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RESEARCH ARTICLE

Comparison Between Human Maxillary Anterior Teeth and Commercial Acrylic Teeth: A Sex-Stratified Analysis

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Abstract:

Objective:

The aim of this study was 1. To compare the total width of human anterior teeth from different races (White, black, and Asian) to the total width of commercially available anterior teeth molds and, 2. To compare the width and length of human central incisors (#9) from different races (White, black, and Asian) with those of commercially available central incisors (#9).

Materials and Methods:

The study consisted of 360 participants, with 60 females and 60 males in each of 3 racial groups: White, Black, and Asian. Metric measurements of natural teeth were obtained from dental casts, and those of acrylic teeth were obtained from company catalogs.

Statistical Analysis:

Data normality was determined by Kolmogorov-Smirnov and Shapiro-Wilk tests. The Kruskal-Wallis and Dwass-Steel-Critchlow-Fligner post hoc tests were used to compare measurements across the racial groups and commercial acrylic teeth. P value of ≤ 0.05 was set as statistically significant.

Results:

The results showed significant intra- and intergroup differences between males and females and across the 3 racial groups, especially among the Black group. Significant differences were also detected between artificial and natural teeth dimensions.

Conclusion:

Although similarities exist, generally, the dimensions of commercially available artificial teeth are different than that of natural teeth in the studied populations. Overall, in both males and females, the median length of natural tooth #9 is always smaller when compared to commercially available teeth. In contrast, in both males and females, the median width of natural tooth #9 is always larger when compared to commercially available teeth, except for female Asian population. Overall, significant racial differences exist in the length, width, and total width of natural teeth compared to commercially available teeth in the Black population. However, both the white and asian population showed less significant differences when comparing the length, width, and total width of natural teeth to commercially available teeth.

Keywords: Artificial teeth, Dentures, Prosthesis, Acrylic teeth, Denture teeth, Removable prosthodontics.

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1. INTRODUCTION

Anterior teeth size selection is important in the fields of prosthetic dentistry and dentofacial orthodontics [1]. The selection process includes selecting the size, form, and shade of the teeth, as this is part of restoring a patient's dental esthetics

and function [1]. Human teeth morphology and dimensions vary according to several factors, including sex [2 - 4]. There is a significant sexual dimorphism in the mesiodistal dimension of the anterior teeth; the mesiodistal dimension is greater in males than in females, with the canines being the most significant tooth among the anterior teeth to express the sexual dimorphism [5 - 8].

In addition, the width of the maxillary anterior teeth varies

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among races [8 - 11]. The largest mesiodistal measurement among the anterior teeth is that of the central incisors in Blacks, while the smallest is that of the lateral incisors in Whites [9]. The greater mesiodistal width of the central incisors in Blacks results in a larger distance between the distal surfaces of the maxillary canines. This distance is important in establishing teeth size and subsequent teeth size selection in restorative dentistry and edentulous patients [9]. The sum of the 6 anterior teeth is significantly different between races, with it being greater in Blacks than in Whites and Asians in both men and women [9, 10]. Asians have more slender teeth than Whites. The only significant difference in mesiodistal width between Whites and Asians is in the central incisors; the length of the central incisors, lateral incisors, canines, and premolars is also significantly different [11].

Despite the importance of comparing the dimensions of available artificial teeth with those of natural teeth, little consensus between them exists. As race- and sex-related variances in natural anterior teeth dimensions are well-reported in the literature, it is critical to assess if available acrylic teeth dimensions are proportionally different from those of natural teeth across sexes and racial groups. The width and length of artificial teeth compared to natural teeth across different races and genders can be different [10]. This study provides useful clinical information that can potentially aid clinicians in the selection of artificial teeth according to the race and gender of the patients. Therefore, the objectives of this study were: 1. To compare the total width of human anterior teeth from different races (White, black, and Asian) to the total width of commercially available anterior teeth molds and, 2. To compare the width and length of human central incisors (#9) from different races (White, black, and Asian) with those of commercially available central incisors (#9).

2. MATERIALS AND METHODS

Using previously published data [5], the maxillary dental casts from 360 participants of 3 different racial groups were reviewed. Each racial group (White, Black, and Asian) consisted of 120 individuals, with 60 males and 60 females in each group. The participants were adults with a complete set of anterior maxillary teeth that were sound, in good alignment, and without significant spacing. Mixed-race individuals or those with extensive teeth wear; a history of trauma, maxillofacial surgery, or orthodontic treatment; congenital or acquired head or neck defects; or obvious facial asymmetry were excluded from the study. The study protocol was approved by the appropriate institutional review board (IRB) no. 5130265 and was conducted in accordance with the Declaration of Helsinki.

A digital caliper (Mitutoyo CD-6" CSX; Mitutoyo Corp.) was used to obtain the width and length of each anterior tooth. The measurements were recorded, and the combined width of the 6 anterior teeth on the straight line was calculated. Measurements were considered to be continuous. The average

of 3 measurements was used descriptively and for testing the hypothesis. All measurements were made by one person (EP).

Acrylic teeth measurements were obtained from company catalogs. We evaluated 53 Dentsply molds (York;PA, USA), 19 SR Phonares II molds (Ivoclar Vivadent, Schaan), and 24 SR Vivodent molds (Ivoclar Vivadent, Schaan).

2.1. Statistical Analysis

Data normality was determined by Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics were reported as the mean, standard deviation, median, and interquartile range. Measurements across sexes in each racial group were compared using the Wilcoxon rank-sum test. The Kruskal-Wallis and Dwass-Steel-Critchlow-Fligner post hoc tests were used to compare measurements across the racial groups and commercial acrylic teeth. The significance level was set at 5% for all analyses.

3. RESULTS

The mean, standard deviation, median, and interquartile range for the included measurements are presented in Table 1. The Wilcoxon test of the differences between males and females across each racial group showed that the central incisor length (White: $P=0.003$, Black: $P=0.0003$, and Asian: $P=0.002$), central incisor width (White: $P=0.002$, Black: $P=0.01$, and Asian: $P<0.0001$), and total width of the maxillary anterior teeth (White: $P=0.001$, Black: $P<0.0001$, and Asian: $P<0.0001$) were significantly different, but not in terms of age (White: $P=0.17$, Black: $P=0.15$, and Asian: $P=0.28$). Because of these significant sex differences, the analysis of the measurements (*i.e.*, central incisor length, central incisor width, and total width of the maxillary anterior teeth) across races and commercially available teeth were stratified by sex. Overall, in both males and females, the median length of natural tooth #9 is always smaller when compared to commercially available teeth. In contrast, In both males and females, the median width of natural tooth #9 is always larger when compared to commercially available teeth, except for female Asian population (Table 1).

For males, the Kruskal-Wallis test showed a significant difference in the central incisor width and total width of the maxillary anterior teeth ($P<0.0001$ and $P<0.0001$, respectively) but not for the central incisor length ($P=0.055$). For the central incisor width, the Dwass-Steel-Critchlow-Fligner test showed significant pairwise comparisons between the following: White vs. Dentsply, Black vs. Dentsply, Black vs. SR Phonares II, Black vs. SR Vivodent, and Asian vs. Dentsply. For the total width of the maxillary anterior teeth, the Dwass-Steel-Critchlow-Fligner test showed significant pairwise comparisons between the following: White vs. Dentsply, Black vs. Dentsply, Black vs. SR Phonares II, Black vs. SR Vivodent, Asian vs. Dentsply, Asian vs. SR Phonares II, and Asian vs. SR Vivodent (Table 2).

Table 1. Comparison of the total width of the maxillary anterior teeth, central incisor width, and central incisor length across groups.

Characteristic	Variable	White		Black		Asian		Dentsply		SR Phonares II (Ivoclar Vivadent)		SR Vivodent (Ivoclar Vivadent)		Kruskal-Wallis Test (P-Value)						
		n	Mean (SD)	Median (IQR)	n	Mean (SD)	Median (IQR)	n	Mean (SD)	Median (IQR)	n	Mean (SD)	Median (IQR)		n	Mean (SD)	Median (IQR)			
		Male																		
	Age	60	38.47 (13.08)	33.5 (18.00)	60	37.82 (11.13)	36.00 (16.00)	60	29.93 (7.43)	28.00 (5.50)	-	-	-	-	-	-	<.0001			
	Length #9	60	10.28 (0.91)	10.38 (1.29)	60	10.62 (1.26)	10.64 (-2.17)	60	10.55 (1.08)	10.35 (1.14)	54	10.70 (0.53)	10.75 (1.50)	18	11.16 (1.03)	10.90 (1.30)	24	10.49 (1.10)	10.95 (1.40)	0.0553
	Width #9	60	8.83 (0.44)	8.86 (0.55)	60	9.33 (0.59)	9.46 (-0.59)	60	8.88 (0.51)	8.95 (-0.74)	54	8.56 (0.63)	8.5 (-0.9)	18	8.52 (0.56)	8.50 (1.00)	24	8.65 (0.54)	8.7 (-0.5)	<.0001
	Total width	60	47.76 (2.27)	47.40 (3.49)	60	50.44 (2.71)	50.98 (-3.4)	60	48.91 (2.22)	48.91 (3.27)	54	46.32 (3.17)	46.00 (4.50)	18	46.18 (1.60)	46.10 (5.40)	24	46.04 (2.99)	46.10 (5.40)	<.0001
Female																				
	Age	60	35.45 (11.49)	33.00 (14.00)	60	40.33 (10.17)	41.00 (17.00)	60	32.07 (9.18)	30.00 (8.50)	-	-	-	-	-	-	-	-	-	<.0001
	Length #9	60	9.66 (1.22)	9.59 (1.68)	60	9.82 (0.84)	9.74 (-1.27)	60	9.92 (0.97)	9.84 (-1.3)	54	10.70 (0.53)	10.75 (1.50)	18	11.16 (1.03)	10.90 (1.30)	24	10.49 (1.10)	10.95 (1.40)	<.0001
	Width #9	60	8.53 (0.51)	8.61 (1.68)	60	9.07 (0.70)	9.11 (-0.82)	60	8.45 (0.57)	8.41 (-0.74)	54	8.56 (0.63)	8.5 (-0.9)	18	8.52 (0.56)	8.50 (1.00)	24	8.65 (0.54)	8.7 (-0.5)	<.0001
	Total width	60	46.09 (2.38)	46.15 (3.35)	60	48.39 (2.78)	48.68 (-4.2)	60	46.61 (2.70)	46.62 (3.75)	54	46.32 (3.17)	46.00 (4.50)	18	46.18 (1.60)	46.10 (5.40)	24	46.04 (2.99)	46.10 (5.40)	0.0002
Male vs. Female (Wilcoxon Rank-sum Test P-value)																				
	Age		0.1693		0.145		0.2772													
	Length #9		0.0029		0.0003		0.0021													
	Width #9		0.0017		0.0121		<.0001													
	Total width		0.0006		<.0001		<.0001													

IQR = Interquartile Range; SD = Standard Variation.

Table 2. Statistical significance of the total width of the maxillary anterior teeth, central incisor width, and central incisor length across groups using Dwass-Steel-Critchlow-Fligner (DSCF) multiple comparison analysis.

Characteristic	Variable	White vs. Dentsply	White vs. SR Phonares II	White vs. SR Vivodent	Black vs. Dentsply	Black vs. SR Phonares II	Black vs. SR Vivodent	Asian vs. Dentsply	Asian vs. SR Phonares II	Asian vs. SR Vivodent	Dentsply vs. SR Phonares II	Dentsply vs. SR Vivodent	Phonares II vs. SR Vivodent
Male													
	Length #9	-	-	-	-	-	-	-	-	-	-	-	-
	Width #9	*	-	-	*	*	*	*	-	-	-	-	-
	Total width	*	-	-	*	*	*	*	*	*	-	-	-
Female													
	Length #9	*	*	-	*	*	-	*	-	-	-	-	-
	Width #9	-	-	-	*	*	*	-	-	-	-	-	-
	Total width	-	-	-	*	*	*	-	-	-	-	-	-

* Significant P Value <0.05

For females, the Kruskal-Wallis test showed a significant difference in the central incisor length, central incisor width, and total width of the maxillary anterior teeth ($P < 0.0001$, $P < 0.0001$, and $P = 0.0002$, respectively). For the central incisor length, the Dwass-Steel-Critchlow-Fligner test showed significant pairwise comparisons between the following: White *vs.* Dentsply, White *vs.* SR Phonares II, Black *vs.* Dentsply, Black *vs.* SR Phonares II, and Asian *vs.* Dentsply. For the central incisor width, the Dwass-Steel-Critchlow-Fligner test showed significant pairwise comparisons between the following: Black *vs.* Dentsply, Black *vs.* SR Phonares II, and Black *vs.* SR Vivodent. For the total width of the maxillary anterior teeth, the Dwass-Steel-Critchlow-Fligner test showed significant pairwise comparisons between the following: Black *vs.* Dentsply, Black *vs.* SR Phonares II, and Black *vs.* SR Vivodent (Table 2).

4. DISCUSSION

The results showed a significant difference in terms of odontometric dimensions between males and females. Of all 3 racial groups, the most significant difference was detected in the central incisor length between Black males and females ($P < 0.0003$). This finding is in agreement with studies showing that Blacks and those of African descent had a larger mesiodistal width of the anterior teeth [4, 12].

The total anterior teeth width significantly differed between males and females almost equally among all 3 racial groups. Overall, males of all races exhibited greater width and length compared to females. This finding is supported by multiple studies, indicating significant differences in tooth width and length across sexes [6, 13 - 15]. Gillen *et al.* found that among both Blacks and Whites, males had wider and longer anterior teeth than females [16].

Males showed a significant difference between the racial groups in all measurements except for the central incisor length. On the other hand, females showed a significant difference between the racial groups in all the parameters. Therefore, such variations can be explained by race in addition to sexual dimorphisms. Black males, on average, had larger teeth than Asians and Whites, while the opposite was true for White females. Despite the greater width of #9 in White females compared to Asian females, the mean of the anterior teeth total width was smallest in White females. The results of several studies from different populations agree with our results, which show that race and sexual dimorphisms influence dental dimensions [9, 17 - 19]. Furthermore, other studies have shown that genetics and environmental factors may also contribute to variations in teeth size [17, 20]. Malkoç *et al.* reported that the mesiodistal dimensions of teeth differed significantly across different malocclusion categories, with females showing greater variability [21].

The pairwise comparisons between the natural teeth and commercially available molds mostly revealed significant findings in the Black group for both males and females. Even though females showed a closer match to the commercial molds, all females showed a significant difference between the central incisor length and the Dentsply molds. In contrast, all available molds from the 3 manufacturers would be suitable for

the males from all the groups in terms of the central incisor length. Baer and Reynolds [22] concluded that the combined width of Bioblend (Dentsply) maxillary anterior teeth was smaller (mean: 50.1 mm) than the natural teeth of both sexes (males: 55.6±3.1 mm, females: 53.6±3.0 mm). This paper was later supported by LaVere *et al.*, who found that artificial teeth were smaller after comparing artificial teeth from 6 different manufacturers to the natural teeth of a diverse racial population [23].

Multiple available molds have a total anterior teeth width that is less than 41 mm, yet most people have a total anterior teeth width of greater than 45 mm [24]. Similarly, the largest mean of the left central incisor width in artificial denture teeth (Premadent: 7.07–9.00 mm) was noted to be smaller than that of natural teeth (7.36–9.96 mm) [24].

McArthur explained that smaller molds are being supplied by manufacturers instead of larger molds due to a possible tendency to select undersized maxillary artificial dentition and patients' perception of too-large artificial maxillary central incisors [25]. McArthur later reported that smaller teeth would be appropriate for seniors, who tend to have a smaller mesiodistal diameter of the central incisors due to incisal and proximal wear [26]. Even with similar results showing available molds to be smaller than natural teeth, Woodhead [27] suggested that the size of artificial teeth should approximate that of natural teeth to avoid prostheses appearing artificial. Ultimately, though, the most critical factor is the satisfaction of the patient and the dentist in terms of the final esthetic outcome and reestablishment of a proper canine-canine relationship [25].

Unfortunately, there is limited data pertaining to denture teeth dimensions other than the central incisor information provided by manufacturers. For the most accurate results, a comparison between other artificial anterior teeth and natural ones was not performed as part of this study; only the central incisor (#9) was used, with size measurements provided by the mold companies.

Generally, significant differences exist in the length, width, and total width of natural teeth compared to commercially available teeth in the Black population. However, Both the White and Asian population showed less significant differences when comparing the length, width, and total width of natural teeth compared to commercially available teeth.

The importance of these results lies in appreciating the variations within and between the different sexes and human populations, hence enhancing the understanding of the clinical relevance of these characteristics.

CONCLUSION

Although similarities exist, generally, the dimensions of commercially available artificial teeth are different than that of natural teeth in the studied populations. Overall, in both males and females, the median length of natural tooth #9 is always smaller when compared to commercially available teeth. In contrast, in both males and females, the median width of natural tooth #9 is always larger when compared to commercially available teeth, except for female Asian

population. Overall, significant racial differences exist in the length, width, and total width of natural teeth compared to commercially available teeth in the Black population. However, both the White and Asian population showed less significant differences when comparing the length, width, and total width of natural teeth to commercially available teeth.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved by the appropriate Institutional Review Board (IRB) no. 5130265.

HUMAN AND ANIMAL RIGHTS

No animals were used that are the basis of this study. All the human procedures were conducted in accordance with the Declaration of Helsinki.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Data are available from the corresponding author [H.S.A], on request.

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This study did not receive funding.

CONFLICT OF INTEREST

The authors declared they have no conflict of interest.

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