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CORRELATION BETWEEN INNER CANTHAL WIDTH AND THE MESIO-DISTAL WIDTHS OF THE MAXILLARY ANTERIOR TEETH IN A KENYAN POPULATION OF AFRICAN DESCENT
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R.M Ariemba, S.W Maina and L.W Gathece

ABSTRACT

Objective: **To investigate the relationship between the inner canthal width and the mesio-distal widths of the maxillary anterior teeth in a Kenyan population of African descent.**

Study design: Descriptive cross-sectional study

Setting: **College of Health Sciences, University of Nairobi, Kenya.**

Subjects: **One hundred and forty six undergraduate and postgraduate students aged 18-30 years were recruited into the study. Data on inner canthal width (ICW) was obtained through direct measurements of the participants. The individual mesiodistal widths of the six maxillary anterior teeth were obtained from type IV gypsum product casts generated from irreversible hydrocolloid impressions of the maxillary arch. These were then summed up to obtain the combined mesio-distal widths of the anterior teeth (CMDWAT).All the measurements were obtained using an electronic digital caliper. These were then recorded on a data capturing sheet designed by the principal investigator.**

Results: **Out of the 146 participants, 78 (53.4%) were males while 68 (46.6%) were females. The overall mean inner canthal width was 34.27 ± 2.68mm with males having significantly higher mean values compared to the females (34.73 ± 2.69mm and 33.74 ± 2.58mm respectively), ($t=2.27$, $p<0.05$). The mean of the combined mesio-distal width of the anterior teeth (CMDWAT) was 47.68 ± 2.55mm with males having significantly higher mean values (48.12 ± 2.49mm) compared to the females (47.16 ± 2.55mm), ($t=2.30$, $p<0.05$). A statistically significant but weak positive correlation was found between the ICW and CMDWAT ($r=0.17$, $r2=0.03$, $p<0.05$).**

Conclusion: **The results from this study suggest a very weak positive correlation between ICW and the CMDWAT. The ICW was reliable in estimating the CMDWAT in only 3% of the population. Therefore, when used alone, the ICW may not be a reliable guide when used to estimate the CMDWAT in the population studied.**

INTRODUCTION

Edentulism is a condition experienced world over that is mainly as a result of tooth loss due to dental caries and periodontal disease. The average total edentulous rate around the world is reported to be 60% at the age of 60 years, although there is a wide disparity among different populations in different countries (1, 2). Loss of natural teeth leads to atrophy of the supporting alveolar tissues, loss of support for the facial musculature and decreased masticatory efficiency which significantly affects the quality of life of the edentulous patient as a result of local anatomical changes and psychological changes that include continued residual ridge resorption, reduced masticatory function, altered facial aesthetics as well as deterioration in social functions.

In order to minimize the effects associated with edentulism therefore, oral rehabilitation of the edentulous patient is necessary and this is usually achieved through fabrication of conventional complete dentures, implant supported complete dentures or implant supported bridges (3, 4).

Regardless of the type of prosthesis to be provided, patient acceptance and overall satisfaction is paramount. To achieve this, there is need to restore the patients' natural appearance as much as possible which is partly achieved through appropriate anterior tooth size, shape and shade selection.(4).

Availability of pre-extraction records such as extracted teeth, dental casts, close up facial photographs showing the dentition and dental radiographs of the patients' teeth makes the process of artificial anterior tooth selection easier for the clinician. However, unavailability of these records as is the case with most patients seeking rehabilitation with complete dentures makes the process of selecting appropriate sizes of anterior teeth a real challenge particularly for an inexperienced one. In order for the clinician to provide aesthetically acceptable complete dentures and enhance overall patient satisfaction, reliable guides for anterior tooth size selection are required. At present there is no single objective and reliable method of anterior tooth size selection for the complete denture patient (5-10).

The inner canthal width (ICW) is one of the anthropometric measurements that have been investigated for use during anterior tooth size selection for the edentulous patient. It is also referred to as the inter-canthal width and is taken as the distance between the medial angles of the palpebral fissures of the eyes. This measurement has been shown to remain relatively stable by the age of 8-11 years and by 18 years of age it is usually 96.5 % and 99.1% developed in females and males respectively (11).

Studies by Al Wazzan et al (12) and Ellakwa et al (13) among Caucasian populations evaluating the relationship between the ICW and the mesio-distal widths of the maxillary anterior teeth reported a weak positive correlation between the two variables. Elsewhere, Abdullah et al (14, 15) reported that when the ICW is multiplied by a factor of 0.618 divided by 2 and ICW multiplied by a factor of 1.35 respectively, it can give an estimate of the mesio-distal width of the maxillary central incisor and combined mesio-distal width of the anterior teeth (CMDWAT) respectively. Yet another study among a Brazilian population (16) reported a moderate positive correlation between the ICW and the MDWAT measured on a curve between the distal surfaces of the left and right maxillary canines on standardized digital images ($r=0.467$ $r2=0.21$). In addition, Ahmed El Sheikh et al (17) reported a significant positive correlation between the ICW and the CMDWAT measured on a curve. The authors of this study concluded

that the CMDWAT may be estimated by dividing the ICW by a factor of 0.9. However, results from other studies have reported no correlation between the ICW and CMDWAT leading to in-conclusive results (18).

A literature search done on the correlation between inner canthal width and the mesio-distal width of the maxillary anterior teeth indicated paucity of data among black Africans. Available data has been conducted mainly on Caucasian populations and the results extrapolated to African populations who have been shown to have wider teeth compared to their Caucasian counterparts (19, 20). Data from various studies on the use of the inner canthal width as a method of estimating the mesio-distal width of the anterior teeth has also given contradictory results hence the need to carry out this study. Therefore the aim of this study was to investigate the relationship between the inner canthal width and mesio-distal widths of the maxillary anterior teeth in a Kenyan population of African descent.

MATERIALS AND METHODS

The study was conducted among undergraduate and postgraduate students at College of Health Sciences, University of Nairobi admitted from different ethnic communities from different parts of Kenya. The participants were aged between 18- 35 years with the following inclusion criteria: intact, unrestored six natural maxillary anterior teeth and including the 1st and 2nd premolars bilaterally, those whose paternal and maternal parents and grandparents were Kenyans of African descent, those with no facial deformities or history of surgery in the oro-facial region; and those with no history of orthodontic treatment

Those presenting with malformed anterior teeth such as peg shaped lateral incisors and Hutchison's incisors, proximal restorations or artificial crowns on their maxillary anterior teeth, interdental spaces, midline diastema and rotations of the maxillary anterior teeth, fractured maxillary anterior teeth and tooth surface loss involving the maxillary anterior teeth were excluded from the study. A total of 146 participants were selected through stratified random sampling which involved dividing them into three strata based on where they take their classes (School of Dental Sciences, Kenyatta National Hospital Campus and Chiromo Campus). A sampling frame comprising of the students from each of the three stations was then made and a minimum of 48 participants who met the inclusion criteria selected per station. Permission to conduct the study was obtained from the Kenyatta National Hospital and University of Nairobi Ethics and Research Standards Committee (Approval No. P174/6/2010). Written consent was also obtained from the participants. Measurements of the inner canthal width were taken in a room under natural light with the participants seated on an ordinary chair with their head in an upright position (Figure 1). Impressions of the maxillary arch were also taken using irreversible hydrocolloid material (Alginoplast fast set, Haraeus Kulzer, Hanau, Germany) on sterile perforated metallic dentate stock trays. The impressions were disinfected by immersion in 1% sodium hypochlorite solution for 5 minutes, rinsed under tap water and stored in zip lock bags. The impressions were then transported to the dental laboratory and with the help of a trained dental technologist, poured in type IV gypsum material (Ultra rock, Kalabhai, Karson Pvt Ltd, Mumbai, India) to generate casts from which the individual mesio-distal widths of the anterior teeth (MDWAT) were then taken once the material had fully set (Figure 2). These were then summed up to obtain the combined mesio-distal widths of the anterior teeth (CMDWAT). All the measurements were taken using an electronic digital caliper (Mossel, USA) that

had been calibrated at the Kenya Bureau of Standards (Certificate No.BS/MET/7/3/30/025) prior to data collection. The measurements were recorded to the nearest 0.01mm and repeated twice at intervals of 5 minutes to obtain an average value. The data collected were analyzed using the Statistical Package for Social Sciences version 13.0 (SPSS Inc, Chicago, Ilinois, USA). Descriptive and analytical statistics (independent sample t-test, correlation analysis and linear regression analysis) were carried out. The confidence level for this study was 95% and the p-value for statistical significance was set at less than 0.05.

Prior to data collection, the principal investigator was calibrated by two supervisors for both the inner canthal width and mesio-distal width of the six maxillary anterior teeth to determine inter-examiner reproducibility. Intra-class correlation coefficient (ICC) values of 0.94 and 0.99 respectively (n=15) were obtained for both measurements, indicating an almost perfect agreement. For intra-examiner reproducibility, repeated measurements of every tenth participant and cast were taken (ICC values obtained; 0.94 for ICW and 0.98 for the MDWAT) indicating an almost perfect agreement.

RESULTS

Socio-demographic characteristics:

Of the 146 participants, 78 (53.4%) were male while 68 (46.6%) were female ranging between 1830 years with a mean age of 22.35 ± 2.65 years. The overall modal age was 22 years while the mean age for the males was higher than that of the females (22.82 ± 2.66 SD and 21.81± 2.55 SD respectively). There were more females than males in the age group 18-20 years and 21-23 years. On the other hand, there were more males in age groups 24-27 years and 28-30 years (Figure 3).

Inner central width:

The mean inner canthal width was 34.27 ± 2.68mm with a range of 28.61-42.46mm. Males had a higher mean inner canthal width compared to the females (34.73 ± 2.69mm and 33.74 ± 2.58mm respectively) and the difference was statistically significant (t=2.27, p=0.03).Overall, males had higher mean inner canthal widths compares to females for all the age groups (Figure 4).

Mesio-distal width of maxillary anterior teeth: The combined mesio-distal width of the maxillary anterior teeth (CMDWAT) ranged between 39.47 - 54.72mm with a mean value of 47.68 ± 2.55mm. Males had a higher mean CMDWAT compared to the females (48.12 ± 2.49mm and 47.16 ± 2.55mm respectively) and the difference was statistically significant (t=2.30, p=0.02). Overall, males had higher mean values for all the teeth compared to females but the differences in the scores between the two groups were statistically significant only for the canine teeth (t=4.49,3.86, p=0.00) (Table 1). In addition, males had higher mean CMDWAT values compared to females for all the age groups (Figure 5).

Correlation between inner canthal width and mesio-distal width of maxillary anterior teeth: There was a statistically significant weak positive correlation between the inner canthal width and CMDWAT (r2=0.03, p=0.00). With regards to the individual mesio-distal widths of the anterior teeth, only the canines displayed a statistically significant weak positive correlation with the inner canthal width (r2=0.07, 0.10, p=0.00) (Table 2).

The association between the inner canthal width and combined mesio-distal width of the anterior teeth was evaluated using a multiple linear regression model using the equation; $y = \beta 0 + \beta x + \varepsilon$ Where,

y- is the actual change in combined mesio-distal width of anterior teeth in mm βo -is the intercept (the value of y when x=0) β- is

the slope of the line (amount by which y changes for each unit change in x) x- is the inner canthal width in mm ε - represents other factors that may influence the dependent variable

The regression analysis yielded a coefficient of determination (r2) of 0.03 which refers to the amount of variation explained by the independent variable. Therefore, only 3% of the variation in change in the combined mesio-distal width of the anterior teeth can be explained by the inner canthal width (Table 3).

Table 1
A comparison of the mean mesio-distal widths of the maxillary anterior teeth by gender

Tooth type	Overall mean widths (mm)	Mean width for the males (mm)	Mean width for the females (mm)	t test	P value (α=0.05)
Right canine	7.91	8.06	7.74	4.49	0.00*
Right lateral incisor	7.10	7.12	7.09	0.35	0.73
Right central incisor	8.80	8.95	8.80	1.63	0.11
Left central incisor	8.87	8.94	8.78	1.72	0.09
Left lateral incisor	7.10	7.14	7.06	0.82	0.41
Left canine	7.88	8.01	7.72	3.86	0.00*
Combined mesio-distal width	47.68	48.12	47.16	2.30	0.02*

*Statistically significant

Table 2
Correlation between the inner canthal width and mesio-distal widths of the anterior teeth

Tooth type	r	r^2	P value (α=0.05)
Right canine Right lateral incisor	0.26	0.07	0.00*
Right central incisor	0.06	0.00	0.45
Left central incisor	0.12	0.01	0.15
Left lateral incisor	0.13	0.02	0.12
Left canine	0.09	0.01	0.29
Combined mesio-distal width	0.31	0.10	0.00*
	0.18	0.03	0.03*

**Statistically significant*

Table 3
Linear regression analysis to demonstrate the relationship between the inner canthal width and combined mesio-distal width of the anterior teeth

Variable	B value	Beta	t value	95% CI Lower	Upper	P value
Inner canthal width	0.14	0.15	1.80	-0.01	0.30	0.08
Gender	-0.96	-0.19	-2.24	-1.80	-0.11	0.03*
Age	-0.14	-0.14	-1.70 40.39	-0.30	0.02	0.09
Constant	47.27	3.58		-	-	0.00

**Statistically significant*

Figure 1
Measurement of the inner canthal width

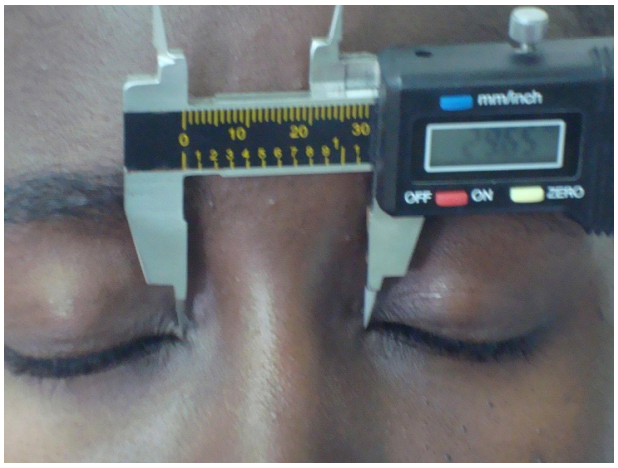


Figure 2
Measurement of the mesio-distal width of the anterior teeth

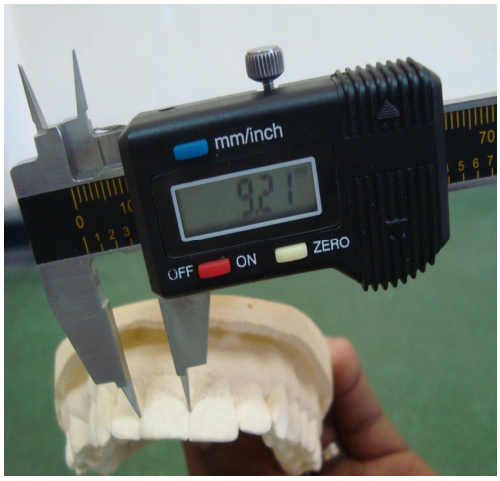


Figure 3
Age and gender distribution of the participants

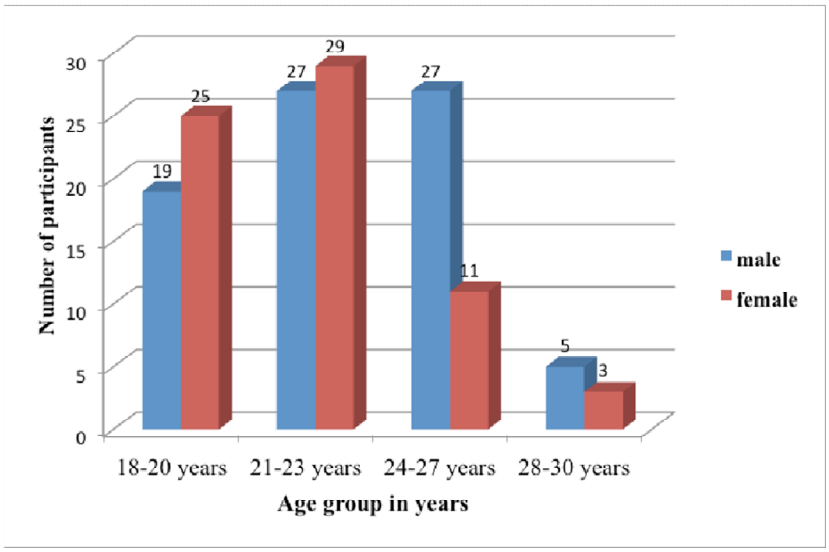


Figure 4
Pattern of the mean inner canthal width of the participants by age group

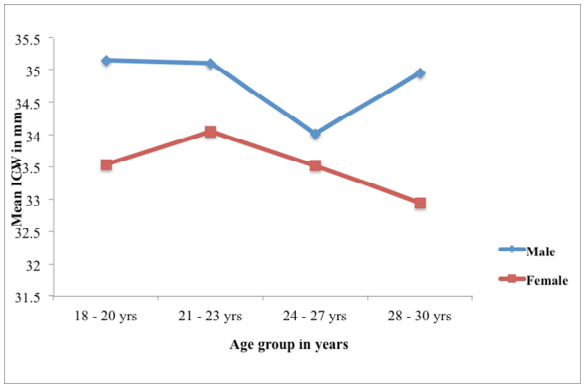
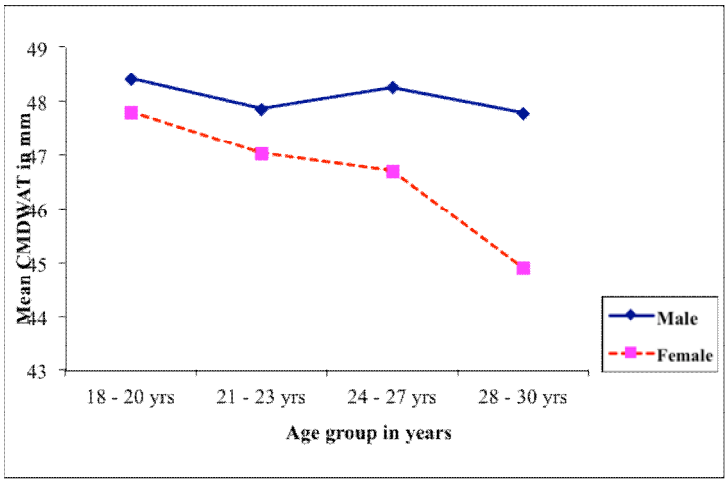


Figure 5
Mean combined mesio-distal width of the anterior teeth by gender and age



DISCUSSION

Anterior tooth selection for complete denture patients lacking pre-extraction records poses a great challenge for the clinician due to lack of reliable and objective methods of artificial anterior tooth size selection (5-10). The inner canthal width is one of the facial measurements that have been investigated by several authors. In the present study, the mean inner canthal width was comparable to that reported by other studies (16, 18). However, some authors have reported lower mean inner canthal width values compared to the present study (15,17,21) while others have reported higher mean values (13). The differences in the mean values reported could be attributed to racial variation whereby most of the studies were conducted among Caucasian populations with only one study involving an African population of Sudanese origin (17). Different instruments used while taking the measurement such as the use of the Boley gauge (12,14,15) and electronic digital calipers (18) could also have led to the differences in the mean values obtained. Different methodologies used while obtaining the participants' measurements either through photographs (16,18,21) or direct clinical measurements of the participants (12,14,15,17) could also have yielded different results. Males had higher mean inner canthal widths compared to females, a difference that is consistent with findings of other authors (14,15,17). However, a study among a Brazilian population (21) reported no statistically significant difference in the mean ICW between the males and females.

Statistically significant but weak positive correlations were reported between the inner canthal width and the combined mesio-distal width of the maxillary anterior teeth in 3% of the population and inner canthal width and the width of the canines in 10% of the population studied (r2=0.03 and r2= 0.10 respectively). These findings are in agreement with those from previous studies (12, 13,16) where the authors have reported weak positive correlations between the inner canthal width and the combined mesio-distal width of the six maxillary anterior teeth (r2=0.09) (12,16). However, this represents only a very small proportion of the population with more than 90% of the population studied not accounted for.

CONCLUSIONS

Based on the findings of the present study, the following conclusions can be made:

1. There were statistically significant differences in mean values for the inner canthal width among the males and females.
2. There was a very weak positive correlation between the inner canthal width and the combined mesio-distal widths of the anterior teeth.
3. The inner canthal width was reliable in predicting the mesio-distal width of the six maxillary anterior teeth in only 3% of the population studied. Therefore, when used alone, the ICW may not be a reliable guide in estimating the mesio-distal width of the six maxillary anterior teeth for the population under study.

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