

# Morphometrics of Permanent Dentition in Chennai Population

<sup>1</sup>K Sridhar, <sup>2</sup>AV Arun, <sup>3</sup>Karthikswamy, <sup>4</sup>P Kiran Kumar, <sup>5</sup>CH Sudheer Kumar, <sup>6</sup>KVV Pratap Verma

## ABSTRACT

As compared to other ethnic groups relatively few measurements on tooth size have been made on Indian population. Hence, a study was carried out in Department of Orthodontics, Saveetha Dental College, Chennai, to discern the average clinical crown dimensions for cervico-incisal heights (CIH) and mesiodistal widths (MDW), permanent dentition for the local population, to find out the amount of variation in CIH and MDW between males and females, between right and left sides and tooth showing maximum and minimum variation. The study was carried out on study models of 100 patients who visited the OPD of the above college, and measurements were done using Digital Vernier calipers. The results showed that CIH and MDW are generally larger for male teeth compared to female and left side 2nd molars showed clinically significant variation in CIH. The study also showed that in both sexes and arches maximum variation in CIH was for central incisor and minimum for 2nd molar. In MDW, maximum variation is for 2nd molar and minimum for 2nd premolars in both arches.

The study is helpful in establishing Bolton's standards for assessing tooth size discrepancy and also in application of mixed dentition model analysis and bracket positioning chart for preadjusted edgewise appliance for the local population.

**Keywords:** Cervico-incisal heights (CIH), Mesiodistal widths (MDW), Digital Vernier calipers, Males and females.

**How to cite this article:** Sridhar K, Arun AV, Karthikswamy, Kumar PK, Kumar CHS, Verma KVV. Morphometrics of Permanent Dentition in Chennai Population. J Ind Orthod Soc 2011;45(3):110-118.

## INTRODUCTION

Variation in tooth size is influenced by genetic and environmental factors. Some of the factors that contribute to the variability of permanent tooth size are race, sex, heredity, environment, secular changes and bilateral asymmetry. The literature review indicates that many investigators have found differences in tooth size between various ethnic and racial groups and, as a result, a number of diagnostic standards have been suggested.

Such discrepancies in tooth size could have important effects in the application of diagnostic criteria derived from

specific populations, as in prediction equations used to estimate the mesiodistal crown dimensions of unerupted permanent teeth.

Tooth size variations have been reported among various ethnic populations, like North American Caucasians, Negroes, Mongoloids, etc. Racial variations have also been observed in the Eskimos, Bushmen, Australian Aborigines, etc.

Historically, India was inhabited by descendants of the Iberian race of Caucasians called the Dravidians. In 300 AD, Aryans, descendants of the Nordic group of Caucasians, infiltrated the Dravidians. Today, North Indians are of Aryan origin, whereas South Indians are with Dravidian characteristics, as there is little information regarding the tooth dimensions of the Chennai population which is intermingled with both North and South Indians. This study was carried out to obtain normative data for the mesiodistal and cervico-incisal dimensions of the clinical crowns and also to assess the variations in tooth size present in the population.

## AIMS AND OBJECTIVES

1. To obtain normative data of crown dimensions (cervico-incisal height and mesiodistal width) in Chennai population
2. To compare variations occurring in crown dimensions on right side with that of left side
3. To predict the teeth showing maximum and minimum variation in crown dimensions
4. To compare the variations occurring in crown dimensions between males and females in Chennai population.

<sup>1,3-6</sup>Reader, <sup>2</sup>Professor

<sup>1,3</sup>Department of Orthodontics, People's College of Dental Sciences Bhopal, Madhya Pradesh, India

<sup>2</sup>Department of Orthodontics, Saveetha Dental College, Chennai Tamil Nadu, India

<sup>4</sup>Department of Orthodontics, Mamata Dental College, Khammam Andhra Pradesh, India

<sup>5</sup>Department of Orthodontics, Teerthankar Mahaveer Dental College Moradabad, Uttar Pradesh, India

<sup>6</sup>Department of Orthodontics, Hitech Dental College, Bhuvaneshwar Orissa, India

**Corresponding Author:** K Sridhar, Reader, Department of Orthodontics, People's College of Dental Sciences, Bhanpur Bhopal, Madhya Pradesh, India, Phone: +91-7869914693 e-mail: sridhar.kodumuru@rediffmail.com

Received on: 19/05/11

Accepted after Revision: 11/09/11

## MATERIALS AND METHODS

### Sampling Procedure

The study was carried out on study models of 100 people (66 females and 34 males) from varied professions and walks of life with an acceptable profile and optimal occlusion. The subjects were selected after critical assessment from the people visiting the Outpatient Department of Saveetha Dental College and Hospitals, various schools and colleges in and around Chennai in the age group of 16 to 25 years.

The study models (Fig. 1) were prepared by taking alginate impressions and pouring them immediately in dental stone. A digital Vernier caliper scale (Fig. 2) read to the nearest 0.01 mm was used to measure the teeth. The tips of the calipers were ground to a point in order to facilitate the greatest degree of accuracy. Moorrees and Reed<sup>1</sup> pioneered the effort to standardize the location of measurement on the models and the best method appears to employ sliding calipers with a Vernier scale to the nearest 0.1 mm, measuring the greatest mesiodistal diameter at the contact point parallel to the occlusal surface of the teeth and also parallel to the vestibular surface of the model.

### Selection Criteria

1. Presence of all fully erupted permanent teeth up to second molars
2. All teeth assessed to be morphologically normal
3. No severe attrition of teeth
4. Presence of class-I molar and canine relationship
5. No significant gingival recessions on teeth
6. No history of previous orthodontic treatment, no dental irregularity or imbrication
7. No presence of restorations or absence of carious tooth.

### Materials Used

1. Study models—made from dental stone, type-III Gypsum product, Kalabhai Company, Mumbai, India (Fig. 1)
2. Digital calipers—measurements on study models were made using Digital Vernier Calipers with an accuracy up to 0.01 mm (Digital Calipers, Model no.:CD-6"CS, Mitutoyo Corporation, Japan) (Fig. 2)
3. HB lead pencils (Nataraj \*621, Mumbai, India) were used to place orientation markings on the teeth.

### METHODOLOGY

Before actual measurements were made, the study models were first assessed for the presence of surface irregularities and porosities, imperfection in anatomical detail, etc. and the presence of the above-mentioned factors in the models eliminated them from the study.

For the determination of cervicoincisal height of clinical crown, a vertical reference plane was taken and measured. The vertical reference plane, for all the teeth up to the second premolars, represented the long axis of the clinical crown and is known as the facial axis of the clinical crown (FACC) (Figs 3A and B). For the molars, the developmental groove between the



Fig. 2: Digital Vernier calipers



Fig. 1: Study models used for the study

mesio Buccal and distobuccal cusps was identified and a line parallel to it running from the mesio Buccal cusp to the gingival margin was scribed to indicate the vertical reference plane.

The cervicoincisal height of the clinical crowns was measured using the incisal edge as the occlusal reference point for the incisors, cuspal tips for the canines and the premolars and for the molars the occlusal reference was the mesio Buccal cusp tip. Using the digital Vernier caliper, the length of the plane was measured cervicoincisally and readings obtained.

The mesiodistal diameter was measured from contact point to contact point which was taken at the maximum convexity of the tooth measured parallel to the occlusal plane and a plane parallel to the vestibular surface (Figs 4A and B).

### ACCURACY OF THE MEASUREMENT TECHNIQUE

As a check on the accuracy of the measurement technique, two investigators independently recorded two measurements for each tooth. Intra and interexaminer reliability were previously determined to be within 0.2 mm. When discrepancies greater

than this limit occurred, a new set of measurements were made and the nearest three measurements averaged.

### STATISTICAL ANALYSIS

The mean standard deviation (SD) and range were estimated for each tooth from central incisor to second molar in all quadrants for:

- i. For only males in sample
- ii. For females in sample.

Mean values were compared between specific tooth on right and left sides of maxillary and mandibular dental arches by Student's t-test. Comparisons between mean values of boys and girls, for each tooth in the sample, were done using Student's independent t-test.

Using range differences for each tooth, for the whole sample (Tables 9 and 10) the dental arch showing maximum and minimum variation in dimensions (cervicoincisal and mesiodistal) were predicted.

In the present study,  $p < 0.05$  was considered as the level of significance.

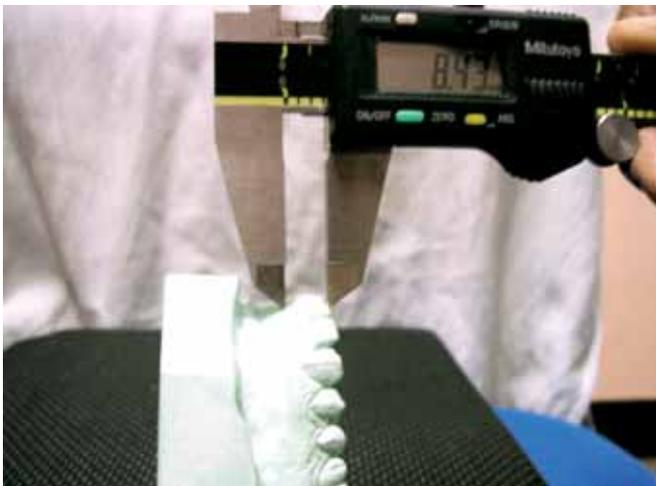


Fig. 3A: Measurement of cervicoincisal height from models using digital calipers



Fig. 3B: Measurement of mesiodistal width from models using digital calipers

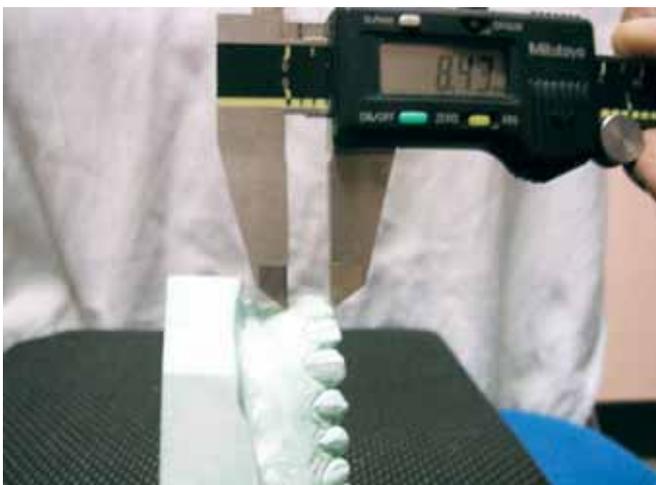


Fig. 4A: Measurement of cervicoincisal height from models using digital calipers (close-up view)

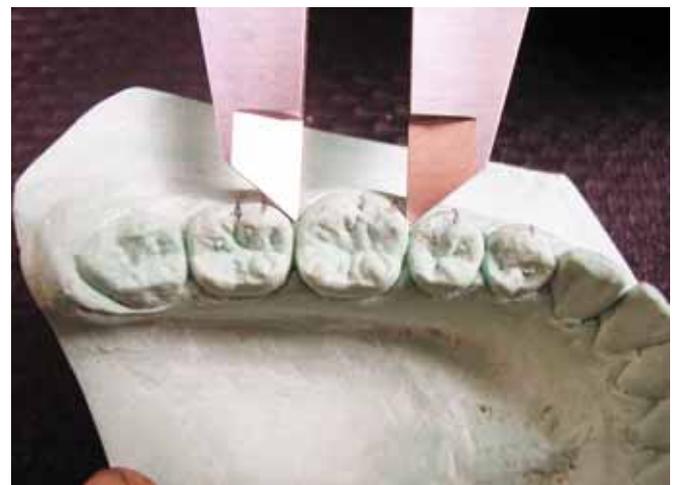


Fig. 4B: Measurement of mesiodistal width from models using digital calipers (close-up view)

**INFERENCES FROM RESULTS**

**Right/Left Comparisons (Tables 5 to 8)**

Of the 28 comparisons, for each type of tooth on each side with its antimere, the mean differences in cervicoincisal height of only eight anteriors were statistically significantly different from each other and mean differences in mesiodistal width were statistically significant between two anteriors.

**Pairs are:**

<i>In cervicoincisal heights</i>	<i>In mesiodistal widths</i>
11 and 21, 12 and 22, 13 and 23	14 and 24
14 and 24, 16 and 26, 17 and 27	16 and 26
36 and 46, 37 and 47	

In cervicoincisal heights, mean differences between any two anteriors ranged from 0.01 to 0.53, of which only value of 0.52 (between upper second molars) and value of 0.53 between lower second molars were clinically significant. In mesiodistal width values ranged from 0 to 0.16 which are of very small magnitude and are not clinically significant.

**Maximum vs Minimum Variation (Tables 9 and 10)**

From the ranges obtained for each tooth side for the whole sample: In cervicoincisal heights, the left maxillary 1st molar shows the maximum variation and the left mandibular 1st molar shows the minimum variation. In mesiodistal widths, the left maxillary central incisor shows maximum variation and the right mandibular lateral incisor shows minimum variation.

**MALE AND FEMALE COMPARISONS**

**Cervicoincisal Heights (Tables 1 and 2)**

*Maxillary Arch*

Comparisons between males and females indicated that maxillary central incisors, maxillary first premolar and

**Table 1:** Mean, standard deviation, range and test of significance of mean values between males and females of maxillary arch for cervicoincisal heights of clinical crowns

Tooth	Males		Females		p-value*
	Mean ± SD	(range)	Mean ± SD	(range)	
Central incisor	10.73 ± 0.67	9.27 to 11.74	10.07 ± 1.10	7.73 to 12.30	< 0.0001*
Lateral incisor	8.76 ± 0.97	7.01 to 10.60	8.52 ± 1.03	6.75 to 11.35	0.27
Canine	9.41 ± 1.04	7.44 to 11.67	9.19 ± 1.05	7.32 to 11.95	0.33
First premolar	8.00 ± 0.86	6.89 to 10.05	7.51 ± 0.90	5.21 to 8.77	0.01*
Second premolar	6.71 ± 0.94	5.57 to 8.96	6.11 ± 0.92	4.81 to 7.92	0.003*
First molar	6.14 ± 0.85	5.03 to 8.42	5.66 ± 1.14	3.72 to 7.60	0.03*
Second molar	5.35 ± 0.82	4.09 to 6.44	5.25 ± 0.92	3.84 to 7.16	0.59

Student's independent t-test was used to calculate the p-value

maxillary first molar were significantly larger in males than females.

*Mandibular Arch*

Comparisons between males and females indicated that mandibular central incisors, mandibular canines, mandibular first premolar and mandibular first molar were statistically significant.

In cervicoincisal heights of the clinical crowns, central incisor was larger in females than males. But the heights of canines, first premolar and first molar in males are larger than females.

**Table 2:** Mean, standard deviation, range and test of significance of mean values between males and females of mandibular arch for cervicoincisal heights of clinical crowns

Tooth	Males		Females		p-value*
	Mean ± SD	(range)	Mean ± SD	(range)	
Central incisor	8.26 ± 0.65	7.43 to 9.00	8.88 ± 1.11	6.67 to 10.77	0.001*
Lateral incisor	8.05 ± 0.80	6.85 to 9.52	8.05 ± 1.10	6.20 to 9.78	1.00
Canine	9.52 ± 0.83	7.83 to 11.01	8.95 ± 1.09	6.77 to 11.08	0.009*
First premolar	8.51 ± 0.69	8.10 to 10.62	8.14 ± 0.75	6.77 to 10.00	0.02*
Second premolar	7.26 ± 0.82	5.69 to 9.27	7.01 ± 0.83	5.27 to 8.53	0.15
First molar	6.71 ± 0.64	5.84 to 8.24	6.40 ± 0.80	5.00 to 7.83	0.05*
Second molar	6.18 ± 0.77	4.90 to 7.27	5.96 ± 0.76	4.41 to 7.41	0.17

Student's independent t-test was used to calculate the p-value

\*Indicates values are statistically significant

## Mesiodistal Widths (Tables 3 and 4)

### Maxillary Arch

Comparisons between males and females indicated that mesiodistal widths of males are significantly larger than females in the width of maxillary lateral incisors, maxillary canines, maxillary first molars and maxillary second molars.

### Mandibular Arch

Comparison between males and females indicated that mesiodistal widths of mandibular central and lateral incisors, mandibular canines, mandibular first and second molar were significantly larger in males than in females.

## DISCUSSION

In order for the maxillary teeth to fit well with the mandibular teeth, there must be a definite proportionality of the tooth size.

According to Bolton,<sup>2,3</sup> tooth size especially the mesiodistal width of the teeth is one of the fundamentals which the orthodontist has to deal with.

Bailit<sup>4</sup> stated that permanent tooth size varies among different races. He also listed a table of mesiodistal widths of all permanent teeth except second molars, for Australian Aborigines, Japanese, White Americans, and Norwegian Lapps showing the tooth size difference among different populations.

The review of literature provides useful information on the variations in tooth size, present among populations and also in different races. Study models are one of the primary tools used in measuring tooth size. The accuracy of plaster casts fabricated from alginate impressions as a representation of actual tooth size was investigated by Hunter and Priest,<sup>5</sup> who concluded that measurements made on dental casts are more reliable than

**Table 3:** Mean, standard deviation, range and test of significance of mean values between males and females of maxillary arch for mesiodistal width of clinical crowns

Tooth	Males		Females		p-value*
	Mean	SD (range)	Mean	SD (range)	
Central incisor	8.84	± 0.86 5.96 to 9.80	8.85	± 0.65 7.76 to 9.93	0.96
Lateral incisor	7.33	± 0.61 6.17 to 8.43	7.05	± 0.67 5.80 to 8.67	0.04*
Canine	8.60	± 0.50 7.96 to 9.71	8.17	± 0.47 7.21 to 8.96	< 0.0001*
First premolar	7.80	± 0.48 6.89 to 8.81	7.65	± 0.48 6.95 to 8.92	0.13
Second premolar	7.14	± 0.34 6.38 to 7.78	7.22	± 0.53 6.24 to 8.67	0.35
First molar	11.04	± 0.66 10.13 to 12.23	10.66	± 0.57 9.41 to 11.56	0.004*
Second molar	11.15	± 0.53 10.36 to 11.96	10.40	± 0.65 8.88 to 11.90	< 0.0001*

Student's independent t-test was used to calculate the p-value

\*Indicates values are statistically significant

**Table 4:** Mean, standard deviation, range and test of significance of mean values between males and females of mandibular arch for mesiodistal width of clinical crowns

Tooth	Males		Females		p-value*
	Mean	SD (range)	Mean	SD (range)	
Central incisor	6.56	± 0.96 5.63 to 9.04	6.11	± 0.49 5.19 to 6.81	0.02*
Lateral incisor	6.60	± 0.32 5.97 to 7.39	6.39	± 0.48 5.43 to 7.20	0.008*
Canine	7.69	± 0.51 7.13 to 8.84	7.07	± 0.40 6.22 to 7.89	< 0.0001*
First premolar	7.71	± 0.43 7.34 to 8.86	7.56	± 0.48 6.70 to 8.77	0.14
Second premolar	7.56	± 0.43 6.82 to 8.43	7.49	± 0.41 6.64 to 8.36	0.44
First molar	12.04	± 0.78 10.4 to 12.84	11.64	± 0.72 10.25 to 13.17	0.01*
Second molar	11.50	± 0.76 10.03 to 12.51	10.79	± 0.48 9.86 to 11.79	< 0.0001*

Student's independent t-test was used to calculate the p-value

\*Indicates values are statistically significant

**Table 5:** Mean, standard deviation, range and test of significance of mean values between maxillary right and left for cervicoincisal heights of clinical crowns

Tooth	Right	Left	p-value*
	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)	
Central incisor	10.19 $\pm$ 1.01 7.81 to 12.12	10.40 $\pm$ 1.14 7.64 to 12.56	0.002*
Lateral incisor	8.48 $\pm$ 1.11 6.32 to 11.04	8.72 $\pm$ 1.01 6.92 to 11.66	< 0.0001*
Canine	9.07 $\pm$ 1.14 6.83 to 12.08	9.46 $\pm$ 1.04 7.52 to 12.09	< 0.0001*
First premolar	7.59 $\pm$ 0.91 5.53 to 9.86	7.77 $\pm$ 1.00 4.88 to 10.23	0.004*
Second premolar	6.32 $\pm$ 0.95 4.75 to 8.47	6.31 $\pm$ 1.13 4.56 to 9.45	0.89
First molar	5.69 $\pm$ 1.10 3.50 to 7.99	5.96 $\pm$ 1.23 3.47 to 8.85	0.003*
Second molar	5.02 $\pm$ 0.96 3.76 to 7.72	5.54 $\pm$ 0.99 3.62 to 7.44	< 0.0001*

Student's paired t-test was used to calculate the p-value

\*Indicates values are statistically significant

**Table 6:** Mean, standard deviation, range and test of significance of mean values between mandibular right and left for cervicoincisal heights of clinical crowns

Tooth	Right	Left	p-value*
	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)	
Central incisor	8.66 $\pm$ 0.99 6.35 to 10.55	8.69 $\pm$ 1.11 6.80 to 10.99	0.52
Lateral incisor	8.07 $\pm$ 1.15 5.83 to 10.18	8.02 $\pm$ 0.95 6.49 to 9.94	0.47
Canine	9.21 $\pm$ 1.10 6.91 to 11.43	9.09 $\pm$ 1.11 6.63 to 11.36	0.11
First premolar	8.23 $\pm$ 0.92 6.71 to 11.27	8.30 $\pm$ 0.82 6.62 to 10.22	0.41
Second premolar	7.10 $\pm$ 0.94 5.25 to 9.48	7.09 $\pm$ 0.85 5.28 to 9.05	0.87
First molar	6.39 $\pm$ 0.91 4.05 to 8.09	7.09 $\pm$ 0.85 5.45 to 8.38	0.002*
Second molar	5.77 $\pm$ 0.90 3.78 to 7.45	6.30 $\pm$ 0.84 5.03 to 8.03	< 0.0001*

Student's paired t-test was used to calculate the p-value

\*Indicates values are statistically significant

**Table 7:** Mean, standard deviation, range and test of significance of mean values between maxillary right and left for mesiodistal width of clinical crowns

Tooth	Right	Left	p-value*
	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)	
Central incisor	8.85 $\pm$ 0.73 6.10 to 10.24	8.85 $\pm$ 0.78 5.81 to 10.41	0.98
Lateral incisor	7.13 $\pm$ 0.70 5.82 to 8.81	7.16 $\pm$ 0.67 5.78 to 8.53	0.48
Canine	8.35 $\pm$ 0.51 7.16 to 9.40	8.28 $\pm$ 0.60 7.17 to 10.02	0.09
First premolar	7.64 $\pm$ 0.51 6.70 to 8.82	7.76 $\pm$ 0.52 6.82 to 9.05	0.001*
Second premolar	7.16 $\pm$ 0.44 6.12 to 8.52	7.22 $\pm$ 0.56 6.03 to 8.81	0.09
First molar	10.87 $\pm$ 0.69 9.54 to 11.99	10.71 $\pm$ 0.69 9.28 to 12.53	0.006*
Second molar	10.68 $\pm$ 0.76 8.79 to 12.20	10.62 $\pm$ 0.84 8.97 to 13.01	0.46

Student's paired t-test was used to calculate the p-value

\*Indicates values are statistically significant

**Table 8:** Mean, standard deviation, range and test of significance of mean values between mandibular right and left for mesiodistal width of clinical crowns

Tooth	Right		Left		p-value*
	Mean ± SD	(range)	Mean ± SD	(range)	
Central incisor	6.26 ± 0.68	5.17 to 8.79	6.27 ± 0.79	5.10 to 9.29	0.7
Lateral incisor	6.50 ± 0.48	5.31 to 7.32	6.42 ± 0.45	5.55 to 7.58	0.02*
Canine	7.29 ± 0.56	6.30 to 9.01	7.27 ± 0.57	5.85 to 8.67	0.49
First premolar	7.65 ± 0.59	6.56 to 9.43	7.58 ± 0.42	6.80 to 8.89	0.09
Second premolar	7.56 ± 0.46	6.45 to 8.59	7.47 ± 0.46	6.76 to 8.86	0.02*
First molar	11.74 ± 0.75	10.24 to 13.22	11.80 ± 0.89	10.14 to 14.30	0.35
Second molar	11.06 ± 0.84	9.84 to 13.09	10.99 ± 0.63	9.88 to 12.25	0.26

Student's paired t-test was used to calculate the p-value

\*Indicates values are statistically significant

**Table 9:** Cervicoincisal height of clinical crowns (range differences from Tables 5 and 6)

Tooth	Maxillary arch		Mandibular arch	
	Right	Left	Right	Left
Central incisor	4.31	4.92	4.2	4.19
Lateral incisor	4.72	4.74	4.35	3.45
Canine	5.25	4.57	4.51	4.73
First premolar	4.33	5.35	4.56	3.6
Second premolar	3.72	4.89	4.23	3.77
First molar	4.49	5.38	4.04	2.93
Second molar	3.96	3.82	3.67	3.00

**Table 10:** Mesiodistal width of clinical crowns (range differences from Tables 7 and 8)

Tooth	Maxillary arch		Mandibular arch	
	Right	Left	Right	Left
Central incisor	4.14	4.60	3.62	4.19
Lateral incisor	2.99	2.75	2.01	2.03
Canine	2.24	2.85	2.71	2.82
First premolar	2.12	2.23	2.87	2.09
Second premolar	2.40	2.78	2.14	2.10
First molar	2.45	3.25	2.98	4.16
Second molar	3.41	4.04	3.25	2.37

those made directly in the mouth. Clinical crown heights were measured from the gingival margin to the incisal edges/cusp tips as mentioned by previous authors. Mesiodistal widths were also measured from contact to contact point of maximum convexity/contour as formulated by studies of Bolton<sup>2,3</sup> etc.

Vernier calipers were used as the device for measurement of tooth size because of its accuracy over the dividers as reported by Hunter and Priest.<sup>5</sup> The use of Digital Vernier calipers can virtually eliminate measurement transfer and calculation errors, compared to analyses that require dividers and calculators. Although, some measurement errors may be associated with

the positioning of the calipers on the mesial and distal surfaces of the teeth, this method is certainly more reliable than manual measurements.

As compared to other ethnic groups, relatively few measurements on tooth size have been made on Indian population. Considering, the cosmopolitan nature of Chennai population which is an admixture of North and South Indians, a study was carried out in the department of orthodontics, Saveetha Dental College and Hospitals to discern the average clinical crown dimensions of the cervicoincisal height and mesiodistal width of the permanent dentition for the local population.

The study revealed that mesiodistal widths and cervico-incisal heights are generally larger for male teeth when compared to female teeth. The results of the study are in agreement with the studies of Richardson and Malhotra,<sup>6</sup> Lavelle,<sup>7</sup> Lysell and Myrberg,<sup>8</sup> Bishara<sup>2,3</sup> et al and Santoro<sup>9</sup> et al who had also carried out similar studies in other populations.

### **AVERAGE CLINICAL CROWN DIMENSIONS AND COMPARISONS OF CROWN DIMENSIONS IN THE LOCAL POPULATION**

#### **Cervicoincisal Dimensions of the Clinical Crown in Males and Females in Both Arches**

In both sexes, in maxillary and mandibular arches, 2nd molar had the least height and maximum height was by central incisor and canine in maxillary and mandibular arches respectively. Height of 1st premolars and 1st molars being greater than 2nd premolar and 2nd molar in both arches and sexes. In both sexes, in maxillary arch more variation is seen in the heights of 1st and 2nd premolars and between heights of 1st and 2nd molars only in males. In females, more variation is seen in the mandibular arch in the heights of 1st and 2nd molars.

#### **Mesiodistal Dimensions of Clinical Crowns in Males and Females in Both Arches**

In mesiodistal width, male maxillary arch was maximum for second molar and minimum for 2nd premolar. In female, maxillary arch, maximum width was for 1st molar and minimum for lateral incisor. In both sexes, in mandibular arch maximum width was for 1st molar and minimum was for central incisor. The increased width of 1st premolars and 1st molars compared to 2nd premolars and 2nd molars respectively was in coincidence with the study of Richardson and Malhotra.<sup>6</sup>

In both sexes, more variation between widths of premolars was seen in maxillary arch, but in widths of molars more variation is seen in mandibular arch. In both sexes and arches, maximum variation was shown in 2nd molar and minimum by 2nd premolar.

The findings of this study are in concordance with the study of Bishara<sup>2,3</sup> et al who studied mesiodistal crown dimensions of the North Mexican and Iowa, United States population where the canines and first molars are larger in size in males than females. This sexual dimorphism is consistent with the findings of other investigators, Dahlberg,<sup>10</sup> Moorrees,<sup>11</sup> Kellam.<sup>12</sup>

### **COMPARISONS OF CLINICAL CROWN DIMENSIONS BETWEEN RIGHT SIDE AND LEFT SIDE OF DIFFERENT TEETH IN THE POPULATION**

#### **Cervicoincisal Dimensions of the Clinical Crowns**

##### *Maxillary Arch*

The study revealed statistical significant variations found in the cervicoincisal heights of all teeth from incisors to second molars except for second premolars which showed no significance. The height of second premolar was almost the

same on both the sides. It was seen that teeth on left side were comparatively longer than that of right side. By calculating the differences in the means of each tooth on right side with left, it was inferred that second molar (0.52) showed greater variation in height when compared between the sides and lesser variation was shown by first premolar (0.18).

The reasons for slightly longer clinical crowns on left side when compared to right cannot be attributed to any factor, and before any interpretation can be made of the same, a further study on a larger sample size is mandatory.

##### *Mandibular Arch*

The study revealed statistical significant variations found in the cervicoincisal heights of only the first and second molars on right and left sides. When, the mean differences on right and left sides were calculated for above teeth 2nd molar showed lesser variation in size (0.53) compared to first molar (0.7), which is clinically significant.

#### **Mesiodistal Widths of Clinical Crowns**

##### *Maxillary Arch*

The study revealed variations in mesiodistal dimensions of first premolar and first molar on right and left sides which were statistically significant. The mean differences for these teeth on either sides revealed values of 0.12 and 0.16 respectively for first premolar and first molar. The amount of variation seen in these teeth on either sides is very minimal (less than 0.2) and hence is not clinically significant.

Thus, in this study no appreciable differences were present for a tooth on either sides and on both sides their crown widths being almost normal.

##### *Mandibular Arch*

The study revealed variations in mesiodistal dimensions of only the lateral incisor and second premolar which are statistically significant, but the mean difference between right and left sides is less than 0.1, and hence not clinically significant.

### **MAXIMUM AND MINIMUM VARIATION SEEN IN THE CLINICAL CROWN DIMENSIONS**

#### **Cervicoincisal Dimensions of the Clinical Crowns**

From the values obtained in Tables 5 and 6, teeth showing maximum and minimum variation in cervicoincisal heights were predicted from the Table 9 which was obtained by calculating the range differences between the greatest value and the least value for each specific tooth. From observation of values, it was predicted that maxillary first molar on the left side showed more variation in its height among the different individuals in the sample and mandibular first molar on left side showed the least variation.

## Mesiodistal Dimensions of the Clinical Crowns

From the values obtained in Tables 7 and 8, teeth showing maximum and minimum variation in mesiodistal widths were predicted from the Table 10 which was obtained by calculating the range differences between the greatest value and the least value for each specific tooth. From the observation of values, it was predicted that maxillary central incisor on the left side showed maximum variation in its width among the different individuals in the sample and mandibular lateral incisor on right side showed the least variation.

## CONCLUSIONS

The following conclusions were made from this study:

- In males and females, first premolar was longer than that of second premolar in both arches. In males, maxillary arch second molar was longer when compared to first molar and in females; first molar was longer than second molar. In both groups, in mandibular arch first molar was longer than second molar. In both sexes, variations were more in the heights of premolars and molars in the maxillary arch and in females in between molars in mandibular arch.
- In males and females, first premolars and first molars were wider than second premolars and second molars respectively in mandibular arch for both groups and in maxillary arch only for females. In males, second molar was wider than first in maxillary arch. Variations in widths between premolars were more in maxilla and between molars more in mandible.
- In the whole sample, variations between right and left side revealed that the teeth were comparatively longer on left side than on right side in maxillary arch. Clinically significant variation was found in second molar height between the sides. No clinically significant variations were seen in width between the sides in both arches.
- Maxillary left molar showed maximum variation in cervico-incisal height and minimum was shown by mandibular left first molar. In mesiodistal width, maxillary left central incisor showed the maximum variation and minimum was seen in case of right central incisor.
- In comparisons between males and females, the cervico-incisal heights and mesiodistal dimensions of males were greater than that of females. Greater variation is seen in heights of central incisors and lesser variation in 2nd molar.

In mesiodistal widths, the canines followed by molars showed significant sexual dimorphism in both the arches.

- The above findings of our study suggest that ideally one has to assume that the most accurate measurements for the prediction of tooth size should be based on the statistically significant measurements obtained on the population studied.
- From the clinical standpoint, it is imperative to understand that this study will be helpful in positioning of the preadjusted edgewise brackets in our population for both males and females; to establish the Boltons standards for assessing the tooth size discrepancy, to use these measurements in the application of the mixed dentition model analysis and also to apply this in deciding the extraction criteria for tooth size arch length discrepancy cases.

## REFERENCES

1. Moorrees CFA, Reed RB. Biometrics of crowding and spacing of the teeth in the mandible. *Am J Phys Anthropol* 1954;12: 77-88.
2. Bishara, et al. Mesiodistal crown dimensions in Mexico and the United States. *Angle Orthod* October 1986.
3. Bishara SE, Jakobsen JR, et al. Comparisons of mesiodistal and buccolingual crown dimensions of the permanent teeth in three populations from Egypt, Mexico and the United States. *Am J Orthod* 1989;96:416-22.
4. Bailit HL. Dental variation among populations: An anthropologic view. *Dent Clin North Am* 1975;19:125-39.
5. Hunter WS, Priest WR. Errors and discrepancies in measurement of tooth size. *J Dent Res* 1960;39:405-14.
6. Richardson ER, Malhotra SK. Mesiodistal crown dimension of the permanent dentition of American Negroes. *Am J Orthod* 1975;68:157-64.
7. Lavelle CLB. Maxillary and mandibular tooth size in different racial groups and in different occlusal categories. *Am J Orthod* 1972;61:29-37.
8. Lysell L, Mysberg N. Mesiodistal tooth size in the deciduous and permanent dentitions. *Eur J Orthod* 1982;4:113-22.
9. Santoro M, Ayoub EM, et al. Mesiodistal crown dimensions and tooth size discrepancy of the permanent dentition of Dominican Americans. *Angle Orthod* 2000;70:303-07.
10. Dahlberg AA. Analysis of the American Indian dentition. *Dental Anthropology*. Pergamon Press: New York.
11. Moorrees CFA. The Aleut dentition. Cambridge, Massachusetts: Harvard University Press 1957.
12. Kellam GA. Tooth size and arch perimeter; their relation to crowding of dentition. A comparison between Navajao Indians and American Caucasians. Master's Thesis, The University of Iowa 1982.