Prediction the widths of maxillary and mandibular canines and premolars from the widths of maxillary incisors and first molars (Iraqi study)

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ABSTRACT

Background: This study aimed to use the combined mesio-distal crowns widths of maxillary incisors and first molars as predictors to the combined mesio-distal crowns widths of maxillary and mandibular canines and premolars.

Materials and methods: The sample included 110 Iraqi Arab subjects with an age ranged between 17-25 years and class I skeletal and dental relations. The crown widths of maxillary teeth and mandibular canines and premolars were measured at the largest mesio-distal dimension on the study casts using digital electronic caliper with 0.01 mm sensitivity. Pearson's correlation coefficient was used to determine the relation between the combined mesio-distal crowns widths of maxillary incisors and first molars and the combined mesio-distal crowns widths of maxillary and mandibular canines and premolars. Regression analysis was used to determine the equations that predict the widths of maxillary and mandibular canines and premolars. Paired sample t-test was used to compare between the actual and predicted mesio-distal crown widths.

Results and Conclusions: The findings showed a non-significant difference between the predicted and actual mesio-distal crown widths; hence the combined mesio-distal widths of maxillary incisors and first molars can be used as predictors for the combined mesio-distal widths of maxillary and mandibular canines and premolars.

Key words: Prediction, regression analysis, space analysis. (J Bagh Coll Dentistry 2013; 25(3):153-157).

الخلاصة

الخلفية: هدفت هذه الدراسة إلى استخدام العرض الانسي الوحشي المجتمع للقواطع والأضراس الأولى العلوية للتنبؤ بعرض الاسنان الانسي الوحشي المجتمع للانياب والضواحك العلوية والسفلية.

المواد والطرق: شملت العينة 110 شخص عراقي بعمر يتراوح بين 17-25 سنة و من ذوي الصنف الأول من العلاقات الهيكلية والسنية. تم قياس العرض الانسي الوحشي لاسنان الفك العلوي وانياب وضواحك الفك السفلي باستخدام الفرجار الالكتروني الرقمي وبحساسية تصل الى 0.01 ملم على القوالب الدراسية خاصتهم. تم استخدام معامل ارتباط بيرسون لتحديد العلاقة بين العرض الانسي الوحشي المجتمع للقواطع والأضراس الأولى العلوية مع عرض الاسنان الانسي الوحشي المجتمع للانياب والضواحك العلوية و السفلية. باستخدام تحليل الانحدار تم تحديد المعادلات التي تتنبأ بعرض الاسنان الانسي الوحشي المجتمع للانياب والضواحك العلوية و السفلية. للمقارنة بين عرض الاسنان الانسي الوحشي الفعلي والمتوقع تم استخدام اختبار t المقترن.

النتائج والاستنتاجات: أظهرت النتائج عدم وجود فروق معنوية بين عرض الاسنان الانسي الوحشي المتوقع و الفعلي ، وبالتالي يمكن استخدام العرض الانسي الوحشي المجتمع للقواطع والأضراس الأولى العلوية لتنبؤ بعرض الاسنان الانسي الوحشي المجتمع للانياب والضواحك العلوية والسفلية.

الكلمات المفتاحية: التنبؤ، تحليل الانحدار، تحليل الفراغ.

INTRODUCTION

Accurate prediction of the space available to accommodate the un-erupted canines and premolars forms an important part of an orthodontic assessment in the mixed dentition as it is reported to assist dental practitioners to determine the treatment options for the patients [(1)].

The accuracy, safety and simplicity are important criteria for a predictive method to become a part of the comprehensive case analysis in contemporary orthodontic practice [(2)].

Many methods had been employed to predict space for un-erupted teeth [(3-17)]. Two of them are the most commonly used methods; Moyers' probability tables [(5)] and the prediction equation of Tanaka and Johnston [(14)]. However, these methods were developed on Caucasian populations and their predictive accuracy on populations from other races is doubtful. This led to development of prediction equations and probability tables for different populations.

Many methods used regression equations based on the high linear correlation between relevant groups of teeth. The main factor in this category is the possibility of predicting the sizes of un-erupted teeth by using the widths of other fully erupted permanent teeth [(2)].

In Iraq, many researches had been performed to predict the widths for un-erupted canines and premolars. Al-Khashan [(18)] studied some of the dimensional features of the permanent teeth that had a relevance of orthodontic treatment in Iraqi sample and compare to the results from different racial and ethnical groups. He found that the probability charts for prediction the width of cuspid and bicuspid utilizing the width of the lower incisor (Moyer's chart) not to be accurate to be used for Iraqi subjects.

Sofia [(19)] developed regression equations to predict the widths of maxillary and mandibular canines and premolars from maxillary and mandibular incisors. On the other hand, Jargees [(20)] predicted the widths of premolars from the widths of deciduous molars.

Awni [(21)] compared two mixed dentition prediction methods that do not require the use of periapical radiographs of the un-erupted permanent lower teeth. The two compared methods were the Tanaka/Johnston (T/J) and the Boston University (BU) prediction approaches.

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She found that the T/J approach can be used when the only permanent four mandibular incisors have completely erupted, whereas the BU approach can be used when the deciduous canines and first molars are still present.

Abdulrasool [22] predicted the combined mesio-distal width of the maxillary and mandibular canines and premolars from the width of maxillary and mandibular first molar respectively, while Al-Bustani [23] used the sum of the mesio-distal widths of the left permanent maxillary central incisor, first molar and mandibular lateral incisor as predictor for the combined mesio-distal width of un-erupted maxillary and mandibular canines and premolars and compared her findings with Sofia [19] and Abdulrasool [22].

In 2011, Al-Dabagh [24] predicted the width of maxillary canine from the width of mandibular canine, while Jargees [25] was able to estimate the widths of un-erupted canines and premolars from the vistibulo-oral crown dimensions of permanent teeth using multiple regression equations.

This study aimed to use the combined mesio-distal crowns widths of maxillary incisors and first molars as predictors to the combined mesio-distal crowns widths of maxillary and mandibular canines and premolars.

MATERIALS AND METHODS

Sample

The sample comprised 110 Iraqi Arab subjects (55 males and 55 females) with an age ranged between 17-25 years had full complement of permanent teeth regardless the third molars, class I skeletal and dental relations [26] with no history of orthodontic treatment, bad oral habits, maxillofacial surgeries or defects. The teeth are free from caries, restorations, attrition or malformations.

Methods

The subjects examined extra- and intra-orally to fulfill the inclusion criteria. Impressions for maxillary and mandibular arches were taken using Alginate impression material, and then poured with 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 arch from the first molar to the first molar in the other side and the mandibular canines and premolars were measured at the largest mesio-distal dimension. The anatomic mesial and distal contact areas of each tooth were marked by a fine marker on the dental cast and then the greatest mesio-distal crown width was measured using electronic digital calipers (sensitivity 0.01 mm) held parallel to the occlusal plane [27].

Statistical analyses

The data were subjected to computerized statistical analyses using SPSS program (version 19). The statistical analyses included:

1. Descriptive statistics (means, standard deviations and the numbers and percentages of the cases that over and underestimated the actual widths of canines and premolars).
2. Inferential statistics that comprised:
   - Pearson's correlation coefficient (r) to find out the relation between the combined mesio-distal widths of maxillary and mandibular canines and premolars with the combined mesio-distal widths of maxillary incisors and first molars.
   - Independent sample t-test to test the presence of gender difference for the measurements.
   - Simple regression analysis to determine the regression equations that can be used to predict the combined mesio-distal widths of maxillary and mandibular canines and premolars.
   - 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.

RESULTS AND DISCUSSION

Most of the published articles tried to determine the width of canines and premolars using the methods of Moyers or Tanaka and Johnston. Nourallah *et al.* [28] depended upon the mandibular central incisors and maxillary first molars. Bernabé *et al.* [29] depended on the maxillary and mandibular central incisors and maxillary first molar, while Melgaço *et al.* [30], Memon and Fida [31] and Mittar *et al.* [32] utilized the mandibular incisors and first molars. On the other hand, Jaju *et al.* [33] depended on three measurements; the sum of width of mandibular incisors, the latter with mandibular and maxillary first molars separately and finally Paredes *et al.* [34] found that the widths of maxillary central incisors and lower first molars were the best predictor for the widths of canines and premolars.

In the present study, the maxillary first molars and incisors were chosen to predict the widths of maxillary and mandibular canines and premolars because they are erupted early in the oral cavity. The first step in the statistics is to demonstrate the relation between the combined mesio-distal

crowns dimensions of maxillary incisors and first molars (MDDIFM) with combined mesio-distal crowns dimensions of maxillary and mandibular canines and premolars (MDDCP). As shown in table 1, there was strong direct highly significant correlation ($p \leq 0.001$) between the measured variables; this comes in agreement with the previous findings [23,24,28-34]. For practical purposes only, correlation coefficient values greater than 0.70 should be considered as reliable for prediction procedures [35]. The value of the Pearson's correlation coefficient was ≥ 0.70 in this study.

The results in table 2 showed the genders difference for the dimensions of teeth measured. Like many findings [2,5,23,24,29-32], the males have wider teeth than females with a high significant difference; hence, the data were analyzed separately for males and females.

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

MDDIFM		MDDCP			
		Maxillary		Mandibular	
		Males	Females	Males	Females
	r	0.8	0.7	0.75	0.7
	p	0.000 (HS)	0.000 (HS)	0.000 (HS)	0.000 (HS)

(HS)=Highly significant P ≤ 0.001

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

Variables	Genders	Descriptive Statistics		Genders difference	
		Mean	S.D.	t-test	p-value
MDDIFM	Males	52.168	2.38	3.72	0.000 (HS)
	Females	50.539	2.21		
Maxillary MDDCP	Males	43.570	1.88	4.20	0.000 (HS)
	Females	42.037	1.95		
Mandibular MDDCP	Males	42.483	1.89	2.10	0.000 (HS)
	Females	40.998	1.89		

(HS)=Highly significant P ≤ 0.001

A linear regression analysis was performed to develop the regression equations. The equation was calculated as; Y= a + b X where "Y" is the combined mesio-distal crowns widths of mandibular or maxillary permanent canines and premolars, "X" is the combined mesio-distal crowns widths of maxillary incisors and first molars, "a" is constant and "b" is the regression coefficient. The results showed the following equations:

Genders	For maxillary arch	For mandibular arch
Males	MDDCP= 10.758 + 0.629 × MDDIFM	MDDCP= 11.279 + 0.598 × MDDIFM
Females	MDDCP= 12.183 + 0.591 × MDDIFM	MDDCP= 11.209 + 0.589 × MDDIFM

After calculation the predicted widths, paired sample t-test was applied to compare between the actual and predicted measurements. The results showed that there was non-significant difference between the predicted and actual mesio-distal crowns dimensions of both maxillary and mandibular canines and premolars (Table 3), this is in accordance with the other studies [23,28-34].

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

Arch	Genders	Actual MDDCP		Predicted MDDCP		Difference between the predicted and actual MDDCP			
		Mean	S.D.	Mean	S.D.	Mean difference	S.D.	t-test	p-value
Maxillary	Males	43.570	1.88	43.572	1.49	0.002	1.14	0.013	0.99 (NS)
	Females	42.037	1.95	42.052	1.31	0.015	1.45	0.079	0.937 (NS)
Mandibular	Males	42.483	1.89	42.476	1.42	-0.007	1.26	-0.044	0.965 (NS)
	Females	40.998	1.89	40.977	1.3	-0.021	1.38	-0.115	0.909 (NS)

(NS)=Non-significant P > 0.05

The ideal prediction method should determine no difference between predicted and actual widths of permanent canines and premolars. The mean differences and their standard deviations between the two methods are very small in its magnitude and are not clinically significant (Table 3).

Prediction methods are not 100% precise and can overestimate or underestimate the actual size of un-erupted teeth. Overestimation seems to be better to prevent lack of space, but this approach could suggest tooth extractions for some patients.

Overestimation of only 1 mm beyond the actual widths of the permanent canine and premolars on each side of the arch would not seriously affect an extraction or non- extraction decision [5,30,33]. The numbers and percentages of cases that lie within the limit of 2 mm, over and underestimated the actual widths of the permanent canines and premolars (both sides of the maxillary and mandibular arches and both genders) were presented in Table 4. The findings revealed small numbers of cases that did not lie within the limit of 2 mm. for both sides. This is considered as a point of strength to this method of prediction in addition to the proper selection of teeth that used in prediction, the high correlation between the variables and non-significant methods difference.

In conclusion, the findings showed a non-significant difference between the predicted and actual mesio-distal crown widths; hence the combined mesio-distal widths of maxillary incisors and first molars can be used as predictors for the combined mesio-distal widths of maxillary and mandibular canines and premolars.

This novel method of prediction is easy, simple, needs study models only (no radiographs) and depends on six teeth that erupt early and can be applied to predict the widths of canines and premolars in both jaws with high reliability.

Table 4. The numbers 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**	51 (92.73%)	2 (3.64%)	2 (3.64%)
	Females	46 (83.64%)	5 (9.09%)	4 (7.27%)
Mandibular	**Males**	49 (89.09%)	4 (7.27%)	2 (3.64%)
	Females	49 (89.09%)	3 (5.45%)	3 (5.45%)

REFERENCES

1. Buwembo W, Kutesa A, Muwazi L, Rwenyonyi CM. Prediction of width of un-erupted incisors, canines and premolars in a Ugandan population: A cross sectional study. BMC Oral Health 2012; 12: 23.
2. Yousaf U, Ijaz A. Prediction of the sizes of un-erupted canines and premolars in Pakistani subjects. Pakistan Oral Dent J 2007; 27(1): 61-6.
3. Smith HP, King DL, Valencia R. A comparison of three methods of mixed dentition analyses. J Pedod 1979; 3(4): 291-302.
4. Staley RN, O'Gorman TW, Hoag JF, Shelly TH. Prediction of the widths of un-erupted canines and premolars. JADA 1984; 108(2):185-90.
5. Moyers RE. Handbook of orthodontics. 4th ed. Chicago: Year Book medical publishers; 1988. pp: 235-40.
6. Staley HP, Hoag J. Prediction of the mesiodistal widths of maxillary permanent canines and premolars. Am J Orthod 1978; 73(2):169-77.
7. Nance HN. The limitations of orthodontic treatment: I. Mixed dentition diagnosis and treatment. Am J Orthod Oral Surg 1947; 33(4):177-223.
8. Foster HR, Wylie WL. Arch length deficiency in the mixed dentition. Am J Orthod 1958; 44(6): 464-76.
9. Ballard ML, Wylie WL. Mixed dentition case analysis-estimating size of unerupted permanent teeth. Am J Orthod Oral Surg 1947; 33(11): 754- 9.
10. Cohen ME. Recognition of the developing malocclusion. Dent Clin North Am 1959; 6: 299-311.
11. Hixon EH, Oldfather RE. Estimation of the sizes of un-erupted cuspid and bicuspid teeth. Angle Orthod 1958; 22(4): 236-40. **(IVSL).**
12. Sim JM. Minor tooth movement in children. 2nd ed. St. Louis: C.V. Mosby; 1977.
13. Moorrees CFA, Reed RB. Correlations among crown diameters of human teeth. Arch Oral Biol 1964; 9(6): 685-97.
14. Tanaka MM, Johnston LE. The prediction of the size of unerupted canines and premolars in a contemporary orthodontic population. JADA 1974; 88(4): 798-801.
15. Brown JE. Predicting the mesio-distal crown width of un-erupted maxillary canines, first and second premolars. A master thesis. School of Dentistry, University of Tennessee, Memphis, 1955.
16. Fonsenca CC. Predicting the mesio-distal crown width of the canine-premolar segment of maxillary dental arches. A master thesis. School of Dentistry, University of Tennessee, Memphis, 1961.
17. Ferguson FS, Macko DJ, Sonnenberg EM, Shakun ML. The use of regression constants in estimating tooth size in a Negro population. Am J Orthod 1978; 73(1): 68-72.
18. Al-Khashan JA. Dimensional features of permanent teeth in Iraqis. Iraqi Dent J 1989; Special issue, Abstract book: 69-70.
19. Sofia SH. Mesio - distal crown diameter of permanent teeth and prediction chart for mixed dentition analysis. A master thesis. Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, University of Mousl, 1996.

20. Jargees HT. Prediction of the mesio- distal crown diameter of the un-erupted lower premolars. A master thesis. Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, University of Mousl, 2003.
21. Awni KhM. Comparison between Tanaka/ Johnston and Boston University prediction approaches in a group of Iraqi pupils. Al-Rafidain Dent J 2005; 5(2): 154-60.
22. Abdulrasool HM. First permanent molar as a guide for space analysis in the canine and premolar region. Iraqi Orthod J 2005; 1(1): 66-7.
23. Al-Bustani SHJ. Prediction of the canines and premolars size (comparative study). A master thesis. Department of Orthodontics, College of Dentistry, University of Baghdad, 2006.
24. Al-Dabagh DJ. Prediction of mesio-distal width of maxillary canines depending on mesio-distal width of mandibular canines by using regression equation. J Bagh Coll Dentistry 2011; 23(2): 114-8.
25. Jarjees HT. Estimation of the crown widths of un-erupted canine and premolars by using vistibulo-oral crown dimensions of permanent teeth. Al-Rafidain Dent J 2012; 12(2): 350-5.
26. Mitchell L. An introduction to orthodontics. 4th ed. Oxford: Oxford University press; 2013.
27. Proffit WR, Fields HW Jr., Sarver DM. Contemporary orthodontics. 5th ed. St. Louis: Elsevier Mosby; 2013.
28. Nourallah AW, Gesch D, Khordaji MN, Splieth C. New regression equations for predicting the size of unerupted canines and premolars in contemporary population. Angle Orthod 2002; 72(3): 216-21.
29. Bernabé E, Flores-Mir C. Are the lower incisors the best predictors for the unerupted canine and premolars sum? An analysis of a Peruvian sample. Angle Orthod 2005; 75(2): 202-7. **(IVSL).**
30. Melgaço CA, de Sousa Araújo MT, de Oliveira Ruellas AC. Mandibular permanent first molar and incisor width as predictor of mandibular canine and premolar width. Am J Orthod Dentofac Orthod 2007; 132(3): 340-5. **(IVSL).**
31. Memon S, Fida M. Development of a prediction equation for the estimation of mandibular canine and premolar widths from mandibular first permanent molar and incisor widths. Eur J Orthod 2012; 34(3): 340-4. **(IVSL).**
32. Mittar M, Dua VS, Wilson S. Reliability of permanent mandibular first molars and incisors widths as predictor for the width of permanent mandibular and maxillary canines and premolars. Contemp Clin Dent 2012; 3(Supp 1): S8-12S.
33. Jaju KR, Gulve ND, Chitko SS. A new equation for predicting the width of unerupted permanent canines and premolars for cosmopolitan Indian population. Jaypee J 2010; 44(2): 83-8.
34. Paredes V, Gandia JL, Cibrian R. A new, accurate and fast digital method to predict unerupted tooth size. Angle Orthod 2006; 76(1): 14–19. **(IVSL).**
35. Vardimon AD, Lambertz W. Statistical evaluation of torque angles in reference to straight-wire appliance (SWA) theories. Am J Orthod 1986; 89(1): 56-66.