ORIGINAL ARTICLE

ARCH FORM ANALYSES: A COMPARISON OF TWO DIFFERENT METHODS

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ABSTRACT

This study determines and compares the frequency distribution and results of two methods establishing morphology of the dental arch form. It was conducted on 250 patients visiting Lahore Medical and Dental College, Lahore. The casts were measured and photocopied, which were analyzed first by using a mathematical model as advocated by Noroozi[3] and then by superimposing orthoform templates to determine the arch forms. The dental arches were classified into square, ovoid, and tapered forms to determine and compare the frequency distributions between the two methods. The comparison between results of both methods was made by applying chi square test. Cross tabulation was done to observe the congruence of two methods on different arch forms. According to Noroozi's mathematical model, frequency distribution of ovoid, square and tapering arch forms was found to be 82%, 64%and 11.2% respectively while according to orthoform templates those were 53.2%, 9.2% and 37.6% respectively. There was a statistically significant difference between results of two methods (P < .001). The ovoid arch form was most common arch form according to both methods. There was a statistically significant difference in the results of two methods as well as their frequency distribution.

Key words: *Arch form, dental arch, measures, dental models, orthodontic*

INTRODUCTION

Arch form describes the position and relationship of the teeth to one another in all three dimensions. It can be considered a result of the underlying skeletal morphology, the surrounding soft tissues, and any additional environmental effects.[1]

Description of dental arch forms vary from geometric forms (ellipse, parabolic curve) to mathematical functions.[2,3] Clinically dentitions are expediently classified as square, round square, round and round "V" shaped arches according to previous classic studies.[4] There have been some descriptive morphological studies differentiating upsilon, elliptique, paraoblique and hyperoblique dentitions.[5]

Nevertheless, conventional methods seem lacking in mathematical evidence and are composed of subjective factors which always lead to diverse understanding because they mainly depend on personal visual examination.[1,6,7] On the other hand, many quantitative studies using mathematical evaluation involving measuring distances between certain reference points and analyzing various algebraic functions have defined 4 to 5 types of dental arch form.[8] However these methods develop voluminous data requiring complicated calibration with specific equipments.[9]

Knowledge of arch form as an anatomical parameter is of considerable reliance, especially regarding the positioning[10] and selection of anterior teeth[11] for artificial prosthesis, number and stress distribution

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pattern of dental implants and stability of any prosthesis in prosthodontics.[12,13]

Clinically, it is important that archform does not change during orthodontic treatment because occlusal stability depends on preservation of the patient's original archform.[14,15] The relapse of orthodontic treatment may occur when teeth are placed in inherently unstable positions outside the soft tissue envelope.[16] The knowledge of arch form before commencing orthodontic treatment is also important for selection of preformed arch wires.[14]

The present study was designed to find difference of results using two dissimilar methods of arch form determination. Such a comparison was not found in literature. The first method employs a mathematical method as proposed by Noroozi[3] and the second by superimposing the diagnostic orthoform templates on casts as advocated and marketed by 3M Unitek.[17]

METHODOLOGY

A cross sectional study was carried out over a period of 7 months from May 2010 to December 2010 at Lahore Medical and Dental College, Lahore. A convenient sampling technique was used on 250 subjects including 125 males and 125 females. Before proceeding, consent was obtained from the study participants.

The subjects were 16-30 years of age who had normal healthy dentition, well aligned arches with all incisors, canines, first and second premolars and molars present. Patients with malformed and malposed teeth, periodontal disease, restored anterior teeth, congenital and/or acquired maxillary defects, orthognathic/ reconstructive surgical procedures and previous orthodontic treatment were excluded.

Squarish, tapering and ovoid arch forms were determined on two hundred and fifty maxillary casts by applying two different methods (Mathematical formula proposed by Noroozi[3] and using diagnostic orthoform templates marketed by 3M Unitek.[17] The results of the two methods were compared to evaluate the difference between them. Cross tabulation was done to observe congruence of both methods on three arch forms.

The squarish, tapering and ovoid arch forms were determined by using the formula of arch width and depth suggested by Noroozi (Wc/Wm)x(Dc/Dm).[3] The arch width was bilaterally measured at two reference points with a standard unmodified vernier caliper (0-150mm by Jing Gong). All casts were photocopied with 1x1 magnification[18,19] and were used to measure arch depth. The formula was applied to find the numerical value for each arch form. Same observer took all readings at three different occasions; in case of disparity in the readings, the mean value was calculated and noted. The arch form formula was applied to the compiled data to find the arch forms.

The second method employed the Diagnostic OrthoForm™ templates marketed by 3M Unitek according to the manufacturer's instructions. The templates were superimposed on each cast photocopy to determine and note the ovoid, tapering and squarish form of the arch.[17,20]

The collected data was entered, cleaned, organized and analyzed using SPSS program version 17. Frequency distribution of different arch forms with two methods was determined. Cross tabulation was done to observe the congruence between two methods. Chi-square test of significance was applied to evaluate the difference in the results of two methods and p value of ≤ 0.05 was considered as the cut off point for statistical significance.

RESULTS

Frequency distribution of arch forms according to Noroozi's mathematical formula is shown in table 1,

TABLE 1: DISTRIBUTION OF ARCH FORMS USING NOROOZI'S MATHEMATICAL FORMULA

		Frequency	Percent
Arch form	Ovoid	206	82.4
	Square	16	6.4
	Tapering	28	11.2
	Total	250	100.0

TABLE 2: DISTRIBUTION OF ARCH FORMS USING ORTHOFORM TEMPLATES BY 3M UNITEK

		Frequency	Percent
Arch form	Ovoid	133	53.2
	Square	23	9.2
	Tapering	94	37.6
	Total	250	100.0

TABLE 3: NOROOZI, DIAGNOSTIC ORTHOFORM; CROSS TABULATION

			Diagnostic Orthoform (DO)			
			Ovoid	**Square**	**Tapering**	**Total**
Noroozi	**Ovoid**	Count	116	12	78	206
		% within DO	87.2%	52.2%	83.0%	82.4%
	Square	Count	5	0	11	16
		% within DO	3.8%	.0%	11.7%	6.4%
	Tapering	Count	12	11	5	28
		% within DO	9.0%	47.8%	5.3%	11.2%
	Total	Count	133	23	94	250
		% within DO	100.0%	100.0%	100.0%	100.0%

while that with diagnostic orthoform templates is presented in table 2. According to the results of both methods the ovoid arch form was most prevalent while squarish arch form was least prevalent. The Chi square test was used to determine the statistical difference between the results of two, the calculated p-value was <0.001 which is statistically significant. Cross tabulation was done to evaluate the congruence of two methods and the results showed that these have 87% congruence on ovoid arch form, 0% on square and 5.3 % on tapering arch form as shown in table 3.

DISCUSSION

In the present study, the results of two different methods for dental arch form analysis were compared. One, based on mathematical calculations by Noroozi and the other based on morphological evaluation by using diagnostic orthoform templates by MBT appliance system of 3M Unitek. Various arch forms and sub forms are described in literature, however; the basic arch forms; ovoid tapering and squarish were considered in this study.

Significant difference in the results ($p \leq 0.001$) and frequency distribution of arch shapes was found by using these methods. Overall, both methods revealed subjects with majority of ovoid arch forms followed by tapering and squarish respectively. Comparative analyses for discussion were done only with those studies which worked on maxillary arch forms because of huge difference in morphological behavior of mandible to maxilla.[10,21,22]

In their quest to discover a consistent method Noroozi etal. tried to find a mathematical model that could determine the arch form with only one equation because the most commonly used mathematical method, beta function was insufficient to describe an expanded dental arch approximating the square shape. Beta function describes square arch form by two equations, i.e., the hyperbolic cosine function for the six anterior teeth and the beta function for the posterior teeth.[23] Noroozi advocated that his model, would represent ovoid, tapered and square arches with high accuracy. However, they applied the model on only 23 casts of angle's class I cases. Nevertheless, mathematical models require voluminous data and time[9]. Ovoid arch form was the most frequent arch in our study, this correlates to the results shown by two earlier studies on the same population group.[10,24] However both these studies reported square arch form as second most common followed by tapering arch form. The study by Saleem[24] used Noroozi's mathematical model and the difference with present study could be because of variation in sample size. Zia[10] used subjective method for arch form determination. Here the difference might be because of large sample size as well as selection of a different method. Even though the subjective method is clinically convenient but it is not reproducible and consistent.

In a study on the morphological characteristics of Saudi sample[21] 641-paired casts were analyzed and ovoid arch form was reported to be the most common type, which relates well to the present study. However, according to the Nakatsuka study[25] the round square arches were the most frequent ones. In the study of Bong ho lee[26] square tapering arch was the most prevalent. These dissimilarities might be due to racial differences.

It is generally acknowledged that there is natural variation of arch form with race and gender[27] and no single arch form is characteristic of a specific malocclusion. Hence the customization of arch wires is always required.[28] The MBT appliance system offers three preformed arch forms that conform to the most common natural arches, providing the versatility to best match an arch form for each patient. Starting orthodontic treatment by determining an arch form, results in fewer wire bends made on chairside[17,20] contributing to greater stability in long term.

MBT appliance system is based on four parts of dental arch that is anterior curvature, intercuspid width, posterior curvature and intermolar width. The average range of intercuspid width is 6mm in the three basic arch forms of natural dentition[17,20] MBT appliance system is based on the same fact. Therefore it is suitable for orthodontic patients as it is very difficult to make adjustments from cuspid to cuspid as opposed to molar area.[17] The system calls for use of three clear plastic templates, the diagnostic orthoforms that can be placed over study model allowing to select arch form with proper intercuspid width and anterior curvature.[17] This means less chair side time and less manipulations to fit in patients original arch form.[29] These templates have also been used by Nojima et al in their study of clinical arch forms.[30]

In another study diagnostic orthoform templates were used in dental arch form analysis on plaster casts and results were compared with the arch forms obtained thru Cone beam computed technology (CBCT) images.[31] There was strong positive correlation between the values obtained in CBCT images and plaster casts, as well as the absence of significant differences between evaluations of the shape of dental arches by both methods.[31]

In the present study we found that the use of diagnostic templates is simple, clinically convenient and is quicker as compared to the mathematical calculations. This study was designed to explore the results of two arch form determining methods having different basis, in order to observe if they generate same results or not. However they both ended up with different results.

As there is a significant difference in the results of two methods as well as their frequency distribution both of these or at least one is not reliable for arch form analysis. The limitation of our study was that reliability and validity of these methods were not explored concurrently so that a superior method could be suggested. It is recommended that further studies be conducted which should take into account the reliability and validity of various arch form determining methods, so that a gold standard may be established.

CONCLUSIONS

1 According to both methods, the most common was ovoid while least common arch form was squarish.

2 Difference in frequency distribution of three arch forms by both methods was found.

3 There is a statistically significant difference (p-value <0.001) in the results of both methods.

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