The relationship between panoramic radiomorphometric indices of the mandible and calcaneus bone mineral density

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Key words: calcaneus; mandible; osteoporosis; panoramic radiomorphometric indices; DXL Calscan.

Summary. Objective. The aim of the study was to determine the relationship between bone mineral density in the calcaneus measured using the dual x-ray and laser osteodensitometry technique and bone mineral density in the mandible calculated using the panoramic radiomorphometric indices obtained by applying linear measurements in panoramic radiograms of postmenopausal women.

Material and methods. The participants of this study were postmenopausal women (n=129) aged 50 and more. The subjects underwent panoramic radiography of the mandibles, followed by the calculation of the panoramic radiomorphometric indices indicating bone mineral density of the mandible. The dual x-ray and laser osteodensitometer DXL Calscan were used for the measurements of bone mineral density in the calcaneus. Statistical analysis was preformed to find the relationship between bone mineral density measurements in the two anatomically different bones.

Results. Following the diagnostic criteria for osteoporosis recommended by the World Health Organization (1994), the subjects were distributed according to the calcaneus bone mineral density T-score into the normal bone mineral density (group 1), osteopenia (group 2), and osteoporosis (group 3) groups. Mean bone mineral density in the calcaneus in the general studied population was 0.38±0.07; the mean value of bone mineral density of the calcaneus in the group 1 (n=34) was 0.47±0.04 (g/cm²), in the group 2 (n=65) was 0.37±0.03 (g/cm²), and in the group 2 (n=30) was 0.29±0.03 (g/cm²). Differences in bone mineral density between the groups were determined using the analysis of variance (ANOVA) F=285.31; df=2; P<0.001 (T1 vs. T2, P<0.001; T1 vs. T3, P<0.001; T2 vs. T3; P<0.001).

A statistically significant correlation was found in the general group between the mental index and bone mineral density in the calcaneus (r=0.356, P<0.001), and between the panoramic mandibular index and bone mineral density in the calcaneus (r=0.397, P<0.001).

Conclusion. Bone mineral density in the calcaneus and the mandible measured using dual energy x-ray and laser osteodensitometer DXL Calscan and by applying panoramic radiography reflect general changes in the mineralization of these bones, characteristic of the postmenopausal period.

Introduction

Osteoporosis (OP) is a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a subsequent increase in bone fragility and the risk of fractures (1, 2). Bone tissue is a tissue undergoing constant change due to the simultaneous processes of decay (resorption) and formation (regeneration), generally termed as bone remodeling (3). This turnover ensures the continuous replacement of old bone tissue, which, in turn, affects bone adaptation to various mechanical forces exerted on the skeleton.

Reduced bone mineral density (BMD) – and thus the development of OP – is more pronounced in postmenopausal women than in other patients (4). The exceptionally progressive phase of bone destruction, which occurs in women during the period of 5 to 10 years following menopause, is associated with the dramatic drop in estrogen levels (5, 6). Various bones are analyzed in studies on bone
mineral density in postmenopausal women. A number
of studies have revealed a significant positive corre-
lationship between BMD of the mandible and that of
the most frequent sites of osteoporosis, namely the lumbar
spine, the femoral neck, and the forearm. Yet we have
not come across a single academic survey aimed at
evaluating the relationship between mandibular and
calcaneal (DXL) bone mineral density. It is note-
theworthy, however, that their anatomical differences
notwithstanding, the mandible and the calcaneus are
metabolically similar bones.

Mandibular bone tissue is a part of the general
skeletal bone structure. The resorption of mandibular
bone tissue as well as the morphological-dimensional
changes in cortical bone – both typically observed in
elderly individuals – is largely attributable to age-
related reduction in bone mineral density. Analyses
conducted over the last few decades have proven a
relationship between mandibular bone mineral density,
alveolar bone height, tooth loss, and changes in general
skeletal bone mineral density (7–9). Interestingly,
while some scientists construe the correlation as parti-
cularly strong, others regard it as less reliable. Never-
theless, changes in the skeletal bone mineral density
in general should also be expected to affect such
functionally active bone as the mandible. Yet contrary
to many research findings that seem to have consis-
tently supported the proposition that, on the one hand,
general skeletal BMD and changes in cortical thick-
ness and, on the other hand, mandibular bone mineral
density, alveolar bone resorption and tooth loss corre-
late in postmenopausal women (10–16), other studies
have traced no such correlation (17, 18).

Approximately 80% of the mandible is composed
of cortical bone and 20% of trabecular bone. Subject
to the effects of occlusal force, the mandible is a func-
tionally as well as metabolically active bone. Changes
in the distribution of functional strain on the mandible
result in mandibular bone mass loss (19). The thick-
ness of cortical bone decreases. Although the reduc-
tion of the cortical bone layer is a rapid process, it
does not normally exceed 2% of the bone mass loss
per year, in which regard the mandible closely resem-
bles other bones containing significant amounts of
cortical bone tissue (20). Changes in bone mineral
density are diagnosed based on the changes detected
in cortical bone thickness and integrity in the mandi-
bular base, which is an important symptom of osteo-
porosis (21). Dutra et al. conclusively demonstrated
that cortical bone thickness changes in the mandibular
base are characteristic of individuals with osteo-
porosis, and increasing bone porosity results in
decreasing bone mass (8, 10).

Findings of histomorphometric and microradiogra-
phic studies show that both cortical and trabecular
bone tissues of the mandible undergo changes. This,
together with the characteristics of the anatomical
structure of the mandible as well as the sufficient
thickness of its cortical bone, accounts for the use of
the mandible to determine changes in BMD. Further-
more, it has been observed that bone mass of the
maxilla, as opposed to that of the mandible, does not
depend on age and sex of the patients (10).

Changes in mandibular bone and skeletal osteo-
porosis share multiple risk factors, such as age,
menopause, race, smoking, diet low in calcium, certain
medications, as well as genetic factors such as family
history of osteoporosis.

It is therefore no coincidence that panoramic radi-
ography and radiomorphometric indices used by odon-
tologists for examining the mandible have attracted
clinicians’ attention. Medical literature abounds in
comparisons of bone mineral density at different ske-
letal sites (dual x-ray absorptiometry, DXA) with pa-
oramic radiomorphometric indices indicating bone
mineral density of the mandible. The aforementioned
indices are calculated by performing linear measure-
ments of the obtained panoramic radiographic images
of the mandible. Panoramic radiomorphometric indi-
ces (mental index, MI; panoramic mandibular index,
PMI) serve as diagnostic criteria that help to select
elderly patients with suspected changes in bone mi-
neral density for further BMD testing (8, 22–24).

Mandibular cortical thickness at the mental foramen
is also known as the MI. Osteopenia can be identified
by the thinning of cortical bone along the lower border
of the mandible (MI) (7). The PMI, described by
Benson et al., in turn, evaluates bone mineral mass in
the mandible (25).

Thorough knowledge of the methods for calculat-
ing panoramic radiographic indices as well as for
determining which changes in the mandibular cortical
bone suggest systemic skeletal osteopenia or osteo-
porosis is thus highly useful. In addition to that, timely
and accurate identification of clinical signs associated
with osteoporosis on the part of dental practitioners
tends to contribute significantly to effective prevention
of early tooth loss.

The calcaneus, which is a weight-bearing bone in
addition to being an easily accessible one, offers a
number of distinct advantages in terms of bone mineral
density measurements. Arguably, the relatively high
proportion (approximately 95%) of metabolically
active trabecular bone (with a turnover rate exceeding
that of cortical bone by 7 to 8 times) in the calcaneus
renders it the best site for early detection of OP (26). DXL Calscan was invented to measure bone mineral density of the calcaneus. This scanner, which combines dual x-ray and laser techniques, is characterized by a low radiation dose and produces peripheral scans, automatically selects measurement areas, and performs calibration procedures before each measurement. Patient-friendly (approved for use without any additional patient protection requirements), quick (allows for a painless scan of a patient’s heel in less than a minute), comfortable to operate and portable, Calscan DXL is intended to speed up the diagnosis of OP (26). According to some authors, the device is particularly suitable for diagnosing post-menopausal osteoporosis (27) and allows for precise and reliable testing (26). Kullenberg and Falch analyzed the results of a series of bone mineral density measurements in the calcaneus with DXL and confirmed that the T-score threshold defined through the use of this innovative method corresponds to the criteria recommended by the WHO and is thus optimal and accurate enough for diagnosing osteoporosis (28). It is important to note that bone mineral density measurements in the calcaneus are not subject to distortion due to kidney diseases, aortic calcification, osteoarthrits, or deformations of the lumbar spine or bone fractures. This peripheral site is therefore particularly suitable for the purposes of monitoring, collecting prognostic information, and estimating the frequency of movement.

The majority of elderly people visit odontologists on a regular basis. They frequently undergo panoramic radiographic examinations, the results of which are used for diagnosing periodontal pathology, identifying the number of teeth, and assessing alveolar bone loss. Patients who have not yet experienced any noticeable symptoms of OP despite being at risk of developing osteoporosis are unlikely to visit health professionals solely for BMD assessment. However, postmenopausal female patients, for example, due to high incidence of periodontal pathology among them, tend to have frequent dental appointments. Odontologists, for their part, through the use of panoramic radiography over the course of their dental treatment, may be able to easily identify signs of bone mineral density loss in sites other than the mandible. Postmenopausal women with suspected low skeletal BMD may then be referred to other professionals for further BMD testing. It can be inferred from the above that constructive interdisciplinary cooperation between odontologists and other medical professionals in the diagnosis and treatment of osteoporosis would benefit patients and would yield good results.

The aim of this study was to assess and find the relationship between BMD of the mandible and of the calcaneus. To this end, a number of objectives were pursued. We measured BMD of the calcaneus using the DXL Calscan. Panoramic radiography of the mandible and, subsequently, vertical linear measurements of the panoramic radiographic images were performed, followed by the calculation of the two panoramic radiomorphometric indices (MI and PMI). Finally, we conducted a statistical analysis in order to establish the relationship between data sets obtained during the research process.

Materials and methods

The sample. The present study was approved by the Clinic of Dental and Oral Pathology and the Institute of Endocrinology of Kaunas University of Medicine (KMU). The study included 129 postmenopausal women who were treated for periodontal diseases at the Clinic of Dental and Oral Pathology.

Exclusion criteria were patients’ age up to 50 years, history of OP treatment or regular drug therapy that would affect bone remodeling during one year, postmenopausal history with estrogen replacement treatment, absence of diseases that may result in secondary osteoporosis, no smoking or alcohol use, diseases of oral mucosa, and edentulous mandibles.

Dual x-ray and laser osteodensitometry. Bone mineral density in the calcaneus was evaluated by applying dual x-ray and laser osteodensitometry using DXL Calscan P/N 031000 (Demetech AB, Solna, Sweden). DXL Calscan software presents the results of bone mineral density measurements in g/cm² and expresses them as T-score and Z-score. The measurements are graphically presented in the computer monitor. The risk margins for osteopenia and osteoporosis were indicated as colored fields or lines.

The duration of the measurement was 4 minutes, and the irradiation dose was 0.2 µSv. The patients were free to choose whether the right or the left calcaneus should be examined for BMD. Following the diagnostic criteria for osteoporosis recommended by the WHO (1994), the subjects were distributed according to the bone mineral density T-score into the normal bone mineral density (group 1), osteopenia (group 2), and osteoporosis (group 3) groups.

Panoramic radiographic measurements. Panoramic radiography (OPG) examination was performed at the Department of Dental and Maxillofacial Orthopedics, KMU, using a panoramic radiograph PC-1000 Panoramic X-ray (Panoramic corporation, Dentalcompare, USA, 1997). The duration of the radiologic
examination was 14 seconds. Current of 6 mA and voltages of 85 kV were used, depending on the patient’s constitution. The obtained radiographic images were scanned (using a scanner produced by the VIDAR Systems Corporation, USA, 2006) and digitalized at the resolution of 300 dpi and 265 (8 bits/pixel) gray shade formats, by applying the logarithmic algorithm. Medical imaging software was used to perform vertical linear measurements in panoramic radiographic images, and subsequently panoramic radiographic indices were calculated.

Mandibular cortical thickness at the mental foramen – mental index (MI) – was measured using the technique described by Ledgerton et al.: “a line was traced which passed perpendicular to the tangent to the lower border of mandible and through the center of the mental foramen” (29). We measured the cortical thickness in the region of interest on the right and the left sides of the mandible because different sides of the mandible may be influenced by different occlusal forces and thus could have the asymmetric signs in topographic anatomy. After the measurements, the mean values of the obtained findings were calculated.

Panoramic mandibular index (PMI) according to Benson et al. is the ratio between cortical thickness in the base of the mandible and the distance from the center of the mental foramen to lower border of the base of the mandible (25).

Using the same line as described above for the determination of the mandibular cortical thickness, measurements between the lower border of mandible and both the upper and the lower margins of mental foramen were recorded, and the average of those two values was calculated. PMI calculations were performed bilaterally for each subject, and mean values were calculated. All measurements in this study were adjusted to account for the magnification coefficient of the panoramic radiograph (coefficient, 0.9).

**Statistical analysis.** Comparison and analysis of the data were performed using the data accumulation and analysis software packages Statistica 5.5, Excel 2000, and SPSS 13.0. The sample volume was calculated during the pilot study. The selected power of the study was \( \beta=0.8, \) and the confidence interval was \( \alpha=0.05. \) Continuous data were evaluated using the following statistical characteristics: mean value (\( \bar{x} \)), median, and standard deviation (SD). Normal distribution of the studied quantitative indices was verified using the Kolmogorov-Smirnov test. Mean values and their dispersions were compared by applying the univariate dispersion analysis technique (ANOVA).

The dependence of the attributes was evaluated by applying Pearson’s linear regression (correlation coefficient, \( r \)). The verification of the statistical hypotheses was performed using the following significance denotations: \( P<0.05 \) (significant), \( P<0.01 \) (highly significant), and \( P<0.001 \) (especially significant); \( P \) denotes the marginal level of significance in the verification of hypotheses.

**Results**

**Analysis of bone mineral density in the calcaneus.** We studied postmenopausal women whose mean age (±SD) was 62.50±6.13 years.

According to the T-score of the bone mineral density in the calcaneus, the subjects were distributed into the following groups: group 1 included 34 women with normal bone mineral density (T-score >–1), group 2 included 65 women diagnosed with osteopenia (T-score ≤–1 to >–2.5), and group 3 – 30 women with osteoporosis (T-score ≤–2.5). The overall mean value of T-scores was –1.62±1.12. The following mean values of T-scores were obtained in the groups: group 1, –0.13±0.55; group 2, –1.77±0.43; and group 3, –2.96±0.48. The difference in T-score in subject groups using the ANOVA was found to be the following: \( F=289.26; df=2; P<0.001 \) (T1 vs. T2, \( P<0.001; \) T1 vs. T3, \( P<0.001; \) and T2 vs. T3, \( P<0.001). \)

Mean bone mineral density in the calcaneus in the general group of subjects was 0.38±0.07; mean BMD in the group 1 was 0.47±0.04, in the group 2 was 0.37±0.03, and in group 3 – 0.29±0.03. The difference in bone mineral density between the groups determined using the ANOVA was the following: \( F=285.31; df=2; P<0.001 \) (T1 vs. T2, \( P<0.001; \) T1 vs. T3, \( P<0.001; \) and T2 vs. T3, \( P<0.001)).

**Morphometric analysis of the mandible.** We performed vertical linear measurements on panoramic radiographic images of the mandible. The data were adjusted for the magnification coefficient of the panoramic radiograph (coefficient, 0.9). The analysis of the findings of the measurements showed that the magnification coefficient did not affect the accuracy of the findings.

The region of the mandible where morphometric analysis on panoramic radiographic images was performed is shown in Fig. 1.

The lower mandibular cortical thickness was measured at the mental foramen, and mean measurement values of the mental index (MI) on the left and the right sides of the mandible were calculated. The lowest
The relationship between panoramic radiomorphometric indices of the mandible and calcaneus bone mineral density

value was found to be 1.46, and the highest – 5.82 (mode 2.48; median 3.07). The differences in the MI between subject groups were calculated by applying ANOVA ($F=9.98$; $df=2$; $P<0.001$). The data of the mental index in the groups are presented in Table 1.

![Fig. 1. Linear measurements of the mandible at the mental foramen on panoramic radiograms](image)

The accuracy of the measurements calibration was performed by three observers. A statistically significant difference was found in the measurements of the cortical thickness in the base of the mandible at the mental foramen between investigators 1 and 2 ($P<0.001$), and between investigators 2 and 3 ($P<0.001$).

Using findings of the linear morphometric measurements in subject groups, we calculated the PMI. Mean values (±SD) of the PMI are given in Table 2.

### Table 1. The mean values of mental index measurements in subject groups

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>MI, mean±SD, mm</th>
<th>Difference in MI between the groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>3.69±0.98</td>
<td>1 vs. 2, $P=0.069$;</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>3.34±0.93</td>
<td>1 vs. 3, $P&lt;0.001$;</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>2.69±0.72</td>
<td>2 vs. 3, $P&lt;0.001$.</td>
</tr>
<tr>
<td>General</td>
<td>129</td>
<td>3.28±0.96</td>
<td></td>
</tr>
</tbody>
</table>

MI, mental index.

### Table 2. The mean values of the panoramic mandibular index by different groups

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>PMI (mean±SD)</th>
<th>Difference in PMI between the groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>0.29±0.08</td>
<td>1 vs. 2, $P=0.016$;</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>0.26±0.07</td>
<td>1 vs. 3, $P&lt;0.001$;</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>0.21±0.06</td>
<td>2 vs. 3, $P=0.009$.</td>
</tr>
<tr>
<td>General</td>
<td>129</td>
<td>0.26±0.07</td>
<td></td>
</tr>
</tbody>
</table>

PMI, panoramic mandibular index.

### Table 3. The relationship between mental index and calcaneus bone mineral density in the groups

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>MI, mean±SD mm</th>
<th>Calcaneus BMD mean±SD, g/cm²</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>3.69±0.98</td>
<td>0.47±0.04</td>
<td>$r=0.158$; $P=0.372$</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>3.34±0.93</td>
<td>0.37±0.03</td>
<td>$r=0.151$; $P=0.228$</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>2.69±0.72</td>
<td>0.29±0.03</td>
<td>$r=0.003$; $P=0.988$</td>
</tr>
<tr>
<td>General</td>
<td>129</td>
<td>3.28±0.96</td>
<td>0.38±0.07</td>
<td>$r=0.356$; $P&lt;0.001$</td>
</tr>
</tbody>
</table>

MI, mental index; BMD, bone mineral density.
As seen in Table 4, a statistically significant correlation was found between the PMI and the mean values of the calcaneus BMD in the general group \( (r=0.397, P<0.001) \). No significant correlation was found between the data in the groups 1, 2, or 3.

**Discussion**

With age, bone density gradually decreases in all anatomical sites. Postmenopausal bone loss severely affects women in the first 10 years after the menopause, whereas subsequently the importance of this factor diminishes. Annual bone loss rates vary substantially among different individuals, ranging between less than 1% to more than 5% for the trabecular bone, and from 0.5% to 2% for the cortical bone. The most significant bone mass loss is observed in the spinal bone (34). The present study sought to assess BMD of the mandible by the use of panoramic radiography as a diagnostic method, primarily due to the fact that mandibular bone mineral density is a parameter closely associated with alveolar bone resorption and early tooth loss. However, the aforementioned medical conditions are subject of further studies and thus are not analyzed in this article.

Overall, our analysis suggests that determining BMD of the mandible (based on panoramic radiographs) and comparing it with BMD of the calcaneus (measured by DXL) is expedient for several reasons. As panoramic radiographic examinations are convenient and informative, and are common in odontological practice, we expect this study to serve as an impetus for the advancement of diagnostic and clinical collaboration between dental practitioners and other medical professionals in predicting low general skeletal BMD. For instance, our research findings indicate that the use of panoramic radiography for assessing bone mineral density of the mandible also allows for determining general skeletal bone mineral density loss in elderly female patients. These measurements, coupled with criteria such as other clinical risk factors and/or family history of OP, could therefore prove to be a promising instrument in the assessment of skeletal osteoporosis risk. Furthermore, panoramic radiographs could produce particularly accurate BMD assessments when calibrated well with the DXA method (30).

In the course of the study, we measured the thickness of the cortical bone using digitized panoramic radiographic images, which facilitates the evaluation of the trabecular to cortical bone thickness ratio in the mandible. Precise determination of the inner and outer margins of the cortical bone together with rigorous vertical linear measurements is a prerequisite for the calculation of panoramic radiomorphometric indices. It should be emphasized, however, that the MI values obtained while using a computer-aided system for measuring mandibular cortical thickness are generally somewhat lower than those resulting from manual measurement (31). In addition, MI values in females are commonly expected to be lower, owing to significantly higher rates of bone loss among women beyond the fourth decade of life (22, 32). Kribbs et al., Klementti et al., Taguchi et al., and Bollen et al., among others, discovered that the thickness of the lower border of the mandible tends to be reduced in subjects with osteoporosis (11–15). Although Devlin et al. also examined panoramic radiographs and reported higher MI values (normal bone density MI, mean±SD, SD±SE, mean±1.96*SE, mean±±SE, mean±±1.96*SE).
4.73±0.88; reduced bone density MI, 3.96±0.88), their measurements were not adjusted to account for the magnification effect, which renders any meaningful comparison of their findings with those of other researchers difficult (7).

Our analysis attests to the existence of a significant correlation between the data on mandibular cortical thickness (MI) and the mean values of BMD in the calcaneus in the postmenopausal age group of the population. On the other hand, lower MI values without any significant correlation with the values of calcaneal BMD were observed in the groups of patients with osteopenia and osteoporosis.

Benson et al., Klementti et al., and Horner and Devlin focused their studies on another panoramic radiomorphometric index, namely, panoramic mandibular index (14, 25, 33). They concluded that PMI had no distinct advantages over MI as a tool for mandibular BMD measurement. Our study revealed a statistically significant correlation between PMI and BMD of the calcaneus in the general population of patients, which corroborates such conclusion.

As already pointed out, approximately 80% of the mandible is composed of cortical bone (35); thus, the mass of its trabecular portion is relatively small. The calcaneus, by contrast, is predominantly trabecular in its composition (95% of trabecular bone). After the menopause, accelerated trabecular bone loss occurs, and bone mineral density of the calcaneus progressively declines throughout the postmenopausal period. In the immediate postmenopausal years, considerable bone tissue resorption occurs in the trabecular bone, while during the sixth and seventh decade of life, the process gathers momentum in cortical bone as well, thus leading to intensified resorption in both types of tissues (36).

Although the calcaneus is a classic example of a weight-bearing bone, it is noteworthy that the mandible is likewise loaded, with occlusal force being the most direct origin of that load. Therefore, examining the functionally as well as metabolically active sites of the calcaneus and the mandible in tandem is essential for an in-depth understanding of changes in bone turnover. Whereas reduced calcaneal BMD is firstly reflected in its trabecular area, and only later in its cortical component, mandibular BMD loss manifests itself through the decrease in its cortical thickness. For instance, mean bone loss in the mandible among females in their early 70s is estimated to be 1.5% per year (13). Mandibular bone loss is similar to other sites consisting mainly of cortical bone and the rate of mandibular bone loss is relatively high. The fast bone loss is intrinsic to this part of the skeleton due to some additional yet still unclear local factors (20).

We traced no statistically significant correlation between calcaneal and mandibular BMD loss in the examined osteoporotic population. This can probably be explained by the fact that changes in the calcaneal trabecular bone become conspicuous at an earlier stage than those occurring in the mandible. We are also inclined to assume that our findings are influenced to a significant extent by variables such as bone aging, bone composition, as well as several secondary factors. In particular, different age-related processes, disturbances affecting bone resorption and deposition, osteodystrophic diseases, hormonal fluctuations, and tooth loss induce alterations in cortical bone of the mandible, such as changes in cortical thickness, BMD, lacunar resorption in the cortical layer, and/or the development of alveolar bone destruction (10, 12, 21, 24, 37).

The National Osteoporosis Society (NOS) recommended DXL Calscan for peripheral x-ray absorptiometry examinations in 2004. Comparative studies, assessing BMD of the calcaneus with the use of DXL Calscan and that of other skeletal sites, have been published (28). However, to date, no investigations similar to ours, namely aimed at comparing panoramic radiomorphometric indices of the mandible with DXL measurements of the calcaneus, have been presented in the academic literature on the subject.

**Conclusions**

The results of the study showed that bone mineral density of the mandible calculated using the panoramic radiomorphometric indices correlated with bone mineral density of the calcaneus measured using DXL Calscan and reflected general changes in the mineralization of these bones, characteristic of the postmenopausal period. The results of our study may be explained by different anatomical structure of these two bones and by different rates of the bone aging process.

Determination of bone mineral density in the calcaneus and radiomorphometric examinations of the mandible may be used for determining changes in bone mineral density among women of this age.

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Apatinio žandikaulio panoraminių radiomorfometrinių indeksų ryšys su kulnakaulio kaulų mineralų tankių

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Raktažodžiai: kulnakaulis, apatinis žandikaulis, osteoporozė, panoraminiai radiomorfometriniai indeksai, DXL Calscan.

Santrauka. Tyrimo tikslas. Nustatyti ryšį tarp kulnakaulio kaulų mineralų tankio, išmatuoto dvigubos energijos rentgeno ir lazerio osteodensitometrijos metodu („DXL Calscan“) ir apatinio žandikaulio kaulų mineralų tankio, apskaičiuotų pagal panoraminus radiomorfometrinus apatinio žandikaulio indeksus (mentalinių indeksų, panoraminių apatinio žandikaulio indeksų), apskaičiuotus atlikus linijinius panoraminių radiogramų matavimus pomenopauzinio amžiaus moterims.


Rezultatai. Remiantis PSO (1994) nustatytais osteoporozės diagnostikos kriterijais, pagal kaulų mineralų tankio T lygmenį, tiriomosios suskirstytos į normalaus kaulų mineralų tankio (1), osteopenijos (2) ir osteoporozės (3) grupes. Kulnakaulio kaulų mineralų tankio vidurkis (±SN) bendroje tyrimo amžiaus grupėje 0,38±0,07; 1 grupės (n=34) tiriama kaulų mineralų tankio vid.±SN 0,47±0,04 (g/cm²); 2 grupės (n=65) vid.±SN 0,37±0,03 (g/cm²); 3 grupės (n=30); vid.±SN 0,29±0,03 (g/cm²). Kaulų mineralų tankio skirtumai tiriomų grupėse nustatyti ANOVA F=85,31; L.s.=2; p<0,001. (T1 vs T2 p<0,001; T1 vs T3 p<0,001; T2 vs T3 p<0,001).

Tarp mentalinių indekso (MI) ir kulnakaulio kaulų mineralų tankio tyrimo amžiaus grupėje nustatyta statistiškai reikšminga korelacija (r=0,356; p<0,001), tarp panoraminių apatinio žandikaulio indekso (PMI) ir kulnakaulio kaulų mineralų tankio (r=0,397; p<0,001).

Išvados. Kulnakaulio ir apatinio žandikaulio kaulų mineralų tankis, išmatuotas dvigubos energijos rentgeno ir lazerio osteodensitometriuo „DXL Calscan“ ir panoraminių radiografijos metodais, atspindi bendrus mineralizacijos pokyčių šiuose kauluose, būdingus pomenopauzinio amžiaus periodui.

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