

# Correlation of Various Anatomical Facial Landmarks with Inter-Canine Distance in Population of Northern Punjab

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## ABSTRACT

**Objective:** To correlate various anatomical facial landmarks, including intercanthal distance (ICD), interpupillary distance (IPD), and inter-alar width, with inter-canine distance (ICaD) in young adults from the northern Punjab population in Pakistan, to assess the mesiodistal width of anterior maxillary teeth in edentulous patients.

**Methodology:** This prospective observational cross-section study was conducted at the Department of Anatomy and Prosthodontics of General Hospital, HBS Medical and Dental College, Islamabad, and Farooq Teaching Hospital, Akhtar Saeed Medical College, Rawalpindi, from December 2022 to December 2023. A total of 600 healthy individuals aged between 18 and 26 years were included. ICD, IPD, and inter-alar width were measured with a digital caliper having a precision of 0.01 mm. A flat metal plate shaped like a "T," known as the "canine tip marker," was used to identify the tips of maxillary canines, which were then measured using a digital caliper. Data was analyzed using SPSS v 25, employing independent t-tests and ANOVA for statistical evaluation.

**Results:** The age of individuals was 24.98±4.5 years, with an equal male-to-female ratio of 1:1. The correlation was significant ( $p < 0.001$ ) between these anatomical landmarks and ICaD, with inter-alar width showing the strongest correlation ( $r = 0.640$ ). The ANOVA test revealed that most individuals had less than 5% variability between actual and calculated ICaD values for all extraoral anatomical facial landmarks measurements, except for ICD.

**Conclusion:** When selecting artificial teeth, it is important to consider a combination of various facial and oral factors. The regression equation can be effectively applied in selecting teeth to attain significant results.

**Keywords:** Anatomy; Alar; Face; Intercanthal; Interpupillary; Inter-canine distance.

### Authors' Contribution:

<sup>1,2</sup>Conception; Literature research; manuscript design and drafting; <sup>3,4</sup>Critical analysis and manuscript review; <sup>5</sup>Data analysis; Manuscript Editing.

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## Introduction

The face is most prominent and expressive part of human anatomy, and it plays a crucial role in determining our social acceptance.<sup>1</sup> Tooth loss impacts not only facial appearance but also causes psychological distress. Therefore, it is crucial to provide a replacement that is both aesthetically pleasing and functionally comfortable.<sup>2</sup> Shifting demographics, such as increased life expectancy and a rising elderly population, have recently highlighted

the growing need for geriatric dental care.<sup>3</sup> In Punjab, Pakistan, there are 12 million individuals aged 60 and older, constituting 9.4% of total population of 127.7 million (Census 2017).<sup>4</sup> This suggests that demand for restorative treatment for edentulous patients will continue to be higher in the near future.<sup>5</sup>

A major challenge in complete denture is selecting the correctly sized anterior maxillary teeth when pre-extraction data are unavailable.<sup>6</sup> Although many

methods can assist dentists in selecting generally suitable teeth for patients, the most aesthetic results are often achieved by those who view anterior teeth selection as both an art and a science.<sup>7</sup> Tooth width is regarded as more important than length. Sadowsky has noted that for pleasing aesthetics, there is a proportional relationship between teeth and other features of face.<sup>8</sup>

The analysis of measurements indicated that intercanthal or inter-alar distance can be applied as alternative predictors for estimating inter-canine width of 6 anterior maxillary teeth, when multiplied by corresponding ratios 1.6 and 1.5.<sup>2</sup> Another study suggested that a consistent relationship between interpupillary distance and central maxillary incisor width, as interpupillary distance remains relatively constant once an individual's growth is complete. This can be used as a reference guide for assessing width of anterior maxillary teeth.<sup>9</sup>

This study was designed to determine the correlation between various anatomical facial landmarks, including intercanthal distance (ICD), interpupillary distance (IPD), and inter-alar width (IAD), with inter-canine distance (ICaD) in young adults from the northern Punjab population in Pakistan. The goal was to predict mesiodistal width of anterior maxillary teeth for selection of tooth in edentulous patients, a crucial step in denture treatment, including implant-supported prostheses.

## Methodology

This prospective observational cross-section study was conducted at the Department of Anatomy and Prosthodontics of General Hospital, HBS Medical and Dental College, Islamabad, and Farooq Teaching Hospital, Akhtar Saeed Medical College, Rawalpindi, from December 2022 to December 2023. The study included 600 healthy individuals (300 males and 300 females) aged 18 to 26 years. Participants were selected from students enrolled in undergraduate and postgraduate courses at the institutions. The

selection criteria included individuals with no missing mandibular or maxillary anterior teeth, well-aligned anterior teeth without interdental spacing or crowding, sharp canine tips with no signs of wear, no prior orthodontic treatment, no anterior restorations, good periodontal health, no signs of tooth structure loss caused by attrition, abrasion, erosion, trauma, deformities, no visible defects, facial imbalance, and no vision defects involving abnormal pupillary size or position, with pupils exhibiting a normal reaction to light. All participants provided informed consent before taking part in the study. Approval was secured from Institutional Ethics Committee for ethical clearance. All measurements were taken personally by the researchers to ensure standardization of the procedure.

Intercanthal distance (ICD), interpupillary distance (IPD), and inter-alar width (IAD) were measured with a digital caliper having a precision of 0.01 mm. Participants were instructed to sit upright with their eyes focused on the horizon. While maintaining the same position, external jaws of caliper were aligned with medial angles of eyes to measure ICD (Fig. 1). To measure IAD, caliper outer jaws were adjusted to make light contact with fullest contour of nasal alae (Fig. 2). The centers of both pupils were measured for IPD while the individuals maintained the same posture (Fig. 3). A flat metal plate shaped like a "T," known as the "canine tip marker," was specially designed to identify the tips of maxillary canines.<sup>10</sup> Horizontal arm of "canine tip marker," which measured 5 cm in length and 1 cm in width with rounded tips, was utilized to mark the tips of canines. Vertical arm of marker, used to hold the tool while recording canine tips, measured 7.5 cm in length and 1 cm in width. To facilitate the measurement of canine tips, carbon soot was applied to one side of horizontal arm of canine tip marker. The marker was held by vertical arm, parallel to floor, ensuring that cusp tips of right and

left maxillary canines were marked on blackened soot. The caliper was employed to measure the distance between markings of maxillary canine tips made on horizontal arm (Fig. 4).



Figure 1: ICD measurement

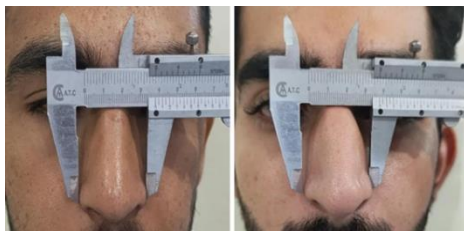


Figure 2: IAD measurement



Figure 3: IPD measurement



Figure 4: ICaD measurement

Variations in landmark selection among observers were minimized by using a consensus of three observers, and differences in measurements were reduced by having a single person record all

landmarks. Holding caliper parallel to floor required careful concentration and coordination from observer, and use of a digital caliper effectively ensured precise recording. The entire procedure was conducted three times for each individual, and mean values for each landmark were calculated. Bivariate correlation and linear regression analyses were carried out to develop a modeling equation. The percentage variability between calculated and actual values for different methods was compared using an ANOVA test. The study maintained a confidence level of 95%, meaning that p-value of  $\leq 0.05$  was considered to show a significant association. Data was analyzed using SPSS v 25, employing independent t-tests and ANOVA for statistical evaluation.

## Results

The study enrolled 600 individuals, with a mean age of  $24.98 \pm 4.5$  years and an equal male-to-female ratio of 1:1. The bivariate analysis revealed that, regardless of gender, all three variables, except for ICD, demonstrated moderate correlation ( $r = 0.5-0.7$ ) with ICaD. ICD exhibited a mild correlation ( $r = 0.4$ ), falling within the range of  $r = 0.3-0.5$ .

Table 1: Correlation of ICaD with ICD, IPD, and IAD

Pearson (r) correlation	ICaD	ICD	IPD	IAD	p-value
Overall (n=600)	1	0.433	0.604	0.640	.001
Male (n=300)	1	0.456	0.603	0.535	.001
Female (n=300)	1	0.330	0.492	0.603	.001

The following regression equations derived as:

$$\text{ICaD (ICD)} = 25.2 + 0.4 \times \text{ICD}$$

$$\text{ICaD (IPD)} = 14.1 + 0.4 \times \text{IPD}$$

$$\text{ICaD (IAD)} = 18.8 + 0.5 \times \text{IAD}$$

All correlations were significant ( $p < 0.001$ ). For males, pattern of correlation mirrored that observed in overall assessment. Among females, however, the

pattern differed: ICD and IPD displayed only a mild correlation ( $r = 0.3-0.5$ ), whereas IAD showed a moderate correlation (Table 1). Scatter plot demonstrate a positive correlation between different landmarks and ICaD in both gender groups (Fig. 5).

Based on abovementioned regression equations, the range of variability percentages between calculated and actual values of ICaD was assessed across different landmarks (Table 2). The mean differences between calculated and actual ICaD measurements were found to be significant when evaluated against different anatomical facial landmarks.

Table II: Percentage range difference between actual and calculated ICaD values			
Variability range	ICD	IPD	IAD
< 1%	108 (18%)	120 (20%)	132 (22%)
1-5%	150 (25%)	336 (56%)	342 (57%)
5-10%	342 (57%)	114 (24%)	126 (21%)
Mean $\pm$ SD variability percentage (range)	4.0 $\pm$ 3.0 (0.01-16.3)	3.5 $\pm$ 2.7 (0.01-18.2)	3.3 $\pm$ 2.6 (0.01-15.4)

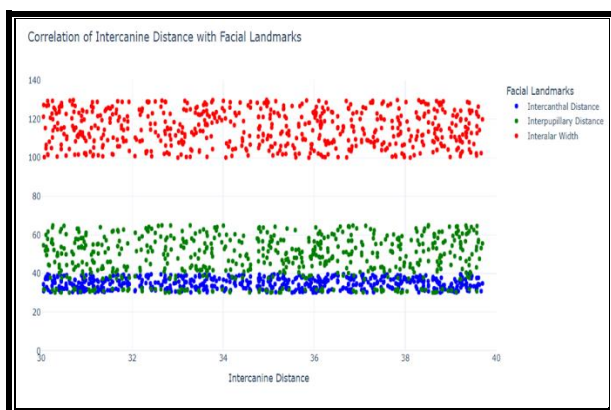


Figure 5: Scatter graph illustrating correlation between ICaD and various facial measurements, including ICD, IPD, and IAD, across both genders

For IAD, the deviations from actual measurements were relatively smaller ( $3.3\pm 2.6\%$ ), while the mean deviations for ICD were larger ( $4.0\pm 3.0\%$ ). For IPD, the mean deviations from actual measurements were moderate, at  $3.5\pm 2.7\%$ .

## Discussion

One of the most challenging aspects of prosthodontic rehabilitation is selecting the appropriately sized maxillary anterior denture teeth. Some studies suggest that assessing overall aesthetics involves applying principles of proportion, balance, rhythm, and empathy, with various facial and bodily features ideally aligning with these proportions.<sup>11</sup> It has been recommended that when choosing teeth for a complete denture, the dentist should select a shape that harmonizes with the patient's facial form and is proportionate to the size of the mouth, overall body structure, age, gender, and personality.<sup>12</sup>

A specialized tool was used for measuring the tips of the canines. The tips of canines, marked on horizontal arm of canine tip marker, were found to be more distinct, easier to measure, and more accurate, reliable, and cost-effective in comparison to measurements obtained from a model of dental stone. This method is also less cumbersome and largely independent of technique.<sup>10</sup> In this study, the association of ICaD with ICD, IPD, and IAD in both genders showed very mild differences in correlation, which were not clinically significant. However, the mean values of the studied facial landmarks were slightly higher in males compared to females. This observation was corroborated by Tripathi et al.<sup>13</sup> It was observed that, regardless of gender, all three variables except ICD exhibited moderate correlation ( $r = 0.5-0.7$ ) with ICaD, while ICD showed a mild correlation ( $r = 0.4$ , within the range of  $r = 0.3-0.5$ ). All correlations were significant ( $p < 0.001$ ). The degree of variability for each independent calculated actual value of ICaD was assessed by

evaluating the variation percentage. This indicates that, for all facial landmarks excluding ICD, majority individuals exhibited less than 5% variability. In this study, IAD demonstrated the strongest correlation, a finding that was also supported by Tripathi et al.<sup>13</sup> However, Kumar Banik et al, Qazi et al, and Pandey et al challenged the idea of a correlation between IAD and ICaD.<sup>14-16</sup> A mild correlation was found between ICD and ICaD, which supports Ahmed et al findings that it can be employed to estimate the mesiodistal width of anterior maxillary teeth in edentulous patients.<sup>17</sup> Wang et al study results indicated that ICD, IPD, and inter-commissural width were most highly correlated with the mesiodistal dimension of the anterior teeth.<sup>18</sup>

Regression methods suggest that widths of anterior teeth within tested population can be estimated utilizing a combination of facial dimensions examined.<sup>19</sup> This study also utilized regression equations, demonstrating that ICaD can be accurately estimated within the population group. While this study has aimed to determine the relationship between ICaD and various stable extraoral landmarks in northern Punjab, Pakistan population, there is a need to incorporate additional reliable extraoral and intraoral landmarks to develop comprehensive guidelines and formulas. This is crucial as aesthetics today are highly concerned with symmetry and proportion. Further research is needed to establish guidelines and selection criteria for successful replacement of missing teeth across various racial groups.

## Conclusion

The extraoral landmarks recorded in the study (ICD, IPD, and IAD) demonstrated significant correlations with ICaD in young individuals examined. Since these landmarks remain stable over time, they can serve as reliable guides for teeth selection in elderly patients. Based on the minimum mean differences and highest number of cases showing less than 5%

error, IAD was deemed the most suitable landmark for tooth selection, while ICD was considered the least preferable. The mesiodistal width of anterior teeth can be effectively predicted employing the regression equations derived from the various landmarks studied.

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