COMPARISON OF ABOUL-AZM AND FOUDA'S APPROACH OF MIXED DENTITION ANALYSIS WITH MOYERS TECHNIQUE

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ABSTRACT

Introduction

The prediction of mesiodistal widths of unerupted canines and premolars are an important aspect of analysis of the developing permanent dentition. Various radiographic as well as non radiographic methods have been tested and researched to predict the width of these teeth. The Moyers mixed dentition analysis is a universally accepted technique. Whereas Aboul-Azm and Fouda's approach of mixed dentition analysis is a concept that derives the measurement from equation based on the bucco lingual width of the permanent first molars. It does not require any table for the prediction.

Objective

The present study compares the Aboul-Azm and Fouda's approach of mixed dentition analysis with Moyers technique.

Methodology

Estimations of the widths of theunerupted permanent canines, first and second premolars were performed for maxillary and mandibular arches using Aboul-Azm and Fouda's and Moyers prediction methods. The predicted values were then compared with the measurements of the actual teeth on 224 study models of males and females. The study was conducted from October to December 2021.

Result

The study was conducted on 112 male and female samples each. For males, statistically significant underestimation were found for Aboul-Azm and Fouda's method in both arches whereas Moyers method showed better accuracy in males. In females Moyers method showed a significant overestimation. In the total sample the Moyers method showed accuracy for maxillary arch whereas Aboul-Azm and Fouda's method was more accurate for the mandibular arch.

Conclusion

Moyers method showed a good accuracy in the maxillary arch while in the mandibular arch Aboul-Azm and Fouda's methodwas moreaccurate.

KEYWORDS

Aboul-Azm and Fouda's approach; Mixed dentition analysis; Moyers method; Prediction.

INTRODUCTION

Mixed dentition period is the period that commences with the eruption of first permanent molar and ends with complete replacement of the primary teeth. It coincides with the rapid growth of cranio facial skeleton and an early identification and intervention of anticipated orthodontic problems in children proves to be beneficial.[1]

Mixed dentition model analysis calculates the difference between the amount of space present in the dental arch and the amount of tooth material that can be accommodated in perfect alignment.[2,3] Various methods have been researched and applied for analysis in the mixed dentition period which incorporate the use of models, radiographs or a combination of both.[4]

Moyers mixed dentition analysis is a universally accepted tool,developed at the University of Michigan based on the odontometric data of American White subjects of Northwestern European descent. It consists of a prediction table which is based on a correlation between the sum of the mesio-distal width of mandibular incisors that predict the combined measurementof unerupted mandibular and maxillary permanent canine and premolar.[2,3,5]

Abuol-Azm and Fouda[6]have documented another approach of mixed dentition analysis. This predicts the combined width of permanent canines and premolars based onthe buccolingual measurements of the permanent first molars using equations for the upper and lower dentition. Using this method Fouda[7] conducted a comparative analysis and reported an accuracy of 75%.Clinically this technique requires shorter time with no requirement for a probability chart.

The present study therefore compared the mixed dentition analysis using the Aboul-Azm and Fouda's approach and Moyers technique.

METHODOLOGY

A cross sectional clinical study was under taken using pre-treatment orthodontic study casts in the Department of Pedodontics at Kantipur Dental College from October to December 2021. The study was started after approval by the Institutional Review Committee (Ref No.22/021). Pre-treatment maxillary and mandibular dental casts of patients aged between 14 to 25 years with fully erupted permanent teeth atleast upto the first permanent molars were used. The sample size was calculated by the formula-

$$n = z^2SD^2 / e^2 = (1.96)^2 \times (0.27)^2 / (0.05)^2$$

$$= 112 = 112 \times 2 = 224$$

(where z= 1.96, e= 0.05, SD= 0.27 (Lee et al 2015 [8]).

The inclusion criteria were good quality pre-orthodontic treatment casts free from distortions, dental caries and interproximal restorations, having fully erupted mandibular incisors, canines, premolars and first permanent molars. The exclusion criteria were study casts of patients with a former history of orthodontic treatment, missing or supernumerary teeth, significant teeth wear, hypoplastic teeth and abnormally sized or shaped teeth.

The teeth were measured by a digital vernier caliper set to read to the nearest 0.01 mm and all measurements were made by a single investigator.

From each model, the following were recorded:

- Mesiodistal Diameter (MDD) for all permanent mandibular incisors, all permanent canines (C)and first and second premolars (P_1 and P_2 respectively) in each quadrant. The measurements were made perpendicular to the long axis of tooth by entering the caliper beak from interproximal area from occlusal side.
- Buccolingual Diameter (BLD) of all permanent first molars in each quadrant , the maximal distance between the buccal and lingual surface perpendicular to the mesio-distal diameter of tooth and parallel to the occlusal plane.

Two different non-radiographic techniques for mixed dentition analysis were used in the study. In Moyers Method the sum of the mesiodistal measurements four permanent mandibular incisors were used to predict the combined size of the permanent unerupted canines and premolars for both quadrants using Moyers probability table at 75th percentile.[2]

In Aboul-Azm and Fouda'smethod[6], the buccolingual measurements of the permanent first molars of each quadrant was used in equation to predict the combined size of permanent canine and premolars for each quadrant. In the maxillary arch, the combined widths of the canine and bicuspids on one side is equal to the bucco-lingual width of the first permanent molar multiplied by 2 and minus 1 from the total value obtained. Whereas in the mandibular arch, the mesiodistal widths of canine and bicuspids on one side equal the buccolingual width of the first permanent molar on that side multiplied by 2.

The statistical analysis of the data was carried out using Statistical Package for Social Sciences (SPSS) for Windows version 20(SPSS Inc., Chicago, III.,USA). The statistical analyses performed were: descriptive statistics including the mean and standard deviation. Gender dimorphism was assessed using Independent sample t-test and paired sample t-test was used to compare the actual and predicted values. The p-value of ≤0.05 was considered to be significant.

RESULTS

The sample consisted of 224 dental casts (112 males and 112 females). The descriptive statistics of sum of actual mesiodistal widths of permanent canines and premolars in all quadrants, sum of permanent mandibular incisors and buccolingual widths of all permanent first molars is depicted in table 1.

Table 1: Descriptive statistics for actual widths.

	Maxillary Right Mean(mm)±SD	Maxillary Left Mean(mm)±SD	Mandibular Right Mean(mm)±SD	Mandibular Left Mean(mm)±SD
Sum of mesiodistal widths of permanent canine and premolars.	21.69±1.18	21.59±1.27	20.82±1.17	21.00±1.23
Buccolingual width of permanent 1st molars.	10.7±0.58	10.7±0.63	10.34±0.01	10.41±0.64
Sum of mesiodistal widths of lower incisors	23.61±12.61			

Table 2 shows the gender dimorphism for actual and predicted values in the maxillary and mandibular arches. A statistically significant difference was present between the genders in the actual values of permanent canines and premolars ($P \leq 0.05$). However the difference was not significant in the calculated values using Moyers and Aboul-Azm and Fouda's methods.

Table 2: Gender dimorphism for actual and predicted values

Maxillary Arch	Gender	Mean (mm)±SD	*P*-Value
Actual Values of permanent canines and pre molars	Male (n=112) Female(n=112)	21.86 ±1.21 21.38±1.06	0.002
Moyers 75%	Male(n=112) Female(n=112)	21.69±1.21 21.43±0.670	0.21
Aboul-Azm and Fouda's	Male (n=112) Female(n=112)	20.48±1.15 20.37±1.20	0.48
Mandibular Arch	**Gender**	**Mean(mm) ±SD**	***P*-Value**
Actual Values of permanent canines and pre molars	Male(n=112) Female(n=112)	21.23±1.20 20.58±0.98	0.000
Moyers 75%	Male(n=112) Female(n=112)	21.40±1.97 21.27±0.77	0.11
Aboul-Azm and Fouda's	Male (n=112) Female(n=112)	20.72±1.18 20.77±1.18	0.71

Table 3 shows the comparison of the actual value with the predicted values using the two methods in the maxillary and mandibular arches of males and females using paired t-test. In the maxillary arch the Aboul-Azm and Fouda's method showed a significant underestimation whereas in the mandibular arch the Moyers method depicted an overestimation. The remaining measures were accurate. In the males the Aboul-Azam and Fouda's method in both the arches showed an underestimation while Moyers method was more accurate to actual value. While in the females the accuracy of Aboul-Azam and Fouda's method was more betterfor mandibular arch while it showed an under estimation in maxillary arch. The Moyers method showed an overestimation in the mandibular arch in females.

Table 3: Comparison of predicted values based on methods of Moyers and Aboul-Azm and Fouda with the actual values.

	Predicted values of permanent canines and premolars Mean(mm)±SD	Actual values of permanent canines and premolars Mean(mm)±SD	Difference predicted minus actual values Mean(mm)±SD	*P*-value
MAXILLARY ARCH (n=224)				
Moyers 75%	21.56±0.68	21.62±1.16	-0.065 ±1.36	0.472
Aboul-Azm and Fouda's	20.42 ±1.17	21.62±1.16	-1.20±1.63	0.00
MALES (n=112)				
Moyers 75%	21.69 ±1.21	21.86±1.21	-0.17±1.49	0.214
Aboul-Azm and Fouda's	20.48 ±1.15	21.86±1.21	-1.38±1.68	0.000
FEMALES (n=112)				
Moyers 75%	21.43 ±0.67	21.38±1.06	0.05±1.21	0.696
Aboul-Azm and Fouda's	20.37 ±1.20	21.38±1.06	-1.01±1.63	0.000
MANDIBULAR ARCH (n=224)				
Moyers 75%	21.33 ±1.5	20.91±1.14	0.42 ±1.87	0.01
Aboul-Azm and Fouda's	20.75 ±1.18	20.91±1.14	-0.16±1.61	0.12
MALES (n=112)				
Moyers 75%	21.40 ±1.97	21.23±0.11	0.17 ±2.31	0.445
Aboul-Azm and Fouda's	20.72 ±1.18	21.23±0.11	-0.51±1.61	0.001
FEMALES (n=112)				
Moyers 75%	21.27 ±0.77	20.59±0.98	0.68 ±1.27	0.000
Aboul-Azm and Fouda's	20.77 ±1.18	20.59±0.98	0.18±1.51	0.203

n=224; Statistical significance *P*≤ 0.05; Paired t-test

When the two methods were compared, there was a statistically significant difference between the two methods, the Moyers method showed a higher calculated values of permanent canines and premolars in both the genders as well as in both the arches.(Table 4)

Table 4: Comparison of predicted values based on methods of Moyers and Aboul-Azm and Fouda

	Predicted values based on Moyers Method (A) Mean(mm)±SD	Predicted values based on Aboul-Azm and Fouda's Method (B) Mean(mm)±SD	Difference in both the predicted values (A-B) Mean(mm)±SD	*P*-value
Maxillary Arch (n=224)	21.56±0.68	20.42 ±1.17	1.14 ± 0.97	0.000
Males (n=112)	21.69 ±1.21	20.48 ±1.15	1.21 ± 0.98	0.000
Females (n=112)	21.43 ±0.67	20.37 ±1.20	1.06 ± 0.96	0.001
Mandibular Arch (n=224)	21.33 ±1.5	20.75 ±1.18	0.58±1.16	0.000
Males (n=112)	21.40 ±1.97	20.72±1.18	0.68±2.0	0.001
Females (n=112)	21.27 ±0.77	20.77 ±1.18	0.5±0.93	0.000

DISCUSSION

The primary dentition paves the future of the permanent dentition and it has been found that the presence of crowding in the primary dentition increases the probability ofmalalignment in the permanent dentition.[9] The arch length has a tendency to decrease during the transition from mixed to permanent dentition.[10] Predicting the size of unerupted canines and premolars during the mixed dentition period is a critical factor because an early correct assessment of these lead to better management of tooth size/ arch length discrepancies.[11,12]

The basic principles for mixed dentition model analysis are that it should be simple, fast, practical, precise and applicable in both the arches.[12,13] The mixed dentition analysis methods use either of the following: radiographs, prediction tables or a combination of both the methods.[10] The mesiodistal (MD) widths of tooth was first estimated by Black, who proposed tables based on average widths.[14] Over the years, many methods have been developed, however no method of mixed dentition analysis has 100% accuracy and may overestimate or underestimate the predicted widths.[12] One of the most widely used methods is the Moyers' analysis where a probability table predicts the amount of space required to align the permanent canines and premolars by utilizing the sum of the width of the four mandibular permanent incisors.[15]

Most of the other non radiographic techniques also utilize the measurements of permanent lower incisors with or without molar dimensions for the prediction. Few researchers have suggested that using only the mesiodistal width of mandibular incisors is not the best predictor for the width of unerupted permanent canines and premolars.[12] However in a comparative study among seven methods of mixed dentition analysis conducted by Kondapaka et al [1], Moyers method was more reliable in maxillary arch in both genders. Many methods have utilized the dimensions of the permanent molars for prediction without requiring prediction charts.[6,7,10]

AboulAzm and Fouda[6] formulated a method that makes predictions based on equations that need the measurements of only the bucco-lingual dimension of the permanent first

molars in each quadrant. The benefit of this technique is that the dimension can be measured clinically as well and it requires minimum time, does not need a probability chart and can also be done before the eruption of the lateral incisors. The use of permanent first molars has an added advantage that they erupt early in the mixed dentition period, are easy to measure showing little variability in size.[13] Fouda MA[7] proved the validity of Aboul-Azmand Foudamethod in Angle's class I cases to be 75%.The more frequently used Moyers method was therefore compared with the less frequently used but simpler approach given by Aboul-Azm and Fouda, in the present study.

This study utilized 224 upper and lower dental casts, of 112 male and female samples each, which were evaluated together as well as separately. The results indicate a significant sexual dimorphism in the actual widths, the males having a larger mesiodistal and buccolingual tooth widths than females which was in consensus with other studies.[9,10,12,13,16,17] Many authors are in disagreement with no difference seen among males and females.[5,18,19]

The predicted tooth size can show either an overestimation or an underestimation. When the prediction is under estimated, it can lead to inadequate space and crowding of the permanent teeth, on the other hand an overestimation may result in unnecessary extraction.[7]An overestimation up to 1 mm beyond the actual value do not affect the decision of extraction or non-extraction.[12]

In the present study, the Moyers method[2]showed more accuracy to actual value in the Maxillary arch in the entire sample while more accurate results were given by the Aboul-El-Azam and Fouda's[6] method in the mandibular arch. Variation in the accuracy while comparing the predicted values using different techniques have showed different accuracy for the maxillary and mandibular arch in different studies.[12] Kondakapa et al[1] reported an over-prediction of 89.16% and 75.83% of cases in maxillary and mandibular arch respectively. Similar overestimations with Moyers prediction at 75% probability have been reported by many authors.[3,5,12,20,21]

The predictions in this study was also analyzed individually for both the genders. In the males the Aboul-Azam and Fouda's method in both the upper and lower arch showed an under estimation whereas Moyers method was more accurate to the actual value. Mahmoud et al[9] found the Moyers method in males to be accurate in the upper arch with less accuracy noted in the lower arch.

In the females the accuracy of Aboul-Azam and Fouda's method was more for mandibular arch while it showed an underestimation in maxillary arch. The findings of Fouda's[7]study are in agreement to this study, where, the predicted widths of the tooth material were close to the actual widths in the lower arch. Moyers method however overestimated the values in the lower arch in females, which is in consensus to the study by Kondapakaet al[1]. Mishra et al[18] have found an over estimation in both arches in females while Grover et al[20] report of a significantly lower actual mean value in female mandibular arch using Moyers analysis. Less accuracy of Moyers method in both genders has also been reported by Mahmoud et al[9]which contrasts with Memon et al[12] where the predicted value is very close to actual value.

In Nepal ample studies on mixed dentition analysis have been carried out using the Moyers method but to the best of our knowledge no studies have utilized the Aboul-Azam and Fouda's approach. Most of the studies in Nepal have shown an overestimation at Moyers probability of 75%.Gyawaliet al[19] reported overestimation in both arches in males and in the mandible in females whose finding is in agreement with the present study. Shrestha et al[22] reported that in the Newar community of Nepal, the Moyers probability table can be used to predict combined mesiodistal width at 75% level for mandible in male which agrees with our study while they state a higher probability levels for other sites.

CONCLUSION

It was observed in the present study that both the methods of mixed dentition analysis have certain deficiencies; however the applicability of Moyers method was accurate for upper arch whereas for mandibular arch,Aboul-Azm and Fouda's method showed better accuracy. It can be concluded that for mixed dentition analysis separate techniques can be used for the upper and lower arch and this can be further studied.

LIMITATIONS OF THE STUDY

The study compared two methods of mixed dentition analysis, further studies can be conducted to compare the Aboul-Azm and Fouda's method with other commonly used techniques.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FINANCIAL DISCLOSURE

None

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