The relationship between the maxillary dental arch width, depth and circumference

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ABSTRACT

This study was carried out on a random sample of (50) upper stone dental caste for intermediate school student (25 males and 25 females) aged (12-15) years from different areas of Mosul city.

The correlation between the dental arch width, depth and circumference was calculated. It was found that male maxillary dental arch is greater in all dimensions than the female one. There was a weak correlation between the dental arch widths and the corresponding palatal vault depths. The correlation was moderate between the maxillary arch circumference and widths except at intercanine distance width, which it showed a high correlation and it was a weak between the arch circumference and the palatal vault depths.

Key Words: Dental arch width, dental arch depth, circumference.

الخلاصة

أجريت هذه الدراسة على عينة عشوائية تكونت من (٥٠) نموذج دراسي للفك الأعلى (Upper Dental Stone) لطلاب المدارس المتوسطة (٢٥ ذكراً و ٢٥ أنثى) لعمر (١٢-١٥) سنة اختيروا من مناطق مختلفة في مدينة الموصل.

تم حساب العلاقة بين عرض (Width) وعمق (Depth) ومحيط (Circumference) الفك الأعلى وبينت نتائج الدراسة أن أبعاد الفك الأعلى لدى الذكور كانت أكبر مما هي لدى الإناث. لقد كانت العلاقة ضعيفة (Weak) بين عرض الفك الأعلى لمختلف النقاط المعتمدة مع عمق الفك لنفس تلك النقاط؛ كما كانت العلاقة متوسطة (Moderate) بين محيط وعرض الفك الأعلى ما عدا تلك مع المسافة ما بين الناببين (Intercanine Distance)، حيث كانت عالية (High)، بالإضافة إلى ذلك فان العلاقة بين محيط وعمق الفك الأعلى كانت ضعيفة.

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INTRODUCTION

The basic form of the maxillary dental arch is determined by at least the fourth month of intrauterine life [1,2]. The arch size and shape varies among individuals according to tooth size, tooth position pattern of craniofacial growth and by several genetic and environmental factors [3, 4, 5]. The heritabitity of dental arch, size and shape indicates a dominance of environmental over genetic factors.

Attempts were made to confirm a possible relation of dental arch dimensions [6-9].

Begg and Kesling [10] admit that the determination of the dental arch form in orthodontic practice remains an empirical art rather than exact science.

Decoster [11] emphasizes that, normality doesn't result in conformity of all land marks within a given law but rather in the proportionality of the different part to one another and the lack of proportion denoted anomaly.

Lebret [12] carried out a longitudinal study on (5) to (18) years and the results showed that the alveolar processes increased in height and breadth continuously. The shape of the palatal vault remained constant except for the increment in breadth at the apex of the palatal vault in three-fourth of the sample.

Bakvin [13] noted that the palatal arch dimensions found to be poorly correlated with each other.

Westerman *et al.* [14] compared the palatal dimensions (width, depth and height) obtained from patients with Down's syndrome to a control population. Results demonstrated that the palatal dimensions of participants with Down's syndrome were narrower in width, shorter in depth and lower in height.

Cholston and Scheetz [15] investigated the correlations of palatal size dimensions and depth. It was found that male exhibited a slight ($r= -0.14$) negative correlation between intermolar width and depth. Females exhibited a slight ($r=0.26$) positive correlation between intermolar width and depth.

Eid *et al.* [16] carried out a study on a random sample of upper and lower dental casts for Egyptian young children aged (9-12) years. The correlation between the dental arch width, depth and circumference & it was a correlation between dental arch widths and the corresponding palatal vault depth, except at the first permanent molar region. The dental arch circumference was highly significantly correlated with the inter first molar

distance, and no significant correlation between the dental arch, circumference and the palatal vault depth was found.

Adkin *et al.* [17] analyzed the relationship between changes in the dental arch perimeter and dental arch widths (inter canine, inter premolar and inter molar distances) resulting from rapid palatal expansion and found that the increase in dental arch perimeter.

Johnson *et al.* [9] compare the palatal dimensions (width, length and depth) in adult occlusions and malocclusion (Cl-I crowded, Cl II-I, Cl-11-2 and Cl-III) in a pilot study. It was found that Cl- II-l palates were narrowest in width and Cl-II-2 palate were shortest in length with other groups similar for these dimensions, Cl III and Cl-I crowded subjects had a deepest platates and Cl-II-2 samples having shallowed palates.

The purpose of this article is to analyze and confirm a possible relation of the maxillary dental arch dimensions (dental arch widths, depths and circumference) of school children in Mosul, using concept of the proportional analysis to obtain information for the planning of resources and facilities for orthodontic diagnosis and treatment.

MATERIALS AND METHODS

The sample of this study consisted of (50) maxillary study models (25) for male and (25) for female randomly selected from intermediate school children aged (12-15) years in Mosul city.

Exclude from the study all children demonstrated any skeletal abnormalities, such as cleft palate, cross bite, malocclusion, or lack of continuity of the dental arch as a result of extraction.

The casts were trimmed with the base parallel to the occlusal plane. Points from which measurements were to be taken, were marked with a line-lead pencil to facilitate identification. Once marked the following measurements were taken from each model:

1-Arch width.

2- Palatal vault depth.

3- Arch circumference.

The arch width was measured from the tip of the right permanent canine, the buccal cusp tip of the right first premolar, the buccal cusp tip of the right second premolar, the mesiobuccal cusp tip of the right first molar to their corresponding land marks on the left side (Figure 1).

The palatal vault depth was defined as the vertical distance from point midway at the measured upper arch widths to the corresponding palatal vault (Figure 2).

The arch circumference was measured by dividing dental arch into four segments, which included two incisal segments and two buccal segments (Figure 3).

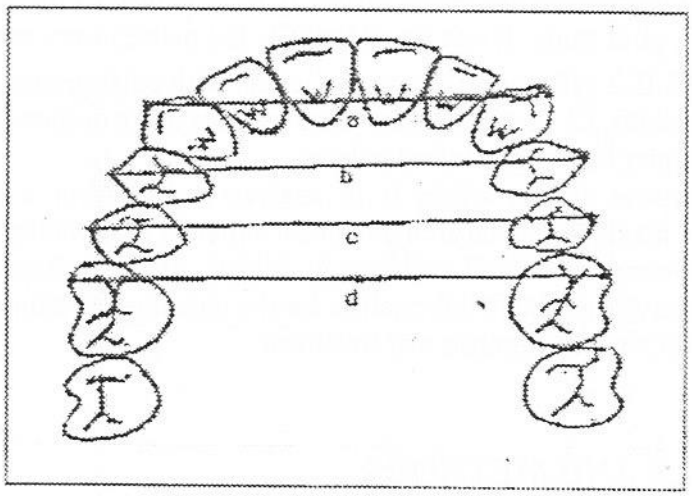

Figure (1): The arch widths distances; a: Inter canine distance; b: Inter first premolar distance; c: Inter second premolar distance; d: Inter molar distance

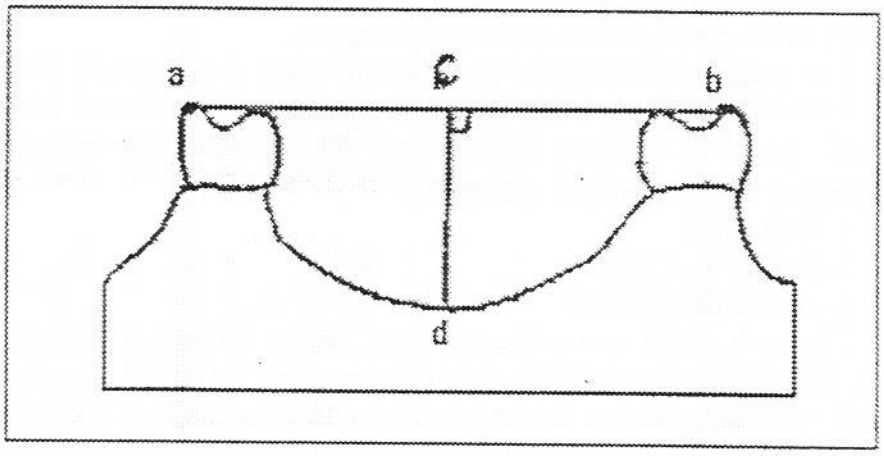

Figure (2): The palatal vault depth; a-b: Arch width; c-d: Palatal vault depth

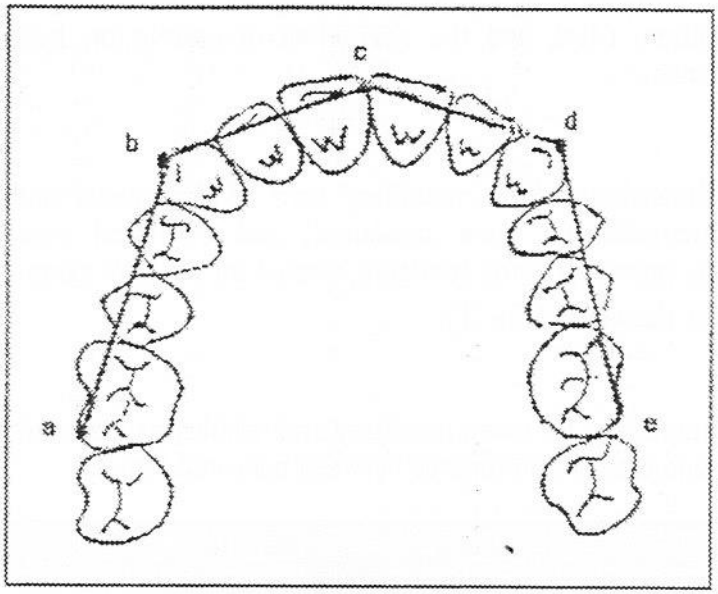

Figure (3): The arch circumference measurement; Arch circumference is the sum of the lengths of the segments connecting points a, b, c, d, and e

The incisal segment was measured as a linear distance from the point mid way between the two central incisors to the canine cusp tip for the right and left sides of the dental arch.

The buccal segment was measured as a linear distance from the canine cusp tip to the distobuccal cusp tip of first permanent molar for the right and left sides of the dental arch. (Figure 3).

The arch width and arch circumference were measured with the use of a sharpen-pointed modified sliding caliper, graduated to one tenth of a millimeter.

The palatal height was measured with the use of a palatometer.

All dental casts were measured independently and each reading was recorded separately. Each palatal dimension was measured twice with an interval of one week between measurements. If first and second measurement differed by more than one-tenth of a millimeter a third measurement was taken and the estimate of a measurement was the arithmetic mean of the three readings.

All recorded data of study sample were subjected to statistical and computerized analysis using the statgraph program for producing the mean, standard deviation, t-test, and the coefficient of correlation between the variables obtained.

RESULTS

The dimensions of the maxillary arch widths, palatal vault depths and arch circumference were measured; and statistical result were distributed on, mean, standard deviation, t-value for the total sample (males and females) as shown in table (1).

Table (1): Comparison for mean maxillary arch widths, palatal vault depths and arch circumference between male and female

Variable	Male		Female		t-value
	Mean	S.D	Mean	S.D	
ICW	34.66	2.02	33.50	1.48	2.19
IP1W	42.78	1.23	41.28	1.65	3.66
IP2W	47.85	1.77	45.98	2.74	2.87
IMW	53.24	1.95	51.14	2.44	3.35
ICD	6.37	1.01	6.13	0.90	0.87
IP1D	13.36	2.11	13.21	1.73	0.28
IP2D	17.1	2.34	16.42	1.62	1.19
IMD	17.70	2.30	16.95	1.75	1.29
AC	92.13	3.80	89.72	2.98	-2.49

ICW: Inter canine width; IP1W: Inter first premolar width; IP2W: Inter second premolar width; IMW: Inter molar width; ICD: Inter canine distance; IP1D: Inter first premolar distance; IP2D: Inter second premolar distance; IMD: Inter molar distance; ACIR: Arch circumference.

Statistical analysis using "t-test" at $p<0.05$ significance level express the presence of sex difference, with males exceeded females in all maxillary arch dimensions.

The greatest significant difference between the average males and females was (2.41) mm for the maxillary arch circumference while the significant sex difference were present in maxillary dental arch widths with

more pronounced sex difference at the inter molar distance, and the least was noticed in palatal vault depths, particularly the palatal vault depth at the inter first premolar distance.

The correlations among the maxillary arch widths, palatal vault depths, and the arch circumference in both sexes are shown in table (2), some of which showed high significant and direct relations while other dimensions exhibit moderate or weak relationship.

The value of "r" ranged from (0.023-0.846) with the highest value is in males between inter second premolar and inter molar widths with r-value equal to (0.846). While the least value (0.117) was found in male between intercanine width and the depth at the intercanine distance.

However, in females the highest r-value (0.828) was between intercanine width and arch circumference and the least value (0.023) was between intercanine width and inter canine depth.

Table (2): Correlation coefficient among the maxillary arch widths, palatal vault depths, and the maxillary arch circumference in both sexes

Variable	Sex	ICW	IP1W	IP2W	IMW	ICD	IP1D	IP2D	IMD
ICW	M	1.000							
	F	1.000							
IP1W	M	.583	1.000						
	F	.624	1.000						
IP2W	M	.435	.751	1.000					
	F	.685	.675	1.000					
IMW	M	.425	.618	.846	1.000				
	F	.639	.634	.772	1.000				
ICD	M	.117	.217	.456	.352	1.000			
	F	.023	.032	.033	.117	1.000			
IP1D	M	.362	.267	.397	.288	.720	1.000		
	F	.247	.227	.209	.086	.498	1.000		
IP2D	M	.512	.162	.321	.246	.486	.803	1.000	
	F	.215	.161	.412	.156	.294	.504	1.000	
IMD	M	.565	.264	.362	.354	.292	.631	.766	1.000
	F	.233	.172	.442	.377	.070	.395	.589	1.000
AC	M	.769	.546	.378	.469	.292	.383	.402	.392
	F	.828	.409	.565	.593	.084	.212	.107	.176

ICW: Inter canine width; IP1W: Inter first premolar width; IP2W: Inter second premolar width; IMW: Inter molar width; ICD: Inter canine distance; IP1D: Inter first premolar distance; IP2D: Inter second premolar distance; IMD: Inter molar distance; ACIR: Arch circumference.

DISCUSSION

In this study the measurements taken for the dimension of the maxillary arch widths, palatal vault depths and the maxillary arch circumference confirm with the accepted view that the male upper dental arch is greater in all dimensions than the female one.

The sex difference in arch dimension variables could be because of the fact that the thickness of the crest of the bony ridge varies in both sexes which is smoother and smaller in females compared to male [5]. Also, the average weakness of the musculature in the females play an important role in the facial breadth measurement profile angle, width and height of the maxillary arch [18].

Different correlations were noticed between the maxillary dental arch dimensions for both males and females with higher r-value in male than female.

Generally, the correlations among the maxillary arch widths were ranged from moderate to strong, while the correlation among the palatal vault depths were ranged from weak to strong.

The maxillary arch widths were poorly correlated with the corresponding palatal vault depths. This result is in agreement with Bakvin [13] and in contrast to the finding of Eid *et al.* [16] who found it to be a strong one.

The maxillary arch circumference was moderately correlated with the maxillary arch widths except at the inter distance with which it showed a high correlation.

On the other hand, the maxillary arch circumference was poorly correlated to the palatal vault depth. These results suggested that an increase in the maxillary arch length was accompanied by an increase in the maxillary arch widths especially at the intercanine distance and by unchanged palatal vault depth.

Due to the different land marks and criteria used among the investigators in measuring the dental arch widths, palatal vault depths and circumference. The comparison will be restricted to that of Eid *et al.* [16] who used the same landmarks except the maxillary arch circumference as in the present study.

The difference in the conclusion of this study from that of Eid *et al.* study at age (12) years as shown in table (3) may be related to the difference in the age group and environmental factors.

Table (3): Comparison of the maxillary arch widths, palatal vault depths and maxillary arch circumference of the present study and Eid *et al.* Study

		ICW	IP1W	IP2W	IMW	ICD	IP1D	IP2D	IMD
Present Study 1997	M	34.66	42.78	47.85	53.24	6.37	13.36	17.1	17.70
	F	33.50	41.28	45.98	51.14	6.13	13.21	16.42	16.95
Eid *et al.* Study 1987	M	36.8	43.4	48.3	52.7	5.6	12.4	15.6	16.3
	F	35.5	42.7	47.6	51.7	5.8	12.5	15.8	16.2

ICW: Inter canine width; IP1W: Inter first premolar width; IP2W: Inter second premolar width; IMW: Inter molar width; ICD: Inter canine distance; IP1D: Inter first premolar distance; IP2D: Inter second premolar distance; IMD: Inter molar distance.

REFERENCES

1. Cohen L. Growth and development of the dental arches in children. *J Am Dent Assoc.*1940; 27: 1250-1260.
2. Cleall N, Chebih M. Craniofacial Morphology. *Am J Orthod.* 1979; 75: 650-666.
3. Bebgott S. Factors of human skeletal craniofacial morphology. *Am J Orthod.* 1977; 47: 222-230.
4. Falconer M. Genetic analysis of occlusal variation in twins. *Am J Orthod.* 1980; 78: 140-154.
5. Ismail AM, Ghaib NH, Manhel SR. Maxillary arch dimensions in Iraqi population sample. Accepted for publication in *Iraqi Dent J.* 1993.
6. Barrow MW. Development changes of Maxillary and mandibular dental arches. *Angle Orthod.* 1952: 41-46.
7. Andria LM, Dias JC. Relation of maxillary and mandibular inter cuspid width to bizygomatic & bigonial breadth. *Angle Orthod.* 1978; 48(2): 154-161.
8. Harris L, Smith N. Study of occlusion & width in females. *Am J Orthod.* 1980; 78: 155-163.

9. Johnson JG, Kuntz TR, Staley RN, Jakobsen JR. Comparison of palatal dimensions in adult normal occlusion and malocclusion. *J Dent Res*. 1994: 73.
10. Begg L, Kesling S. Serial study of good occlusion from Birth to 12 years of age. *Am J Orthod*. 1951; 37(7): 481-507.
11. Decoster L. The net work method of orthodontic diagnosis. *Angle Orthod*. 1959; 31:14-18.
12. Lebret L. Growth changes of the palate. *J Dent Res*. 1962; 41(6): 1390-1404.
13. Bakvin O. Association in width dimension of the upper and lower Jaw. *Trans Eur Orthod Soc*. 1971; 465-471.
14. Westerman CH, Johnson R, Cohen MM. Variation of palatal dimensions in patients with Down's Syndrome. *J Dent Res*. 1995; 54(4): 767-771.
15. Cholston LR, Scheetz JP. Three plane correlations of palatal size dimensions. *J Dent Res*. 1982; 61(1): 317.
16. Eid AA, Nammrawy MM, Kadry WA. The relationship between the width, depth and circumference of dental arch for group of Egyptian school children. *Egypt J Orthod*. 1987; 1(2): 113-137.
17. Adkins MD, Nanda RS, Currier GF. Arch perimeter changes on rapid palatal expansion. *Am J Orthod*. 1990; 97(3): 323-335.
18. Younes SA. Maxillary arch dimensions in Saudi & Egyptian population sample. *Am J Orthod*. 1984; 85(1): 83-87.