Estimation of the Intercanine Width, Intermolar Width, Arch Length, and Arch Perimeter and Its Comparison in 12–17-year-old Children of Faridabad

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Abstract

Context: Dental arch morphology is an important consideration in the orthodontic treatment of dentofacial deformities. The size and shape of the arches have considerable implications in treatment planning, affecting space available, dental esthetics, and stability of dentition. The data provided by this study will be of considerable importance and relevance for practicing orthodontists and pedodontists in the region of Faridabad

Aim and objective: This study aims to determine and compare the intercanine width, intermolar width, arch length, and arch perimeter in the early adolescent group (12–14 years) and middle adolescent group (15–17 years) of Faridabad.

Materials and methods: Maxillary and mandibular impressions were made, study casts were prepared then the measurement of the individual intercanine widths, intermolar widths, arch length of maxillary and mandibular casts with the digital caliper, and arch perimeter with the help of brass wire was taken, obtained values were calculated, hence the results were evaluated.

Statistical analysis: Data were entered into a Microsoft Excel spreadsheet. It was analyzed using Statistical Package for Social Sciences (SPSS) version 21. Graphs were prepared using Microsoft Excel. Data were normally distributed as tested using the Shapiro-Wilk W test (p value was <0.05). Inferential statistics were performed using independent Student's t-test. The level of significance was set at 0.05.

Results: In the present study, all the parameters measured were increased in males in both the age-groups, i.e., the early adolescent group (12–14 years) and the mid adolescent group (15–17 years), and a significant increase was seen in the intercanine and intermolar widths in males.

Keywords: Maxillary central incisor, Maxillary first molar, Primary dentition.

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Introduction

For >100 years, researchers have been trying to define the "ideal" arch form, frequently using the concept that the dental arch is symmetric in nature and can be represented by an algebraic or geometric formula.[1] Dental arches are dynamic and they change due to treatment intervention as well as growth and development.[2]

The relationship between arch dimensions and crowding has become a subject of interest and concern to many investigators which has led to many conflicting and contradictory views.[3]

Arch form and dimensions are two important factors in case assessment, diagnosis, and treatment planning.[4] The values of the dimensions of the arch include: width, depth and circumference, intercanine and intermolar distances, overjet and overbite, which change during growth in different ways (the width of the teeth remains the same, whereas the lengths of the mandibular and maxillary bones increase).[5]

Arch dimensions are explained by arch width, arch length, and arch depth. Arch width is noted by measuring intercanine width, interpremolar width, and intermolar width. The circumference or perimeter is the most important dimension of the dental arch and changes according to age and gender (Figs 1 to 4).

The primate spaces allow the eruption of the permanent canines. The intercanine and intermolar widths do not change after 13 years in females and 16 years in males.[6]

Because of this, many studies have investigated arch dimensional changes in various stages of growth and development, such as arch width and arch dimensions.[7] The orthodontists and pedodontists grant significant importance to the dental arch width

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for diagnosis and treatment planning to address the dental esthetics and stability of the dentition. The findings determined for other regions might be insufficient for application to different racial or ethnic groups and may exhibit variations.[8]

The clinical significance of this study is that the knowledge of dental arch widths in a population plays a key role in orthodontics and pedodontics. Because of the increasing number of adults seeking orthodontic care, an understanding of the changes that normally take place in the craniofacial structures during later stages of development becomes critical. Since the stability of treatment results, is of paramount importance to both patients and clinicians, a greater understanding of these changes could influence the

Fig. 1: Materials and armamentarium
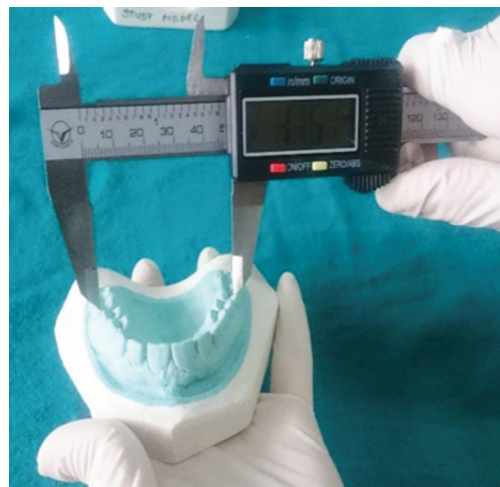

Fig. 2: Measuring intercanine width

Fig. 3: Measuring intermolar width

Fig. 4: Measuring arch perimeter with help of brass wire

patient's expectations as well as the treatment and retention plans designed by the clinician.[9]

Dental arch morphology is an important consideration in the orthodontic treatment of dentofacial deformities. The size and shape of the arches have considerable implications in treatment planning, affecting space available, dental esthetics, and stability of dentition.

The data provided by this study will be of considerable importance and relevance for practicing orthodontists and pedodontists in the region of Faridabad.

Materials and Methods

The cross-sectional study was done on a sample of 300 dental casts obtained from 12–17-year-old patients visiting the Outpatient Department of Pedodontics and Preventive Dentistry, and Children studying in nearby schools of Faridabad, to determine and compare the intercanine width, intermolar width, arch length, and arch perimeter in the early adolescent group (12–14 years) and mid adolescent group (15–17 years).

Ethical Considerations

Ethical clearance was obtained from the ethical committee of the institutional review board.

Sample Size Information and Study Population

Three hundred children (150 males and 150 females) with completely erupted permanent canine and premolars at ages ranging from 12 to 17 years were divided into:

- Early adolescent group (12–14 years) and
- Mid adolescent group (15–17 years).

The early adolescent group was further divided into 75 males and 75 females.

The mid adolescent group was further divided into 75 males and 75 females.

Inclusion Criteria

- The origin of children should be of Faridabad.
- Congenital craniofacial and dental anomalies should not be present.
- Angle's class I molar relationship with no or mild malocclusion.
- No previous history of orthodontic treatment.
- Abnormal oral deleterious habits like thumb sucking, tongue thrusting, and mouth breathing should not be present.
- Intact dentition with no grossly carious teeth, multi-surface restorations, or significant attrition.
- High-quality impressions which were free of distortions.

Exclusion Criteria

- Children or parents of the children not willing to participate.
- Hypoplastic teeth.
- Partially erupted or any impacted teeth present from the central incisor to the first molar.
- Patients with congenital craniofacial and dental anomalies.

Following widths were measured on 300 study models.

- Intercanine width: The distance between cusp tips of the right and left maxillary and mandibular permanent canines.
- Intermolar width: The distance between the mesiobuccal cusp tips of the right and left maxillary and mandibular first molars.
- Arch length: dental arch length is measured at the midline from a point midway between the central incisors to a tangent touching the distal surfaces of the second primary molars or second premolar.[5]
- Arch perimeter or circumference: The most important of the dental arch dimensions is arch circumference or perimeter, which usually is measured from the distal surface of the second primary molar (or mesial surface of the first permanent molar) around the arch over the contact points and incisal edges in a smoothened curve to the distal surface of the second primary molar (or first permanent molar) of the opposite side.

Landmarks on the dental cast were located and marked with a sharp lead pencil. The measurement of the individual intercanine widths, intermolar widt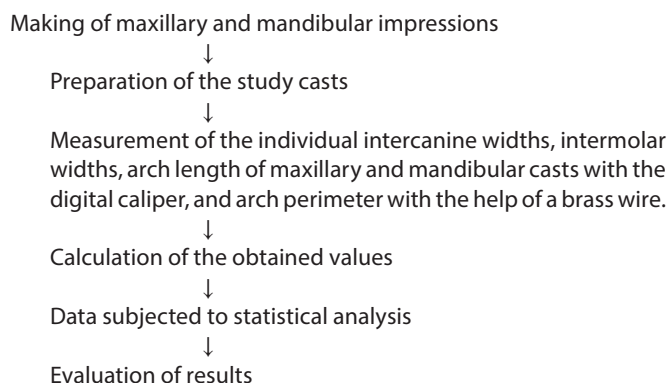hs, arch length of maxillary and mandibular casts was taken with the Digital Vernier caliper, and arch perimeter with the help of a Brass wire.

All measurements were done by a single examiner to eliminate intraobserver error. The intraexaminer variability was obtained by repeating the measurements for 10 pairs of dental casts (randomly selected from the sample) with 1-week intervals and subjecting them to Dahlberg's formula for the calculation of measurement method error. The measurements for each cast were done twice and compared. If they varied by 0.2 mm or less, the values were averaged. In instances where the measurements varied by >0.2 mm, the teeth were remeasured and the nearest three measurements were averaged.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet. It was analyzed using Statistical Package for Social Sciences (SPSS) version 21. Graphs were prepared using Microsoft Excel. Data were normally distributed as tested using the Shapiro-Wilk W test (p value was <0.05). Inferential statistics were performed using Independent Student's t-test. The level of significance was set at 0.05.

METHODOLOGY FLOWCHART

Making of maxillary and mandibular impressions
↓
Preparation of the study casts
↓
Measurement of the individual intercanine widths, intermolar widths, arch length of maxillary and mandibular casts with the digital caliper, and arch perimeter with the help of a brass wire.
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Calculation of the obtained values
↓
Data subjected to statistical analysis
↓
Evaluation of results

RESULTS

Independent Student's "t" test (for comparing two groups). The intercanine width, intermolar width, arch length, and arch perimeter among males and females were compared using Independent Student's "t". The intercanine width, intermolar width, arch length, and arch perimeter among the early adolescent group (12–14 years) and mid adolescent group (15–17 years) were also compared using independent Student's "t" test. The level of statistical significance was set at p value < 0.05 (Tables 1 to 9).

DISCUSSION

Early growth, that of childhood and adolescence, is dramatic and well-documented; however, later growth, that of adulthood, is much less obvious and the object of far fewer studies.[10]

Table 1: Gender-wise distribution of subjects according to age-groups

	Males		Females		Total	
Age-groups	n	%	n	%	n	%
Early adolescent group (12–14 years)	75	50	75	50	150	50
Mid adolescent group (15–17 years)	75	50	75	50	150	50
Total	150	50	150	50	300	100

Table 2: Mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in the early adolescent group (12–14 years) in the maxilla

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males	33.8 ± 0.54	51.2 ± 1.38	25.5 ± 1.71	74.3 ± 3.59
Females	32.1 ± 1.57	50.1 ± 3.89	25.1 ± 2.06	73.6 ± 3.56
p^a value	0.002*	0.091	0.113	0.741

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Table 3: Mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in the early adolescent group (12–14 years) in the mandible

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males	25.4 ± 0.88	43.5 ± 2.12	21.2 ± 1.35	64.0 ± 4.0
Females	24.4 ± 3.30	42.4 ± 2.73	20.3 ± 1.60	62.4 ± 3.41
p^a value	0.122	0.171	0.192	0.522

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Table 4: Mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in the mid adolescent group (15–17 years) in the maxilla

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males	36.5 ± 1.53	53.2 ± 1.92	26.5 ± 1.80	78.1 ± 6.39
Females	35.1 ± 0.72	51.8 ± 2.12	24.9 ± 2.23	76.6 ± 3.50
p^a value	0.021*	0.62	0.50	0.62

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Table 5: Mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in the mid adolescent group (15–17 years) in the mandible

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males	26.9 ± 2.06	45.3 ± 2.33	21.3 ± 1.45	66.0 ± 3.4
Females	26.04 ± 1.93	43.1 ± 3.54	20.8 ± 1.55	65.0 ± 3.69
p^a value	0.99	0.01*	0.78	0.33

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Table 6: Comparison of mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in early adolescent (12–14 years) group with a mid adolescent group (15–17 years) in the maxilla

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males				
Early adolescent 12–14 years	33.8 ± 0.54	51.2 ± 1.3	25.5 ± 1.71	74.3 ± 3.5
Mid adolescent group 15–17 years	36.5 ± 1.53	53.1 ± 1.9	26.5 ± 1.80	78.1 ± 6.3
p^a value	0.001*	0.213	0.223	0.321
Females				
Early adolescent 12–14 years	32.1 ± 1.57	50.1 ± 3.89	25.1 ± 2.06	73.6 ± 3.5
Mid adolescent group 15–17 years	35.1 ± 0.72	51.8 ± 2.12	24.9 ± 2.23	76.6 ± 3.5
p^a value	0.015*	0.714	0.640	0.311

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Intercanine Width

In the present study, there is a significant increase of intercanine width in the maxilla in both the age-groups, whereas intercanine width was found to be non-significant in the mandible in both age-groups. The mean intercanine width in the present study is reported to vary between 33.8 mm and 36.5 mm.

Yavuz and Oktay[11] reported similar findings, intercanine width increased in the maxilla, while it decreased in the mandible. Changes in the maxilla were statistically significant, but changes in the mandible were not. He reported that the cause of intercanine width increase in the maxilla was growth in the median suture during normal growth. Similar findings were reported by Mills,[12]

Table 7: Comparison of mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in early adolescent (12–14 years) group with a mid adolescent group (15–17 years) in the mandible

	Intercanine width	Intermolar width	Arch length	Arch perimeter	
Males					
Early adolescent 12–14 years	24.9 ± 0.88	43.5 ± 2.12	21.2 ± 1.35	64.0 ± 4.0	
Mid adolescent group 15–17 years	26.9 ± 2.06	45.3 ± 2.34	21.3 ± 1.45		66.0 ± 3.4
p^a value	0.02*	0.34	0.94	0.51	
Females					
Early adolescent 12–14 years	25.4 ± 3.30	43.1 ± 2.7	20.3 ± 1.6	62.4 ± 3.41	
Mid adolescent group 15–17 years	26.0 ± 1.93	43.4 ± 3.5	20.8 ± 1.55		65.0 ± 3.6
p^a value	0.76	0.18	0.59	0.55	

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Table 8: Mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in the maxilla

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males	35.1 ± 1.035	52.2 ± 1.65	26 ± 1.75	76.2 ± 4.9
Females	33.6 ± 1.45	50.9 ± 3.0	25 ± 2.14	75.1 ± 3.53
p^a value	0.048*	0.003*	0.235	0.013*

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Table 9: Mean and standard deviation (mean ± SD) of intercanine width (ICW), intermolar width (IMW), arch length (AL), and arch perimeter (AP) of males and females in the mandible

	Intercanine width	Intermolar width	Arch length	Arch perimeter
Males	26.1 ± 1.47	44.4 ± 2.22	21.2 ± 1.4	65 ± 3.7
Females	25.2 ± 2.61	42.7 ± 3.13	20.8 ± 1.5	63.7 ± 3.5
p^a value	0.03*	0.016*	0.074	0.290

[a]Independent Student's "*t*" test, *Significance of relationship at $p < 0.05$

Grewe,[13] Younes,[14] Hassanali and Odhiambo,[15] Sangwan et al.,[16] Amin,[4] and Sodhi and Sodhi.[1]

Also, in contrast to our findings, Sinclair and Little[17] found a decrease in intercanine width of 0.44 mm from 13–14 to 19–20 years, whereas Bishara et al.[9] found a decrease of 0.5 mm for male subjects and 0.6 mm for female subjects aged between 26 and 45 years. On the other hand, Harris,25 after conducting a longitudinal assessment of individuals aged between 20 years and 54 years, did not find changes in intercanine width.

Intermolar Width

The present study reported non-significant changes in the intermolar width in the early adolescent group (12–14 years) but significant changes in the intermolar width was found in the mid adolescent group (15–17 years) in the mandibular arch, but the differences were greater in males than females in both the age-groups. In the present study, the mean intermolar width is reported to vary between 51.2 mm and 53.2 mm.

These findings were in accordance with Staley et al.,[18] Qamar,[8,19] and Harris.[20]

Arch Length

In the present study, non-significant differences were observed in both the age-groups and were observed to be constant in comparison between both the groups. There were no significant changes observed in the arch length from early adolescence to mid-adolescence and were rather found to be constant. Similar findings were reported by Louly et al.,[7] who stated that the arch lengths remain constant after 12 years of age, and Moorrees and Chadha[21] who reported the age to be 14 years.

Arch Perimeter

In the present study, no significant changes were observed in the early adolescent group and mid adolescent group and observed to be constant. This is in accordance with the study done by the classical study of Moorrees and Chadha[21] showed constant values for these factors after 14 years unlike that indicated by most of the orthodontic literature. The upper arch perimeter showed a mean reduction of 0.67 mm, and the lower arch perimeter showed a mean reduction of 0.71 mm.

In contrast to the present study, Tibana et al.[22] showed significant reductions of 0.67 and 0.71 mm, respectively, the upper and lower arch perimeters due to the anterior component of occlusion force. Sinclair and Little[17] and Carter and McNamara[23] also reported a significant reduction in the upper and lower arch perimeters with time. Vego[24] reported a loss in arch perimeter in cases with third molars than in cases with congenital absence of lower third molars. It was found the mean arch perimeter loss of 0.8 mm was found to be a statistically significant difference, the erupting lower third molars were considered the responsible factor.

Sexual Dimorphism

In the present study, all the parameters measured were increased in males in both the age-groups, i.e., the early adolescent group (12–14 years) and the mid adolescent group (15–17 years), and a significant increase was seen in the intercanine and intermolar widths in males. Similar findings were observed by Younes[14] and Forster et al.[25] In other words, Raberin et al.[26] reported dental arches of the women have smaller dimensions.

In corroboration with a study by Moyers, it was also observed that sexual dimorphism for inter first molar arch width was greater in the maxilla than mandible.[27] Differences in arch width have also been reported to exist between the races. Blacks have been shown to have larger arch widths than Whites.[28–30]

The findings of the present study indicated that there are morphologic characteristics of the dental arches that differ between genders; males had larger diameters in both age-groups. It was established that there is a characteristic form of the arches for each ethnic group. Further studies should be developed to identify correlations between the different parameters measured in this study to establish the interactions among them in the human face growth.

CONCLUSION

Based on the results obtained from the present study, the following conclusions were drawn:

- The intercanine width is significant in maxilla for both early and mid adolescent groups whereas it is found to be non-significant in the case of mandible in both age-groups.
- While comparing the intercanine width, intermolar width, arch length, and arch perimeter in the early adolescent group (12–14 years) and mid adolescent group (15–17 years) between males and females only the intercanine width was found to be significant in both males and females in maxilla, whereas in mandible it was only found to be significant in males.
- The intermolar width is found to be significant in the mid adolescent group in the mandible but an increase in the values of intermolar width was found in maxilla in mid adolescent group which was statistically non-significant.
- The arch length and arch perimeter were found to be statistically non-significant. The arch length remains unchanged in both the age-groups and both males and females, whereas the arch perimeter showed an increase from early adolescent to mid adolescent age-group but statistically non-significant.
- The intercanine width, intermolar width, arch length, and arch perimeter were larger in males than females in both the age-groups, hence demonstrating sexual dimorphism in the population of Faridabad.

ACKNOWLEDGMENTS

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