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ORIGINAL RESEARCH

Evaluation of the Current Techniques and Introduction of a Novel Approach for Estimating Maxillary Anterior Teeth Dimensions

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ABSTRACT

Introduction: Several techniques and methods have been proposed to estimate the anterior teeth dimensions in edentulous patients. However, this procedure remains challenging especially when preextraction records are not available. Therefore, the purpose of this study is to evaluate some of the existing extraoral and intraoral methods for estimation of anterior tooth dimensions and to propose a novel method for estimation of central incisor width (CIW) and length (CIL) for Saudi population.

Materials and methods: Extraoral and intraoral measurements were recorded for a total of 236 subjects. Descriptive statistical analysis and Pearson's correlation tests were performed. Association was evaluated between combined anterior teeth width (CATW) and interalar width (IAW), intercommisural width (ICoW) and interhamular notch distance (IHND) plus 10 mm. Evaluation of the linear relationship between central incisor length (CIL) with facial height (FH) and CIW with bizygomatic width (BZW) was also performed.

Results: Significant correlation was found between the CATW and ICoW and IAW (p-values <0.0001); however, no correlation was found relative to IHND plus 10 mm (p-value = 0.456). Further, no correlation was found between the FH and right CIL and BZW and right CIW (p-values = 0.255 and 0.822). The means of CIL, CIW, incisive papillae-fovea palatinae (IP-FP), and IHND were used to estimate the central incisor dimensions: CIL = FP-IP distance/4.45, CIW = IHND/4.49.

Conclusion: It was concluded that the ICoW and IAW measurements are the only predictable methods to estimate the initial reference value for CATW. A proposed intraoral approach was hypothesized for estimation of CIW and CIL for the given population.

Clinical significance: Based on the results of the study, ICoW and IAW measurements can be useful in estimating the initial reference value for CATW, while the proposed novel approach using specific palatal dimensions can be used for estimating the width and length of central incisors. These methods are crucial to obtain esthetic treatment results within the parameters of the given population.

Keywords: Central incisor dimensions, Esthetics, Saudi population, Teeth dimensions.

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INTRODUCTION

Anterior teeth dimension is the most important factor in overall facial esthetics and harmony and it becomes even more challenging while replacing teeth in a prosthesis when the patient is edentulous and preextraction records are not available.[1-4]

Many theories and formulas have been proposed in the past for the selection of anterior tooth dimension. Berry's[5] "biometric ratio method" presented dimensions of maxillary central incisor as one-sixteenth of the face width and one-twentieth of the face length. House and Loop[6] in their study on 555 dentulous subjects found that one-sixteenth of the greatest bizygomatic width (BZW) gives the width of maxillary central incisor (CIW);

however, when divided by 3.3 it gives the overall width of all the maxillary anteriors at their maximum dimensions. Sears[7] put forward "Anthropometric Cephalic Index" method in which maxillary anterior teeth width was determined by dividing either the transverse circumference of the head by 13 or BZW by 3.3 and the tooth length was considered in proportion to the face length. Pound[8] introduced the concept of measuring the distance from zygoma to zygoma, one to one and a half inches posterior to the lateral corner of the eyes. Central incisor width should be equal to BZW divided by 16 and length of central incisor (CIL) equal to length of the face divided by 16.[9] Hasanreisoglu et al[4] did not find any statistically significant difference between CIW to BZW ratio of 1:16. LaVere et al[10] suggested that the teeth selected via this method were larger as compared with the actual dimensions. Radia et al[11] could not verify this biometric ratio and recommended this technique to be used as a guide only, not absolute, and proposed a ratio for CIL and total face height as 1:18.

Studies have also used interalar width (IAW), intercommisural width (ICoW), interpupillary distance (IPD), and intercanthal distance (ICD) to predict maxillary anterior tooth width.[3,12-14] Wehner et al[15] in 1967 suggested dropping parallel lines from the ala of the nose on the occlusal rims for the estimation of the width of maxillary anterior teeth between canine tips (ICTD). However, Picard[16] showed it to be related to the distance between the distal surfaces of canines. The ICTD was found to be equal to IAW in study conducted by Mavroskoufis and Ritchie,[17] although other authors[3,18] proposed a multiplication factor. Smith[14] did not show any significant correlation between the IAW and ICTD. Interalar width was related by several authors[3,17-19] to the overall mesiodistal width of anterior teeth, although it was proposed by Al-Kaisy and Garib[2] to estimate the straight-line distance between the distal surfaces of canines in males. Qamar et al[20] showed that IAW cannot be taken as a predictor for combined maxillary anterior teeth width.

Intercommisural width has been related to the width of the maxillary anterior teeth. Kini and Angadi[21] suggested a biometric ratio of 1:1.35 for ICTD and ICoW, while Sinavarat et al[22] found relationship between the two and showed correlation to be even stronger when compared with the distance of the left and right projection lines drawn from the inner canthus of the eyes to the ala of the nose. Other authors found a weaker or no correlation between ICoW and intercanine distance among different racial groups.[13,23-26]

Al Wazzan[27] suggested biometric ratios of 1:0.267 and 1:1.426 for estimation of CIW and combined width of maxillary anterior teeth as compared with intercanthal distance (ICD). Abdullah[12] projected ICD as a reliable predictor for CIW by applying a formula (ICDx.618/2) although Deogade et al[19] put forward a multiplication factor of 1.67 for estimating the maxillary anterior teeth dimensions up to the distal surfaces of canines. Kaisy[2] and Cesario and Latta[28] found ratios of 6.93 and 1:6.6 between IPD and CIW and noticed them to differ with gender and race, although other studies have disregarded them as reliable predictors.[29] Gomes et al[30] reported that IPD, ICoW, and ICD showed highest probability of being correlated to the mesiodistal width of the teeth on cast. In addition, it was postulated that not a single method is accurate even when the population is divided based on the race, sex, and group and a combination of them should be used for selection of anterior teeth.[13,31]

Studies[32,33] have related the shape of the central incisor to the shape of the arch, while others have considered certain landmarks on the palate, as permanent landmarks will not be affected by aging.[34-36] Pterigomaxillary notches are not affected by aging, weight changes, or extraction of teeth.[34] Interhamular notch distance (IHND) has also been related in the past with the anterior teeth dimensions.[36,37] Baker et al[38] suggested IHN distance plus 10 mm for selection of maxillary anterior teeth width. However, the dimensions of the palate have never been related to the dimensions of the central incisors.

Existing data for estimating the size for anterior teeth were obtained from different ethnic groups and geographical locations and limited data are known for Saudi Arabian population. Therefore, the purpose of this study was to evaluate some of the existing extraoral methods (i.e., facial length and BZW, IAW, and ICoW) and intraoral method (i.e., IHND plus 10 mm) for estimation of anterior tooth dimensions for a given Saudi population and to propose a novel method for estimation of CIW and length for the same population.

MATERIALS AND METHODS

A total of 236 subjects (131 male and 105 female subjects) with mean age of 23 years were included in this cross-sectional clinical study, in which sampling was performed using convenient sampling approach. The subjects were patients who attended the dental clinics at Jazan University, College of Dentistry, Kingdom of Saudi Arabia, between September 1, 2015, and April 30, 2016, for regular dental care. The inclusion criteria were patients between 18 and 38 years of age, Saudi nationality, medically fit, well-aligned maxillary anterior teeth, and healthy periodontium, while subjects who have undergone orthodontic treatment, wear of anterior teeth, crowding or spacing, missing or restored anterior teeth, developmental tooth anomalies and facial deformities, extraoral or intraoral defect, and bald patients were

excluded from the study. Ethical approval was obtained from the Institutional Review Board at Jazan University College of Dentistry.

For protection of subjects, each participant signed a written informed consent, following a thorough explanation of all procedures needed for data collection. To satisfy subject's confidentiality, all data were stored in a closed cabinet following the storage protocol legislated by the college. Three examiners were trained and calibrated for accurate impression making, measurements on subjects, and their respective stone casts prior to starting the study. Intraexaminer and interexaminer reliability and reproducibility were evaluated using ICC and ICCR tests.

This study was designed to evaluate four of the existing extraoral techniques, i.e., facial height (FH), BZW, IAW, and ICoW, and one intraoral technique that utilizes the IHND plus 10 mm (Table 1). An additional intraoral technique was proposed by the authors to estimate the maxillary CIL and CIW. All the measurements were performed using a digital vernier caliper with accuracy of 0.01 mm. For FH, the measurements were done between two points placed at the hairline and slightly below the chin while patients were at the maximum intercuspation position. Bizygomatic width measurements were done between two points placed one and a half inches posterior to the lateral corner of the eyes. The FH and BZW were divided by 16 to estimate the CIL and CIW respectively. For IAW measurements, the sides of the caliper's jaw were placed at the widest dimension of nostrils, while ICoW were measured between the right and left corner of the mouth with the lip at resting position. For protection, all points were marked on clear tape (3M) placed at the required position. Upon extraoral measurements, the tips of the caliper were placed gently against the points to avoid distortion and measurement errors.

For intraoral technique, accurate maxillary irreversible hydrocolloid impressions (BMS Dental) were made in modified stock trays (ASA Dental). The trays were border molded using periphery wax sticks (Heraeus Kulzer) prior to impression making. The impressions were boxed using modeling wax (Cavex Holand BV) and poured in type IV dental stone (Royal Rock) using a vacuum mixer and a laboratory vibrator. Powder to liquid ratios for the alginate and stone materials were measured following manufacturer's instructions and stone casts were allowed to set. The casts were then separated from the alginate impressions and trimmed. Measurements were initiated with individual width and length of all maxillary anterior teeth using the caliper tips at the highest and widest dimensions of each tooth on each cast. Furthermore, the combined width of maxillary anterior teeth was measured from the distal convexity of upper right canine to the distal convexity of the contralateral canine using markings on clear celluloid strips (Medidental Corp.). The hamular notches were marked on both sides and the distance between them was measured and 10 mm was added. A novel approach was introduced by the authors to estimate the maxillary CIL and CIW. To estimate the length, the distance between the midpoint of incisive papillae (IP) and the center of a line joining both fovea palatines (FP) was measured. However, for width estimation, the distance between the hamular notches was used (Fig. 1). The authors proposed two formulae to estimate the dimensions of maxillary central incisors as following: CIW = IHND/*X*, CIL = IP-FP distance/*Y*.

The means of CIL, CIW, IP-FP, and IHND were planned to be used, following statistical analysis, to calculate the *X* and *Y* denominators as shown in the formulae. These formulae were suggested to estimate CIL and CIW in edentulous patients using IP-FP and IHN measurements. Data were entered in a Microsoft Excel Spreadsheet and descriptive statistical analysis along with Pearson correlations were conducted using SPSS 20 statistics software (SPSS Inc.) set at 5% level of significance.

Table 1: Acronyms used in the study

CIL	Central Incisor Length
CIW	Central Incisor Width
CATW	Combined Anterior Teeth width
BZW	Bizygomatic Width
FH	Facial Height
IAW	Interalar Width
ICoW	Intercommisural Width
IPD	Interpupillary Distance
ICD	Intercanthal Distance
IHND	Interhamular Notch Distance
IP	Incisive Papilla
FP	Fovea Palatinae
ICTD	Intercanine Tip Distance

Fig. 1: Maxillary cast showing measurements done for estimation of central incisor width and length

RESULTS

High level of examiner reliability was detected. The intraclass and interclass correlation coefficient values were 0.989 and 0.971 respectively. The mean, standard deviation, and range of the width, length, and width/length ratio of maxillary anterior teeth and combined anterior teeth width (CATW) for male and female subjects are presented in Table 2.

Tables 3 and 4 show means, standard deviation, and range of extraoral and intraoral measurements for both genders respectively. Pearson correlation statistical testing was performed to investigate correlation between the CATW and ICoW, IAW, and IHND plus 10 mm. Significant correlation was found between the CATW and ICoW and IAW (p-values < 0.0001); however, no correlation was found relative to IHND plus 10 mm (p-value = 0.456) (Table 5). Additional correlation testing was performed between the FH relative to the right CIL and BZW relative to the right CIW (Table 5) and no correlation was found between these parameters (p-values = 0.255 and 0.822 respectively). The authors proposed a novel approach since the evaluated FH, BZW, and intraoral methods were not in correlation with CIL, CIW, and CATW reported for the studied population. The formulae, mentioned earlier, were proposed to estimate the CIL and CIW in edentulous patients using IP-FP and IHND measurements. Following compensation in the formulae using the means of CIL, CIW, IP-FP, and IHND, the *X* value was found to be equal to 4.49, whereas *Y* value was equal to 4.45.

DISCUSSION

In the present study, IAW, ICoW, and IHND were measured and compared with the overall mesiodistal width of all the anterior teeth. A weak but significant relationship (Pearson's correlation coefficient) was found between CATW and IAW and ICoW; however, the relationship with IHND plus 10 mm was not significant. A positive but nonsignificant relationship was found between CIW and CIL when compared with the BZW and facial length respectively.

Interalar width has been reported in the past to be related with either the ICTD or distance between the distal surfaces of the canines.[15,16] Latta et al[13] found IAW to be 43.93 mm in North American population, Leong and White[39] compared East Asians and Caucasians and found an average difference of 4 mm between the two for both males (East Asian – 41 mm, Caucasian – 37 mm) and females (East Asian – 38 mm, Caucasian – 34 mm). Others found IAW to be 33.27,[39] 34,[38] 34.28,[3] 35.3,[17] 37,[37] 37.59,[24] and 41.22 mm[18] in different population settings globally.

Table 2: Mean and Standard deviation of length and width of each individual maxillary anterior tooth (mm) and combined anterior teeth width (measured with Mylar strip)

	Gender	*n*	*Width*	*Length*	*W/L ratio*
Central Incisor 8	M	131	8.70 ± 0.59 (7 to 10.27)	9.67 ± 0.83 (7.49 to 11.38)	0.90 ± 0.08 (0.72 to 1.14)
	F	105	8.56 ± 0.47 (7.32 to 9.73)	9.22 ± 0.93 (7.49 to 11.53)	0.93 ± 0.09 (0.70 to 1.20)
9	M	131	8.73 ± 0.56 (7.19 to 10.27)	9.66 ± 0.80 (7.50 to 11.37)	0.90 ± 0.08 (0.72 to 1.14)
	F	105	8.63 ± 0.52 (7.25 to 9.75)	9.21 ± 0.91 (7.12 to 11. 08)	0.94 ± 0.09 (0.71 to 1.24)
Lateral Incisor 7	M	131	6.57 ± 0.53 (5.47 to 8)	7.88 ± 0.52 (5.17 to 10.52)	0.84 ± 0.10 (0.56 to 0.10)
	F	105	6.73 ± 0.53 (5.44 to 8.44)	7.72 ± 0.73 (5.76 to 9.54)	0.87 ± 0.9 (0.66 ± 1.16)
10	M	131	6.77 ± 0.78 (6.67 to 10.52)	7.71 ± 0.96 (5.17 to 10.52)	0.89 ± 0.17 (0.56 to 0.10)
	F	105	6.87 ± 0.64 (4.83 to 9.06)	7.67 ± 0.74 (5.88 to 9.47)	0.89 ± 0.10 (0.59 to 0.13)
Canine 6	M	131	7.77 ± 0.45 (6.70 to 9.16)	8.87 ± 0.86 (6.18 to 10.76)	0.88 ± 0.08 (0.70 to 1.33)
	F	105	7.60 ± 0.46 (6.34 to 9.02)	8.28 ± 0.86 (5.58 to 10.35)	0.92 ± 0.09 (0.65 to 1.35)
11	M	131	7.76 ± 0.48 (6.53 to 9.85)	8.89 ± 0.88 (6.73 to 11.31)	0.88 ± 0.13 (0.70 to 20)
	F	105	7.55 ± 0.49 (6.36 to 9.25)	8.27 ± 0.94 (6.60 to 10.51)	0.92 ± 0.09 (0.70 to 1.17)
Combined Anterior Teeth Width	M	131	53.16 ± 2.84 (45.85 to 61.53)	-	-
	F	105	51.67 ± 2.51 (45.76 to 59.41)	-	-

Table 3: Mean, Standard deviation and Range of different extra oral technique measurements (mm)

	All (n=236)		*Females (n=105)*		*Males (n=131)*	
Variable (mm)	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*
FH	178.7 (9.41)	139.14 to 212.45	176.7 (8.31)	155.07 to 194.80	180.4(9.93)	139.14 to 212.45
BW	120.2 (13.96)	79.79 to 184.51	131.5 (8.80)	97.53 to 184.51	111.2 (10.32)	79.79 to 150.35
IAW	35.5 (3.77)	27.64 to 63.76	33.9 (2.77)	27.64 to 40.54	36.8 (3.96)	29.96 to 63.76
ICW	51.7 (6.44)	40.01 to 99.40	47.8 (3.66)	40.01 to 85.03	54.9 (6.49)	41.07 to 99.40

FH: Facial height, BW: Bizygomatic width, IAW: Interalar width, ICW: Intercommisural width

Table 4: Mean, Standard deviation and range of Intraoral technique measurements (mm)

	All (n=236)		*Females (n=105)*		*Males (n=131)*	
Variable (mm)	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*
IHND + 10	49.01(6.89)	29.99 to 62.04	47.1 (7.61)	29.99 to 60.96	50.5 (5.88)	33.90 to 62.04
IP-FP*	42.1 (3.82)	32.09 to 54.90	40.8 (3.78)	32.09 to 52.20	43.2 (3.51)	34.63 to 54.90
IHND*	38.9 (6.97)	19.99 to 52.04	37.1 (7.61)	19.99 to 50.96	40.4 (6.06)	21.20 to 52.04

*Author's novel technique, IHND+10: Interhamular notches distance plus 10, IP-FP: Incisive papilla to Fovea palatine, IHND: Interhamular notches distance

Table 5: Pearson correlation coefficient (r) and statistical significant value (P-value) between CATW, IAW, ICW, IHND+10, CIL, FH, CIW and BW

	FH		*BW*		*IAW*		*ICW*		*IHND +10*	
CATW	-		-		*r*	*P-value*	*r*	*P-value*	*r*	*P-value*
					0.269	.000*	0.300	.000*	0.049	0.456
CIL	*r*	*P-value*	-		-		-		-	
	0.074	0.255								
CIW	-		*r*	*P-value*	-		-		-	
			0.015	0.822						

*Correlation is significant if p value ≤.05; CATW: Combined anterior teeth width, IAW: Interalar width, ICW: Intercommissural width, IHND: Interhamular notch distance, CIL: Central incisor length, FH: Facial height, CIW: Central incisor width, and BW: Bizygomatic width

In our study population, IAW was found to be 35.5 mm for total sample with a range of 27.64 to 63.76 with males having higher mean IAW (36.8 mm) than females (33.9 mm). This could be specific to Saudi ethnic background. Mean IAW was seen higher in males as compared with females and this was in accordance with several populations globally.[2,19,39-41] Farkas et al[42] also compared between African, Asian and Caucasians, and found larger values of IAW for Asians and Africans. Although IAW was projected to be based on climatic variations, genetic heritage still remains the main cause.[17,39,42]

According to Al-Kaisy and Garib,[2] IAW was nearly equal to straight line distance between the distal surfaces of canines in Kurdish males only. This was in agreement with Hussain et al[29] but contradicts the results of Latta et al[13] and Sinavarat et al.[22] Hoffman et al[3] compared IAW with the anterior teeth width and they found a multiplication factor of 1.03 and 1.31 to predict ICTD in a straight line and distance between distal surfaces of canines (CATW) on a curve respectively. Gomes et al[18] found these ratios to be 8.6% less value of IAW for ICTD and an increased value of 30.5% for CATW. Mavroskoufis and Ritchie[17] suggested adding 7 mm to IAW to determine CATW up to the mesial half of canines. Some authors did not found a significant relationship between IAW and CATW.[14,20] However, for CATW, Abdullah et al[43] suggested a multiplication factor of 1.26, while Deogade et al[19] and Al-el-Sheikh and Al-Athel[40] suggested multiplication factors of 1.14 for Indian population and 1.57 for Saudi population respectively. However, in our study, this factor was found to be 1.47.

Kini and Angadi[21] suggested ICoW to be related to ICTW in a ratio of 1.35:1 when measured on a photograph. Sinavarat et al[22] also found it to be related to ICTW and intercanine distance from distal surface of canines in a straight line and suggested it to be used only as a tentative method. In this study, the mean ICoW was found to be 51.7 mm ranging from 40 to 99 mm. Significant correlation ($r = 0.30$) was found between ICoW and CATW. However, this was not in accordance with other authors who either found it to be nonsignificant or not related.[13,23,25,26] This contradiction can be related to various methodologies used for measurement of either ICoW or intercanine distance.

Width/Length (W/L) ratios of the anterior teeth are related to the anterior esthetics. Magne et al[44] found a W/L ratio of 0.78 for central incisors, while others found this ratio to be 0.85,[45] 0.72 for Asians,[46] and 0.78 for Whites.[46] Furthermore, Ahmad[47] suggested a ratio of 0.75 to 0.8 to be ideal and postulated that any ratio lesser than 0.6 would result in longer crowns whilst ratios above 0.8 would result in a much wider central incisor dimension.

In our study, it was found to be 0.91 for the given population. This ratio was found to be slightly higher than the aforementioned ratios, suggesting a slightly shorter and wider central incisor dimension. The W/L ratio for lateral incisors was found to be 0.85 in our studied population, which was also slightly higher than the ratios suggested by Tsukiyama et al[46] (0.67 for Asians and 0.73 Whites), Sterrett et al[45] (0.76 for males and 0.79 for females), and Magne et al[44] (0.73). Similarly, a ratio of 0.90 was found for canines in our studied population, whilst relatively smaller ratios were suggested by Tsukiyama et al[46] (0.67 for Asians and 0.73 for Whites), Sterrett et al[45] (0.77 for males, 0.81 for females) and Magne et al[44] (0.73).

Hamular notches are said to be stable landmarks and are not affected even after extraction of teeth. Petricevic et al[36] recommended IHND as a guide for estimating the sum of maxillary anterior teeth width. Bing et al[35] showed that incisive papilla and hamular notches are useful in the selection of the size of maxillary anterior teeth and proposed a formula adding the distance from the centre of the incisive papilla to both right and left side hamular notches and the IHND divided by 3.7. Guldag et al[37] could not find IHN distance to be a predictor factor for the combined width of maxillary anterior teeth. Johnson and Stratton[48] found CATW to be equal to IHND plus 5 mm. Baker et al[38] suggested an IHND plus 10 mm for selection of anterior teeth width; however, they related this measurement to the ICoW distance and not actual maxillary teeth width. This study could not find any significant relationship between IHND plus 10 mm and CATW, and this could be attributed to the difference in methodology used.

Central incisor width has been reported in the literature by Abdullah[12] (8.77 mm), Scandrett et al[31] (8.48 mm), Ash[49] (8.5 mm), Al-Wazzan[27] (8.48 mm), Singh and Goyal[50] (8.62 mm) and varies from ethnic groups. In our study, the mean right CIW was found to be 8.64 ± 0.55, which is similar to the dimension (8.65 mm) reported by Radia et al.[11] Central incisor width has been related in the past to BZW in the ratio of 1:16,[5,6] although this ratio was verified by Scandrett et al[31] and was not found to be a reliable predictor for determining CIW. Hasanreisoglu et al[4] found this relationship to be true only for females in Turkish population. In this study, this biometric ratio could not be confirmed and suggested that it should not be taken as a reliable predictor for CIW.

Central incisor length has been studied much less as compared with CIW. Central incisor length was reported by Radia et al[11] to be 10.28 mm, Tsukiyama et al[46] (11.93 mm), Magne et al[44] (11.69 mm), however, in our study it was found to be 9.45 mm for Saudi population. This variation could be related to different measurement techniques used in the studies and different ethnic backgrounds among studied populations. Central incisor length has been proposed to be in ratios of 1:16[9] and 1:20[5] as compared with the FH. Radia et al[11] suggested an approximate proportion of 1:18 although LaVere could not relate it to 1:16 ratio.[10]

Maxillary arch forms have been related to the shape of the central incisor. Therefore, the novel technique proposed in this study was based on the fact that the anatomic structures on the hard palate are relatively stable and could be easily measured at any given point of time. This was in accordance with the studies done by Ferrario et al,[34] Bing et al,[35] Petricevic et al,[36] Johnson and Stratton,[48] and Baker et al.[38] Authors found the divisional factors to be 4.45 with the FP-IP distance and 4.49 for the IHND for estimating the CIL and CIW respectively, for the Saudi population. These were evaluated in our study knowing that central incisor is the cornerstone of esthetics and knowing its dimensions will help to estimate all other anterior teeth either for fixed or removable rehabilitation. Also the shape of the arch is relatively close to the shape of central incisors, i.e., why we chose FP-IP to represent its length and IHND to represent its width.

Up-to-date literature has shown so many different extraoral and intraoral techniques for prediction of either the dimensions of all maxillary anterior teeth or individual tooth dimensions but the question still remains the same as which method can be generalized to all populations so that selection of teeth becomes easier for edentulous patients. Many factors might have affected the accuracy of formerly published data. These factors include the type and accuracy of instrument used for measuring specific dimensions, materials used, determination of landmarks, cast measurement, or photographic analysis or whether measurement was done on straight line or curvature. Although the numbers of subjects analyzed in the present study were small, efforts were made to standardize the measurements but still variation cannot be negated. Literature shows much less published data on Saudi Arabian population where prediction of anterior teeth dimensions was done. This study is the first and one of its kind to evaluate many extraoral and intraoral dimensions for the given population and quantified a novel method for the estimation of central incisor width and length. This will provide clinical and laboratory guidelines that will help Saudi clinicians and laboratory technicians in selecting anterior teeth size for their patients. Although the application of anterior teeth measurements in forensic dentistry has been documented extensively, future efforts are needed to establish a common national or global database to assist in individual, gender, and ancestry identification.[51-53] This objective is beyond the scope of this study and should be planned as a future research.

CONCLUSION

Within the limitations of this study, it can be concluded that the ICoW and IAW measurements are predictable to

estimate the initial reference value for CATW. However, utilizing the IHND plus 10 mm, FH and BZW measurements were found to be unpredictable for determining the CATW, CIL, and CIW respectively. Additionally, our studied population was found to have relatively shorter and wider anterior teeth in comparison to other populations. A proposed approach was hypothesized based on the data obtained from the Saudi Arabian population. Further studies to investigate the predictability of this approach to estimate the central incisor dimensions among different populations are needed.

CLINICAL SIGNIFICANCE

Based on the results of the study, ICoW and IAW measurements can be useful in estimating the initial reference value for CATW, while the proposed novel approach using specific palatal dimensions on the master cast can be used for estimating the width and length of central incisor. These methods are crucial to obtain esthetic treatment results within the parameters of the given population.

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