Alveolar Bone Density after the Orthodontic Treatment in Patients of Rsgm Universitas Airlangga

Ernie Maduratna Setiawatie[1], Mohamad Rubianto[1], Muhammad Naufal Ilmi Roswandi[2]

[1]Professor of Periodontics, Department of Periodontology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya Indonesia, [2]Student of Department of Periodontology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya Indonesia

Abstract

Background: There is a relation between the orthodontic therapy and the periodontal tissue. In the moving teeth and planning treatment, the periodontal tissue is very influential in an orthodontic therapy. During the movement of the teeth, all components of the periodontal tissue such as the bones, periodontal ligaments, and gingiva will change and move together. Some studies indicate a decrease in alveolar bone fraction and alveolar bone density. The changes in density are seen by comparing the new bone mineralization with the old bones. **Purpose:** This research aims to analyze the differences in alveolar bone density after an orthodontic treatment in patients of RSGM Universitas Airlangga. **Methods:** This study used a patient's panoramic radiograph at the time before the orthodontic treatment and the time after it. Photographs of panoramic radiographs were measured using a digital densitometer. **Results:** The results of the study revealed a decrease in alveolar bone density after orthodontic treatment, both anterior and posterior. The average decrease in the anterior was 35.4%, while in the posterior was a decrease of 31.5%. Conclusion: There was a decrease in the alveolar bone density after orthodontic treatment in the anterior and posterior sections.

Keywords: *Bone Density, Orthodontic Treatment, Panoramic Radiography, Remodeling*

Introduction

The community awareness of the orthodontic treatment is increasingly high and becoming popular in the dentistry [1–4]. This is based on the desire to improve facial appearance, the position of the teeth, as well as the jaw relations[5]. Orthodontic treatment has an influence on the periodontal tissue, such as inflammation, changes in tooth root length, alveolar bone resorption, and changes in gingival structure. In some cases orthodontic therapy can improve gingival health such as removing black triangle in the interdental area [6].

Orthodontic treatment is based on the principle that if a pressure is applied to the teeth for a certain period of time, a tooth movement will occur because the periodontal ligaments and bones around the teeth change. When a pressure is applied to the crown of the tooth, the pressure will cause the other pressure and strain areas in the alveolar bone and periodontal ligament. In the area of pressure, there will be bone resorption in response to this pressure. Whereas in the strain area, the bone apposition will occur to maintain the integrity and mechanism of the teeth attachment to the bone. As a result, the socket of the tooth will move along with the movement of the tooth through the alveolar bone. In a study indicates a change in the alveolar bone density. That changes in the density are seen by comparing the new bone mineralization with the old bones [7,8].

Several methods are available for measuring the bone density. Magnetic resonance imaging, ultrasound, computed tomography, Dual energy X-ray absorptiometry (DXA), and densitometry radiography have been used for the medical evaluation [9]. Panoramic and periapical radiographs are one of the conventional densitometry methods. It can be measured with digital densitometers or can be digitized and processed using special software programs for the digital radiography. Using conventional film, the bone density measurement has several clinical benefits, such as low dose exposure,

cheap, easily available, and not invasive [10].

Research on the alveolar bone density after orthodontic therapy is rarely done and the orthodontic therapy requires multidisciplinary knowledge to obtain the maximum treatment results. This is because the moving teeth will affect the condition of periodontal tissues, especially the alveolar bone. Based on this fact, this research aims to analyze the differences in the alveolar bone density after the orthodontic treatment in patients of RSGM Universitas airlangga.

Methods

The type of research used was observational analytic with a retrospective approach. With studies comparing radiographs before orthodontic treatment and radiographs after it by a measurement using a digital densitometer. The population in this study was panoramic radiographs of patients who had completed fixed orthodontic treatment in January-May 2018 at the RSGM (Hospitals Teeth and Mouth) Universitas Airlangga. The selection of samples using the secondary data from the panoramic radiographs of patients before and after the treatment with criteria for treatment, and the 3 years duration of treatment and have a panoramic radiograph from the Parahita lab. Those 20 samples radiographic were obtained before and after the treatment that matched the criteria.

Panoramic radiographs of the patients who fit the criteria are collected. The radiograph was measured in the anterior and posterior regions of the mandible. First, the measurements are taken in the anterior region before and after the treatment. The second one is the measurements on the alveolar bone radiographs between the anterior teeth, from the left canine to the right canine. Afterward, measuring the density using the digital densitometry then calculating the average results to obtain the average anterior bone density value.

The measurements then are carried out in the posterior region before and after the treatment. The next one, the measurements on the alveolar bone radiographs between posterior teeth from canines to permanent second molars of patients both on the left and right. Measured density using digital densitometry, then performed an average calculation of the results to obtain the posterior average bone density value. The data that has been obtained from the measurement results are carried out by the normality test using the Kolmogorov-Sminov test which then tested by the T-Test to distinguish the difference in the density on the sides.

Results

The results of measurements on 20 panoramic radiographs before and after fixed orthodontic treatment at the RSGM Universitas Airlangga. The results of the study revealed a decrease in the alveolar bone density after orthodontic treatment, both anterior and posterior. The average reduction in the anterior was 35.4%, while the posterior decrease was 31.5%.

Table 1. Mean Value and Standard Deviation of Alveolar Bone Density Data

Bone Density	Standard Deviation
Anterior Before Treatment	1,0644 ± 0,2368
Anterior After Treatment	0,6871 ± 0,2891
Posterior Before Treatment	1,207 ± 0,2157
Posterior After Treatment	0,8267 ± 0,2728

The research was tested using Kolmogorov-Smirnov Test with the result of all groups have a value greater than 0.05. It can be concluded that the data are normally distributed. Afterward, the statistical test during before and after the treatment were conducted using paired T-Test at the significance level of sig less than 0.05. It can be concluded that there are significant differences in the bone density between before and after treatment. In addition, it then continued by the statistical test for anterior and posterior density using paired T-Test at the significance level of sig more than 0.05. The result can be concluded that there are no significant differences between the anterior and posterior density.

Discussion

Movement of the teeth in the area of pressure will cause another pressure on the periodontal ligament and on the reverse side strain. When given a mechanical force it will affect bones and periodontal. These mechanical forces also influence the tissue vascularization and blood flow. It then also affects molecular release, such as neurotranmitters, cytokines, growth factors, colony-stimulating factors, and arachidonic acid metabolism [11].

The mechanical force applied will cause hygiene of the periodontal ligament and cause resorption of the alveolar bone. Resorption in the alveolar bone is caused by osteoclast activity. This is initiated by the inflammatory cells such as interleukin-1 beta (IL-1β), PGE2, interleukin-6 (IL-6), and the other ones. These cells will regulate osteoclastic activity from activation of RANK - RANKL. Osteoblast cells also regulate osteoclastic processes by synthesizing RANKL. In the strain area new bone growth occurs by osteoblasts. That osteoblasts differentiate the local precursor cells, namely, mesenchymal stem cells. These activities are called bone remodeling and affect the density of the alveolar bone [11].

The density of the alveolar bone can be measured and analyzed through various methods. In several studies used radiographic photographs to determine alveolar bone density by computerized methods. There also used radiography photos to determine the bone density from the mandible which correlated with BMD of skeletal bone. Several methods are available for measuring the bone density. For example, magnetic resonance imaging, ultrasound, computed tomography, Dual energy X-ray absorptiometry (DXA), and densitometry radiography. All of that have been used for the evaluation in the fields of medicine and dentistry [12,13].

In this study, the measurement of panoramic radiographs of patients before and after the treatment using digital densitometer was used. A research stated that there was a correlation from the measurement of the bone density using radiographic films by computerization and digital densitometer. Using conventional film, the bone density measurement has several clinical benefits such as low dose exposure, cheap, easily available, and not invasive measures [10].

However, the panoramic radiographs have several lacks, including the presence of images that overlap with the other structures. Afterward, there is also an experience enlargement and distortion when compared to the actual size. That enlargement of panoramic radiographs can be >30%, especially when the patient is not in the optimal position. There is an error from the operator or patients that may have effects as well as affect the quality of the panoramic radiograph. Panoramic radiography also has low contrast and detail so that it can affect the density measurements [14,15].

In the several studies using CBCT radiographs to determine changes in the bone density occurring during orthodontic treatment. The advantage of using CBCT compared to panoramic radiographs is obtaining a picture of the 3 dimensions and density of each bone structure. However, in some developing countries, an examination is rarely done using CBCT as a result of low socio-economic conditions. In addition, CBCT also provides high exposure doses compared to panoramic radiographs [7,8,16].

Decreasing bone density can affect the success of orthodontic treatment. The use of a retainer will provide maximum results in the orthodontic treatment. The use of a retainer aims to maintain stability and prevent relapse because the gingiva and periodontal tissue tend to return to their original position and require time to reorganize when the orthodontic device is removed. A study was found that during the active orthodontic treatment, there was a significant decrease in the bone. However, after being given the use of a post-retainer retainer, there was an increase in the bone density in these patients [14]. Giving bisphosphonates can also improve the stability

of post-orthodontic treatment. The bisphosphonates can inhibit osteoclastic activity which stimulates new bone formation. However, the prolonged administration of bisphosphonates can cause osteonecrosis of the jaw [17].

Orthodontic treatment in patients with periodontal abnormalities will affect the capacity of the alveolar bone to regenerate the tissue. A study stated that fixed orthodontic treatment would maintain bone height, but was unable to maintain the bone density for patients with periodontitis. The study showed that changes in the bone density may be more susceptible than changes in the bone height of periodontitis patients. Further research is needed regarding fixed orthodontic treatment in undetected patients in the regeneration capacity of the periodontal tissue or in patients with periodontal abnormalities [18].

Conclusion

Based on the results of the measurements of alveolar bone density before and after orthodontic treatment on panoramic radiographs using a digital densitometer, we found a decrease in the bone density of 35.4% in the anterior, meanwhile in the posterior is 31.5%.

Ethical Clearance: This research involves participants in the process using a questionnaire that was accordant with the ethical research principle based on the regulation of research ethic regulation. The present study was carried out in accordance with the research principles. This study implemented the basic principle ethics of respect, beneficence, non-maleficence, and justice.

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Conflict of Interest: There is no conflict of interest

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