

MIXED DENTITION SPACE ANALYSIS: A REVIEW

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ABSTRACT

During mixed dentition period discrepancy between spaces available and required in the arch is predicted so that teeth can erupt freely with good alignment. Mixed dentition space analysis is done for this purpose in which size of unerupted canine and premolars is predicted. Accurate prediction is very important regarding correct orthodontic diagnosis and treatment planning. Prediction equation and or tables based on size of already erupted permanent teeth are the most widely used methods. Tooth size varies in different racial and ethnic groups and among genders so prediction equation and tables specific to each population for both male and female must be made. Mandibular incisors; combination of mandibular incisors and mandibular 1st molars; and mandibular incisors and maxillary 1st molars have been used worldwide. Recent studies have reported that mandibular incisors are not the best predictors and sum of mandibular incisors and maxillary 1st molars are even more accurate predictor for the estimation of size of unerupted teeth. In Pakistani population combination of mandibular incisors and maxillary 1st molar have not been employed so study must be conducted to estimate which combination of group of teeth is more accurate for the estimation of size of unerupted canine and premolars in local population.

Keywords: *Mixed dentition, space analysis, mesiodistal width, unerupted, prediction equation.*

INTRODUCTION AND LITERATURE REVIEW

Dental occlusion is the way in which maxillary and mandibular teeth come into contact with each other. It can be static when the jaw is in rest position or centric in which maxillary and mandibular teeth are in maximum intercuspation position.¹ For all orthodontic patients achievement ideal dental occlusion is the main therapeutic goal.²

DENTAL MALOCCLUSION

Malocclusion is any deviation from normal occlusion. Dental malocclusion can occur as a result of genetic factors, environmental factors or combination of both factors. Most of them are the result of an imbalance between teeth size and arch sizes with which teeth are associated.³ Dental malocclusion arise during mixed dentition period and if they are managed timely they can be reduced in severity or even removed entirely.⁴

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Mixed Dentition Period and Its Importance in Interceptive Orthodontics

Mixed dentition period is between six to twelve years of age during which both deciduous and permanent teeth are present. During this period one can make accurate and specific prediction of future dental development and also can assess whether there will be spacing or crowding of teeth in the dental arch.⁵ In interceptive orthodontics treatment planning, it is important to predict space required and available for unerupted canine and premolars in the arch and this determination of tooth size must be done before eruption of canine and premolars by a method called Mixed Dentition Space Analysis (MDSA).⁶

Mixed Dentition Space Analysis

In mixed dentition space analysis, mesiodistal width of unerupted canine and premolars is predicted so that discrepancy between space available and space required for these teeth in the dental arch can be determined.⁷⁻¹² This also helps to determine whether sufficient space is available for posterior teeth in the arch so that they can erupt freely with good alignment.¹³

This analysis is very important regarding orthodontic diagnosis and treatment planning.¹⁴ It helps in determining whether treatment plan is going to involve serial extractions, eruption guidance, regaining of space, space maintenance, or simple observation of patient for the time period is required.^{15,16} Accurate prediction of size of unerupted posterior teeth is important in order to establish a good orthodontic treatment plan.^{17,18}

METHODOLOGY

A review of literature reveals three main approaches used to estimate mesiodistal width of unerupted canine and premolars in mixed dentition patients: 1) Direct measurement of the teeth from dental radiograph (periapical and cephalometric)^{8,9}; 2) Using prediction equations and tables based on measurements of deciduous teeth⁸ or other erupted permanent teeth^{7, 12}; 3) Combination of both methods.^{8,19-21}

i. Direct Measurement from Radiograph

Width of permanent canine and premolars (first and second) is measured directly from dental radio-

graphs (periapical and cephalometric). Several studies have reported methods to improve accuracy for the estimation of size of unerupted teeth by using dental radiographs.²¹⁻²⁶

ii. Use of Prediction Equation and/ or Table

Prediction equation and or tables based on of mesiodistal width of already erupted permanent teeth are used to estimate size of unerupted canine and premolars. The most commonly used are Moyer's probability tables and Tanaka and Johnston's regression equations.^{7,12}

iii. Combination of Radiograph and Prediction Equation

In combined method, mesiodistal width of permanent canine and premolars is predicted from sum width of first and second premolars measured from radiograph plus width of erupted mandibular central and lateral incisor of the same quadrant.^{21,27} It was first recommended by Hixon and Old Father (1958). He established regression equation to predict size of unerupted mandibular canine and premolars from radiographic measurement of mandibular premolars.^{21,28} Oldfather's method was modified by Stahle (1959) by including the sizes of the mandibular permanent incisor to predict mesiodistal width of canine and premolars.²⁷ Staley, R. N. and P. E. Kerber (1980) revised Hixon and Old Father and developed prediction equation and made a graph for the estimation of mesiodistal width of unerupted canine and premolars.²⁰ Several researchers predicted mesiodistal width of unerupted canine and premolars in Caucasian population by a combination of measurements of teeth from dental radiograph and regression analysis done on dental casts and they found it to be more accurate in their respective population.^{29, 30}

Radiographic Vs Prediction Equation and / or Table

Accurate radiographic prediction requires good quality radiographic technique and equipment. Radiograph gives two dimensional image of object so it may give false measurement when teeth may be rotated in their bony crypt.¹⁶ It also have disadvantage of exposure to increase radiation dose. So prediction equation and or tables based on mesiodistal width of already

erupted permanent teeth are the most widely used methods. The most commonly used are Moyer's probability tables and Tanaka and Johnston's regression equations.^{7,12}

Moyers Probability Method

Moyers (1958) developed two probability tables to predict mesiodistal width of unerupted canine & premolars during mixed dentition based on sum of mesiodistal width of four mandibular permanent incisors.¹² This is the most widely used for mixed dentition because of the following advantages: 1) Minimal known systematic error. 2) Can be used by beginner and expert with equal reliability. 3) Less time consuming. 4) doesn't require specific equipment or exposure to radiographs. 5) Applicable to both upper and lower dental arches. 5) Best done on dental cast bit it can be done in mouth with reasonable accuracy. Moyers method is applied most frequently by many populations.^{7,12,23,31,32} Profit and Ackerman also found Moyers method to be satisfactory.³³

Tanaka and Johnston Method

Tanaka and Johnston (1974) developed probability equation to predict mesiodistal width of unerupted canine & premolars by using sum of width of four mandibular incisors.⁷ This is simple, easy, relatively noninvasive and accurate, applicable for both dental arches and genders. This method has also been used widely with an acceptable accuracy for both dental arches and in both genders.^{7,34-36}

Racial and Ethnic Difference in Tooth Size

Literature shows that tooth size varies among different racial and ethnic groups. This variation in tooth size is related to genetic, epigenetic and environmental factors.^{37,38}

Since Moyer and Tanaka and Johnston prediction equation and tables were developed for North American Caucasian children. So its applicability in population of other racial and ethnic origins has been studied and doubted by many researchers.^{4,6,14,18,36,39-62}

Gender Difference in Tooth Size

These methods were not developed for both genders separately while literature shows that tooth size

varies among both males and females with males having larger teeth than females.^{6,14,43,45,46,54,59,60,63} Many authors reported that sex factor should also be included as an additional predictor for the estimation of MDW sum of unerupted canine and premolars based on sexual dimorphism on teeth size. So regression equation and or tables must be made separate for both males and females.^{11,45,63}

Combination of Group of Teeth Used as Predictor

Different combinations of teeth have been used as predictor for the estimation of size of unerupted canine and premolars in mixed dentition space analysis.

• Sum of Four Mandibular Incisors

Sum of mesiodistal width of four mandibular incisors has been most widely used to develop regression equation to accurately predict size of unerupted canine & premolars specific to their own population by many researchers.^{16,39,41,44,46-51,53,54,57,59,61,64}

• Other Combinations of Group of Teeth Used as Predictor

In addition to mandibular incisors, combinations of other erupted permanent teeth (e.g mandibular first molar, maxillary first molar and maxillary incisors) also have been used by some researchers to accurately predict size of unerupted canine & premolars. Fonseca (1961) firstly introduced an additional combination of teeth (sum of maxillary first molar and maxillary four permanent incisors) to develop a multiple regression equation.⁶⁵ Recent studies have reported that sum of mesiodistal width of permanent mandibular incisors is not the best predictor for estimating mesiodistal width of unerupted permanent canine & premolars.^{11,63,66,67} so other teeth along with incisors also have been evaluated to predict mesiodistal width of unerupted canine & premolars.

- Sum of mesiodistal width of permanent mandibular incisors and mandibular first molar has been used as predictor in Brazilian population.⁶⁷
- Sum of mesiodistal width of maxillary central incisor and mandibular first molar is found to be the best predictor to estimate mesiodistal width of permanent canine & premolars in Spanish and Egyptian population.^{52,58}

- Bernabe E, Flores Mir-C (2005) reported that sum of maxillary and mandibular central incisor and maxillary 1st molar is more accurate predictor for estimating mesiodistal width of unerupted canine & premolars in Peru population.¹¹
- Sum of mesiodistal width of maxillary first molar and mandibular incisors is found to be the best predictor to estimate mesiodistal width of unerupted canine & premolars by most of the researchers in Syrian, Croatia and Italian population.^{63,66,68}

Nourallah (2001) developed a more accurate prediction equation and table in Syrian population based on sum of mesiodistal width of maxillary first molar and mandibular central incisors to predict size of unerupted canine & premolar.⁶⁶ Legovic et al (2003) developed regression equation based on mesiodistal and buccolingual width of permanent incisors and maxillary first molar to estimate size of unerupted canine and premolars in a population sample of Croatia.⁶³ Cattaneo C et al (2010) studied combination of group of teeth to predict size of unerupted canine and premolars with most common groups of teeth including four mandibular incisors; mandibular incisors and mandibular first molar; mandibular incisors and maxillary first molar and concluded that sum of four mandibular incisors and maxillary 1st molar is the best predictor for estimating mesiodistal width of unerupted permanent canine & premolars in Italian sample.⁶⁸

Studies Conducted in Pakistan

Applicability of Moyers and Tanaka method has been tested by some researchers and they found that these methods do not accurately predict size of unerupted canine and premolars in our population.^{4,59} Rasool G et al (2008) checked applicability of regression equation developed by Melgaco to estimate mesiodistal width of unerupted mandibular canine and premolars from sum of mandibular incisors and first molars. They concluded that this equation is not suitable in males while it can be applied to females in Islamabad population (100 males, 100 females).⁶⁹ In 2011, prediction equation to estimate MDW of unerupted canine and premolars was developed from sum of MDW mandibular incisors and mandibular

first molars separate for both males and females in the mandibular arch in Karachi population (106 males, 182 females).⁶⁹

Bherwani et al (2011) developed regression equation to predict mesiodistal width of maxillary and mandibular canine and premolars from sum of mesiodistal width of mandibular incisors with significant correlation for maxillary arch ($r=0.65$) and mandibular arch ($r=0.59$) on Karachi population (100 boys, 100 girls).¹⁶ They reported no significant gender difference in tooth sizes while other researchers have reported larger tooth size in males as compared to females in the country.^{4,59,69,70} In this regard prediction equation separate for both males and females and both arches must be developed to enhance accuracy and treatment planning in mixed dentition space analysis in Pakistani population.

Accurate prediction of mesiodistal width of unerupted permanent teeth is required to determine tooth size and arch length discrepancies in mixed dentition. Inaccurate mixed dentition space analysis may lead to wrong extraction decision and poor patient's facial profile.⁵⁴ As patient's demand to seek an early orthodontic treatment is increasing therefore it is important for orthodontists to predict any discrepancy in arch space in advance and initiate appropriate treatment in a timely manner.

CONCLUSION

Mandibular incisors alone; and combination of Mandibular incisors and mandibular first molar, have been used to estimate the mesiodistal width of unerupted canine & premolars in Pakistani population, but combination of maxillary first molar and mandibular incisors, which has been found to be better than the above mentioned group of teeth for estimation of mesiodistal width of canine & premolar, has not been validated on Pakistani population. There is a need to conduct large scale study on a local population sample to evaluate which combination of group of teeth gives more accurate prediction for the estimation of size of unerupted canine and premolars so that discrepancy between tooth size and arch perimeter can be diagnosed early and appropriate treatment can be initiated in time. This will prevent patient from developing adult malocclusion leading to prolonged and expensive future dental management.

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