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EDITORA

EVALUATION OF ROOT PARALLELISM AFTER LEVELING IN CORRECTIVE ORTHODONTIC TREATMENT

AVALIAÇÃO DO PARALELISMO RADICULAR APÓS NIVELAMENTO NO TRATAMENTO ORTODÔNTICO CORRETIVO

EVALUACIÓN DEL PARALELISMO RADICULAR DESPUÉS DEL NIVELADO EN EL TRATAMIENTO ORTODÓNTICO CORRECTIVO

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ABSTRACT

This study aimed to evaluate the root parallelism in patients under orthodontic treatment by the Straight Wire technique through panoramic radiographs taken before and after the leveling phase, usually during the first nine months of treatment. The sample was composed of 40 initial and 40 post-leveling panoramic radiographs, where incisors, canines, premolars and first molars were measured. The Student t statistic test was used for the paired sample and the Wilcoxin statistic test was used for the not normal distribution data. The results presented a significant difference of the root inclination between the initial and the post-leveling panoramic radiographs in many teeth, except for the 11,13,31,32,35,42,45,46, that presented always higher values after the leveling phase, when significant statistical differences were observed (p<0,05). When the root inclinations of the “post leveling” group were compared to the ones found in previous studies, there were significant differences for most of the teeth, except for the 13, 23 and 24. As a conclusion, the values found in this study were higher for the inferior arch and lower for the superior arch.

Keywords: Panoramic Radiography. Tooth Root. Corrective Orthodontics. Or-thodontic Appliances. Tooth Movement Techniques.

RESUMO

O objetivo deste trabalho foi avaliar o paralelismo radicular em dentes tratados ortodonticamente pela técnica Straight Wire pelas radiografias panorâmicas obtidas antes e

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após a fase de nivelamento que se dá em torno dos primeiros nove meses do tratamento ortodôntico. A amostra constou de 80 radiografias (40 iniciais e 40 após-nivelamento). Incisivos, caninos, pré-molares e primeiros molares foram medidos. Os dados foram analisados estatisticamente pelo teste t de Student para amostra pareada e Wilcoxon para os dados que não apresentavam distribuição normal. Os resultados encontrados mostraram uma diferença significante entre as inclinações radiculares dos grupos iniciais e após-nivelamento em vários elementos dentários, exceto dos dentes 11, 13, 31, 32, 35, 42, 45, 46 sendo que estes valores foram sempre maiores ao final do nivelamento e observadas diferenças estatisticamente significantes ($p<0,05$). Quando se comparou as inclinações radiculares do grupo após-nivelamento com aquelas obtidas na literatura, houve diferenças significantes para todos os elementos dentários à exceção dos dentes 13, 23 e 24, concluindo-se que os valores obtidos neste estudo foram maiores para a arcada inferior e menores para a arcada superior.

Palavras-chave: Radiografia Panorâmica. Raiz Dentária. Ortodontia Corretiva. Aparelhos Ortodônticos. Técnicas de Movimentação Dentária.

RESUMEN

Este estudio tuvo como objetivo evaluar el paralelismo radicular en dientes tratados ortodóncicamente mediante la técnica Straight Wire, a través de radiografías panorámicas obtenidas antes y después de la fase de nivelación, que ocurre durante los primeros nueve meses del tratamiento ortodóncico correctivo. La muestra estuvo compuesta por 80 radiografías panorámicas (40 iniciales y 40 posteriores a la nivelación). Se midieron los incisivos, caninos, premolares y primeros molares. Los datos fueron analizados estadísticamente mediante la prueba t de Student para muestras pareadas y la prueba de Wilcoxon para aquellos datos que no presentaron distribución normal. Los resultados mostraron una diferencia significativa entre las inclinaciones radiculares de los grupos inicial y post-nivelación en varios elementos dentales, con excepción de los dientes 11, 13, 31, 32, 35, 42, 45 y 46, cuyos valores fueron consistentemente mayores al final de la fase de nivelación, con diferencias estadísticamente significativas ($p<0,05$). Al comparar las inclinaciones radiculares del grupo post- nivelación con los valores reportados en la literatura, se observaron diferencias significativas en la mayoría de los dientes, excepto en los dientes 13, 23 y 24. Se concluye que los valores obtenidos en este estudio fueron mayores para la arcada inferior y menores para la arcada superior.

Palabras clave: Radiografía Panorámica. Raíz Dental. Ortodoncia Correctiva. Aparatos Ortodóncicos. Técnicas de Movimiento Dental.

1 INTRODUCTION

Since the beginning of orthodontics, one of the greatest concerns of researchers has centered on the normalization of dental occlusion and oral functions of patients at the end of treatment (Almeida-Pedrin et al., 2001). The concept of normality, attributed to those dental positions characteristic of individuals with untreated optimal occlusion, was described by Andrews (1972), who determined the six keys to a normal occlusion, defining a standardization with more precise concepts for ideal occlusion, with emphasis on the mesial axial inclination.

The correct mesiodistal positioning of the long dental shafts is essential so that the roots are parallel to each other at their bone bases, allowing normal occlusion and a balanced distribution of masticatory forces. Therefore, a stable orthodontic treatment will depend on the correct mesiodistal axial tilt (Andrews, 1972; Lucchesi, 1988). This parameter, one of those adopted clinically to define the excellence of a well-finished case, is observed in panoramic radiography (Almeida et al., 1988), which provides an evaluation of tooth positioning before, during and after orthodontic therapy.

There are few studies that study individual tooth inclinations and angulations (Almeida et al., 1988; Almeida et al., 2001; Pacce, 2008). At most, only the recommendation for its realization, without there being a normal standard to serve as a reference (Gilbert, 1962). During orthodontic therapy, one of the primary factors commonly observed in panoramic radiography is root parallelism after aligning and leveling the crowns of the teeth (Almeida et al., 1988; Brandão, 2003; Pacce, 2008). Failure to observe this parallelism can cause damage, especially recurrence in the tooth position (Pacce, 2008). In most cases, the causative factor of the lack of parallelism is the incorrect bonding of the accessories, where during the procedure, the long axis of the roots was not considered (Ursi, 1989) Due to the importance of stability in orthodontic treatment, the present study aimed to evaluate the root parallelism of patients treated orthodontically by the Straight-Wire technique, Roth prescription , at the beginning of treatment and at the end of the initial alignment and leveling. The angles were compared to those proposed by Ursi (1989) in the literature.

2 METHODOLOGY

The present research was developed after approval of the Research Project by the Research Ethics Council of the Dental Research Center of São Leopoldo Mandic, under number 07/026.

From 200 orthodontic folders containing, in addition to panoramic radiographs, teleradiographs, study models and photos, 80 panoramic radiographs of patients treated in

private practice were selected. The criteria used to obtain the research were: patients undergoing corrective orthodontic treatment in the final phase of alignment and leveling; Patients with fixed apparatus with the Straight Wire technique, Roth prescription and with stainless steel wires in thicknesses from 0.016mm to 0.020mm. The exclusion criteria consisted of: patients who do not use corrective orthodontic appliances; Patients up to 12 years of age; Patients with absence of permanent teeth up to first molars.

The following materials were used to trace the anatomical structures on panoramic radiographs: negatoscope for panoramic radiographs; Straight Wire brackets, Roth prescription; Stainless steel wires in thicknesses from 0.016mm to 0.020mm; Ultraphan paper; Black cardstock; Transparent adhesive tape; 0.3mm mechanical pencil and white eraser. To prepare the tracing of the radiographs, a sheet of ultraphan paper was adapted and performed next to a black cardboard to facilitate the visualization and evidence of the anatomical structures.

The following anatomical structures were traced according to Tavano et al. (1989): inferior contour of the orbital cavities; External contour of the mandible image; Mental foramin; External contour of the crowns and roots of the upper and lower teeth to the first permanent molars.

The horizontal and vertical reference lines were drawn based on the points and dentoskeletal structures demarcated according to Tavano et al. (1989). The horizontal lines consisted of: interorbital line (upper reference line that passes through the right and left orbital points); Intementonian line (lower reference line that passes through the right and left chin points). For vertical lines, lines were drawn on the long axes of the upper and lower teeth to the first molars.

After the demarcation of the points and determination of the reference lines, the angles formed by the teeth were measured The reference values for the angles followed the values found by Ursi (1989) who evaluated the mesiodistal axial inclinations of orthodontically treated teeth. The incisors, canines, premolars, and first molars were the dental units measured.

The collected data were tabulated on a specific form by the same examiner, containing the identification of each individual, the angle of inclination of each tooth on the initial radiograph and the angle measured on the radiograph after leveling. To observe the replicability of the measurements taken, repetitions of the measurements obtained on panoramic radiographs were made using the intraclass correlation test (Fleiss, 1986), which consisted of random acquisition of 20 radiographs that were retraced by the same operator.

The distribution of the data was analyzed using the D'Agostino-Pearson test and, when the data did not present normal distribution, they were analyzed using the Wilcoxon test. Otherwise, it was compared using the Student's t-test for paired samples. The values obtained at the end of the treatment were compared with those obtained by Ursi (1989) by the unpaired t-test for means. The level of significance used was 5%. The statistical tests were performed using the statistical program BioEstat version 4.0 for Windows.

3 FINDINGS

The intraclass correlation test (ICC) for the measures repeated at two time points by the same operator (intra-examiner error) was 0.9874 ($p < 0.0001$; 95% CI=0.9762-0.9934), showing excellent replicability between the measurements. In the comparison of the same measurements also performed by an experienced former aminator (Gold-standard), the ICC also showed ex-cellent replicability (ICC=0.9885; 95%CI=0.98-0.99; $p < 0.0001$), with the reliability of the measurements.

For the sample, patients of both genders, aged between 12 and 28 years and Class I and II Angle malocclusion, treated with or without extractions, were selected. This age group was chosen because it is a period with fewer problems of tooth loss, periodontal or caries problems and the presence of all permanent teeth. The sample consisted of 80 radiographs (40 initial and 40 post-leveling).

The analysis (Wilcoxon signed rank test) showed statistically significant differences ($p<0.05$) between the pre-treatment and post-level leveling of teeth 16, 15, 14, 12, 24, 26, 36, 34, 33, 41, 43 and 44. The other teeth did not present statistically significant differences ($p>0.05$). As a rule, the values were lower at the end of the treatment for the lower teeth and higher for the lower teeth. In addition, it was possible to observe that the most affected groups of teeth were, in order, the molars (75% or 3 of the 4 premolars (62.5% or 5 of 8), canines (50% or 2 of 4) and incisors (25% or 2 of 8). Six upper and six lower teeth underwent alterations, and therefore there was no predominance of changes in leveling in relation to the upper and lower right and left hemi arches.

The comparison (unpaired t-test for means) between the values observed before the leveling and those obtained by Ursi in 1989 showed significant differences ($p<0.05$) for all dental elements except tooth 14 ($p=0.8791$). The same comparison (t-test not paired for means) between the leveling obtained in the "post-leveling" with those obtained by Ursi (1989) also showed highly significant differences ($p<0.001$) for all dental elements except teeth 13 ($p=0.3103$), 23 ($p=0.0501$) and 24 ($p=0.1624$).

In the dental elements where statistically significant differences were verified, it was found that the values observed in this study were higher than those obtained by Ursi (1989) for the teeth of the lower arch, but lower for the upper arch (in most cases).

4 DISCUSSION

Panoramic radiography obtained in the intermediate phase of orthodontic treatment is an effective means of diagnosis, since it allows the simultaneous examination of a set of bone structures with a lower dose of radiation, constituting a simple procedure that is easily accepted by the patient. Usually, in orthodontic intervention, this tool is requested at the beginning and end of the treatment. However, intermediate panoramas should be obtained more frequently to diagnose alterations that may occur in this period (Almeida et al., 1988; Ursi, 1989; Almeida-Pedrin et al., 2001). In the present study, in order to determine the mesiodistal inclination of the long dental axes, panoramic radiographs were measured before and after leveling.

However, several authors such as Mckee et al. (2002), Oliveira et al. (2003), Peck found on panoramic radiographs that should be considered when using these radiographs to measure root inclinations. Thus, it should also be taken into account that panoramic radiographs tend to increase anatomical structures.

The correct positioning of the patient's head in the x-ray machine minimizes the distortions of panoramic radiographs (Stramotas et al., 2002; Yeo et al., 2002), making it a reliable instrument in dental research, diagnosis and clinical follow-up of root parallelism, which is of fundamental importance for the stability of orthodontic treatment (Ursi, 1989; Capelozza Filho et al., 1994; Almeida, 1999; Almeida-Pedrin et al., 2001; Almeida-Pedrin et al., 2006). Studies report panning as a tool widely used as a means of measuring the mesiodistal inclinations of teeth (Mckee et al., 2001; Almeida-Pedrin et al., 2001; Brandão et al., 2003; Rabi et al., 2010).

If there is no root parallelism after leveling, the erroneously caused radicular inclinations should be corrected by repositioning brackets or artistic folds before using the rectangular wires. The correct positioning of the teeth at the end of orthodontic treatment is one of the factors for the balance and stability of the results (Andrews, 1972). The different dental anatomies or fractures should be taken into account at the time of bracket bonding and preferably corrected before collation to reduce the risk of positioning error, according to Vianna et al. (2006).

The results showed statistically significant differences between the pre-treatment and post-leveling of teeth 16, 15, 14, 12, 24, 26, 36, 34, 33, 41, 43 and 44. The other teeth did

not present statistically significant differences. The values were lower at the end of treatment for the upper teeth and higher for the lower teeth. In addition, it was possible to observe that the most affected groups of teeth were, in order, molars, premolars, canines and incisors. Six upper and six lower teeth were altered, and therefore there was no predominance of changes in leveling in relation to the maxilla or mandible. Perhaps these differences occurred because in the technique used, the brackets already had pre-defined angles. Therefore, the inclinations incorporated into the brackets of the StraightWire technique in the Roth prescription should be taken into account in this study when evaluating root parallelism.

Variations in the inclinations or torques suffered in the teeth during orthodontic treatment can affect the visualization of root inclinations on panoramic radiographs. Lingually inclined roots are projected more mesially than in reality. On the other hand, the roots inclined to the vestibular are projected distally, especially in the region of the canines and premolars, which also explains the variations found in the study. According to Ursi (1989), the professional should observe in the panoramic radiography that some dental elements have different positions in normal occlusion. The maxillary central and lateral incisors, for example, have slightly converging roots, and from the canines onwards the roots maintain a slight inclination to the distal, as do the remaining teeth, thus confirming that the changes found in the inclinations are not significant.

The comparison between the leveling obtained after leveling with those obtained by Ursi in 1989 showed highly significant differences for all dental elements except teeth 13, 23 and 24. In the dental elements where statistically significant differences were verified, it was verified that the values observed in this study were higher than those obtained by Ursi (1989) for the teeth of the lower arch, but lower for the upper arch (in most cases), probably because the sample used by that author did not use orthodontic apparatus and had ideal occlusion. These results are corroborated by Owens & Johal (2008), who found large variations in mesiodistal inclinations, especially in the region of maxillary canines and premolars and lateral incisors and lower canines when evaluating panoramic radiographs in patients with normal occlusion. This is justified because patients who seek orthodontic treatment do not have normal occlusion, so the root inclinations before treatment are already altered. Although there is no proven relationship between differences in tooth angulations and recurrence in orthodontic treatment, root pa- ralelism contributes to its stability.

Pacce (2008), when evaluating mesiodistal inclinations by means of panoramic radiographs at the beginning and end of orthodontic treatment using the "Straight Wire" technique, was concerned with the correction or maintenance of tooth inclinations during treatment, since he found a significant difference between the mesiodistal axial inclinations

of the initial and final groups in practically all dental elements and concluded that if there is no root parallelism at the end of the treatment, there is a greater possibility of reopening closed spaces during it.

The correct positioning of the brackets using panoramic radiography is extremely important so that the full potential of the pre-adjusted appliances is transferred to the teeth, in addition to contributing to a better completion of the cases, according to Almeida (1999). These findings are in agreement with Almeida-Pedrin et al. (2001), who suggest that the panoramic X-ray obtained during orthodontic treatment allows the evaluation of the mesiodistal inclinations of the roots, allowing the repositioning of the brackets before the end of the treatment, promoting greater stability, reducing the risk of recurrence. Also according to Ursi (1989), a case treated orthodontically should present the same root arrangement on panoramic radiography as a patient with normal occlusion in order to confer stability to the treatment.

5 CONCLUSION

It was concluded based on the results that:

- The mesiodistal axial inclinations after leveling were different from the initial ones;
- The mesiodistal axial inclinations after leveling presented values different from the normal mean values of the dental elements found in the literature, except for teeth 13, 23 and 24, concluding that the values obtained in this study were higher for the lower arch and lower for the upper arch;
- Obtaining the parallelism of the long dental axis provides security for the professional and reliability for the patient in the face of treatment stability;
- This study has limitations related to the small size of the study group and the use of panoramic radiographs of apparithology from several radiological centers. Future studies applied to different types of dental malocclusion are necessary.

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