The Tanaka-Johnston orthodontic analysis for Brazilian individuals

Efetividade da análise ortodôntica de Tanaka e Johnston em brasileiros

Abstract

Purpose: To assess the applicability of the Tanaka-Johnston analysis in Brazilian subjects.

Methods: A total of 650 plaster casts of dental arches were examined, and 95 were selected to comprise the study sample. The largest distance between the contact points of mandibular and maxillary incisors as well as mandibular canines and premolars on the right side were measured with a calliper held parallel to occlusal plane and perpendicular to the long axis of the tooth. A prediction of the length of canines, and first and second premolars in both arches was made by using the Tanaka-Johnston analysis. Predicted and actual dental sizes were compared in relation to the gender and ethnic group of the sample subjects.

Results: The Tanaka-Johnston analysis overestimated the sum of mesiodistal widths of maxillary and mandibular canines and premolars only in the white female group. The difference between the Tanaka-Johnston prediction and the actual measurement was significant. For the other groups studied no statistical difference was observed.

Conclusion: The Tanaka-Johnston analysis provided an acceptable prediction of the sum of mesiodistal widths of maxillary and mandibular canines and premolars in black and white Brazilian men, but not in white Brazilian women.

Key words: Mixed dentition; evaluation; radiography

Resumo

Objetivo: Avaliar a aplicabilidade da análise de Tanaka e Johnston em indivíduos brasileiros de cor de pele branca e de cor de pele negra.

Metodologia: Um total de 650 modelos de gesso de arcadas dentárias foram examinados e 95 foram selecionados para compor a amostra. Mediu-se a maior distância entre os pontos de contato dos incisivos inferiores e caninos e pré-molares, superiores e inferiores do lado direito, com o paquímetro paralelo ao plano oclusal e perpendicular ao longo eixo do dente. A predição do comprimento dos caninos, primeiros e segundos pré-molares em ambos os arcos foi feita através da análise de Tanaka e Johnston. Comparou-se a predição e o valor real do tamanho dos dentes em relação ao gênero e à cor da pele dos sujeitos da amostra.

Resultados: A análise de Tanaka e Johnston superestimou o somatório dos diâmetros mésio-distais dos caninos e pré-molares apenas no grupo de indivíduos de cor de pele branca do gênero feminino. Para os outros grupos não foram observadas diferenças estatisticamente significantes.

Conclusão: A análise de Tanaka e Johnston permite uma predição aceitável do somatório dos diâmetros mésio-distais dos caninos e pré-molares dos indivíduos brasileiros de cor de pele negra e de cor de pele branca do gênero masculino. Com relação aos indivíduos de cor de pele branca do gênero feminino, os valores foram superestimados.

Palavras-chave: Dentição mista; avaliação; radiografia

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Introduction

The difficulty in quantifying the mesiodistal diameters of unerupted permanent teeth can complicate orthodontic treatment planning in mixed dentition. During this phase, a valuable auxiliary tool is the mixed-dentition space analysis (1), which is performed after the eruption of the first permanent molars and the four mandibular incisors, as most of the mandibular and maxillary growth has already occurred (2). This analysis predicts the mesiodistal diameters of the permanent canines and premolars and determines the difference between the tooth sizes and the available space in the dental arch.

The first attempt to estimate the sum of the mesiodistal diameters was performed by Black (3). The author developed tables that were based on mean values. Three methods of measurement are currently used: radiographic methods (periapical and oblique cephalometric radiographs), non-radiographic methods (based on correlations, prediction tables and equations), and a combination of both (4-7).

Methods that are based on 45-degree cephalometric radiographs are considered to be more precise (8-11). However, they are not practical because of the need for additional time and specific equipment (12,13).

Tanaka and Johnston (12) have developed formulas for each dental arch that are based on simple linear regressions. The authors used erupted mandibular incisors to estimate the length of canines and premolars in 506 Northern European children. However, research has shown variation in some dental characteristics among different populations (14-16). African descendants, for example, have larger mesiodistal tooth diameters than European descendants (17-19). As a result, the Tanaka-Johnston formula should only be used in other populations when specific data have been analyzed for the included ethnic groups.

The objective of this study was to assess the applicability of the Tanaka-Johnston analysis for Brazilian white and black individuals.

Methods

The present study was approved and monitored by the local ethical committee (protocol 271/11).

A total of 650 plaster casts of dental arches from the archives of the Fluminense Federal University Ortho-dontic Clinic (Niteroi City, Rio de Janeiro State, Brazil) were examined and selected for study according to the following criteria: 1) there was no interproximal wear on the mandibular incisors; 2) the teeth were in good condition to be measured, and there were no fractures in the plaster cast models; 3) the canines and premolars were sufficiently erupted to be measured; 4) individuals were younger than 25 years old; and 5) there was no clinical evidence of enamel defects. Using these criteria, 95 plaster casts were selected, 48 belonging to white individuals (15 males and 33 females) and 47 belonging to black individuals (26 males and 21 females).

The teeth were measured using an electronic digital caliper (Lee Tools, Brazil) with an accuracy of $\pm\,0.02$ mm and a reproducibility of $\pm\,0.01$ mm. The largest distance between the contact points of the right mandibular incisors and the right maxillary and mandibular canines and premolars was measured with the caliper held parallel to the occlusal plane and perpendicular to the long axis of the tooth. The first author measured 25 plaster cast models each day.

The predictions of the length of the canines and the first and second premolars in both arches were made with the Tanaka-Johnston analysis (12). For the maxillary arch, the calculation was performed by adding 11 mm to half of the total value of the mesiodistal lengths of the four mandibular incisors, whereas 10.5 mm was added to half of the total value of the four mandibular incisors regarding to the mandibular arch. The predictions of the length of the three teeth were compared to the length of the plaster cast models.

The following variables were established for the statistical analysis:

- **Su** represents the sum of the mesiodistal diameters of the right maxillary canines and premolars;
- **Sl** represents the sum of the mesiodistal diameters of the right mandibular canines and premolars;
- **Pu** represents the prediction of the Tanaka-Johnston analysis for the sum of the mesiodistal diameters of the right maxillary canines and premolars;
- **Pl** represents the prediction of the Tanaka-Johnston analysis for the sum of the mesiodistal diameters of the right mandibular canines and premolars.

Arithmetic means, standard deviations, and simple and percentage frequency distributions were calculated. In addition, the Snedecor's F-test was used for variance analysis to compare the arithmetic means among white and black individuals of both genders for Su, Sl, Pu, and Pl. A Bonferroni's test was used to determine the statistical significance between multiple comparisons. Student's t-test was employed to compare the arithmetic means between Pu and Su and between Pl and Sl within the same group.

Ten plaster cast models were randomly selected to assess the reproducibility of the results, which consisted of another measurement procedure within a 10-day interval.

Significance levels of 5% ($P\!\leq\!0.05$) were adopted, and the SPSS statistics software version 13.0 was used.

Results

Intra-observer error in determining the measurement values was calculated based on the 100 teeth of the 10 plaster cast models. The error of the method was verified as 0.06 mm, which was considered to be unimportant in this study.

According to the results listed in Table 1, no statistically significant age differences were found among the groups.

According to Bonferroni's test, a significant (1% level) difference was observed for Su and Sl between black males and white females. Compared to white females, black males exhibited larger maxillary (Table 2) and mandibular (Table 3) teeth.

In comparing the arithmetic means that were found in the Tanaka-Johnston analysis (Pu and Pl) with the means that were measured directly from the canines and premolars (Su and Sl), a statistically significant difference was only observed in white females, who exhibited higher Pl (Table 4) and Pu (Table 5) values at the 1% and 5% significance levels, respectively.

Table 1. Arithmetic means ($\bar{X}$), standard deviations (SD), Snedecor's F test and Bonferroni's test for age across the four groups.

Groups	$\bar{X}$	SD	F	P
White male	16.07	4.46		
White female	15.70	4.65	0.35	0.791[n.s.]
Black male	14.96	3.06		
Black female	15.97	4.71		

n.s. = not statistically significant.

Table 2. Arithmetic means ($\bar{X}$), standard deviations (SD), Snedecor's F test and Bonferroni's test for Su across the four groups.

Groups	$\bar{X}$	SD	F	P
White male	22.47	0.80		
White female	21.84	1.12	5.48	0.002**
Black male	23.13	1.12		
Black female	22.24	1.43		

** Statistically significant at the 1% level.

Table 3. Arithmetic means ($\bar{X}$), standard deviations (SD), Snedecor's F test and Bonferroni's test for Sl across the four groups.

Groups	$\bar{X}$	SD	F	P
White male	21.96	0.70		
White female	21.09	0.99	8.52	<0.001**
Black male	22.75	1.14		
Black female	21.74	1.52		

** Statistically significant at the 1% level.

Table 4. Arithmetic means ($\bar{X}$), standard deviations (SD), Student t-test and significance of Pl and Sl for white females.

Variable	$\bar{X}$	SD	t	P
Pl	22.03	0.16	3.44	0.001**
Sl	21.09	0.99		

** Statistically significant at the 1% level.

Table 5. Arithmetic means ($\bar{X}$), standard deviations (SD), Student t-test and significance of Pu and Su for white females.

Variable	$\bar{X}$	SD	t	P
Pu	22.53	0.86	2.34	0.024*
Su	21.84	1.11		

** Statistically significant at the 5% level.

Discussion

Analyses of mixed dentition can quantify lack or excess space in permanent dentition, which can lead to the development of treatment plans for patients.

Dental and facial characteristics vary among individuals from different ethnic groups (8,9), and differences occur in the tooth width of male and female individuals (5,9,20,21). Because the Tanaka-Johnston analysis for predicting mesiodistal diameters of canines and premolars was based on Northern European children (12), the present study was performed to assess the test's precision among Brazilian individuals across gender and ethnicity.

The black individuals in our sample were identified as brown and black; that is, they shared physiological and genetic characteristics with individuals of African origin. In turn, the white individuals were selected based on their skin color and their physiological and genetic characteristics of Caucasian origin. The individuals were all younger than 25 years old, so the possibility of considerable wear in the proximal dental structure was decreased (22).

The results of the statistical analysis revealed no significant age differences among the groups, which demonstrates that the sample was homogeneous according to effects of age.

When tooth size was compared between the groups, the sum of the mesiodistal diameters of the maxillary canines and premolars was statistically smaller in white females compared to black males. This result demonstrates discrepancies in the mesiodistal tooth diameters between Brazilian individuals of different genders and ethnic groups.

Finally, the Tanaka-Johnston analysis overestimated the sum of the mesiodistal widths of the maxillary and mandibular canines and premolars for white females. This result is in accordance with other studies (9,23,24) and favors a comprehensive orthodontic treatment to account for overestimations of the lack of space. Nevertheless, in those cases of borderline space deficiency, this approach could involve tooth extraction for some patients, as the excessive size of their teeth would be greater than the available space in the dental arch. Therefore, the Tanaka-Johnston analysis should be used with caution in such cases. An alternative solution would be to combine the analysis with other predictive methods, such as 45-degree cephalometric radiographs.

Conclusions

The Tanaka-Johnston analysis provided an acceptable prediction of the sum of the mesiodistal widths of the maxillary and mandibular canines and premolars in black and white Brazilian men but not in white Brazilian women.

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