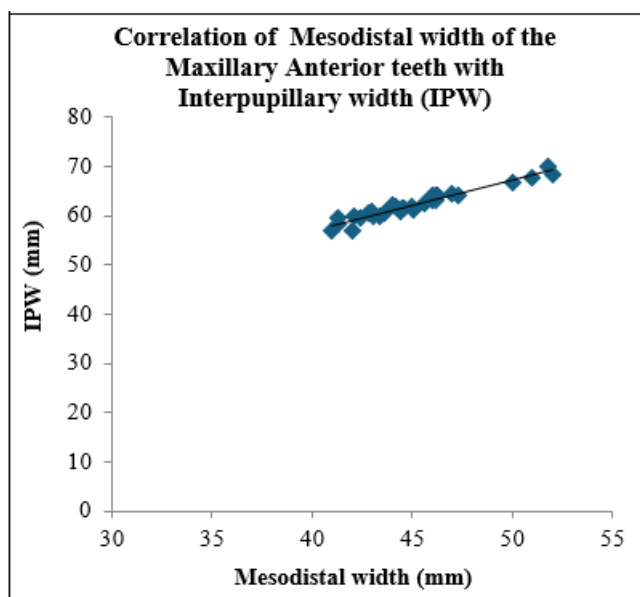


**Graph 2**



**Graph 3**



**Graph 4**

To further evaluate the differences in the strength of correlation between the facial parameters and the mesiodistal width of the maxillary anterior teeth, a comparison was made using Fisher's Z transformation. The analysis provides a more strong comparison of correlation coefficients. The results are as showed in Table 2.

**Table 2**
**Comparison of 2 correlation coefficients for all the possible pairs using test based on "Fisher's Z transformation for r"**

| Number | Parameters | r | (1+r)/(1-r) | ln (1+r)/(1-r)] | Fisher's Z | Pairs of 2 parameters | Z for pairs | SE diff | Z diff | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Inter canthal width (MCW) | 0.9876 | 160.29 | 5.08 | 2.54 | 1 Vs 2 | 0.3908 | 0.2722 | 1.4362 | NS |
| 2 | Inter pupillary width (IPW) | 0.9731 | 73.35 | 4.30 | 2.15 | **1 Vs 3** | 0.9343 | 0.2722 | 3.4328 | **HS** (P<0.01)** |
| 3 | **Inter commisural width (ICW)** | 0.9223 | 24.74 | 3.21 | 1.60 | 1 vs 4 | 0.2656 | 0.2722 | 0.9758 | NS (P>0.05) |
| 4 | Inter alar width (IAW) | 0.9790 | 94.24 | 4.55 | 2.27 | **2 vs 3** | 0.5434 | 0.2722 | 1.9966 | **Sig* (P<0.05)** |
| | | | | | | 2 vs 4 | -0.1253 | 0.2722 | - 0.4604 | NS (P>0.05) |
| | | | | | | **3 vs 4** | -0.6687 | 0.2722 | - 2.4570 | **Sig* (P<0.05)** |

**Inter Canthal Width (MCW)** had a significantly higher correlation with the mesiodistal width of the maxillary anterior teeth than **Inter Commissural Width (ICW)** ($p < 0.01$). **Inter Alar Width (IAW)** and **Inter Pupillary Width (IPW)** also showed significant differences in their correlations when compared to ICW ($p < 0.05$).

The descriptive statistics for the facial anthropometric measurements and mesiodistal width of the maxillary anterior teeth are summarized below for the entire sample (n=30) in Table 3.

**Table 3**

| Summary of width parameters among all subjects (n=30) | | |
|---|---|---|
| Parameters | Mean (SD) in mm | Range in mm |
| Mesodistal width (Inter canine width) | 45.11 (2.99) | 41 – 52 |
| Inter canthal width (MCW) | 38.42 (3.13) | 34.3 – 45.6 |
| Inter pupillary Width (IPW) | 62.16 (3.14) | 56.8 – 69.8 |
| Inter commisural width (ICW) | 57.37 (3.10) | 51.4 – 64.6 |
| Inter alar Width (IAW) | 41.56 (3.05) | 36.8 – 48.4 |

These values represent the mean and standard deviation for each parameter, along with the observed range. For example, the mean mesiodistal width (inter-canine width) was 45.11 mm, with a range from 41 to 52 mm.

As per Table 4, a comparison of the facial anthropometric parameters and mesiodistal width of the maxillary anterior teeth between males and females. The data clearly shows that all anthropometric measurements, including the mesiodistal width of the maxillary anterior teeth, were significantly greater in males than in females. For example, the mesiodistal width in males was 47.33 mm (SD = 2.55), whereas in females it was 42.88 mm (SD = 1.17), with a highly significant p-value of 0.0001.

**Table 4**

| Comparison of width parameters by gender | | | |
|---|---|---|---|
| Parameters | Male (n=15) | Female (n=15) | P value |
| Mesodistal width (Inter canine width) | 47.33 (2.55) | 42.88 (1.17) | 0.0001 |
| Inter canthal width (MCW) | 40.79 (2.61) | 36.05 (1.21) | 0.0001 |
| Inter pupillary Width (IPW) | 64.45 (2.60) | 59.87 (1.54) | 0.0001 |
| Inter commisural width (ICW) | 59.32 (3.19) | 55.41 (1.26) | 0.0001 |
| Inter alar Width (IAW) | 43.89 (2.50) | 39.23 (1.20) | 0.0001 |

## 4. Discussion

This study follows a fundamental principle of Prosthodontics, where various facial anthropometric measurements are utilized to estimate the width of the anterior teeth and the intercanine width, aiding in accurate teeth arrangement.

Scandrett et al.[11] evaluated multiple facial and cranial measurements, including bizygomatic distance, inter-alar width, inter-commissural width, sagittal cranial diameter, inter-buccal frenulum distance, philtrum width, and age, as potential predictors of the width of the maxillary anterior teeth and central incisors. Their findings indicated that none of these factors, when considered alone, provided a reliable basis for clinical prediction. This suggests that a combination of variables is necessary to accurately estimate the width of the maxillary anterior teeth.[12]

This study aimed to explore the relationship between inner-canthal distance, inter-alar width, inter-pupillary distance, intercommisural width in relation to inter-canine width, examining these measurements in a balanced sample of 15 males (50%) and 15 females (50%).

The average inner canthal distance measured ***33.30 mm*** in males and ***27.08 mm*** in females, showing that females had a ***6.22 mm*** smaller distance. This difference could be attributed to the generally smaller facial features in females. Bozkir MG[13] (2003) conducted a study in a Turkish population and found that the mean inner canthal distance was $30.7 \pm 3$ mm in males and $30 \pm 2.6$ mm in females. The overall mean inner canthal distance in this study 38.42mm. The measurements being recorded in population and races of different areas might be the reason for variation in the value.[14]

The average inter-alar distance in males in the study undertaken was 41.56 with a range of 36.8 – 48.4 and were smaller than the values reported by Latta et al[15] 43.93 mm with a range from 29.0 mm to 63.0 mm. The mean IAW in present study was found to be higher in men (43.89 mm) compared to women (39.23 mm). The greater IAW seen in men reveals the influence of male dominance factor, as is also appreciable by the difference in size of jaws and teeth between the two sexes.[14]

The average interpupillary distance in males was 64.45 mm and in females was 59.87 mm. It seems to show that the interpupillary distance was lesser in females by 6.89 mm. This difference may be attributed to the smaller facial features in females. The interpupillary distance is a facial landmark that is stable and does not modify after the age of fourteen and remains fairly constant once the growth of the individual stops which makes it an excellent reference guide in determining the width of the maxillary anterior teeth.[16]Just similar to the present study Gomes VL et al conducted their study to find out the relationship of inter-pupillary and inter-canine distance, that could help in the selection of the denture

teeth. They found out that the interpupillary distance could be used reliably for the selection of maxillary anterior teeth.[17]

The average inter canine distance in males was 47.33 mm was and in females was 42.88 mm. McArthur29 in 1985 reported the mean of combined width of maxillary six anterior teeth was 54.6 mm in male and the mean value of inter canthal distance was 52.3 mm in female.[18]

The intercommissural width in males was 59.32 mm and in females was 55.41 mm. Lieb et al [19] in their study showed that the average distance through the commissures was 5.27 cm. In their study, the variations in measurements can be attributed to ethnicity.

# 5. Conclusion

Within the limitations of this study, the following conclusions were drawn-

1) Based on the findings of this observational study, we can conclude that there is a **strong and statistically significant correlation** between the **mesiodistal width of the maxillary anterior teeth** and several **facial anthropometric measurements**, including **Inter Canthal Width (MCW)**, **Inter Pupillary Width (IPW)**, **Inter Commissural Width (ICW)**, and **Inter Alar Width (IAW)**. Among these, **Inter Canthal Width (MCW)** demonstrated the highest correlation with the mesiodistal width, suggesting that the distance between the inner corners of the eyes could be a reliable indicator of the mesiodistal tooth width.

2) The **correlation analysis** further revealed that all four facial parameters were **positively correlated** with the mesiodistal width of the maxillary anterior teeth, supporting the hypothesis that certain facial measurements may be used as predictive guides in determining appropriate tooth size for dental restorations and prosthetics.

3) Additionally, **gender-based comparisons** showed that all the facial measurements, including the mesiodistal width of the maxillary anterior teeth, were significantly larger in males than in females. This finding is consistent with established anatomical differences between genders, where males tend to have larger facial dimensions and tooth widths.

Overall, these results suggest that **facial anthropometric measurements**, particularly **Inter Canthal Width**, could serve as useful predictors for the **mesiodistal width of the maxillary anterior teeth** in clinical practice. The findings could assist in enhancing aesthetic outcomes in restorative dentistry, orthodontics, and prosthodontics by helping to select or design anterior teeth that are proportionate to an individual's facial structure. Further studies with larger sample sizes and additional ethnic or demographic considerations are recommended to validate and expand upon these findings.

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## Author Profile

**Dr. Shreya M. Kukreja,** Department of Prosthodontics, Ranjeet Deshmukh Dental College and Research Centre, Nagpur 440019
Email: *shreyakukreja14[at]gmail.com*

**Dr. N. A. Pande,** Department of Prosthodontics, Ranjeet Deshmukh Dental College and Research Centre, Nagpur 440019
Email: *neelampande112[at]gmail.com*

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