A New Method for Dental Cast Analysis

Jassim Ali Al-E'nizy[1], Zainab Bahjat Mohammed Amin Al-Ani[2], Mohammed Nahidh[3]

[1]Assistant Lecturer, [2]Lecturer, Department of POP, College of Dentistry, Al-Anbar University, Iraq,[3]Assistant Professor, Department of Orthodontics, College of Dentistry, University of Baghdad, Iraq

Abstract

Objectives: This study aimed to develop a new method of dental cast analysis using angular measurements.

Materials and methods: One hundred study models belong to 100 Iraqi healthy adults with class I occlusion were assessed using Planmeca dimax software. Three angular measurements at the levels of maxillary canines, second premolar and second molars cusp tips with the tip of the angles at the midpoint between the two central incisors were measured. Gender difference was evaluated by unpaired t-test and the relation between the angles was assessed by Pearson's correlation coefficient test.

Results: The results revealed higher mean values of the measured parameters in males with direct, moderate to strong, significant correlation.

Conclusions: A new method was developed and could be used to assess the growth and treatment changes in the future researches.

Key words: *Dental cast, analysis, arch form*

Introduction

Many diagnostic aids can help orthodontists reach definitive diagnosis before treating orthodontic cases. Dental casts are considered as one of these aids [1]. Orthodontists utilized these models in determination dental arch length, width, perimeter, individual tooth width, space analysis and dental arch forms [2].

Initially, dental casts or study models are constructed from plaster of Paris and dental stones. These are subjected to breakage and degradation issues and required meticulous archiving and enormous storage space [3].

Corresponding author
Mohammed Nahidh
Department of Orthodontics, College of Dentistry, University of Baghdad, Iraq
e-mail: m_nahidh79@yahoo.com
ORCID ID: 0000-0003-0155-418X
Mobile: 009647702551616

At the mid 1990s, three-dimensional (3D) scanning technology was introduced, hence facilitated transforming the plaster study into digital format that stored in computer with easy transmission between professionals with accurate analysis of treated cases [4]. In comparison with plaster models, digital models present high degree of validity, accuracy and reliability in measurement with clinically acceptable differences between them [4,5].

The major issue with 3D scanner is the cost, [4] hence it may not be provided in all clinics, so photocopy of the study models can serve as a digital format for the plaster one to aid in preserving the space and performing accurate cast measurements, although the problem of 2D image still exists.

Every patient has his/her own dental arch form that should be maintained at the end of the orthodontic therapy to get stable results [6]. Numerous methods had been adopted to determine the dental arch forms using the liner analysis or the proportional measurements [7], arch width and arch length [8] arch length, width, and depth [9].

This study aimed to introduce a new method for dental cast analysis that depended on measuring three angles at the maxillary canine, second premolar and second molars levels.

Methods

Study design

This cross-sectional study was approved by the ethical and scientific committees in the College of Dentistry of Baghdad and Al-Anbar Universities and conducted in accordance with the principles of the Declaration of Helsinki.

Sample

After getting the approval for participation in this study, 250 students in the College of Dentistry/ Al-Anbar University were examined to ensure their fulfillment of study's inclusion criteria and only 100 students (40 males and 60 females) met these criteria which were:

1. Normal healthy individuals aged 18-25 years old with clinically symmetrical face.

2. Have full complement of permanent dentition (regardless the third molars) with bilateral class I molars and canines relationships and good alignment of the maxillary and the mandibular teeth with less than 3mm of spacing or crowding [10].

3. Normal overjet and overbite (2-4mm) with no crossbite.

4. No history of previous orthodontic, orthognathic interventions.

5. Normal teeth size, number and position with no crown fracture and absence of detectable massive interproximal or occlusal caries.

Methods

Firstly, the aims of the study were explained for the participants who seated comfortably on the dental chair. Personal information like name, age, history of facial trauma, orthodontic treatment and surgery were gathered and recorded in the case sheet.

Clinical examination both extra- and intra-orally was performed to check the students' fulfillment of the sample inclusion criteria. Then maxillary dental impression was taken using Alginate impression material (Hydrogum soft mint scent Alginate, Zhermack, Italy). The impression was checked for accuracy, washed with tap water and disinfected by Sodium hypochlorite 1% for ten minutes, then washed and poured with type IV dental stone (Elite® stone, Zhermack, Italy) to get a standardized dental cast. Using fine ended permanent marker, the following points were determined on the casts [10]:

1. Incisal point: The mid point between central incisors at the level of incisal edge

2. Canine point: The cusp tips of the maxillary canines.

3. Second premolar point: The buccal cusp tips of the maxillary 2nd premolars.

4. Second molar point: The mesio-buccal cusp tips of the maxillary 2nd molars.

After that, the casts were photographed using digital camera under standardized method. Image from occlusal surface of each maxillary cast was taken at about 20 cm distance from the base using professional camera. The images were imported to Planmeca dimax software to measure the following angles (Figure 1):

1. Superior inter-canine angle (SICA): The angle between right and left canine points with its head at incisal point opposite to inter-canine distance (the red one).

2. Superior inter-second premolar angle (SI2PA): The angle between right and left 2nd premolar points with its head at incisal point opposite to inter-second premolar distance (the blue one).

3. Superior inter- second molar angle (SI2MA): which is the angle between right and left 2nd molar point with its head at incisal point opposite to inter- second molar distance (the green one).

Reliability test

Fifteen images were selected randomly and the angles were re-measured after one month to determine the reliability of the measurements. Intra-class correlation coefficient test revealed excellent reliability (>0.90).

Statistical Analyses

Data were analyzed by SPSS program (version 25). Means and standard deviations were obtained and

gender difference was assessed using independent sample t-test. Pearson's correlation coefficient test was used to determine the relation among the measured angles in each gender. The level of probability was set at 0.05.

Table 1: Descriptive statistics and gender difference for the measured angles in degrees

Variables	Genders	Descriptive statistics			Comparison	
		N	Mean	S.D.	t-test	p-value
SICA	Males	40	128.803	6.174	1.697	0.093
	Females	60	126.830	5.353		
SI2PA	Males	40	95.123	4.225	2.211	0.029
	Females	60	93.125	4.554		
SI2MA	Males	40	75.073	2.979	3.453	0.001
	Females	60	72.767	3.451		

Table 2: Correlation among the variables in male group

Variables	Relation	SI2MA	SI2PA
SICA	R	0.600	0.811
	p-value	0.000	0.000
SI2PA	R	0.732	
	p-value	0.000	

Table 3: Correlation among the variables in female group

Variables	Relation	SI2MA	SI2PA
SICA	R	0.556	0.683
	p-value	0.000	0.000
SI2PA	R	0.810	
	p-value	0.000	

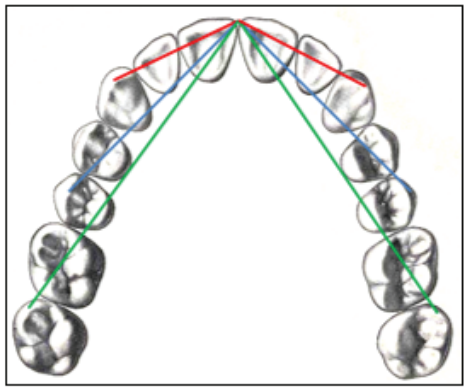

Figure 1: The angles used in the present study

Figure 1: The angles used in the present study

Results

Table 1 showed the means and standard deviations of the angles used in this study for both genders. Generally, these angles were higher statistically in males with significant difference in second premolar and molar angles.

Tables 2 and 3, related to the correlation between the measured angles in males and females respectively. The results revealed moderate to strong, direct and high significant correlations among these angles.

Discussion

Many methods had been adopted to determine the dental arch form. The most commonly used of Raberin et al. [11] who utilized six transverse and longitudinal dimensions to calculate ratios that determined the mandibular dental arch form.

In this study, a trial was made to introduce a simple method using angular measurements to obtain three angles at the level of the maxillary canines, second premolars and second molars with the head of these angles on the midpoints between the maxillary central incisors.

Previously, Ghaib and Odeh [12] selected 122 students aged 12-13 years with class I molar relation to study the maxillary arch form by measuring the inter-canine angle and inter-first molar angle with the midpoint of maxillary central incisors as a head for these angle, moreover; they measured the angle between lines connecting the maxillary central incisor with canine cusp tip and canine cusp tip and mesio-buccal cusp of maxillary first molars. Nearly the same measurements were used by Oliva et al. [13] on Italian adults.

In the current study, the mean values of all angles measured were higher in males than females (table 1). This comes in accordance with the findings of Ahmed and Ali [14] and Nahidh et al. [15] who found significant gender difference regarding the inter-canine and inter-second molar distance thus it is normal to get higher means for these angles in males. Moreover; it is obvious that the facial form of adult males and females is significantly different both in hard and soft tissue components [16]. Regarding dental arch form, a sexual dimorphism was anticipated too. This can be explained by the smaller and smoother bony ridge and alveolar process in addition to the average weakness of females' musculature that play vital role in facial breadth measurements, width and height of dental arch adding to that the longer period of growth males took that allowed later growth in males [10].

The means (±the standard deviations) of SICA in the present study (128.8º±6.17º for males and 126.83º±5.35º for females) are different from that of Oliva et al. (123.76º±7.81º for males and 127.65º±9.85º for females). This may be related to the difference in the ethnic group, sample size and selection with regard to the facial type. Oliva et al. [13] explained that difference by the more ovoid and flatter maxillary arch form of females.

Regarding the relation among the measured angles, Pearson's correlation coefficient test revealed direct, moderate to strong, significant relation in both genders.

Further studies are recommended to evaluate the effect of growth and treatment on the dental arch form; moreover, an Iraqi study is needed to determine whether the preformed arch wires are conformed to that measured from the normal population with different facial types.

Conclusions

New method of dental cast analysis has been introduced using simple three angular measurements. This method is simple quick and depends on angular measurements that not need magnification correction upon measurements.

Conflict of Interest : No conflict of interest

Source of Funding: Self-funded

References

1. Singh G. Textbook of orthodontics. 3rded. New Delhi: Jaypee Brothers medical publishers (P) Ltd.; 2015.
2. Proffit WR, Fields HW Jr, Larson BE, Sarver DM. Contemporary orthodontics. 6th ed. Philadelphia: Elsevier; 2019.
3. Westerlund A, Tancredi W, Ransjö M, Bresin A, Psonis S, Torgersson O. Digital casts in orthodontics: A comparison of 4 software systems. Am J Orthod Dentofacial Orthop 2015; 147(4): 509-516.
4. Fleming PS, Marinho V, Johal A. Orthodontic measurements on digital study models compared with plaster models: a systematic review. Orthod Craniofac Res 2011; 14: 1–16
5. Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi CL. Diagnostic accuracy and measurement sensitivity of digital models for orthodontic purposes: A systematic review. Am J Orthod Dentofacial Orthop 2016; 149(2): 161-170.
6. Graber LW, Vig KWL, Vanarsdall RL Jr, Huang GJ. Orthodontics current principles and techniques. 6th ed. St. Louis: Elsevier Inc; 2017.
7. Slaj M, Spalj S, Pavlin D, Illes D, Slaj M. Dental archforms in dentoalveolar Class I, II and III. Angle Orthod 2010; 80(5): 919-924.
8. Lineberger MB, Franchi L, Cevidanes LH, Huanca Ghislanzoni LT, McNamara JA Jr. Three-dimensional digital cast analysis of the effects produced by a passive self-ligating system. Eur J Orthod 2016; 38(6): 609-614.
9. Thilander B. Dentoalveolar development in subjects with normal occlusion. A longitudinal study between the ages of 5 and 31 years. Eur J Orthod 2009; 31(2): 109-120.
10. Younes SAS. Maxillary arch dimensions in Saudi and Egyptian population sample. Am J Orthod 1984; 85(1): 83-87.
11. Raberin M, Laumon B, Martin J-L, Brunner F. Dimensions and form of dental arches in subjects with normal occlusions. Am J Orthod Dentofacial Orthop 1993; 104(2): 67-72.
12. Ghaib NH, Odeh FD. The establishment of the harmonious upper arch form. J Coll Dentistry 1998; 2: 255-263.
13. Oliva B, Sferra S, Greco AL, Valente F, Grippaudo C. Three-dimensional analysis of dental arch forms in Italian population. Prog Orthod 2018; 19: 34.
14. Ahmed HMA, Ali FA. Dental arches dimensions, forms and the relation to facial types in a sample of Iraqi adults with skeletal and dental class I normal occlusion. J Bagh Coll Dentistry 2012; 24(Sp Iss 1): 99-107.
15. Nahidh M, Ahmed HMA, Mahmoud AB, Murad SM, Mehdi BS. The role of maxillary canines in forensic odontology. J Bagh Coll Dentistry 2013; 25(4): 109-113.
16. Tanikawa C, Zere E, Takada K. Sexual dimorphism in the facial morphology of adult humans: a three-dimensional analysis. HOMOJ Comp Hum Biol 2016; 67(1): 23–49.