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The Arch Form Before and After Orthodontic Treatment

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Orthodontics in Partial Fulfillment for the Bachelor in Dental Surgery

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CERTIFICATION OF THE SUPERVISOR

I certify that this project entitled "The Arch Form Before and After Orthodontic Treatment" was prepared by **Mina Basil Salman** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor degree in dentistry.

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I Dedicate my graduation project to the most precious and important person in my life, without you I'm nothing!
Mom, thank you for your unconditional selflessness, your unwavering support, your countless sacrifices that have opened many doors for me to grow and succeed and all of the little (and big) things you have taught me along the way. I hope I make you as proud as you make me.

Dear bestie, you were always there for me in the dark days…
You stood by my side when I was sailing aimlessly without a sail in a sea of depression. I can't thank you enough for your love and support, yet I'm saying; thanks **Heba**.

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Because of you, I have the vision to reach for my dreams, and the grit to push through the challenges that are in my way. Thank you for making me strong and for always encouraging me to do my best. Anything in this world would be meaningless without you..

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INTRODUCTION

The dental arch form is initially shaped by the configuration of the supporting bone. After the eruption of teeth, it is further modified by the surrounding musculature and functional forces **(Braun *et al.*, 1998)**. If this arch form is altered during orthodontic treatment, there is a tendency for it to return to its pretreatment shape.

Correct identification of a patient's arch form is an important aspect of achieving a stable, functional, and esthetic orthodontic treatment result, since failure to preserve the arch form might increase the probability of relapse **(Shapiro, 1974; De la cruz *et al.*, 1995)**.

Various studies have reported the return of the canine and molar widths to pretreatment position during the post-retention phase if the original arch form is modified **(Welch, 1956; Kahl-Nieke *et al.*, 1995)**. Hence, the maintenance of original arch form rather than arch modification is generally recommended to reduce the relapse tendency.

Relapse of the corrected malocclusion, being one of the biggest dilemmas of orthodontic treatment, has consistently been a topic of discussion in the orthodontic literature. A review of the literature showed that only 30% of the treated cases retained their alignment ten years post-retention, which is further reduced to only 20% at the twenty years follow up **(Little, 1999)**.

Several authors **(Strang, 1952; Tweed, 1966)** have proved that the deformation of the arch shape by expansion is rarely permanent, and eventually relapses by a contraction **(Shapiro, 1974; Burke *et al.*, 1998)**. Maintaining the initial inter-canine and inter-molar distances is a key to stability, because these values represent the position of the teeth, resulting from the muscular balance of each patient. Several

studies have reported arch form changes at the end of orthodontic treatment, by measuring parameters either on photocopies of plaster models **(Housley *et al.*, 2003)** or on digital models **(Taner *et al.*, 2004)**.

This study will be conducted to evaluate the effect of orthodontic treatment on the arch form.

AIM OF THE STUDY

This study aimed to evaluate the changes of the arch form after the orthodontic treatment Iraqi populations.

HYPOTHESIS

The null hypothesis stated that: there is no significant difference in the arch form before and after orthodontic treatment.

CHAPTER 1: REVIEW OF LITERATURE

1. Normal Development of Dental Arches

Dental arch form is the arch, formed by the buccal and facial surfaces of the teeth when viewed from their occlusal surfaces. It is commonly believed that the dental arch form is initially shaped by the configuration of supporting bone. Following eruption of teeth and by circum oral musculature and intra oral functional forces.

As arches grow and as teeth erupt into the mouth arch dimensions change. **Moorrees (1969)** stated that there is a large amount of variation between individuals, regarding arch form, but there is a central tendency for an increase in intermolar width in the transition from primary to permanent dentition and even increasing up to 18 years old, particularly in males. Intercanine width increases from primary to permanent dentition, but after eruption of the permanent canines the width no longer increases. Into the 30s and 40s patients arch depth tends to decrease **(DeKoch, 1972)**. After the age of 12, there is little to no increase in arch length or in arch perimeter **(Sinclair, 1983)**. Arch length tends to decrease during the transition from primary to permanent dentition and continues to decrease with age **(Shapiro, 1974)**.

The impact of soft tissue role in the development of arch form has been controversial. **Scott (1957)** stated that a case can be made for the importance of the pressures exerted by the adjacent muscular tissues of the tongue, lips and cheeks in determining arch form, but the fact that arch form is determined before tooth eruption and that it depends for its final development on the direction and extent that of alveolar process growth, would indicate that under normal conditions the soft tissue

plays a minor role in its determination. Alternatively, **Brader (1972)** stated that "the primary determinants of arch form morphology are the (muscle) tissue forces of the resting state in contradistinction to the intermittent forces of muscles in functioning states". **Currier (1969)** postulated that due to the shape of the arches the buccinator had a greater effect on the maxillary dentition in the second and third molar region creating a more elliptical shape to the arch. Mandibular arch shape was more dictated by occlusion rather than the effect of the tongue or other circumoral musculature. "It is generally accepted that the dental arch form is initially shaped by the form of underlying bone, and then after eruption of the teeth, the shape becomes influenced by the oral musculature" **(McLaughlin, 2001)**.

When comparing the size of the individual arches the maxillary tends to be wider than the mandibular arch in normal occlusions allowing for proper intercuspation of teeth, overbite and overjet. **Fujita (2002)** found that "the association between the upper and lower dental arches did not vary by more than 0.3mm, but showed consistent lateral gaps of about 4.3mm for the opposing canines and 2.8mm for the molars".

2. Different Concepts of Arch Form

2.1. Bonwell Concept

Bonwill (1885) developed certain postulates for artificial dentures. He noted the tripod shape of the mandible is formed by an equilateral triangle, with its base extending from condyle to condyle and the sides extending from each condyle to the midline of the central incisors. Length of each side is approximately 4 inches. He stated that

this triangle existed for the proper functioning of the teeth. Importantly, he noted that the bicuspids and molars formed a straight line from the cuspids to the condyles.

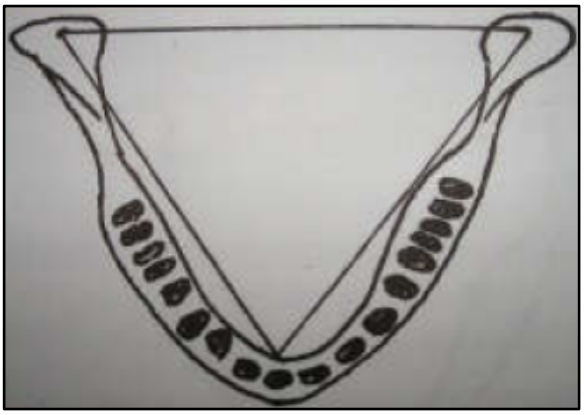

Figure 1: Bonwell Concept

2.2. Bonwell Hawley Concept

Hawley (1905) modified Bonwill's concept. He Proposed A geometric method for predetermining the dental arches in which the lower anterior teeth were arranged on the arc of a circle and the premolars and molars aligned with the second and third molars turned toward the center. Further, It was modified by Boone In 1963.

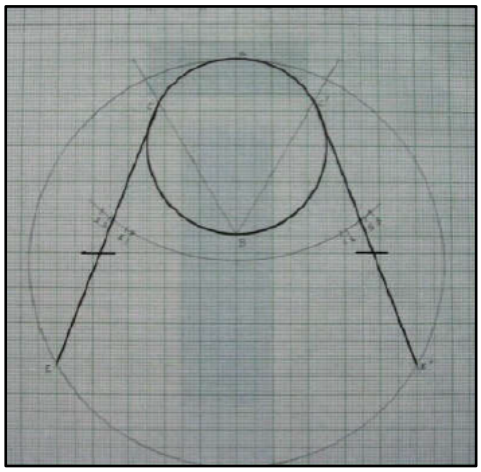

Figure 2: Bonwell Hawley concept

2.3. Angel's Line of Occlusion

Angle (1907) described the Line of Occlusion as “The line of greatest normal occlusal contact”. The line of occlusion is a smooth curve passing through the central fossa of each upper molar and across the cingulum of the upper canine and incisor teeth. The same line runs along the buccal cusps and incisal edges of the lower teeth, thus specifying the occlusal as well as interarch relationships once the molar position is established.

2.4. Apical Base Concept

Lundstrom (1925) highlighted the need to consider the apical base when determining the arch form for the patient. “Orthodontic experiments showed that a normal occlusion attained by mechanical treatment is not necessarily accompanied by a development of apical base in harmony with the position of the teeth, with the result that the occlusion cannot be maintained.” “Occlusion doesn't control form and amount of apical base development but apical base is capable of affecting the dental occlusion”.

2.5. Brader Arch Form

Brader (1972) used mathematical model of arch form based on trifocal ellipse.

PR = C

where P is Pressure in gm/cm2, R is radius of curvature of elliptic curve at the pressure site in mm and C is mathematical constant. Thus the equation expressed the most fundamental association between forces and shape and revealed an inverse relation between force and curvature.

2.6. Cantenary Curve Concept

Musich and Ackerman in 1973 used an instrument that was a modified Boley Guage with a chain incorporated in it-CATANOMETER to measure the arch perimeter. Caternary curve is the shape that the loop of a chain would take if it were suspended from 2 hooks. Shape of the curve depends on the length of the chain and the distance between the hooks. When the width across the first molars is used to establish the posterior attachments, a caternary curve fits the dental arch form nicely for most individuals.

2.7. Computer-Derived Arch Design

Rocky Mountain Data Systems developed a computer-based program that takes into account facial form, intermolar width, intercanine width and arch depth to predict a best fit mandibular arch form **(White, 1978)**. While numerous studies have been undertaken to study the ideal or normal human arch form no one arch form has been proven to be universal for all patients.

Chuck (1934) was the first to predict that there were three main arch forms seen in the human population: tapered, square and ovoid.

2.8. The Tapered Arch Form

This arch form provides the narrowest inter-cuspid width and indicated for patients with narrow, tapered arch form and gingival recession in canine and premolar regions. Cases undergoing single arch treatment, in this way no expansion of treated arch occurs. The

posterior part of this arch form can easily be modified to match the inter-molar width of the patient.

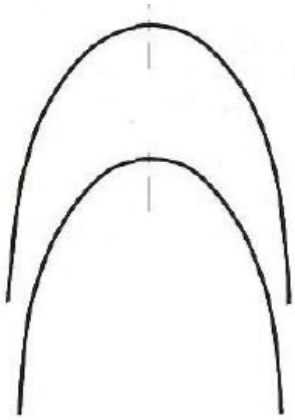

Figure 3: Tapered arch form

2.9. The Square Arch Form

Indicated in cases with broad arch form and cases that require buccal uprighting of the lower posterior segments and expansion of the upper arch. After over-expansion has been achieved, it may be beneficial to change to the ovoid arch form in the later stages of treatment. The square arch form is useful to maintain expansion in upper arches after rapid maxillary expansion.

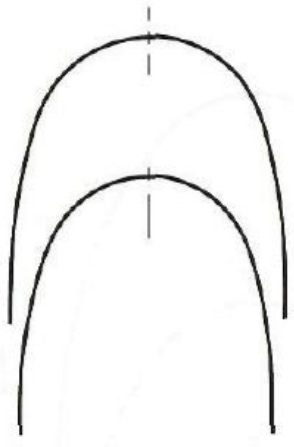

Figure 4: Square arch form

2.10. The Ovoid Arch Form

It is the most preferred arch form. The ovoid arch form has proved to be good, reliable arch form for high percentage of cases treated. Treated cases have shown good stability, with minimal amounts of post-treatment relapse. When superimposed, the three shapes vary mainly in inter-canine and inter-first premolar width, giving a range of approximately 6 mm in this area.

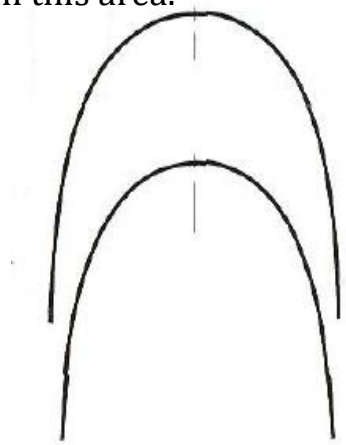

Figure 5: Ovoid arch form

3. Differences among Angle Classification

Braun (1998) found there were differences in arch form between the different Angle classifications such that all maxillary arch depths were similar, but when compared to Class I the Class III's were wider distal to the lateral-canine area and Class II's were narrower distal to the lateral-canine area. Comparing the mandibular arches to the Class I casts the Class III casts showed a smaller arch depth and greater arch width while the Class II's had both a reduced arch with and depth. Nojima and Kook found that Class II canine depth was greater than in Class I samples. The Class II sample showed the smallest canine and molar width to depth ratio, followed by Class I then Class III **(Nojima, 2001)**. Kook found that in Class II sample there was an increased tendency for a tapered arch form in comparison to Class I arches and

Class III sample had the highest frequency in the square arch form **(Kook, 2004)**.

4. Gender Differences

There is a difference in normal growth of the mandible and maxilla between males and females. More width growth is seen in the maxilla (3mm) then the mandible (2mm), from ages 7-12. After 12 years old there is only growth in males. Male jaws tend to be wider than female jaws **(Moorrees, 1969; Lee RT, 1999; Knott, 1972)**. Intercanine width and depth are not significantly related to sex **(Raberin, 1993)**.

5. Importance of Arch Forms

1. **Stability: (Little et al., 1981)** did a study on Stability and relapse of mandibular anterior alignment and concluded that Arch dimensions of width and length typically decreased after retention whereas crowding increased. This occurred in spite of treatment maintenance of initial intercanine width, treatment expansion, or constriction.
2. **Occlusion:** Unless the teeth are aligned in a proper arch form in both upper and lower arches, the occlusion will not be normal. **Angle (1907)** emphasized this with his concept of Line of Occlusion.
3. **Esthetics:** Primary reason for the patient to take treatment. Teeth arranged in proper arch form, will improve smile value as proposed by **Sarver (2003)**.

6. Components of an Arch Form

1. **Anterior curvature:** Based on inter-canine width the shape becomes more tapered when inter-canine width is narrow and squarer when inter-canine width is wide.
2. **Inter-canine width:** This appears to be the most critical aspect of arch form, because significant relapse occurs if this dimension is changed.
3. **Posterior curvature:** In the posterior area a gradual curvature between canine and second molars are preferred.
4. **Inter-molar width:** Treatment changes in this dimension is more stable. Arch form in the inter-molar region can be widened or narrowed, depending on the need of the case.

CHAPTER 2: MATERIALS AND METHODS

1. Study Design

This is a cross-sectional national survey study. Ethical approval was obtained from the Ethics Committee of the College of Dentistry-University of Baghdad on March 25th, 2021 with ID Number: 263421.

2. Study Settings

The study was conducted in the Teaching Hospital at the College of Dentistry-University of Baghdad in addition to private orthodontic clinics in Iraq.

3. Subjects

`The database for this study consisted of pretreatment mandibular study models of Iraqi populations.

The sample was collected according to the following criteria:

1. Inclusion Criteria

1. Angle's dental Class I, II, and III malocclusions.
2. Complete permanent dentition excluding the third molars.
3. No obvious teeth malformation.
4. No local factors that disturb the integrity of dental arches (e.g. congenital missing teeth, retained deciduous teeth, supernumerary teeth).
5. A 3-mm or less arch length discrepancy.
6. No previous orthodontic treatment, orthognathic surgery, or fixed prosthodontic therapy.

2. Exclusion Criteria

1. Presence of restorations/prosthetic restoration extending to the contact areas, cuspal tips (incisal edges), or cervical areas.
2. History of facial/dental trauma.
3. Severe transverse arch discrepancies.
4. Patients with cleft palate.

5. Severe crowding or spacing.

4. Data Collection and Measurements

1. Arch Form Analysis

The models were scanned digitally using Canon, Canoscan Lide25 scanner (1200 dpi) with a ruler was used for magnification correction (Figure 6). The most facial aspect of 13 proximal contact areas around the arch were digitized using AutoCAD software (Autodesk 2020). The contact point between the two central incisors was taken as the origin of the X and Y coordinates.

In order to locate clinical bracket points for each anterior tooth and premolar, a perpendicular line was drawn to extend facially to the midpoint of the line connecting the mesial and distal contact points (Figure 7) (**Nojima *et al.*, 2001; Kook *et al.*, 2004; Bayomi *et al.*, 2011; Gafni *et al.*, 2011**). This was according to the data of Andrews of crown prominence **(Andrews, 1989)**. For the molars, this line was drawn from the point connecting the mesial third to its distal two thirds. Another line connecting the clinical bracket points was then drawn to identify the arch form (Figure 7) and the digital model was printed in a 1:1 scale. Then, the three different arch forms (tapered, ovoid, and square) were identified using the 3M Unitek templates (Figure 8). This was performed based on the arch form that provided the best fit to the eight clinical bracket points ranging from the right first premolar to the left first premolar **(Battagel, 1996**) (Figure 9)

A

B

Figure 6: A) Canon, Canoscan Lide 25 scanner; B) Scanning with a ruler used for magnification correction

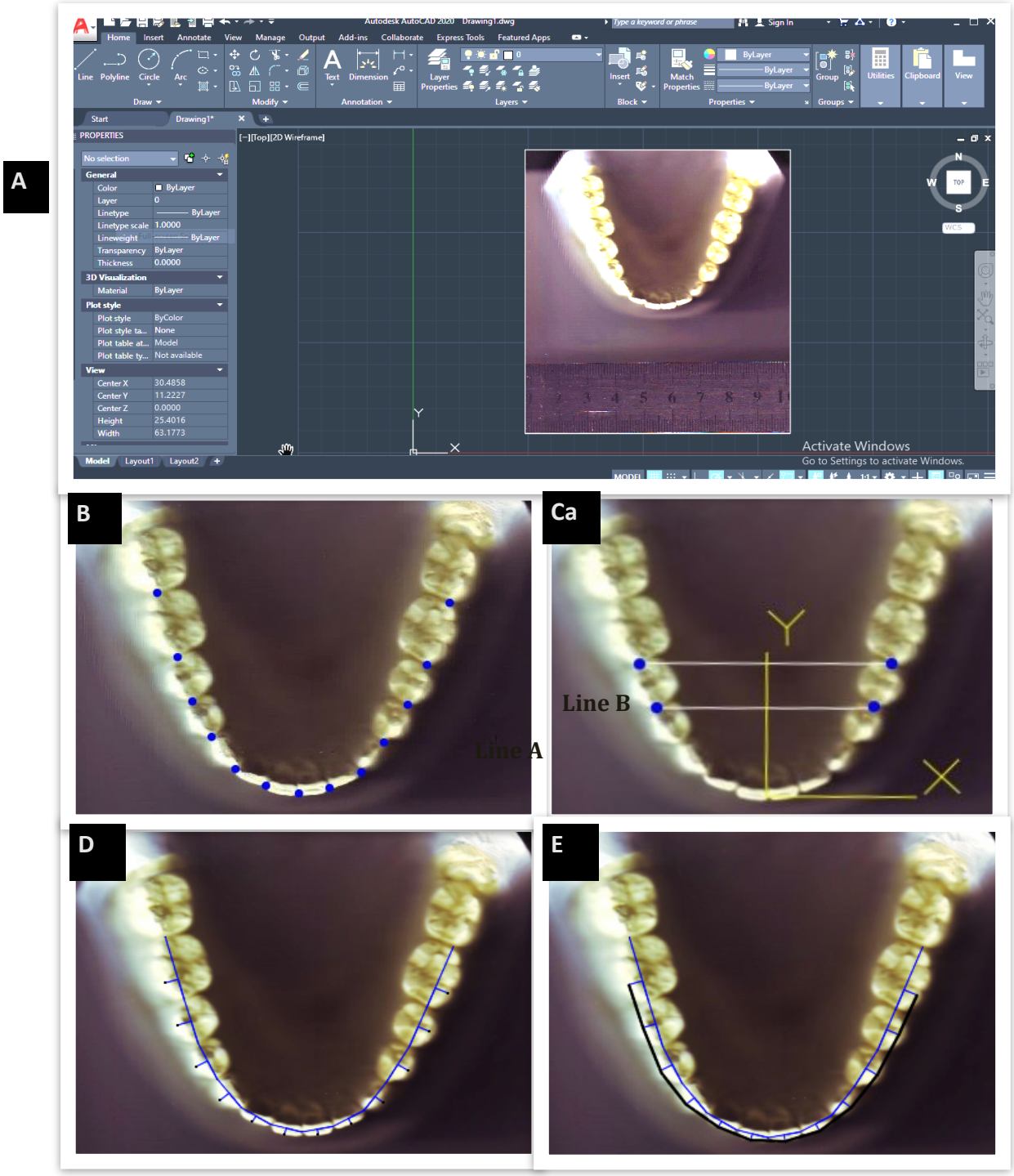

Figure 7: Digitization procedure: A) AutoCAD software (Autodesk 2020); B) Digitized contact points on a mandibular cast; C) Adjusted X and Y axes; D) Clinical bracket points; E) Contact point and clinical bracket point lines.

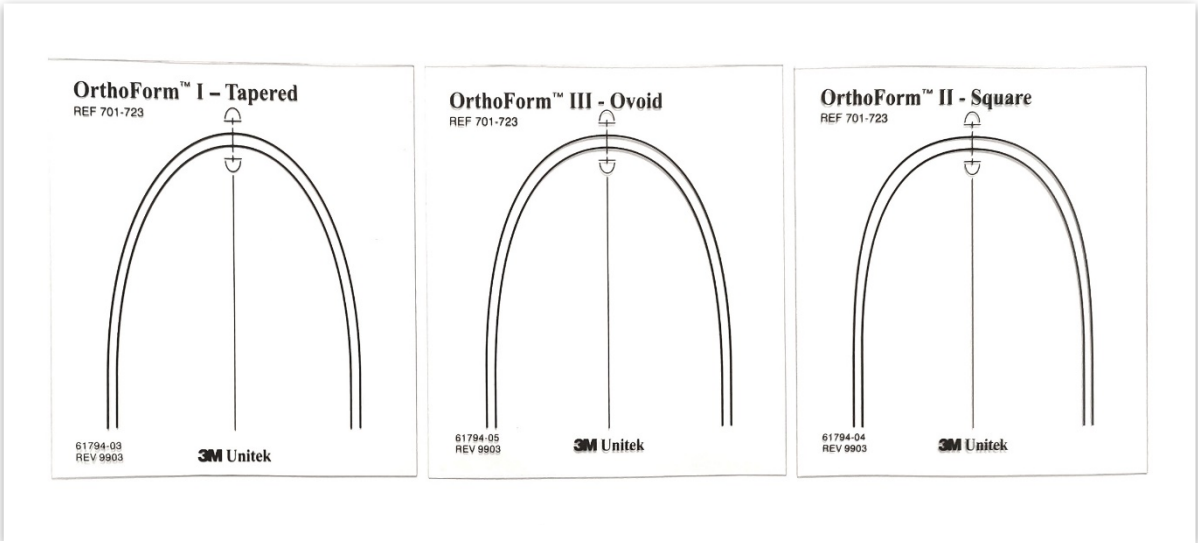

Figure 8: Clear orthoform template (3M, Unitek)

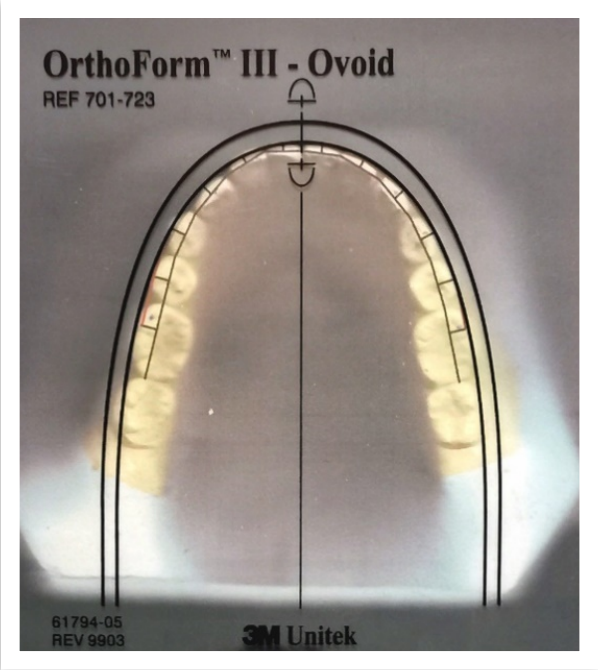

Figure 9: Superimposition of clear orthoform template on printed digital model.

2. Linear Measurements

The linear measurements included (Figure 10):

1. **Intercanine width:** The distance between the canine clinical bracket points.
2. **Intermolar width:** The distance between the first molar clinical bracket points.
3. **Canine depth:** The shortest distance from a line connecting the canine clinical bracket points to the origin between the central incisors.
4. **Molar depth:** The shortest distance from a line connecting the first molar clinical bracket points to the origin between the central incisors.

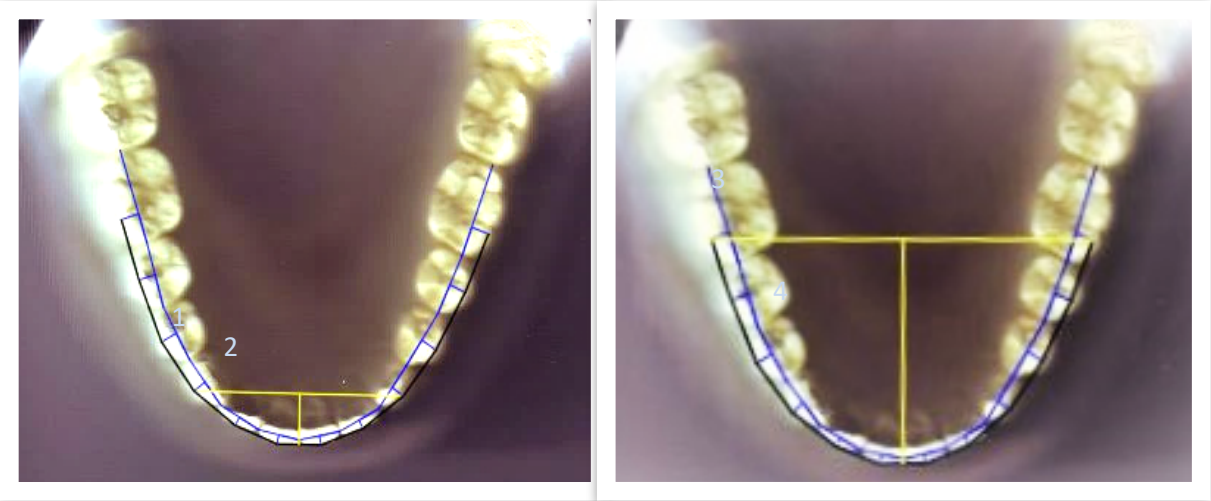

Figure 10: Linear measurements: 1) Intercanine width; 2) Intercanine depth; 3) Intermolar width; 4) Intermolar depth.

3. Validation and Reliability Study for Digital Measurements

This part of the study was conducted to ensure that digital measurements were reliable in comparison to the standard direct

measurement. The measurements of dental arch dimensions that were included:

1. **Intercanine distance:** which was measured from cusp tip of the right canine tooth to cusp tip of the left canine tooth.
2. **Intermolar distance:** which was measured from mesiobuccal cusp tip of the right first molar tooth to the mesiobuccal cusp tip of the left first molar tooth. All the distances were measured in millimeters twice; directly with a digital caliper and digitally with AutoCAD 2020 software (after correcting the magnification using the ruler). The two measurements for each parameter were then compared to test their reliability and if there is any systematic difference between them (Figure 11).

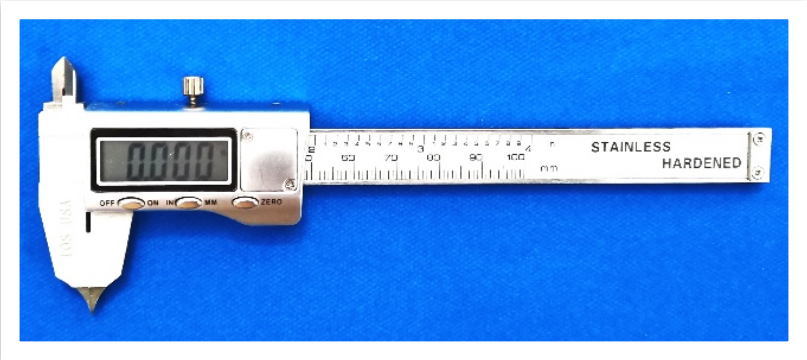

Figure 11: Digital vernier caliper.

CHAPTER 3: RESULTS

1. Descriptive Statistics

The descriptive statistics of participants' age and dental arch dimensions (pre- and post-treatment) are presented in Table 1. Table 2

and Figures 1 to 4 showed the frequencies and percentages of participants' gender, malocclusion, arch forms (pre- and post-treatment).

Table 1: Descriptive statistics for the age and arch dimensions

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	58	13.00	29.00	17.79	3.87
Pre ICW	58	25.97	34.05	29.25	1.67
Post ICW	58	26.15	31.11	28.62	1.15
Pre CD	58	3.65	7.84	5.87	1.03
Post CD	58	4.53	7.35	5.82	0.68
Pre IMW	58	42.85	54.21	47.99	2.41
Post IMW	58	44.98	53.36	48.81	1.86
PreMD	58	23.00	31.02	26.24	1.89
Post MD	58	23.24	29.71	26.00	1.54
Pre CW/DR	58	3.60	7.92	5.13	0.90
Post CW/DR	58	3.97	6.39	4.97	0.50
Pre MW/DR	58	1.53	2.11	1.84	0.12
Post MW/DR	58	1.54	2.19	1.88	0.12

Table 2: Frequencies and percentages of gender, malocclusion, and arch forms

Variables		Frequency	Percent
Gender	Females	46	79.3
	Males	12	20.7
Malocclusion	Cl I	39	67.2
	Cl II	15	25.9
	Cl III	4	6.9
Pre-treatment Arch Form	Ovoid	31	53.4
	Tapered	23	39.7
	Square	4	6.9
Post-treatment Arch Form	Ovoid	30	51.7
	Tapered	25	43.1
	Square	3	5.2

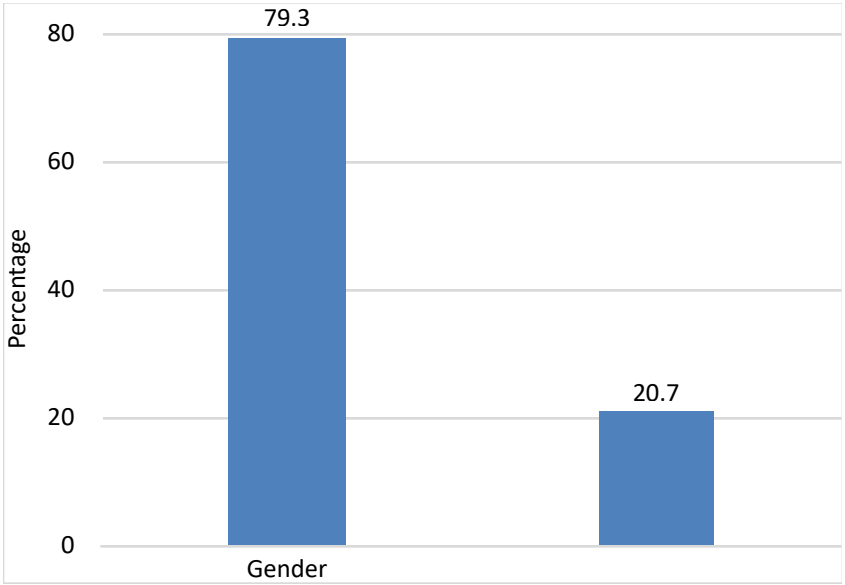

Figure 12: Percentage of participants' gender

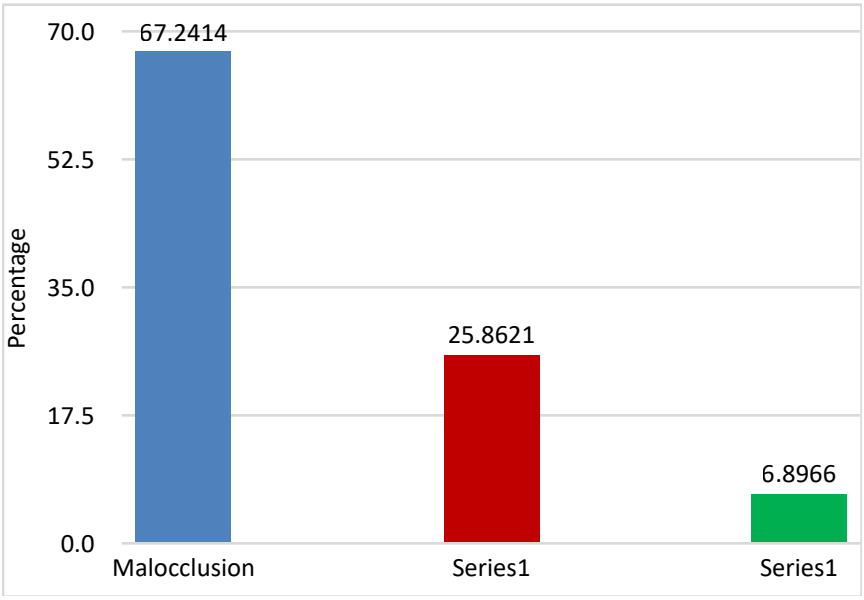

Figure 13: Percentage of participants' malocclusion

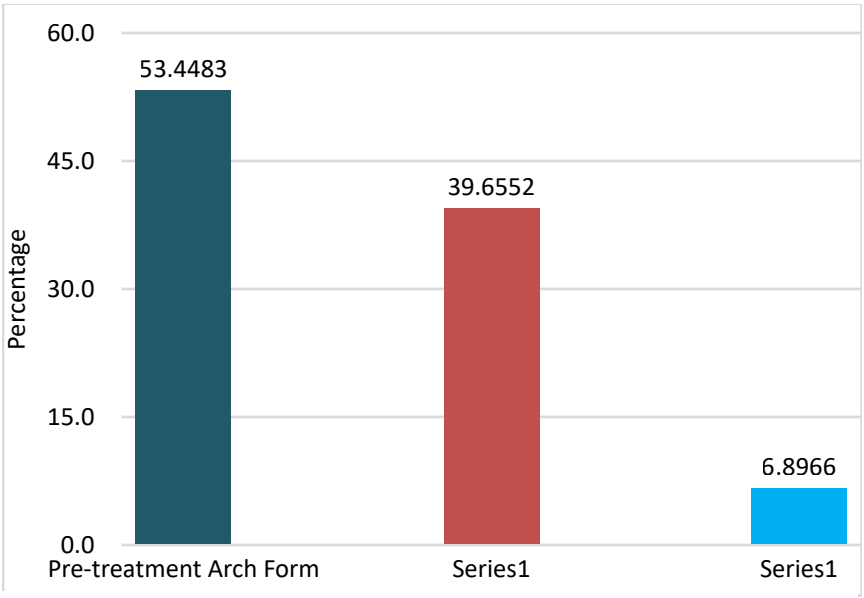

Figure 14: Percentage of participants' pre-treatment arch forms

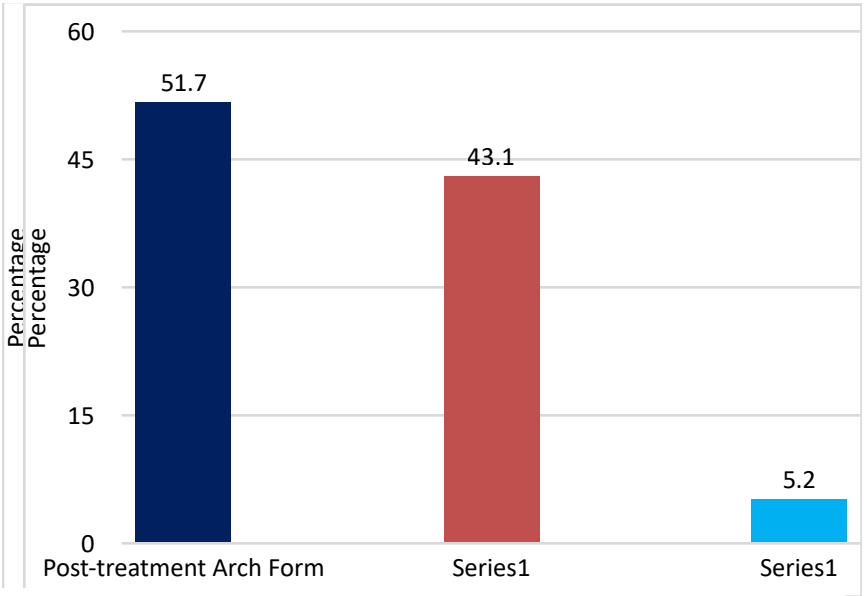

Figure 15: Percentage of participants' post-treatment arch forms

2. Comparison of Dental Arch Dimensions Before and After Treatment

Paired t-test was used to compare arch dimensions changes before and after treatment. It has been shown that post-treatment intercanine width was statistically significantly smaller than that of pre-treatment intercanine width. While intermolar width and molar width/depth ratio were significantly greater post-treatment (Table 3).

Table 3: Paired t-test between pre-treatment and post-treatment dental arch dimensions

Variables	Paired Differences					t	df	P
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Diff				
				Lowe	Upper			
Pre ICW - Post ICW	0.63	1.31	0.17	0.29	0.98	3.687	57	0.00
Pre IMW - Post IMW	-0.82	1.39	0.18	-1.19	-0.46	-4.505	57	0.00
Pre CD - Post CD	0.06	1.02	0.13	-0.21	0.32	0.421	57	0.67
PreMD - Post MD	0.24	1.51	0.20	-0.16	0.63	1.190	57	0.23
Pre CW/DR - Post	0.15	0.97	0.13	-0.10	0.41	1.192	57	0.23
Pre MW/DR - Post	-0.05	0.12	0.02	-0.08	-0.02	-3.113	57	0.00

3. Comparison of Dental Arch Form Before and After Treatment

It has been shown that there was no statistically significant difference between arch form before and after treatment (Table 4). The frequency of tapered arch form showed a slight increase after treatment while ovoid and square arch forms were slightly reduced in their frequencies.

Table 4: McNemar's test comparing dental arch dimensions before and after treatment

			Post-treatment AF			Total
			Ovoid	Tapered	Square	
Pre-treatment AF	Ovoid	Count	21	8	2	31
		Expected Count	16.0	13.4	1.6	31.0
		% within Pre-treatment AF	67.7%	25.8%	6.5%	100.0%
		% within Post-treatment AF	70.0%	32.0%	66.7%	53.4%
	Tapered	Count	7	16	0	23
		Expected Count	11.9	9.9	1.2	23.0
		% within Pre-treatment AF	30.4%	69.6%	0.0%	100.0%
		% within Post-treatment AF	23.3%	64.0%	0.0%	39.7%
	Square	Count	2	1	1	4
		Expected Count	2.1	1.7	0.2	4.0
		% within Pre-treatment AF	50.0%	25.0%	25.0%	100.0%
		% within Post-treatment AF	6.7%	4.0%	33.3%	6.9%
Total		Count	30	25	3	58
		Expected Count	30.0	25.0	3.0	58.0
		% within Pre-treatment AF	51.7%	43.1%	5.2%	100.0%
		% within Post-treatment AF	100.0%	100.0%	100.0%	100.0%

CHAPTER 4: DISCUSSION

The basic goals of any orthodontic treatment are always related to esthetic, function, and stability. The instability of the dental arches is a major problem, and the change in arch form during treatment contributes to relapse. So, the initial dental arch form must be respected **(Daou *et al.*, 2020)**. The expansion of the dental arch is rarely permanent, and it gradually returns to its original form **(Burke *et al.*, 1998)**. Maintenance of intercanine and intermolar width is the key to stability **(Shapiro, 1974)**, since these values reflect the position of the teeth as a result of each patient's muscle balance **(Riedel, 1960; Daou *et al.*, 2020)**.

With the widespread of preformed stainless steel and superelastic archwires and since preformed archwires are available in three basic forms (Tapered, Ovoid, and Square), therefore choosing the most convenient arch form based on each patient's pre-treatment arch form may be more clinically relevant **(Gafni *et al.*, 2011)**.

Since the ovoid archwire form is highly available in the market, and the most routinely used, this study was conducted to investigate if there are any post-treatment changes in the arch form and dimensions.

4.1. Study Design

This study was designed to identify the changes that occur in mandibular arch form and dimensions after orthodontic treatment. This was carried out using a retrospective cross-sectional study, which represents appropriate study design for such a purpose.

4.2. Hypothesis

The null hypothesis stated that "there is no significant difference between pre-treatment and post-treatment mandibular arch forms". Therefore, there was insufficient evidence to reject the null hypothesis.

4.3. Sample size and distribution

Pre-treatment and post-treatment mandibular dental models of 58 patients were assessed for changes in arch dimensions and form after orthodontic treatment. All the patients who were selected for the study received nonextraction treatment in the mandibular arch, since treatment with teeth extraction is likely to be associated with more changes in arch form during treatment than nonextraction treatment **(Sampson *et al.*, 1995)**. All patients were treated in the Teaching Hospital at the College of Dentistry-University of Baghdad.

This total sample size was considered appropriate compared to other studies, with similar aims, such as **Taner *et al.* (2004)** who assessed study models of 21 participants and **Daou *et al.* (2020)** who assessed 50 participants.

4.4. Methodology

The mandibular arch was investigated for this study since the mandible has fewer therapeutic options than the maxilla, and preserving mandibular canine width is a critical component of establishing sustained orthodontic treatment results **(Oda *et al.*, 2010; Proffit *et al.*, 2019)**. It has become popular that the original mandibular arch been used for determination of the individual arch forms **(Nojima**

***et al*., 2001; Kook *et al*., 2004; Bayome *et al*., 2011; Olmez and Dogan, 2011; Gafni *et al*., 2011; Celebi *et al*., 2016)**.

A two-dimension scanner was used in this study, and this method has been used in previous investigations **(Taner *et al*., 2004; Bayome *et al*., 2011; Othman *et al*., 2012; Aldrees *et al*., 2015; Ahmed *et al*., 2019)**. The facial axis point was difficult to mark using this method. As a consequence, the contact points were localized in order to define the clinical bracket points as landmarks for mandibular arch form evaluation, as mentioned and used previously by **Nojima *et al*. (2001)**, **Kook *et al*. (2004)**, **Bayome *et al*. (2011)**, and **Gafni *et al*. (2011)**.

Many studies used mathematics to determine arch form **(Raberin *et al*., 1993; Kosaka, 1997; Braun *et al*., 1999)** and others used incisal edges and cusp tips as landmarks for identifying the arch form **(Ferrario *et al*., 1994; Kasai *et al*., 1997; Othman *et al*., 2012; Saeed and Majeet, 2018; Omar *et al*., 2018)**. The method used in this study is more relevant to orthodontic treatment, because the selected landmarks are more related to the bracket positions and the archwire than to the incisal edges and cusp tips.

The software program that used in this study was AutoCAD (2020), in order to help the researcher to get accurate measurements in shorter time, as used by **Bayomi *et al*. (2011)** and **Aldrees *et al*. (2015)**.

Evaluation of mandibular arch forms was performed using arch form templates (Tapered, Ovoid, and Square). These templates used by **(Chuck, 1934)** for the first time, and specified by **Bennett, McLaughlin** and **Trevisi (McLaughlin *et al*., 2001)**. **Chuck (1934)** thought that arch form determination of the patient and choosing the suitable arch wire form would result in successful treatment, and as a result, these templates were used to create a visual description of dental arch form.

These orthoform templates were used by many researchers in their studies for mandibular arch form identification **(Nojima *et al.*, 2001; Kook *et al.*, 2004; Yun *et al.*, 2004; Bayome *et al.*, 2011; Gafni *et al.*, 2011; Olmez and Dogan, 2011; Othman *et al.*, 2012; Lee *et al.*, 2013; Celebi *et al.*, 2016)**. This subjective approach, which uses tapered, ovoid, and square forms to identify prefabricated orthodontic archwires for each patient, is widely used in orthodontic clinics **(McLaughlin and Bennett, 1999)**.

4.5. Descriptive Statistics

The participant's age was between 13 and 29 years including adult and growing patients. **Bashara *et al.* (1997)** stated that intercanine and intermolar widths in both the maxillary and mandibular arches considerably increased between the ages of 3 and 13, and after the eruption of permanent dentition, either no changes or a slight decrease in arch widths should be expected by clinician. **Sinclair and Little (1983)** reported that there is little to no increase in arch length or perimeter after the age of 12. **Gupta *et al.* (2010)** Concluded that dental and basal arch shapes of adolescents and adults did not differ significantly.

Females represent 79.3%, while males represent 20.7%, and this higher percentage of females in comparison to males may be attributed to that females are more interested in improving their dental and facial appearance than males, and this agrees with other studies which found that females seek orthodontic treatment more than males **(Kerosuo *et al.*, 2000; Harris and Glassell, 2011; Mahmoudzadeh *et al.*, 2018)**.

4.6. Comparison of Dental Arch Form and Dimensions Before and After Treatment

Post-treatment intercanine width was statistically significantly smaller than that of pre-treatment intercanine width and this coincide with the increased frequency of tapered arch form post-treatment that also revealed in this study. This may occur as a result of proclination of lower anterior teeth in nonextraction treatment. **Miyake *et al*. (2008)** reported that the lower incisors moved toward the anterior direction in the nonextraction treatment.

While, intermolar width and molar width/depth ratio were significantly greater post-treatment. Intermolar width was found to be likely increased by nonextraction treatment **(BeGole *et al*., 1998)**. **Weinberg and Sadowsky (1996)** also reported that the dental arch expanded as a whole because of the performance of nonextraction therapy. This agrees with **Taner *et al*. (2004)** who found a significant increase in the intermolar width during orthodontic treatment. **Daou *et al*. (2020)** reported in their study that the mandibular intercanine and intermolar distance did not significantly change after treatment and arch depth increased significantly after orthodontic treatment. **Aksu and Kocadereli (2005)** also reported no significant change in the mandibular intermolar width.

It has been shown that there was no statistically significant difference between arch form before and after treatment. The frequency of tapered arch form showed a slight increase after treatment and this may be due to proclination of the lower anterior teeth during treatment.

Taner *et al*. (2004) concluded in their study that 33% of the mandibular arch forms were changed during orthodontic treatment, tapered arch forms kept their original shapes or changed to normal or

narrow tapered, and pre-treatment narrow tapered mandibular arch forms remained mostly narrow tapered or changed to normal or tapered arch forms, while pre-treatment normal mandibular arch forms were not changed with treatment.

Felton *et al*. (1987) stated that 70% of their class II sample had their arch forms changed during orthodontic treatment. The difference in results between studies may be related to the different treatment needs. The differences in the current study (even the statistically significant) are minors. Therefore, it is suggested to evaluate the change in arch form with larger sample and including extraction cases.

CHAPTER 5: CONCLUSIONS

1. Intercanine width decreased post-treatment.
2. Intermolar width and molar width/depth ratio increased post-treatment.
3. There was a slight (non-significant) increase in the tapered arch form compared to other forms post-treatment
4. It is necessary to assess the arch form pre-treatment to reduce the possibility of relapse post-treatment.

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