ORIGINAL ARTICLE

Applicability of Two Non-Radiographic Mixed Dentition Analysis Methods in Orthodontic Patients

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ABSTRACT

Background: Using erupted components of a dental arch to estimate the width of the unerupted dental components are the basis of mixed dentition analysis. Non-radiographic mixed dentition analysis employs a regression equation to assess the width of the unerupted canines and premolars. In this study, we assessed the applicability of two non-radiographic methods of mixed dentition analysis in orthodontic patients.

Methods: This cross-sectional research was carried out from the records of Ziauddin College of Dentistry, Department of Orthodontics, from November 2019 to March 2020. Pre-treatment dental casts of 120 subjects (60 males and 60 females) aged between 12-30 years undergoing orthodontic treatment were selected. The mesiodistal widths from the left first molar to the right first molar were measured using a digital Vernier caliper on pretreatment dental casts of both arches. Bachman's and Tanaka-Johnston methods were applied to estimate the widths of canine and premolars. Gender dimorphism for actual and estimated values was assessed using an independent t-test and a paired t-test was applied for the comparison between the actual and estimated mesiodistal widths of canine and premolar.

Results: The actual and estimated widths of canine and premolars reported 14.3±1.4 years for males and 13.4±1.2 years for females. In addition, the Bachman's and Tanaka-Johnston method overestimated the actual widths of unerupted canine and premolar but the difference was statistically insignificant ($p \geq 0.05$) in both the genders.

Conclusion: The two non-radiographic methods were reliable for mixed dentition analysis with minor overestimation between actual and estimated widths (ICC=0.79). This makes both the methods applicable interchangeably in regular clinical practice.

Keywords: Mixed Dentition; Unerupted Teeth; Dental Models; Radiography.

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INTRODUCTION

The mixed dentition period initiates, at approximately 6 years of age, once the first permanent molars or incisors erupt. Mixed dentition is a transitory stage demarcated from the time the first permanent tooth erupts and lasts until the last primary tooth is shed[1]. Mixed dentition, from the point of view of the orthodontist, is a crucial stage of occlusal development. Arch length and discrepancy of tooth size are two factors involved in eliciting problems in the mixed dentition phase[1-3]. Dental malocclusion can commonly occur during this phase. To address effectively, this problem, various prediction methods consisting of systems and formulas based on fixed algorithms have been devised. These are termed as mixed dentition analysis. Calculation of the space required and space available is carried

out so that treatment can be accordingly and teeth in the arches can be aligned well. Accurate prediction plays a key role in orthodontic treatment planning. The fundamental principles for mixed dentition analysis are that they should be easy to use, not time-consuming, uncomplicated, have a minimum margin for systemic error, can be carried out in both arches and can be directly carried out in the oral cavity as well[4-6]. These are the methods established to evaluate the mesiodistal widths of the canines and premolars and for this purpose, study casts are used.

The goal of carrying out mixed dentition analysis is to evaluate the amount of space present for the succeeding dentition in each of the dental arches. Once the prediction size of the unerupted permanent teeth is found, the most likely degree of crowding can be established[7]. Early diagnosis and interception of crowding undoubtedly aids in better treatment planning to tackle crowding and thereby the effects produced by it[8-10]. The severity of malocclusion in the future can be markedly decreased using timely interception. There are a variety of accepted methods, broadly divided into 3 categories - regression equations used, radiographs used and a combination of both[11-14].

The most commonly used prediction methods worldwide are Moyer's Prediction Tables and Tanaka-Johnston equations[2-4]. However, it has been established that these are not always accurate when used on populations of varying descent[7,15]. Prediction tables do not give accurate results unless they are made gender and race-specific. There is a dissimilitude in tooth sizes among different racial and ethnic groups, as well as a difference between genders; due to this, there can often be imprecise and faulty results when standardized and non-specific methods are used. It has also been concluded by recent studies, that mandibular incisors alone are not the most accurate predictors. For better accuracy, a sum of incisors and maxillary first molars should be used[16,17]. Moreover, the accuracy and reliability of Bachman's method for mixed dentition analysis was required to be assessed in our population. Therefore, this study aimed to assess the applicability of two non-radiographic methods of mixed dentition analysis in orthodontic patients.

METHODS

This cross-sectional research was done on pre-treatment dental casts of patients seeking treatment at Department of Orthodontics, Ziauddin University, Karachi, Pakistan for a period of 6 months beginning from November 2019 to March 2020. Institutional acceptance was obtained preceding the initiation of the research.

The sample size was calculated n=96, which was augmented to 120 to add 20 percent attrition. The power of the study was kept 80% at a 95% confidence level with a margin of error of 5%. Pretreatment dental casts of patients aged between 12 to 30 years with fully erupted permanent teeth from the second central incisor until the second molar were included in the study. Dental casts of patients with a former history of orthodontic treatment, missing teeth, carious and restored teeth at the measurement landmark (mesiodistally and vestibule-orally), hypoplastic, worn, or with anomalies, were excluded. The principal investigator measured all the study models using a digital Vernier caliper (0-150 mm ME 00183, Dentaurum, Pforzheim, Germany) with an accuracy of ±0.02 mm and repeatability of ±0.01 mm (manufacturer specification). The mesiodistal diameter (MD) of teeth from the right first molar to the left first molar of both maxillary and mandibular arches was measured. The primary investigator randomly picked up thirty dental casts after two weeks and the mesiodistal diameter of teeth was re-measured. Intraclass correlation (ICC) was applied to calculate the intra-examiner reliability for the measurements for mesiodistal widths of canines and premolars.

Tanaka-Johnston and Bachmann's prediction equations (Figures 1 and 2) were used in this research to estimate the mesiodistal widths of the canine and premolars in both arches.

Figure 1: Tanaka and Johnston method for mixed dentition analysis.

Tanaka and Johnston prediction equation:
Maxillary arch = Mesiodistal width of four lower incisors/2 + 11.0mm
Mandibular arch = Mesiodistal width of four lower incisors/2 + 10.5mm

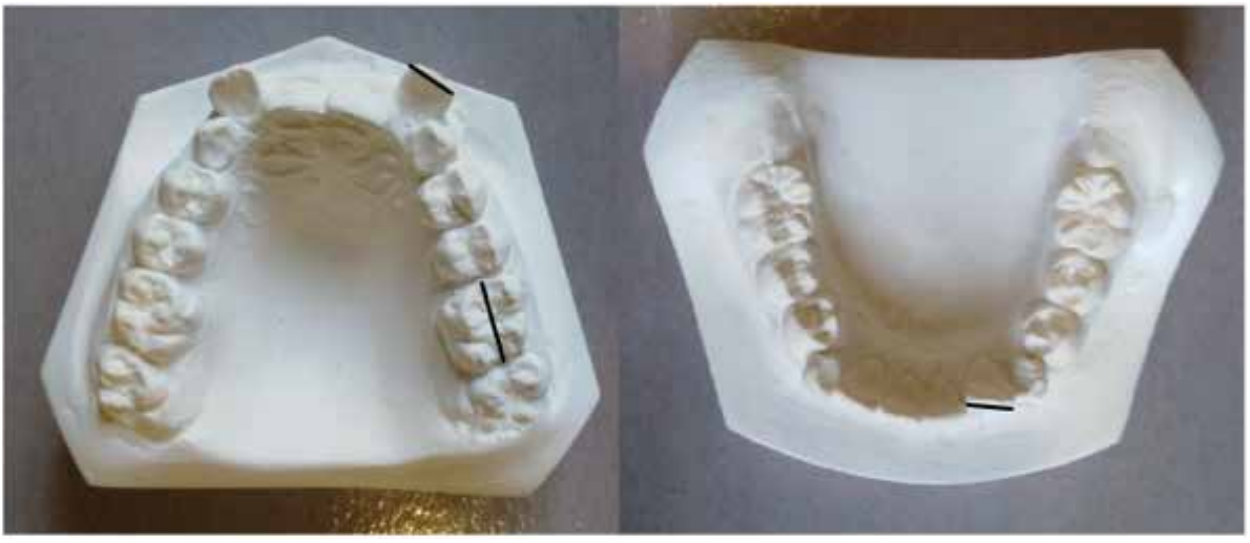

Figure 2: Bachmann's method for mixed dentition analysis.

Bachmann's prediction equation:
Maxillary arch = 0.81 × (22MD) + 0.54 × (26MD) + 0.56 × (32MDD) +6.98
Mandibular arch = 0.71 × (22MD) + 0.39 × (26MD) + 0.86 × (32MDD) + 6.96

The 22 and 26 represent MD (mesiodistal) width of the crowns of the upper and lower lateral incisors, 32 MDD (mesiodistal diameter) of the crown of the left upper first permanent molar. The data was evaluated through SPSS version 21. A paired sample t-test was applied to compare the actual and estimated sum of the mesiodistal widths of canine and premolars for both prediction methods. An independent sample t-test was conducted to compare means of actual and estimated sums of canine and premolars widths in both genders and *p*-value ≤0.05 was considered statistically significant.

RESULTS

The study sample comprised of 120 dental casts of 60 males (14.3±1.4 years) and 60 females 13.4±1.2 years). A gender dimorphism for actual and estimated widths of canine and premolars is shown in Table 1. Although gender variances were visible in the actual and estimated values of canine and premolars in both arches, however, gender variances were statistically insignificant ($p \geq 0.05$).

Table 1: Actual and estimated combined widths of canine and premolars in both genders.

Prediction Method (Mean±SD)		Male	Female	*p*-Value
Permanent canine and premolars in maxillary arch		21.80±1.35	22.37±0.96	0.38
Permanent canine and premolars in mandibular arch		20.60±1.51	20.81±1.73	0.82
Tanaka and Johnston	Maxillary arch	21.97 ± 1.29	21.06 ± 1.10	0.50
	Mandibular arch	21.09 ±2.42	20.56 ± 2.25	0.43
Bachmann's Method	Maxillary arch	21.41±0.61	21.2±0.49	0.97
	Mandibular arch	21.05±0.69	21.2 2±0.56	0.63

** p≤ 0.05 as statistically significant; Independent sample t-test.*

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The actual and estimated sum of canine and premolars constructed on the methods of Tanaka and Johnston and Bachmann were assessed using paired t-test as depicted in Table 2. Both prediction methods overestimated the actual sum of canine and premolars however the difference was statistically insignificant in both genders. Good intraclass correlation was found between the two sets of measurements (ICC=0.79).

Table 2: Actual and estimated values based on both non-radiographic methods in both genders.

Prediction Method		Gender	Actual Mean±SD	Estimated Mean±SD	Difference Mean±SD	*p*-Value
Tanaka and Johnston	Maxillary arch	Male	21.44±1.54	20.35±1.29	1.09±0.25	0.55
		Female	20.71±0.78	20.96±1.08	-0.25±0.23	0.69
	Mandibular arch	Male	21.09 ± 2.42	20.35±1.29	0.73 ± 2.38	0.43
		Female	20.56 ± 2.25	20.96 ± 5.06	0.39 ± 5.23	0.36
Bachmann's Method	Maxillary arch	Male	21.80±1.35	21.41±0.61	0.39±1.05	0.46
		Female	21.00±1.66	21.42±0.49	-0.42±1.40	0.42
	Mandibular arch	Male	20.60±1.51	21.06±1.05	-0.46±0.89	0.32
		Female	20.18±1.7	21.22±0.56	-0.40±1.42	0.44

*n= 120; * p ≤ 0.05 as statistically significant; Paired sample t- test*

DISCUSSION

Bachmann's Mixed Dentition analysis method employs a regression equation to measure the combined width of the canines and premolars. Kondapaka et al. conducted a study where they compared seven methods of analysis to find the most reliable method. Bachmann's method proved to have an average correlation, which did make it reliable but not the most reliable[16]. Legović et al. compared different mixed dentition analysis methods for predicting the size of unerupted canines and premolars[17]. They found statistically significant differences between mesio-distal and buccolingual measurements justifying the use of both of these dimensions. Bachman Analysis is one such analysis, which makes use of both of these. Amongst the methods that use regression equations, are Bachmann, Gross and Hasund and Tränkmann et al. According to a study by Legović et al, Bachmann's method was the most reliable and significant, therefore in the maxilla for females, and both maxillary and mandibular arches for males observed in this study, had no significance between methods or any statistically significant difference between the genders[17].

In the present study, Bachmann's Method overestimated the sizes from the actual. This may be due to racial and ethnic variation since the method was originally used in children of northwestern European descent. According to Galvão et al. who studied methods of mixed dentition analysis, it is not clinically problematic if a method of analysis overestimates because it leaves some space available; however, it is a problem if the analysis underestimates from the real, as compensating space, in this case, is difficult[18]. In the present study, the difference between the values predicted by Bachman's method and the real values was found to be statistically insignificant. This makes the method applicable to our routine practice.

Tanaka-Johnston Method was created on drawing parallels between size of the teeth and the arch. It is more widely used for people of Northern European descent. The method is based on using simple linear regression equations and the indices used here are the mandibular permanent incisor teeth. The concern shared by most authors who studied the method is that due to its greater use in the North European population, the method's reliability for analysis in other ethnicities could be dubious. In a study by Handayani and Hidayah[19], who assessed the applicability of the method in an Arab population, showed a statistically insignificant difference between the actual values and those predicted by this method. This does not concur with the findings of Lee-Chan et al. in an Asian-American population, who found Tanaka Johnston to overestimate the size of smaller unerupted canines and premolars and underestimated larger canines and premolars. Hence, the method was not found to predict accurately and a reason could be racial and ethnic differences[20].

Another concern has been the method's ability to predict reliable values in all genders. According to Vilella et al. in the Brazilian population though, the method was generally reliable to predict widths in groups of both black and white descent. There was a great disparity in its applicability between the genders where it did not show an acceptable prediction in white women[21].

The present study, which was applied over a Pakistani population and the findings for the Tanaka-Johnston Method do overestimate the sizes from the actual but these are statistically insignificant. There was also a statistically insignificant disparity of the findings between genders. This is not in agreement with the study of Goyal et al. regarding the applicability of Tanaka-Johnston methods. Goyal et al. found that the method significantly overestimates the sizes in a North-Indian population[22], which is to an extent ethnically similar to the Pakistani population. This concurs with a study by Giri et al. where they studied the two methods in a Nepalese mongoloid population[23]. The Nepalese mongoloid ethnicity population exists within the South Asian Association for Regional Cooperation (SAARC) region and is influenced by the Asian race. The findings for this ethnicity concur with the findings for similar Asian ethnicities of other nationalities (such as Asian American) where Tanaka-Johnston method has not proved to be applicable either[20]. The study by Giri et al. is quite important since it discusses a comparison of the general Nepalese population with the Mongoloid ethnicity, which is one-fifth of their population[23].

According to a study in the Nepalese population, the method was found to be applicable in their population[24,25]. Akhtar et al. applied Tanaka-Johnston mixed dentition equation in orthodontic patients presenting to the Armed Forces Institute of Dentistry. They reported that this method overestimated the sized of canine and premolars and the difference was statistically significant in their studied sample[25]. These findings and discussion of the afore-mentioned studies bring to light two areas of potential further research. Firstly, that there could be similarities amongst similar races in different nationalities. Secondly, in multiethnic countries such as Pakistan, India etc., there are strong ethnic variations amongst populations, e.g., Pukhtoons, Balochs, etc. These variations might lead to significant differences in results obtained for the generalized population of the country, which does not take into account ethnic variations[23]. A limitation of this study could be the fact that it was conducted at a single center. Further studies on the applicability of Tanaka-Johnston and Bachman's Method in a Pakistani population, could be multi-centered. Future studies could explore the individual differences in applicability for different ethnicities within the Pakistani population.

CONCLUSION

The Bachman's and the Tanaka and Johnston Method are reliable for analyzing the mixed dentition in a Pakistani population with minor, statistically insignificant differences between actual and predict values, and those between the genders. This makes both the methods applicable to interchangeably in regular clinical practice.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS APPROVAL

The research approval was taken as per departmental protocol before starting the orthodontic patient study.

AUTHORS' CONTRIBUTION

SM conceived the idea, analyzed the patient data and reviewed the manuscript, HM and FN had major contributions in writing of the manuscript and MK collected the data.

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