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The effects of non-extraction fixed orthodontic treatment on the vertical mandibular bone level

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Abstract

Background: The purpose of this study is to investigate the effects of non-extraction fixed orthodontic treatment on the vertical mandibular alveolar bone level.

Methods: This study examined 49 patients who had been treated with a non-extraction treatment modality. The mean age of the patients at the start of treatment was 19 years and 5 months, and treatments were carried out for a mean length of 21 months. By comparison, the study's control group consisted of 62 subjects with a mean age of 21 years and 2 months. The study was performed by using panoramic radiographs that had been taken of the study and control subjects. A reference line that passed from the top point of the right and left mental foramen was applied to the panoramic radiographs. In the area from the distal of the lower canine to the mesial of the second molar, vertical lines were constructed from the alveolar crest ridges to this reference line. Pre- and post-treatment data were compared between the intra- and inter-groups.

Results: In the treatment group, statistically significant increases in the alveolar bone level were found. These increments were also significantly different from those of the control group.

Conclusion: Non-extraction orthodontic treatment has capability of increasing vertical alveolar bone level when compared with the control group.

Keywords: Interdental bone, Orthodontic treatment, Panoramic radiography

Introduction

Fixed orthodontic treatments are the most commonly used option in the treatment of dental malocclusion. When compared to removable appliances, fixed appliances have important advantages. One of the most important ones is undoubtedly the ability to generate complex tooth movements such as torquing, rotation and bodily movements. Therefore, fixed treatment modalities have been indispensable to orthodontists.

In addition to these advantages, there are also various problems that may come into play if careful treatment processes have not been carried out by both patients and orthodontists. Depending on a patient's attitude, deterioration of oral hygiene,(1) white spot lesions,(2) gingivitis,(3) increased pocket depth(4) and periodontal attachment loss(5) can easily occur. Additionally, root resorption,(6) gingival recession(7) and alveolar bone defects can be happened due to improper treatment technique or misapplication of the proper technique.

The alveolar bone level has hitherto been studied by several researchers. For instance, Schei et al. investigated the association between age, mouth hygiene and bone resorption in the anterior and posterior areas of the dental arch.(8) As a measurement method, these researchers used intraoral radiographs that had been taken at angles of 35°, 45° and 55°. Many other studies have used radiographs as a method of measurement, and several of these studies have examined the effects of orthodontic treatment on interdental alveolar bone height.(9-11)

These studies used periapical and bitewing radiographs to measure the vertical height of the alveolar bone. In these studies, distance from cementoenamel junction to alveolar crest ridge was measured and changes between the pre- and post treatment were evaluated. Whether there is any destruction of the alveolar bone was determined according to these changes. They have reported a decrease resulting from fixed orthodontic treatments in the vertical alveolar bone level.(9-11)

In addition to intraoral radiographic methods, it was stated that panoramic radiography and tomography can also be used to determine interdental alveolar bone height during the surgical implant planning process.(12) The cost, relatively high radiation and materials such as fixed prostheses and amalgam restorations that can form artefacts in images are the main disadvantages of tomographic method.(13)

Although panoramic radiography is a routine examination material in orthodontics, a method for measuring the alveolar bone level with this radiograph has yet to be developed so far. Therefore, the purpose of this study is to determine whether any changes at the posterior mandibular alveolar vertical bone level can occur as a result of fixed orthodontic treatment through the use of panoramic radiographs.

Material and Methods

This study was approved by the Clinical Research Ethics Committee of the Ondokuzmayıs University. Because of the retrospective structure of this study, informed consent from the study's subjects was not required. Two different groups—the treatment and control groups—were constituted. Subjects without systemic diseases that affected bone metabolism and who were not taking any medication were chosen for both groups. Systemic anamnesis information was obtained from the patients' records. Moreover, radiographs that did not provide adequate imaging quality were excluded from the study.

Fig. 1: Measurement technique used in the study

The treatment group consisted of 49 patients who had undergone non-extraction fixed orthodontic treatment for a mean treatment period of 21 months. These patients had a mean age of 19 years and 5 months at the beginning of treatment. In addition, two panoramic radiographs—pre-treatment and post-treatment—were acquired from each patient's records.

The control group consisted of 62 individuals who had never undergone permanent tooth extraction and who had a mean age of 21 years and 2 months at the date of taken their first radiographs. Subjects who were included in this group were chosen in who was applied to faculty for various non-orthodontic reasons. Two panoramic radiographs for each subject which were taken with a mean of 20 months were used. Attention was also paid for that the interval between the two radiographs had to be least 15 months.

All panoramic radiographs were taken by a Planmeca 2002 CC Proline (Helsinki, Finland) that was adjusted to 65 KVp, 7 mA. Images were obtained from irradiated x-rays in an automatic processor (Dent X 9000, New York, USA). On panoramic radiographs, a reference line was formed that passed from the top point of the right and left mental foramen. From the distal of the lower canine to the mesial of the second molar, vertical lines were constructed from the alveolar crest ridges to reference line. In sum, a total of eight measurements—four on the right side and four on the left side—were obtained manually from the analog radiographs (Fig. 1). Finally, intra- and inter-group comparisons were performed after the acquired data were statistically analysed.

Statistical Analysis: Before the study, the sample size was analysed based on $\alpha = 0.05$ to achieve 95% power. It was calculated that at least 14 subjects per group were needed for detecting the difference of bone changes between the groups (PASS 2008, NCSS, LLC, Kaysville, UT, USA). The number of subjects in this study—111 subjects with 49 in the treatment group and 62 in the control group—was also parallel with the sample size of a similar study.[9]

The Kolmogorov-Smirnov test was performed and the distribution was found to be normal ($p > 0.05$). Pre-treatment measurements were compared between the control and study groups with the aid of t-test and no difference was found among the groups. Paired t-test was performed to compare changes in bone height.

All statistical analyses were done by using the SPSS (SPSS V12.0; SPSS Inc., Chicago, IL, USA) statistical package program and the findings were tested for significance level of 0.05.

Results

The descriptive statistics for each group are demonstrated in Table 1. Posterior mandibular interdental bone height values that were obtained from the measurements in the first panoramic radiographs (T0) had a mean of 19.63 ± 3.61 mm for the treatment group and 19.14 ± 3.93 mm for the control group. These values were analysed with t-test, wherein no differences were found between the treatment and control groups ($p = 0.068$).

In the control group, while a slight decrease in the mean posterior mandibular height values was observed between the first (T0) and second (T1) panoramic radiographs, this reduction was not statistically significant.

Comparisons of the first and second measurements of the treatment group revealed statistically significant increases in the three interdental alveolar spaces (45 – 44, p= 0.007; 34 – 35, p= 0.002; 35 – 36, p= 0.010) (Table 1). Comparisons of the control and treatment groups revealed statistically significant differences between the four interdental alveolar spaces among the groups (46 – 45, p= 0.019; 45 – 44, p= 0.002; 34 – 35, p= 0.013; 35 –36, p= 0.006) (Table 1).

Table 1: Comparison of the pre and post treatment results in both of intra- and inter-groups

Interdental bone between teeth	*Control*				*Treatment*				
	T0 (mm)	*T1 (mm)*	*T1-T0 (Sd) (mm)*	p^a	*T0 (mm)*	*T1 (mm)*	*T1-T0 (Sd) (mm)*	p^a	p^b
47-46	22.29	22.14	-0.16(2.20)	0.575	23.43	23.65	0.21(2.56)	0.570	0.430
46-45	19.58	19.31	-0.26(1.47)	0.171	20.15	20.60	0.44(1.58)	0.058	0.019*
45-44	18.22	17.83	-0.35(1.67)	0.099	18.32	18.91	0.56(1.38)	0.007*	0.002*
44-43	17.02	16.91	-0.10(1.41)	0.591	16.92	17.15	0.16(1.30)	0.387	0.309
33-34	16.81	16.88	0.07(1.89)	0.763	16.71	17.00	0.24 (1.60)	0.289	0.561
34-35	17.79	17.77	-0.02(1.50)	0.900	17.82	18.53	0.65(1.39)	0.002*	0.013*
35-36	19.16	18.93	-0.21(1.50)	0.266	19.68	20.43	0.74(1.96)	0.010*	0.006*
36-37	21.96	21.90	-0.06(2.05)	0.817	23.11	23.48	0.34(2.23)	0.289	0.323

[a]Within group (T0 vs T1)

[b]Between groups [Control (T0-T1) vs Treatment (T0-T1)]

*Indicates significant difference ($p < 0.05$) between the groups compared

Mandibular bone height was not significantly affected by gender (*p*= 0.867), measurement location (right vs. left) (p= 0.949) or the length of treatment periods (interval between the first and second radiographs) (*p*= 0.575).

Discussion

Although clinical examinations are given priority during diagnoses, radiographs are important diagnostic tools that can provide information that cannot be derived from clinical examinations. For instance, radiographs can determine the presence of bone loss that has been caused from periodontal disease and distinguish between anatomical and pathological formations.(14,15) Interdental alveolar structures can also be investigated with the aid of radiographs. Indeed, panoramic, bitewing and periapical radiographs have been used for this purpose in existing studies.

In spite of their common use, radiographs have some negative qualities that can limit their utility, such as limited field of view, standardization problems, two-dimensional image,(16) distortion(17,18) and magnification.(18) Previous studies have stated that tomography, which can be used as an alternative to radiography, can provide reliable measurement values(19) and the opportunity for three-dimensional assessments.(16) Since radiographs produce less radiation, they are still preferred over other advanced imaging techniques such as tomography.(20) In addition, radiographs cost less, and materials, such as fixed prostheses and amalgam restorations, can cause artefacts during tomographic imaging.(13)

The present study used panoramic radiographs to assess posterior mandibular alveolar bone heights and the used method did not require any additional radiation. Because these images have already been taken as a routine record material. Furthermore, studies have reported that panoramic radiographs are as reliable as periapical radiographs during the assessment of the posterior mandibular area.(21)

Previous studies have used periapical and bitewing radiographs to measure the linear distance between the cementoenamel junction and the interdental alveolar crest ridge.(9,10) The present study carried out its measurement by using a reference line that passed from the right and left foramen. This method was chosen due to the potential for the axial slope of the teeth to change as a result of orthodontic treatment. Therefore, if the present study would have used the cementoenamel junction as the reference point, it would have produced false results.

There are studies that have used the measurable lengths between anatomical points on panoramic radiographs in determining alveolar bone height.(22) Since the location of mental foramen does not change depending on age and gender,(23) and can be easily identified on panoramic radiographs, we used the right and left mental foramen as reference points. Following this, a reference line that passed from the top point of the right and left mental foramen was constructed.

In this study, we observed that the vertical heights of the alveolar bone were increased in study subjects compared to the control ones. As contradiction with our results, Zachrisson and Alnaes(9) reported that height of the alveolar bone decreased with orthodontic treatment. These conflicting results may be due to the different measurement technique used in their study. Because they used the cementoenamel junction as the reference line, it is likely that it produced false results.

In our study, extrusive forces that were exerted by the fixed orthodontic mechanics may have resulted in increases to alveolar bone height. In support of this assertion, Salama and Salama's study(24) reported that the extrusive effect of forces caused by orthodontic treatment can increase bone quantity.

Patients who had undergone non-extraction fixed treatment were chosen for the current study. Because bone loss that might occur as a result of tooth extraction, could have affected the results. Several studies have asserted that extraction can affect alveolar crest height. These studies have reported that the height of alveolar crests in the extraction area can never reach previous vertical heights(25) and that the resorption activity in bones can increase after extraction.(26) A substantial amount of bone resorption can also frequently occur after the first year of extraction.[27]

When the data derived from the present study's control subjects were analysed, no statistically significant differences were found in their alveolar bone height. This is likely because no significant vertical bone increases occurred within the subjects' age group since they had completed their vertical growth. In support of these findings, Snodell et al.[28] found that vertical increases in the lower mandible of individuals whose growth is completed were not significant.

Ward and Manson asserted that periodontal alveolar bone loss was frequent in males between the ages of 45 and 65 and in females between the ages of 35 and 45.[29] In the current study, subjects who served as the control group had a mean age of 21 years and 2 months when the first radiographs were taken. Therefore, decreases of alveolar bone height in the control group had not already been expected. Eventually, it became reasonable to assume that there were neither increases nor decreases of alveolar bone height in the control group.

In this study, radiographs with adequate imaging quality were used and the reference line was insusceptible to teeth positions and movements. Nevertheless, the standardisation and reliability of panoramic radiographs is an important issue that should not be ignored.[30] Additionally, in using this technique, it is impossible to detect endosseous defects or to determine the alveolar bone heights in the buccal and lingual areas.

Conclusion

The findings of the present study suggest that non-extraction orthodontic treatment has capability of increasing the vertical alveolar bone level when compared with the control group. However, due to limitations, additional clinical and experimental studies will be necessary before more definitive judgments can be made.

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