Tanaka–Johnston Mixed Dentition Analysis in Yazd

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Abstract:
Aim: To compare the prediction of unerupted permanent canine and premolar size of a comparable sample size of Iranian (Yazd) population with that of the study of Tanaka and Johnston.
Materials and Methods: Teeth on study casts of an unselected sample from a 11 to 25 years old (n 120; 60 males and 60 females) were measured in the mesiodistal dimension. An Iranian mixed dentition analysis based on the Tanaka and Johnston method was constructed with new linear regression equations for prediction of the mesiodistal widths of unerupted canines and premolars. Digital calipers were used to measure the mesiodistal widths of all teeth on study models fabricated from alginate impressions. The predicted widths of the canines and the premolars in both arches were compared with the actual measured widths.
Results: Sexual dimorphism was evident between Iranian (Yazd) males and females in incisors, canines, and premolars in the mesiodistal dimension.
Conclusions: To predict the space (in mm) required for alignment of unerupted canine and premolars in Iranian(Yazd) children, divide the sum of the mesiodistal dimensions of the four mandibular incisors by two and add the respective constants for males (upper, 12.91; lower, 10.51) or females (upper, 9.09; lower, 8.22).
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The mixed dentition stage is the time of occlusion development in which, simultaneously, permanent and deciduous teeth are present. The mixed dentition analysis is performed when all permanent mandibular incisors and the first permanent molars are erupted.[1]
To determine the difference between the amount of available space in dental arch and the amount of tooth material that should be accommodated, prediction of unerupted permanent canines and premolars widths is essential. [2]

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The mixed dentition analysis has great importance in determining the therapeutic options. It helps in determining whether the treatment plan will include serial extractions, guidance of eruption, space regaining, space maintenance, or periodic observation of the patient. [3]
There are three most commonly used MDS analyses developed by Tanaka and Johnston, Moyers, and Hixon and Oldfather. Tanaka and Johnston used the erupted permanent mandibular incisors to estimate the size of the unerupted maxillary and mandibular canines and premolars. They created formulas for each dental arch for a sample of 506 children of northwestern European descent, based on simple linear regression. This method was used in many other MDS analysis studies because it was more

practical and requires no radiographs or prediction tables as used in the Hixon and Oldfather and moyers analyses. The Moyers analysis uses the dental casts to measure the width of Mandibular permanent incisors and a probability table to complete the MDS analysis. Hixon and Oldfather -using 41 subjects of northwestern European ancestry- requires periapical radiographs , the measured width of the erupted permanent mandibular incisors ,and a probability table to estimate only the mandibular arch MDS analysis. [4]

These prediction methods are not 100% precise and can either underestimate or overestimate the actual size. Researchers have investigated the accuracy of the Tanaka-Johnston analysis in various ethnic groups and made necessary modifications.[5]Teeth in the same person tend to have a close relationship in proportional sizes. [1]

In addition, there are also tooth-size differences between the sexes (males generally have larger teeth than females)and in various populations. [5]

The aim of this study was to determine linear regression equations to predict the sum of the mesiodistal widths of the mandibular permanent canines and premolars in an Iranian population from Yazd, by using the 4 permanent incisors as predictors.

MATERIAL AND METHODS:

A total of 506 consecutive pretreatment records of patients , age 11 to 25, undergoing treatment in an orthodontic office in Yazd were examined until records of 60 male and 60 female who met the following inclusion criteria were identified: (1) all teeth on the initial plaster study models in good clinical condition(no caries, ...);(2) mandibular permanent incisors with no proximal reduction; (3) no clinical evidence of enamel defects, such as hypoplasia, worn ,or malformed; (4) no congenitally missing teeth; (5) younger than 25 years of age at the beginning of the study to exclude mesio-distal loss of tooth structure because of age-related proximal wear[6], (6) all teeth (excluding second and third molars) had to be present and fully erupted to allow accurate mesio-distal width measurements; and (7) all impression were taken with a same clinician and same brand of alginate.

This young age group was chosen for measurement to minimize the alteration of the mesiodistal tooth dimensions because of attrition, restoration, or caries. [7]

Each study model was assigned a random identification number to ensure examiner masking for sex. By using digital calipers (CD-15; Mitutoyo Co, Tokyo, Japan) with accuracy of 0.03 mm, the greatest distances between contact points on the proximal surfaces of each tooth on plaster casts were measured(figure 1).

Fig 1. Digital caliper for measurements.

The sum of mesiodistal measurements of these groups were pooled and the mean widths were calculated:

(1) the four mandibular incisors,(2) the mandibular canines and premolars per quadrant,(3) the maxillary canines and premolars per quadrant.

These data were used to develop regression equations which can be used clinically to determine the sum of the mesiodistal widths of the mandibular and maxillary permanent canines and premolars in male, female and in both sex of Iranian sample.

These regression equations were calculated as follows:

$$Y=A+B(X)$$

When Y equals the predicted mesiodistal width of canine and premolars (maxillary or Mandibular) in each quadrant in millimeters and X equals the mesiodistal width four permanent mandibular incisors in millimeters. A+B equal the constants to be derived(A is the y-intercept and B the slope of regression line).

Results:

The results showed a significant statistical difference between males and females (widths are generally larger in males than in females). Sexual dimorphism in the mesiodistal dimension was evident between males and females especially in mandibular canine and premolars. The largest percentage of sexual dimorphism of the mesiodistal dimension in our population was the mandibular canine and premolars followed by the maxillary canine (2.83%).

The least percentage of sexual dimorphism was mandibular central incisor (0.63%). Therefore, separate prediction equations are needed for males and females. No statistical difference was found in tooth widths between the left and right sides. However, the regression equations determined in this study were based on both sides of the mandibular arch. The standard deviations and coefficients of the variation given in Table 1 show that mesiodistal tooth dimension differed between tooth types

Sums of Teeth	sex	mean	SD	P value	D%
Cenral incisors and laterl incisors mandible(X)	male	23.40	1.71	0.145	1.74
	female	22.99	1.29		
	both	23.20	1.52		
Maxillary canine and premolars (Y)	male	21.85	1.25	0.077	1.77
	female	21.47	1.07		
	both	21.66	1.18		
Mandibular canine and premolars (Y)	male	21.45	1.29	0.007	2.83
	female	20.86	1.06		
	both	21.15	1.22		

Table 1.Means, Standard Variations, and Standard Error of the Means of Sums of Teeth (mm)

Based on these new equations, predicted values for the sum of the widths of the permanent canines and premolars were obtained:

Maxillary Male patients: $Y = 12.91 + 0.38X$.

Maxillary Female patients: $Y = 9.09 + 0.54X$.

Mandibular Male patients: $Y = 10.51 + 0.47X$.

Mandibular Female patients: $Y = 8.22 + 0.55X$.

For simplicity and easy memorization when performing mixed dentition analysis, the constants for male and female (Iranian ,Yazd) are approximated, and these approximated constants are shown in Table 2. The original Tanaka and Johnston constants for Americans are also shown in Table 2 for comparison.

	Iranian(yazd)		Tanaka and Johnston (Americans)	
	A	B	A	B
Maxillary arch	11.27	0.45	11.0	0.5
Mandibular arch	9.22	0.51	10.5	0.5

Table 2. Tanaka and Johnston Constants for Iranian(Yazd) and Americans (Ais the y-inter cept and B the slepe of regression line)

Discussion:
Prediction of the mesiodistal dimensions of unerupted permanent canines and premolars during the mixed dentition is important in diagnosis and planning treatment. Accurate estimation of the size of the unerupted canines and premolars allows the dentist to manage tooth size arch length discrepancies better. However, great care must be taken because dental arch perimeter may change with time. Several authors found differences between male and female tooth widths [5,8] although others did not consider sex differences. [9,10] In this study, we also found a statistical difference between male and female tooth widths .Therefore, separate prediction equations are needed for males and females.

In this study, the differences between the right and left sides of the mandibular arch were small and not statistically significant; this symmetry was also found by other investigators. [3,11] Some researches considered both sides of the mandibular arch, according to the method of Staley et al., to determine a more precise correlation and practical result. [12] All prediction methods used in this study were based one side.

Conclusions:
To predict the space (in mm) required for alignment of unerupted canine and premolars in Iranian(Yazd) children, divide the sum of mesiodistal dimensions of the four mandibular incisors by two and add the respective constants for males (upper, 12.91; lower, 10.51) or females (upper, 9.09; lower, 8.22).

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