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The morphological variation of mandibular arch among different classes of malocclusions in Jordanian adolescent population: A preorthodontic prospective study

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Abstract
Purpose: To determine the variations in mandibular arch morphology among different Angles' Classes of malocclusion using canine width to depth ratios.
Material and methods: Canine width and depth linear measurements were performed on 93 study models to determine the arch form. Canine width to depth rations were calculated and compare with occlusal patterns and between genders.
Results: The most common class was Class I (54.8%), more females (p<0.05) had Class I and II than males.
Females significantly (p<0.05) recorded higher canine width: depth ratios, they had tapered and ovoid arch forms (p<0.05), opposite to males who had square arches (p<0.05).
In females, tapered and ovoid forms predominated in Classes I and II arches. However, square form was recorded in males with Class III relations.
Conclusion: The most common arch form in Class I was the ovoid, tapered form in Class II, and square form in Class III subjects.

Keywords: Arch form, angle's classification, malocclusion, mandibular arch, orthodontics

1. Introduction
One of the important objectives of orthodontics is to achieve esthetic and functional arch form [1]. The identification of a suitable arch form can be achieved and used in the treatment of each case [2]. The configuration of the bony ridge that forms the curving shape defines the dental arch form [3].
Different methods have been developed to describe the dental arch morphology ranging from simple classification of arch shape [4], through combinations of linear dimensions [5], to complex mathematical equations [6]. In 1932, Chuck [7] classified the arch forms as tapered, ovoid and square for the first time. In addition, Paranhos *et al*., expressed these arch forms as narrow, normal and wide [4].
It has been recognized that Angle's classes of malocclusion is of high variability in the shape and size of arch form [8-14]. In addition, the width, length and depth of dental arches have had considerable implications in modern orthodontic diagnosis and treatment planning so as to achieve early diagnosis of oral disease and aids in the prevention of its occurance [15-17]. Several researchers studied the mandibular arch [12, 15, 18], while some others studied the maxillary arch [9, 10, 19], however, many others studied both arches [3, 6-8, 10, 11, 13, 16, 17, 19-22].
A previous study investigated the differences in the maxillary arch forms in various types of Angle's classes was published before [23], therefore, the present study was conducted to investigate theses differences in the mandibular arch forms so that both arches would be investigated in order to obtain baseline information on the morphological arch dimensions of the fully dentate adolescent population, in order to serve as a database and reference study for future comparisons as these variations highly influence orthodontic rehabilitation of patients.
This study aimed to determine the variations of clinical mandibular arch forms in different Angles classes in the Jordanian adolescents and to investigate the gender effect on the arch

dimension parameters. Therefore, it was hypothysed that different types of Angle's classes would not be affected by the morphology and dimensions of the mandibular arch.

2. Material and Methods

A cross-sectional study included Jordanian adolescent males and females who are fully dentate with different arch skeletal patterns, in the City of Amman who attended the Department of Orthodontics, Farah Rehabilitation Center, King Hussein Medical Center, Royal Medical Services. The study sample was selected from patients who seek orthodontic treatment, accept to participate and included in accordance with specific inclusion criteria.

2.1. Ethical approval and consent

The study was approved by the Head of the Orthodontic section/Department of Dentistry and The Human Research Ethics Committee (No.2/2020 dated 6th January 2020) at the Royal Medical Services. Each patient was required to provide verbal acceptance and signed a written informed consent of his/her participation in the study.

2.2. Inclusion/exclusion criteria

Adolescent subjects who accepted to participate were fully dentate with no dental anomaly or history of congenital abnormality, those who were not exposed to any orthognathic surgical procedure, no extensive restorative procedure and no missing tooth/teeth; and accepted to undergo clinical oral and dental examination, were able to understand and agreed with procedures carried out and used in the study and who accepted the protocol and provided informed consent were included. Exclusion criteria included those with history of missing teeth, fixed or removable prostheses, in addition to those who did not agree to participate.

2.3. Participants

A total of 93 (57 females and 36 males) adolescent Jordanian subjects were clinically examined and divided according to Angle's classifications (Class I, II and III) into three groups. All recruited patients were clinically examined and provided information regarding their age, gender, occupation, medical insurance number, and residence.

2.4 Measurements

Irreversible hydrocolloid (alginate) material was used to take an impression of the mandibular arch for each participant, and dental stone was poured to fabricate a model cast (positive replica). The cast was then marked with two reference points (with a 2H pencil), at the canine tips, these points were used to perform to measure the inter-canine width and to determine the Canine depth (CD) linear distance measurement, which is defined as the shortest linear distance measured from a line connecting the canines to the mid mesio-incisal point between the central incisors [Figure 1].

Measurements were performed using an electronic digital caliper "Fowler" (EuroCal IV Electronic Caliper Co., LTD., Berlin, Germany) with a measuring accuracy of ±0.01mm.

The arch form was determined according to Park *et al*., [24]. method in accordance to the values obtained from the measurements. When this canine width: depth ratio is less than 6, it can be assumed that the arch form is tapered. If the depth is between 6 and 8, then the arch form can be considered as ovoid, however, if the depth is more than 8, the arch form can be considered as square. [Figure 2]. After the arch form was determined, it was then related to the occlusal pattern of each patient.

2.5. Statistical analysis: The SPSS (Version 17) statistical package (SPSS Corporation, Chicago, IL, USA) was performed to analyze data. The means of dimension measured on the casts were compared using Student's t-test and between genders using chi square test. One-way ANOVA table was constructed for the comparisons between different arch forms and the skeletal patterns. Level of significance was set at 0.05.

3. Results

The mean age of subjects was 15.2±1.33 (ranged between 13 and 17) years, of these, there were 36 (38.7%) males with mean age 15.8±1.09 and 57 (61.3%) females with a mean age of 14.8±1.34. In the two groups, the age ranged between 13 and 17 years. Females were insignificantly younger than males (t-test=0.47; p=0.95).

The most common class was Class I (54.8%), followed by Class II (37.6%) and Class III (7.5%). Significantly, females had more Class I and Class II ($p<0.05$) occlusal relationship than males. However, males significant ($p<0.01$) had more Class III relation compared with females [Table I].

Table II shows differences in the mean values in depth and width measurements between different class groups. Statistically significant differences were recorded in arch depth ($p<0.05$), width measurements ($p<0.01$) and in width: depth ratios ($p<0.01$). Class III arches were significantly wider than Class I, however, Class II arches were significantly the narrowest ($p<0.01$). Class II arches were significantly longer than Class I arches, however, Class III arches were significantly the shortest ($p<0.05$).

Table III shows the gender differences in the mean canine width and depth measurements and width: depth ratios. Males significantly recorded higher mean values in depth ($p<0.05$) and width ($p<0.01$) measurements, compared to females. However, females significantly ($p<0.05$) recorded higher mean values of canine width: depth ratios than males.

Table IV shows the gender distribution of participants' arch form (square, tapered and ovoid) according to Angle's classification. According to the mathematical calculations, analyses of data showed that 85% of subjects had ovoid (41%) and tapered (44%) mandibular arches. The most common arch form in Class I was the ovoid followed by tapered, however, tapered form was most frequently encountered in Class II, and square form in Class III subjects.

In general, more females had tapered and ovoid arch forms than males ($p<0.05$), oppositely, more males had square mandibular arches ($p<0.05$). Statistically significant gender differences were recorded in tapered and ovoid arch forms with female predominance in Classes I and in tapered arch form in Class II. However, square arch form was significantly more frequent in males with Class III and relations.

4. Discussion

This study was conducted to determine the differences of clinical mandibular arch forms in Angle Class I, II, and III using arch dimension parameters, in an adolescent sample of patients seeking orthodontic treatment.

In this study, more than 60% of the participants were females, although males were slightly older than females but the differences in the mean age were not significant. Additionally, the limitation of age distribution (in the late adolescent stage), eliminated the effects of variations in arch dimensions related to age.

In the present study, in all arch width and depth measurements, gender-related differences were obviously noticed. The results showed remarkable male predominance over females. Similar findings were reported previously [21, 25, 26]. In addition, although there were significant gender differences in inter-canine width, canine depth and in canine width/depth ratio, all measurements were found to be higher in males. Males possess wider and longer arch form than females in the inter-canine region, in contrary with a previous study that reported no gender variance with respect to arch forms [27].

This study have shown that Class I relation predominated in 54.8% of patients followed by Class II (37.9%), however, Class III was the least reported (7.3%). Additionally, gender differences in the prevalence of occlusal relationship demonstrated significant female predominance to Classes I and II compared with males. However, Class III relation predominated in males when compared to females thus these gender differences were justified by the effects of racial variations related to study samples. Similar findings were reported in a previous study [5].

Upon examination of the arch dimension differences between Angles classes, this study revealed significant differences between classes in terms of canine width and depth measurements and width to depth ratios. Class III arches were significantly wider and shorted compared with the other classes, however, Class I arches were significantly the longest and Class II were significantly the narrowest arches.

In this study, when mandibular canine depths were considered, the differences were clearly detected between different occlusal relations, namely Class I, II and Class III. The characteristics of a particular occlusion pattern can be defined using arch shapes. Othman *et al*., [28] evaluated the arch forms in Angles Class I, II and III using tapered, square and ovoid arch form templates.

The data obtained in this study were analyzed according to mathematical width to depth ratio to exclude the subjective influence of personal judgment, have reported variations in the arch form among the participants. The tapered arch form was the most frequently encountered (44%). followed by ovoid (41%). However, the least common arch form was the square which was recorded in 15% of participants. Similarly, some previous studies reported findings coincide with our results [8].

When comparing the arch form (square, tapered and ovoid) according to different classes, the most common arch form in Class I was the ovoid, tapered in Class II and square in Class III subjects. These findings strongly suggest that ovoid form should be considered when dealing with Class I, tapered with Class II and square with Class III cases. Several previous researches postulated similar findings [5, 9].

Significant gender-related variations were recorded in tapered and ovoid arch forms with female predominance in Classes I and II. At the opposite side, significantly, the square arch form was more frequent in males with Class III. The aim in the specification of the arch form was to evaluate the final arch form in relation to gender differences which will be obtained by the use of fixed orthodontic appliances in patients who have referred to the orthodontic clinic due to orthodontic malocclusion. Recently published researches have reported that this more realistic arch form is preferred in determining the individual arch form [6, 12].

Several studies used arch form templates for the evaluation of photo-copies of dental models, these are the three types of (wide, normal narrow and) arch forms specifically provided by Paranhos *et al*., [4] and used by Chuck [7] for the first time in 1932. However, in this study, the mathematical calculation of width to depth ratios was carried out so as to determine the mandibular arch form. Different mathematical procedures have been performed, such as the use of coordinate system axes [9] and the beta function [6].

The importance of this study is that determination of arch form in relation to the different occlusal pattern is a pre-request to orthodontic treatment in order to obtain the best outcome. As far as esthetic is concerned, tapered arch form presents a better smile arc than a square arch form which provides a flatter smile arc that is not esthetically pleasing [29]. Space availability and stability of dentition are the factors of particular significance especially in a tapered arch group as the inter-canine width is the narrowest comparing the ovoid and square variety. Any arch expansion of the tapered arch group is adversely affecting the proper alignment of the lower labial segment since this region is constrained by circumoral musculature [3, 4, 6].

The present study that provides information concerning the differences of clinical mandibular arch forms in Angle Class I, II, and III demonstrates a baseline knowledge by identifying its morphological variations and evaluating gender differences with respect to canine dimension parameters, thus refuted the null hypothesis due to the existence of morphological variation among different classes of occlusal patterns and in relation to gender. Although some researcher studied the differences in the mandibular arch forms in various types of occlusal patterns [12, 15], but it was difficult to compare their results with this study due to the incorporation of several variables and differences in racial variations [12, 17, 30].

One of the limitations of this study was the use of mathematical calculation of width to depth ratios which gives information about arch form mathematically did not considered the perceived personal judgment and ignored the clinical perception, thus other methods to determine the arch form were not considered. In addition, the limited participation rate, age group and sample size. Therefore, further research is still needed to overcome the limitations of this study which includes studying a larger sample and the inclusion of different age groups and incorporation of other methods for arch form determination are needed before the results of this study can be popularized to the general population.

5. Conclusion

Class I occlusal relationship was the most common class of malocclusion followed by Class II, more females had Class I and II arches compared with males who had Class III arches.Ovoid and tapered arch forms comprised 85% of subjects. The commonest arch form in Class I was ovoid, in Class II was tapered and in Class III was square. More tapered and ovoid arch forms are recorded in females while square arch forms are predominated in males.

Table 1: Distribution of the participants according to Angle's classification in relation to gender. (Chi square test)

Gender	Class I	Class II	Class III	Total n (%)
Male	18 (35.3%)	13 (37.1%)	5 (71.4%)	36 (38.7%)
Female	33 (64.7%)	22 (62.8%)	2 (28.6%)	57 (61.3%)
Chi square	0.031 (*)	0.027 (*)	0.0046 (**)	
Total	51 (54.8%)	35 (37.6%)	7 (7.5%)	93 (100%)

n: number, NS: not significant; * $p<0.05$; ** $p<0.01$.

Table 2: Differences in the Mean (SD) values of canine Width and Depth measurements between different class groups. (ANOVA; Bonferroni test)

		Canine Width	Canine Depth	W/D Ratios
Class I	Mean ±SD	32.3±2.1	4.5±1.2	7.17±0.73
(n=51)	Min-Max	30.6-35.5	4.0-5.2	6.27-7.32
Class II	Mean ±SD	30.8±2.5[a]	5.3±1.4 [b]	5.81±0.65 [a]
(n=35)	Min-Max	28.4-33.6	4.8-6.3	5.06-6.37
Class III	Mean ±SD	34.7±2.7[b]	3.7±0.75 [a]	9.38±0.58 [b]
(n=7)	Min-Max	31.7-37.7	3.1-4.7	8.55-9.98
Overall	Mean ±SD	31.9±2.3	4.7±1.3	6.82±0.70
(n=93)	Min-Max	28.4-37.7	3.1-6.3	5. 06-9.98
Two-way ANOVA		**	*	**

SD: standard deviation; W/D: canine width: depth ratio; * $p<0.05$; ** $p<0.01$, [a]and [b] denotes sig. category from the mean (Bonferroni test, ANOVA).

Table 3: Gender differences in the mean values of canine Width, Depths and Width:Depth ratios. (one-way ANOVA test)

		Canine width	Canine Depth	Width/Depth
Male	Mean ±SD	33.4±2.82	5.9±1.22	5.66±0.76
(n=36)	Min-Max	32.1-37.7	4.8-6.3	5.06-6.38
Female	Mean ±SD	31.0±2.26	3.9±1.46	7.95±0.58
(n=57)	Min-Max	28.4-31.9	3.1-5. 9	6.45-9.98
Overall	Mean±SD	31.9±2.30	4.7±1.3	6.82±0.70
(n=93)	Min-Max	28.4-37.7	3.1-6.3	5.06-9.98
One-way ANOVA		**	*	*

*: $p<0.05$; **: $p<0.01$ (Post hoc test)
n: number; SD: standard deviation

Table 4: The distribution of participants' arch form (square, tapered and ovoid) according to Angle's classification in relation to gender (chi square test).

		Class I	Class II	Class III	Total
		51 (54.8%)	35 (37.6%)	7 (7.5%)	93 (100%)
Tapered	Total	18 (35.3%)	21 (60.0%)	2 (28.6%)	41 (44.1%)
	Males	6 (33.3%)	6 (28.6%)	1 (50.0%)	13 (31.7%)
	Females	12 (66.7%)	15 (71.4%)	1 (50.0%)	28 (68.3%)
		$p<0.05$	$p<0.05$	NS	$p<0.05$
Ovoid	Total	26 (51.0%)	10 (28.6%)	2 (28.6%)	38 (40.9%)
	Males	8 (30.8%)	5 (50.0%)	1 (50.0%)	14 (34.2%)
	Females	18 (69.2%)	5 (50.0%)	1 (50.0%)	25 (65.8%)
		$p<0.05$	NS	NS	$p<0.05$
Square	Total	7 (13.7%)	4 (11.4%)	3 (42.9%)	14 (15.0%)
	Males	4 (57.1%)	2 (50.0%)	3 (100.0%)	9 (64.3%)
	Females	3 (42.9%)	2 (50.0%)	0 (0.0%)	5 (35.7%)
		NS	NS	$p<0.05$	$p<0.05$

NS: not significant

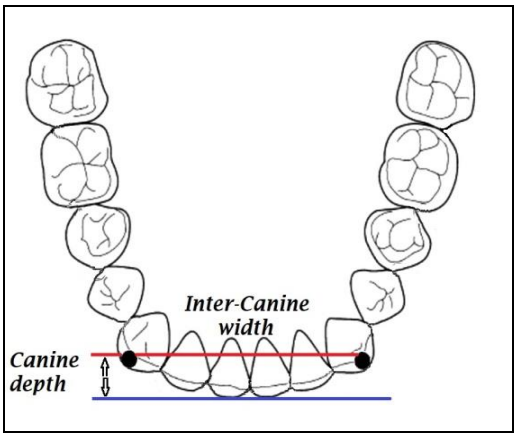

Fig 1: The Canine width and depth dimensions of the mandibular arch.

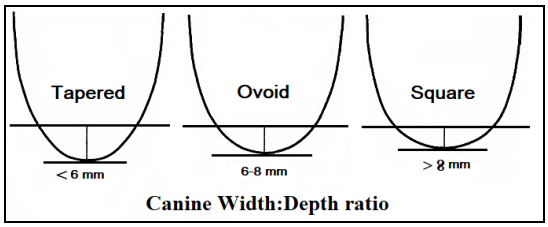

Fig 2: Mandibular arch form determination method

References

1. Bishara SE, Jakobsen JR, Treder J, Nowak A. Arch width changes from 6 weeks to 45 years of age. Am J Orthod Dentofac Orthoped. 1997; 111:401-409.
2. Isık F, Sayınsu K, Nalbantgil D, Arun T. A comparative study of dental arch widths: extraction and non-extraction treatment. Eur J Orthodont. 2005; 27:585–589.
3. Walter DC. Changes in the form and dimensions of dental arches resulting from orthodontic treatment. Angle Orthod. 1953; 23:3-18.
4. Paranhos LR, Andrews WA, Jóias RP, Bérzin F, Júnior ED, Triviño T. Dental arch morphology in normal occlusions. Braz J Oral Sci. 2011; 10:65-68.
5. Murshid ZA. Patterns of dental arch form in the different classes of malocclusion. J Am Sci. 2012; 8:308-312.
6. Noroozi H, Nik TH, Saeeda R. The dental arch form revisited. Angle Orthod. 2001; 71:386-389.
7. Chuck GC. The ideal arch form. Angle Orthod. 1933; 3:312-327.
8. Barrow GV, White JR. Developmental changes of the maxillary and mandibular dental arches. Angle Orthod. 1952; 22:41-46.
9. Braun S, Hnat WP, Fender DE, Legan HL. The form of the human dental arch. Angle Orthod. 1998; 68:29-36.
10. Halicioglu K, Yavuz I. Comparison of the effects of rapid maxillary expansion caused by treatment with either a memory screw or a Hyrax screw on the dentofacial structures - transversal effects. Eur J Orthodont. 2014; 36:140-149.
11. Miyake H, Ryu T, Himuro T. Effects on the dental arch form using a preadjusted appliance with premolar extraction in Class I crowding. Angle Orthod. 2008; 78:1043-1049.
12. Nojima K, McLaughlin RP, Isshiki Y, Sinclair PM. A comparative study on Caucasian and Japanese mandibular clinical arch forms. Angle Orthod. 2001; 71:195-200.
13. Sayin MO, Turkkahraman H. Comparison of dental arch and alveolar widths of patients with class II, division 1 malocclusion and subjects with class I ideal occlusion. Angle Orthod. 2004; 74:356-360.
14. Ward DE, Workman J, Brown R, Richmond S. Changes in arch width. A 20-year longitudinal study of orthodontic treatment. Angle Orthod. 2006; 76:6-13.
15. Beazley WM. Assessment of mandibular arch length discrepancy utilizing an individualized arch form. Angle Orthod.1971; 41:45-54.
16. Henrikson J, Persson M, Thailander B. Long-term stability of dental arch form in normal occlusion from 13-31 years of age. Eur J Orthodont. 2001; 23:51-61.
17. Louly F, Nouer PRA, Janson G, Pinzan A. Dental arch dimensions in the mixed dentition:a study of Brazilian children from 9 to 12 years of age. J Appl Oral Sci. 2011; 19:169-174.
18. Nakatsuka M, Iwai Y, Huang ST, Huang HC, Kon HI, Morishita A *et al*. Cluster analysis of maxillary dental arch forms. Taiwan Oral Med Sci. 2011; 27:66-81.
19. Burris BG, Harris EF. Maxillary arch size and shape in American blacks and whites. Angle Orthod. 2000; 70:297-302.
20. AlHarbi S, Alkofide EA, AlMadi A. Mathematical Analyses of Dental Arch Curvature in Normal Occlusion. Angle Orthod. 2008; 78:281-287.
21. Cassidy KM, Harris EF, Tolley EA, Keim RG. Genetic influence on dental arch form in orthodontic patients. Angle Orthod. 1998; 68:445-454.
22. Slaj M, Jezina MA, Lauc T, Mestrovic SR, Miksic M. Longitudinal dental arch changes in the mixed dentition. Angle Orthod. 2003; 73:509-514.
23. Al Shammout RW, Al-Jabrah O, Aburumman K, Alhabahbah A, Almanaseer W. The Effect of various classes of malocclusions on the maxillary arch forms and dimensions in Jordanian population. Adv Dent Oral Health 2016; 2:17-23
24. Park SJ, Leesungbok R, Song JW, Chang H, Lee SW, Ahn SJ. Analysis of dimensions and shapes of maxillary and mandibular dental arch in Korean young adults. J Adv Prosthodont. 2017; 9:321-327.
25. Zhou L, Mok CW, Hagg U, McGrath C, Bendeus M, Wu J. Anteroposterior dental arch and jaw-base relationships in a population sample. Angle Orthod. 2008; 78:1023-1029.
26. Iseri H, Tekkaya AE, Oztan O, Bilgic S. Biomechanical effects of rapid maxillary expansion on the craniofacial skeleton, studied by finite element method. Eur J Orthodont. 1998; 20:347-356.
27. Ferrario, VF, Sforza C, Miani A, Taraglia G. Mathematical definition of the shape of dental arches in human permanent healthy dentitions. Eur J Orthod. 1994; 16:287-294.
28. Othman SA, Xinwei ES, Lim SY, Jamaludin M, Mohamed NH, Yusof ZYM *et al*. Comparison of arch form between ethnic Malays and Malaysian aborigines in Peninsular Malaysia. Korean J Orthod. 2012; 42:47-54.
29. Ackerman MB, Ackerman JL. Smile analysis and design in the digital era. J Clin Orthod. 2002; 36:221-236.
30. Mutinelli S, Manfredi M, Cozzani M. A mathematic-geometric model to calculate variation in mandibular arch form. Eur J Orthod. 2000; 22:113-125.