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Predicting the combined widths of unerupted maxillary and mandibular canines and premolars utilizing the widths of maxillary and mandibular central incisors and first molars

Mohammed Nahidh, B.D.S., M.Sc.
Assistant Professor. Department Of Orthodontics. College Of Dentistry, University Of Baghdad.

Abstract
Background: *Prediction the width of unerupted permanent canines and premolars is far important in assessing the space available to them in an attempt to prevent the future malocclusion. The present study utilized the combined mesio-distal crowns widths of maxillary and mandibular central incisors and first molars to predict the combined mesio-distal crowns widths of maxillary and mandibular canines and premolars in an Iraqi sample.*
Materials and methods: *One hundred ten Iraqi Arab subjects with an age ranged between 17-25 years and normal skeletal and dental relations were accepted to participate in this study. Dental impressions for maxillary and mandibular arches were taken with alginate impression material then poured with type IV dental stone to get study models. On these models, the mesio-distal crown widths of maxillary and mandibular central incisors, canines, premolars and 1st molars were measured using digital electronic caliper with 0.01 mm sensitivity. Pearson's correlation coefficient test was used to determine the relation between the combined mesio-distal crowns widths of maxillary and mandibular central incisors and first molars and the combined mesio-distal crowns widths of maxillary and mandibular canines and premolars. The equations that predict the widths of maxillary and mandibular canines and premolars were obtained using simple regression analysis test. Paired sample t-test was used to compare between the actual and predicted mesio-distal crown widths.*
Results: *Non-significant differences between the predicted and actual mesio-distal crown widths were shown in this study.*
Conclusions: *The combined mesio-distal widths of maxillary and mandibular central incisors and first molars can be used to predict the combined mesio-distal crown widths of maxillary and mandibular canines and premolars with a high percentage of accuracy reaching to more than 80%.*
Key words: *Prediction, teeth width, space analysis*

I. INTRODUCTION

During mixed dentition stage, diagnosing dental arch length deficiency is a vital procedure to prevent malocclusion. The maxillary and mandibular anterior teeth and 1st molars erupted in this stage in addition to the primary canines and molars. Crowding may occur after normal exfoliation of the primary canines and molars. Although these teeth possess larger widths than their successors in addition to the primary spaces, crowding may be developed due to large teeth (genetically determined) or deficient size of dental arches because of the increasing trends towards soft food so the dental arches will not be developed well to accommodate the whole teeth (environmental factor). Many methods were developed to predict the widths of permanent canines and premolars to help in managing the space for them in the dental arch.

G.V. Black [(1)] was the first who published the average widths of the teeth. Black's work was not so accurate because of the individual variations in the size of the teeth in different genders and racial groups. The most popular two methods of prediction of unerupted canines and premolar were developed by Tanaka and Johnston in 1974 and Moyers in 1988.

Tanaka and Johnston [(2)] predicted the mesio-distal width of the unerupted canine and premolars in one quadrant by adding 10.5 mm. (in the mandibular arch) and 11 mm. (in the maxillary arch) to half the total width of the mandibular four incisors measured from the dental casts, on the other hand, Moyers [(3)] developed his famous chart for predicting the width of canines and premolars depending on the correlation between the sum of the width of mandibular incisors and the combined width of the mandibular canine and premolars. These methods may not be applicable for all racial groups as they may give an over-estimated result. Many other methods [(4-20)] utilized the regression analysis test using the widths of the maxillary or mandibular anterior teeth and 1st molars had reached to acceptable results in different racial groups.

In Iraq, many researches have been performed to predict the canines and premolars widths using different methods [(21-29)] and this is a new study utilized the combined mesio-distal crowns widths of maxillary

and mandibular central incisors and first molars to predict the combined mesio-distal crowns widths of maxillary and mandibular canines and premolars using simple regression analysis.

II. MATERIALS AND METHODS

Sample

One hundred ten Iraqi Arab subjects (55 males and 55 females) with an age ranged between 17-25 years and normal skeletal and dental relations in three planes of space [(30)] accepted to participate in this study. All of them had full sets of permanent teeth excluding the wisdom teeth. The teeth were free from caries, attrition, proximal restorations or any other defects. The individuals had no history of bad oral habits, orthodontic treatment and maxillofacial surgeries or defects.

Methods

To fulfill the inclusion criteria for sample selection, each individual was examined extra- and –intra-orally, then dental impressions for maxillary and mandibular arches were obtained using alginate impression material and poured with type IV dental stone. After setting, the impressions were inverted over a plastic mold containing Plaster of Paris to make the bases for the casts.

The teeth in maxillary and mandibular arches from the first molar to the first molar in the other side except the lateral incisors were measured at the largest mesio-distal dimension using electronic digital calipers (Mitutoyo, Japan with a sensitivity of 0.01 mm) held parallel to the occlusal plane [(31)].

Statistical analyses

The data were subjected to computerized statistical analyses using SPSS program (version 21). These analyses included:

1. Descriptive statistics (mean values, standard deviations and the numbers and percentages).

2. Inferential statistics that comprised:

- Pearson's correlation coefficient test to find out the relation between sum mesio-distal widths of maxillary and mandibular central incisors and first molars with the sum mesio-distal widths of maxillary and mandibular canines and premolars.
- Independent sample t-test to verify the gender difference.
- Simple regression analysis to determine the regression equations.
- Paired sample t-test to show whether there is significant difference between the predicted and actual mesio-distal widths of maxillary and mandibular canines and premolars in both genders.

III. RESULTS

Table 1 demonstrated the relation between the combined width of maxillary and mandibular central incisors and 1st molars with the combined width of maxillary and mandibular canines and premolars. The findings illustrated direct moderate highly significant relations between the measurements in both genders and arches.

Table 1. The relation between the combined mesio-distal crowns dimensions of maxillary and mandibular central incisors and first molars (MDDCIM) with combined mesio-distal crowns dimensions of maxillary and mandibular canines and premolars (MDDCP)

Genders	**Males**		**Females**	
Arch	**Maxillary**	**Mandibular**	**Maxillary**	**Mandibular**
r	0.661	0.609	0.575	0.589
p-value	0.000 (HS)	0.000 (HS)	0.000 (HS)	0.000 (HS)

(HS)=Highly significant P □ 0.01

The mean values and standard deviations of the measurements were presented in Table 2. Generally, males had significantly higher mean values than females in all measurements.

Table 2. Descriptive statistics and genders difference for the measured variables (mm.)

Variables	**Genders**	**Descriptive statistics**			**Genders difference**		
		N	**Mean**	**S.D.**	**Mean difference**	**t-test**	**p-value**
MDDCIM	**Males**	55	72.208	2.893	3.347	6.670	0.000 (HS)
	Females	55	68.861	2.341			
Maxillary MDDCP	**Males**	55	43.650	1.826	1.868	5.393	0.000 (HS)
	Females	55	41.782	1.805			
Mandibular MDDCP	**Males**	55	42.690	1.719	1.844	5.500	0.000 (HS)
	Females	55	40.846	1.796			

(HS)=Highly significant P □ 0.01

The third step was employing simple regression analysis test where MDDCIM representing the independent variable while maxillary and mandibular MDDCP act as dependent variables. The regression equations for predicting the mesio-distal crowns dimensions of maxillary and mandibular canines and premolars were obtained as followed:

Genders	Maxillary arch	Mandibular arch
Males	**MDDCP = 13.541 + 0.417 MDDCIM**	**MDDCP = 16.572 + 0.362 MDDCIM**
Females	**MDDCP = 11.266 + 0.443 MDDCIM**	**MDDCP = 9.729 + 0.452 MDDCIM**

Based on the values gained from the equations, the actual and predicted mesio-distal crowns dimensions of maxillary and mandibular canines and premolars were compared using paired samples t-test (Table 3). The results revealed non-significant difference (P > 0.05).

Table 3. Descriptive statistics and comparison between the predicted and actual combined mesio-distal crowns dimensions of maxillary and mandibular canines and premolars (mm.)

Arch	Genders	Actual MDDCP		Predicted MDDCP		Difference between the predicted and actual MDDCP		
		Mean	S.D.	Mean	S.D.	Mean difference	t-test	p-value
Maxillary	**Males**	43.650	1.826	43.652	1.207	-0.002	-0.011	0.991 (NS)
	Females	41.782	1.805	41.771	1.037	0.011	0.055	0.957 (NS)
Mandibular	**Males**	42.690	1.719	42.711	1.047	-0.022	-0.118	0.907 (NS)
	Females	40.846	1.796	40.854	1.058	-0.008	-0.042	0.967 (NS)

(NS)=Non-significant P > 0.05

To test the numbers and percentages of cases that lie within the limit of 2 mm. difference or over- and under- estimating the actual width of canines and premolars, each predicted measurement was subtracted from the actual one and the results showed that the percentage of cases that lie within the limit of 2mm. reached more than 80% of the cases with a percentage of less than 11% regarding the under- and over-estimated cases (Table 4).

Table 4. The frequency and percentages of cases that lie within the limit of 2 mm, over and underestimated the actual combined width of canines and premolars

Arch	Genders	Within the limit	Overestimation	Underestimation
Maxillary	**Males**	45 (81.82%)	5 (9.09%)	5 (9.09%)
	Females	45 (81.82%)	4 (7.27%)	6 (10.91%)
Mandibular	**Males**	49 (89.09%)	3 (5.45%)	3 (5.45%)
	Females	47 (85.45%)	4 (7.27%)	4 (7.27%)

IV. DISCUSSION

In order to prevent the problem of crowding in the dental arches, prediction of the combined widths of maxillary and mandibular canines and premolars should be performed during the period of mixed dentition. Tanaka and Johnston [(2)] and Moyers [(3)] developed their methods of predicting the widths of these teeth. These methods can not be applied on all ethnic groups due to the racial variations in teeth sizes.

Regarding the previous works on prediction of combined widths of maxillary and mandibular canines and premolars, the researchers either depended on Tanaka and Johnston or Moyers methods. Other used the mesio-distal width of some or all anterior teeth with or without the first molar for prediction. In the present study, the maxillary and mandibular central incisors and first molars were selected to predict the widths of maxillary and mandibular canines and premolars because they erupted early in the oral cavity.

The relations between the combined mesio-distal widths of maxillary and mandibular central incisors and first molars (MDDCIM) with combined mesio-distal crowns dimensions of maxillary and mandibular canines and premolars (MDDCP) were determined in table 1. Generally, there was direct moderate high significant relation between the variables. Vardimon and Lambertz [(32)] stated that "for practical purposes only, correlation coefficient values greater than 0.70 should be considered as reliable for prediction procedures". In the present study, the value of the Pearson's correlation coefficient test was < 0.70 and it was near to that reported by Tanaka and Johnston [(2)].

In an attempt to verify the genders difference for the variable measured, independent sample t-test was applied and the findings showed significantly higher mean values of males' teeth confirming the fact that males had larger teeth than females, so each genders developed a specific regression equation. This equation was applied as Y= a + b X where "Y" is the sum mesio-distal crowns widths of mandibular or maxillary permanent

canines and premolars, "X" is the sum mesio-distal crowns widths of maxillary and mandibular central incisors and first molars, "a" is constant and "b" is the regression coefficient.

After computing the predicted widths, paired sample t-test was applied to compare the actual and predicted measurements. Non-significant difference was shown between the predicted and actual mesio-distal crowns dimensions of both maxillary and mandibular canines and premolars (Table 3), this comes in agreement with previous studies [11-14,17,18,20,29]. The mean differences between the measurements were clinically negligible.

To check the precision of this method of prediction, the actual measurements were subtracted from the predicted one and the results showed that more that 80% of the predicted cases lie within a limit of 2 mm. in either direction. Many authors suggested that overestimation of only 1 mm beyond the actual widths of the permanent canine and premolars on each side of the arch might not gravely change an extraction or non-extraction judgment [13,14,16]. Small numbers of cases were either over-or under-estimated the actual measurements. This makes the method used more reliable for application.

V. CONCLUSIONS

The finding revealed a non-significant difference between the predicted and actual mesio-distal crown widths; consequently the sum mesio-distal widths of maxillary and mandibular central incisors and first molars can be used to predict the combined mesio-distal widths of maxillary and mandibular canines and premolars with high reliability as no X-ray is required and it does depend on eight permanent teeth that erupt early in life.

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