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The Determination of Teeth Size in Different Skeletal Jaw Relations by Using Anthropometric and Study Model Analysis

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Abstract

Determination of size of teeth in complete denture may be difficult when pre extraction records are not available as there is no universally acceptable method that can be used reliably. Appropriate size of teeth is important for good esthetics and functions of denture. This study is designed to find out the relationship between teeth size and different facial parameters in different skeletal jaw relations using different techniques like anthropometry and study model analysis.

Keywords: Teeth size selection, anthropometry, study model analysis.

Introduction After loss of teeth esthetically acceptable dentures should not differ from natural teeth. The selection of appropriate size of teeth is one of the most confusing and difficult aspect of denture construction. The prosthesis replacing teeth frequently look artificial because the teeth which are selected are smaller or larger than the natural teeth which they are replacing, and this is considered a problem in fabricating dentures. Therefore, the selection of artificial teeth is an important concern in denture construction. This study is designed to find out the exact ratio proportion between teeth size and different facial parameters in different skeletal jaw relations using different methodology like anthropometry and study model analysis

Materials and methods- The study sample consisted of randomly selected 150 subjects (50 subjects each of Angle's class I, class II, class III skeletal classification) aged 18 years and above. The total period of the study was 18 months. Informed consent was obtained from all subjects. The parameters studied were 1) anthropometric measurements,2) study model analysis. The tools used in the study were digital vernier calliper, modified slide calliper, rubber bowl, spatula and different sizes of perforated impression trays, alginate impression material and dental stone (Pic1). All dentate subjects with full set of natural permanent teeth (with the exclusion of third molars), class I, class II, Class III skeletal relationship with average vertical proportions and no transverse discrepancies and with no systemic bone diseases were selected for this study. The subjects had good alignment of teeth without spacing, missing, overlapping and with the absence of caries, proximal restorations, abrasion, attrition and crowns that grossly affected their width. All subjects were Indian and above 18 years of age, hence their facial growth was completed.

Anthropometric measurements direct facial measurements were obtained from each subject while he/she was sitting in upright position with his/her teeth in centric occlusion, lips relaxed and with unsupported head, looking straight forward to maintain natural head position. The measurements were carried out by using an electronic digital vernier calliper (Pic2) which measure to the nearest of 0.01 mm by keeping the callipers in contact with soft tissue points with minimum pressure. The average of 3 readings for every distance was considered as a final reading The various anthropometric measurements studied were 1)Bizygomatic width (Pic 6), 2)Inner canthal width (Pic7), 3)Intra alar width(Pic 8) ,4)Bigonial width(Pic9). Study model analysis-For study model analysis maxillary and mandibular alginate impression were taken and dental stone cast were made for each subjects.(Pic10) Measurements obtained from study model were 1)Central incisor width (Pic12),2)Intercanine width (Pic13),3)Inciso cervical width ((Pic11) 4)1st premolar to 2nd molar width (Pic15) .The data thus found were tabulated. The obtained data was studied, analyzed statistically and correlated to obtain results. Statistical method used Students "t" tests for comparisons of two averages

When sample figures are equal (n).

$$t_k = \frac{x_1 - x_2}{\sqrt{s_1^2 + s_2^2 / n}}$$

When x_1, x_2 as the two average values to be compared,

S_1 & S_2 as the respective S.D values

n = Sample Size and k = d.f. = 2n-2

pic1


pic2


pic3


pic4


pic5


pic6

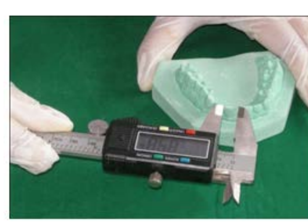

pic7


pic8


pic9


pic10


pic11


pic12


pic13

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pic14

Results and analysis

The anthropometric, study model measurements obtained from 150subjects (50 class I subjects,50 class II subjects and 50 class III subjects) were tabulated .A student t-test and Pearson correlation coefficient were used to analyse the data using SPSS statistical package. In this present study $p < 0.05$ is considered as the level of significance.

Table1. 1: Comparison between maxillary intercanine width with inner canthus width in Angle's class I subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Inner canthus width(mm)		P value
		Mean	S.D	Mean	S.D	
Male	25	38.73	1.072	23.9	0.735	<0.001
Female	25	37.34	0.720	20.9	1.655	<0.001
Total subjects	50	38.03	1.147	22.4	1.972	<0.001

Table1. 2: Comparison between maxillary intercanine width (mm) with intraalar width for Angle's class I subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Intra alar width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	38.73	1.072	34.1	1.722	<0.01
Female	25	37.34	0.720	29.7	1.568	<0.001
Total subjects	50	38.03	1.147	31.9	2.764	<0.001

Table1.3: Comparison between maxillary intercanine width (mm) with bizygomatic width for Angle's class I subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Bizygomatic width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	38.73	1.072	123.3	5.555	<0.001
Female	25	37.34	0.720	113.4	2.353	<0.001
Total subjects	50	38.03	1.147	118.4	6.535	<0.001

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Table1.4: Comparison between bizygomatic width with upper central incisor width for Angle's class I subjects:

Sex	No of subjects	Bizygomatic width (mm)		Upper Central incisor width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	123.3	5.555	8.49	0.448	<0.001
Female	25	113.4	2.535	8.42	0.437	<0.001
Total subjects	50	118.4	6.535	8.45	0.447	<0.001

Table1.5: Comparison between bigonial width with lower first premolar to second molar width in Angle's class I subjects

Sex	No of subjects	Bigonial width (mm)		Lower first premolar to second molar width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	121.9	4.727	35. 72	0.963	<0.001
Female	25	109.3	6. 274	35. 68	0.816	<0.001
Total subjects	50	115.6	8.399	35.705	0.893	<0.001

Table1.6: Comparison between upper facial height with upper central incisor length in Angle's class I subjects

Sex	No of subjects	Upper facial height(mm)		Upper central incisor length (mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	56.07	5.007	9.59	0.046	<0.001
Female	25	53.9	5.140	9.32	1.408	<0.001
Total subjects	50	55.0	5.006	9.61	1.068	<0.001

Table 2.1: Comparison between maxillary intercanine width (mm) with inner canthus width for Angle's class II subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Inner canthus width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	37. 516	1.277	22.80	4.823	<0.001
Female	25	37. 122	2.072	22.78	3.356	<0.001
Total subjects	50	37.319	1.732	22.79	4.155	<0.001

Table 2.2: Comparison between maxillary intercanine width (mm) with intraalar width for Angle's class II subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Intra alar width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	37. 516	1.277	29.3	1.806	<0.001
Female	25	37. 122	2.072	28.3	2.638	<0.001
Total subjects	50	37.319	1.732	28.8	2.315	<0.001

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Table2.3: Comparison between maxillary intercanine width (mm) with bizygomatic width for Angle's class II subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Bizygomatic width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	37. 516	1.277	110.4	2.310	<0.001
Female	25	37. 122	2.072	109.3	4.643	<0.001
Total subjects	50	37.319	1.732	109.9	3.708	<0.001

Table 2.4: Comparison between bizygomatic width with upper central incisor width for Angle's class II subjects:

Sex	No of subjects	Bizygomatic width (mm)		Upper Central incisor width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	110.4	2.350	9.304	0.416	<0.001
Female	25	109.3	4.643	8.698	0.289	<0.001
Total subjects	50	109.9	3.708	9.001	0.469	<0.001

Table2.5: Comparison between bigonial width with lower first premolar to second molar width in Angle's class II subjects

Sex	No of subjects	Bigonial width (mm)		Lower first premolar to second molar width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	103.1	5.598	36.19	1.572	<0.001
Female	25	98.0	5.839	35.14	1.307	<0.001
Total subjects	50	100.5	6.623	35.77	1.500	<0.001

Table 2.6: Comparison between upper facial height with upper central incisor length in Angle's class II subjects

Sex	No of subjects	Upper facial height(mm)		Upper central incisor length (mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	25	58.31	4.073	10.42	0.801	<0.001
Female	25	53.35	4.90	9.584	1.074	<0.001
Total subjects	50	55.93	4.834	10.002	1.317	<0.001

Table 3.1: Comparison between maxillary intercanine width (mm) with inner canthus width for Angle's class III subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Inner canthus width(mm)		Value (P)
		Mean	S.D	Mean	S.D	
Male	30	40.12	1.289	23.1	1.75	<0.001
Female	20	36.78	0.060	21.0	0.40	<0.001
Total subjects	50	38.73	1.147	22.55	1.59	<0.001

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Table3.2: Comparison between maxillary intercanine width (mm) with intraalar width for Angle's Class III subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Intra alar width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	30	40.12	1.289	34.1	1.722	<0.01
Female	20	38.78	0.060	20.9	1.568	<0.05
Total subjects	50	38.73	1.919	27.3	2.064	<0.001

Table3.3: Comparison between maxillary intercanine width (mm) with bizygomatic width for Angle's class III subjects

Sex	No of subjects	Maxillary Intercanine width(mm)		Bizygomatic width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	30	40.12	1.289	111.0	2.0	<0.001
Female	20	36.78	0.060	101.10	6.19	<0.001
Total subjects	50	38.73	1.919	106.05	5.093	<0.001

Table3.4: Comparison between bizygomatic width with upper central incisor width for Angle's class III subjects

Sex	No of subjects	Bizygomatic width (mm)		Upper Central incisor width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	30	108.6	6.196	8.59	0.404	<0.001
Female	20	101.10	2.0	8.19	0.315	<0.001
Total subjects	50	106.05	5.093	8.43	0.422	<0.001

Table3.5: Comparison between bigonial width with lower first premolar to second molar width in Angle's class III subjects

Sex	No of subjects	Bigonial width (mm)		Lower first premolar to second molar width(mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	30	108.6	6.94	37.683	0.538	<0.001
Female	20	106.0	5.50	37.10	0.045	<0.001
Total subjects	50	107.6	6.53	36.025	2.069	<0.001

Table 3.6: Comparison between upper facial height with upper central incisor length in Angle's class III subjects

Sex	No of subjects	Upper facial height(mm)		Upper central incisor length (mm)		Value(P)
		Mean	S.D	Mean	S.D	
Male	30	55.185	0.445	10.37	1.205	<0.001
Female	20	51.000	0.707	9.665	0.176	<0.001
Total subjects	50	53.889	2.632	10.01	1.018	<0.001

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Discussions-From the ancient times various guidelines have been suggested for correlation of the teeth size with different facial parameters when preextraction records are not available. However none of these parameters are conclusive. Most of these studies conducted earlier considered normal skeletal jaw relationship only. The purpose of the current study is to establish correlation between different anthropometric and study model parameters and teeth size in different skeletal jaw relationship.

The study design involved 150 subjects (50 Angle's class I malocclusion, 50 Angle's class II malocclusion, 50 Angle's class III malocclusion).Different anthropometric parameters were taken in those subjects. Study models were also made of dental stone after obtaining alginate impressions of upper and lower arch in those subjects The results of the study have been statistically analysed and interpreted.

Table 1.1 shows that the average intercanine maxillary width is 1.69 times greater than those of inner canthus width and the results are all statistically significant as indicated by their P values in class I subjects. Table 2.1 shows that the average intercanine maxillary width is 1.64 times greater than those of inner canthus width and the results are all statistically significant as indicated by their P values in class II subjects. Table 3.1 shows that the average intercanine maxillary width is 1.72 times greater than those of inner canthus width and the results are all statistically significant as indicated by their P values in class III subjects. The table 1.1, 2.1, 3.1 also show that the average intercanine maxillary width and inner canthus width are greater in male than in female. Inner canthal distance was selected for measurement in the present study for the following reasons: It has been reported to be a stable anthropometric parameter as suggested by Laestadius ND et al (1969), the reference points (namely, medial angles of the palpebral fissures of the eyes) can be identified and located easily as suggested by Abdullah M.A[1] (2002) and these reference points can be measured easily with a simple instrument. Mavroskaufis [26]and Ritchie G.M (1980) reported intercanine width (34.5mm),Puri M[30] et al (1972) reported intercanine width as 34.86mm in class I subjects. Compared to the results of the above investigators the value of intercanine width in the present study for class I subjects is slightly greater (38.03mm).The difference of value is attributed to the fact that the measurement of the intercanine width in this study has been done along the arch taking the combined mesiodistal width of the six anterior teeth in comparison to the linear measurement of the tip of the canines across the arch in a straight line in other studies. Within the limit of the present study it may be suggested that inner canthal width may be a reliable predictor of the intercanine width. It is possible that ethnic-related differences in inner canthal distance may exist. Further research is necessary to validate the outcomes of this investigation.

Table 1.2 shows that the average intercanine maxillary width is 1.19 times greater than those of intra alar width and the differences are all statistically significant as indicated by their P values in Angle's class I subjects. Table 2.2 shows that the average intercanine maxillary width is 1.29 times greater than those of intra alar width and the difference are all statistically significant as indicated by their P values in Angle's class II subjects. Table 3.2 shows that the average intercanine maxillary width is 1.42 times greater than those of intra alar width and the difference are all statistically significant as indicated by their P values in Angle's class III subjects. The table 1.2, 2.2, 3.2 also show that the average intercanine maxillary width and intra alar width are greater in male than in female.

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Mavroskafis[26] and Ritchie G.M.(1980) found a closer relationship between intra alar width and intercanine width measured in a straight line. Puri M Bhalla and Khanna V.K.[30](1972) compared the mean intraalar width (35.09mm) with intercanine distance (34.86mm). Smith B.J[41] (1975) found the mean intercanine distance and intaalar distance to be 33.00 and 34.00 mm respectively. Wehner P.J and Hickey J.C[45] (1967) also observed that the intraalar width were same as the tips of the maxillary cuspids measured in a straight line. Gomes V.L.et al [12](2009) suggested that intraalar distance, when increased by 31% of its value, can suggest the circumferential distance of the six maxillary anterior teeth. McNamara K et al (2011) suggested that the average length and width of the maxillary arch and interalar width were the anatomical landmarks that provided the strongest predictive relationship with maxillary anterior teeth. But all these studies were done over Angle's class I subjects. Compared to the results of the above investigators the value of intercanine width in this study for class I subjects is slightly greater (38.03mm) than intra alar width. The difference of value is attributed to the fact that the measurement of the intercanine width in this study has been done along the arch taking the combined mesiodistal width of the six anterior teeth in comparison to the linear measurement of the tip of the canines across the arch in a straight line in other studies. So the intercanine width can be used as a reliable predictor for determination of teeth size in different skeletal jaw relationship.

Table 1.3 shows that the average bizygomatic width is 3.11 times greater than those of maxillary intercanine width in Angle's class I subjects and the differences are all highly significant as indicated by P values. Table 2.3 shows that the average bizygomatic width is 2.94 times greater than those of maxillary intercanine width and the difference are all highly significant as indicated by P values in Angle's class II subjects. Table 3.3 shows that the average bizygomatic width for male is 2.74 times greater than those of maxillary intercanine width and the differences are all highly significant as indicated by P values in Angle's class III subjects. The table 1.3, 2.3,3.3 also show that the average maxillary intercanine width and bizygomatic width are greater in male than in female. According to Nagle RJ and Sears V.H (1962) the sum of the breadth of the upper six anterior teeth normally should measure slightly less than one third of the bizygomatic breadth. Boucher[4] (1975) stated that the greatest bizygomatic width divided by 3.3 provides the estimation of the overall width of upper six anterior teeth. Hasanreisoglu U et al (2005) suggested that bizygomatic width and interalar width may serve as references for establishing the ideal width of the maxillary anterior teeth, particularly in women.Compared with the results of the above investigators the correlation between bizygomatic width and intercanine width in the present study is consistent with the findings of the above investigators in case of Angle's class I subjects.So it can be suggested that bizygomatic width can be used as a reliable anthropometric parameter for determination of anterior teeth size in different skeletal jaw relations.

Table1.4 shows that the average bizygomatic width is 14.01 times greater than those of upper central incisor width and the difference are all highly significant as indicated by P values in Angle's class I subjects. Table 2.4 shows that the average bizygomatic width is 12.21 times greater than those of upper central incisor width and the difference are all highly significant as indicated by P values in Angle's class II subjects. Table 3.4 shows that the average bizygomatic width is 12.58 times greater than those of upper central incisor width and the difference are all highly significant as indicated by P values in Angle's class III subjects. The table 1.4, 2.4, 3.4 also suggest that

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the average width of upper central incisor and bizygomatic width are greater in male than in female. Boucher[4] (1975) stated that the greatest bizygomatic width divided by sixteen gives an approximation of the width of upper central incisor. Nagle R.J and Sears V.H[36] (1962) suggested that breadth of the upper central incisor should be about one eighteenth of the bizygomatic breadth. Rahn O.A and Heartwell C.M [16](2002) also supported the same fact. Compared to the results of the above investigators the correlation between the bizygomatic width and central incisor width are slightly less in the present study. This difference is because of the fact that there are no definite guideline for measuring the bizygomatic width clinically. So within the limitation of the present study it can be suggested that, bizygomatic width can be used as a reliable predictor to determine the width of upper central incisor.

Table 1.5 shows that the average bigonial width is 3.24 times greater than those of lower first premolar to second molar width and the difference are all highly significant as indicated by P values in Angle's class I subjects. Table 2.5 shows that the average bigonial width is 2.81 times greater than those of lower first premolar to second molar width and the differences are all highly significant as indicated by P values in Angle's class II subjects. Table 3.5 shows that the average bigonial width is 2.99 times greater than those of lower first premolar to second molar width and the differences are all highly significant as indicated by P values in Angle's class III subjects. The table 1.5,2.5,3.5 also show that the average lower first premolar to second molar and bigonial width are greater in male than in female. Within the limitation of the present study it can be suggested that bigonial width can be used as a predictor of mandibular posterior teeth (first premolar to second molar) width.

.Table 1.6 shows that the average upper facial height for male is 5.72 times greater than those of upper central incisor length and the differences are all highly significant as indicated by P values in Angle's class I subjects. Table 2.6 shows that the average upper facial height for male is 5.59 times greater than those of upper central incisor length and the difference are all highly significant as indicated by P values in Angle's class II subjects. Table 3.6 shows that the average upper facial height is 5.38 times greater than those of upper central incisor length and the differences are all highly significant as indicated by P values in Angle's class III subjects. The table 1.8, 2.8, 3.8 also show that the average upper facial height and upper central incisor length are greater in male than in female. Sterrett et al (1999) also supported the result of the present study by suggesting that the mean length of the clinical crowns of the maxillary anterior teeth of men to be significantly greater than the corresponding dimensions in women in a white population. Within the limitation of the present study the result suggests that upper facial height can be used as a reliable predictor of upper central incisor crown length.

So within the limitation of the present study it can be suggested that certain anthropometric parameters like inner canthus width, intra alar width, bizygomatic width can be used to determine the size of upper six anterior teeth (intercanine width) in different skeletal jaw relations. Bizygomatic width can also be applied for determination of size of maxillary central incisor. For determination of upper posterior teeth size (maxillary first premolar to second molar width) bigonial width can also help.

From the results of our present study a significant difference in anthropometric parameters are noticed between male and female subjects. It is shown that male have a significantly higher anthropometric measurements than female. However further study on large number of

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subjects of different races is required to obtain a more conclusive result.

Summary and conclusion- From the obtained results no definite ratio proportion could be established between teeth size and different anthropometric, cephalometric and study model parameters. Within the limitation of the present study it can be concluded that the anthropometric parameters like innercanthal distance, bizygomatic width, intraalar width had overall a significant relation to the width of the upper anterior teeth and can be a reliable predictor for estimation of the maxillary anterior teeth width. Bigonial width can be used as a reliable predictor for estimation of the width of mandibular posterior teeth irrespective of different skeletal jaw relations. However further study on large number of subjects of different races may be conducted to arrive at more conclusive result. Also new techniques should be found to standardize the anthropometric, cephalometric and study model measurements to obtain more accurate result.

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