Radiographic Comparison of the Width of the Inferior Cortex of the Mandible and the Height and Density of the Alveolar Bone in Smoking and Non-smoking Males using Cone-beam Computed Tomography Images

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Abstract: Cone-beam computed tomography (CBCT) images have favorable quality and are more valuable in the evaluation of the dimensions and density of the alveolar bone. In the present study, CBCT images were used to compare the height and density of the alveolar bone and the width of the inferior cortex of the mandible in smoking and non-smoking males using cone-beam computed tomography images. J Int Oral Health 2016;8(8):839-842.

Results: The heights of the alveolar crest in smokers and non-smokers were 684.49 ± 126.8 and 653.25 ± 131.45, respectively (P = 0.063). The means of alveolar bone density based on the gray level in non-smokers and smokers were 3.12 ± 0.22 and 3.49 ± 0.85 mm, respectively (P = 0.063).

Conclusion: In the present study, the alveolar bone density and the width of the inferior cortex of the mandible were the same in smokers and non-smokers while the heights of the alveolar crest were less in smokers.

Key Words: Bone density, bone loss, cone-beam computed tomography

Introduction

Some of the systemic factors affecting the dimensions and density of human bones are smoking, estrogen deficiencies, a decrease in physical activity, and vitamin D deficiency. Smoking has been reported as a significant risk factor for periodontal diseases, with a major role in decreasing the height of the alveolar crest and in the induction of peri-implant conditions. In addition, it has been shown that smoking results in a decrease in the regeneration of bone after periodontal treatment. Smokers exhibit a decreased blood flow to the gingival tissues and have decreased gingival crevicular fluid as a result of the presence of vasoconstrictors in tobacco smoke, such as nicotine, resulting in a decrease in tissue oxygenation and compromised immune system, with the final loss of gingival attachments and loss of bone.

Several studies have evaluated the effects of smoking on the dimensions and density of the alveolar bone. Rosa et al. reported that smoking exerts deleterious effects on the height and density of the alveolar bone and can be considered a potential risk factor for the loss of the density of the alveolar bone, even at young ages and with low levels of smoking. They used bitewing radiographic technique in their study. Levin and Levine used bitewing radiographic technique and reported lower density and height of bone in smokers compared to non-smokers. In addition, Javed et al. evaluated the clinical symptoms and signs and reported more resorption of marginal bone in smokers compared to non-smokers. In such studies, researchers have conventionally used intraoral radiographs (periapical and bitewing) and panoramic radiographs to evaluate the jaw dimensions and the amount of alveolar bone resorption. These radiographic techniques provide two-dimensional images of the body structures and have limitations such as distortion and overlapping of anatomic structures. In addition, these radiographic techniques are not sufficiently accurate to determine bone density in different areas.

In 1997, cone-beam computed tomography (CBCT) technique was introduced for dental applications and soon replaced conventional tomography technique. This new imaging technique has some advantages such as lower radiation
dose compared to conventional CT technique, high resolution of the images, and a decrease in artifacts. In addition, CBCT has no image distortion and overlapping of anatomic structures compared to intraoral and panoramic radiographic techniques; furthermore, measurements made on CBCT images are more close to the real measurements. \(^9\) \(^{12}\) de Faria Vasconcelos et al. reported that CBCT technique was more accurate than intraoral radiographic techniques in determining the height of the alveolar bone. \(^9\) In a study by Mol and Balasundaram, too, measurements made on CBCT images were more accurate than those on conventional radiographs and the measurements achieved were more close to real values. \(^13\)

In a study by Babaloo et al., too, CBCT radiographic technique was more accurate in determining the dimensions of bone compared to panoramic radiographic technique. \(^4\) Therefore, CBCT images not only have favorable quality but also are more valuable in the evaluation of the dimensions and density of the alveolar bone. Therefore, in the present study, CBCT images were used to compare the height and density of the alveolar bone and the width of the inferior cortex of the mandible in smoking and non-smoking male subjects.

Materials and Methods

In the present descriptive/cross-sectional study, the study population consisted of all the patients of the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, in 2015, who had been referred to the Department for CBCT examinations for diagnostic or therapeutic purposes. Sampling was carried out using the census technique and the subjects’ demographic data (including age, gender, a history of smoking, a history of oral surgery, a history of systemic conditions, and a history of taking supplements, or hormonal medications) were recorded when they referred to the Department of CBCT examinations. A total of 286 subjects were included in the study based on inclusion and exclusion criteria. The subjects were divided into two groups of smokers and non-smokers based on a history of smoking, and the study variables were evaluated in the subjects.

Inclusion criteria

- Males over 20 years of age
- Subjects with at least 6 teeth in the lower jaw
- Subjects with mandibular molar and premolar teeth
- Smokers smoking <20 cigarettes/day
- Non-smokers reporting no previous history of smoking.

Exclusion criteria

- Patients with a history of taking supplements or hormonal medications
- Patients with secondary osteoporosis, hyperparathyroidism, uncontrolled thyrotoxicosis, malabsorption, liver diseases, alcoholism, and other systemic conditions
- Patients with a history of oral surgeries.

Digital CBCT images were taken with a NewTom VGI unit (Veromy, Italy) at kVp = 110. The images were viewed and evaluated on a monitor with a resolution of 1280 x 800 by an oral and maxillofacial radiologist who was blinded to the study procedures. Measurements were made by NNT Viewer software program on CBCT images. To this end, the distance between the cement-enamel junction, and the alveolar crest was measured on premolar and molar teeth on both sides in each subject, and their mean was calculated and considered as the height of the alveolar bone. Then, the width of the inferior cortex of the mandible was measured at a location perpendicular to the mental foramen on both sides, and their mean was considered as the width of the inferior cortex of the mandible in each patient. Finally, the mean density of a 3-mm² area between the two premolars above a hypothetical line and above the mental foramen on both sides was determined, and its mean was considered as the mean bone density in each patient. Data were analyzed separately in the two study groups with the use of descriptive statistics (frequencies, percentages, means, and standard deviations) and independent samples t-test and non-parametric Mann–Whitney test, using SPSS 21. Statistical significance was set at \(P < 0.05\). Kolmogorov–Smirnov test was used to evaluate the normal distribution of data.

Results

In the present study, 286 male subjects with a mean age of 43.6 ± 10.46 years were evaluated; 203 subjects (71%) were non-smokers and 83 (29%) were smokers. Kolmogorov–Smirnov test showed that distribution of data on the density of the mandibular bone was normal, and distribution of data on the height of the alveolar crest and the width of the inferior cortex of the mandible was not normal. Therefore, t-test for independent groups was used to evaluate the relationship between the bone density of the mandible and smoking, and non-parametric Mann–Whitney test was used to evaluate the relationship between smoking and the height of the alveolar crest and the width of the inferior cortex of the mandible.

As shown in Table 1, evaluation of CBCT images in the study groups showed that the heights of the alveolar crest in smokers and non-smokers were 3.12 ± 0.22 and 3.49 ± 0.85 mm, respectively. Mann–Whitney test showed that this finding was statistically significant \((P = 0.001)\), and the height of the alveolar crest in smokers was significantly less than that in non-smokers (Graph 1).

As shown in Table 2, evaluation of CBCT images in the study groups showed that the means of the width of the inferior cortex of the mandible in smoking and non-smoking subjects were 4.36 ± 1.00 and 4.43 ± 1.47 mm, respectively (Graph 2). Mann–Whitney test showed no significant differences between the two groups \((P = 0.65)\).

As shown in Table 3, evaluation of CBCT images in the study groups showed that the means of alveolar bone density...
based on the gray level in non-smokers and smokers were 684.49 ± 126.8 and 653.25 ± 131.45, respectively (Graph 3). t-test for independent groups showed that the difference between the two groups was not significant (P = 0.063).

**Discussion**

The present study was undertaken to evaluate the effect of smoking on the height and density of the alveolar bone and the width of the inferior cortex of the mandible. A total of 286 male patients, referring for CBCT examinations, to the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, were included in this study. The results showed that smoking had no effect on changing the density of the alveolar bone and the width of the inferior cortex of the mandible; however, the height of the alveolar crest in smokers was less than that in non-smokers. Therefore, under the limitations of this study, smoking decreased the height of the alveolar crest. Similar previous studies, too, have yielded such a result, and widespread destruction of the alveolar crest has been reported in smokers, especially in heavy smokers.\(^2,3,7,15-17\)

Mesa et al. (2014) evaluated the height and density of the alveolar bone in 110 Caucasian patients 21-46 years of age, using CBCT images and concluded that smoking clearly resulted in a decrease in the height of the alveolar crest; however, no significant relationship was detected between smoking and a change in the density of the mandibular bone, consistent with the results of the present study. However, in the present study, only male subjects were included to avoid the negative effects of hormonal fluctuations in female subjects; in addition, the sample size was larger than that in the study above.\(^3\)

Saldanha et al. used standard periapical and panoramic radiographs to evaluate the effect of smoking on remodeling of the alveolar ridge after tooth extraction and concluded that there was a decrease in the height of the alveolar crest after tooth extraction in both smokers and non-smokers; however, there was a greater decrease in the height and width of the alveolar crest in smokers compared to non-smokers. In this
study, too, the bone density was the same in smokers and
non-smokers.17

In another study by Levin and Levine on 480 young men, the
height and density of the alveolar bone at the mesial aspect of
first molars were evaluated using bitewing radiographs and
computer-dependent densitometric analyses. The results
showed a significantly lower bone height in smokers compared
to non-smokers. In addition, a lower alveolar bone density was
reported in smokers compared to non-smokers.2 In a study by
Rosa et al., too, both alveolar bone density and height were
lower in smokers compared to non-smokers.7 However, in the
present study, there was no significant difference in alveolar
bone density between smokers and non-smokers. Such a
discrepancy might be attributed to differences in measuring
tools and the type of the radiographic technique used in
different studies.

Conclusion
In general, it can be concluded from the results of the present
study and other similar studies18 that smoking is an important
risk factor for decreasing the height of the alveolar crest and
can result in tooth loss and failure of dental implants. Although
the alveolar bone density and the width of the inferior cortex
of the mandible were the same in smokers and non-smokers in
the present study, there are discrepancies between the results
of different studies and reports in relation to the decrease in
the density of the alveolar bone due to smoking, necessitating
further studies with more modern tools. Finally, it is suggested
that further cohort studies be carried out at longer time
intervals by considering other confounding factors and the
number of cigarettes smoked by subjects.

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