

Patterns of Dental Arch Form in the Different Classes of Malocclusion

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Abstract: Objective: The aim of this study was to identify the pattern of arch form among patients with Angles Class I, II and III malocclusions. **Materials and Methods:** Sample consisted of 299 records of orthodontic patients who attended the clinic at the Faculty of Dentistry, King Abdulaziz University. The mean age was 16.3 (± 0.83) years. Patients were assigned into three groups according to their Classification; Class I, Class II and Class III. The lower arch form was assessed and categorized as ovoid, tapered, and square. **Results:** There was a significant difference in the pattern of lower arch form among the three groups ($P > 0.05$); ovoid arch form being the most prevalent among Class I and Class II cases and square was the most prevalent among Class III cases for both genders. There was a significant trend in proportion among Class I cases where the percentage of ovoid shape was higher in males while taper arch shape was higher among females. **Conclusions:** The ovoid type of preformed arch wire with different sizes is recommended in orthodontic treatment for most of Class I, II malocclusions, and the square type is recommended in the treatment of most of Class III malocclusion. With the availability of different preformed shapes and sizes of arch wires, this study highlights the importance of selection of patients' clinical arch form and customization of arch wire is usually necessary.

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1. Introduction

The epidemiological data on the prevalence of malocclusion and arch shape, length and width are important determinants in planning appropriate levels of orthodontic services. In addition, knowing the different characteristics of the dental arch form among different types of malocclusion can have an impact on orthodontic diagnosis and treatment planning, affecting the space available, post-orthodontic stability and esthetics⁽¹⁾. The term arch form refers to the overall configuration of the dental arch. Researchers made great efforts to find a universal arch form that can be used universally to fit any dental arch. Lundstrom⁽²⁾ recommended that the dental arch form should follow the outline of the supporting bone. Proffit⁽³⁾ and Brader⁽⁴⁾ emphasized that during growth, where the soft tissue envelopes (cheeks, lips and tongue) was suggested to regulate the development of the arch form. The review of literature shows diversity in adopting a reliable and definitive method in determining the shape and size of the dental arch form. Black⁽⁵⁾ described the arch form as Simi-ellipse, Bonwell⁽⁶⁾ developed the equilateral triangle with inter-condylar distance as a base and the apex lying in between the central incisors. Hawley⁽⁷⁾ on the other hand, modified this concept by using the widths of the six anterior teeth arranged in an arc of a circle and the buccal segments extending along a straight line, and it was called the Bonwell-Hawley arch form. Several authors,

preferred the Catenary curve,⁽⁸⁻¹⁰⁾ while others preferred the parabola, ellipse, Trifocal ellipse, Cubic spline and polynomials forms.⁽¹¹⁻¹⁹⁾ Some adapted a more complex concept by using the Beta Function method.^(20,24)

Due to this large number of methods and disagreement among researchers for the best-fit formulae to describe the arch form, White⁽¹⁸⁾ compared the closeness of fit of a different curve fitting formula on untreated cases, and found that no universal ideal arch form was applicable and the majority of dental arch forms were asymmetrical. However, human dental arch forms are variable and do not follow such a rigid geometric pattern. It was more logical to describe the dental arch form in simple shape forms such as ovoid, tapered or squared⁽²⁵⁻²⁷⁾ instead of the complicated mathematical formulae. Furthermore, these studies analyzed the arch form from anatomic and anthropologic perspectives to evaluate its application during orthodontic therapy or its modifications after treatment.

The aim of this study is to bear out the pattern and categorize the three types of dental arch form (Ovoid, Tapered and Square) among patients with different malocclusions, Angles Class I, II and III.

2. Materials and methods

The study was conducted using study models that were taken during routine orthodontic visits for

patients attending the Orthodontic Department at the Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia. This study was part of larger study involving the prevalence of malocclusion and dental anomalies that previously published.^(28, 29)

Study sample

The study sample consisted of 299 study models (149 males and 150 females) age ranged from 14 to 18 years for both genders. The mean age was 16.3 (± 0.83) years. The study models were selected from 1000 orthodontic records based on the following criteria: 1) All permanent teeth present, including second molars, 2) Dental arches with < 3mm of crowding, 3) The teeth are free of restorative treatment other than Class I restorations, 4) The study models are free of air bubbles or fractured teeth, 5) No previous orthodontic treatment, and 6) No malformed or ectopically erupted teeth.

Malocclusion was classified according to Angle's classification system. Patients were assigned into three groups according to their Classification; Class I, Class II and Class III. The lower dental arches were assessed and were described as ovoid, tapered and square shaped⁽²⁶⁾. Intra-examiner calibration was done by repeated examination of 10 study casts one week apart (Kapa=0.84). The study was reviewed and approved by the ethical committee,

at the Faculty of Dentistry, King Abdulaziz University.

Statistical analyses:

Chi-square test for association and for trend was used to evaluate if there is a significant difference between and within gender for different shapes of arch forms in the classes of malocclusion. Monte Carlo exact test was used instead of chi square in case of small cell frequency. Z test for comparison of two proportions was also used. Level of significance was set at $P < 0.05$. Statistical analyses were performed using the Statistical Package for Social Science (SPSS, version 16.0, Chicago, IL).

3. Results:

Classification of malocclusion:

Table 1 shows the results of the number and percentage of malocclusion classification for both males and females. The results show that 58.2% of the sample scored Angle Class I occlusion, while Class II div 1 and III scored 28.4% and 5.7% respectively, while Class II div 2-scored only 4.3%. There were significant differences between males and females in the prevalence of class I and class II, where the prevalence of class I in males was more while class II was more in females.

Table 1: Prevalence and comparison for Angle's classification for both males and females

| Angle's Classifications | Males (n=149) No. (%) | Females (n=150) No. (%) | Total (n=299) No. (%) | (p value) z test |
|-------------------------|--------------------------|----------------------------|--------------------------|---------------------|
| Class I | 104 (69.8%) | 80 (53.3%) | 174 (58.2%) | 0.003* |
| Class II Div. 1 | 30 (20.1%) | 55 (36.7%) | 85 (28.4%) | 0.002* |
| Class II Div. 2 | 5 (3.4%) | 8 (5.3%) | 13 (4.3%) | 0.400 |
| Class III | 10 (6.7%) | 7 (4.7%) | 17 (5.7%) | 0.400 |

Z test of two proportions ($p < 0.05$)

Table 2: prevalence of different types of arch forms in Class I, II and III malocclusion for males and females (lower arch).

| Sex | Type | Class I (n = 156) | | Class II (n = 124) | | Class III (n = 19) | | Total (n = 299) | | P for Class by types in each sex |
|----------------------------------|--------|----------------------|-------|-----------------------|-------|-----------------------|-------|--------------------|-------|----------------------------------|
| | | No. | % | No. | % | No. | % | No. | % | |
| Males | Ovoid | 85 | 94.4 | 34 | 69.4 | 1 | 10.0 | 120 | 80.5 | 0.000¥* |
| | Taper | 5 | 5.6 | 10 | 20.4 | 0 | 0.0 | 15 | 10.1 | |
| | Square | 0 | 0.0 | 5 | 10.2 | 9 | 90.0 | 14 | 9.4 | |
| | Total | 90 | 100.0 | 49 | 100.0 | 10 | 100.0 | 149 | 100.0 | |
| Females | Ovoid | 56 | 84.8 | 51 | 68.0 | 2 | 22.2 | 109 | 72.7 | 0.000¥* |
| | Taper | 8 | 12.1 | 20 | 26.7 | 0 | 0.0 | 28 | 18.7 | |
| | Square | 2 | 3.0 | 4 | 5.3 | 7 | 77.8 | 13 | 8.7 | |
| | Total | 66 | 100.0 | 75 | 100.0 | 9 | 100.0 | 150 | 100.0 | |
| P for types by sex in each Class | | 0.035* | | 0.515¥ | | 0.921¥ | | 0.106§ | | |

¥ Monte Carlo P * $P < 0.05$ (Significant) § Chi-square test

Chi-square test for trend

Arch form:

Table 2 shows the prevalence and percentage of the different types of arch forms for both males and females. There was a significant difference in the pattern of distribution of arch types between classes; ovoid being the most prevalent among class I and class II cases, 94.4% and 69.4% respectively, while square is the most prevalent among class III cases, 90% and 77.8% respectively for both males and females.

There is no significant difference between males and females in the distribution of arch types. However, a significant trend in proportion was observed among class I cases where the percentage of ovoid was higher in males (94.4%) compared to females (84.8%) while taper and square types were higher in females (12.1% and 3.0%, respectively) compared to males (5.6% and 0.0%, respectively).

4. Discussion:

Classifying patients' malocclusion is a very important tool in orthodontic diagnosis and treatment planning. Furthermore, the determination of the shape and size of dental arch form have considerable implications for the success orthodontic treatment. Angle⁽³⁰⁾ recognized the importance of arch form, and described the line of occlusion as the key of ideal occlusion. Later, Chuck⁽²⁵⁾ believed that determining patient's arch form and selecting the proper arch wire shape will lead to successful treatment and thus proposed a visual description of dental arch forms, namely, ovoid, round, tapered and squared. This concept initiated the concern of orthodontists to conduct several studies to find the best curve fit to describe dental arch forms, through application of linear (arch width, depth and size), geometric and mathematical models. Several studies highlighted the differences in arch form types and sizes among different racial groups. Nojima *et al.*⁽²⁶⁾ and Bishara *et al.*⁽³¹⁾ agreed on that, due to the great variability in individual arch forms, one arch form could not be used in all orthodontic cases. Raberin,⁽³²⁾ Proffit,⁽³⁾ and Brader⁽⁴⁾ believed that lower arch in a normal individual dictates the form upper arch. Moreover, it is generally accepted that no single arch form is characteristic of a specific malocclusion and customization of arch wire is always necessary. Additionally, individualization of lower arch form is widely agreed upon as a method for construction of treatment arch wire.^(18,27,31-33)

In the current study, the lower arches were used and categorized according to the three types of dental arch form (ovoid, narrow (tapered) and square) and the pattern of these three shapes of arch form observed showed dissimilar frequency level. The ovoid arch shape was the highest 80.5% for males

and (72.7%) for females, which was found to be in agreement with the results of Bulkhi and Zahran⁽³⁴⁾ where they reported (76% combined). In addition, they reported higher score for the square shape arch (14%) and tapered (10%). While in this study less square for both females and males 8.7%, 9.4% respectively, and more tapered was found, the female tapered arch shapes (18.7%) were more than in males (10.1%). Moreover, in Classes II and III, square shapes were higher in males compared to females. This trend of pattern of the arch form types confirming the previous finding on different sample of our population being ovoid having the highest pattern followed by tapered arch form⁽²⁹⁾. Nojima *et al.*⁽²⁶⁾ used a template of the three types of arch form (ovoid, tapered and square) and they found more narrow (tapered) arch form in American Caucasian while it was more square arches in Japanese. Bayome *et al.*⁽³⁵⁾ reported that the arch forms of Egyptians were narrower compared to whites. The distribution of the arch form types in Egyptians showed similar frequency of arch form types. This is not in agreement with this study. In addition, they reported that the square arch form was less frequent in white American, and that supported the findings of Nojima *et al.*⁽²⁶⁾ and Gafni *et al.*⁽³⁶⁾ where white American showed more tapered arches. Conversely, to this study, Tajek *et al.*⁽³⁷⁾ in a similar study of arch forms among different Angle classifications in Pakistan, reporting that Tapered arch forms with (49.2%) were more prevalent than ovoid (29.2%) and square (21.2%) type arch forms. This high percentage of tapered arch form coincided relatively with finding of Nojima and Felton *et al.* for White American (44% and 50%) respectively, and against for the Japanese with (12%).

In Saudi Arabia, the research with regard the common types of malocclusions, shapes and sizes of arch form is still lacking. Therefore, this report may provide an understanding of the relationship between different arch forms for different classes of malocclusions. The description of the shape of arch form employing visual method is a simple method, but a computer method obviously is more accurate. One limitation of this study is that study casts were collected from one center. This can be improve by including more dental centres and homogenizing the study population and with the aid of computerized Three-dimensional scanning to further explore the types of arch form shapes within each class of malocclusion.

Conclusions:

1. Class I is more common than Class II and III in both genders. Class II is more frequent in females.

2. Ovoid arch shape is more frequent in males, and Tapered shape in females
3. The pattern of arch form shapes in this study sample appears to be different from that reported previously in Riyadh, Saudi Arabia with respect to Class II and III.
4. Orthodontists should consider ethnic background when selecting pre-formed arch wires.
5. Based on the results of this study, it could be reasonable to recommend using the ovoid type of preformed arch wire with different sizes in orthodontic treatment in the majority of cases.

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