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APPLICABILITY OF MOYER'S MIXED DENTITION ANALYSIS IN INDIAN POPULATION: A REVIEW

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ABSTRACT

The treatment planning in interceptive orthodontics 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. The accurate prediction is very important to determine the severity of malocclusion and achieve correct orthodontic diagnosis and treatment planning. Moyers 75th percentile level prediction table is the globally used method to estimate the mesiodistal crown width of unerupted teeth; however the accuracy of this probability table has been recently questioned. Since the mixed dentition analysis is of paramount importance to precisely determine the space needed for alignment of canines and premolars, this research aimed at objectively assessing in the literature such an important step for orthodontic dignosis to test the reliability of Moyer's method in Indian population and it was concluded that the probability of 75% was not as accurate as expected.

KEYWORDS: mixed dentition, mesiodistal width, space analysis, prediction equation, unnerupted teeth.

INTRODUCTION

Model analysis is the study of dental casts which helps to study occlusion and dentition from all the three dimensions and analyse the degree of severity of malocclusion and derive the degree of diagnosis and treatment plan. The period of mixed dentition is a critical period for the prevention or interception of any developing malocclusion. Early diagnosis and successful treatment of dento-alveolar discrepancies can help in achieving the goal of occlusal harmony, function and dento-facial aesthetics The mixed dentition analysis helps in the identification of a tooth size-arch length discrepancy and, according to the results obtained, proposes different treatment approaches such as: Eruption guidance, space regaining, serial extractions or not to intervene by keeping the development of the dentition under observation.[1,2]

The first attempt to estimate mesio distal width was made by Black in 1897, who proposed tables based on average widths.[3] Later on periapical radiographs were used to determine the width of unerupted permanent canines and premolars. But this method has the disadvantage that it tends to overestimate the required size and thus a mathematical proportion was proposed to compensate for image enlargement.[4] Today, the methods of mixed dentition analysis based on 45°

cephalometric radiographs seem to be the most precise, but are time consuming and require sophisticated equipment.[5] To avoid these inconveniences, the correlation statistical methods such as prediction tables and regression equations were proposed by many authors and are frequently applied. Carey reported the existence of a significant linear association between the sum of the lower permanent incisors and the sum of the unerupted mandibular permanent canines and premolars in 1946.[6]

Among the different methods available Moyer's 75th percentile level prediction table is the most widely used method to predict the size of unerupted permanent canine and premolars. It was developed in the University of Michigan based on data obtained from American whites of North Westeran European descent.[7] It established a probability table to predict the mesiodistal diameter of unerupted canines and premolars, in both arches. This table is based on the sum of mesiodistal width of the four permanent mandibular incisors and, for each value obtained there is a corresponding value for unerupted canines and premolars. The probabilities ranges from 5% to 95%. Moyer has suggested that the seventy-fifth percentile readings on the prediction chart be taken as the most applicable value. However, the applicability of these tables to other ethnic groups has been studied and it has been well established in the literature that

mesiodistal widths of teeth vary considerably between different racial groups.[8, 9]

Indications of mixed dentition analysis: (Nanda)
1. Premature loss of primary canine
2. Rotation or blocking of lateral incisors
3. Ectopic eruption of first permanent molar
4. Distal terminal plane relationship

Principles of mixed dentition analysis: (Proffit)
1. First permanent molars and incisors should be erupted
2. Succedenous permanent teeth are forming
3. High corelation among group of teeth. Measuring one group of teeth gives predilection of other group of teeth.
4. There is size difference in primary canine and molars and their succedenous teeth.
5. Mesiodistal width of primary canine and molar is greater than permanent sucessors and is known as Leeway space of nance which is 3.4mm in mandibular arch and 1.8 in maxillary arch.

Advantages of Moyer's mixed dention analysis
a) Minimal systemic error.
b) Can be done with equal realibility by a beginner and expert.
c) Simple, easy and not time consuming.
d) Requires no special equipment or radiograph.
e) It can be done with reasonable accuracy in mouth as well.
f) It can be used on both arches.

Limitations of Moyer's mixed dention analysis
a) It is a predictability analysis.
b) It does not take into account the tipping of mandibular incisors lingually or facially.
c) There are population variations.
d) Individual variations in transition from primary to permanent dentition.
e) It does not take into account the curve of Spee.
f) Sexual dimorphism has also been confirmed.

Racial and Gender Difference in Tooth Size
Tooth size varies among different racial and ethnic groups and this variation in tooth size is related to genetic, epigenetic and environmental factors. Since Moyer's 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.[10,11] These methods were not developed for both genders separately while it has been proved in the literature that tooth size varies among both males and females with males having larger teeth than females.[12] Many authors reported that sex factor should also be included as an additional predictor for the estimation of mesiodistal width 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 female.[13]

Other Combinations of Group of Teeth Used as Predictor
Recent studies have reported that sum of mesiodistal width of permanent mandibular incisors proposed by Moyar is not the best predictor for estimating mesiodistal width of unerupted permanent canine & premolars, 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.[14]

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.[15]

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.[16,17]

Melgaço in 2007 found high values of correlation and determination coefficients when the mesiodistal widths of the mandibular first permanent molars were added to those of the four mandibular permanent incisors.[18]

Study design
The review was undertaken to summarize the results of the published articles to test the reliability of Moyers mixed dentition analysis in Indian population. Articles were searched and identified using the PubMed, EBSCO, Science Direct, and Medline databases. The search included articles published from 2008 to 2018. The keywords such as mixed dentition analysis, Moyer's method, prediction equation and unerupted teeth were used.

Selection criteria
Article titles and abstracts were reviewed, and irrelevant papers were excluded from the study. If the abstract was deemed relevant, then the full paper was reviewed. To be included in this review the article had to have used Moyer's method or be very similar and used simple regression analysis to predict the canine and premolar dimensions. The exclusion criteria were: Dental casts of patients with some type of syndrome or cleft patients, literature reviews and clinical case reports.

DISCUSSION
Mixed dentitioin analys is one among the routine investigations employed in pediatric dentistry, for which Moyer's analysis is most commonly utilized in the

clinical practice. Moyer's analyses was derivedfrom populationof North European and were proven to be unreliable in populations of various ethnic background. The influence of changing secular trends also demands a revision or validation of population based statistics, at least once in every generation, which is approximately 30 years. Hence, the present study was planned to assess the applicability of this analyses to indian population.

Philip et-al conducted a study to evaluate the applicability of Moyers probability tables in a contemporary orthodontic population of India and to formulate more accurate mixed dentition prediction aids. Odontometric data were collected from 300 male and 300 female subjects who had fully erupted mandibular permanent incisors and maxillary and mandibular canines and premolars. The casts were made from dental impressions of children in various schools of Punjab state in India. The odontometric values obtained were statistically compared with predicted values from Moyers tables at the 5% to the 95% confi-dence levels. Significant differences were found at all percentile confidence levels, except at 95% and 85% for males in both arches; there were significant differences for female at all percentile levels, except at 95% and 85% in the mandibular arch and at 95% in the maxillary arch. The Moyers probability tables were found to signif-icantly underestimate canine and premolar mesio- distal widths of Indian children, at almost all percentile levels, including the commonly used 75% and 50% levels. The regression analysis was used to formulate new prediction equations that can be used clinically to predict the mesiodistal crown widths of the unerupted canine premolar segments (Y) when the combined mesiodistal crown widths of the 4 mandibular perma- nent incisors are known (X) for the children of Punjab.[19]
Male: Maxillary 7.15 **1** 0.67(X) Mandibular 5.55 **1** 0.71(X)
Female: Maxillary 7.44 **1** 0.65(X) Mandibular 6.15 **1** 0.67(X)

A study was conducted by Umapathy Thimmegow et-al to test the reliability of Moyer's predictability table and to produce new regression equation for Bangalore population for predicting the mesiodistal diameters of the unerupted permanent canines and premolars. Data was collected from study models of 400 randomly selected Bangalore subjects aged 13 to 16 years with fully erupted. This data was then utilized to predict the mesiodistal widths of canines and premolars and further compared with Moyer's table. In this study it was found that 50% probability level is more applicable to boys and 75% probability level to girls than the Moyer's probability table. The canine premolar segment in both arches was statistically larger in men than in women and new regression equation was formulated. The sizes of canines and premolars of the Bangalore subjects are larger than those predicted by the Moyers tables. The difference is approximately 1mm per quadrant.

The equation is Y = a+b.(x) For LCPM width
1. Y= 17.204+0.174.(x)—Males
2. Y= 13.431+0.330.(x)—Females
For UCPM width
1. Y=16.904+0.209.(x)—Males
2. Y=15.627+0.263.(x)—Females. Probability tables (males and female) for Bangalore population were derived.[20]

A study was formulated to evaluate the applicability of the Melgaço's prediction equation in comparison with Moyers' mixed dentition analysis table for prediction of unerupted permanent canine premolar width for Gujrati Population. From this study it was concluded that neither Moyers' mixed dentition analysis tables nor Melgaço's prediction equation was completely accurate when applied to the present contemporary Indian population. The Moyer's mixed dentition analysis and Melgaço's prediction equation overestimated the tooth dimension in this population and thus a simplified equation, $Y = 0.925X$, was formulated to the present Gujarati population without sexual dimorphism.[21]

A study study was undertaken to evaluate the accuracy of methods proposed by Moyers, Bachmann and Trankmann et al to forecast the mesiodistal dimensions of permanent canine and premolars in Patiala (North India) population. All the three methods exhibited overestimation of actual sum of permanent canine and premolars in both the arches and genders in this population. The Moyers mixed dentition analysis method at 75th percentile gave relatively closer estimate for prediction of mesiodistal dimensions of permanent canines and premolars amongst the methods compared in Patiala population.[22]

A study was conducted by Kondapaka, et al to determine the most reliable mixed dentition analysis method for Nalgonda population. Seven different mixed dentition analyses were performed which include Bachmann's, Gross and Hassund's, Trankmann et al., Camilo et al., Legovic et al., Tanaka–Johnston and Moyer's methods and were later compared. The Moyer's mixed dentition analysis method was found to be the most reliable method amongst the methods compared in children of Nalgonda population among all the methods Moyer's analysis showed highest correlations in both boys and girls and in both maxilla and mandible. The correlations for Moyer's method were higher in the maxilla compared to the mandible in both the sexes.[23]

A study was formulated to evaluate the applicability of Moyer's mixed dentition space analysis in the Marwari community of Rajasthan, India by Baheti, et al. There was significant statistical difference between values of the present study and Moyer's prediction values. Hence they developed the following new regression equations for the Marwari community of Rajasthan to predict tooth width of unerupted teeth in Marwari children of Rajasthan.

Male: Maxilla‑ Y = 10.52 + 0.46x, Mandible‑ Y = 9.45 + 0.48x

Female: Maxilla‑ Y = 11.67 + 0.45x, Mandible‑ Y = 11.58 + 0.32

A study was conducted to test the reliability of Moyers mixed dentition analysis in school going children from the city of Belgaum (Karnataka). They found that Moyers prediction tables were not accurate when applied to this population. The differences noted between predicted values of the Moyers tables and those of the present investigation are the result of racial and ethnic diversityand tooth dimension showed sexual dimorphism. Mesiodistal crown dimension in the buccal segment of the mandibular arch was larger in males than in females. P =0.04) in males than in females. With the help of the data obtained, new regression equations were derived separately for male and female subjects to be used to predict tooth dimension.[25]

Male: Maxilla - Y = 10.52 + 0.48x Mandible - Y = 9.46 + 0.50x

Female: Maxilla - Y = 11.73 + 0.41x Mandible - Y = 11.67 + 0.39x.

To evaluate the applicability of Moyer's mixed dentition analysis at 75th Percentile in predicting the size of permanent canines and premolars in children of Aligarh city a studuywas conducted by Bhatnagar et-al. On the basis of the findings of the present study, Moyer's method at 75th Percentile level significantly overestimates the mesiodistal widths of maxillary and mandibular canines and premolars in males and females children of Aligarh City, UP, India.[26]

Kamatham et-al evaluated the applicability of Moyers' and Tanaka–Johnston's (TJ) mixed dentition analyses in predicting canines and premolars dimensions in South Indian population. They concluded that TJ method and Moyers' method at 35 and 75% probability level could not be applied for the considered population. For boys, Moyers' at 50% level was better applicable, whereas, for girls Moyers' at 65% level was applicable only for maxilla. Hence, population-specific new regression equations have to be formulated to accurately predict the size of un-erupted canines and Premolars.[27]

CONCLUSION
In conclusion Moyers prediction tables were not accurate and have population variations from one state to another. For one to be sure of the accuracy while using Moyer's method it is necessary to develop prediction tables for specific populations through regression analysis as the majority of the articles analyzed showed that the probability of 75% was not as accurate as expected for Indian population. Therefore, we suggest that the probability tables be adapted according to each population, or that another method be used to predict the width of unerupted permanent canines and premolars**.**

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