

The relationship between innercanthal dimension and interalar width to the intercanine width of maxillary anterior teeth in central Indian population

Suryakant Chhagan Deogade, Sneha S. Mantri, K. Sumathi, Shivani Rajoriya

Department of Prosthodontics, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India

Abstract

Statement of Problem: Selection of proper sized maxillary anterior teeth is one of the difficult clinical steps in complete denture esthetics. Several studies have been reported to establish methods of estimating the combined width of maxillary anterior teeth.

Purpose: The aim of this study was to determine whether a relationship exists between the innercanthal distance (ICD) and interalar width (IAW) with the combined width of maxillary anterior teeth.

Material and Methods: The maxillary anterior teeth of 600 adult subjects were examined. ICD was measured between the median angles of the palpebral fissure. IAW was measured between the ala of the nose at their widest point. The mean combined width of the maxillary anterior teeth was determined intraorally at their widest dimension. Pearson's correlation coefficients were calculated to determine the relationship between ICD, IAW and the combined width of maxillary anterior teeth ($\alpha = 0.05$).

Results: Although the Pearson correlation coefficients were relatively small, a significant relationship existed between innercanthal dimension and IAW ($P < 0001$).

Conclusion: Within the limitations of this study, the results suggest that ICD and IAW cannot be used as a preliminary method for determining the width of the maxillary anterior teeth for edentulous patients.

Key Words: Innercanthal distance, interalar width, intercanine width

Address for correspondence:

Dr. Suryakant Chhagan Deogade, Flat No. 502, Block-D, Apsara Apartment, South Civil Lines, Pachpedi Road, Jabalpur - 482 001, Madhya Pradesh, India.

E-mail: dr_deogade@yahoo.co.in

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INTRODUCTION

The selection of maxillary anterior artificial teeth is one of the primary concerns in complete denture esthetics. In the absence of preextraction records, it becomes difficult to estimate the combined width of maxillary six anterior teeth. Several

anatomic measurements, including bizygomatic width (BZW), interpupillary distance (IPD), interalar width (IAW), innercanthal distance (ICD), and intercommissural width have been suggested to aid in the estimation of a combined width of the maxillary anterior teeth (intercanine width [ICW]).^[1-18]

Young^[19] claimed a BZW-to-maxillary central incisor width ratio of 1:1.6 and a BZW-to-ICW ratio of 1:3.3. However, other authors^[2,6,20,21] found no correlation between BZW and central incisor width. The relationship between the IPD and mesiodistal width of maxillary central incisors was suggested and evaluated by Cesario and Latta.^[22] A ratio of 1:6.6 occurred in 95% of white and black female patients in the sample group tested. In black male patients, the ratio was 1:7. A separate investigation^[6] showed no such correlations. Several authors^[23,24]

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have advocated the use of the IAW as a guide in the selection of maxillary anterior teeth. However, Smith^[4] found no significant relationship between IAW and intercanine distance (tip to tip). Similar results were reported for the dimension from distal of the canine to distal of canine^[6] and for the dimensions of the four maxillary incisors.^[25]

The ICW method is based on the hypothesis that the distal surface of the maxillary canines should be located approximately at the commissures of the mouth. Silverman^[26] found that the distal surface of maxillary canines was ± 4 mm from the commissures. Al Wazzan *et al.*^[6] found no significant correlation between the ICW and maxillary anterior teeth. Scandrett *et al.*^[2] evaluated BZW, IAW, ICW, sagittal cranial diameter, interbuccal frenum distance, philtrum width, and age as predictors of the width of maxillary anterior teeth and central incisors. The investigators concluded that no single predictor was accurate enough for clinical application. Therefore, it appears that more than one variable is needed to predict the width of maxillary anterior teeth and central incisors.

Abdullah *et al.*^[5] studied ICD, IAW and ICW in Saudi population and showed that the ICD may be used as a tentative predictor for the estimation of the combined width of the maxillary six anterior teeth, and serve as a useful additional factor in tooth selection. He reported the ratio of ICD (32.0 mm) to the width of maxillary anterior teeth (43.0) to be 1:1.35; however, no correlations were calculated to determine the significance of the relationship. However, Al Wazzan^[27] reported a weak correlation between ICD and 4 measurements of maxillary anterior teeth. He found biometric ratios of 1:0.267 and 1:1.426 to estimate the central incisor width and the combined width of the maxillary anterior teeth, respectively.

Different views and conflict had been reported on the significance of the IAW in the selection of anterior teeth. Picard^[28] reported that the IAW could be used to establish the width of the maxillary anterior teeth. This was substantiated by Whener *et al.*^[24] who suggested extending parallel lines from the lateral surfaces of the ala of the nose onto the labial surface of the maxillary occlusion rim to estimate the inter-canine cusp tip. Scandrett *et al.*^[2] also reported a significant correlation between the IAW and the width of maxillary anterior teeth. Smith^[4] however, reported a low relationship between radiographic measurement of the IAW of the nose and the distance between the maxillary canine's tips.

Mavroskoufis and Ritchie^[25] demonstrated some relationship between the nasal width and the intercanine distance which

suggested its use to establish the width of the anterior teeth. Hoffman *et al.*^[3] reported that the combined width of the maxillary six anterior teeth may be estimated through the use of IAW. He suggested that IAW may be multiplied by a factor of 1.31 to obtain the combined width of the maxillary six anterior teeth.

The medial junction of the two eyelids is called the medial angle (medial canthus).^[29] The ICD is the distance between the medial angles (canthi) of the palpebral fissure bilaterally. At 5 years of age, 93% of ICD growth has been achieved; maturity is reached between 8 and 11 years.^[30,31] The ICD is considered normal at a dimension of 28–35 mm.^[32] No differences related to sex,^[32,33] race^[34-36] (black or white) or age,^[5,32] have been shown in the ICD. This makes ICD a reliable anatomic dimension that may provide a valid approach to anterior tooth selection.

According to Gerber's embryogenetic philosophy,^[37] the nose has been considered as the most essential guide in selecting the size of the upper incisors. As it has been known that the nose and the four upper maxillary incisors develop from the same embryonic origin called the frontonasal process. Gerber suggested that the line passing through the incisal edges of the four maxillary incisors draws a line nearly parallel to the baseline of the nose; hence, it can be used as a guide for the arrangement of the anterior teeth. Furthermore, the IAW is a facial landmark that is at the closest distance from the teeth.

The variations in the reported studies may be the result of ethnic characteristics specific to the population studied. There are relatively few studies reported in a Central Indian population to estimate an overall width of maxillary six anterior teeth by correlating several facial measurements. The purpose of this study was to evaluate the relationship between ICD, IAW and the combined width of the maxillary six anterior teeth in Central Indian population.

MATERIALS AND METHODS

Before initiating the survey, a pilot study was conducted on fifty subjects to set the objectives and to check the feasibility of the study. Based on the results of the pilot study, the sample size was determined keeping the significance level and power of the study at 5% and 80%, respectively. A total of 600 adult Indian subjects (300 men and 300 women) were randomly selected from the outpatient dental clinic of Hitkarini Dental College and Hospital at Rani Durgawati University, Jabalpur, Madhya Pradesh, India. They ranged in age from 19 to 30 years. All subjects had their maxillary anterior teeth present without any caries, restorations, crowding, diastema or severe attrition. Those subjects with a congenital anomaly, orbital disease,

trauma, or facial surgery were excluded. Nature of the study was explained with subject information sheet, and an informed consent of all the subjects was obtained. The approval was obtained from the ethical committee of the University, after which, this investigation was carried out from April 2012 to September 2013.

The three parameters, ICD, IAW, and ICW of each subject were measured with a digital vernier caliper (Mitutoyo, UK Ltd.,) (0.01 mm). The ICD is the distance between the median (inner) angles (canthi) of the palpebral fissure. The distance between these two points was measured with a digital vernier caliper without the application of pressure by bringing the recording parts of the caliper just in contact with the medial angle of the palpebral fissure [Figure 1]. The IAW is the distance between the ala of the nose at the widest point. The distance between these two points was measured using a digital vernier caliper without the application of pressure by bringing the recording parts of the caliper just in contact with the outer surface of the nose [Figure 2]. While measuring IAW, the subject was told to stop breathing momentarily to avoid any change in shape of the nose. ICW is the distance between the distal contact points of anterior teeth. ICW was measured with a dental floss [Figure 3]. A dental floss beaded at one end was inserted between the contact of right first and second premolar. The bead facing palatally was securing the floss in position. The floss was circumferenced along the curvature of the anterior dentition such that it passed along the contact point of all the teeth. This was then passed through the contact between the left first and second premolar. The distal end of the canine teeth on both sides was then marked on the floss while it was stretched in the patient's mouth. Floss was marked on both the distal sides with the marking pen. The distance

between the two proximal contact points was measured using a vernier caliper and recorded as the ICW [Figure 4]. For each subject, each parameter was measured 2 times, and the average value was recorded separately by two calibrated investigators. The recorded data were compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 13.0 (SPSS Inc., Chicago, Illinois, USA). The data were statistically analyzed with the use of the *t*-test at $P < 0.05$.

OBSERVATIONS AND RESULTS

The descriptive statistics (mean, standard deviation, minimum and maximum) of the recorded measurements for all subjects and by sex are listed in Table I. The values were greater for men than for women [Graph 1], with significant differences ($P < 0.001$), for the variables tested. A significant differences were found between sexes with respect to ICW ($P = 0.016$). Pearson's correlation coefficient[®] between ICD and IAW was 0.696 as well as statistically significant ($P < 0.001$) [Table 2].

The correlation[®] between IAW and ICW was -0.084 but statistically significant ($P < 0.05$). The correlation[®] between ICD and ICW was -0.038 and non-significant ($P < 0.05$) Table 2. Graphs 2 and 3 demonstrated the correlation of ICD and IAW with relation to ICW, respectively. Regression

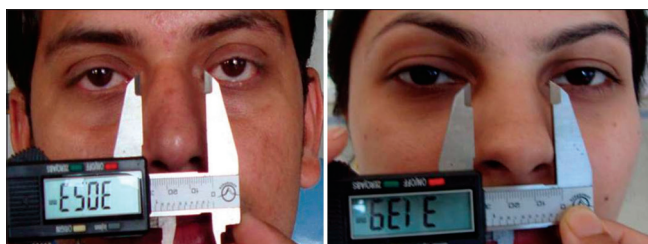


Figure 1: Innercanthus distance in male and female subjects



Figure 3: Intercanine width in male and female subjects



Figure 2: Interalar width in male and female subjects

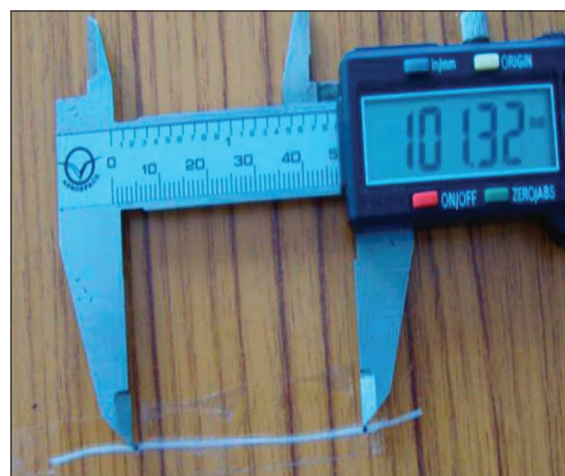


Figure 4: Intercanine width measured between the markings on the floss

coefficient of ICW using ICD and IAW is demonstrated in Table 3. The correlation matrix for ICD, IAW and ICW within men and women subjects are demonstrated in Tables 4 and 5. Multiplication factor of ICD and IAW to estimate ICW in all the subjects and in both the sexes are shown in Table 6.

DISCUSSION

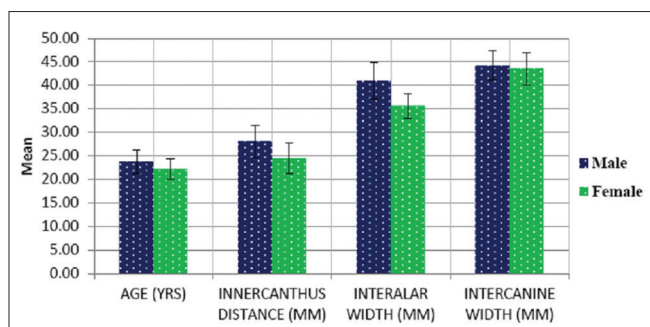
In the present study, all the three dimensions were significantly larger in men than in women. This is consistent with previously

reported studies.^[1,3-5,7,11,12,15,27,38] The mean ICD (26.22 mm) of all the subjects was smaller than the mean values reported by Abdullah *et al.*^[5] (32.0 mm), Laestadius *et al.*^[33] (30.0 mm), Freihofer^[32] (31.2 mm), Al Wazzan^[27] (31.92 mm), and Murphy and Laskin^[35] (33.9 mm). The mean ICD was found to be higher in men (28.04 mm) compared to women (24.4 mm). The measurements being recorded in the population of different countries might be the reason for the variation in the values.

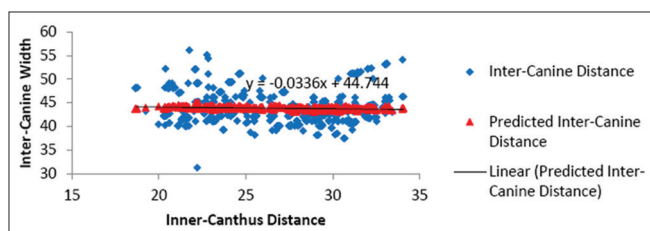
The mean IAW (38.28 mm) of subjects with a range of 24.06 mm – 48.98 mm, was smaller than the values reported by Latta *et al.*^[1] (43.93 mm with a range from 29.0 mm to 63.0 mm), Qamar *et al.*^[39] (35.46 mm) but was higher than the values reported by Smith^[4] (33.5 mm), Mavroskoufis and Ritchie^[25] (35.3 mm), Abdullah *et al.*^[5] (34.0 mm), Hoffman *et al.*^[3] (34.28 mm), Scandrett *et al.*^[2] (34.4 mm), al-el-Sheikh and al-AtheI^[7] (33.27 mm), and Ibrahimagic *et al.*^[38] (32.2 mm). The mean IAW was found to be almost similar to the values reported by Al Wazzan *et al.*^[6] (37.59 mm). The mean IAW was found to be higher in men (40.96 mm) compared to women (35.59 mm). The greater IAW seen in men reveals the influence of male dominance factor, as is also appreciable by the difference in size of jaws and teeth between the two sexes.

The mean ICW (43.86 mm) of subjects was higher than the values reported by Abdullah *et al.*^[5] (32.0 mm), Esan *et al.*^[12] (36.1 mm), Freihofer^[32] (31.2 mm), and Ibrahimagic *et al.*^[38] (37.08 mm) but was smaller than the values reported by Scandrett *et al.*^[2] (53.61 mm), Al Wazzan *et al.*^[6] (45.16 mm), al-el-Sheikh and al-AtheI^[7] (52.22 mm), Al Wazzan^[27] (45.23 mm), Qamar *et al.*^[39] (46.01 mm) and Shillingburg *et al.*^[40] (45.8 mm). The mean ICW in the present study supports the findings of Hoffman *et al.*^[3] (44.85 mm) and Abdullah *et al.*^[5] (43.0 mm). The variation in the values can be attributed to the differences in measuring techniques and in the ethnicities of the population studied. The mean ICW in men (44.19 mm) was little higher than women (43.54 mm).

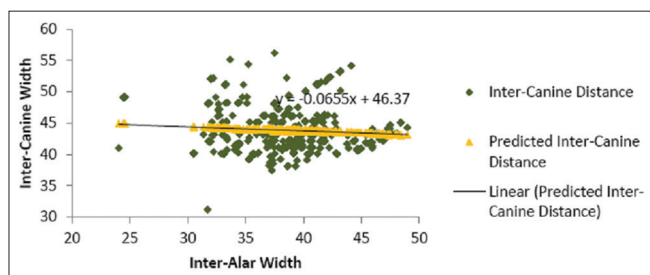
The subjects were divided into men and women groups to determine the correlation with all these dimensions. The



Graph 1: Mean of Age, innercanthal distance, interalar width and intercanine width (men and women)



Graph 2: Intercanine width prediction using innercanthal distance



Graph 3: Intercanine width prediction using interalar width

Table 1: Descriptive statistics of measurements (men and women)

Parameters	Age (years)			ICD (mm)			IAW (mm)			ICW (mm)		
	Men	Women	All	Men	Women	All	Men	Women	All	Men	Women	All
Mean	23.79	22.16	22.98	28.04	24.40	26.22	40.96	35.59	38.28	44.19	43.54	43.86
SD	2.51	2.25	2.52	3.44	3.25	3.81	3.88	2.69	4.28	3.16	3.47	3.33
Minimum	19	19	19	20.28	18.67	18.67	24.44	24.06	24.06	39.02	31.20	31.20
Maximum	30	27	30	34.08	33.25	34.08	48.98	42.23	48.98	54.12	56.13	56.13
Mean difference	1.627			3.640			5.368			0.655		
t	8.362			13.317			19.709			2.418		
P	<0.001**			<0.001**			<0.001**			<0.05*		

*Significant; **Highly significant. SD: Standard deviation, ICD: Innercanthus distance, IAW: Interalar width, ICW: Intercanine width of maxillary anterior teeth

Table 2: Correlation matrix (for all subjects) for ICD, IAW, and ICW

Correlations	ICD	IAW	ICW
ICD			
<i>r</i>	1	0.696	-0.038
<i>P</i>	-	<0.001*	0.348
IAW			
<i>r</i>	0.696	1	-0.084
<i>P</i>	<0.001*	-	0.039*
ICW			
<i>r</i>	-0.038	-0.084	1
<i>P</i>	0.348	0.039*	-

ICD: Innercanthus distance, IAW: Interalar width, ICW: Intercanine width of maxillary anterior teeth

Table 3: Regression: Predicting ICW using ICD and IAW

Predictor	β	SE (β)	<i>t</i>	<i>P</i>	95% CI for β		<i>R</i> ² (adjusted)
					Lower bound	Upper bound	
Constant	46.28	1.23	37.663	<0.001*	43.87	48.70	0.0050
ICD	0.03	0.05	0.688	0.492	-0.06	0.13	
IAW	-0.09	0.04	-1.961	0.050	-0.17	0.00	

ICD: Innercanthus distance, IAW: Interalar width, ICW: Intercanine width of maxillary anterior teeth, SE: Standard error, CI: Confidence interval

Table 4: Correlation matrix (within men subjects) for ICD, IAW, and ICW

Correlations	ICD	IAW	ICW
ICD			
<i>r</i>	1	0.579	0.080
<i>P</i>	-	<0.001*	0.168
IAW			
<i>r</i>	0.579	1	-0.229
<i>P</i>	<0.001*	-	<0.001*
ICW			
<i>r</i>	0.080	-0.229	1
<i>P</i>	0.168	<0.001*	-

ICD: Innercanthus distance, IAW: Interalar width, ICW: Intercanine width of maxillary anterior teeth

Table 5: Correlation matrix (within women subjects) for ICD, IAW, and ICW

Correlations	ICD	IAW	ICW
ICD			
<i>r</i>	1	0.579	0.080
<i>P</i>	-	<0.001*	0.168
IAW			
<i>r</i>	0.579	1	-0.229
<i>P</i>	<0.001*	-	<0.001*
ICW			
<i>r</i>	0.080	-0.229	1
<i>P</i>	0.168	<0.001*	-

ICD: Innercanthus distance, IAW: Interalar width, ICW: Intercanine width of maxillary anterior teeth

Table 6: Multiplication factor of ICD and IAW to obtain ICW

	Factor	
	ICD/ICW	IAW/ICW
Men	1.57	1.07
Women	1.78	1.22
All subjects	1.67	1.14

ICD: Innercanthus distance, IAW: Interalar width, ICW: Intercanine width of maxillary anterior teeth

results showed that the mean ICD was higher in men compared with women and the difference between them was statistically significant ($P < 0.001$). The difference between the mean IAW of men and women was highly significant ($P < 0.0001$), whereas the difference between mean ICW of men and women was not significant ($P < 0.05$).

The Pearson's correlation coefficient (r) between ICD and IAW was found to be positive and strong ($r = 0.696$) with a high statistical significance ($P < 0.001$). The correlation coefficient (r) between IAW and ICW was negative and weak ($r = -0.084$) with statistical difference ($P < 0.05$), whereas between ICD and ICW was also negative and weak with no statistical significance ($P > 0.05$). Both the predictors (ICD and IAW) were not significant predictors of ICW ($P > 0.05$). The amount of variation in ICW that could be explained by these two predictors was only 0.5% (R^2 adjusted = 0.0050).

Hoffman *et al.*^[3] found that ICW may be estimated by increasing the IAW by 31% or multiplying it by a factor of 1.31. Abdullah *et al.*^[5] estimated a multiplying factor of IAW as 1.26 and for ICD as 1.35 in a Saudi population. al-el-Sheikh and al-Athel^[7] found a significant correlation between the IAW and ICW in Arab population and recommended to increase the measured values of IAW by the statistically derived multiplying factor (1.56). In the present study, the multiplying factor of IAW was 1.14 and for ICD was 1.67 as shown in Table 6. In men, the average multiplication factor to estimate the ICW from the mean ICD was 1.57 and from IAW was 1.07. In women, the average multiplication factor to estimate the ICW from the mean ICD and IAW was 1.78, and 1.22, respectively. The existence of the factor suggests that ICD may be used as a tentative predictor for the estimation of the ICW in conditions, where IAW cannot be used due to obliteration of the nose in cleft lip patients.

The prime concerns of comfort, function and esthetics must be properly focused while treating completely edentulous patients.^[41] Failure to restore the esthetics often results in the rejection of well-constructed denture.^[42] Maxillary anterior teeth plays an important role in the esthetics of a complete denture. The size, form, and color of the teeth must be in harmony with the supporting facial structures.^[19,38,43-46] Comparing the results of previously reported studies, it is well understood that the differences rooted primarily in ethnic and morphological characteristics of different population. Keeping in mind, the great individual variations in human physiognomy and morphological parameters, the application of inaccurate standards in the selection of maxillary anterior teeth would have lead to unsatisfactory and unaesthetic results of complete denture therapy. Therefore, the results of specific relations of facial landmarks and width of anterior teeth must be perceived

as distinctive features of the investigated population. The present study was conducted in a Central Indian population to determine the correlation between facial measurements and the combined width of maxillary anterior teeth. The observations ruled out the existence of any correlation between facial measurements and the combined width of maxillary anterior teeth. Hence, it can be recommended that this method should be used as a guideline in selecting the width of anterior artificial teeth, only when combined with other methods. Additional studies are required to replicate the present findings in Indian sub-population groups, so as to confirm the relationship among the anthropometric parameters investigated.

Measurements of ICD, IAW and the combined width of the maxillary anterior teeth were made on 600 subjects. The analysis of these measurements showed a strong correlation between ICD and IAW in both the sexes. The measurements of ICD and nasal widths showed a weak relationship with maxillary ICW for males and no relationship for females. Therefore, the ICD or the IAW cannot be used as a tentative predictor for the selection of mesiodistal width of maxillary anterior teeth.

Within the limitations of the present study the following conclusions can be drawn:

- The mean values of ICD, IAW and ICW, were significantly higher for men than for the women
- The Pearson's correlation coefficient for the ICD, IAW and ICW were not statistically significant even when they were considered separately for men and women. Hence, according to this study, the ICD and IAW cannot be used as anatomical landmarks to select the size of maxillary anterior teeth in edentulous patients
- The Pearson's correlation coefficient between ICD and ICW was negative and very weak ($r = -0.038$)
- The Pearson's correlation coefficient between IAW and ICW was negative and weak ($r = -0.084$)
- The multiplying factor for ICD and IAW to calculate ICW was 1.67, and 1.14, respectively.

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