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ORIGINAL ARTICLE

Interdental alveolar bone density in bruxers, mild bruxers, and non-bruxers affected by orthodontia and impaction as influencing factors.

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Abstract: Aim: To assess the interdental alveolar bone density within specific regions of interest in the mandible of bruxers, mild bruxers and non-bruxers in absence or presence of influencing factors, such as orthodontia and impaction. Materials and methods: The study consisted of 104 subjects (64 bruxers and 40 controls) from the female students in the Faculty of Dentistry. Students were classified into bruxers, non-bruxers, and mild bruxers. The presence of modifying factors, such as impacted mandibular third molars and/or current or recent orthodontic treatment were identified. Panoramic radiographs were obtained, and the mean bone density values of interdental alveolar bone were measured using ImageJ software. Results: Non-bruxers had the highest mean bone density in all measured regions. The mesial aspect of the second premolar was an area of higher mean bone density in bruxers and in mild bruxers, compared to non-bruxers. In the presence of orthodontic treatment, the mean bone density in non-bruxers surpassed that of bruxers and mild bruxers. Conclusion: Bruxism, whether mild or severe decreased the interdental mean bone density in the studied regions of interest. The presence of influencing factors affected the interdental mean bone density.

Keywords: *Bruxism, Bone density, Orthodontic treatment, Tooth impaction, Panoramic radiography.*

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INTRODUCTION.

Radiographic images reflects the dynamics of bone, where bone densities varies indicating adaptation to functional demands such as masticatory loads on natural teeth. Accordingly, increase or decrease in trabecular bone density is associated with the functional demands of each region[1]. The number, density, and alignment of cancellous trabeculae are influenced by forces exerted on teeth, where it is speculated that excessive occlusal forces may increase alveolar bone density[2].

Bruxism is defined as an oral habit consisting of grinding of teeth and associated with nonfunctional gnashing or clenching of teeth in other than chewing movements leading to occlusal trauma[3]. Bruxism can be mild, presented with less sign and symptoms, or it can be frequent and violent with more dysfunctional signs and symptoms to the masticatory system[4].

Bone adapts to loads exerted upon it, leading to change in its internal material properties and external geometry, via a biological process called bone remodeling[5].

Bone resorption occurs when the mechanical loading is below a lower threshold. When the load attains an upper threshold values, bone apposition will take place. If the loading stimulus is between the upper and lower threshold values, remodeling will not occur. Moreover, where mechanical loading increases excessively resorption may

occur with bone loss[6].

Moreover, orthodontic movements cause altering of the blood flow, this alteration generates a cascade of biochemical and celluar reaction that affects mineralized (alveolar bone) and nonmineralized (periodontiunm)[7].However, there have been no studies of the effect of an impacted mandibular third molar on surrounding bone density.

Horner and Devlin[8] investigated the potential of dental panoramic tomography for densitometric evaluation of the bone mineral content of the mandible, using a nickel stepwedge attached to the cassette to provide a reference image. This previous study demonstrated that the dental panoramic tomogram could be used to provide a quantitative measure of mandibular bone mineral content *in vitro*.

Accordingly, the aim of this study was to assess the interdental alveolar bone density within specific regions of interest in the mandible in bruxers, mild bruxers and non-bruxers in absence or presence of influencing factors, such as orthodontia and impaction.

MATERIALS AND METHODS.

The research project has been approved by the Ethics Committee of the Riyadh Colleges of Dentistry and Pharmacy within which the work was undertaken and that it conforms to the provisions of the Declaration of Helsinki.

Our study population consisted of 104 female dental students (64 bruxers and 40 controls) from Faculty of Dentistry. Each subject was counted as 2 indicating the right and left sides and forming 208 units. Female students were selected to prevent skewing of measurements due to sex-related differences. The students who volunteered for the study ranged in age from 18 to 25 years. After we obtained written consent, students were asked if they were bruxers or not.

A clinical examination of their dentition, especially canines and incisors, was then performed to look for signs of wearing; flat canines were an immediate red flag for tooth grinding. Furthermore, the excessive motions associated with bruxing first appear in the incisal anatomy. Thus, the largest loss of substance and the greatest amount of shape loss caused by bruxism can be seen in the anterior teeth[9,10]. If wearing was detected on the canine and the anterior teeth, the subject was defined as a bruxer (group B). Those who were self-designated as bruxers but showed no signs of wearing, were re-designated as mild bruxers (group MB). Finally, the non-bruxer (NB) or control group comprised those who were self-designated as NBs and showed no signs of wearing on their anterior teeth.

Modifying factors were considered if the student had impacted mandibular third molar(s) or was undergoing or had previously undergone orthodontic treatment, which may affect bone density (BD). Students were excluded from the study if they had more than 2 missing teeth in each quadrant (*i.e.*, the third molar and another tooth); had an interdental lesion; or were suffering from any endocrine or metabolic disease or receiving any medication that may affect bone remodeling.

Most of participating students welcomed to perform panoramic radiographs were these can be utilized afterwards as a reference for managing any evolving dental complaints. The panoramic machine used was orthopantomographic scanner (Orthophos XG, Sirona Dental Systems, Bensheim, Germany). We used an aluminum step wedge composed of 9 steps, with increasing thicknesses of 1mm., 11 where comparison between obtained measurements and densitometric readings from the aluminum plate using proportioning was performed, hence, it was possible to obtain a BD value for each patient. The machine was operated at 64kVp (kilovoltage peak), for all students who had nearly similar body stature, with a constant current of 10 mA and an exposure time of 19 seconds.

We used ImageJ software 1.74 v (National Institutes of Health, Bethesda, USA) to measure the mean bone density (MBD) values of the interdental alveolar bone in the following regions of interest (ROIs): the mesial of the second premolar (2nd pre-M); the mesial of the first molar (1st

MM); the first molar furcation area (1st M fur); the mesial of the second molar (2nd MM); the distal of the second molar in absence of an impacted third molar (2nd MD); the third molar mesial (3rd MM); and the third molar distal (3rd MD), from the alveolar crest to the level of the apices, excluding the crestal bone and the lamina dura (Fig. 1). Only these areas were selected to avoid superimpositions of the chin rest, airway, and bony shadows during densitometry.

It is important to note that the distal surface of the second molar was excluded when we studied the effect of impaction on BD, as we relied upon the mesial and distal of surfaces of the third molar. In the case of orthodontia, the distal surface of the second molar was considered, in addition to the mesial and distal surfaces of the third molar, if an erupted third molar was present.

Data were analyzed using SPSS v.20 (SPSS Inc, Chicago, USA), where analysis of variance (ANOVA) and Tukey's honestly significant difference (HSD) tests were used. To determine the inter-observer reliability, 6 cases were repeated by the first author (SS) and third author (HK) where intra-class reliability coefficient was calculated using two way mixed effect.

RESULTS.

Intra-class reliability coefficient showed high degree of reliability (0.98). According to the clinical examinations, the total number of examined cases when considering both sides for B group was 128 distributed as follows: 94 B and 34 MB, while the NB group constituted 80 cases, when considering both sides. All 3 groups were further classified according to the presence or absence of influencing factors. (Table 1).

Figure 1. The measured bone density (BD) of regions of interest (ROIs) including, the mesial of the second premolar (2nd pre-M); the mesial of the first molar (1st MM); the first molar furcation area (1st M fur); the mesial of the second molar (2nd MM); the distal of the second molar in absence of an impacted third molar (2nd MD); the third molar mesial (3rd MM); and the third molar distal (3rd MD). Tracing is done from the alveolar crest to the level of the apices, excluding the crestal bone and the lamina dura.

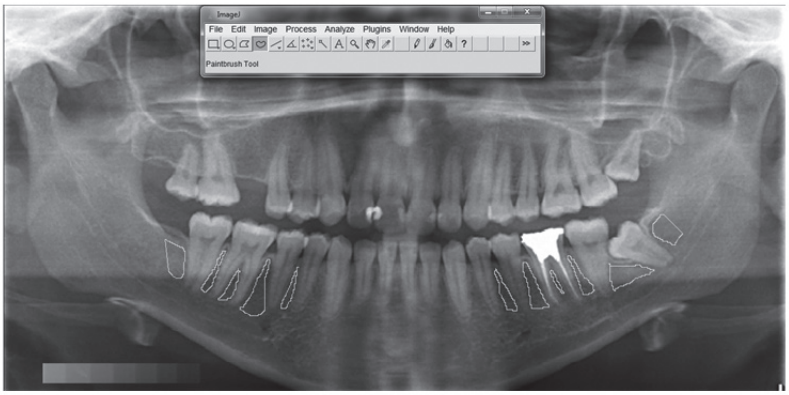
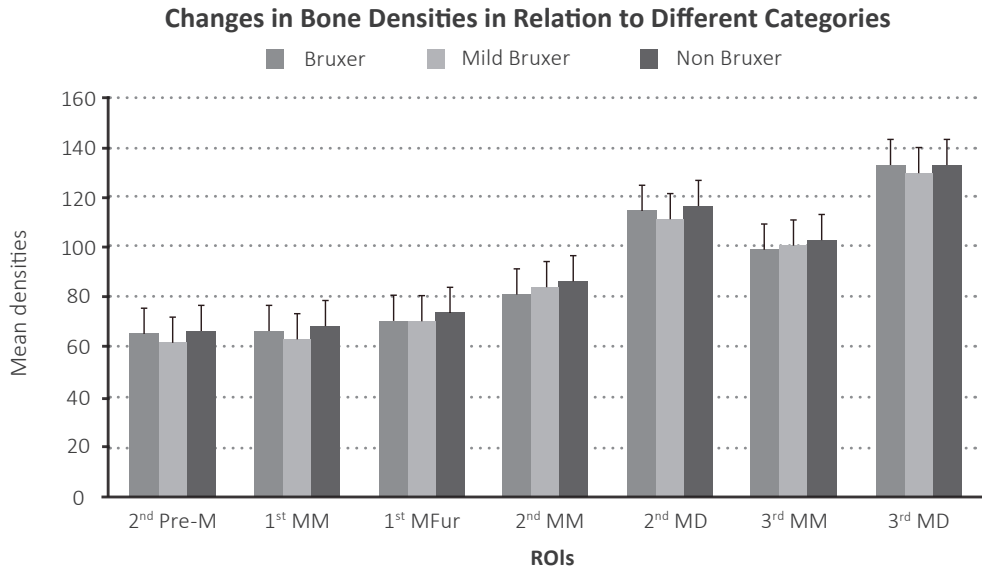


Table 1. Number of students in 3 categories (B= Bruxer, MB= Mild Bruxer, NB= Non Bruxer) with percentage in relation to influencing factors.

		Influencing Factors								Total	
		None		Orthodontia		Impaction		Orthodontia/ Impaction			
		(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Bruxism	B	17	26.9	34	59.6	13	38.2	30	55.5	94	45.2
	MB	15	23.8	8	14.1	5	14.7	6	11.2	34	16.3
	NB	31	49.3	15	26.3	16	47.1	18	33.3	80	38.4
Total		63	100%	57	100%	34	100%	54	100%	208	100%

Regardless of the presence or the absence of any influencing factors, the NBs had the highest MBD in all measured regions followed by the B group and finally the MB group. Nevertheless, the MB group showed higher MBD than B group in 2nd MM, (84±2.6) and (81.2±1.5) respectively; as well as the 3rd MM area (101.2±4.3) and (99.1±2.2) respectively. A significant difference was found in MBD between the NB group (68.7±1.5) and the MB group (63.3±1.7) in the 1st MM region, p=.049 (Fig. 2).

Figure 2. Changes in mean bone densities (MBD) according to whether subjects were bruxers (B), mild bruxers (MB), or non-bruxers (NB) in relation to different measured regions of interest (ROIs), and regardless of the presence or the absence of any influencing factors. The NB group had the highest MBD in nearly all measured regions followed by the B group and finally the MB group. Exceptions were found in the MB group showing higher MBD than B group in the 2nd MM area as well as the 3rd MM area. A significant difference was found in MBD between the NB group and the MB group in the 1st MM region (p=0.049).

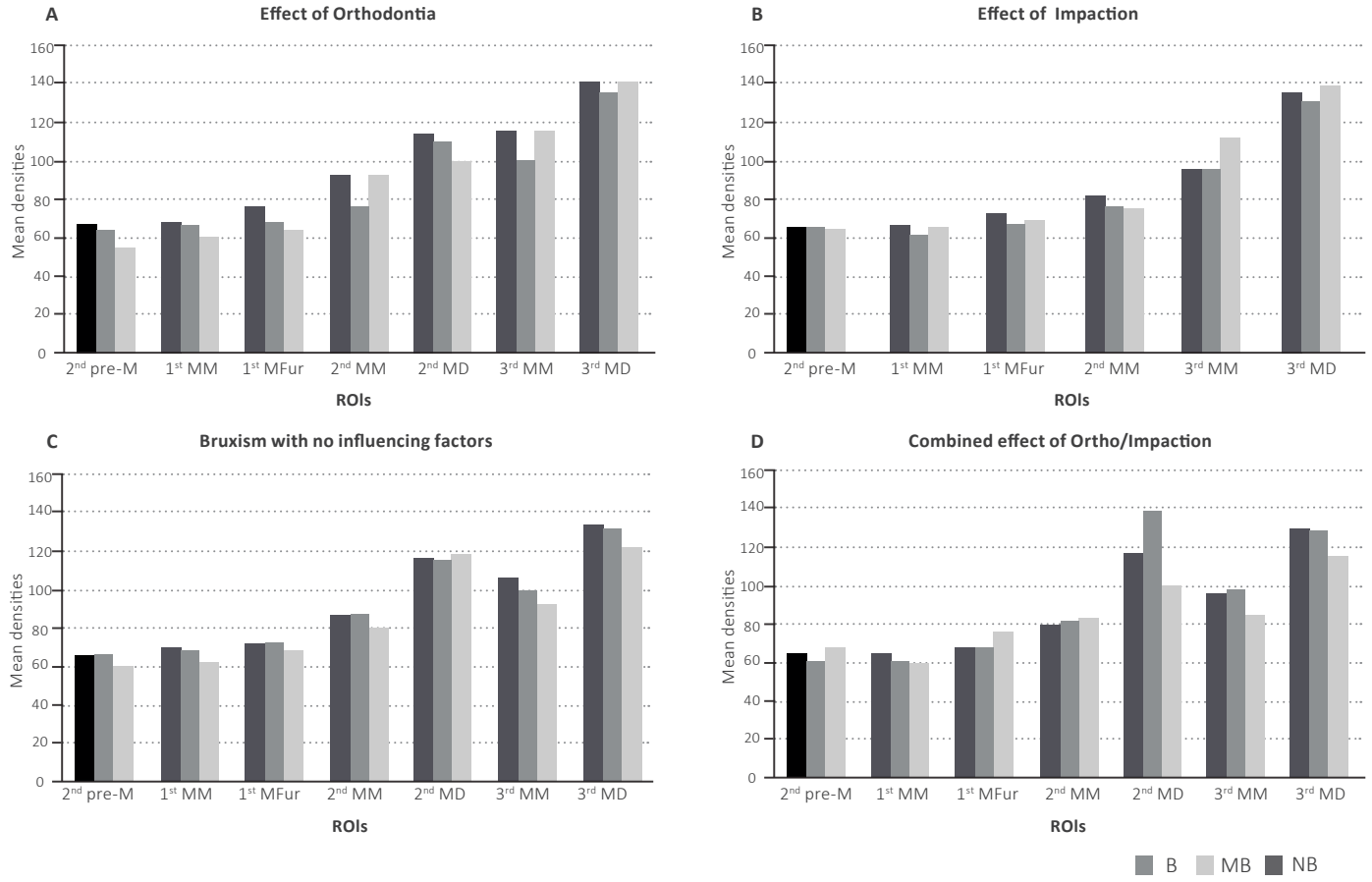


When comparing the MBD between patients without influencing factors and those undergoing orthodontic treatment, we found that in NB group, orthodontic treatment increased the MBD in 2nd Pre-M (67.1±15.1),1st MM (68.9±12.5) and 1st Fur M (77.1±12.5) In MB group, orthodontic treatment increased the MBD in the NB group in the 2nd MM (94±20.4) and the 3rd MM (118.4±17.5) and 3rd MD (143.1±4.2) areas. The B group had the least MBD among both groups. whereas significantly apparent difference was found in the 2nd MM region (p=0.04). According to Tukey (HSD) significance was found between the B group (77.2±12.2) and the MB (94±20.4), and NB (93.4±21.2) groups (Fig. 3a).

In the presence of an impacted third molar, the MBD in MB group increased in mesial and distal aspects of 3rd molar (112.2±18.9), (139.9±4.9) respectively. For the B group, the presence of impaction increased the MBD in 2nd premolar ROI (67.5±0.9), while for the NB group, the MBD increased in 1st MM (67.2±11.8), 1st Mfur (72.9±17.6), and 2nd MM (81.9±11.5). No significant difference was found between studied groups, p>.05 (Fig. 3b).

When studying the difference in MBD between NB, MB and B groups in absence or presence of influencing factors (orthodontia and impaction, either separately or combined) it was found that in case of absence of influencing factors (None), the NB group had the highest MBD in 1st MM (70.6±15.7), 3rd MM (107.5±18.3), 3rd MD (133.7±15.1) and equal MBD to B group in 2nd

Figure 3. (A) In case of orthodontia, the MBD increased in nearly all regions of interest, in the NB group, except in 2nd MM and the 3rd MM and 3rd MD areas which increased in MB group, whereas significantly apparent difference was found in the 2nd MM region between the NB and the B groups (p=.04). (B) In case of impaction, the MBD increased in NB group in nearly all regions, except for the mesial and distal aspects of 3rd molar where the MBD increased in MB. In the B group the MBD increased in relation to the mesial of 2nd premolar. (C) Lack of influencing factors, led to increase in the MBD in the NB group. (D) The combined effect of orthodontia/impaction, led to increase of the MBD in the 2nd MD or the 3rd MM in the B group.



MM (87.8±14). In the 2nd Pre-M (66. 7±13) and 1st Mfur (73.1±8.7) the B group had the highest MBD among all the groups. The MB group showed the least MBD in all ROIs, except in the 2nd MD (119.3±10.5) area, where no significant difference was found between studied groups, p>.05 (Fig. 3c).

When examining the combined effect of orthodontia and impaction, it was noted that the MBD increased in NB group in 1st MM area only (67.7±6.7), while In B group, the increased density was apparent in 2nd MD (141.5±36.3) and 3rd MM (99.7±15.1). Furthermore, equal density was found in 3rd MD in both B and NB groups (131.7±10.7), (131.7±13.6) respectively. On the other hand, the MB group showed Increased density In 2nd pre-M (69.2±5.7), 1st M fur (78.4±13.5), and 2nd MM (86.3±14.7) areas. No significant difference was found between studied groups, p>.05 (Fig. 3d).

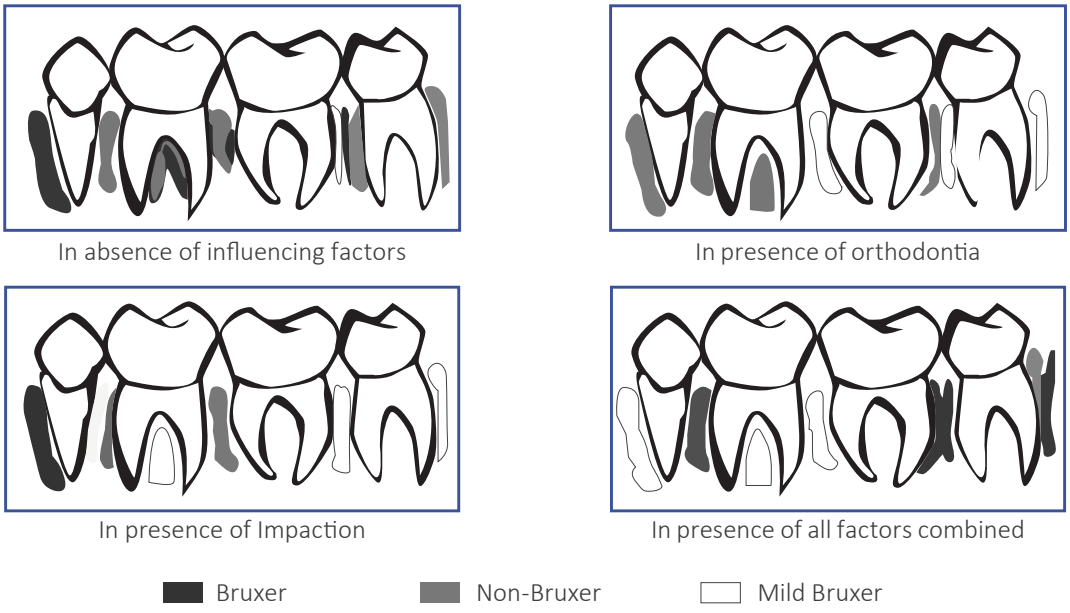
In general, bruxism, whether mild or severe, led to a decrease in the interdental MBD in the studied ROIs. The presence or absence of influencing factors affected the MBD in the studied ROIs. The 2nd Pre-M region showed higher MBD in B and MB groups compared to NB; however in the presence of orthodontic treatment, the MBD in NB surpassed that in both B and MB.

The 1st MM region showed the highest MBD in NB and wasn't influenced by B and MB, and also was not influ-

enced by any of the studied modifying factors. In the 1st MFur region, the MBD was higher in B and in MB compared to NB ; however, in the presence of orthodontia or impaction, their effect overcome the effect of bruxism , where the MBD increases in NB group.

In case of the 2nd MM region, the MBD was higher in the MB group compared to NB, while in the presence of impaction only, the MBD was highest in the NB group. The 2nd MD or the 3rd MM region showed higher MBD in MB group, while the B group revealed increase in MBD in the presence of combined orthodontia/impaction effect. The 3rd MD area, showed higher MBD in MB and B groups compared to NB group in the in the presence of orthodontia, impaction, or combined orthodontia/impaction, while absence of any of the influencing factors led to increase in the MBD in the NB group (Fig. 4).

Figure 4. Illustrative diagram demonstrating differences in interdental bone density under the influence of bruxism and other modifying factors. The 2nd Pre-M, is highly affected by parafunctional habits in favor of bone deposition that is intensified by orthodontic treatment . The 1st MM is an area with high density that resists forces caused by bruxism, orthodontic forces and impaction pressure. Also, the 2nd MM is an area similarly affected by parafunctional habits in favor of bone deposition, while the mesial and distal of 3rd molar areas are regions of stress concentration.



DISCUSSION.

Alveolar bone undergoes constant physiological alteration in response to external forces, particularly occlusal forces. It is generally agreed that the application of a certain degree of mechanical stress is necessary to maintain bone volume and structure[12]. Forces exerted on the tooth also influence the number, the density, and the alignment of cancellous trabeculae[13]. Radiographic monitoring of alveolar bone changes represents a non-invasive, painless alternative to direct bone density measurement[8]. Radiographic densitometry of the mandible had been performed in several studies using digital panoramic radiography[14,15].

To our knowledge, this is the first study to compare between mandibular MBD between B, MB, and NB groups in specific ROIs, in the absence or the presence of influencing factors, such as orthodontia, presence of an impacted 3rd molar and orthodontia and impaction combined.

In our study, we found that the greatest overall MBD was related to the NB group, this was followed by the B group and finally the MB group in nearly all ROIs regardless of the presence or absence of influencing factors.

Moreover, a significant difference was found between the NB and the MB groups in the 1st MM region, where the MBD of the NB group exceeded the MB group and dominated in this region. This finding opposes the finding of Özcan and Sabuncuoglu[2], who found that the interdental MBD decreased as the degree of occlusal wear increased, where the MBs have no wearing cusps, but showed the least MBD.

Furthermore, an earlier study[14] found that before teeth begin to exhibit wear, the forces to which they are subjected inhibit alveolar bone deposition, resulting in resorption and moderate decreases in MBD. This finding agrees with our results, where the MB group showed the least measured MBD.

When comparing between the MBDs in the B, the MB, and the NB groups in absence and presence of influencing factors, it was found that 1st MM region showed the highest MBD in NB group under all circumstances, which indicates that this particular ROIs resists bone loss and it is not affected by forces generated by bruxism. This finding correlates with the finding of Ashwinirani *et al.*[15] in their study of bone density regarding bone loss in relation to moderate and severe chronic periodontitis that bone loss is more common on the distal aspect of the first molar more than its mesial aspect. Similarly, Chugh *et al.*[16] assessed interdental MBD using computed tomography scans in the maxilla and the mandible, and they found that the inter-radicular area between second premolar and first molar at the alveolar bone level showed the highest MBD.

The 2nd Pre-M area, represented an area of high MBD in both B group and in MB group under all circumstances, except in case of orthodontia which abolished the effect of bruxism in this particular area increasing the MBD in NB group. This finding is in accordance with those of D'Apuzzo *et al.*[7], who asserted that the development of areas of pressure and tension within the alveolar bone during orthodontic treatment favors increasing MBD.

Moreover, the 1st Mfur area, increased in its MBD in NB group where B and MB groups showed the least bone densities under the separate effect of orthodontic treatment and impaction. On the contrary, absence of any influencing factors lead to similar bone densities between NB and B groups. On the other hand, the MB group had the highest effect in the presence of all factors combined. These findings indicate that the furcation area is not affected by bruxism, except in the presence of all pressurizing factors, where mild bruxism will enhance bone deposition. This finding contradicts the finding of Ahathya *et al.*[17], who mentioned that trauma from occlusion has been shown to affect bone loss in the furcation region.

Regarding the 2nd MM area, it increased in its MBD in MB group where the NB group showed the higher bone density under the effect of impaction. On the contrary, the absence of any influencing factors lead to similar bone densities between NB and B groups. This may be due to the closeness between the 2nd MM and the impacted 3rd molar, where the stresses induced by the impacted 3rd molar were sustained by NB group.

Finally, the 3rd MM and 3rd MD areas were affected by bruxism for favor of bone deposition in all circumstances except in absence of any influencing factor, where the NB group increase in their MBD. This finding agrees with the explanation of Rossi *et al.*[18], where they found in their study related to stress distribution based on photo-elastic analysis and finite element analysis that the area distal to second molar and retro-molar area are regions of stress concentration when they applied forces with increasing magnitudes on the mandibular first molar.

From these findings, we can conclude that the 1st MM is an area with high density that resists overwhelming forces caused by bruxism, orthodontic forces and impaction pressure. The 2nd Pre-M, is an area that is highly affected by parafunctional habits in favor of bone deposition, although in the presence of orthodontic treatment, forces induced overcome the pressure caused by parafunctional habits. On the other hand, 2nd MM is an area similarly affected by parafunctional habits in favor of bone deposition although the pressure caused by impacted 3rd molar vanquish that of bruxism. The mesial and distal of 3rd

molar areas are regions of stress concentration. Moreover, forces induced by MBs who do not feature any signs of enamel wearing cause decrease in bone density more than frank bruxers with obvious wearing facets.

Limitations of this study appears in the involvement of females only, where another study is required for comparison between both genders. The other considered limitation is the exact duration and onset of orthodontic treatment that may alter bone density.

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Densidad ósea alveolar interdental en bruxómanos, bruxómanos leves y no bruxómanos influenciada por ortodoncia e impactación dentaria.

Resumen: Evaluar la densidad ósea alveolar interdental en áreas de interés de la mandíbula de bruxómanos, bruxómanos leves y no bruxómanos en ausencia o presencia de factores como ortodoncia e impactación dentaria. Material y métodos: El estudio consistió de 104 (64 bruxómanos y 40 controles) estudiantes de odontología. Los estudiantes fueron clasificados en bruxómanos, bruxómanos leves y no bruxómanos. Se identificó la presencia de factores modificadores: terceros molares mandibulares y/o tratamiento de ortodoncia actual o reciente. Se obtuvieron radiografías panorámicas, y los valores medios de densidad ósea del hueso alveolar interdental se midieron utilizando el software ImageJ. Resultados: Los no bruxómanos tuvieron la mayor densidad ósea media en todas las áreas de interés. La cara mesial del segundo premolar fue un área de mayor densidad ósea media en bruxómanos y en bruxómanos leves, en comparación con los no bruxómanos. En presencia de un tratamiento de ortodoncia, la densidad ósea media en los no bruxómanos superó a la de bruxómanos y bruxómanos leves. Conclusión: El bruxismo, ya sea leve o grave, disminuye la densidad ósea interdental promedio en las regiones de interés estudiadas. La presencia ortodoncia e impactación dentaria influye en la densidad ósea interdental promedio.

Palabras clave: *Bruxismo, Densidad ósea, Tratamiento de ortodoncia, Impactación dentaria, Radiografía panorámica.*

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