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Evaluation of Relation between Extraoral Facial Measurement and Mesiodistal Width of the Anterior Teeth

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ABSTRACT

Introduction: The selection of anterior teeth is essential for establishing a correct proportion for facial rhythm and pleasant looks. In the absence of a pre-extraction record, a various extraoral facial landmark can be used to determine the width of maxillary anterior teeth. Using facial measurements to determine the size of the anterior teeth no suitable universal reliable method is present.

Objective: This study was done to find the correlation between various extraoral landmarks and the width of six anterior maxillary teeth.

Methods: A total of 100 dentate subjects (64 females, 34 male) were included in this in vivo study. The various extra oral-facial landmarks such as the interpupillary distance (IPD), intercanthal distance (ICD), bizygomatic distance (BZW), internal distance (IAD), philtral width (PW) were measured with a digital vernier calliper. The combined mesiodistal width of six anterior teeth (CW) was recorded with a flexible scale. The collected data were analysed using Statistical Package for Social Sciences (SPSS) version 21, software (IBM Inc, USA).

Results: Extra oral-facial measurements and CW were higher in the males as compared to the females. Among all the extraoral facial measurement, only Bizygomatic width show significant correlation with the combined width of maxillary anterior teeth.

Conclusion: The regression equation $31.291 + 0.040 \times BZW$ can be applied to determine the width of the anterior teeth.

Key Words: Interpupillary Distance, Intercanthal Distance, Bizygomatic Width, Interlar Distance, Regression Analysis

INTRODUCTION

In this competitive world full of economically, professionally and socially sound population that is steadily cutting across the limitations and confinements, an attractive and pleasant look is becoming a sheer necessity. As we all know the human face plays a major role in highlighting human appearance in the forms of identity, personality, social identity and the individuals' self-confidence.¹

Loss of the natural teeth takes a generalised effect on the individual especially the facial appearance which in result leads to creating a psychological trauma to a person leading to poor self-esteem.² Denture esthetics is defined as 'the cosmetic effect produced by a dental prosthesis which affects the desirable beauty attractiveness, character and dignity of

the individual'.³ It becomes the goal of a prosthodontist to recreate what the ailing individual has lost with simultaneously maintaining the harmony of the facial appearance and the surrounding dento-labial relations of the anterior maxillary teeth. The selection of appropriate sized artificial anterior teeth requires both scientific knowledge and skill.

In the early work before the 19th-century tooth size was determined by the "temperamental theory", in which the dentist or practitioner determined the tooth forms based on the patients' health and appearance. This hypothesis was replaced further on by using a system in which facial form was used to determine the tooth form; it was although later on discredited. "Frush and Fischer" then introduced the Dentogenic Theory in which they used the "sex, personality, age (SPA) factor" for selecting the denture teeth.⁴ hence the early

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and late 19th century, methods mostly involved the “Trial and Errors” until the patient and dentist established a satisfaction for a particular size of a tooth.

As dentistry is evolving now a day there are numerous parameters for anterior teeth selection which involves parameters such as pre-extraction records which mainly include the photographs, extracted teeth, radiographs and stone models. In the absence of such records, it becomes a major hassle and hurdle in replacing and designing the aesthetics for a completely edentulous patient. Therefore, in such cases, we use various extra oral-facial landmarks as guides for the determination of the mesiodistal width of artificial maxillary anterior teeth.⁴

The facial proportion was defined as the comparative relation of facial elements in a profile.⁵ The size, form, and colour of the teeth must be in harmony with the surrounding oral and facial structures, the width of the teeth is considered by some to be more critical than the length.⁵ Several authors have attempted to identify normal tooth dimensions. When no pre-extraction records are available, selecting the proper anterior teeth size for edentulous patients can be difficult. Several efforts have been made to precisely quantify the selection of the anterior teeth. The golden proportion has been well known for hundreds, perhaps thousands, of years, but Ricketts has been the first orthodontist to apply it to the composition of facial hard and soft tissues. He also used the term “golden sectioning.” Applying a divider, the divine proportion is the length of the longer side in 2 linear measurements, at 1.618, and the short side is 1.^{6,7}

According to Young “it is apparent that beauty, harmony, naturalness, and individuality are major qualities” of esthetics.⁷ Esthetics is one of the primary considerations for patients seeking prosthetic treatment. The size and form of the maxillary anterior teeth are important not only to dental esthetics but also to facial esthetics. The goal is to restore the maxillary anterior teeth in harmony with the facial appearance. However, there is little scientific data in the dental literature to use as a guide for defining the proper size and shape of anterior teeth or determining normal relationships for them.⁸

We all know that facial surface anthropometry is a term used to describe the measurements for the facial features and the method of recording the positions of these facial features. The various facial measurements are substantially based on the spatial correspondence between the definable points present on the face. There have been a total of 20 landmarks and parameters which are of interest for the various medical and dental professionals. In the current era, there are three methods present to conduct the facial measurements they are— Manual anthropometry, 2D photography and 3D stereophotogrammetry. The method 3D stereo-photogrammetry uses the various laser scanners and records the images as a

3D virtual object which can be further evaluated and viewed from the various aspects.⁹ This tool has been proved as an excellent guide but with only a current drawback the cost of the equipment involved.

2D photography has been found as an alternative way to measure the landmarks as an alternative to manual anthropometry. In this method, the photographs are taken of the subject or individual with their head positioned in orientation with their Frankfurt plane horizontal to the ground. In this 2D method measurements are taken from the photograph instead of from the patient directly, but in this method locating the bony structures under the skin requires palpation. Whereas the manual anthropometry method makes the records and the measurements using sliding and spreading calliper or by using a flexible measuring tape. This technique is easily accessible and of less cost.

However, the studies have shown a lot of variations in their results and also made it clear that no single variable is accurate enough for clinical application. Extraoral landmarks of an individual have been used as a guide for anterior teeth selection.^{10,11} Correlating the anterior teeth size and the extraoral landmarks can help in achieving an aesthetically pleasing appearance.

In the prosthodontics literature, we mostly come across studies of populations outside of India, along with the apparent lack of information about the reliability of determining the width of the maxillary anterior teeth with the various extra oral-facial landmarks. There are no universally accepted parameters for the selection of the width artificial maxillary anterior teeth for the Indian population. Hence the purpose of this in vivo study was to evaluate the reliability of the various extra oral-facial landmarks such as the interpupillary distance (IPD), inner canthal distance (ICD), bizygomatic width (BZW), inter alar distance (IAD), and the philtral width (PW) with the combined mesiodistal width of the 6 anterior maxillary teeth (CW) for the selection of the width of artificial maxillary anterior teeth in the population.

MATERIALS AND METHODS

The current descriptive cross-sectional in vivo study was done in the department of prosthodontics crown and bridge, Maharishi Markendeshwar College of Dental Sciences and Research, Mullana, Ambala, Haryana, India. The subjects selected were under and postgraduate students. Approval for the study was obtained from the institutional ethical committee (IEC). Written consent was obtained from the subjects and they were explained in detail about the procedure. A total of 100 dentate subjects (male and females) were selected according to the following inclusion and exclusion criteria.

Inclusion criteria

- Dentulous subjects having permanent maxillary teeth with good alignment.
- No history of orthodontic treatment or extraction of anterior teeth.
- Patients having attained the age of 18, complete facial growth.
- No gross facial asymmetry.
- No restoration or caries in anterior teeth.

Exclusion criteria

- Artificial crowns on upper front teeth.
- Gingival inflammation or hypertrophy of maxillary anterior teeth.
- Congenital or surgical facial asymmetry defects.
- Loss of tooth structure due to caries, restorations
- History or evidence of any dental irregularities, microdontia or macrodontia and malformed teeth.
- No abnormal pupillary response and vision inability or defect.

Recording of the combined width of the maxillary anterior (CW)

Subjects were seated upright in a dental chair, having their heads supported, so they can look forward towards the horizon and the head is parallel to the floor. The maxillary impression was made using the irreversible hydrocolloid (*Coltoprint-ncr, Coltene*). The impressions were thoroughly washed under water and disinfected by spraying 1% sodium hypochlorite solution and poured with type IV dental (*Kalabhai Ultrarock*). The combined mesiodistal width of the 6 anterior maxillary teeth (CW) was measured on the dental cast with the help of a flexible millimetre scale, which was kept on the distal most of one canine to the distal-most part of other canine following the curvature of the arch on a dental model

Recording of the extra oral-facial measurements

- I. Inter pupillary width (IPD)
- II. Inter canthal distance (ICD)
- III. Bizygomatic width (BZW)
- IV. Inter Alar distance (IAD)
- V. Philtrum Width (PW)

The landmarks were measured using a digital vernier calliper (*Yuri*) having the following specifications-

- Measuring field as model: 150mm/6in, 200mm/8in, 300mm/12in
- Resolution: .01mm/.0005in
- Accuracy (DIN862): max deviation-0.02mm over 100mm, 0.03mm above*
- Measuring system: Capacitive
- Display: LCD (11mm)
- Max. Measuring Speed: 3m/s

- Power Supply: 1×AG13 or SR44 Battery, 1.5v

The IPD was measured from the centre of one pupil to the centre of the other pupil. A steel metal scale was used to mark and depict the centre of the pupil. The ICD was measured as a distance between the medial angles of the palpebral fissures of the eye. The BZW was measured between the two most prominent point on the zygomatic bone with the help of a facia face bow. The IAD was measured as the distance between the widest points on the outer surface of the alae of the nose on either side. The PW was recorded between the two most prominent parts at the base of the philtrum.

All the measurements were recorded in millimetres. Each reading of extra oral-facial measurement and CW were made 3 times and the mean was obtained.

The collected data were analysed using Statistical Package for Social Sciences (SPSS) version 21, software (IBM Inc, USA). The data so obtained were compiled, tabulated, evaluated and statistically analysed with Tukey Hsd Post Hoc and the Pearson Correlation test.

RESULTS

The **Table 1** depicted the mean and standard deviations for the extra oral-facial measurements (in millimetres) for the total population subjects (N-100). The mean and SD for IPD, ICD, BZW, IAD and PW were 52.6626 + 5.85833, 27.5151 + 2.92275, 125.0746 + 12.08289, 34.1742 + 9.54873, 14.1366 + 14.72079 respectively.

The mean of the facial measurements (IPD, ICD, BZW, IAD and PW) for males (N-64) were found to be higher as compared with the female (N-36). When male and female facial measurements were compared with the Tukey Hsd Post Hoc test, the males reported significantly higher IPD ($p = 0.012^*$), ICD ($p = 0.036^*$), BZW ($p = 0.017^*$) as compared to the female population. Although males reported higher IAD ($p = 0.222$) and PW ($p = 0.635$) it failed to reach the level of significance Table 2.

The mean and SD of combined mesiodistal width of the 6 maxillary anterior teeth (CW) for the total population, females and males were shown in **Table 3**. The males (39.5269) reported significantly higher CW ($p = 0.041^*$) as compared to female (38.7052) population.

Table 4 showed the regression equation with different facial measurement. Pearson's correlation coefficient was calculated to measure the strength of a linear relationship between facial measurements and, it was not found to be significant except for BZW which was found to be significant ($p=0.0042^*$), showing a weak positive (0.208) correlation between the variables.

DISCUSSION

The selection of anterior teeth is done to satisfy the esthetics of an individual seeking rehabilitation or a complete denture fabrication. To select artificial teeth, the dentist or clinician requires scientific knowledge as well as artistic skill. The prosthodontist has to very carefully blend the art and science with the arrangement as well as the selection of the anterior teeth.²

When a completely edentulous patient seeks treatment for rehabilitation with no pre-extraction record available, it becomes great difficult for the dentist to select the proper anterior teeth for the individual.¹² To overcome this problem a systematic approach is needed, several anatomical facial landmarks such as IPD, ICD, BZW, IAD and PW have been suggested and said to aid in the estimation and selection of the width of the maxillary anterior teeth.¹³

Various instruments can be used for recording facial measurements. Different authors used a vernier calliper, Willis Gauge, Boley Gauge in our present study we had used the digital vernier calliper to record the facial measurements and the Facebook to measure the bizygomatic width as done by Rawat et al.^{2,4,14}

A wide variety of instruments had been used to record the intraoral measurements like a piece of string or dental floss,² digital³ and non-digital vernier calliper, flexible scale. For the measurements of the CW different researchers measured the distance from the curve present between the distal aspects of the two maxillary canines at the contact points. Whereas the other researchers used the cusp tips of the canines.¹⁵ The use of the flexible scale had been used in the study conducted by Gomes et al.¹⁶ Measuring the combined width of anterior teeth had also been done by recording the individual value of each tooth.¹⁴ The type IV gypsum product used to make the dental casts due to its high strength.¹⁷

The mean for the inner canthal width in various populations was compared and reported by similar studies by Gomes et al. Lucas et al. and Ellkhawa et al. While the El-sheikh, and Kassab reported lower ICD widths compared to the present study.^{5,18-21} In a study conducted by Park et al. recording of the bizygomatic width was done by using the widest dimension of the face.²² In a study conducted by Bonakchandar-chain the Inter alar value was found to be 36.37mm similar to our study but greater inter alar width were found in the study by Dharap AS et al. 39.8 mm and smaller values reported by Hoffman et al. (34.28 mm) and Al-El-Sheikh (33.27 mm).^{23,24} ²⁵ In a study reported by Cesario et al.¹⁵ The IPD was found to be 59.16mm greater than our study whereas a study by Mishra et al. reported a similar value of IPD as of our study.²⁶ Variation found in the mean values reported can likely be due to racial variations and difference in measuring technique.

In our study extra oral-facial measurement, CW was more in male as compared to female. Higher values in males may be

due to various factors such as hereditary, robust built, hormones. These findings were also supported by Tripathi et al. Vajro & Nogueira, Smith. and Cesario & Latta.^{15,27,28}

Higher mean inner canthal widths in male compared to females was also found by Gomes et al. and Wazzan et al.^{5,12} However, a study done in the Brazilian population by Gomes et al. reported statistically insignificant difference for the mean of the ICD between the males and females.⁵

In this study the use of regression analyses was carried out among the entire facial dimension only BZW showed a significant correlation with CW. The regression method was also used by Isa et al.,²⁹ Tripathi et al. Scandrett et al. and Neda et al. in their studies.^{1,30,31} The estimated combined width of the anterior teeth was found to be less than one-third of the BZW in a study by Tripathi et al.¹ which concluded that the BZW is an important landmark for the selection of the anterior teeth. In our study the combined width of maxillary anterior teeth may be estimated from the equation $CW_{BZW} = 31.291 + 0.040 \times BZW$. Therefore the use of the regression formulas in the current study may aid in the selection of the anterior teeth for edentulous individuals, for an inexperienced dentist.

Scandrett et al. evaluated various facial parameters such as the bizygomatic distance, the inter-alar width, the inter-commissural width, the sagittal cranial diameter, the inter-buccal frenulum distance, the philtrum width, and the age as predictors for the width of the maxillary anterior teeth and the maxillary central incisors.³⁰ The investigators concluded that no single predictor is accurate enough to be used 100% for the clinical application. Therefore, more than one variable is needed for the prediction of maxillary anterior teeth width.

Similar to our study Authors Patel et al. and Sinavarat et al. also found no significant correlation between the IAD and the CW.^{32,33} In the study done by Mishra et al.,²⁶ the Pearson's correlation coefficient for the CW and the IAD was found to be weak, negative (except in Aryans), whereas it was found to be highly significant. Also, a significant correlation of value 0.05 level (two-tailed) was found for the Mongoloids. Ellakwa et al. reported a weak and insignificant correlation between IAD and CW. Latta et al. found a non-significant correlation for the BZW and IAD.^{19,34}

In our study magnitude of the correlation between facial and tooth variable was small, as if the correlation between the variables reach 1, the use for the biometric ratio can justify the prediction, by which the error will be significantly small.²⁶ The investigators concluded that no single predictor is accurate enough to be used 100% for the clinical application. Therefore, more than one variable is needed for the prediction of maxillary anterior teeth width.

The limitations of this study were that this study was conducted in a smaller population. There is a need for further investigations to be done in a larger population as well as

in different races. The use of the digital vernier calliper for measurement presents with an inability of the thinner beaks of the calliper to be inserted into tight teeth contacts, as well it had been seen that many individuals do not cooperate with the placement of the calliper to record the facial landmark. The measurements were recorded on the soft tissue landmarks and intra operator reading variations were found in the same individual due to the inconsistent pressure applied during the recording of the measurement. Such difficulties can lead to errors in the measurements.

Clinical implication: Extra oral-facial landmarks found to remain stable with time, can be used as initial guides to select the width of the anterior maxillary teeth for better aesthetic results when no pre-extraction records are available. More than one facial measurement can be used as a predictor for the selection of the anterior maxillary teeth. The BZW may serve as a reference for establishing the width of maxillary anterior teeth.

CONCLUSION

Based on the findings of the study, it can be concluded that:

1. The extra oral-facial measurements were higher in the males as compared to the females.
2. The combined width of the anterior maxillary teeth was significantly more in males than in females.
3. Only bizygomatic width showed a significant correlation with the combined width of anterior teeth.
4. The regression equation $31.291 + 0.040 \times \text{BZW}$ can be applied to determine the width of the anterior teeth.

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Authors contribution

1. Dr. Jeewan Bachan Dhinsa - Data analysis
2. Dr. Sanjeev Mittal - Investigation
3. Dr. Urvashi Sukhija - Manuscript preparation
4. Dr. Rishabh Ranjan - Statistical analysis
5. Dr. Manasvi Jamwal - Evaluation
6. Dr. Manini Monica - Editing

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Table 1: Descriptives of Extra-Oral Facial Measurements (in mm) for the Total Population

Extra oral facial measurements	N	Mean	SD
IPD	100	52.6626	5.85833
ICD	100	27.5151	2.92275
BZW	100	125.0746	12.08289
IAD	100	34.1742	9.54873
PW	100	14.1366	14.72079

Table 2: Descriptives of Extra-Oral Facial Measurements (in mm) for the Females and Males

Extra oral facial measurement	Sex	Number	Mean	SD	P value	
IPD	F	64	51.569	5.236	0.012*	Sig
	M	36	54.606	6.454		
ICD	F	64	27.057	2.904	0.036*	Sig
	M	36	28.329	2.813		
BZW	F	64	122.930	13.268	0.017*	Sig
	M	36	128.886	8.529		
IAD	F	64	33.296	11.597	0.222	NS
	M	36	35.736	3.448		
PW	F	64	13.609	13.340	0.635	NS
	M	36	15.075	17.066		

Table 3: Descriptives of CW (in mm) for the Total Population, Females and Males

	N	Mean	SD	Minimum	Maximum
Total population	100	39.029	1.8264	30.39	42.55
Females	64	38.750 ^a	1.9518	30.39	42.40
Males	36	39.526 ^b	1.4767	36.00	42.55

CW- combined width of six anterior teeth, SD- standard deviation, N- Number, Mean with different superscript letters within same column are significant

Table 4: Fitted regression model and Correlation (r) between the combined width of anterior maxillary teeth (CW) and the Facial Measurement

Range of variability	IPD N = n%	ICD N = n%	BZW N = n%	IAD N = n%	PW N = n%
Combined width of Maxillary anterior teeth	31.321 - (0.007 × IPD)	31.131 + (0.057 × ICD)	31.291 + (0.040 × BZW)	31.105 + (0.047 × IAW)	31.111 - (0.010 × IFW)
r (correlation coefficient)	-0.022	0.087	0.208	0.193	-0.081
P VALUE	0.831	0.398	0.042*	0.059	0.432