COMPARISON OF PREDICTIVE ACCURACY OF TANAKA-JOHNSTON ANALYSIS, MELGACO FORMULA AND BHERWANI'S REGRESSION EQUATION FOR PATIENTS PRESENTING TO ARMED FORCES INSTITUTE OF DENTISTRY

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ABSTRACT

Objective: To compare Tanaka-Johnston Mixed Dentition Analyses, Melgaco's Formula and Bherwani's Regression Equation in predicting the widths of mandibular canine and premolars, in a population presenting to AFID.

Study Design: Cross-sectional Analytical Study.

Place and Duration of Study: Department of Orthodontics, Armed Forces Institute of Dentistry Rawalpindi, from Aug 2018 to Jul 2019.

Methodology: According to selection criteria, 200 subjects presenting to AFID were selected through non-probability consecutive method. Study models were poured and mesiodistal widths of mandibular incisors, canines, premolars and molars were measured. The results were compared with predicted width values obtained from Tanaka Johnston Analysis, Melgaco Formula, and Bherwani's Regression Equations and analyzed using paired sample t tests.

Results: There was a significant difference between actual and predicted widths of lower canines and premolars for all three methods; Tanaka Jhonston Analysis (p<0.001), Melgaco's Formula (p<0.001) and Bherwani's Regression Equation (p<0.001), although values predicted by Bherwani's Equation were closest to the actual widths. There existed a mean discrepancy of 0.37 mm among tooth widths between both the genders which was statistically significant with a p-value of <0.001.

Conclusion: Tanaka Johnston Analysis, Melgaco's Formula and Bherwani's Regression Equation did not accurately predict for our sample although Bherwani's Regression Equation was closest in predicting the actual tooth widths. Sexual dimorphism was established in our sample population as there existed a mean discrepancy of 0.37mm for tooth widths among both the genders.

Keywords: Mixed dentition analysis, Prediction tables, Space Analysis, Tanaka-Johnston analysis.

INTRODUCTION

Mixed dentition phase is one of the significant stages of developing dentition. Features of mixed dentition are signs of future orthodontic problems[1]. Furthermore, since this stage is a transition towards permanent esthetics, majority of the patients and their parents are concerned about these transitional changes and present to the dentist with a variety of complaints.

Being at a critical standpoint, an orthodontist may be able to diagnose and differentiate what is not a problem from the actual problem. Assessment of available space to accommodate permanent dentition is a matter of concern for majority of dentists as well as orthodontists. Direction of treatment is decided at this point, whether to go for serial extractions, space gaining, space maintenance, space supervision or mere guidance of eruption[2].

Many methods have been used in orthodontic literature for making Mixed Dentition Analyses (MDA), including radiographic techniques, prediction equations and combination of radiographic and prediction equations. The radiographic techniques are most reliable in predicting the widths of unerupted teeth as they allow exact measurements from the X-Ray, however unnecessary radiographic exposure is one major

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drawback to this method especially as growing children are sensitive to effects of radiation. On the other hand, the Moyers Prediction Charts, Tanaka Johnston Mixed Dentition Analysis, Hixon and Oldfather[3], Melgaco *et al* Formula[4], are popular and commonly practiced prediction equations, which have added benefit of being safe, since need of x-ray exposure is eliminated. It has been proven in literature that Moyers prediction chart and Tanaka Johnston methods tend to overestimate the sizes[4] of canines and premolars along with great variations in age, gender and different ethnicities[5-13]. Besides having predictive inaccuracies, these methods are not universal since they were originally created for the North American population, therefore leading to inappropriate results in different populations.

South Asian descent is unique in many features as compared to Caucasians and Whites. Norms created for those population cannot be translated to our region as straight forwardly as expected. Multiple studies have been conducted in our populations proving the inapplicability of many of thecommonly used mixed dentition analysis including Moyer's and Tanaka Johnston[14-19]. A lot of disparities were encountered when these methods were applied to our population. This inappropriateness created a void in literature to which we should refer to. Hence there aroused a need for development of some prediction mechanism that truly represents the population of Pakistan. Bherwani *et al*[12] formulated a set of regression equations and proposed them to be a good prediction technique for Pakistani population. He proposed that maxillary Y = 10.25 + 0.48 X whereas mandibular Y=08.56 + 0.54 X. Here Y is the sum of canine, first and second Premolars and X is the sum of all four incisors. Using these equations in their local population they generated a prediction table similar to that of Moyers'.

Objectives of this study were, to compare the techniques of Melgaco *et al*, Tanaka-Johnston Mixed Dentition Analyses and Regression Equation made by Bherwani *et al*[12], in accurately predicting the widths of canine and premolars, in a population presenting to Armed Forces Institute of Dentistry (AFID). This would help in determining which formula can be reliably used in our local setting to predict tooth widths, and therefore help in orthodontic diagnosis and treatment planning.

METHODOLOGY

The study was approved by ethics review committee (Letter number: 905/Trg-ABP1K2) of Armed Forces Institute of Dentistry (AFID). It was a cross-sectional analytical study where patients opting for orthodontic treatment in AFID were selected through non-probability consecutive method. Sample size calculation was done by taking a 5% type 1 error and 10% type 2 error. The expected correlation coefficient of r=0.59 between predicted mesiodistal width of unerupted mandibular canine and premolars calculated through Bherwani's regression equation to the actual mesiodistal width of unerupted mandibular canines and premolars were also taken for sample size calculation[15]. 200 patients were eventually selected for the study.

Records of these patients were taken as a routine procedure and informed consent was obtained from patients/parents to include their records in research. Pretreatment casts included in the study were fulfilling the following inclusion criteria: 1) Pakistani decent, 2) Class I Molar and Canine relationship, 3) Minor malocclusions like minimal incisor crowding or spacing, 4) All permanent teeth erupted (fully erupted with exception of 2nd and 3rd Molars). On the other hand, the exclusion criteria included cases with: 1) Proximal caries, 2) Inter-proximal restorations, 3) Fractures, 5) Morphological variabilities, 6) Attrition or abrasion secondary to any parafunction, 7) Craniofacial congenital anomalies, and 8) History of previous orthodontic treatment. Alginate impressions of selected cases were obtained at record taking room of Orthodontics Department, AFID. Impressions were poured in orthodontic plaster; models were trimmed and a serial number was assigned to each cast.

Mesiodistal widths of mandibular molars and incisors, canines, premolars were measured using Vernier calipers with sharpened tips to allow access to proximal surfaces. Vernier calipers were held perpendicular to long axis of all the teeth either from occlusal or buccal surfaces and measurements were taken by introducing the beaks into interproximal contact areas.

The statistical analysis was carried out using statistical software (version 23; SPSS).

Frequencies and percentages were calculated for Gender. Since the data showed normality of distribution, parametric, paired sample t tests were applied for testing the statistical significance between the actual values of mesiodistal dimensions of lower premolars and canines, and values predicted by Melgaco Formula, Tanaka Johnston Analysis and Bherwani Regression Equations. A *p*-value ≤0.05 was considered to be significant.

RESULTS

Sample consisted of 92 (46%) males and 108 (54%) females. Mean actual width of mandibular canines and premolars was 21.55 ± 1.34mm for our sample of population. On the other hand, the widths predicted using Tanaka Johnston analysis, Melgacoequation and Bherwani's regression equation are mentioned in table-I.

The widths obtained from the three prediction equations was individually compared to the actual widths using t-test and a *p*-value of ≤0.05 was considered significant. Difference between Actual width and Tanaka Jhonston predicted width was statistically significant with a *p*-value of <0.001. Similarly, Melgaco Formula predicted widths was significantly different from the actual widths with a *p*-value of <0.001 (table-I). The Tanaka Johnston and Melgaco Formula tendedto overestimate the mesiodistal widths in our sample, mean disparity being 0.68 mm and 0.82 mm for Tanaka Johnston and Melgaco Formula respectively.

Bherwani's Regression Equation was devised basically for Pakistani population but it tended to under estimate the widths and also showed a statistically significant difference in predicting the values, with a *p*-value of <0.001. However, the Bherwani's Regression Equation seemed to predict much closer to the actual widths with a mean difference of just 0.32 mm between actual and predicted values.

Sample was also tested to check if there existed any variation in combined sizes of teeth (mandibular canines, 1st and 2nd premolars) among male and female subjects. Mean actual widths of these teeth in male sample was 21.75 ± 1.13mm whereas in females it was 21.38 ± 1.47 mm. There existed a mean discrepancy of 0.37 mm among both the genders which was statistically significant with a *p*-value of <0.001. Sexual dimorphism was assessed and compared for all the methods (table-II). A general trend of male

Table-I: Comparison of mean widths of mandibular dentition calculated by different methods.

	Actual Widths	Tanaka Johnston Analysis	Melgaco Formula	Bherwani's Regression Eq.
Mesiodistal widths with standard deviations	21.55 ± 1.34mm	22.23 ± 0.73mm	22.37 ± 1.15mm	21.23 ± 0.81 mm
p-value		<0.001	<0.001	<0.001

Table-II: Gender variability assessment.

	Gender	Mean Mesiodistal Widths (mm)	Mean Difference	*p*-value
Actual widths (n=200)	Male (n=92)	21.75 ± 1.13	0.37	<0.001
	Female (n=108)	21.38 ± 1.47		
Tanaka Johnston Analysis (n=200)	Male (n=92)	22.35 ± 0.70	0.22	<0.001
	Female (n=108)	22.13 ± 0.75		
Melgaco Formula (n=200)	Male (n=92)	22.66 ± 1.10	0.54	<0.001
	Female (n=108)	22.12 ± 1.15		

tooth sizes being larger than the females was observed, which was reciprocated in results obtained by different methods of assessments (table-II).

DISCUSSION

Mixed Dentition Analysis forms the foundation of orthodontic diagnoses and treatment planning. Accuracy of prediction of mesiodistal dimensions of canines and premolars is of prime importance and marks the hallmark of successful orthodontic treatment. We faced many troubles while predicting these widths using available methods and formulas, which complicated the process of achievement of defined orthodontic goals. Tanaka Johnston Analysis tend to underestimate the sizes of canines and premolars in Jordanian population[20], and overestimated the mesiodistal widths in Turkish populations[21], and multiple other ethnic groups including Saudi, Nepalese, Indian, Bangladesh, Sudanese and Libyan populations[3-11]. A study on Pakistani population by Rasool *et al*[22] showed similar trends for estimation of these widths and concluded that Melgaco's Formula was not an adequate method of assessment for males while it could be applied to females in Islamabad population. Our study confirmed these findings that neither of the methods already devised and tested prove effective in Pakistani population. Tanaka Johnston as well as Melgaco equation had over-estimated the mesiodistal width in our sample of population (Islamabad/Rawalpindi, Pakistan) which was statistically significant depicted by the *p*-value of <0.001.

Quest of knowing the unknown has led to many discoveries. Facing difficulties in effective width prediction in Pakistani population, led Bherwani *et al* to devise a set of Regression Equations whose results showed significant correlation for maxillary arch (r=0.65) and mandibular arch (r=0.59) in Karachi population[13]. This was an attempt to fill the void in literature for our sample population by indigenous equations, however this method is yet to be tried and tested for its accuracy by our researchers. In our study we tested the applicability of the norms developed by this Equationon apopulation sample from Rawalpindi/Islamabad region and our results showed significant disparity in actual widths and the ones predicted by Bherwani table of norms, as indicated by a *p*-value of <0.001. However, in comparison to Tanaka Johnston and Melgaco Formula, the Bherwani table of norms estimated the mesiodistal widths quite closer to that of actual widths. Hence, we cannot generalize Bherwani's Regression Norms to population sample of Rawalpindi/Islamabad region of Pakistan. Further research from different regions is required to establish this finding.

Similar to ethnic variation, gender variation is also a common occurring, while we talk about the widths of premolars and canines in mixed dentition. Generally, males have teeth larger in size than females[23,24]. In our study we found a mean discrepancy of 0.37 mm between males and females and this discrepancy was also statistically significant. Tanaka Johnston Analysis and Melgaco Formula also showed a difference in tooth sizes between males and females, the results being statistically significant. (table-II) Bherwani *et al*[13] stated that there existed no significant difference in tooth sizes hence they did not devise separate value tables for males and females. Quite contrary to Bherwani's findings, in our study there existed a significant difference (*p*-value <0.001) between both the genders. Therefore, there arises a need to test these findings in different regions of Pakistan to establish their validity.

Precise prediction of mesiodistal width of unerupted permanent teeth, in mixed dentition phase, is an essential prerequisite indetermining thetooth size and arch length discrepancies. Nevertheless, imprecise mixed dentition space analysis may lead to erroneous extraction pattern decisions resulting in poorfacial soft tissue profiles and in turn low patient satisfaction levels.

CONCLUSION

Tanaka Johnston Analysis, Melgaco Formula and Bherwani's Regression Equation derived

table of norms are inapplicable on Pakistani population. The Tanaka Jhonston Analysis and Melgaco Formula tended to overestimate the sizes with mean disparity of 0.68mm and 0.82mm from actual widths respectively. Bherwani's Regression Equation predictions although being very close to actual widths tended tounder estimate these widths with a mean difference of 0.32mm. Disparities encountered by all the three methods were statistically significant (p-value <0.001).

Sexual dimorphism is an established finding in our sample population as there existed a mean discrepancy of 0.37 mm among both the genders, which was statistically significant with a p-value of <0.001. Hence, negating the findings of Bherwani *et al*, which stated that there exists no gender variability in sizes of teeth, in Pakistani population.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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