Original Article

Prediction of Lower Permanent Canine and Premolars Width by Correlation Methods

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Abstract: The aim of this study was to determine linear regression equations to estimate the widths of unerupted lower permanent canines and premolars using measurements obtained from 45° oblique teleradiographs. The sample consisted of 30 white Caucasian patients orthodontically treated at the Faculty of Dentistry, Universidade Federal do Rio de Janeiro. The records for each patient included a 45° oblique teleradiograph (left side) in the mixed dentition period and a dental cast of the permanent dentition. Pearson's test was applied between each lower canine, first and second premolars measured on the radiograph, and the sum of their actual widths measured on the dental cast. The strongest correlation occurred for the first premolars for one side (.82) and both sides (.84). One linear regression equation was determined to estimate the widths of unerupted lower canine and premolars of both sides from a single measurement of the first premolar. (*Angle Orthod* 2005;75:805–808.)

Key Words: Mixed dentition; Prediction; Correlation methods; 45° Teleradiography

INTRODUCTION

The universe of malocclusions commonly identified in an orthodontic clinic is a result of dental problems, skeletal problems, and a combination of dental and skeletal problems.[1] Angle, at the end of the 19th century, classified different malocclusions through his renowned classification.[2] Based on the numbers shown by Angle and confirmed by subsequent studies, most malocclusions involve problems of an imbalance between the size of the teeth and the size of the arches with which they are associated. This is especially seen in the lower arch, which is constrained by the upper arch, and can be seen clinically in the Class I malocclusion with crowding. Most of these cases have less than three mm of negative tooth size arch length discrepancy.[3]

In 1947 Nance, in an important longitudinal study, described the leeway space as the difference between the mesiodistal diameter of the canines and the deciduous molars and their respective successors. The author found that, on average, there is a positive difference in favor of the deciduous teeth. This excess of space, when diagnosed in the mixed dentition and when adequately managed, allows simple treatment for crowding in the anterior region of the arch.[4]

Other studies followed that of Nance[4] with the objective of determining what is conventionally called a mixed dentition analysis. Thus, several methods have appeared for analyzing the mixed dentition to determine what discrepancy will be present when the permanent teeth erupt. Based on these calculations, therapeutic procedures can be introduced ranging from resolving slight incisor crowding by simple methods to more complex mechanisms of space regaining or even serial extractions.[5]

Black[6] determined the average mesiodistal width of the lower deciduous canines and molars and lower permanent canines and premolars. Brash[7] stated that increases in jaw sizes occur at all points up to 12 months after birth, but after this period there is no increase in length between the symphysis and the sixth tooth. There is also no increase in the diameter of the alveolar process in the maxilla as well as in the man-

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TABLE 1. Correlation Coefficients Obtained in Each Analysis

	Left Lower Canine	Left Lower First Premolar	Left Lower Second Premolar
Lower canines and premolars (one side)	.51	.82	.62
Lower canines and premolars (both sides)	.52	.84	.64

TABLE 2. Regressive Equations of Each Analysis

Analysis	Equation
1	Y = 1.36X + 11.9
2	Y = 1.82X + 7.5
3	Y = 1.42X + 10.2
4	Y = 2.78X + 23.3
5	Y = 3.67X + 14.8
6	Y = 2.9X + 19.7

TABLE 3. Average Error, Accuracy Coefficient, and Explication Factor Identified in Each Method for Analysis of Mixed Dentition

Analysis	Average Error (mm)	Accuracy Coefficient (mm)	Explication Factor (R^2)
1	.74	.0335	.26
2	.54	.0244	.68
3	.61	.0275	.39
4	1.49	.0337	.27
5	1.06	.0239	.70
6	1.26	.0285	.41

dible. After 12 months of age, the jaws increase only in the posterior region.

Moorrees et al[8] and Moorrees and Reed[9] found relatively low correlations between the size of the deciduous and the permanent teeth, indicating that great variation exists between the size of the permanent teeth compared with their deciduous predecessors. Moyers[10] and Tanaka and Johnston[11] proposed a table for prediction of the mesiodistal diameter of permanent canines and premolars based on the sum of the widths of the permanent four lower incisors.

Lima and Monnerat[12] proposed the use of 45° oblique teleradiography for determining the sizes of unerupted lower permanent canines and premolars. They proposed that measurements of the teeth on the radiograph should be multiplied by 0.928 for correction of magnification. This method produced a high determining coefficient (R^2 = .99) and low standard error (.41 mm for each hemiarch) for white Brazilian individuals.

This study aims at establishing a correlation between the mesiodistal width of permanent canines and premolars, obtained from 45° oblique teleradiography, with the actual sum of width of the same teeth determining the regressive equation and testing the accuracy of the method.

MATERIALS AND METHODS

The sample consisted of the records from 30 white Caucasian children in the transition period of the mixed dentition. All of them had undergone orthodontic treatment at the Faculty of Dentistry, Universidade Federal do Rio de Janeiro. Each patient record included a 45° oblique teleradiography from the mixed dentition stage and dental casts in the permanent dentition stage. Lower right and left permanent canines and premolars were measured on the radiograph of the mixed dentition stage and on the dental casts of the permanent dentition stage. All measurements were made with a caliper (0.1 mm) at the largest width of each tooth. To determine the error of the method, all measurements were repeated by the same investigator seven days after the first one, and the Student's *t*-test revealed no statistical difference.

Six dental size correlations were performed. Three of them were made between one tooth on the left side measured on the radiograph (canine, first premolar, second premolar) and the sum of the three teeth of the left side measured on the dental cast. The other three correlations were made between the same single tooth measured on the radiograph and the sum of permanent canines and premolar on both sides. Based on these correlations (Table 1), regressive linear equations (Table 2) established six methods of tooth size prediction[13] as follows: 1) canine, 2) first premolar and 3) second premolar correlated with the three left teeth and 4) canine, 5) first premolar and 6) second premolar correlated with all six teeth (both sides).

RESULTS

Table 1 shows that the correlation between lower left first premolar measured on the radiograph and the sum of lower permanent canines and premolars of both sides was the strongest. Table 2 expresses the regressive linear equations of the six methods of tooth size prediction. Table 3 demonstrates that analysis 5 has the lowest average error (consider both sides) and highest explication factor (R^2). Table 4 shows that on average, all methods are suitable for mixed dentition analysis.

TABLE 4. Average and Standard Deviation of Actual and Predicted Values in Each Analysis

Analysis	Actual Value (mm)	Predicted Values (mm)
1	22.13 ± 1.07	22.10 ± 0.54
2	22.13 ± 1.07	22.09 ± 0.88
3	22.13 ± 1.07	22.13 ± 0.64
4	44.22 ± 2.13	44.15 ± 1.11
5	44.22 ± 2.13	44.22 ± 1.40
6	44.22 ± 2.13	44.12 ± 1.36

DISCUSSION

Sampson and Richards[14] and Lima and Monnerat[12] all agreed that, despite the existence of several methods of tooth size prediction, it is still difficult to know which dentition will and which dentition will not develop favorably. Sampson and Richards[14] recommended the use of 45° oblique teleradiographs but suggested the need to correct for image enlargement. Lima and Monnerat[12] proposed a method for image magnification correction in the teleradiographs and reported a high degree of accuracy.

The studies of Moorrees and Reed,[9] Moyers,[10] and Tanaka and Johnston[11] reported correlations between the tooth widths of the four permanent lower incisors and the lower permanent canines and premolars varying from .58 to .66.

Hixon and Oldfather[15] found one of the strongest correlations between the central and lateral incisors measured in the dental casts plus first and second premolars measured on periapical radiographs and the actual sum of lower permanent canines and premolars of the same hemiarch.

In this study, a high correlation was present between the lower first premolar measured on the 45° oblique teleradiographs and the actual sum of the widths of the lower canine and premolars of one side and the total of the six permanent teeth. These correlations are similar to those found by Hixon and Oldfather,[15] and they were obtained in a more simplified manner. On the other hand, correlations obtained from the second premolar with the sum width of one side were low and similar to those found by the simpler methods of Moyers[10] and Tanaka and Johnston.[11] Correlations obtained from lower permanent canines were even lower and not adequate for a prediction. When correlating both single teeth with the total width of six permanent teeth, a slight improvement was observed, but this was still similar to the findings of Moyers[10] and Tanaka and Johnston.[11]

Analyses 2 and 5 obtained a relatively low average error, 0.54 mm (one side) and 1.06 mm (both sides), respectively (Table 3), contrasting under a clinical point of view, with the average error found by Lima and Monnerat[12] (0.82 mm) for the width of the six teeth (both sides). Analysis 5 reached a better accuracy coefficient (0.0239) followed by analysis 2. Analyses 1 and 3 showed average error for the hemiarch of 0.74 mm and 0.61 mm, respectively. Analyses 4 and 6 presented average error for the six permanent teeth total width of 1.49 mm and 1.26 mm, respectively.

The averages between actual and predicted values do not present a statistically significant difference in all analyses. However, other data show a higher precision for those methods that use a correlation from the width of the lower first premolar in the 45° oblique teleradiography (Table 4).

Recommendations

The correlations between the width of the lower first premolar in the 45° oblique teleradiographs and the actual sum widths of lower permanent canines and premolars showed adequacy for space analysis in mixed dentition. The error is minimal, but it would be pertinent to avoid possible crowding by using a more pessimistic approach. Therefore, the following formula is suggested:

$$\sum = (Y \times 4) + 14$$

where Σ is the predicted value for the sum with of lower permanent canines and premolar of both sides (six teeth) and Y is the width of the lower first premolar measured in the 45° oblique teleradiography.

CONCLUSIONS

The strongest correlation occurred for the first premolars for one side (0.82) and both sides (0.84). One linear regression equation was determined to estimate the widths of unerupted lower canine and premolars of both sides from a single measurement of the first premolar.

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