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Comparison between Tanaka/Johnston and Boston University prediction approaches in a group of Iraqi pupils

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ABATRACT

The purpose of this study was to compare two mixed dentition prediction methods that do not require the use of periapical radiographs of the unerupted permanent lower teeth. The two compared methods were the Tanaka/Johnston (T/J) and the Boston University (BU) prediction approaches.

Study casts of 52 children (20 males and 32 females) were used; those children were selected from primary and secondary schools located in different areas of Mosul City. All subjects have normal Class I molar relationship.

The finding indicated that on the average the T/J approach overestimated the tooth size of the unerupted teeth (mean $\pm$ SD = 1.02 $\pm$ 1.07 mm). On the other hand, the BU approach underestimated the tooth size of the unerupted teeth (mean $\pm$ SD = –0.2 $\pm$ 1.07 mm). The findings further indicated that there were statistically significant correlation between the predicted and actual tooth size.

The error involved in the use of the prediction equations was expressed as the standard error of the estimate (SEE). The present findings indicated that the SEE for T/J prediction ranged between 0.52–0.63 mm and the corresponding values for BU equation ranged between 0.45–0.68 mm. Depending on the stage of dental development; i.e., which deciduous and permanent teeth are present, 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 all the deciduous (canines and first molars) are still present.

Key Words: Prediction, mesio–distal crown diameter, unerupted premolar.

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INTRODUCTION

One of the goals in comprehensive orthodontic treatment is to obtain an optimal final occlusion, over bite and over jet.[1] This could be evaluated by the determination of mesio–distal diameter of crowns of unerupted canines and premolars which has great importance in finding the therapy and treatment plan during the mixed dentition.[2] The mixed dentition arch analysis is an important criterion in determining whether the orthodontic treatment plan is going to involve serial extraction, guidance of eruption, space maintenance, space regaining, or just periodic observation of the patient.[3]

The determination of the tooth size–arch length discrepancy in the mixed dentition requires an accurate prediction of the mesio–distal width of the unerupted permanent teeth. Three approaches have been used to estimate the mesio–distal crown width of the unerupted canines and premolars:[4, 5] Measurements from erupted teeth,[6–10] measurements from 45º cephalometric radiograph,[11, 12] measurements from periapical radiograph,[13] and a combination of measurements from erupted teeth

and from radiographs of unerupted teeth.[5, 14–16] The last approach is considered to be the most accurate because it generally has the lowest standard error of estimate (SEE).[5, 17]

A step–by–step chart was developed for use in conjunction with the prediction graph to estimate the tooth size–arch length discrepancy for the patient. The chart and graph could be participated in the clinical record of patients undergoing mixed dentition assessment and treatment.[18]

There was a consensus that small primary teeth were likely to be followed by small successors and large primary teeth by large permanent successors but the low correlation coefficients precluded their use for making reasonably accurate predictions.[19–21] The need to use various prediction equations is based on the fact that the correlation between the mesio–distal diameter of the deciduous and succedaneous teeth, although significant, are, in general, fairly low.[22, 23]

As stated earlier, both radiographic and non radiographic approaches for prediction have been attempted. The latter is used when the practitioner is either unable to obtain periapical radiographs on the young patient or the parents are unwilling to consent to the procedure. These disadvantages may largely be overcome by a variety of regression schemes in which tooth is predicted from permanent teeth that are already present and easily measured – the mandibular incisors.[24]

The purpose of this study was to compare two mixed dentition prediction methods that do not require the use of periapical radiographs of unerupted permanent teeth. The methods compared were the Tanaka/Johnston (T/J) and the Boston University (BU) prediction approaches.

MATERIALS AND METHODS

The sample size of this study comprised 52 children (20 males and 32 females). It was carried out over 6 primary and 4 secondary schools selected randomly from different areas of the right and left banks of river Tigris in the center of Mosul City.

All children were of Iraqi origin, their parents and grandparents were born in the center of Mosul. Each child had a normal Class I occlusion according to Angle's classification,[25] with no apparent facial disharmony, non had congenitally missing teeth or had undergone orthodontic therapy throughout the period of the study. Subjects with gross dental abnormalities, apparent loss of teeth substance due to attrition, trauma, fracture, massive caries, restoration or artificial crown on teeth were excluded.

Each child had dental cast at two stages of dental development; namely, at the time when the child had mixed dentition (lower right and left permanent centrals, laterals and first molars, and lower right and left primary canines and first and second molars), and at the time of eruption of the lower right and left permanent canines and premolars. A new record was taken for the same patient. These selection criteria limited the number of subjects in this investigation to 52 children; namely, 20 males and 32 females.

Impression of the mandibular dental arch was made with plastic orthodontic tray using alginate hydrocolloid impression material (Alginmax, Italy). The impressions were poured immediately in the dental stone and vibrated manually. Measurements were carried out on the lower casts (right and left permanent central and lateral incisors, canines, premolars and deciduous canines and first molars) by using modified sliding caliper with a vernier scale permitting reading to 0.1 mm (Figure 1).

Crown diameters were taken as the distance between the anatomic contact points (from anatomic mesial contact point to anatomic distal contact point) which was taken to a nearest 0.1 mm by means of sharp end calipers with the sharpened beaks of the calipers parallel to the long axis of the crown[24] (Figure 2).

The T/J approach to predict the mesiodistal diameter of the unerupted mandibular canine and two premolars is based on adding 10.5 mm to half the total width of the mandibular four incisors as measured from dental casts.[7] The BU prediction method is based on adding the sum of the width of the mandibular deciduous canines and twice the width of first deciduous molars.[3]

Figure (1): The sliding caliper gauge with vernier scale

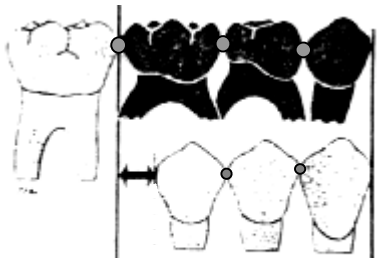

Figure (2): The approximate location of contact points of the mandibular teeth

Student's t–test was calculated to determine whether statistical differences were present between the right and left sides for male and female subjects besides the sex comparison at 5% level of significance. Descriptive statistics, including the minimum and maximum, mean and standard deviation values were calculated for predicted tooth and actual tooth size. Correlation coefficient "r" was measured between the predicted and actual tooth size for both predicted methods. In addition, the standard error of measurements was calculated.

RESULTS

Table (1) showed the descriptive statistics of the mesio–distal crown diameters of total mandibular teeth, which include minimum and maximum, mean and standard deviation values.

Student's t–test indicated that males had larger mesio–distal crown diameters than females. As a result, the findings for male and female subjects were presented separately as well as combined in Table (2).

Table (1): Descriptive statistics (in mm) of the mesio–distal crown diameters of total mandibular teeth

Tooth	No.	Minimum	Maximum	Mean (mm)	± SD
1	52	4.40	6.50	5.37	0.39
2	52	4.80	7.00	5.78	0.47
3	52	6.00	9.60	6.51	0.62
4	52	6.20	9.60	6.93	0.36
5	52	5.60	7.70	7.18	0.33
C	52	5.00	6.60	5.73	0.40
D	52	6.60	8.00	7.55	0.32
3+4+5	52	18.10	23.40	20.62	0.89

SD: Standard deviation.

Table (2): Comparison of means between the males and females mesio–distal crown diameter of mandibular teeth

Tooth	Mean (mm) ± SD		t–value	*p*–value	Significance
	Males	Females			
1	5.43 ± 0.37	5.33 ± 0.40	0.95	0.35	NS
2	5.75 ± 0.46	5.80 ± 0.48	0.39	0.70	NS
3	7.15 ± 0.58	6.12 ± 0.08	9.93	0.00	S
4	7.00 ± 0.42	6.90 ± 0.32	0.96	0.34	NS
5	7.30 ± 0.26	7.10 ± 0.35	2.19	0.03	S
C	5.82 ± 0.36	5.68 ± 0.42	1.22	0.23	NS
D	7.55 ± 0.33	7.55 ± 0.32	0.03	0.97	NS
3+4+5	21.45 ± 0.69	20.12 ± 0.54	7.76	0.00	S

SD: Standard deviation; NS: Not significant; S: Significant ($p \leq 0.05$).

The descriptive statistics for the predicted tooth size with the use of the T/J and BU equations as well as the actual tooth size were presented in Table (3). The differences between the two prediction methods and the actual tooth size for males, females and both sexes were presented in Table (4). The finding indicated that on the average the T/J approach overestimated the tooth size of the unerupted teeth (mean ± SD = 1.02 ± 1.07 mm). On the other hand, the BU approach underestimated the tooth size of the unerupted teeth (mean ± SD = –0.20 ± 1.07 mm).

Table (3): Descriptive statistics (in mm) of the predicted and actual mesio–distal diameters of the mandibular canine and first and second premolars

Study Groups	Sex	No.	Minimum	Maximum	Mean (mm)	± SD
Tanaka and Johnston	Males	20	20.70	23.40	21.68	0.76
	Females	32	19.70	23.20	21.62	0.79
	Total	52	19.70	23.40	21.64	0.77
Boston University	Males	20	19.20	22.00	20.92	0.75
	Females	32	18.70	22.40	20.77	0.88
	Total	52	18.70	22.40	20.83	0.83
Actual Tooth Size	Males	20	20.10	23.40	21.45	0.69
	Females	32	18.10	20.80	20.11	0.54
	Total	52	18.10	23.40	20.63	0.89

SD: Standard deviation.

Table (4): Descriptive statistics (in mm) of the differences between the actual and predicted values of the mesio–distal diameters of the permanent mandibular canine and first and second premolars

Prediction Method	Sex	No.	Minimum	Maximum	Mean (mm)	± SD
Tanaka and Johnston	Males	20	–2.50	1.80	0.23	1.01
	Females	32	0.00	3.10	1.51	0.78
	Total	52	–2.50	3.10	1.02	1.07
Boston University	Males	20	–4.20	1.10	–0.53	1.14
	Females	32	–0.70	1.80	0.66	0.72
	Total	52	–4.20	1.80	–0.20	1.07

SD: Standard deviation.

The correlation coefficient indicated the strength of association (positive or negative) between the predicted and actual tooth size. The finding represented in Table (5) indicated that there were statistically significant correlation between the predicted and actual tooth size for female group, while Table (6) showed significant correlation between the predicted tooth size from the two predicted methods (T/J and BU methods).

Table (5): Correlation coefficient "r" between the predicted tooth size from the prediction methods and actual tooth size

Prediction Method	Sex	r	*p*–value	Significance
Tanaka and Johnston	Males	0.22	0.93	NS
	Females	0.36	0.01	S
	Total	0.17	0.23	NS
Boston University	Males	–0.27	0.26	NS
	Females	0.58	0.001	S
	Total	0.224	0.11	NS

NS: No significant difference; S: Significant difference ($p \leq 0.05$).

Table (6): Correlation coefficient "r" between the predicted tooth size from the two prediction methods

Sex	r	*p*–value	Significance
Males	0.53	0.02	S
Females	0.43	0.01	S
Total	0.46	0.001	S

S: Significant difference ($p \leq 0.05$).

The error involved in the use of the prediction equations is expressed as SEE. The present findings indicated that the SEE for T/J prediction equations ranged between 0.52–0.63 mm for various groups evaluated and the corresponding values for the BU equations ranged between 0.45–0.68 mm, as shown in Table (7).

Table (7): Comparison of standard errors of estimate in mm for the two prediction methods evaluated

Prediction Method	Sex	SEE
Tanaka and Johnston	Males	0.53
	Females	0.52
	Total	0.63
Boston University	Males	0.45
	Females	0.55
	Total	0.68

SEE: Standard errors of estimate.

DISCUSSION

Clinicians and researchers are interested in predicting the potential for tooth size–arch length discrepancy in their growing patients. If accurate predictions can be made while patients are in the deciduous or mixed dentition, clinicians might attempt to intercept any developing malocclusions. On the other hand, if such discrepancies can not be accurately predicted, one will have to expect the advisability for such procedures.

The present investigation found that mesio–distal crown diameters in both dentitions of the same sample showed that bilateral asymmetry was insignificant and these results were in agreement with other studies.[5, 22, 23, 26, 27]

The present investigation found that statistically significant sex differences were only found in two permanent teeth (canine and second premolar), not including the lower incisors. Hence, the primary tooth sizes were investigated with the sexes pooled while the permanent tooth sizes were assessed separately. The canines showed the largest sex difference within the permanent teeth, but the primary canines were not the most dimorphic teeth. These results were in agreement with those of other studies.[5, 22, 23, 27]

One of the objectives of the tooth size–arch length analysis in the mixed dentition is to obtain the most accurate prediction for each patient by reducing to a minimum the errors involved in measurement and judgement. Currently, the most accurate prediction methods involve the use of periapical films[5, 14–18] and particularly the use of the modified Hixon–Oldfather prediction equation that has a 0.44 mm SEE.[16, 18] If, on the other hand, the patient/parent are unwilling to allow for the needed radiographs, the clinicians may have to use non radiographic methods for predicting the unerupted permanent canines and premolars.[3]

The present findings indicated that the SEE for the two non radiographic prediction methods of T/J and BU were 0.63 and 0.68, respectively; while Bishara and Jakobsen[3] found the SEE 0.81 and 0.92, respectively. Therefore, the accuracy of these two methods of tooth prediction are fairly comparable but are not as accurate as the radiographic methods of prediction.

The findings indicated that on the average the T/J approach overestimated the tooth size of the unerupted teeth (mean $\pm$ SD= 1.02 $\pm$ 1.07 mm), while the BU approach underestimated the tooth size of unerupted teeth (mean $\pm$ SD= –0.2 $\pm$ 1.07 mm). These findings were somewhat corresponding to the findings of Bishara and Jacobsen[3] which were (1.1 $\pm$ 0.9 mm) and (–0.1 $\pm$ 1.2 mm) respectively.

The T/J approach requires the presence of the mandibular permanent incisors to be completely erupted but does not use deciduous tooth measurements, whereas the

BU method requires the presence of the deciduous canines and first molars. As a result the clinician can use either of these two methods depending on which teeth are available in the mandibular dental arches at the various stages of the dental development.

CONCLUSIONS

Two radiographic methods for predicting the mesio–distal diameter of the unerupted mandibular canine and premolar were compared. When using the equations for combined male and female samples, both methods have comparable SEE (0.63 mm for the T/J and 0.68 mm for the BU approach). Depending on the stage of dental development; i.e., which deciduous and/or permanent teeth are present, the T/J approach can be used when the four mandibular incisors have completely erupted. The BU approach can be used when the deciduous canines and first molars are still present.

REFERENCES

1. Freeman JE, Maskeroni AJ, Lorton L. Frequency of Bolton tooth size discrepancies among orthodontic patients. *Am J Orthod Dentofac Orthop*. 1996; 110: 24-27.
2. Legovic M, Novosel A, Legovic A. Regression equations for determining mesio–distal crown diameters of canines and premolars. *Angle Orthod*. 2002; 73(3): 314-318.
3. Bishara SE, Jakobsen JR. Comparison of two non radiographic methods of predicting permanent tooth size in the mixed dentition. *Am J Orthod Dentofac Orthop*. 1998; 113: 573-576.
4. Abe K, Suzuki A, Takahoma Y. Prediction of coronal size of third molars by factor and multiple regression analysis. *Am J Orthod Dentofac Orthop*. 1996; 109: 79-85.
5. Staley RN, Shelly TH, Martin JF. Prediction of lower canine and premolars in mixed dentition. *Am J Orthod*. 1979; 76(3): 300-308.
6. Moyers RE. Handbook of Orthodontics for the Student and General Practitioner. 3rd ed. Yearbook Medical Publisher, Inc. Chicago. 1973; Pp: 369-379.
7. Tanaka MM, Johnston LE. The prediction of the size of unerupted canines and premolars in a contemporary orthodontic population. *J Am Dent Assoc*. 1974; 88: 798-801.
8. Lee–Chan S, Jacobson BN, Chwa KH, Jacobson RS. Mixed dentition analysis for Asian–American. *Am J Orthod Dentofac Orthop*. 1998; 113(3): 293-299.
9. Vander MSW, Rossouw P, Van–Wyk KTJ, Trutero H. An adaptation of the moyers mixed dentition space analysis for a Western Cape Caucasian population. *J Dent Assoc S Afr*. 1991; 46(9): 475-479.
10. Nourallah AW, Gesch D, Khordaji MN, Splieth C. New regression equations for prediction the size of unerupted canines and premolars in a contemporary population. *Angle Orthod*. 2001; 72(3): 216-221.
11. De–Paula S, Almeida MA, Lee PC. Prediction of mesio–distal diameter of unerupted lower canines and premolars using 45º cephalometric radiograph. *Am J Orthod Dentofac Orthop*. 1995; 107: 309-314.
12. Martinelli FL, di–Lima EM, Rocha R, Araujo MS. Prediction of lower permanent canine and premolars width by correlation methods. *Angle Orthod*. 2004; 75(5): 662-665.
13. Staley RN, O'Gorman TW, Hoag JF. Prediction of the widths of unerupted canines and premolars. *J Am Dent Assoc*. 1984; 70: 185-190.
14. Hixon EH, Oldfather RE. Estimation of the sizes of unerupted cuspid and bicuspid teeth. *Angle Orthod*. 1958; 28: 236-240.
15. Staley RN, Hoag JF. Prediction of the mesio–distal widths of maxillary permanent canines and premolars. *Am J Orthod*. 1978; 73: 169-177.
16. Staley RN, Kerber PE. A revision of the Hixon and Oldfather mixed dentition method. *Am J Orthod*. 1980; 78: 296-302.
17. Staley RN, Hu P, Hoag JF, Shelly TF. Prediction of the combined right and left canine and premolar widths in both arches of the mixed dentition. *Pediatr Dent*. 1983; 5: 57-60.
18. Bishara SE, Staley RN. Mixed dentition mandibular arch length analysis: A step–by–step approach using the

revised Hixon–Oldfather prediction method. *Am J Orthod*. 1984; 86: 130-135.
19. Garn SM, Cole PE, Wainright RL. Dimensional correspondences between deciduous and permanent teeth. *J Dent Res*. 1977; 56: 12-14.
20. Brown T, Margetts B, Townsend G. Correlation between crown diameters of the deciduous and permanent teeth of Australian aboriginals. *Aust Dent J*. 1980; 25: 219-223.
21. Lysell L, Myrberg N. Mesio–distal tooth size in deciduous and permanent dentition. *Eur J Orthod*. 1982; 4: 113-122.
22. Yuen KK, Tang EL, So LL. Mesio–distal crown diameters of the primary and permanent teeth in Southern Chinese. A longitudinal study. *Eur J Orthod*. 1997; 19: 721-731.
23. Yuen KK, Tang EL, So LL. Relation between the mesio–distal crown diameters of the primary and permanent teeth of Hong Kong Chinese. *Archs Oral Biol*. 1996; 41(1): 1-7.
24. El–Kattan ES, Eid AA. An Egyptian prediction chart for mixed dentition analysis. *Egypt Orthod J*. 1988; 2(1): 47-63.
25. Angle EH. Classification of malocclusion. *Dent Cosmos*. 1899; 41: 248-264.
26. Jarjees HT. Prediction of mesio–distal crown diameter of unerupted lower premolars. MSc thesis. College of Dentistry. University of Mosul. 2003.
27. Yuen KK, Tang EL, So LL. Mixed dentition analysis for Hong Kong Chinese. *Angle Orthod*. 1998; 68(1): 21-28. (Abstr)