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Original Article

Dentistry Section

Assessment of Tooth Proportions in an Aesthetically Acceptable Smile

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ABSTRACT

Introduction: Aesthetic facial animation is mostly reported to be due to a close relationship between soft and hard tissue i.e. dynamic smile with appropriate tooth proportions. But variations in tooth size have been seen among various ethnic populations globally.

Aim: To evaluate the size and morphology of maxillary anterior teeth, the tooth with maximum variation both mesiodistally and cervicoincisally. Also, the tooth to tooth ratio in percentage of the mean tooth sizes in both genders in patients with aesthetically acceptable smile decided by a panel in North Indian population.

Materials and Methods: A total of 100 subjects (50 males and 50 females) were taken and a video clip of their dynamic smile was captured .The smiles were analyzed by a panel and the tooth proportions of the selected attractive smiles were evaluated in both males and females separately.

Statistical analysis: Data obtained was subjected to statistical analysis using Microsoft Excel 2007 software; test used was Unpaired t-test and also Mean ± S.D., Variance, Ratio of W/L and its ranges were calculated. Significance is assessed at 5% level of significance.

Results: The mesiodistal width and cervicoincisal length of maxillary central incisor was greater compared to lateral incisor and canine in both males and females. There was a statistically significant difference between the width/length ratio of maxillary anterior teeth between males and females.Canine and Lateral incisor showed maximum variation mesio-distally and cervico-incisally.

Conclusion: A smile is more pleasing if the visible teeth are in proper morphological proportions. Thus, it relates that teeth play a vital role in increasing the attractiveness of a smile. The mean coronal width/length ratio displayed a more square like tooth form for both males and females.

Keywords: Cervico-incisal length, Dynamic smile, Mesio-distal width

INTRODUCTION

Smile plays an important role in self-perception of an individual and is an important element of facial expression and physical attractiveness. A bright smile is associated with intelligence, empathy, extroversion and creates its own perception towards facial attractiveness [1].

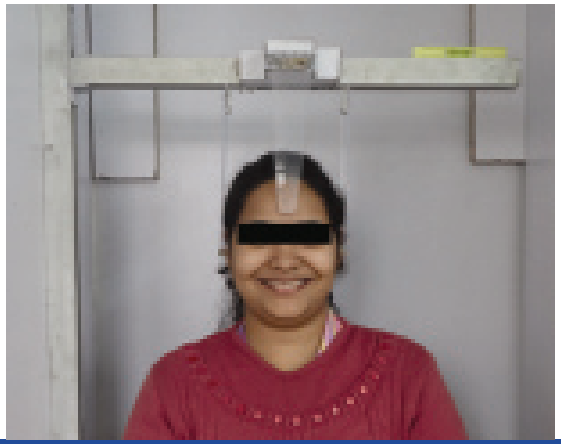
There has been a paradigm shift in analysis of smile from static to dynamic. Ackerman et al., [2] and Tarantili et al., [3] advocated the use of video recording due its distinct advantage over clinically posed photographs for accurately capturing a true representation of the smile.

Nowadays, treatment methodology has shifted the focus on soft tissue–hard tissue relationships. So, the relationship between smile and tooth proportions is important, as the anterior tooth display during dynamic facial animation has entered clinical evaluation [4]. Tooth size variations have been reported among various ethnic populations, like North American Caucasians [5], Negroes [6] etc. So, the knowledge of racial norms of tooth proportion may help to specify certain aesthetic modifications to the treatment for that particular population [7]. Therefore, owing to human variability and gender differences in tooth size proportions, a study was taken up on North Indian population with the aims of selecting a sample with aesthetically acceptable smile and evaluating its width/length ratio, tooth to tooth ratio in percentage and the tooth with maximum variation in maxillary anterior teeth region for both genders.

MATERIALS AND METHODS

A sample of 100 subjects (50 males and 50 females) from dental college in Meerut, Uttar Pradesh, India, were solicited by a written consent as prescribed and approved by ethical committee of University, Meerut, Uttar Pradesh to participate in the study. The inclusion criteria were (1) Age group between 18 to 26 y. (2) No previous history of orthodontic treatment. (3) No significant skeletal /dental asymmetry. (4) No missing or malformed teeth causing a tooth-size discrepancy. (5) No interdental spacing and crowding. (6) No retained primary or supernumerary teeth. (7) All subjects presented a complete permanent dentition with the exception of third molars. (8) No gingival alteration like gingival inflammation, hyperplasia and periodontal surgery. (9) There should be no incisal edge/proximal tooth alteration in the form of restoration, fracture, caries and attrition. The only exclusion Criteria was: Poor video clip quality (out of focus, not viewable).

Each sample was positioned in the customized cephalostat in natural head position to stabilize the head and to avoid excess motion [Table/Fig-1]. The digital video camera (Sony DHX-7V) was mounted on the adjustable tripod stand and was set at a fixed distance of 36 inches from the subject. The lens was positioned parallel to the true perpendicular of the face in natural head position, and the camera was raised to the level of the patient's lower facial third. Then, the patient was made to smile [8].

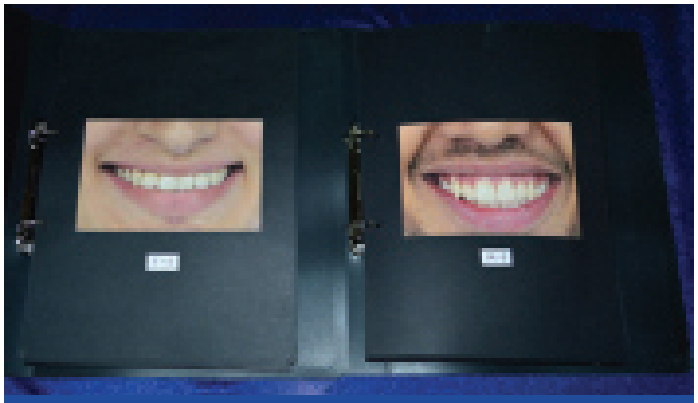


[Table/Fig-1]: Customized cephalostat to standardize photographic conditions

While capturing the dynamic smile, 5 sec video clip was recorded with video camera capturing at 30 frames/sec. The raw video clip was downloaded to a computer and imported to video editing software (Free studio video to JPG converter, V.5.0.29 build 925) for converting streaming video into individual 150 photographic frames. It was seen that every 16th frames showed a change in smile, so every 16th frame out of 150 frames were selected. Out of the selected 10

frames of each sample, the frame representing the subject's posed unstrained social smile was selected and identified as "held smile [2]. The chosen frame was imported into Picasa 3.9.0(Build 136.20, 0) to eliminate any rotations due to head positioning. In addition, the images were cropped to eliminate most of the nose, cheeks, and chin to minimize the influence of background facial attractiveness [9].

The resolution settings and computer monitor sizes affect the quality of photographs, and it causes variation in rating among the raters [10]. Therefore, to minimize the bias and to standardize the response, the photographs were edited and printed in dimensions of 4 x 6 inches, were number coded (for females it was F1, F2, F3… to F50 and for males it was M1, M2, M3…to M50), each subject's photograph was centred on a single page and finally placed in an 8.5 x 11-inch survey binder [Table/Fig-2] [11].



[Table/Fig-2]: 4 x 6 inches print of photographs in a 8 x 11 inch ring binder

The judgment for aesthetically acceptable smile was given by a panel comprising of 2 general dentists, 2 teachers and 2 artists. Serial numbers were given to the raters as R1, R2, and R3 ….to R6. The raters were instructed to evaluate the smile for aesthetic value of teeth and lip appearance and to disregard the facial blemishes as well as any variations in teeth shade, or picture quality. It was made sure that the binder was evaluated individually by each panelist to eliminate the bias. Each sample in the binder was shown for 20 seconds without being able to re-evaluate the previously seen photographs [12]. Raters gave scores to the closest aesthetically acceptable smile and categorized them as:

Score 1- Average

Score 2- Good

Score 3 - Excellent

After evaluation of the scores given by the panelist, a sample could achieve a maximum score of 18 and minimum of 6. The sample that attained a score of 9 and above were selected as a sample having the most attractive smiles.

In the selected subjects, the irreversible hydrocolloid (alginate) impression of maxillary arch were made in stock tray and poured in dental stone (Type III). To estimate the mesiodistal width and cervico-incisal length of the maxillary anterior teeth measurements were made on the casts. All measurements were recorded in millimetres on the facial surface of tooth with the help of digital verniercalliper (Aerospace) with least count of 0.01mm [5] and to evaluate the mean tooth sizes of each tooth (central incisor, lateral incisors and canine) in percentage and to compare these among each other, a formula was used which was given by Richardson [6]: $X^1/X \times 100$

Where X^1 is the mesiodistal width/cervico-incisal length of the smaller tooth and; X is the mesiodistal width/cervico-incisal length of the larger tooth. Thus, for example the ratio between the maxillary incisors is computed as follows:

$$\frac{\text{Mean mesiodistal crown dimension of maxillary lateral incisor}}{\text{Mean mesiodistal crown dimension of maxillary central incisor}} \times 100$$

STATISTICAL ANALYSIS

Data obtained was subjected to statistical analysis using Microsoft Excel 2007 software; test used was Unpaired t-test and also Mean±S.D., Variance, Ratio of W/L and its ranges were calculated. Significance is assessed at 5% level of significance.

RESULTS

The comparison between the right and left side for three maxillary anterior teeth mesiodistally and cervicoincisally in both males and females showed no significant difference using unpaired t-test. So, the single mean values were taken and used further in the study for both males and females. [Table/Fig-3] shows that when the mean mesiodistal widths of three teeth were compared for the differences between the genders, the data revealed that the maximum mesiodistal width is for central incisor in both males and females. Further unpaired t-test revealed that significant difference was present for central incisor and canine between males and females at 0.05 level of significance.

It was observed in [Table/Fig-4] that maximum cervico-incisal length was for central incisor in both males and females. Further unpaired t-test revealed that significant difference was present for central incisor, lateral incisor and canine between males and females at 0.05 level of significance.

S.No	Tooth	Male	Female	Probability of unpaired t-test
1	Central incisor	8.55±0.01	8.26±0.01	< 0.05*
2	Lateral incisor	6.70±0.00	6.62±0.01	0.3233
3	Canine	7.76±0.06	7.45±0.02	< 0.05*

[Table/Fig-3]: Mean, standard deviation and probability of unpaired t-test of mean values of central incisor, lateral incisor and canine between males and females for mesiodistal width *indicates values are statistically significant ($p < 0.05$), * All measurements are in millimetre

S.No	Tooth	Male	Female	Probability of unpaired t-test
1	Central incisor	10.00±0.00	9.03±0.04	< 0.05*
2	Lateral incisor	8.34±0.02	7.54±0.10	< 0.05*
3	Canine	9.26±0.00	8.24±0.00	< 0.05*

[Table/Fig-4]: Mean, standard deviation and probability of unpaired t-test of mean values of central incisor, lateral incisor and canine between **males** and **females** for **cervicoincisal length** *indicates values are statistically significant. ($p < 0.05$), * All measurements are in millimetre

[Table/Fig-5] expresses mean width/length of central incisor, lateral incisor and canine in ratio for males and females.

[Table/Fig-6] shows the width/length ratio in percentage for both genders and on comparison between them a statistically significant difference was seen for all the three teeth.

S.No	Tooth	MALES Ratio	FEMALES Ratio
1	Central incisor	1.06:1.25	1.03:1.13
2	Lateral incisor	0.83:1.04	1.65:1.88
3	Canine	0.86:1.03	0.93:1.03

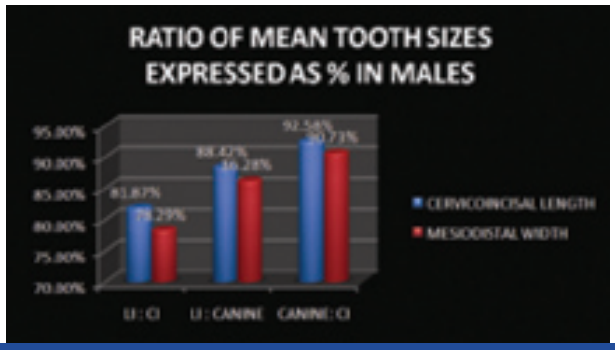
[Table/Fig-5]: Mean width/length ratios of central incisor, lateral incisor and canine for males and females

S. No	Tooth	Males Width/ length	%	Females Width/length (mm)	%	Probability of unpaired t-test
1	Central incisor	8.55/10.00	85.55	8.26/9.03	91.47	0.0009*
2	Lateral incisor	6.70/8.34	80.33	6.62/7.54	87.79	0.0001*
3	Canine	7.76/9.26	83.80	7.45/8.24	90.41	0.0009*

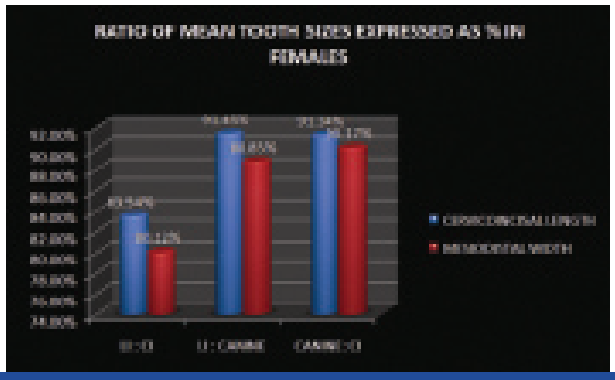
[Table/Fig-6]: Width/length ratios in percentage and the mean coronal tooth width / length ratios for both the genders. A comparison between male and female of the rating of central incisor, lateral incisor and canine showed significant difference*indicates values are statistically significant ($p < 0.05$), * All measurements are in millimeter

[Table/Fig-7] reveals that 81.87%, 88.42%, 92.58% difference was present between LI: CI, LI: canine, canine: CI respectively for cervicoincisal length; and 78.29%, 86.28%, 90.73% difference was present between LI: CI, LI: canine, canine: CI respectively for mesiodistal width in males.

[Table/Fig-8] reveals that 83.54%, 91.45%, 91.34% difference was present between LI: CI, LI: canine, canine: CI respectively for cervicoincisal length; and 80.12%, 88.85%, 90.17% difference was present between LI: CI, LI: canine, canine: CI respectively for mesiodistal width in females.



[Table/Fig-7]: Ratio of mean tooth sizes expressed as % in males



[Table/Fig-8]: Ratio of mean tooth sizes expressed as % in females

Using statistical variance it was seen that tooth with maximum variation in mesiodistal width was canine between males and females as shown in [Table/Fig-9].

Using statistical Variance it was seen that tooth with maximum variation in cervico-incisal length was lateral incisor between males and females as shown in [Table/Fig-10].

S.No	Tooth	Male Mesiodistal Width (VARIANCE)	Female Mesiodistal Width (VARIANCE)
1	Central incisor	0.0003	0.0002
2	Lateral incisor	0.0001	0.0003
3	Canine	0.0039	0.0005

[Table/Fig-9]: Variance of central incisor, lateral incisor and canine in mesiodistal width between males and females

S.No	Tooth	Male Cervico-incisal Length (VARIANCE)	Female Cervico-incisal Length (VARIANCE)
1	Central incisor	0.0000	0.0017
2	Lateral incisor	0.0009	0.0112
3	Canine	0.0001	0.0000

[Table/Fig-10]: Variance of central incisor, lateral incisor and canine in cervico-incisal length between males and females

DISCUSSION

There has been a pattern shift in capturing the maximum extent of smile from a single photographic image to its video recording depicting its dynamic nature. Also, clinician strongly preferred videography over photography [13].Therefore, in the current study a five second clip of dynamic smile was video recorded. The raw video clip was downloaded to a computer for converting streaming video into individual 150 photographic frames. Out of these, frame representing the subject's posed unstrained social smile was selected and then presented before the selected panel so as to evaluate the best smiling photographs that were further used in the study for evaluation of tooth proportions.

Many studies [14] have reported a direct relationship between an aesthetic smile and correct tooth proportions. Aesthetic is assessed by viewing the patient from the front in dynamic states, like conversation, facial expressions and smiling [15]. Also, a genetic diversity is seen in various populations due to its geographical location and historical background, giving rise to many dental and facial variations. Therefore, information regarding tooth norms in this group may prove useful to clinicians since the 7th key to occlusion is important while finishing an orthodontic case.

Therefore, the present study was taken up on Western Uttar Pradesh population to evaluate the size and morphology of the maxillary anterior teeth in aesthetically acceptable smile by a panel.

In this study, firstly the width/length ratio of maxillary anterior teeth was established for which mesiodistal width and cervico-incisal length of maxillary anterior teeth was evaluated separately as shown in [Table/Fig-3,4] respectively for both males and females.

In mesiodistal width [Table/Fig-3] showed that the mean values of males central incisor, lateral incisors and canine were 8.55 ± 0.01mm, 6.7 ± 0.01 mm and 7.76 ± 0.06 mm whereas in females the mean values were 8.26 ± 0.01mm, 6.62 ± 0.01mm and 7.45 ± 0.02 mm respectively. Therefore, it was inferred that in both males and females central incisor was the widest tooth mesiodistally followed by canine and then lateral incisor. It was also seen that males had wider teeth than females, akin to the findings of Sashi B Ekka [16], Fernandes et al., [17] and Srivastava R [18].

A statistically significant difference was observed in mesiodistal width of each tooth in both genders; Sashi B Ekka [16] conducted a study on different populations and found similar results in the African group whereas Japanese group showed contrasting results. Nikola et al., [19] stated that there was no statistical difference between men and women which was also not in agreement with our results and this disparity might be due to the racial differences between the various populations assessed.

Secondly, in Cervico-incisal length the mean values of males for central incisor, lateral incisor and canine as shown in [Table/Fig-4] were 10.00 ± 0.00mm, 8.34 ± 0.02mm and 9.26 ± 0.00mm respectively.Whereas in females the mean values were 9.03 ± 0.04mm, 7.54 ± 0.10mm and 8.24 ± 0.00mm of central incisor, lateral incisor and canine respectively. Therefore it was inferred that the central incisor was the lengthiest tooth in both males and Females cervico-incisally, followed by canine and the lateral incisor and it was also observed that males had cervico-incisally lengthier teeth than females. Both these results are in accordance with the study done by Sterret et al., [5], Ufuk Hasanreisoglu et al., [7] and in an In-Vitro study done by Eduardo et al., [20] on Asian population. A statistically significant difference was observed among maxillary anterior teeth i.e. central incisor, lateral incisor and canine ($p<0.05$) while comparing between males and females. This result was in contrast to the study done by UfukHasanreisoglu et al., [7] where he reported that there was no significant difference between males and females for lateral incisors.

Thirdly, Width/length ratio was expressed in percentage it was seen that the mean coronal tooth width/length ratios for males vs. females were central incisor (85.55% versus 91.47%), lateral incisor (80.33% versus 87.79%) and canine (83.80% versus 90.41%) as shown in [Table/Fig-6]. The crown to width /length ratio was accepted to be most stable reference, as it showed minimal variation between the genders or between teeth [21,22]. In the present study, ratios ranging

from 70.35% to 108.23% were recorded, compared to ratios ranging from 76% to 86% noted in the dental literature [5,23-25]. That is, the width /length ratios of maxillary anterior teeth in both genders were found to be greater than those suggested in previous studies [5]. So, it appears that maxillary anterior teeth of north Indian population group studied display a more square like form due to the teeth having shorter height and/or greater width than those of the other population. Also, the results of current studies revealed significant gender differences in width /height proportion of all three maxillary anterior teeth, contrasting to the findings of previous studies [5,26].

In the current study according to best of our knowledge for the first time we evaluated the width/length Ratio of each tooth in both males and females, respectively in our population which were as follows: for males: CI :: 1.06 : 1.25, LI :: 0.83 : 1.04 and Canine :: 0.86 :1.03 and females CI :: 1.03 : 1.13, LI :: 1.65 : 1.88 and Canine :: 0.93 : 1.03 as shown in [Table/Fig-5].

Fourthly, tooth to tooth ratio of mean tooth size in percentage for cervico-incisal length and mesiodistal width in both genders were also evaluated. For males, the difference between the two teeth in percentage for lateral incisor to central incisor was 81.87% and 78.29%, lateral incisor to canine 88.42% and 86.28% and canine to central incisor was 92.58% and 90.73% respectively as shown in [Table/Fig-7]. Whereas in females, on comparing lateral incisor to central incisor, lateral incisor to canine and canine to central incisor, the difference between the two teeth in percentage were found to be 83.54% and 80.12%, 91.45% and 88.85%, 91.34% and 90.17% respectively as shown in [Table/Fig-8]. No study had evaluated the tooth to tooth ratio in percentage for cervico-incisal length to the best of our knowledge. So, these results can help us in evaluating the tooth to tooth ratios not only mesiodistally and cervico-incisally but also separately in males and females in our population and can act as a guide for comparing with other populations too.

Finally, the tooth with maximum variance in mesiodistal dimension and cervico-incisal length in males and females was evaluated. It was found that the tooth with maximum variation in mesiodistal width was canine in both genders as shown in [Table/Fig-9].

This result was in disagreement with the study done by Sashi B Ekka et al., [16] in which mesiodistal width of lateral incisor was most variable in both genders. Whereas, in cervico-incisal length lateral incisor showed maximum variation in both males and females as shown in [Table/Fig-10], which was in contrast to study done by K Sridhar [27] in which canine showed maximum variation cervico-incisally.

CONCLUSION

It was seen that mesio-distally and cervico-incisally central incisor is the widest and lengthiest tooth in both males and females. Males had wider and lengthier tooth than females. The mean coronal tooth width/length ratio for males and females revealed a more square like form due to teeth having shorter height and/or greater width. Canine showed maximum variation in mesiodistal width whereas cervico-incisally lateral incisor showed maximum variation.

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