

APPLICABILITY OF TANAKA AND JOHNSTON MIXED DENTITION ANALYSIS IN A CONTEMPORARY PAKISTANI POPULATION

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ABSTRACT

Mixed dentition analysis is carried out to predict the size of unerupted canine and premolar in the developing occlusion. The aim of this study was to assess the applicability of Tanaka and Johnston method of mixed dentition analysis in predicting the size of permanent canines and premolars in patients visiting Islamic International Dental Hospital, Islamabad. The sample consisted of 80 dental casts (40 male and 40 female), obtained from patients reporting at the department of orthodontics, Islamic International Dental College, Islamabad with the age range between 12 to 21 years. Mesiodistal tooth widths were measured with a digital vernier caliper. A paired student t test was used to compare the predicted and actual sum of the maxillary (PUCPM and AUCPM) and mandibular permanent Canines and Premolars (PLCPM and ALCPM) for both genders combined and separately. Significant difference was found between PUCPM and AUCPM in maxilla for both male and female together ($M + F : 0.000$) and when both genders were compared separately ($M : 0.032, F : 0.001$). Tanaka and Johnston method was only applicable in predicting the space for unerupted canine and premolars in mandible in both male and female sample.

Key words: Mixed dentition analysis; Tanaka and Johnston ; Space analysis

INTRODUCTION

Early treatment is becoming increasingly popular in the contemporary orthodontics and it is important that the mixed dentition space analysis is accurately done before such orthodontic treatment is carried out.^{1,2} In planning the management of such cases it is important that any deficiency of arch space is predicted in advance and the indicated procedures undertaken early.^{2,3} An accurate mixed dentition space analysis is one of the important criteria in determining whether the treatment plan may involve serial extraction, guidance of eruption, space maintenance, space regaining or just periodic observation of the patients.^{1,4-6}

Tooth size prediction of the unerupted permanent canines, first and second premolars forms part of the critical aspects of the mixed dentition space analysis. Three main approaches have been used to estimate the mesiodistal crown widths of the permanent canines and premolars in the mixed dentition patients:

- i) Measurement of the unerupted teeth on the radiographs.^{2,7,8}
- ii) Use of the regression equation that relate the mesio-distal widths of erupted teeth to the mesio-distal widths of unerupted teeth.^{9,10}
- iii) A combination of measurements from erupted and radiographs of unerupted teeth.¹¹⁻¹⁴

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The most accurate predictions of the mesio-distal widths of unerupted canines and premolars can be obtained by measurements of mesio-distal widths of these teeth on radiographs combined with measurement of mesio-distal widths of the erupted mandibular permanent teeth.^{3,15} However, it requires the use of dental casts and radiographs to complete the analysis.¹⁶

In the developing countries the availability of the dental x-ray machines is inadequate and quality of the available radiographic films is questionable^{17,18} and thus use of radiographic prediction techniques may not provide an accurate estimation of tooth size. Pakistan, being one of the developing countries, has limited resources that are being directed mainly to deal with more life threatening health conditions. Therefore, the availability of the dental x-ray machines is still insufficient to be employed in the general management of patients in most of its oral health delivery centres. Due to these economic limitations the radiographic based prediction methods does not offer enough solutions to the management of mixed dentition patients. Therefore, the non-radiographic approaches (use of dental casts alone) would be the best in the Pakistani situation. Additionally, it has been reported that the most commonly used non-radiographic approaches are not as accurate in other ethnic groups as they are in Caucasian populations.^{19,20} This is because these non-radiographic methods^{9,10} were derived from patients of Northern European descent.² In studies conducted locally, concluded that Tanaka and Johnston is not applicable in Pakistani population²¹ while a similar study concluded that this method of mixed dentition analysis is applicable in Pakistani population.¹⁴

The importance of carrying out accurate mixed dentition analysis is that if those patients who are faced with developing malocclusions are properly referred to orthodontist and treated in time, the incidence of dental crowding in adult dentitions would probably be reduced. On the other hand, it is fruitless to refer patients without carrying out mixed dentition analysis only on the basis suspicion of having orthodontic problems when in fact, no problem exists. Further more, Islamabad being the capital of Pakistan has the people of different casts and tribes from all the provinces and cities of the country who are working

and studying in various institutes of the city and thus it represents the population of Pakistan in true manner.

In view of the related problems as discussed above and since no similar studies of these non-radiographic methods have been reported in sample of patients reporting to Islamic International Dental College, this study was designed to evaluate the applicability of Tanaka and Johnston method in predicting the size of unerupted permanent canines and premolars.

METHODOLOGY

Pretreatment orthodontic casts of 80 patients (40 males and 40 females) with the age range of 12 to 21 years of different malocclusions were selected from the records of the Orthodontic Department of Islamic International Dental Hospital, Islamabad. All patients had all teeth from first molar to first molar fully erupted and presented with no proximal caries or fillings, morphological anomalies, missing teeth, proximal or occlusal abrasion, or bruxism. Impressions were taken in Alginate impression material (Lygin Chromatic, Dentamerica) and were poured in orthodontic plaster within half an hour to avoid any shrinkage of impressions.

<i>GROUP 1</i>	: Class I	20
<i>GROUP 2</i>	: Class II div 1	20
<i>GROUP 3</i>	: Class II div 2	20
<i>GROUP 4</i>	: Class III	20

Measuring technique:

A set of both maxillary and mandibular study casts from each patient was serialized and names kept anonymous. A vernier gauge calibrated with digital micrometer whose measuring beaks were sharpened, was used to measure the mesio-distal widths of the individual teeth from unsoaped study casts (Fig 1). All the teeth from left second premolar through to the right second premolar of each set of dental casts were measured to the nearest 0.01 mm.

The sum of the mesiodistal width of the following groups of teeth were calculated for each sex, and the whole sample.

1. The four mandibular incisors

2. The mandibular canines and premolars per quadrant
3. The maxillary canines and premolars per quadrant.

The sum of the four permanent mandibular incisors were used to predict the combined sizes of the permanent unerupted canines and premolars using Tanaka and Johnston method.¹⁰

For each maxillary left and right mandibular canine and both premolar width $Y = 11.0 + 0.5 X$ and for each mandibular left and right permanent canine and both premolars width $Y = 10.5 + 0.5 X$ whereby Y is the sum of canine and both premolars of each side and X is the sum of the width of the four mandibular incisors.

The data obtained were computerised and analysed using SPSS version 16. Descriptive statistics including

mean, standard deviation and minimum maximum values were calculated (Fig 2 and Fig 3). Comparison between the actual and predicted sum of the mesiodistal widths of canine and premolars was made by using paired sample t-test. The level of significance was set at $P < 0.05$.

RESULTS

There were 40 males and 40 females with average ages of 15.9 ± 2.2 and 17.2 ± 1.9 years respectively (Table 2). Statistically significant differences were found for Tanaka and Johnston method for both male and female together (M + F: 0.000) and when they were compared separately in the maxillary arch (M: 0.032 and F: 0.001, Table 4). In the mandibular arch no significant difference was found when both male and female were compared together (M+F: 0.615) and when both genders were compared separately (M: 0.278 and F: 0.908, Table 4).

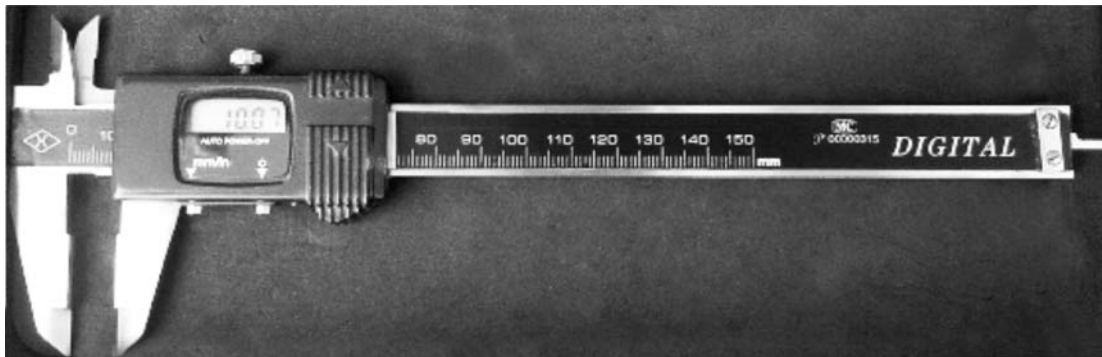


Fig 1: Electronic digital vernier caliper (Mitu-toyo; Kawasaki, Kanakawa, Japan)

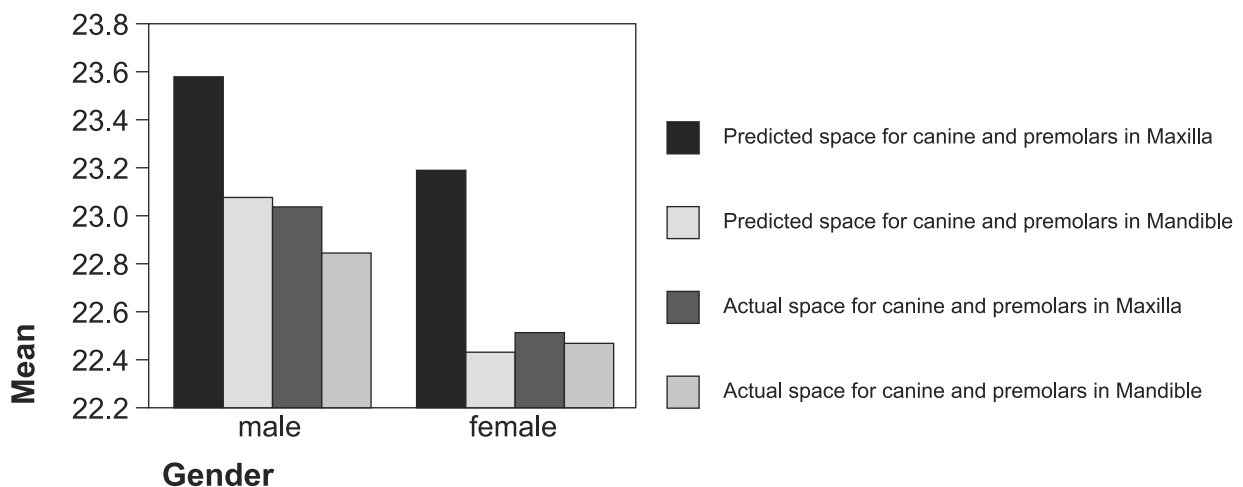


Fig 2: Bar graph showing mean of predicted and actual space for canine and premolars in mandible and maxilla for male and female separately.

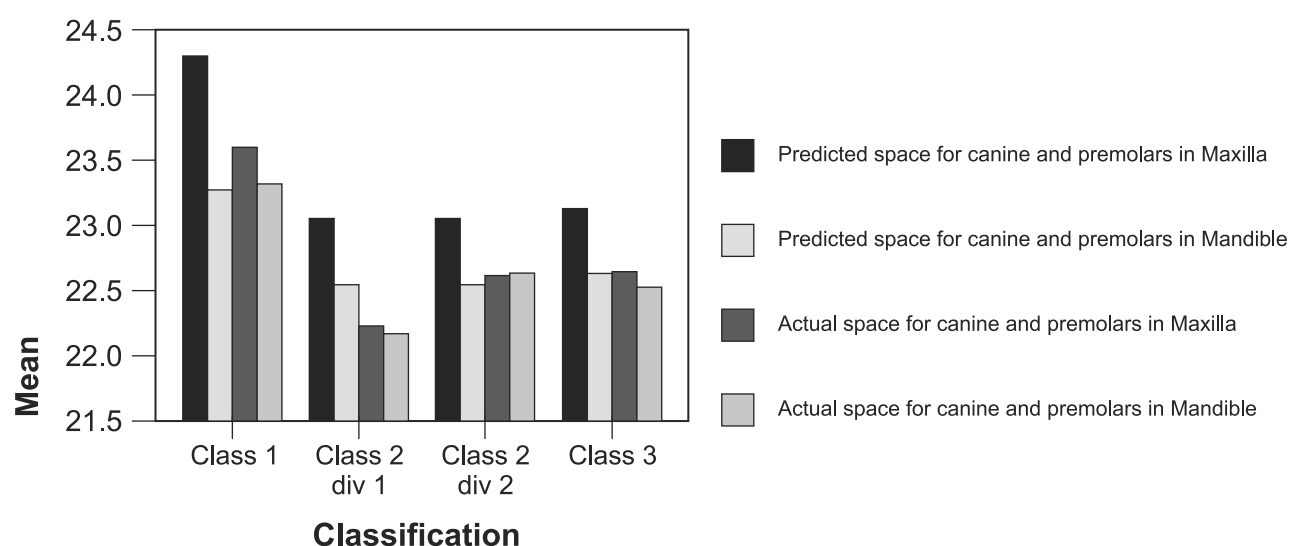


Fig 3: Bar graph showing mean of predicted and actual space for canine and premolars in maxilla and mandible for different malocclusion groups.

TABLE 1: DISTRIBUTION OF SUBJECTS ACCORDING TO GENDER AND MALOCCLUSION GROUPS

Malocclusion group	Number of Females	Number of Males	Total
Class I	10	10	20
Class II division 1	10	10	20
Class II division 2	10	10	20
Class III	10	10	20
Grand total	40	40	80

TABLE 2: MEAN, STANDARD DEVIATION AND RANGE OF AGE OF PATIENTS

Gender	Number of patients	Mean (Years)	SD	Range
M +F	80	16.6	2.2	7.00
M	40	15.9	2.2	7.00
F	40	17.2	1.9	7.00

SD : Standard deviation

TABLE 3: DESCRIPTIVE STATISTICS FOR THE SUM OF THE ACTUAL VALUES AND PREDICTED VALUES OF MAXILLARY (UCPM) AND MANDIBULAR (LCPM) CANINE AND PREMOLARS

	Gender	N	Minimum	Maximum	Mean	SD
PUCPM	M+F	80	21.50	29.50	23.4	1.4
PLCPM	M+F	80	11.50	29.00	22.8	1.9
AUCPM	M+F	80	19.50	28.00	22.8	1.6
ALCPM	M+F	80	19.00	27.50	22.7	1.6

N: Number of patients

F: Female

M: Male

SD: Standard deviation

TABLE 4: COMPARISON OF ACTUAL SUM OF CANINE AND PREMOLARS (ASCPM) AND THE PREDICTED (PSCPM) ONES FROM TANAKA AND JOHNSTON EQUATION FOR THE SAME SUBJECTS

	Actual values		Predicted values		Correlation	P value
	Mean	SD	Mean	SD		
Maxillary F+M	22.8	1.6	23.4	1.4	0.581	0.000*
Mandibular F+M	22.7	1.6	22.8	1.9	0.508	0.615
Maxillary M	23.1	1.6	23.6	1.6	0.503	0.032*
Mandibular M	22.9	1.6	23.1	1.6	0.641	0.278
Maxillary F	22.6	1.6	23.2	1.6	0.679	0.001*
Mandibular F	22.5	1.5	22.5	2.2	0.399	0.908

F: Female

M: Male

SD: Standard deviation

Test of significance: Paired sample t test

Level of significance: $P < 0.01$ *Significant Value $P < 0.05$

DISCUSSION

Prediction of the mesiodistal dimensions of unerupted permanent canines and premolars during the mixed dentition is of clinical importance in diagnosis and planning treatment. Underestimation of the mesio-distal tooth widths would result in a more conservative clinical approach, while overestimation tends to exaggerate space requirements and result in unnecessary extractions. Accurate estimation of the size of the canines and premolars allows the dentist to better manage tooth size/arch length discrepancies. Of all the different mixed dentition analysis methods reported in the literature (regression equations, radiographic methods, or combination of both), the regression equations based on measurements from the already erupted permanent teeth in early mixed dentition are the most widely used. Therefore, the present study was conducted to see the applicability of simple equations based on sum of mesio-distal width of permanent incisors and, in patients visiting Islamic International Dental Hospital, Islamabad.

Most studies, to date, have found the sum of the four mandibular incisors to be still one of best predictors in the linear regression equations for determining the combined mesio-distal widths of the unerupted permanent canines and premolars both in the mouth²² and dental casts.^{3,9,23} Since several clinical advantages of using the four permanent mandibular incisors in prediction equations and probability tables have previ-

ously been demonstrated.^{9,10,23} The present study also used four permanent mandibular incisors as the independent variable. Such advantages include the ease of measuring four permanent mandibular incisors both in the mouth²² and on the dental casts.⁹ Although moderate correlation values have also been found in other predictors^{24,25} their use in the regressions are limited because of local complicating factors. These include distal gingival coverage or late eruption, as in the use of a combination of two permanent mandibular first molars and the four permanent mandibular incisors, or morphological drawbacks as in when combination of maxillary four permanent incisors due to deformity of the maxillary lateral permanent incisors^{24,25}

In an attempt to improve the reliability of the measurements undertaken in this present study we used high quality dental casts made from dental stone, digital vernier calliper that could greatly help to reduce eye fatigue and the possibility of reading Error²⁶ and finally predetermination of inter-examiner and intra examiner reliability at 0.2 mm as suggested by Bishara et al.²⁷ A maximum age of 21 years had to be set as an upper age limit since it has been reported that beyond 21 years individual teeth may be reduced significantly by interproximal attrition²⁸ restoration or caries and this could bias the results of our study. Efforts were made to ensure randomization, and adequate sample size was used to ensure validity and adequate clinical significance of the prediction equations.

Moyers⁹ claimed that from the mandibular incisors on cast alone, 95 per cent of the patients have combined mesio-distal widths of canine and premolars within one millimetre of the predicted value in his tables, which should be considered clinically acceptable. Most of the studies have found the sum of the four mandibular incisors to be still one of the best predictors in the linear regression equations for determining the combined mesio-distal widths of the unerupted permanent canines and premolars both in the mouth²² and dental casts.^{3,9,22} On the other hand some studies indicated that the combined width of only the 4 mandibular permanent incisors is not a good prediction approach for the mesiodistal diameters of unerupted mandibular permanent canines and premolars.^{24,25} Several clinical advantages of using the four permanent mandibular incisors in prediction equations and probability tables have previously been demonstrated, such advantages include the ease of measuring four permanent mandibular incisors both in the mouth²² and on the dental casts.^{9,30}

It was found that the method was applicable in the mandibular arch but it was not applicable in the maxillary arch (Table 4). Studies on Turkish and Jordanian population also concluded that Tanaka and Johnston method is not applicable on their population.^{31,32} A local study performed also concluded that this method does not accurately predict the mesiodistal diameters of unerupted canines and premolars in Pakistani population.²¹ Another local study concluded that Tanaka and Johnston method is applicable for mixed dentition analysis.¹⁴

This difference of the results between our study and Tanaka and Johnston study could be due to a number of reasons e.g difference in sample sizes and racial and ethnic differences among the two populations studied. In our study the sample size was comparatively smaller and increased sample size could have increased the reliability and strength of our study and might have shown similar results to their study. Further more their study was carried out in a different population (American) and there are ethnic and racial differences in the sizes of teeth as reported by Smith et al²⁹ in their study on three population groups which might have lead to difference in the results of two studies.

CONCLUSIONS

- There are limitations in the application of Tanaka and Johnston's prediction method to Pakistani population.
- Tanaka and Johnston method is valid for predicting the size of unerupted mandibular canine and premolars but it is not applicable in the maxillary arch.
- No Gender discrepancy was seen in the present study as in the maxillary arch both showed significant difference.
- Pakistani subjects should be divided according to arch (Maxillary or Mandibular) prior to carrying out a mixed dentition analysis when applying Tanaka and Johnston method.

RECOMMENDATION

A study with large sample size should be conducted in local population to see the applicability of simple equation or otherwise.

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