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EVALUATION OF BONE DENSITY USING DIFFERENT ORTHODONTIC ARCH WIRES

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ABSTRACT

Objective: The aim of the present study was to make an evaluation of the bone density in the mandible using three different orthodontic arch wire. **Subjects and methods**: Thirty orthodontic patients both males and females were selected and treated by the same researcher. The patients were randomly divided equally into three groups according to the type of wire that was used and each group had 10 patients equally. **Results**: The results showed that bone density showed a decrease in premolar area of the mandible between the beginning of orthodontic treatment and the end of levelling and alignment stage. **Conclusion**: There was a decrease in tissue mineral density with using the three archwires with non-significant difference between them.

KEYWORDS: Bone density, orthodontic arch wires.

INTRODUCTION

The term density has been used in a variety of different meaning by various skeletal tissue investigators. To some, density is the quality of radiopaqueness of roentgenograms. A weight per volume concept is based on the fact that the x-ray absorption is proportional to the mass of calcium in that unit of bone volume. Others have used density to be weight of bone per unit volume as reflected by the external envelope of the organ bone. Density has been used as an expression of specific gravity of bone tissue. Lastly, density has been used to describe the relative amount of marrow spaces present in a unit of bone tissue(1).

Knowledge of bone density in the maxillofacial region has numerous advantages for dental research and clinical practice. Muscle loading forces influence bone formation as well as bone density. The knowledge of three-dimensional distribution of bone density would permit a more comprehensive assessment of the intricate relationship between adaptive deformation of the skeleton and its biomechanical environment. An increase in the bone density on the skeletal surface indicates active addition of mineral. Changes in its distribution during growth could reveal the growth sites. Measurement of these properties would be useful for planning sites for implant placement and determination of bone healing in dental implantalogy, as well as evaluation of orthodontic tooth movement(2).

Linkow LI, Chercheve R (1970) classified bone density into three categories namely Class I, Class II and Class III bone structure. Class I bone structure is the ideal bone type consisting of evenly

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spaced trabeculas with small cancellated spaces. Class II bone structure is the bone that has slightly larger cancellated spaces with less uniformity of the osseous pattern. Class III bone structure has large marrow filled spaces existing between trabeculas. Consequently, this study aimed to evaluate the bone density of the mandible using different orthodontic arch wires[(3)].

SUBJECTS AND METHODS

Thirty orthodontic patients both males and females were selected and treated by the same researcher. The patients were randomly divided equally into three groups according to the type of wire that was used, so Group A,B and C will be used. Group A, this group included 10 patients treated with (CNA) wire. Group B, this group included 10 patients treated with (Cu NITI) wire. Group C, this group included 10 patients treated with (NITI) wire. Eligible patients got selected according to the following inclusion and exclusion criteria. The inclusion criteria included age ranged from 14 to 20 years, good oral and general health with absence of any nutritional problems, no systemic diseases or chronic illness that might affect normal growth, absence of any growth abnormality and bone metabolic disorders, the patient should have a permanent dentition, and the patients should have no systemic or genetic disease that could interfere with orthodontic treatment.

While the exclusion criteria include, patients with retained deciduous teeth, uncooperative patients who don‘t follow the operator‘s instructions, and patients who had a systemic diseases or chronic illness that might affect normal growth.

All patients were subjected to extra oral and intra oral clinical examination and the relevant clinical data were in the patient examination form. Diagnostic records included standard records, such as orthodontic study models, intra and extra oral photography, panorama and lateral cephalometric radiographs. The records were taken before and after the treatment except the intra and extra oral photographs, they were taken before, during and after the treatment. A CBCT of the mandible taken before orthodontic treatment and after completing the aligning of the teeth of the lower arch.

Bonding procedure included some steps. All teeth were cleaned with water and fluoride-free pumice for at least 30 s and then dried with an oil-free air syringe. The enamel was then etched for 30 s with 37% orthophosphoric acid, and the Primer was applied with a small brush and spread with oil-free compressed air. The composite was applied on the bracket base, and the attachment was positioned on the tooth surface. Composite excess was removed with a probe before polymerization. The composite was polymerized with a LED lamp for 80 s per bracket (20 s for side: mesial, distal, occlusal and gingival)[(4)].

The loading of wires done as it mentioned before, every group had its wire, as a sequences of 0.014”, 0.016”, 0.018” and 0.016*0.022”.

Each CBCT scan was assessed separately by inserting their DICOM files (Digital Imaging and Communication in Medicine) into Invivo dental software version 5.2 (Anatomage Inc., San Jose, CA) to perform the study measurements. Density was measured for each patient using HU unit module on Invivo software by drawing a polygon with fixed dimension covering the interdental bone between first and second premolar as it shown in figure 1.

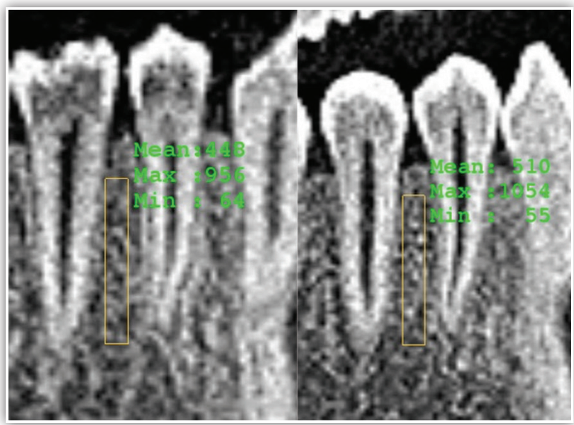

FIG (1) Measuring bone density.

RESULTS

Data entry, processing and statistical analysis was carried out using MedCalc ver. 18.2.1 (MedCalc, Ostend, Belgium). Tests of significance (Student‘s t, Chi square, factorial and repeated measures ANOVA) were used. Data were presented and suitable analysis was done according to the type of data (parametric and non-parametric) obtained for each variable. P-values less than 0.05 (5%) was considered to be statistically significant.

Descriptive statistics included:

- Mean, Standard deviation (± SD) and range for parametric numerical data, while Median and Inter-quartile range (IQR) for non-parametric numerical data.
- Frequency and percentage of non-numerical data.

Analytical statistics:

- Student's t test was used to assess the statistical significance of the difference between two study group means.
- Paired Student's t test was used to assess the statistical significance of the difference between two (paired) study group means.
- Repeated measures and factorial ANOVA tests was used to assess the statistical significance of the difference between more than two (paired) study group means; with the ability to insert grouping factors, which was used to generate clustered multiple variable graphs.
- Chi-Square test was used to examine the relationship between two qualitative variables.

TABLE (1) Socio-demographic data among 30 patients seeking orthodontic treatment:

Variables		Frequency (%)
Age (years)		17.2 ± 1.76*
Gender	Female	19 (63.3%)
	Male	11 (36.7%)

** Mean ± SD.*

TABLE (2): Comparison between the 3 groups as regards socio-demographic data using ANOVA and Chi square tests.

Variable		CNA group (10)	Cu NITI group (10)	NITI group (10)	ANOVA test
		Mean ±SD	Mean ±SD	Mean ±SD	P value
Age (years)		17.6 ± 1.6	16.8 ± 2.1	17.4 ± 1.5	= 0.588
Variable		CNA group (10)	Cu NITI group (10)	NITI group (10)	Chi square test
					P value
Gender	Female	6 (60%)	6 (60%)	7 (70%)	= 0.8663
	Male	4 (40%)	4 (40%)	3 (30%)	

*ANOVA: analysis of variance. * Percentage of Column Total.*

TABLE (3): Comparison between the 3 groups as regards pre-treatment data using ANOVA test.

Variable	CNA group (10)	Cu NITI group (10)	NITI group (10)	ANOVA test
	Mean ± SD	Mean ± SD	Mean ± SD	P value
TMD at Premolar area (mg/cm^3)	592.5 ± 184.9	508.3 ± 203	551.9 ± 241.2	= 0.675

TMD: tissue mineral density.

TABLE (4): Comparison between the 4 groups as regards post-treatment data using ANOVA test.

Variable	CNA group (10)	Cu NITI group (10)	NITI group (10)	ANOVA test
	Mean ± SD	Mean ± SD	Mean ± SD	P value
TMD at Premolar area (mg/cm^3)	479.5 ± 192.5	403.8 ± 71.87	489.6 ± 238.8	= 0.523

TMD: tissue mineral density.

DISCUSSION

In this study it's aimed to evaluate the changes of bone density that it may happen in the premolar area of the mandible. Orthodontic treatment has been a popular oral rehabilitation approach for several decades. Orthodontists correct irregularities of the teeth themselves or the relation between the teeth and surrounding anatomy in order to correct malocclusion problems or for aesthetic reasons. In general, orthodontists can straighten the teeth or otherwise move them into better positions within several months to years, which is readily observable externally. In contrast, changes in density of the alveolar bone around teeth during orthodontic treatment are difficult to observe and measure[5].

Some researches have indicated that the alveolar bone fraction and tissue mineral density are reduced after orthodontic treatment in rat models. The main reason was the newer bone induced by the application of orthodontic forces having lower mineralization and being less dense than older bone. However, all of these studies were based on animal experiments. Some researchers have created three-dimensional finite element models of the teeth and jawbone to study the response of the alveolar bone to orthodontic forces. However, it is difficult to simulate the time-dependent effects such as bone density changes after several months of orthodontic treatment in the finite element method. Thus, few finite element researches have investigated bone density change during orthodontic treatment[5-15].

Many orthodontists have confused the terms of "modelling" and "remodelling" in recent decades. According to the definitions of Frost et al., "modelling" is the sculpting mechanism that uses the raw material of bone growth to shape structures, whereas "remodelling" is the mechanism involving the lifelong skeletal turnover and maintenance. Basically, tooth movements resulting from orthodontic forces provide a mechanical stimulus to biological responses, and the transformation involves both bone modelling and remodeling[16].

In the present study, it found that bone density showed a decrease in premolar area of the mandible between the beginning of orthodontic treatment and the end of levelling and alignment stage, this come in agreement with Yu et al. as they perform a study to assess the bone density changes around the teeth before, during, and after orthodontic treatment, they found that comparing the difference between T0 and T1—a 7-month period of active orthodontic treatment—revealed 23.36% reduction in bone density around the teeth, whereas the difference between T1 and T2 (after the retention period) showed a 31.81% increase in bone density. In addition Comparing the difference between T0 and T2 (before and after orthodontic treatment) confirmed that the bone density around the teeth remained mostly constant (0.75% mean reduction). However, the bone density around ~11% of the teeth in this region failed to recover to only 80% of its original state. [17].

Abdolaziz et al. Has performed a study to assess changes of alveolar trabeculation in children, young adults and adults of the two genders. They found that, trabecular structure of mandibular interdental areas became denser in children after fixed orthodontic treatment. In contrast, the trabeculation became sparser in young adults after treatment. Changes in trabeculation in young adults were more prominent than in children. Therefore, orthodontists should be cautious when treating young adults and adults, especially in those who already have background osseous problems. The difference in the results between the two studies may back to the difference in the age, study design and methodology[18].

María et al performed a systematic review and meta-analysis to assess changes in alveolar bone thickness around the incisors of extraction patients measured with CBCT. Despite the methodological variations between the studies reviewed, it may be stated that a significant increase in alveolar bone thickness occurs in the cervical third on the labial side of the central incisor after orthodontic treatment involving extractions. On the palatal side, the findings vary. These changes may be influenced by factors such as incisor position and inclination before and after treatment, the technique and mechanics employed, the timing of the final CBCT scan, and the bone's capacity for remodelling during en-masse retraction of the incisors. Some of these results come in disagreement with the present study, the difference may come back some major differences in the study design and methodology[19].

CONCLUSION

There was a decrease in bone density with using the three archwires with non-significant difference between them.

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