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Research Article

Applicability of Tanaka Johnston and Moyers [50th and 75th Percentile] Analysis for Northeastern Karnataka Population in Comparison with the Newly Derived Regression Equations

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Abstract

Estimation of mesiodistal dimensions of unerupted canine and premolars in early mixed dentition stage acts as necessary aid in managing space in developing malocclusions. The commonly used Moyers and Tanaka Johnston mixed dentition analysis seems to fit for northwestern European children. However, the changes in the growth pattern and tooth size vary according to ethnicity which was different for other parts of the world. So, in Indian ethnicity the application of these mixed dentition analyses is debatable. This study aimed to evaluate the applicability of Moyers (50th and 75th percentile) and Tanaka and Johnston (TJ) mixed dentition analysis in a sample of children from north eastern part of Karnataka, India.

Materials and Methods: With the consideration of inclusion and exclusion criteria, 100 children were randomly selected between the age group of 13 to 15 years and Study models were prepared. Digital vernier caliper was used to calculate the mesiodistal proportions of the teeth. Moyer's (50th and 75th percentile) and Tanaka - Johnston's mixed dentition arch analysis was done to get the estimated values which were further compared with the actual values.

Statistical Analysis: ANOVA test, Pearson's coefficient tests and Simple regression analyses were used.

Results: In males and females of both arches Overrated values were reported than the actual values with TJ analysis and Moyers 75th percentile, whereas underrated values were observed in both the arches with Moyers 50th percentile.

Conclusion: The analyzed values displayed highly marked variation from both Moyers at 50th and 75th percentiles as well as TJ analysis, so there was questionability of application regarding the acquired values for the current sample. Hence, the modified regression equations were elicited for this population.

Keywords: *Mixed Dentition Analysis; Tanaka Johnston Analysis; Moyers 50th Percentile; Moyers 75th Percentile*

Introduction

Malocclusion being one of the significant issues confronted during mixed dentition stage, particularly during dentofacial development, which traverses an interim from sixth to twelfth year of life [1,2]. A majority of these malocclusions develop because of arch length-tooth size discrepancies [3]. Early detection and timely intervention of developing malocclusions will lead a way to reach the goals of occlusal harmony, function and dentofacial aesthetics [4]. Mixed dentition arch analysis is a vital part of early diagnosis and treatment planning which consists of periodic evaluation of the patient, space maintenance, space regaining or serial extraction [5].

To evaluate the combined mesiodistal width of unerupted canine and premolars in mixed dentition stage three types of methods can be used are (a) Measurement of the unerupted teeth on radiographs (b) Use of regression equations (c) Combination of regression equation and radiographs [6].

Among the various mixed dentition analysis, measurements which use radiographs [7-11] will be technique sensitive, more of image distortions, inaccuracy of dimensions in case of rotated tooth in their crypts along with more time consuming, so more chances of bias [12]. Hence, use of regression equations alone will be more reliable with fewer errors.

Tanaka and Johnston's analysis includes the sum of mesiodistal width of the lower central and lateral incisors by dividing it with 2 and adding 11.0 mm for the teeth in maxilla, and 10.5 mm for the teeth in mandible [13] for predicting the sizes of the unerupted canines and premolars. Moyer's analysis can be done by using probability charts at levels (5 - 95%) and checking summed up value of the total widths of the mandibular incisors [14].

Both Tanaka-Johnson and Moyer's method for space analysis was developed for North European descent. Various studies shown that those were not accurate if used in different population of different ethnicities because of change in size of tooth, growth pattern [15]. Hence our study aimed to evaluate the applicability of Moyers 50th, 75th percentile from probability charts and Tanaka Johnston analysis in a sample of children of North eastern part of Karnataka, India.

Materials and Methods

A sample of 100 children (50 boys and 50 girls) each within the age group of 13 - 15 years who were native to north eastern part of Karnataka, India were selected from the outpatient Department of Pedodontics and Preventive Dentistry of AME's Dental College and Hospital, Raichur with the inclusion criteria being the children with fully erupted permanent mandibular incisors, permanent canines and premolars. Exclusion criteria included children with any dental anomalies, with clinical evidence of hypoplasia, proximal caries, proximal wear or fractures and with history of orthodontic therapy.

Alginate impressions were made using standard procedures for material mixing as per manufacturer instructions and dental casts of high quality, without any distortion, were obtained with dental stone (Type III). Digital Vernier calipers (Baker SDN 10, India) was used to measure the size of teeth by holding the caliper at highest mesiodistal dimension of tooth, as advocated by Jensen., *et al* [16]. Then the values were predicted using Moyer's analysis at 50th and 75th percentile and Tanaka and Johnston analysis and were further compared with the actual values (mesiodistal width of erupted canine and premolars as measured on the cast).

Statistical analysis

The statistical analysis was performed using SPSS version 21.0 (IBM, Chicago, USA) are: Descriptive statistics including the mean, standard deviation, and minimum and maximum values were calculated for the actual tooth size as well as predictive tooth size and comparison of the actual widths with the predicted widths done by Tanaka Johnston method, Moyer's method (75th percentile) and Moyer's method (50th percentile) using ANOVA test. To assess the association between the groups of teeth, Pearson's coefficient tests was used and to refine the regression equations for the present population, Simple regression analyses were executed.

Results

Comparisons of Tooth Sizes Between Right and Left Sides: No significant differences were present

Male and Female Comparisons: Preliminary examination indicated that predictive differences between the genders were statistically not significant for both the prediction methods in maxilla and in addition to mandible. Hence the regression equations developed for the present sample were not intended individually for males and females.

Comparison of the actual width of canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) and Moyer's method (50th percentile) using ANOVA test shown in figure 1 and 2.

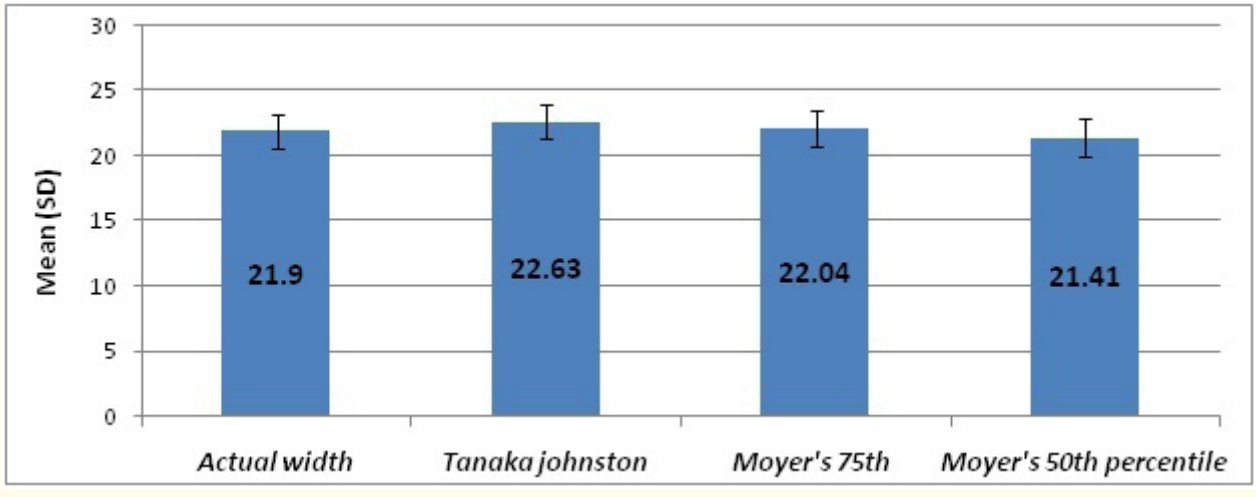

Figure 1: *Comparison of the actual width of upper canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) and Moyer's method (50th percentile) using ANOVA test.*

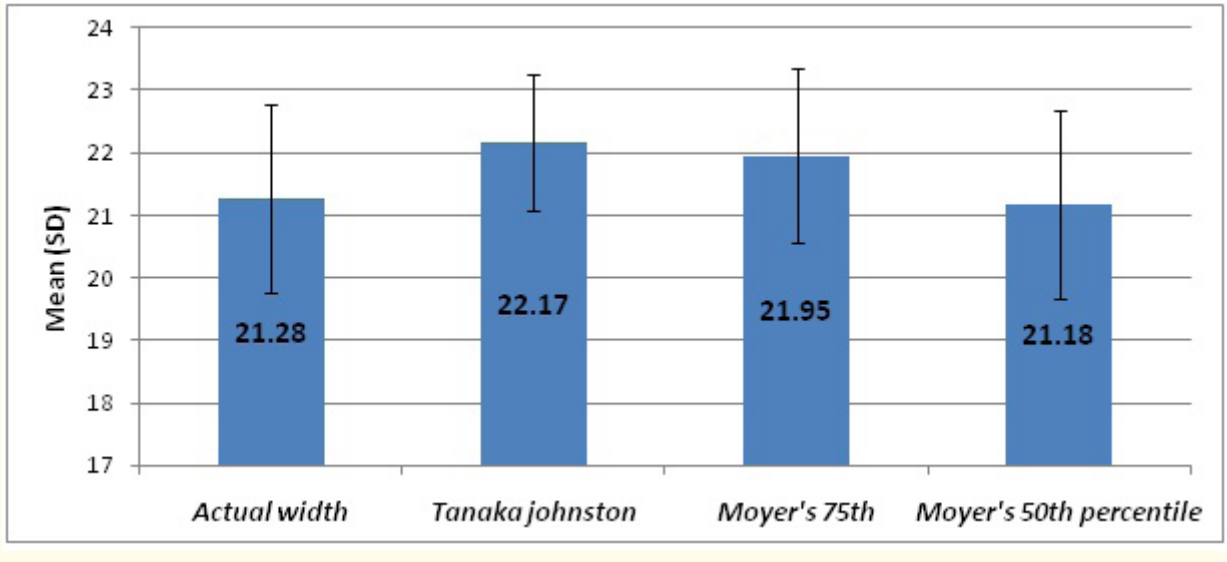

Figure 2: *Comparison of the actual width of lower canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) and Moyer's method (50th percentile) using ANOVA test.*

Differences between the estimated values by Tanaka Johnston and Moyers method and actual widths of canine and premolars were highly significant in the statistical sense, as indicated by ANOVA tests with F value = 13.396 and P value = < 0.001 in the maxilla and F value = 12.498 and P value = < 0.001 in the mandible. Overrated values were reported than the actual values with TJ analysis and Moyers 75th percentile, whereas underrated values were observed in both the arches with Moyers 50th percentile.

Correlation coefficient (r) between the predicted and actual teeth size

There are statistically significant correlations between the actual and predicted tooth size obtained by both Tanaka Johnston approach and Moyers 75% and 50% confidence level, as r value for:
Tanaka Johnston prediction method is

- r = 0.673 for mandibular teeth
- r = 0.589 for maxillary teeth.

Moyers 75% level is

- r = 0.681 for mandibular teeth.
- r = 0.626 for maxillary teeth.

Moyers 50% level is

- r = 0.626 for mandibular teeth.
- r = 0.618 for maxillary teeth.

In general, the 'r' values are higher for the Moyers 75% prediction than for Tanaka Johnston and Moyers 50% prediction method.

Simple Linear Regression Analysis

Analyzing the data and by using Tanaka Johnston method, Moyer's method (75th percentile) and Moyer's method (50th percentile) as predictors, regression equations were formulated, for maxilla and mandible separately with the help of SPSS software version 21.0 (IBM, Chicago, USA).

Y = a + b (X) where,

- X = independent variable (sum of mandibular incisors measurements)
- Y = dependent variable (sum of canine and premolars).

REGRESSION EQUATIONS	FOR MAXILLARY TEETH	FOR MANDIBULAR TEETH
Tanaka - Johnston	Y = 7.875 + 0.620 (X)	Y = 1.760 + 0.880 (X)
Moyers 75th percentile	Y = 8.636 + 0.602 (X)	Y = 5.494 + 0.719 (X)
Moyers 50th percentile	Y = 10.265 + 0.543 (X)	Y = 6.616 + 0.692 (X)

Figure 3 (a, b, c) and 4 (a, b, c) represents the scatter plots of the data show the presence of outlying values, the linearity of the relationship around the regression line for different methods.

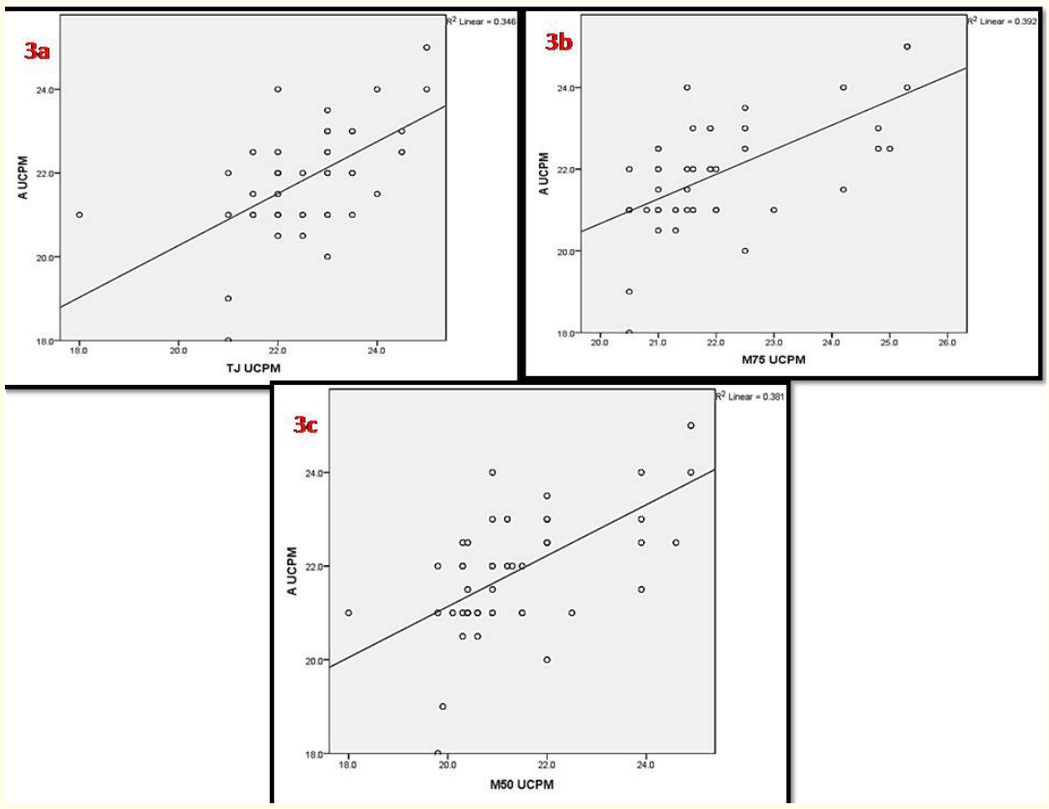

Figure 3: *Correlation between actual width of upper canines and premolars with the predicted width by 3a) Tanaka Johnston method, 3b) Moyer's method (75th percentile) and 3c) Moyer's method (50th percentile).*

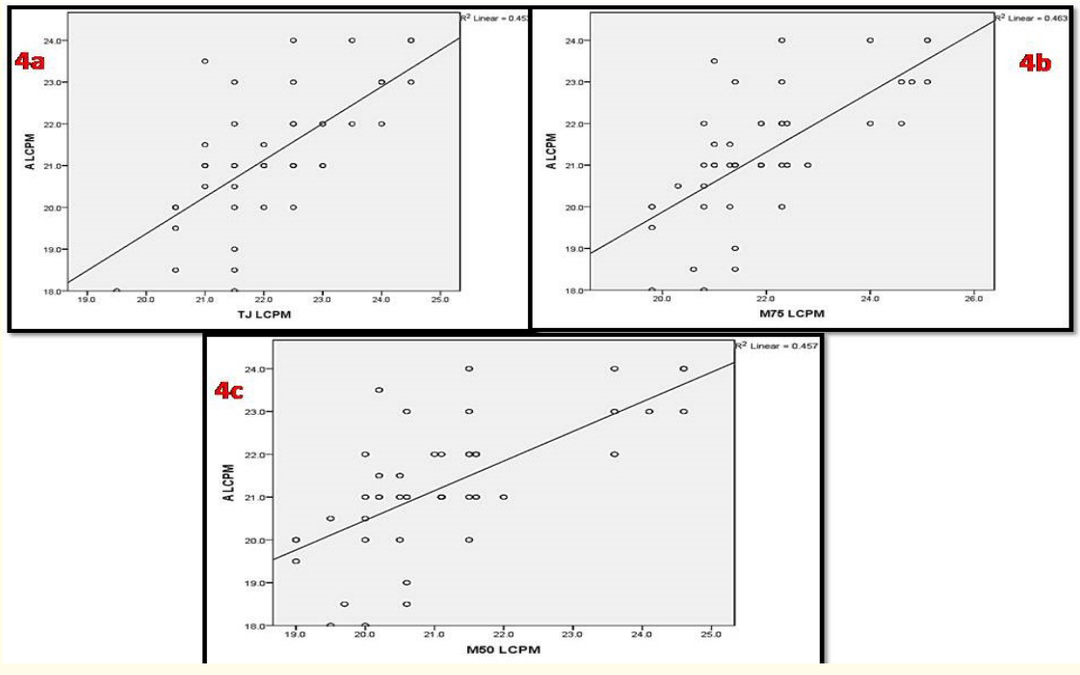

Figure 4: *Correlation between actual width of lower canines and premolars with the predicted width by 4a) Tanaka Johnston method, 4b) Moyer's method (75th percentile) and 4c) Moyer's method (50th percentile).*

Discussion

Mixed dentition arch analysis frames a basic part of early orthodontic intervention [5]. Understanding the significance of diagnosing the tooth size and arch length errors at an early stage, numerous investigators have figured criteria for predicting the size of unerupted permanent teeth which include Ballard and Wylie (1947); Hixon and Old Father (1958); Bull (1959); Moyers (1973, 1988); Tanaka and Johnston (1974); Staley and Hoag (1978); and Ingervall and Lennnartson (1978) were developed on the basis of three criteria in particular, in view of regression equation, radiograph and combination [17-20]. The most common methods which uses simple regression equations i.e. Tanaka and Johnson (1974) Moyers (1976) were used because of least systematic error, usability, less time consuming and least armamentarium required [21,22]. Mesiodistal dimensions of the teeth were measured on the casts using digital calipers since the errors were less and it is quick and simple [23].

There is marked deviation observed between the actual values and predicted values by Tanaka and Johnston method. In the maxillary arch overrated values were reported more by 0.73 mm when compared to the actual widths. These results were in agreement with the studies done by Goyel., *et al.* [6] Sonahita., *et al* [24]. Sonawane., *et al.* [25] and Shobha., *et al.* [2] but in contrast, Abu Alhaija and Qudeimat [26] reported underrated values. In the mandibular arch, overestimated values were observed by 0.89 mm. These results were in harmony with the studies by Shobha., *et al.* [2] Chandna., *et al.* [27] Sonawane., *et al.* [25] Buwembo., *et al*. [28] and Sonahita., *et al*. [24] Contrary to this, underestimated values were detected by Abu Alhaija and Qudeimat. [26].

Moyers' prediction at the 50th percentile in the maxillary arch, Underestimation of 0.49 mm was observed, similar to the studies done by Abu Alhaija and Qudeimat. [26] and Nik Tahare., *et al* [29]. In contrary studies done by Memon and Fida [30] and Shobha., *et al*. [2] showed no difference between the actual values and predicted values in males.

At Moyers 75th percentile of estimation in the maxillary arch, an overrated value of 0.14 mm was reported. Results were similar to the work done by Sonawane., *et al.* [25] Durgekar and Naik [31]. In contrary, underrated values were reported by Hammad and Abdellatif [32] Philip., *et al.* [33] and Chandna., *et al.* [27] whereas Nik Tahere., *et al.* [29] Memon and Fida [30] and Buwembo., *et al.* [28] reported its reliability for estimating the values. In the mandibular arch, an overrated value by 0.67 mm was noticed, in consistent with the studies done by Shobha., *et al.* [2] and Chandna., *et al.* [27] In contrary, underrated values were shown by Hammad and Abdellatif [32].

In the present population, under and over assessed values were observed when Tanaka and Johnston and Moyer's prediction methods were applied, which could be due to variety in racial, ethnic, sample size and secular patterns. In this manner, focussing the reality that a single prediction method may not be applicable globally [34-36]. Even however the exact etiology was not known for variations in tooth size among various racial groups, nutrition and environment along with genetics plays an imperative role during development of tooth [37,38].

Conclusion

The analyzed values displayed highly marked variation from both Moyers at 50 and 75 percentile as well as TJ analysis, so there was questionability of application regarding the acquired values for the current sample. Hence, the modified regression equations which elicited were applicable for this current sample of population.

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