Research Article / Araştırma Makalesi

Evaluation of Hounsfield Unit Value and Radiomorpometric Indexs in Panoramic Radiographs of Patients with Bruxism

Bruksizmli Hastaların Radyograflarında Hounsfield Birim Değeri ve Radyomorfometrik İndekslerinin Değerlendirilmesi

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Abstract

Background: The aim of this retrospective study is to evaluate the effects of bruxism on the mandibular bone using radiomorphometric indices and Hounsfield unit (HU) value on digital panoramic radiography (DPR).
Materials and Methods: Panoramic radiographs of 120 patients, 60 with bruxer and 60 without (control), were analyzed. Mental index (MI), panoramic mandibular index (PMI), antegonial index (AI), gonial index (GI), antegonial notch depth (AND) and mandibular cortical index (MCI) were measured bilaterally in DPR. Gray values of the cancellous bone and cortical bone at predetermined landmarks in the mandible were measured using the HU value on the DPR.
Results: MI was found to be higher and statistically significant in bruxers compared to the control group ($p<0.05$). There was no statistically significant difference between the bruxism group and the control group in terms of AI, GI and MCI ($p>0.05$). While there was a significant difference in HU value in the cancellous bone in the bruxism group and the control group ($p<0.05$), there was no statistically significant difference in HU values between the two groups in the cortical bone ($p>0.05$).
Conclusions: MI and AND measurements can be used in the diagnosis or follow-up of bruxism. There is no difference in mandibular cortical bone height in patients with and without bruxism according to AI, GI, and MCI. The mean PMI value measured on the left side differs between the groups. In bruxism patients, increased density in the mandibular cancellous bone, is greater and significantly different from the increase in cortical bone.

Key Words: Panoramic radiography, Bruxism, Radiomorphometric indices, Hounsfield unit

Öz

Amaç: Bu retrospektif çalışmanın amacı bruksizmin, mandibular kortikal kemik üzerindeki etkisini dijital panoramik radyografi (DPR) üzerinde radyomorfometrik indeksler kullanarak ve mandibular kemik yoğunluğundaki farkı DPR'de HU değerini ölçerek değerlendirmektir.
Materyal ve Metod: 60 brukser ve 60 kontrol olmak üzere toplam 120 hastaya ait panoramik radyografi analiz edildi. Mental İndeks (Mİ), Panoramik İndeks (PMİ), Antegonial İndeks(Aİ), Antegonial Notch Derinliği (AND) ve Mandibular Kortikal İndeks (MKİ) DPR'de iki taraflı ölçüldü. Mandibulada önceden belirlenmiş işaret noktalarında spongioz kemik ve kortikal kemiğin gri değerleri DPR üzerinde HU değeri kullanılarak ölçülmüştür.
Bulgular: Brukserlerde MI, kontrol grubuna göre daha yüksek ve istatistiksel olarak anlamlı bulunmuştur ($p<0.05$). Sol tarafta PMI, bruksizm grubunda kontrol grubuna göre daha yüksek iken sağ tarafta istatistiksel olarak anlamlı fark görülmemiştir($p>0.05$). Aİ, Gİ ve MKİ açısından bruksizm grubu ve kontrol grubu arasında istatistiksel olarak anlamlı fark bulunmamıştır($p>0.05$). AND, bruksizm grubunda kontrol grubuna göre daha yüksektir ve istatistiksel olarak anlamlı bir fark göstermektedir ($p<0.05$). Spongioz kemikte bruksizm grubu ve kontrol grubunda HU değeri açısından anlamlı bir fark izlenirken ($p<0.05$), kortikal kemikte iki grup arasında HU değerleri istatistiksel olarak anlamlı bir fark oluşturmamaktadır ($p>0.05$)
Sonuç: MI ve AND ölçümleri, bruksizm tanısında veya takibinde kullanılabilir. AI, GI ve MCI'ye göre bruksizm olan ve olmayan hastalarda mandibular kortikal kemik yüksekliğinde fark yoktur. Sol tarafta ölçülen ortalama PMI değeri gruplar arası fark göstermektedir. Bruksizmde, mandibular spongioz kemikteki yoğunluk artışı, kortikal kemikteki artışa oranla daha fazla ve önemli ölçüde farklıdır.

Anahtar Kelimeler: Panoramik radyografi, Bruksizm, Radyomorfometrik indeksler, Hounsfield birimi

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Received / Geliş tarihi: 04.07.2023

Accepted / Kabul tarihi: 10.08.2023

DOI: 10.35440/hutfd.1320900

Introduction

The most frequently observed parafunctional (non-functional) movements are teeth clenching and grinding, which are called bruxism (1). Bruxism is included under the title of sleep-related movement disorders in the International Classification of Sleep Disorders (ICSD), and according to this classification, A+B criteria are required for its diagnosis (2).

A. Regular or frequent grinding noises during sleep

B. Presence of at least one of the following clinical findings

1. Presence of signs of wear on the teeth consistent with the above symptom

2. Pain or fatigue in the jaw in the morning and/or temporal headache and/or locking of the jaw

Although it is known that bruxism is affected by various factors, its ethiology is not fully understood. However, emotional stress may be associated with the use of selective serotonin reuptake inhibitors (SSRIs), excessive alcohol and caffeine consumption (3).

Bruxism is basically divided into primary and secondary. While primary (essential) bruxism is not associated with a sociopsychological or medical problem, secondary bruxism includes an underlying disease, used medicinal products (antipsychotics, cardioactive drugs) and drugs (amphetamine, ecstasy, cocaine) (1, 3). We can also classify bruxism as diurnal (occurring during the day) and nocturnal (occurring during sleep).

In dentistry, dental panoramic radiographs (DPR) are mostly used to examine the jaw bones. With DPR, bone morphology can be examined and values such as mental index (MI), panoramic mandibular index (PMI), ante gonial index (AI), gonial index (GI), ante gonial notch depth (AND) and mandibular cortical index (MCI) can be calculated. In addition, the density and quality of the bone can be measured with DPR.

The Hounsfield unit (HU) value allows numerical evaluation of bone mineral density. These values are proportional to the degree of attenuation/absorption of the X-ray beam by the tissue. Dense tissues with higher X-ray absorption appear bright and have a high HU value. Less dense tissues have less X-ray absorption, appear darker and have a lower HU value (4, 5). The HU value, which is frequently used in the evaluation of mineral density in computer tomography (CT) and cone-beam computed tomography (CBCT) images, has not been widely used in DPRs.

Radiographic evaluation of bone mineral density and bone height is important in dental treatment planning in patients with bruxism (6). The aim of this study is to evaluate the changes in the jaw bones of bruxers exposed to long-term, strong bite forces using radiomorphometric indices and HU.

Materials and Methods

Our research was carried out with the approval of Harran University Clinical Research Ethics Committee dated 12.12.2022 and numbered HRÜ/22.24.05. Patient registration forms of patients who applied to Harran University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology in 2022 for various reasons were scanned. DPRs of patients who were found to have bruxism in patient registration forms were retrospectively analysed. Patients with disease or fracture in the mandibular ramus region, images containing distortion, magnification and artifacts, syndromic patients, patients having any tooth missing and images with low diagnostic quality were excluded from the study. Panoramic views of 60 patients with bruxism were included in the study. As the control group, 60 patients of similar age group without bruxism were selected. A total of 120 radiographs (60 bruxer, 60 non-bruxer) were included in the study.

DPRs of all patients were obtained with the same X-ray device; It was taken at 70 kVp, 10 mA and 32 seconds exposure time, according to the manufacturer's recommendations. In order to avoid positioning errors as much as possible, image acquisition and calibration was performed by a single technician, and quality images were tried to be obtained by adapting to the reference points determined by the manufacturer on the device. MCI, MI, PMI, AI, AND and GI were used for qualitative and quantitative evaluation of bone.

In MCI, the lower mandibular cortex is classified as follows: C1 (Fig. 1), the endosteal edge of the cortex is straight and sharp on both sides (normal cortex); C2 , there are semilunar defects (lacunar resorption) at the endosteal rim and/or endosteal cortical remnants are present on one or both sides; There are C3 ,heavy endosteal cortical residues and porosity in the cortical layer (7).

MI (Fig. 2), a measure of cortical width, is calculated in the mental foramen region as follows, according to Ledgerton et al.(8) : After the mental foramen is determined, it is measured with a line perpendicular to the tangent of the lower border of the mandible. The mean bilateral cortical width is determined. PMI (Fig. 2) is determined by dividing the width of the mandibular cortex by the distance between the lower border of the mental foramen and the lower mandibular cortex (7).

AI (Fig. 3) is found by measuring the cortical bone thickness of the mandibular base in the region where the line extending from the anterior border of the ascending ramus to the lower border of the mandible passes (7). AI (Fig. 3) is found by measuring the cortical bone thickness of the mandibular base in the region where the line extending from the anterior border of the ascending ramus to the lower border of the mandible passes (7).

As for AND (Fig. 4), it is the vertical distance between the mandibular plane and the deepest point of the concavity on the lower border of the mandible. The GI (Fig. 4) corresponds to the cortical thickness at the gonial angle, as measured by bisecting the angle between another line tangential to the posterior border of the ramus and tangent to the inferior border of the mandible is the vertical distance between the deepest points of the concavity (8).

The GI (Fig. 4) corresponds to the cortical thickness at the gonial angle, as measured by bisecting the angle between another line tangential to the posterior border of the ramus and tangent to the inferior border of the mandible (8).

The measurement of HU (Fig. 5) was performed using an average gray level value that quantitatively indicates the density of the region of interest. Hu values were examined in cancellous and cortical bone by selecting the region least affected by superposition, magnification and distortion in DPRs. These values allow a relative assessment of bone density.

Figure 1. Example of mandibular cortical index to category C1

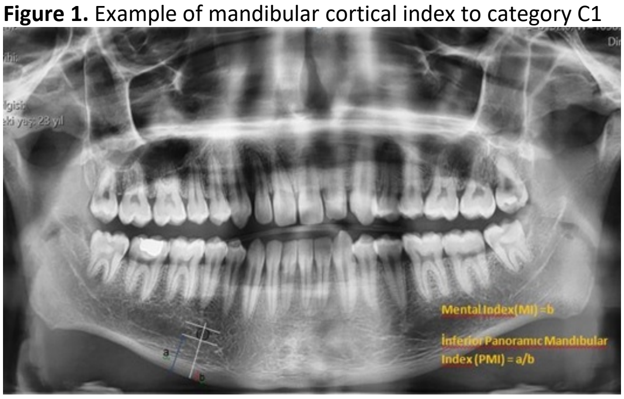

Figure 2. Panoramic radiograph showing inferior panoramic mandibular index (a/b) and mental index (b) measurements

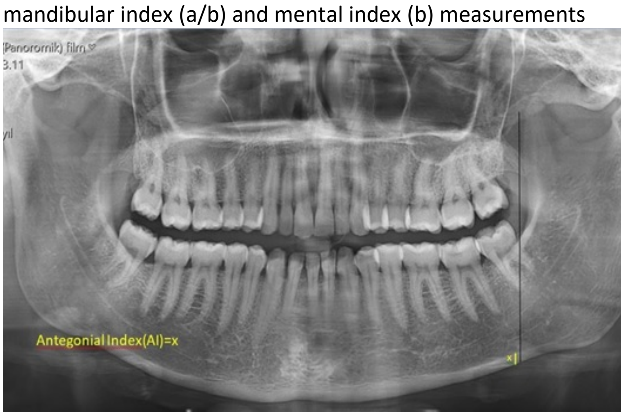

Figure 3. Panoramic radiograph showing Antegonial Index (x) measurements

Figure 4. Panoramic radiograph showing gonial index (y) and antegonial notch depth (z) measurements

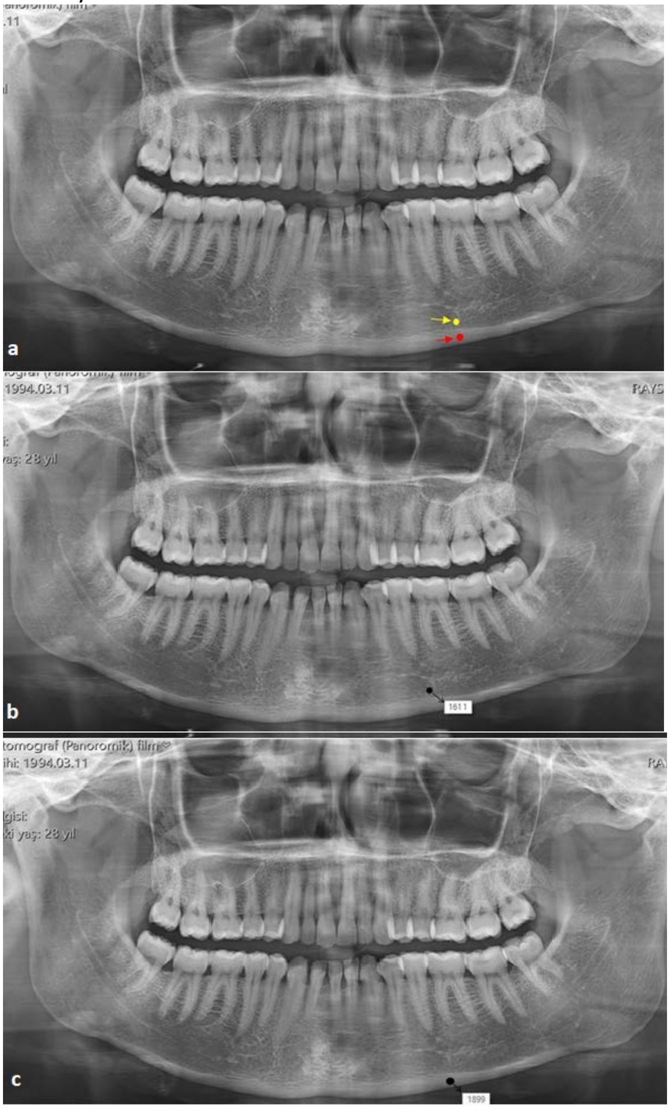

Figure 5. (a) Selection of region of interest for cortical bone (red arrow) and cancellous bone (yellow arrow), (b) first area selected with a mean of 1611 HU, (c) second field selected with an average of 1899 HU

Results

A total of 120 patients (mean age 31.20±7.92), 60 with bruxism (mean age: 33.27 ± 8.39), 60 without bruxism (mean age: 29.13±6.89 years) were included in this study. Of these patients, 60 were male (mean age: 32.57 ± 8.38) and 60 were female (mean age: 29.83±7.25).

Descriptive statistics for MI, PMI, AI, GI, and AND are shown in Table 1. After radiomorphometric indices, MI on the right and left sides was higher in the bruxism group than in the control group ($p<0.05$). PMI on the right side does not show a statistically significant difference between bruxism patients and control group patients ($p>0.05$). PMI on the left side was higher in the bruxismgroup than in the control group ($p<0.05$). There is no statistically significant difference between AI and GI measured on the right and left sides between bruxism patients and control group patients ($p>0.05$). The AND on the right and left sides are higher in the bruxism group than in the control group and show a statistically significant difference ($p<0.05$)

There was no statistically significant difference in terms of MCI in the right ($p=0.547$) and left-hand sides ($p=0.532$) in the bruxism and control groups ($p>0.05$) (Table 2).

While there was a significant difference in HU value in the cancellous bone in the bruxism group and the control group ($p<0.05$), there was no statistically significant difference in HU values between the two groups in cortical bone ($p>0.05$) (Table 3).

Table 1. Descriptive statistics of MI, PMI, AI, GI and AND measurements in bruxism and healthy control patient groups.

	Patient group	Mean±Std. Deviation	P value
MI right	Bruxism	4,4617±0,77330	0,010 *
	Control	4,1083±0,70092	0,010 *
MI left	Bruxism	4,6533±0,71532	0,004 *
	Control	4,2767±0,69681	0,004 *
PMI right	Bruxism	0,4223±0,07639	0,116
	Control	0,3998±0,07927	0,116
PMI left	Bruxism	0,4490±0,07192	0,001 *
	Control	0,4013±0,07418	0,001 *
AI right	Bruxism	2,8617±0,35706	0,679
	Control	2,8300±0,47023	0,679
AI left	Bruxism	2,9683±0,53851	0,506
	Control	2,9067±0,47295	0,506
GI right	Bruxism	1,3200±0,33436	0,383
	Control	1,2700±0,28895	0,383
GI left	Bruxism	1,4367±0,40796	0,558
	Control	1,4000±0,26038	0,559
AND right	Bruxism	2,1750±0,73729	0,000 *
	Control	1,0017±0,53946	0,000 *
AND left	Bruxism	2,0550±0,75339	0,000 *
	Control	1,0102±0,64184	0,000 *

Cortical width in the mental foramen (MI), panoramic mandibular index (PMI), antegonial index (AI), antegonial notch depth (AND), gonial index (GI).
*' * ' Indicates the significant difference.*

Table 2. Descriptive statistics of right and left side MCI measurement indices between bruxism and healthy control patients

Patient group	MCI right			MCI left		
	C1	C2	P value	C1	C2	P value
Bruxism	16	44	0.547	14	46	0.532
Control	19	41		17	43	

Table 3. Descriptive statistics of right and left HU values between bruxism and healthy control patients

	Patient group	Mean±Std. Deviation	P value
HU spongious right	Bruxism	7290,3500±2128,62245	0,020 *
	Control	6579,5667±971,15481	0,021 *
HU cortical right	Bruxism	6885,7500±2089,57476	0,148
	Control	7348,7500±1309,07800	0,149
HU spongious left	Bruxism	7913,4407±2336,00336	0,023 *
	Control	7107,3833±1343,45776	0,024 *
HU cortical left	Bruxism	7790,2712±2294,98623	0,660
	Control	7635,1167±1452,76038	0,661

*' * ' Indicates the significant difference.*

Discussion

Increased alveolar bone thickness and adjacent trabecular bone density in chronic occlusal trauma conditions such as bruxism; irregular enlargement of the periodontal space; periodontal adaptation to repetitive eccentric forces is observed in tissues (9). These changes in the mandibular bone can be affected by many factors, including the presence of traumatic occlusion due to bruxism. The structuring of the bone tissue is adjusted according to the severity of the pressure on it. In response to increased occlusal forces, repair activity increases, supportive new bone formation is observed, and bone thickness increases (10). These changes should be considered when planning dental treatment in patients with bruxism Therefore, in our study, the effects of bruxism on bone mineral density and shape were evaluated using HU value and radiomorphometric indices (9).

As far as we know, there are few studies in the literature evaluating radiomorphometric indices on DPRs of bruxism (7, 11-13). The first study reporting the relationship between radiomorphometric measurements and bruxism status is Isman's (2020) study (7). According to this study, MI and AND were found to be statistically significantly higher in bruxers than in the control group, regardless of gender (p<0.05). It was found that the PMI value did not show a statistically significant difference in the bruxism and control groups, and this was due to the high distance between the lower border of the mental foramen and the lower border of the mandible. In our study, while PMI did not show a statistically significant difference on the right side, PMI on the left side was higher in the bruxism group than in the control group (p<0.05).

In Isman's study, GI was found to be higher in male bruxers. It has been reported that the reason for this may be the thickening of the bone in order to adapt to the excessive biting force in the bruxers. In the same study, AI was not found to be associated with bruxism (p= 0.4). Isman observed a significant relationship between MCI and bruxism status (p= 0.012). In our study, however, no statistically significant difference was found in the bruxism and control groups in terms of MCI on the right (p=0.547) and left sides (p=0.532). This may be because there were no patients with type C3 in our study. The fact that the mean age of the patients participating in our study was younger (31.20±7.92) may be the reason for not having type C3 (14).

In the study of Eninanç et al. (11) , mandibular cortical index (MCI), mental index (MI) and panoramic mandibular index (PMI) were evaluated in DPRs of 126 bruxer and 126 control patients. While 163 (64.6%) of 252 individuals were C1 and 89 (35.3%) C2 type, there was no C3 type in either group. When bruxer and control subjects were compared in terms of MCI type, there was no statistically significant difference, which is similar to our study. Although the mean MI values calculated from DPRs were significantly higher in bruxers than in controls (p = 0.007), there was no difference between the groups in terms of mean PMI values. MI results with our study

Although similar, in our study, PMI did not show a statistically significant difference on the right side while it showed a statistically significant difference on the left side.

Aziza et al. (12) , who measured the mandibular cortical bone height according to the gonial and antegonial index on DPRs in 30 bruxism and 30 non-bruxism patients, found that these two index values were not statistically different between bruxism and non-bruxism patients. In another similar study, Fauziah et al. (13) created two groups: 30 DPRs of patients with bruxism and 30 DPRs of patients without bruxism. They reported that there was no significant difference in the height of the mandibular cortical bone between bruxism patients and non-bruxism patients based on PMI. The reason why these results differ from the results obtained in our study may be the sample size.

Demonstrating the variation in mandibular bone density between bruxer and non-bruxer patients based on panoramic radiographs with the "Histogram" tool from ImageJ, Casazza et al. (6) showed the ratio of cancellous bone to cortical bone density using gray values. In the study using 84 panoramic radiographs (37 bruxer, 47 non bruxer), a specific region of interest was selected in line with the first premolar. As a result of their studies, the ratio of cancellous bone to cortical bone was found to be higher in bruxers than in non-bruxers, and these values showed a statistically significant difference for the right and left sides.

Demonstrating that the definition of HU value can be used in DPR, Chugh et al. (15), 36 anatomical points determined on DPR from 20 participants (the mesial and distal sides of the right and left first molars and canines, and the points determined 3 and 10 mm apical of the alveoli crest crest in the region in the interproximal area of the central incisors in the maxilla and mandible) used the HU value to evaluate bone density. As a result of his studies, he made the use of panoramic radiology a suitable alternative to CT for the accuracy of the determination of bone density.

Our study is the first to compare HU value on DPR in a bruxism patient. In our study, a significant difference was observed between the bruxism group and the control group in the cancellous bone in terms of HU values, while HU values did not create a statistically significant difference between the two groups in the cortical bone. The level of remodeling in cancellous bone is 5-10 times higher than in cortical bone (16). This can be explained by the fact that cortical bone has a lower metabolic capacity and remodeling activity compared to alveolar bone.

One of the limitations of this study is the severity and duration of bruxism, whether the patient has been treated before, and the limited data obtained about the patient. In addition, panoramic radiography, which was preferred in our study due to its low radiation dose, has disadvantages such as creating magnifications in the image and inability to prevent superpositions. These limitations can be eliminated if further studies are planned prospectively and more advanced imaging techniques (such as CT and CBCT) are used.

Conclusion

Bone density and shape differ in bruxers compared to non-bruxers. It is possible to evaluate the bone shape and density of bruxism patients with panoramic radiographs before dental treatments, by means of radiomorphometric indices and HU value.

Ethical Approval: *Ethical approval was obtained from Ethical Committee of Harran University (approval date and number: 12 December 2022; HRÜ/ 22.24.05)*

Author Contributions:
Concept: SK, NU
Literature Review: SK, NU
Design : MED
Data acquisition: SK,NU
Analysis and interpretation: SK
Writing manuscript: SK,NU
Critical revision of manuscript: YY
Conflict of Interest: *The authors have no conflicts of interest to declare.*
Financial Disclosure: *Authors declared no financial support.*

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