Eur. J. Prosthodont. Rest. Dent., Vol.20, No. 2, pp 67-70
Printed in Great Britain

doi:10.1922/EJPRD_1103Lucas04

Comparison of Three Anthropometric Techniques for Tooth Selection

B.L. Lucas*, R.Bernardino-Júnior‡, I.Lopes-Júnior†, L.C. Gonçalves‡ and V.L. Gomes‡

Abstract - *The absence of a reliable method to assess the proper dimension of artificial teeth can lead to errors that reduce aesthetic outcomes of the dental treatment. Previous studies indicate facial anthropometric parameters as guides to estimate the width of the six maxillary anterior teeth. Nasal width, distance between the medialis angles of the eyes and mouth width were measured in young subjects Brazilian as well as the width of their six maxillary anterior teeth. Data were analyzed by ANOVA/Tukey's ($p \leq 0.05$). The distance between the medialis angles of the eyes is a reliable anthropometric method to indicate the width of artificial teeth similar to the natural extracted.*

KEY WORDS**:** artificial teeth, dental esthetics, prosthodontics, anthropometry.

INTRODUCTION

Tooth selection during any rehabilitation treatment is a complex procedure especially when no pre-extraction records of the patients are available [1-13]. The correct selection of artificial teeth is essential to guarantee facial aesthetics, patient acceptance and, as a consequence, success of the dental treatment [2,4,10]. Frequently, removable prosthesis cannot reproduce dental characteristics of partially or completely edentulous patient, mostly when tooth width is evaluated [14,15,16]. When the selected teeth are smaller than the natural extracted, the smile of the patient using artificial anterior teeth usually appears artificial [11-16].

The border of the upper lip is usually a reasonable guide to assess the length of anterior teeth [9-12]. However, there is no agreement regarding a protocol to select the width of those teeth[10,11,13-17]. Various anatomical parameters have been used as a guide during tooth selection for patient without pre-extraction records [1,4,10,11,13,15,17)]. The combined width of the six maxillary anterior teeth (6MAT) was associated in previous studies with the following facial structures: nasal width [7,10,15,18-20], distance between the medialis angles of the eyes [10,21,22)] and width of the mouth[7,9,10,15-16)].

The nasal width is 3% smaller than the distance between the maxillary canines in a straight line, and 30% smaller than the same dental measurement on a curve[18,19]. Due to the dimensional stability [8,21,23] of the distance between the medialis angles of the eyes, Lucas et. al[22] compared this facial measurement to the width of anterior teeth in young dentate subjects. A mathematical equation, as well as a ratio of 1.56 between this facial measurement and the combined width of the 6MAT were suggested to guide tooth selection[22]. However, commonly clinicians have a tendency to use the width of the mouth to estimate the width of those teeth, since it has also been suggested that the maxillary canines should to be placed at the corner of the mouth[9,10,14-16].

The comparison among the results of those studies is unviable due to differences either in methodology or ethnicity of the population evaluated. Photogrammetry has been commonly used as an anthropometric method to obtain accurate body measurements without soft tissue compression[10,19,22,24-28]. In order to assess the most recommended method to guide tooth selection in oral rehabilitation treatments, the values of the natural teeth were compared to the values obtained by means of the following anthropometric techniques: nasal width (NW), distance between the medialis angles of the eyes (ME) and width of the mouth (MW). Furthermore, the purpose of this study was to determine which anthropometric technique is more suitable for selecting artificial anterior replacements with dimensions similar to the natural teeth.

METHOD

The research project was accepted by the Local Ethical Committee (protocol #109/07) and 50 subjects were invited to contribute to this study (aged 17 - 33 years). Subjects were informed about all procedures and gave their consent to the investigation. The subjects were all healthy dentate Brazilians, undergraduate students, with Angle's Class I occulsion. Subjects with a previous history of craniofacial trauma, surgery or congenital anomalies, as well as those with malocclusions, missing teeth, or under orthodontic treatment were not included in the sample.

The volunteer's face was positioned at the Wavrin modified set square (Wavrin Trutype Tooth Guide, Dentist's Supply Co., New York, USA.), as described in previous studies[10,19,22,24]. Digital images were recorded and analysed using photogrammetry by means of the HL IMAGE ++2005 (Western Vision Software, L.C, East Layton, Utah, USA). The following facial structures were measured on the digital image: nasal width (NW), measured between alas of the nose; mouth width (MW), measured between the corners

* BDS, MPhil
† BDS, MSc, MPhil
‡ BDS, MSc, MPhil, PhD

Table 1. *Mean values, in millimetres, standard deviation (SD) and Student's t-test results for all facial measurements of the total sample and when divided to gender.*

Facial Measurements	*Total*	*Female*	*Male*	*P values*
ME	34.17 (3.59)	33.69 (3.46)	34.84 (3.75)	0.141
NW	40.55 (3.49)	39.00 (3.33)	42.71 (2.44)	0.000
MW	56.30 (4.00)	54.30 (3.00)	59.91 (3.60)	0.000

Table 2. *Mean values, in millimetres, and standard deviation (SD) for real dental values (6MAT) and values estimated by each anthropometric technique (NW, nasal width; FME, formulae of the medialis angles of the eyes; RME, ratio of the medialis angles of the eyes; MW, mouth width) and Tukey's test results.*

Variables	*Mean (SD)*	*Results*
NW	53.31 (4.547)	a1
FME	53.40 (1.150)	a1
6MAT	53.63 (3.502)	a1
RME	54.00 (5.627)	a1
MW	56.30 (4.155)	a2

of the mouth, on the lip vermillion; and distance between the medialis angles of the eyes (ME), measured between the palpebral fissure of the right and left eyes.

Volunteers had impressions of their teeth recorded using Silicon (Silon 2 APS, Dentsply Ind e Comercio Ltda, Petropolis, RJ, Brazil) and stone dental casts were constructed (Empresa e Indústria Gesso Mossoró SA, Rio de Janeiro, RJ, Brazil). The combined mesiodistal width of the six maxillary anterior teeth (6MAT) was measured on the dental cast by means of a flexible millimeter ruler placed on the labial surfaces of anterior teeth[9,10,11,19,22,24]. A point at the medial third of the distal surface of maxillary canines was used as reference. A trained researcher performed all measurements, on three different days and times. Correlation coefficient was used to assess the reliability of the 3 measurements. The mean value of the measurements was considered for analysis.

With the purpose of testing the NW technique[18,19] the values of the nasal width taken from digital images were increased by 31%. In order to evaluate if the position of distal surfaces of the maxillary canines matches with the corners of the mouth[9,10,14-16] mouth width was compared to the combined width of 6MAT. For the technique that uses the distance between the medialis angles of the eyes, both mathematical equation (FME) and mean ratio (RME) proposed previously[22] were evaluated. Values of ME were used as the independent variable (x) of the mathematical equation (y = 0.322x + 42.362) according to FME technique. Values of ME were also increased by 56% to test RME technique [22].

Data were submitted to descriptive statistical analysis and normality test using the **Statistical Package for Social Sciences**, version 13 (SPSS, Chicago, IL, USA) considering $p \leq 0.05$. A One-Way Analysis of Variance (ANOVA) tested the equality of four tooth selection techniques (NW, MW, FME, RME) and real values at one time by using variances. The Tukey's Test was the post hoc test performed to identify the significance of the differences.

RESULTS

The sample comprised 48 undergraduate young dentate subjects (20 females and 28 males) aged between 17-33 years (mean 21 y/o, ± 3 years). Table 1 presents mean values, standard deviation for all facial and dental measurements as well as Student's t-test results for differences according to genders. For NW and MW, female measurements were lower than the male ones. No significant differences were found between gender for ME ($p=0.141$).

The combined width of 6MAT was compared to the estimated values obtained after the application of each anthropometric technique. For this evaluation, Table 2 presents mean values, in millimeters, and standard deviation for total sample. The ANOVA and Tukey's test results are also shown on Table 2.

Significant differences were found only for the values obtained by the technique of MW. The combined width of the 6MAT measured on the dental cast with the flexible millimetre ruler was similar to the values obtained from the following three techniques: nasal width (NW), distance between the medialis angles of the eyes through the mathematical equation (FME), distance between the medialis angles of the eyes through the ratio of 1.56 (RME). The values obtained using the mathematical equation (FME) showed the lowest standard deviation and more similar values to the 6MAT.

DISCUSSION

Choosing the correct size of the six maxillary anterior teeth is essential in achieving a pleasing dental and facial aesthetics and one of the most challenging aspects of complete denture prosthodontics[1-13]. Several methods have been developed for the assessment of aesthetic features in determining artificial tooth dimensions[7,8,9-12,17,21,27]; however, none of these methods have been used consistently for tooth selection[10,11,14,16,28].

Anthropometric measurements can vary according to ethnic characteristics, as well as to age, gender and to the measuring procedure used[29]. Such differences prevent the comparison of the results among studies published throughout the last decade. It is known that Brazilian population was influenced by a combination of several ethnic groups. Due to this fact, it is not appropriate to classify these individuals within a specific ethnic group: Caucasian, Black, or Asian[10,29]. Tooth selection is still more complex with this background. This enormous variation associated both to the absence of a universally consistent method and to the production of teeth for a definite ethnic group, impedes clinicians to predict the proper width of maxillary anterior denture tooth.

The present study was conducted on young subjects, to avoid progressing physiological aging process that affects the natural dentition, changing its morphology and appearance[7-10,15]. The results obtained after evaluating 48 Brazilian subjects are in agreement with some concepts stated in dental literature, but contrast to other theories. Frequently, the information regarding the location of the canines' distal aspects in relation to the corners of the mouth may provide a guide for clinicians when restoring anterior teeth. However, in a recent study[14] this reference was found only in 8% of Egyptian and Saudi subjects while the majority of subjects showed canines in a medial position to the commissures.

Varjao and Nogueira[9] also showed that the use of the corners of the mouth for the selection of artificial teeth is generally inaccurate, especially in the Asian cohort. The authors divided the sample according to ethnic characteristics: white, mulatto, black and Asian and found, respectively, 47.020 mm, 48.120 mm, 50.330 mm and 43.100 mm for the mouth width on a curve. The mouth width in 90 North-American subjects presented a mean of 48.500 mm[7], and in edentulous patient, with the wax registration positioned inside the mouth, 53.743 mm[15]. In this study, photogrammetry presented the mouth width with a mean of 56.30 mm, which was significantly different according to gender ($p<0.001$). The female group showed smaller values, mean of 54.30 mm, when compared to the male group, mean of 59.91 mm (Table 2).

The sphincter of the lips is the orbicularis oris. It consists of circular fibres surrounding the orifice of the mouth. Some of its fibres are contained entirely within the lips while others are contributed from the dilator muscles and especially from buccinator. Contraction of orbicularis oris compresses the lips against the teeth as well as closing the oral orifice[31]. As shown on Table 2, when measuring the width of the mouth through photogrammetry, values obtained are different from combined width of maxillary canines (6MAT). Asal et.al.[14] classified the sample according to ridge relationship and found that occlusion must be considered when measuring the mouth. The sample evaluated in the present study consisted of volunteers Class I of Angle. The enormous variability from either ethnicity or methodology used turns the mouth width into an unreliable parameter to predict the width of the 6MAT, mainly when it is observed in a straight line, through photogrammetry.

A range between 29.00 mm and 63.00 mm for the nasal width (NW) was established[15], with differences to ethnicity[12] as follows: 35.28 mm for white subjects, 36.89 mm for mulatto subjects, 42.39 mm for black subjects and 37.27 mm for Asian subjects. The present study shows for NW a mean of 40.55 mm which is in agreement to the currently literature: 34.40 mm[7] , 43.97 mm[12] and 34.28 mm[18]. The female group showed a mean of 39.00 mm against 42.71 mm from male group. Significant differences according to gender ($p<0.001$) were also found in other studies[17, 20].

The nasal width (NW), when increased by 31%, can predict the combined width of the 6MAT on the dental arch[18, 19]. In this study, NW values of the total sample (44.85 mm) were multiplied by 1.31 and the estimated values (53.32 mm) were statistically similar to the combined width of the 6MAT (53.63 mm). Thus, the nasal width can be useful to clinicians for selection of proper maxillary anterior denture tooth width (Table 2). The mean distance between the medialis angles of the eyes, in the present study, was 33.69 mm for females and 34.84 for males with no significant differences ($p=0.141$). This is in agreement with other studies[10,21,22]. As published previously[22] the medialis angles of the eyes when increased by 56%, can predict the combined width of the 6MAT on the dental arch. In this study, ME values of the total sample (34.17 mm) were multiplied by 1.56 (RME) and the estimated values (54.00 mm) were statistically similar to the combined width of the 6MAT (53.63 mm). The mathematical equation published previously[22] was also tested. The ME values were the independent variable (x) of the formula ($y = 0.32x + 42.36$) and the estimated values (53.40 mm) were statistically similar to the combined width of the 6MAT (53.63 mm). Furthermore, the standard deviation obtained through this technique was the smallest. Thus, the medialis angles of the eyes can be useful to clinicians for selecting accurate anterior tooth width (Table 2). The dimensional stability[8,21,23] and similarity between genders[22] indicate that the distance between the eyes (ME) is more reliable than the nasal width (NW). Both methods require only a facial digital image of the patient for measurements[10,19,22,28]. As these anatomical landmarks are easily identified on the picture, all clinicians are able to estimate appropriate width of 6MAT. However, limitations of this study include the relatively small number of sample available, and the possible effects of ethnicity upon the results. Further studies on application of these techniques for tooth selection in other racial populations are required.

CONCLUSION

The following facial anthropometric methods for tooth selection were evaluated: nasal width, distance between the medialis angles of the eyes and mouth width. From these three anthropometric methods, only the mouth width measured through photogrammetry is not recommended to select the adequate combined width of the six maxillary anterior teeth.

ACKNOWLEDGEMENTS

The authors are grateful to CAPES (**Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Brazil)** for a student scholarship and to Miss Ana Lucas and Mr Jerry Steward for revising this paper

DISCLOSURE

The authors have no financial interest in any company or products mentioned in this article.

ADDRESS FOR CORRESPONDENCE

Department of Morphology, Biomedical Sciences Institute, Federal University of Uberlandia, Rua Pará, 1720, Bl 2E Sl 36, Umuarama Camp, Uberlandia, Minas Gerais 38405-320, Brazil. E-mail: lucas.barbara@gmail.com

REFERENCES

1. LaVere A M, Marcroft K R, Smith R C, Sarkra R J. Denture tooth selection: size matching of natural anterior tooth width with artificial denture teeth. *J Prosthet Dent*. 1992;**67**: 661-3.
2. Berry F H. Is the theory of temperaments the foundation of the study of the prosthetic art? *Dentist Mag*. 1905;**1**:405-13.
3. Baer ML, Elias SA, Reynolds MA. The use of psychological measures in predicting patient satisfaction with complete dentures. *Int J Prosthodont*. 1992;**5**:221-6.
4. House M M, Loop J L. Form and color in dental art (monograph). California: *Whittier* 1939: p.3-33.
5. Silverman SI. Physiologic factors in complete denture esthetics. *Dent Clin North Am*. 1967:115-22.
6. Shillingburg H J Jr, Kaplan M J, Grace S C. Tooth dimension- a comparative study. *J South Calif. Dent. Assoc*. 1972;**40**:830-9.
7. Scandrett F R, Kerber P E, Umrigar Z R. A clinical evaluation of techniques to determine the combined width of the maxillary anterior teeth and the maxillary central incisor. *J Prosthet Dent*. 1982;**48**:15-22.
8. Abdullah M A. Inner canthal distance and geometric progression as a predictor of maxillary central incisor width. J *Prosthet Dent*. 2002;**88**:16-20.
9. Varjao F M, Nogueira S S. Intercomissural width in 4 racial groups as a guide for the selection of maxillary anterior teeth in complete dentures. *Int J Prosthodont*. 2005;**18**:513-5.
10. Gomes VL, Gonçalves LC, do Prado CJ, Junior IL, de Lima Lucas B. Correlation between facial measurements and the mesiodistal width of the maxillary anterior teeth. *J Esthet Restor Dent*. 2006;**18**:196-205.
11. Gonçalves LC, Gomes VL, De Lima Lucas B, Monteiro SB. Correlation between the individual and the combined width of the six maxillary anterior teeth. *J Esthet Restor Dent*. 2009;**21**:182-91.
12. Varjão FM, Nogueira SS, Russi S, Arioli Filho JN. Correlation between maxillary central incisor form and face form in 4 racial groups. *Quintessence Int*. 2006;**37**:767-71.
13. Sellen P N, Phil B, Jagger D C, Harrison A. Methods used to select artificial anterior teeth for the edentulous patient: A historical overview. *Int J Prosthod*. 1999;**12**:51-58.
14. Asal S, Al-Shehri SA, Rashad HMA. Canine location in different maxillomandibular relationships in Egyptians and Saudis Rashad. *Saudi Dental J*. 2011;**23**:37–42
15. Latta G H Jr, Weaver J R, Conkin J E. The relationship between the width of the mouth, interalar width, bizygomatic width, and interpupillary distance in edentulous patients. *J Prosthet Dent*. 1991;**65**:250-4.
16. Baker PS, Morris WJ, Lefebvre CA, Price GA, Looney SW. Relationship of denture cast measurements to width of maxillary anterior teeth. *J Prosthet Dent*. 2011;**105**:44-50.
17. Zlatari D K, Kristek E, Celebi A. Analysis of width/length ratios of normal clinical crowns of the maxillary anterior dentition: correlation between dental proportions and facial measurements. *Int J Prosthodont*. 2007;**20**:313-5.
18. Hoffman W Jr, Bomberg TJ, Hatch RA . Interalar width as a guide in denture tooth selection. *J Prosthet Dent*. 1986 Feb;**55**:219-21.
19. Gomes VL, Gonçalves LC, Costa MM, Lucas Bde L. Interalar distance to estimate the combined width of the six maxillary anterior teeth in oral rehabilitation treatment. *J Esthet Restor Dent*. 2009;**21**:26-35.
20. Sülün T, Ergin U, Tuncer N. The nose shape as a predictor of maxillary central and lateral incisor width. *Quintessence Int*. 2005;**36**:603-7.
21. Al Wazzan K A. The relatioship between intercanthal dimension and the widths of maxillary anterior teeth. *J Prosthet Dent*. 2001;**86**:608-12.
22. Lucas BL, Bernardino-Júnior R, Gonçalves LC, Gomes VL. Distance between the medialis angles of the eyes as an anatomical parameter for tooth selection. *J Oral Rehabil*. 2009;**36**:840-7.
23. Laestadius ND, Aase JM, Smith DW. Normal inner canthal and outer orbital dimensions. *J Pediatr*. 1969;**74**:465-8.
24. Gomes VL, Gonçalves LC, Correia CLM, Lucas BL, Carvalho PM. Vertical dimension of the face analyzed in digital photographs. *Eur J Esthet Dent*. 2008 Winter;**3**:362-70.
25. Bishara S E; Cummins D M; Jorgensen G J; Jakobsen JR. A computer assisted photogrammetric analysis of soft tissue changes after orthodontic treatment. Part I: methodology and reliability. *Am J Orthod Dentofacial Orthop*. 1995;**107**:633-39.
26. Baudouin JY, Tiberghien G. Symmetry, averageness and feature size in the facial attractiveness of women. Acta Psychol. 2004. Nov;117:313-32. Preston J.The Golden Proportion Revised. *J. Esthet. Restor Dent*. 1993.**5**:247-51
27. Celebi A, Stipeti J, Nola P, Petricevi N, Papi M.Use of digital photographs for artificial tooth selection. *Coll Antropol*. 2004;**28**:857-63.
28. Guldag MU, Büyükkaplan US, Sentut F, Ceylan G. Relationship between pterygomaxillary notches and maxillary anterior teeth. *J Prosthodont*. 2010;**19**:231-4.
29. Farkas LG, Katic MJ, Forrest CR. Antropometric proportion indices in the craniofacial regions of 73 patients with forms of isolated coronal synostosis. *Ann Plast Surg*. 2005;**5**:495-499.
30. Johnson DR, Moore WJ. Anatomy for dental students. 3rd edition. Oxford University Press. New York. 1997. p 140.