The efficiency of dental volumetric tomography-derived radiomorphometric indices for diagnosing osteoporosis

Osteoporoz Teşhisinde Dental Volumetrik Tomografiden Üretilen Radyomorfometrik İndekslerin Etkinliği

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ABSTRACT

Objective:
The aim of the present study was to assess the efficiency of dental volumetric tomography (DVT) radiomorphometric indices to detect osteoporosis in post-menopausal females, compare them with the osteopenic and normal groups and to assess the correlations of the DVT findings with the bone mineral density values measured by Dual energy X-ray absorptiometry (DEXA).

Method:
This study consisted of 120 post-menopausal females, with age ranging from 48 to 67 years. Based on their DEXA results, they were classified into osteoporotic, osteopenic and normal groups. Dental volumetric tomographical radiomorphometric indices were measured and compared with DEXA parameters of the patients.

Results:
Dental volumetric cortical thickness (DVT-CT) displayed significant differences between the groups and decreased in osteoporotic individuals. The mean values of dental volumetric tomographic mandibular index superior (DVT-MIS) and dental volumetric tomographic mandibular index inferior (DVT-MII) for osteoporosis group was significantly lower than osteopenic and normal groups. In both normal and osteopenic patient groups, there were significant correlations between the spine t score and DVT-MIS (p<0.05). Osteoporotic patient group displayed statistically significant relationship between spine t score and DVT-CT.

Conclusions:
DVT-CT parameter which was found to be associated with the spine DEXA measurements, can be used to diagnose osteoporotic patients. Dental volumetric tomography can help clinicians as a useful tool to evaluate osteoporotic patients.

Keywords: Dental volumetric tomography, Dual energy x-ray absorptiometry, Osteoporosis.

ÖZ

Bu çalışmanın amacı post-menopozal hastalarda osteoporozu saptamak için dental volumetrik tomografi (DVT) radyomorfometrik indekslerinin etkinliğini değerlendirilmek, bunları osteopenik ve normal gruplarla karşılaştırmak ve çift enerjili X-ışını absorpsiyometrisi (DEXA) ile ölçulen kemik mineral yoğunluğu değerleri ile DVT bulgularının korelasyonlarını değerlendirilmektir.
Yöntem:
Bu çalışmaya, yaşları 48-67 arasında değişen 120 post-menopozal hasta dahil edildi. Çalışma grubu DEXA sonuçlarına göre osteoporotik, osteopenik ve normal olarak sınıflandırıldı. Dental volumetrik tomograf radyomorfometrik indeksler ölçüldü ve hastaların DEXA parametreleri ile karşılaştırıldı.

Bulgular:
Dental volumetrik kortikal kalınlık (DVT-KK) gruplar arasında önemli farklıklar gösterdi ve osteoporotik bireylerde azaldı. Osteoporoz grubında dental volumetrik tomograf mandibular indeks superior (DVT-MIS) ve dental volumetrik tomograf mandibular indeks inferior (DVT-MII) orataları değerleri, osteopenik ve normal gruplara göre anlamlı olarak düştü. Hem normal hem de osteopenik grupta, omurga t-skoru ile DVT-MIS arasında anlamlı korelasyon vardır (p <0.05). Osteoporotik hasta grubu, omurga t-skoru ile DVT-KK arasında istatistiksel olarak anlamlı ilişki gösterdi.

Sonuç:
Omurga DEXA ölçümleri ile ilişkili olduğu bulunan DVT-KK parametreleri, osteoporotik hastalara teşhis etmek için kullanılabilir. Dental volumetrik tomografi, klinisyenlere osteoporotik hastalara değerlendirmek için yararlı bir araç olarak yardımcı olabilir.

Anahtar Sözcükler: Çift enerjili X-ışını absorpsiometri, Dental volumetrik tomografi, Osteoporoz.

Introduction
Bone Mineral Density (BMD) in the scope of densitometer is defined as bone tissue mass that includes both bone and bone marrow components. Before the development of bone densitometers, bone density was measured using X-ray by comparing the radiance of the skeleton with other surrounding tissues (1). Osteoporosis, which causes low bone quality, is a chronic, systemic metabolic bone disease that affects people’s quality of life. Osteoporosis-related changes in jawbones are not different from the other bones of the body (2).

Dual energy X-ray absorptiometry (DEXA) is commonly performed for measuring BMD (3). Although DEXA has been considered the gold standard for this purpose, it has some disadvantages, such as large equipment size, high cost, and difficulty in interpreting results, which limit its utility (4). In DEXA, BMD, z-scores and t-scores are reported. Per standard protocol, a t-score between −1.0 and −2.4 yields a diagnosis of osteopenia; a t-score below −2.5 corresponds to a diagnosis of osteoporosis (5,6).

Dental volumetric tomography (DVT), which is also known as cone beam computed tomography (CBCT), became a useful tool for oral and maxillofacial imaging, providing clinicians access to excellent image quality and greater diagnostic accuracy and sensitivity (7-9). CBCT allows images to be acquired using a low dose of radiation, shorter patient examination time and lower costs than conventional computerized tomography (CT), which makes its routine use practicable for oral and maxillofacial imaging and surgical procedures (7-9).

The primary aim of the present study was to assess the efficiency of radiomorphometric indices to detect osteoporosis in post-menopausal females and compare the results with the osteopenic and normal groups. The second aim was to assess the correlations of the CBCT findings with the bone mineral density values measured by DEXA.

Materials and Methods
This study was approved by Non-Interventional Clinical Research Ethics Committee of Cukurova University Faculty of Medicine (approval number: 30.06.2009-7). The participants of the study were 120 post-menopausal women (ages range between 48 and 67; average: 59.9 ± 5.33) whose BMD measurements were performed using DEXA (Hologic Explorer QDR, Hologic Inc., Bedford, MA 01730, USA) device in the same month. The participants were divided into three groups as normal group (n=40), osteopenia group (n=40) and osteoporosis group (n=40) according to the WHO criteria. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All the participants signed the informed consent form. The exclusion criteria were as follows: individuals with metabolic diseases (hyper / hypoparathyroidism, diabetes mellitus, osteomalacia, thyrotoxicosis and renal disease), hormone replacement treatment, early menopause, medication that can affect BMD, chronic alcoholism and long-term partial or total edentulism without prosthetic rehabilitation. Each patient’s BMD value, t-score and z-score were measured in terms of L1-L4 spine from the lumbar area, femur neck of the left femoral area and total hip (g/cm2) with DEXA method.

The participants of the study were referred from Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cukurova University to Department of Oral and Maxillofacial Radiology, Faculty of Dentistry in order to evaluate jaw-bones by CBCT scanning. Images were obtained from the institution’s CBCT device (Illuma CBCT Scanner, imtec imaging, LLC, Ardmore, OK, USA) at 120 kV, 3.8 mA, 20 seconds, FOV of 24.4 x 19.5 cm and the voxel size was 0.3 mm3. Two oral and maxillofacial radiologists performed the linear and radiomorphometric measurements on a 22-inch LG Flatron monitor (LG, Seoul, Korea) set at a screen resolution of 1440 x 900 pixel screen resolution and 32-bit color depth. Each image was evaluated separately in a random order using the CBCT device software and enhancement tools of the imaging system. Images were re-evaluated 2 weeks after the initial evaluation to permit calculation of the intracllass correlation coefficient (ICC) with a confidence interval (CI) of 95%.

Radiomorphometric Measurements
The measurements were performed on coronal CBCT images by modifying Ledgerton’s (10) classification on the panoram-
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Results

For all measurements, CV values ranged between 4.1% and 5.1%, while ICC values ranged between 0.94 and 0.95 showing excellent agreement.

A statistically significant difference was found between the groups for DVT-CT, DVT-MIS and DVT-MII parameters. The mean values for osteoporosis group was found significantly lower compared to other two groups for DVT-MIS and DVT-MII parameters. No significant difference was found between the normal and osteopenia groups for DVT-MIS and DVT-MII (p>0.05) (Table I).

Table I: Comparison of DVT parameters of all the participants.

| Indices  | Normal  | Osteopenia | Osteoporosis | p*    |
|----------|---------|------------|--------------|-------|
| Mean DVT- | DVTMIS  | 0.268a     | 0.258a       | 0.235b <0.001 |
|          | DVTMII  | 0.332a     | 0.313a       | 0.264b <0.001 |
|          | DVTCT   | 4.0a       | 3.8a         | 3.2b <0.001   |

DVTMIS: Dental volumetric tomographic mandibular index superior
DVTMII: Dental volumetric tomographic mandibular index inferior
DVTCT: Dental volumetric tomographical cortical thickness
a,a,b: No difference between two groups, the third group is different from others
a,b,c: Three groups different from each other
*One-way variance analysis (ANOVA)

The spine t-score was the only DEXA parameter that correlated with the DVT-indices in all three groups. In both normal and osteopenic patient groups, there was a statistically significant relationship between the spine t score and DVT-MIS (p<0.05). Osteoporotic patient group showed statistically significant relationship between spine t-score and DVT-CT. Statistically significant relationships were observed between DEXA results and DVT measurements for the groups (Table II).
The aim of the present study was to assess the efficiency of dental volumetric tomography (DVT) to diagnose osteoporotic patients. CBCT scans can help clinicians as a useful tool to evaluate osteoporotic patients. CBCT images of post-menopausal patients to perform mandibular index measurements in the present study. It was aimed to assess the efficiency of radiomorphometric indices derived from CBCT to detect osteoporosis in post-menopausal females and compare the results with the osteopenic and normal groups. DVT-MIS and DVT-MII measurement mean scores did not show any significant differences between normal and osteopenic groups, but the osteoporosis group displayed significant difference compared to the other two groups (p<0.001). In their CBCT study, Koh and Kim (11) also found that there were significant differences between normal group and osteoporosis patients for DVT-MIS and DVT-MII parameters. Our findings are consistent with Kim and Koh.

DVT-CT measurement was found to be correlated with the spine t-score in the osteoporosis group. Also, DVT-CT measurement revealed significant differences between the three groups and was found to be decreased in the osteoporosis group when compared to the other two groups. This finding suggests that DVT-CT measurement can be a useful tool to diagnose osteoporosis. The risk of osteoporosis should be considered in radiological examinations of women in the post-menopausal period. With the widespread use of CBCT devices, further studies should be conducted to identify radiological signs of osteoporosis in the mandible using CBCT databases.

**Conclusion**

In conclusion, DVT-CT parameter which was found to be associated with the spine DEXA measurements, can be used to diagnose osteoporotic patients. CBCT scans can help clinicians as a useful tool to evaluate osteoporotic patients. Clinicians should consider the effect of osteoporosis on jaw bones during dental treatments such as prosthetic rehabilitation with dental implants, orthodontic treatments and surgical interventions.

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**Ethics Committee Approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (approval number: 30.06.2009-7) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.
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Informed Consent: All the participants’ rights were protected and written informed consents were obtained before the procedures according to the Helsinki Declaration.

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Conflict of Interest: BE, UT, TS and HÖ declare that they have no conflict of interest.

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