

Original Research Article

A novel approach for establishing angular ratio at the diagonal junction between the maxillary canine and maxillary first molar- A prospective photogrammetric study

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Abstract

Background: Subtle but measurable changes in craniofacial morphology persist beyond biological maturity. Transverse dimensions of the dental arch, such as intermolar and intercanine widths, are important for functional occlusion and esthetics. The determination of angular relationships among important maxillary landmarks may be helpful in orthodontic diagnosis, treatment planning, and establishment of population-specific norms.

Aim: To determine and record the angular ratio at the diagonal junction of the maxillary canine and maxillary first molar in untreated North Indian subjects with Angle's Class I malocclusion based on Andrews' six keys of occlusion.

Materials and Methods: This prospective photogrammetric study included 64 participants (34 males, 30 females) aged 16–25 years from the outpatient department. Standardized intraoral occlusal photographs were captured using a Canon EOS 1500D DSLR camera with a 100 mm macro lens and ring flash. Angles between the maxillary canine cusp tip and the contralateral mesiobuccal cusp tip of the first molar were measured using Adobe Photoshop software. Data was analyzed using SPSS version 21.0 with a 95% confidence interval. A p-value < 0.05 was considered statistically significant.

Results: The mean intermolar angle was $130.50 \pm 3.04^\circ$, and the mean canine–molar angle was $49.83 \pm 3.02^\circ$. There was no statistically significant difference between males and females for either the intermolar ($p = 0.370$) or the canine–molar angle ($p = 0.631$).

Conclusion: There was no significant difference in the measured angular parameters with respect to gender, indicating a similar craniofacial pattern in the North Indian population. The angular values thus obtained can be used as normative values for future anthropometric and orthodontic studies. More studies on different face forms are suggested to increase its clinical relevance.

Keywords: Maxillary arch, Photogrammetry, Intermolar angle, Canine–molar angle, North Indian population, Orthodontic analysis.

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1. Introduction

Craniofacial structures do not completely stop changing once biological maturity is reached. Even when accounting for age related adult changes due to dental disease and imbalances in bone dynamics, it is clear that several decades of adult life are not a period without growth. Although the rate of change is much slower and the direction of growth or aging may differ from that seen in children and adolescents, these changes remain noticeable, especially over long periods.^{1,2} Arch widths do change with age, but the amount of change is usually small and tends to vary across different groups. Most studies have also observed that these changes are more noticeable in males.

The transverse dimension plays an important role in the smile. Intercanine and intermolar arch widths vary

depending on the population being studied and the type of malocclusion present.³ Many studies have also reported differences in canine and molar arch width measurements across different populations.⁴

Dental casts have long been a part of both clinical practice and research, largely because they are affordable and relatively easy to make and handle. That said, they come with their own set of drawbacks like moving them around can be inconvenient, they require proper storage and upkeep, and they are prone to damage. Because of these limitations, efforts have been made to find alternatives, such as using standardized two-dimensional photographs instead of physical casts.^{5,6}

Maxillary arch width and arch length had been helpful in various studies for gender determination,⁷ anthropometric analysis, and orthodontic treatment planning.⁸

The need for this study was to determine the angular ratio at the diagonal junction to assess the maxillary inter-canine and inter-molar width as a standard for the population in North India in untreated Class 1 malocclusions complying with Andrews' six keys of occlusion.^{9,10}

2. Aims and Objectives

The study aimed to establish angular ratio at the diagonal junction between maxillary canine and maxillary first molar.

The objectives of this study were:

1. Evaluation of diagonal relation at the level of inter-canine width and inter-molar aspect.
2. To assess and establish definitive angular ratios.
3. To establish a standard measurement for the population.
4. For recording differences between males and females if they exist.

3. Materials and Methods

Data was collected from the outpatient department.

The study was a prospective photogrammetric study with photographs taken of males and females having equal chance to be selected due to random sampling. The study adhered to ethical guidelines, ensuring participant confidentiality and anonymity. Data collected was used solely for research purposes and handled in compliance with relevant ethical standards.

3.1. Inclusion criteria

1. Subjects that belong to North India
2. The age of the subjects should be between 16 to 25 years.
3. No history of previous orthodontic treatment.
4. Patients should adhere to Andrews six keys of occlusion
5. No severe skeletal anomaly along with cleft lip and palate.
6. Only Angles Class 1 occlusions should be included.

3.2. Exclusion criteria

1. Subjects that do not belong to North India.
2. History of previous orthodontic treatment.
3. Skeletal anomaly present.
4. Patient suffering from any systemic disease.
5. Any other occlusion other than Class 1 occlusion

3.3. Method of collection of data

Data was primary collected from the outpatient department.

All subjects comprising of males and females were selected. The subjects were informed and explained about the study and the procedure and informed consent was taken.

3.4. Materials

1. Photographs of the patient were taken using:
 - i. Digital-SLR camera CANON EOS 1500D
 - ii. 100mm Macro lens
 - iii. Ring Flash (Canon MR 14 EX 2)
 - iv. An intraoral full arch mirror
2. Materials that were used for evaluation:
 - i. ADOBE photoshop software
 - ii. Microsoft Excel.

3.5. Methodology

The records were taken in supine position. Each subject was shown where to sit and asked to relax and open the mouth wide. Spectacles were removed. An intraoral mirror was placed in the patients mouth such that it is resting on the mandibular anteriors and giving us a detailed view of the maxillary occlusal plane. The patient photographic records were taken. The standardized intraoral upper occlusal photograph used for angular measurements is shown in **Figure 1**.

The photographic records were then transferred to the Adobe software and two lines, each from the canine

tip to the contralateral mesiobuccal cusp tip of the maxillary first molar was drawn.¹¹ (**Figure 2**)

The photographs with the lines were printed ensuring that 1:1 magnification is maintained and recording of the angles was done. Angles of both sexes was determined. This study helped us to get a standard value of angles and the ratios for the population in the study. This ratio acts as a standard for further studies.



Figure 1: Intraoral upper occlusal photograph with markings from canine cusp tip to mesiobuccal cusp of molar

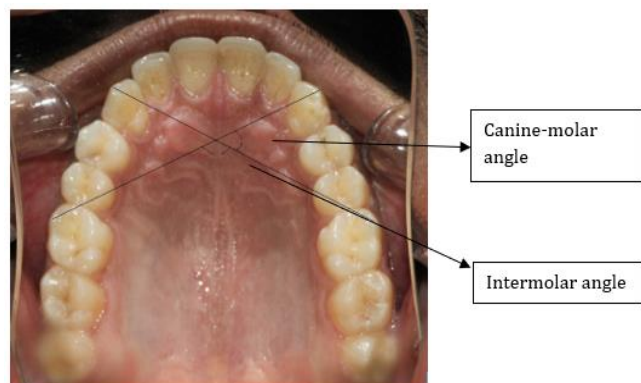


Figure 2: Represents angles

3.6. Statistical analysis

Statistical Package for Social Sciences (IBM SPSS Statistic for window, version 21.0. Armonk, NY: IBM Corp.) was used for statistical analysis at 95% CI and 80% power to the study.

To check for normal distribution of the data, Kolmogorov-Smirnov and Shapiro Wilk test was done.

Table 3: Mean intermolar angle and canine molar angle of all participants

	N	Minimum	Maximum	Mean	Std. Deviation
Intermolar Angle	64	125.00	136.00	130.5000	3.04464
Canine-molar angle	64	45.00	55.00	49.8281	3.01612
Valid N (listwise)	64				

Descriptive statistics was performed in terms of Mean, Std Deviation, Frequency and percentage

Unpaired t test was applied for statistical analysis of the results.

Statistical significance was calculated at $p < 0.05$ and $p < 0.001$ was considered statistically highly significant.

4. Results

4.1. Gender distribution in the study

A total of 64 participants enrolled in the study, 30 (46.9%) were females and 34 (53.1%) were males, indicating a nearly equal distribution of participants across both genders. (**Table 1**)

Table 1: Gender distribution in study

		Frequency	Percent
Gender	Female	30	46.9
	Male	34	53.1
	Total	64	100.0

4.2. Mean age of male and female participants

The mean age of the participants was comparable between males and females. Male participants ($n = 34$) had a mean age of 19.53 ± 2.56 years, while female participants ($n = 30$) had a mean age of 19.83 ± 2.39 years. (**Table 2**)

Table 2: Mean age of male and female participants

	Gender	N	Mean	Std. Deviation
Age	Male	34	19.5294	2.56119
	Female	30	19.8333	2.39372

4.3. Mean intermolar angle and canine-molar angle of all participants

When assessed across the entire sample ($n = 64$), the mean intermolar angle was $130.50 \pm 3.04^\circ$, with values ranging between 125° and 136° . Similarly, the mean canine-molar angle was $49.83 \pm 3.02^\circ$, with a range between 45° and 55° . These findings suggest relatively narrow variability in both angular parameters among the participants, reflecting a consistent anatomical pattern within the study population. (**Table 3**)

Table 4: Comparison of mean intermolar angle between gender

	Gender	N	Mean	Std. Deviation	p-value
Intermolar Angle	Male	34	130.8235	2.92814	0.370
	Female	30	130.1333	3.18112	

Table 5: Comparison of mean canine – Molar angle between gender

	Gender	N	Mean	Std. Deviation	p-value
Canine-Molar Angle	Male	34	50.0000	3.07482	0.631
	Female	30	49.6333	2.98829	

4.4. Comparison of mean intermolar angle between genders

On comparing intermolar angles between genders, males (n = 34) demonstrated a mean value of $130.82 \pm 2.92^\circ$, while females (n = 30) showed a mean of $130.13 \pm 3.18^\circ$. The difference between the two groups was not statistically significant (p = 0.370). (Table 4)

4.5. Comparison of mean canine-molar angle between genders

In terms of canine-molar angle, male participants (n = 34) had a mean value of $50.00 \pm 3.07^\circ$, whereas female participants (n = 30) showed a mean of $49.63 \pm 2.99^\circ$. The difference was statistically non-significant (p = 0.631), suggesting that the canine-molar angle is comparable between males and females. (Table 5)

5. Discussion

The study comprised 64 participants, 30 females (46.9%) and 34 males (53.1%), which is almost equal gender distribution. The mean age of the participants was similar between genders. The mean age for males was 19.53 ± 2.56 years and for females 19.83 ± 2.39 years. There is a slight age difference but this is unlikely to influence the overall findings of the study.

Conversely, two important angles were measured in the study as an anatomical parameter: intermolar angle and canine-molar angle. The mean intermolar angle was $130.50 \pm 3.04^\circ$, ranging from 125° to 136° and the mean canine-molar angle was $49.83 \pm 3.02^\circ$, ranging from 45° to 55° for the whole sample. Both angular parameters show relatively small variability, which indicates a consistent anatomical pattern in the group of participants.³

When comparing the mean intermolar angle between genders, males had a mean of $130.82 \pm 2.92^\circ$, while females had a mean of $130.13 \pm 3.18^\circ$. The difference between the two groups was not statistically significant

(p = 0.370), indicating that the intermolar angle is similar for both males and females.

The mean value of the canine-molar angle was $50.00 \pm 3.07^\circ$ in males and $49.63 \pm 2.99^\circ$ in females. This difference was also statistically non-significant (p = 0.631), further supporting the notion that the canine-molar angle is not meaningfully different between genders.

These results suggest that gender does not significantly influence the measured craniofacial angles in this study population, implying that any anatomical differences observed were likely minimal.

According to a study by Patel et al., gender differences in craniofacial parameters were often reported in orthodontic literature, though many studies, similar to the current one, show minimal significant variation between genders when considering angular measurements like the intermolar and canine-molar angles.^{12,13} This supports the idea that while individual variation may exist, the overall gender-based differences in craniofacial anatomy were not substantial for the angles studied here.

A similar study by Taner et al. on craniofacial morphology also found that while gender differences can influence certain skeletal measurements, such as the size of maxillary and mandibular structures, the angular relationships between key teeth (such as those measured in this study) tend to exhibit consistent patterns across genders, especially in younger populations.¹⁴

Thus, the findings in this study align with broader research trends, indicating that gender does not play a major role in determining the intermolar or canine-molar angles in this cohort.¹⁵

6. Conclusion

The present study results suggest that gender does not have significant effect on intermolar and canine-molar angles in the study population. The results are also

confirmed by the almost equal number of male and female participants and the similar average ages. The mean intermolar angle ($130.50 \pm 3.04^\circ$) and mean canine-molar angle ($49.83 \pm 3.02^\circ$) was found to be minimally variable among the participants, indicating a consistent anatomical pattern. Statistically significant differences were not seen when these angles were compared between genders, again supporting the idea that these particular craniofacial characteristics were not influenced by gender.

These results align with previous studies in the orthodontic literature, which also report minimal gender-based differences in angular craniofacial measurements. This suggests that factors other than gender, such as genetics or environmental influences, may play a more prominent role in shaping the anatomical relationships between teeth. Future research could explore the impact of these other factors to further clarify the determinants of craniofacial morphology.

The major drawback in this study is that patients with the same facial form were taken thereby showing no significant differences. A study can be done or modified by incorporating and comparing the angles in three different facial forms.

Author Contributions

Janak Lodha: Conceptualization, methodology, data collection, formal analysis, and original draft preparation. **Tarun Sharma:** Study design, methodology, supervision, manuscript review, and editing. **P. Narayana Prasad:** Methodology, data interpretation, and critical review of the manuscript. **Anupa Rawat, Sumit Joshi, and Anushi Mishra:** Data collection, investigation, and manuscript review. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of Seema Dental College and Hospital, Rishikesh, Uttarakhand, India (Approval No.: SDCH/SS-ORTHO/IEC03/2025).

Declaration of Patient Consent

Written informed consent was obtained from all participants prior to their enrollment in the study. Participant confidentiality and anonymity were maintained throughout the study.

Financial Support and Sponsorship

Nil.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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