Biometric study of human teeth*

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Abstract

Objectives: To determine the biometric dimensions of human teeth in the mesiodistal, buccolingual and occlusal/incisal-cervical directions. **Methods:** It was used a sample of dental casts from 57 patients, i.e., 31 females with a mean age of 15 years and 5 months, and 26 males with a mean age of 16 years and 6 months. The sample was previously qualified by adopting the criteria established by Andrews' six keys to normal occlusion, whose values were matched to the variations obtained by Bolton. Two examiners used a digital caliper with original (short) and modified (long) tips. **Results and Conclusions:** After statistical analysis of the data it was concluded that the teeth were shown to be symmetrical in the dental arches of both genders. Tooth dimensions are smaller in females than in males and should therefore be studied separately. Overall mean values were obtained and used to build tables distinguishing such dimensions according to gender. Mean values for the three tooth dimensions, occurrence rates of these dimensions and their standard deviations were also calculated. These values allowed the development of an equation called "C" equation as well as "C" percentile tables. With the aid of both, it became possible to measure only one dimension of a given tooth to find the other two "probable" dimensions of the other teeth in the dental arches.

Keywords: Tooth dimensions. Tooth proportions. Tooth size.

INTRODUCTION

In view of the difficulty to accommodate mesiodistal, buccolingual and occlusal/incisal-cervical volumes of the dental masses in restricted locations available in the jaws, orthodontists are ultimately hard pressed to resort to alternative therapies to change the perimeter of the dental arches, either reducing them through extractions and stripping, or expanding them by proclining the teeth. Although these alternatives have been uncontroversially established, decision-making can sometimes prove challenging. If on the one hand, extractions, when needed, can assist in adjusting the dental arches and promoting function, on the other hand, retoclined upper central incisors may cause cosmetic damage, with consequent

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prominence of the nose, particularly if lip retraction is excessive.

Given the uncertainty in deciding whether or not to perform tooth extractions or stripping, this study aimed to determine the biometric dimensions of orthodontic patients' teeth properly finished in the mesiodistal, buccolingual and occlusal/incisal-cervical direction in both genders, with a view to providing mathematical support for this decision.

LITERATURE REVIEW

Literature review disclosed that many researchers have sought to address issues that have been accepted but not yet well understood. This constant search stems from the investigative spirit of human beings who, not satisfied with the information currently available, seek out conceptual definitions that can be supported by existing scientific methods.

To this end one sees studies focused on several areas, such as dentistry,[15] endodontics,[9] orthodontics,[1,5,12,17,18,22] prosthesis[16] and forensics.[6,21]

As the first author to publish a table of measurements of human teeth, Black[4] is credited as having conducted the first and most detailed study of dental morphology and anatomical nomenclature of all times.

One hundred and one years after Black's publication[4] in 1902, Harris and Burris,[11] in 2003, emphasized that the most often cited tooth dimensions in literature were those published by Black.[4] However, they also argue that these values differ from modern values and should therefore be reassessed. The authors of the present study were motivated by this contention to undertake this research.

MATERIAL AND METHODS

Material

Sample

This study used a sample of orthodontic plaster models of 57 patients distributed between the two genders of the human species, 31 were female with mean age of 15 years and 5 months, and 26 males with mean age of 16 years and 6 months. No racial, cultural or socio-economic criteria were established. All cases were treated with standard Straight-Wire orthodontic appliances ("A" Company). Cases had no extractions, no pre- and post-treatment interproximal stripping and were all well finished.

Sample qualification (Andrews and Bolton)

The goal consisted in finishing all cases with the six keys to normal occlusion recommended by Andrews.[2] Results received an "A" qualification, the highest quality grade for this method. Additionally, all cases showed proportionality between the 12 maxillary teeth and the 12 mandibular ones, and between the 6 upper anterior teeth and the 6 lower ones when compared to the values described by Bolton[5] (Fig 1).

Digital caliper

In seeking to emulate the method adopted by Yamaguto[22] and Castro[7] some modifications were made (Fig 2) to the tips of the original digital caliper. They were replaced by two longer tips to enable measurements in areas of difficult physical access, i.e., to measure exclusively the mesiodistal dimensions (Fig 3) of dental crowns on plaster models and thereby determine whether or not errors occurred in the methods, i.e., original tips vs. modified tips. Original tips were referred to as "short" and the modified tips, "long".

Methods

Methods used to perform measurements in the models

Taking the occlusal plane as reference during measurements the caliper was placed parallel to this plane for mesiodistal measurements and in a perpendicular position for buccolingual measurements as well as for the incisal or occlusal cervical measurements. (Figs 3 and 4).

FIGURE 1 - Images of case used for sample qualification.

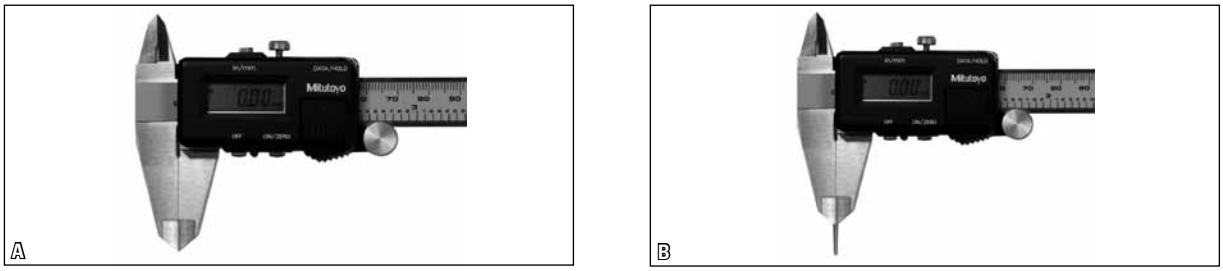

FIGURE 2 - Images showing digital caliper with **A**) its original tips (short) and **B**) the modified tips (long).

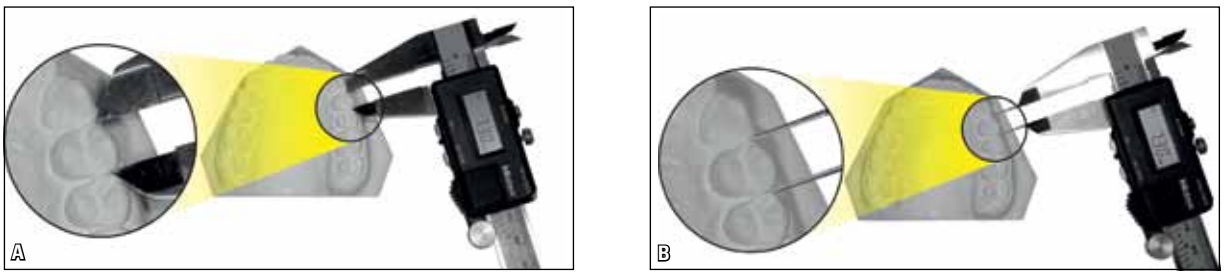

FIGURE 3 - Mesiodistal measurement of a first upper premolar using the digital caliper with **A**) its original tips (short) and **B**) the modified tips (long).

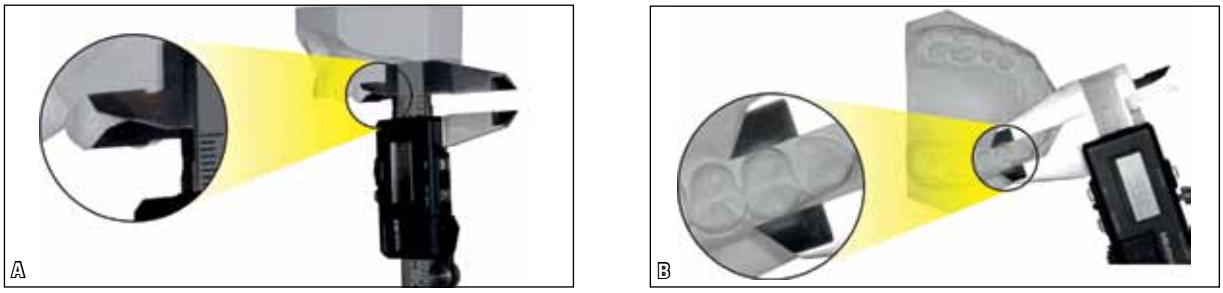

FIGURE 4 - Occlusal-cervical (**A**) and buccal-lingual (**B**) measurements of a first upper premolar using the digital caliper with its original tips (short).

Statistical study

In strict compliance with all scientific protocols, the results and values obtained from tooth size in the sample were subjected to statistical tests. In comparing gender variables Student's t-test was applied whereas to assess the correlations between measurements Pearson's correlation coefficient was employed. Paired t-test was used to identify intra-examiner, inter-examiners and inter-methods systematic errors. Random error was calculated using the method proposed by Dahlberg[8] as described by Houston.[13] In all statistical tests a significance level of 5% was adopted.[23] The tests were performed using the software Statistics for Windows v. 5.1 (Statsoft, USA).

RESULTS

This study made use of a sample of 57 patients examining the differences between the genders. It required measuring all teeth in three dimensions, resulting in 6,620 measurements, which resulted in 59 tables, with 19 of these tables being named primary, 22 secondary and 18 tertiary or consequent. It should be underlined that due to the format constraints of this publication only a few tables were made available.

TABLE 1 - Mean values in mm of mesiodistal, buccolingual and occlusal/incisal-cervical dimensions of the upper and lower arches in males and females.

Values in millimeters						
	Male			Female		
Tooth	M-distal	B-lingual	I-cervical	M-distal	B-lingual	I-cervical
Upper arch						
1	9.18	7.79	10.33	8.93	7.33	9.79
2	7.26	6.98	8.52	7.04	6.55	8.20
3	8.29	8.4	10.05	7.92	7.96	9.53
4	7.28	9.60	7.90	7.06	9.46	7.55
5	7.10	9.82	6.72	6.82	9.58	6.48
6	10.87	11.39	5.65	10.31	11.05	5.45
Σ	49.98			48.08		
Lower arch						
1	5.63	6.42	8.72	5.44	6.15	8.15
2	6.18	6.60	8.60	6.01	6.32	8.04
3	7.34	7.50	9.99	6.91	7.04	9.14
4	7.50	8.20	8.41	7.13	7.76	7.85
5	7.53	8.76	6.97	7.20	8.49	6.79
6	11.31	10.70	5.77	10.95	10.43	5.56
Σ	45.49			43.64		

TABLE 2 - Mean percentage values of mesiodistal, buccolingual and occlusal/incisal-cervical dimensions of the upper and lower arches in males and females.

	Percentage values					
	Male			Female		
Tooth	M-distal	B-lingual	I-cervical	M-distal	B-lingual	I-cervical
			Upper arch			
1	18.37	14.40	21.02	18.57	14.09	20.84
2	14.52	12.92	17.32	14.63	12.57	17.42
3	16.58	15.64	20.44	16.48	15.33	20.29
4	14.57	17.78	16.06	14.68	18.23	16.07
5	14.21	18.18	13.69	14.18	18.47	13.79
6	21.74	21.08	11.47	21.46	21.31	11.60
Σ	100%			100%		
			Lower arch			
1	12.37	13.33	18.01	12.47	13.31	17.90
2	13.59	13.69	17.75	13.77	13.67	17.67
3	16.13	15.56	20.61	15.83	15.22	20.06
4	16.48	17.02	17.38	16.33	16.81	17.24
5	16.56	18.19	14.36	16.49	18.40	14.93
6	24.86	22.21	11.89	25.10	22.60	12.19
Σ	100%			100%		

DISCUSSION

Variables under study

Intra-examiner and inter-examiners errors

In the statistical analysis, two examiners were used to prevent potential distortions in the measurement methods:

» **Intra-examiner error:** Examiner 1 measured the materials (models) twice with a 60-day interval to ensure that the results would not become inductive and eventually allow humor factors to disqualify the outcomes.

» **Inter-examiners error:** Examiner 2 used the same materials for measuring in order to compare his values with those of examiner 1, since any natural inclination or affinity with the work performed by examiner 1 did not interfere with the outcome.

» **Inter-method error:** With the purpose of ascertaining whether there was error in the methods, the same investigator used calipers with different tips to measure the mesiodistal dimensions of the teeth. One had the original tips, and was called "Short" and one had modified tips and was named "Long". Ten cases were measured, 5 male and 5 female.

In checking intra-examiner and inter-examiners systematic and random errors results revealed that only two of the 42 measures showed statistically significant differences. However, in checking the means it was found that these differences lay below the random error, i.e., tenths of a millimeter, and therefore should be ignored as operational values.

Inter-methods systematic and random inter-examiners errors

In examining systematic and random inter-method errors when using a digital caliper in two different manners, i.e., with original tips (short) and modified tips (long), no statistically significant difference was found between these two techniques.

OUTCOME ANALYSIS

Sexual dimorphism between genders

This investigation revealed that 27 of the 42 measurements taken between the genders displayed statistically significant differences, with women's measurements showing lower values than men's. Therefore, in absolute terms it is suggested that men and women be studied separately. These results agree with most authors,[10,14,19,20,22] with the sole exception of Baum and Cohen,[3] who, in attempting to assess the occurrence of dimorphism, found striking similarities between patients of both genders.

Symmetry

Ghose and Baghdady[10] identified statistically non-significant variations between the mesiodistal diameters of teeth after comparing the right and left sides. In the present study, the results showed that only 3 of 42 measures yielded statistically significant differences. It cannot therefore be implied that there is any difference between the sides (Tables 3, 4 and 5).

TABLE 3 - Comparison between mesiodistal measurements in the left and right sides.

	Left		Right		Diff.	t	p
Tooth	Mean	sd	Mean	sd			
Upper arch							
1	9.04	0.54	9.05	0.53	-0.01	-0.200	0.842 ns
2	7.09	0.41	7.18	0.44	-0.09	-3.022	**0.004** *
3	8.06	0.51	8.12	0.48	-0.06	-1.742	0.087 ns
4	7.18	0.41	7.14	0.37	0.04	1.526	0.133 ns
5	6.93	0.46	6.96	0.48	-0.03	-0.990	0.327 ns
6	10.57	0.64	10.56	0.70	0.01	0.212	0.833 ns
7	10.00	0.60	9.89	0.49	0.11	2.112	**0.042** *
Lower arch							
1	5.52	0.36	5.54	0.39	-0.02	-1.013	0.316 ns
2	6.08	0.39	6.10	0.38	-0.02	-0.710	0.481 ns
3	7.11	0.44	7.11	0.47	0.00	-0.010	0.992 ns
4	7.28	0.42	7.31	0.40	-0.03	-1.342	0.185 ns
5	7.35	0.41	7.35	0.44	0.00	0.014	0.989 ns
6	11.12	0.54	11.11	0.53	0.01	0.609	0.545 ns
7	10.52	0.57	10.47	0.56	0.05	0.950	0.349 ns

ns = no statistically significant difference.
* Statistically significant difference ($p<0.05$).

TABLE 4 - Comparison between buccolingual measurements in the left and right sides.

Tooth	Left		Right		Diff.	t	p
	Mean	sd	Mean	sd			
Upper arch							
1	7.52	0.67	7.55	0.65	-0.03	-1.083	0.283 ns
2	6.72	0.80	6.78	0.83	-0.06	-0.896	0.374 ns
3	8.18	0.59	7.19	0.58	-0.02	-0.371	0.712 ns
4	9.52	0.44	9.53	0.45	-0.01	-0.479	0.634 ns
5	9.69	0.47	9.69	0.49	0.00	0.025	0.980 ns
6	11.20	0.54	11.21	0.56	-0.02	-0.545	0.588 ns
7	11.15	0.63	11.19	0.66	-0.04	-0.169	0.249 ns
Lower arch							
1	6.29	0.48	6.26	0.51	0.04	1.411	0.164 ns
2	6.46	0.49	6.43	0.49	0.02	0.869	0.389 ns
3	7.26	0.54	7.28	0.56	-0.02	-0.684	0.497 ns
4	7.91	0.51	8.02	0.63	-0.11	-1.839	0.071 ns
5	8.60	0.51	8.63	0.48	-0.03	-0.749	0.457 ns
6	10.56	0.63	10.55	0.64	0.01	0.384	0.702 ns
7	10.26	0.63	10.15	0.69	0.11	1.480	0.146 ns

ns = no statistically significant difference.
* Statistically significant difference ($p<0.05$)

TABLE 5 - Comparison between occlusal/incisal-cervical measurements in the left and right sides.

Tooth	Left		Right		Diff.	t	p
	Mean	sd	Mean	sd			
Upper arch							
1	10.06	0.90	10.02	0.87	0.04	1.195	0.237 ns
2	8.36	0.87	8.33	0.90	0.02	0.387	0.700 ns
3	9.73	0.91	9.80	0.96	-0.06	-0.820	0.416 ns
4	7.69	0.76	7.73	0.73	-0.03	-0.852	0.398 ns
5	6.60	0.69	6.58	0.70	0.01	0.213	0.832 ns
6	5.48	0.68	5.62	0.77	-0.14	-2.523	**0.015 ***
7	5.43	0.78	5.38	0.78	0.05	0.625	0.535 ns
Lower arch							
1	8.42	0.78	8.40	0.75	0.02	0.666	0.508 ns
2	9.56	0.70	8.30	0.82	-0.01	-0.275	0.784 ns
3	9.56	1.00	9.50	1.07	0.06	0.915	0.364 ns
4	8.12	0.66	8.09	0.76	0.03	0.622	0.536 ns
5	6.87	0.64	6.88	0.71	-0.01	-0.240	0.812 ns
6	5.60	0.70	5.71	0.81	-0.11	-1.874	0.066 ns
7	5.09	0.77	5.21	0.77	-0.12	-1.587	0.119 ns

ns = non statistically significant difference.
* Statistically significant difference ($p<0.05$).

DEVELOPMENT OF "C" FORMULA

In view of the fact that the dimensional reference tables (Tables 1 and 2) depict the mean values as well as the percentages of mesiodistal, buccolingual and occlusal/incisal-cervical dimensions in both genders, the following equation — named the "C" Formula — was developed based on the dimensions of only one tooth so that allows one to calculate the likely dimensions of the other teeth on the same quadrant:

$$Wx = \frac{Wk \times Px}{Pk} = R$$

Wx = Width of unknown tooth
Wk = Width of known tooth
Px = Percentage of space that unknown tooth occupies in the arch
Pk = Percentage of space that known tooth occupies in the arch
R = Resultant

"C" PERCENTILE TABLES

To facilitate searching and reading the reference values that correspond to the three tooth dimensions in each gender, 6 (six) Tables (6, 7, 8, 9, 10 and 11) were developed from the "C" formula. These show respectively the minimum values, percentiles 10, 20, 30, 40, means, 60, 70, 80 and 90, and maximum values (in mm) and Σ mesiodistal values (1-6) of each quadrant in both genders.

Tables 6, 7 and 8 depict respectively female percentile values for mesiodistal, buccolingual and occlusal/incisal-cervical measurements.

Tables 9, 10 and 11 depict respectively the male percentile values for mesiodistal, buccolingual and occlusal/incisal-cervical measurements.

TABLE 6 - Percentile values of mesiodistal measurements / Female.

Arch	Tooth	n	min.	P10	P20	P30	P40	Mean	P60	P70	P80	P90	max.
Upper	1	31	8.0	8.2	8.4	8.6	8.8	8.9	9.3	9.3	9.4	9.5	10.0
	2	31	6.1	6.4	6.7	6.8	7.0	7.0	7.2	7.3	7.4	7.5	7.8
	3	31	7.3	7.5	7.7	7.7	7.8	7.9	8.1	8.1	8.1	8.4	8.5
	4	31	6.2	6.6	6.8	6.9	7.0	7.1	7.2	7.2	7.4	7.5	7.8
	5	31	5.6	6.2	6.5	6.6	6.7	6.8	7.0	7.1	7.1	7.3	7.8
	6	31	9.3	9.8	9.9	10.1	10.2	10.3	10.4	10.5	10.7	10.9	11.3
	1 - 6	31	44.6	45.5	45.9	47.0	47.9	48.1	48.9	49.2	49.4	50.5	51.4
Lower	1	31	4.7	5.0	5.2	5.3	5.4	5.4	5.5	5.5	5.7	5.8	6.1
	2	31	5.4	5.5	5.8	5.9	5.9	6.0	6.1	6.2	6.3	6.6	6.8
	3	31	6.2	6.4	6.5	6.8	6.8	6.9	7.1	7.1	7.3	7.4	7.5
	4	31	6.4	6.7	6.8	6.9	7.0	7.1	7.2	7.2	7.5	7.6	7.9
	5	31	6.3	6.7	6.9	7.0	7.1	7.2	7.3	7.4	7.6	7.7	8.1
	6	31	9.7	10.4	10.7	10.7	10.8	11.0	11.1	11.2	11.4	11.6	11.8
	1 - 6	31	39.9	41.6	42.1	42.7	43.2	43.6	44.1	44.2	45.4	46.0	47.7

TABLE 7 - Percentile values of buccolingual measurements / Female.

Arch	Tooth	n	min.	P10	P20	P30	P40	Mean	P60	P70	P80	P90	max.
Upper	1	31	5.9	6.6	6.8	7.0	7.1	7.3	7.4	7.6	7.9	8.3	8.5
	2	31	4.2	5.3	5.9	6.2	6.6	6.5	7.0	7.2	7.3	7.4	7.7
	3	31	6.5	7.6	7.7	7.7	7.9	8.0	8.0	8.1	8.4	8.5	9.4
	4	31	8.4	9.1	9.2	9.2	9.3	9.5	9.6	9.7	9.9	9.9	10.4
	5	31	8.7	8.8	9.3	9.4	9.5	9.6	9.8	9.9	10.0	10.1	10.4
	6	31	10.3	10.5	10.6	10.8	10.9	11.1	11.2	11.4	11.4	11.5	12.0
Lower	1	31	4.9	5.6	5.7	5.8	6.1	6.2	6.4	6.5	6.6	6.7	6.8
	2	31	5.3	5.6	6.0	6.1	6.3	6.3	6.5	6.7	6.7	6.8	7.1
	3	31	5.8	6.2	6.5	6.9	7.0	7.0	7.3	7.3	7.5	7.7	7.8
	4	31	6.3	7.2	7.4	7.7	7.8	7.8	7.9	8.0	8.1	8.2	8.7
	5	31	7.5	7.8	8.1	8.3	8.4	8.5	8.7	8.8	8.8	9.0	9.1
	6	31	9.3	9.9	10.2	10.3	10.4	10.4	10.5	10.6	10.8	10.9	11.2

TABLE 8 - Percentile values of occlusal/incisal-cervical measurements / Female.

Arch	Tooth	n	min.	P10	P20	P30	P40	Mean	P60	P70	P80	P90	max.
Upper	1	31	8.4	8.9	9.1	9.2	9.4	9.8	10.0	10.2	10.6	10.8	11.4
	2	31	6.8	7.2	7.5	7.6	8.0	8.2	8.5	8.6	8.9	9.2	10.2
	3	31	7.7	8.6	8.8	8.9	9.3	9.5	9.8	10.0	10.1	10.6	11.3
	4	31	6.5	6.7	7.0	7.2	7.3	7.5	7.7	7.8	7.9	8.4	9.2
	5	31	5.4	5.9	6.1	6.2	6.3	6.5	6.5	6.6	6.8	7.2	8.1
	6	31	4.4	4.7	5.1	5.1	5.3	5.5	5.5	5.8	5.9	6.2	6.9
Lower	1	31	6.7	7.4	7.8	7.9	8.0	8.1	8.4	8.5	8.7	8.8	9.2
	2	31	6.7	7.4	7.5	7.7	8.1	8.0	8.3	8.4	8.5	8.8	9.1
	3	31	7.6	7.8	8.7	9.0	9.0	9.1	9.2	9.6	9.8	10.1	10.7
	4	31	6.7	7.1	7.4	7.5	7.7	7.9	8.0	8.2	8.3	8.6	9.2
	5	31	5.8	6.2	6.5	6.6	6.7	6.8	7.0	7.1	7.1	7.2	8.0
	6	31	4.2	4.9	5.0	5.3	5.4	5.6	5.7	5.9	6.0	6.6	6.8

TABLE 9 - Percentile values of mesiodistal measurements / Male.

Arch	Tooth	n	min.	P10	P20	P30	P40	Mean	P60	P70	P80	P90	max.
Upper	1	26	8.0	8.5	8.7	8.8	9.2	9.2	9.3	9.5	9.6	9.7	10.0
	2	26	6.5	6.7	6.9	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.9
	3	26	7.1	7.6	7.8	8.0	8.3	8.3	8.5	8.6	8.7	9.0	9.3
	4	26	6.4	6.8	7.1	7.1	7.2	7.3	7.5	7.6	7.6	7.6	7.8
	5	26	6.1	6.6	6.9	7.0	7.0	7.1	7.2	7.4	7.5	7.6	7.7
	6	26	9.5	9.9	10.3	10.4	10.7	10.9	11.1	11.3	11.5	11.7	12.4
	1 - 6	26	46.2	46.4	46.9	49.1	49.5	50.0	50.8	51.5	52.0	52.6	54.3
Lower	1	26	4.7	5.2	5.4	5.5	5.5	5.6	5.8	5.9	5.9	6.1	6.3
	2	26	5.5	5.7	5.9	6.0	6.0	6.2	6.3	6.4	6.5	6.5	7.2
	3	26	6.5	6.8	7.1	7.2	7.2	7.3	7.4	7.6	7.6	8.0	8.1
	4	26	6.6	7.0	7.3	7.4	7.5	7.5	7.6	7.7	7.8	7.8	8.0
	5	26	6.8	7.2	7.3	7.4	7.4	7.5	7.6	7.7	7.7	8.0	8.3
	6	26	10.5	10.6	10.8	11.1	11.3	11.3	11.5	11.7	11.7	11.8	12.3
	1 - 6	26	41.7	42.7	43.4	45.5	45.6	45.5	46.2	46.4	46.8	47.3	48.7

TABLE 10 - Percentile values of buccolingual measurements / Male.

Arch	Tooth	n	min.	P10	P20	P30	P40	Mean	P60	P70	P80	P90	max.
Upper	1	26	6.8	7.3	7.4	7.5	7.6	7.8	7.9	8.1	8.3	8.3	8.9
	2	26	5.9	6.3	6.5	6.6	7.0	7.0	7.1	7.3	7.4	7.6	8.1
	3	26	7.6	7.9	8.1	8.1	8.4	8.4	8.6	8.7	8.9	9.0	9.3
	4	26	8.7	9.1	9.3	9.5	9.5	9.6	9.7	9.8	9.9	10.2	10.5
	5	26	9.1	9.4	9.4	9.5	9.6	9.8	9.9	10.1	10.2	10.4	10.8
	6	26	9.6	10.9	11.0	11.1	11.2	11.4	11.5	11.7	11.8	12.2	12.4
Lower	1	26	5.6	5.9	6.1	6.2	6.4	6.4	6.5	6.6	6.7	7.0	7.2
	2	26	5.6	6.1	6.3	6.5	6.6	6.6	6.7	6.7	6.8	7.2	7.3
	3	26	6.6	6.9	7.1	7.3	7.3	7.5	7.5	7.9	8.0	8.1	8.3
	4	26	7.3	7.6	7.7	7.9	8.1	8.2	8.2	8.5	8.7	8.9	9.1
	5	26	7.6	8.0	8.4	8.7	8.7	8.8	8.9	9.0	9.2	9.4	9.5
	6	26	7.8	10.1	10.4	10.5	10.8	10.7	11.1	11.1	11.1	11.3	11.7

TABLE 11 - Percentile values of occlusal/incisal-cervical measurements / Male.

Arch	Tooth	n	min.	P10	P20	P30	P40	Mean	P60	P70	P80	P90	max.
Upper	1	26	8.2	9.4	9.5	9.9	10.1	10.3	10.7	10.8	11.0	11.5	11.7
	2	26	7.3	7.6	7.7	8.0	8.2	8.5	8.6	8.7	9.0	9.9	10.3
	3	26	7.8	9.2	9.4	9.8	9.9	10.0	10.2	10.6	10.7	11.1	11.8
	4	26	6.0	7.1	7.4	7.6	7.7	7.9	8.1	8.2	8.4	8.5	10.3
	5	26	5.5	6.0	6.3	6.3	6.4	6.7	6.9	7.0	7.2	7.3	8.7
	6	26	4.2	5.0	5.2	5.2	5.4	5.7	5.7	5.8	6.3	6.4	7.9
Lower	1	26	7.5	7.7	8.0	8.2	8.6	8.7	8.9	9.3	9.4	9.6	10.0
	2	26	7.2	7.7	8.0	8.2	8.2	8.6	8.8	8.9	9.2	9.6	10.3
	3	26	8.1	8.9	9.2	9.5	9.7	10.0	10.1	10.4	10.8	11.3	12.1
	4	26	7.0	7.6	8.1	8.2	8.3	8.4	8.5	8.7	8.8	9.1	10.2
	5	26	4.7	6.1	6.6	6.9	6.9	7.0	7.2	7.3	7.5	7.6	8.7
	6	26	3.8	5.0	5.3	5.4	5.5	5.8	6.0	6.1	6.2	6.7	7.6

Example of application and use of "C" percentile tables

Assuming a patient with the following characteristics: Female, with missing first premolars. Planning involved prosthetic reconstruction of the first upper premolars with implant support. What should the mesiodistal dimension of the first maxillary premolars be?

First step: Measure the dimensions of any one of the teeth either in the casts or clinically in the patient. Assuming that the mesiodistal size of one of the upper central incisors was measured and found to be 9.5 mm, the value that corresponds to this dimension is then checked in Table 6 in the "C" percentile table for females. Since the value of 9.5 mm is in column P90, the probable value of the first upper premolars is 7.5 mm.

Additionally, the following conclusions can be drawn. The mesiodistal, buccolingual and occlusal/incisal-cervical dimensions shown in the P90 columns in the Tables 6, 7 and 8 are the probable dental dimensions of the remaining teeth whenever the female upper incisors show a mesiodistal distance of 9.5 mm.

Note also that the sum of the upper and lower quadrants is shown in the respective columns. One could also measure the distances from incisors to canines, and from incisors to second premolars, adding to the respective values.

CLINICAL CONSIDERATIONS

"C" percentile tables may be applied along with other preexisting methods to determine tooth size and thus assist in various areas of dentistry, such as in morphological, esthetic and functional reconstructions. In orthodontics, they could be used to determine individual, collective and inter-arch discrepancies. They can also contribute as an auxiliary method in forensic investigations.

The feasibility of the clinical applications and hypotheses suggested in this study can only be confirmed, denied or amended by means of longitudinal applications and assessments of the outcomes. However, one should note that often human dental arches exhibit morphological variations and disproportionate tooth dimensions. As a result of these events it is suggested that given the size variations a more conservative alternative should be tried first rather than hastily propose a reduction in dental materials.

CONCLUSIONS

Based on the materials and methods used and the results obtained in this study, the following could be established:

- The biometric mesiodistal, buccolingual and occlusal/incisal-cervical dimensions of human teeth are distinguishable between genders in terms of the mean, minimum and maximum coefficients, standard deviations, variation coefficients and percentages of each tooth in their respective dimension.
- Tooth dimensions are smaller in females than in males and should therefore be studied separately.
- The teeth in their mesiodistal, buccolingual and occlusal/incisal-cervical dimensions proved to be symmetrical in both genders.

Through the overall values obtained, it was possible to build tables to distinguish these dimensions according to gender.

The mean values of mesiodistal, buccolingual and occlusal/incisal-cervical tooth dimension were provide along with the percentage of occurrence between these dimensions and their standard deviations.

By using the mean values of tooth size and the percentages of occurrence it was possible to develop the "C" equation and "C" percentile tables. Thus, with the aid of the "C" equation and/or "C" percentile tables one can measure one single dimension of a given tooth and find the three probable dimensions of other teeth.

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