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Relationship between mandibular cortical bone height and bone mineral density of lumbar spine

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SUMMARY

The aim of this study was to evaluate the association between lumbar spine bone mineral density and mandible cortical bone height at the mental foramen and at the angle of the jaw. Patients and Methods: A total of 130 women living in Lithuania, were examined. None of the participants were known to have endocrine, metabolic or skeletal disorders. Bone mineral density (BMD) was measured in the spine lumbar area L2-L4. The mandibles were examined on panoramic x-ray images. On each radiograph cortical thickness of mandible was measured at the mental foramen and at the angle of the jaw. The results demonstrated a tendency of high probability of osteoporosis in cases were radiomorphometric parameters are low. There was a significant difference between bone mineral density of lumbar spine and cortical bone height of mandible below the foramen mentale and at the angle of the jaw (p<0,01).

Key words: mandible, cortical bone mineral density, gonion, panoramic.

INTRODUCTION

Osteoporosis is the most common metabolic bone disease. It is characterized as by imbalance between bone resorption and bone formation, resulting in decrease in both trabecular and cortical bone mass [1].

It could allow reasonably infer that a patient who has osteopenia is likely to have decreased oral bone density [2]. The data of the studies showed the relationship between skeletal and mandible reduced bone mineral density (BMD) [3, 4]. M. K. Jeffcoat et al. established significant dependence between femur bone mineral density and BMD measured at the base of the mandible [3]. K. A. Southard et al. showed that bone mineral density of the lower and upper jaws correlates significantly with BMD of femur, forearm, and spine [4]. After menopause the loss of trabecular bone is much more evident than in cortical bone.

The current gold standard for diagnosing osteoporosis is changes in bone mineral density. It serves as the best predictor for individuals which likely can suffer fractures of the hip or vertebra [5]. The most commonly studied measures of mandibular morphology in relation to osteoporosis include measurements of cortical bone thickness and integrity of the inferior border in the panoramic radiographs [6]. Cortical thickness of the inferior border of the mandible below the *foramen mentale* has often been measured. The thickness of the inferior border tends to reduce in subjects with osteoporosis, although some studies have found no relationship between skeleton and mandible BMD [7, 8, 9]. If cortical thickness decreases due to reduced skeleton mineral density, it could be useful parameter in evaluation of determining metabolic bone loss.

The aim of the study was to evaluate the relationship between lumbar spine bone mineral density and mandible cortical bone height beside *foramen mentale* and at the angle of the jaw.

PATIENTS AND METHODS

In this study, 130 women aged 30 – 80 years (average age 60,3 yrs), living in Lithuania, were ex-

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amined. For avoiding side effect to the bone mineral density all risk factors having an influence to bone metabolism were excluded [10]. None of the participants were known to have endocrine, metabolic or skeletal disorders. None of women were on hormonal replacement therapy or taking calcitonin, bisphosphonates or fluorides except of low doses of calcium or vitamin D. The local ethic committee approved the study and informed consent was obtained from all subjects. The study was performed in the National Osteoporosis Center and in Þalgiris Clinical Hospital Vilnius University.

Bone mineral density (BMD) was measured in the lumbar spine L2-L4 area. The values of BMD (g/cm^2) were determined by a dual-energy x-ray absortiometry machine, Lunar DPX (GE Lunar Corporation, Madison, WI, USA) by the same operator.

According to BMD and T-score each woman was included to the two groups (OST and T-score), each of them had three subgroups (OST 1-3 and T-score 1-3). OST group was divided into: OST 1 with BMD from 0.67 to 0.93 g/cm^2; OST 2 – from 0.94 to 1.19 g/cm^2 and OST 3 – from 1.20 to 1.46 g/cm^2. T-score group was divided into: T-score 1 (osteoporotic) – women with T-score -2.5 and below, T-score 2 (osteopenic) – women with T-score ranging from -1 to -2.5 and T-score 3 (normal) – women with T-score from -1 and +1.

The mandibles were examined on panoramic images taken with radiographic apparatus ORTHOPHOS 3 (Sirona, Germany) by single operator. The position of the head was standardized. Measurements were made with an odontometer (Masel Enterprises, Bristol, PA). For evaluation of radiographic images a magnification loupe with frames (SDI, Sweden) creating a dark field was used.

The following radiomorphometric indices were measured on each radiograph in left and right sides of mandible:

1. Cortical thickness below *foramen mentale* (Cortical Index, CI) [11];
2. Cortical thickness at the angle of the mandible (Gonion Index, GI) [12].

Cortical thickness (CI) below *foramen mentale* was measured placing the rule across the image of the mandible perpendicular to the horizontal axis of the mandibular body, with the edge of the ruler adjacent to the posterior edge of the *foramen mentale*.

Two tangent lines were drawn on the panoramic radiograph – one that contacts the entire base of the mandible and one that connects the most posterior aspects of the ramus and condyle. The thickness of the cortical bone at the angle of mandible (GI) was measured along a line bisecting the angle formed by these tangents.

Each subject was allocated an identifying number and, in order to avoid bias in measurements, radiographs were measured in random order so that the observer was blind to the subject's personal details. Each panoramic radiograph was viewed three times by the same investigator in a blinded fashion, and twice – by another observer. The results demonstrated good intra-observer correlations (r=0.7-0.9; p<0.001).

Statistical analysis

All statistical analyses were performed using STATISTICA 5.5 for Windows and SPSS 12. The data were expressed as mean and standard deviation (SD). Analysis of variance (ANOVA) was performed to determine group differences in mandibular measurements. Pearson's correlation coefficient (r) was used to assess agreement between repeated measurements of cortical width, and to assess levels of association of each of the variables with bone mineral density. P values were considered to be statistically significant at the level 0.05. The descriptive analysis was performed using standard statistical indices: the arithmetic mean of the parameters, 95% confidence interval (CI), standard deviation (SD) and dispersion.

The repeatability of CI and GI was assessed using a weighted kappa statistic (ê). The characterization system devised by Landis and Koch was used to assess the degree of agreement suggested by the result kappa values [13]. These were classified as: >0.75 – excellent agreement, beyond chance; 0.4-0.75 – fair to good agreement, beyond chance; <0.4 – poor agreement.

RESULTS

The study comprised 130 women. Their age ranged from 30 to 80 years average age 60.3; SD 9.93). The osteoporosis was diagnosed in 22.3% (n=29) patients, osteopenia – in 49.2% (n=64) and 28.5% (n=37) were defined as normals.

The minimum value of bone mineral density was 0.67 g/cm^2, while the maximum value was 1.46 g/cm^2 (BMD mean 1.02 g/cm^2; SD 0.15). The minimum value of T-score was 4.30, and the maximum value was 2.30 (T-score mean 1.39; SD 1.3).

All measurements of mandibular cortical height were made on both the left and right sides of panoramic radiograms. The mean and range of values of cortical thickness below *foramen mentale* and at the gonion of the mandible are given in Table 1. There was significant correlation between the right and left sides of CI and GI measurements ($p<0.001$). Therefore, the mean of the right and left sides was used in all further statistical analyses.

The significant differences between CI and bone mineral density ($p<0.001$) are demonstrated in Tables 2, 3. Low cortical height of the mandible was typical of reduced bone mineral density.

Pearson Correlation Coefficent of radiomorphometric parametrs of mandible and bone mineral density in the lumbar spine are shown in Table 4. There was a significant correlation between cortical bone height of the mandible and bone mineral density in the lumbar spine ($p<0.001$).

DISCUSSION

During the life constant remodeling of skeletal bones is taking place. The system is balanced when bone formation occurs at the same rate as bone destruction. When decreased bone formation or increased bone resorption occurs, demineralization and the severest degree of osteopenia – osteoporosis develops. It is consider that osteoporosis could be the reason of jaws bone mineral density and mass reduction [14, 15].

Morphometric researches carried out *in vitro* demonstrated the porosity of cortical bone not only in the jaw but also in other skeleton sites of the elderly population. These changes of cortical bone were more evident among women than among men [16].

Particularly during last decade there are investigations searching for the link between bone mineral density of femur, spine and mandible. The results of different studies revealed that cortex height of a mandible significantly correlates not only with the bone mineral density of the spine but also with forearm, femur, spine and wrist BMD [3, 4, 18]. In our previous investigations we also were searching for the relation between bone mineral density and alveolar ridge height, panoramic-based mandibular indices and tooth loss [8, 19, 20]. The results of present study demonstrated the meaningful dependence between cortical bone height of mandible below the *foramen mentale* and bone mineral density of lumbar spine ($r=0,478$, $p<0.01$) and cortical bone height at the angle of mandible and bone mineral density of lumbar spine ($r=0,493$, $p<0,01$). Cortical bone height below *foramen mentale* and at the gonion of mandible significantly depends on BMD of lumbar spine ($p<0.01$). Studies of H. Devlin and K. Horner showed the results which coincided with ours [21]. These authors proved that cortical bone height of the mandible significant depends not only upon the spine BMD ($r=0.514$; $p<0.01$) but also upon the bone mineral status of femur and forearm ($p<0.01$). Similarly to the data of other researchers that have been carried out, the data of our study also proved that cortical width dependended significantly on the state of bone mineral density of the lumbar spine ($p<0.05$).

To judge about the structural changes of the mandibular bone is possible to estimate the cortical bone changes of mandible on the panoramic images [21]. The results of our study indicated that the cortex height of lower jaw depends significantly on the bone mineral density both on the left and the right sides of the man-

Table 1. The mean and range of values of cortical thickness below foramen mentale and Gonion Index

Indices	N	Minimum (mm)	Maximum (mm)	Mean (mm)	SD
Cortical thickness below *foramen mentale*	130	0.60	7.30	3.3754	1.3667
Gonion Index	130	0.50	2.40	1.2577	0.4273

Table 2. Cortical thickness (CI) below foramen mentale in different bone mineral density groups (OST 1 - OST 3)

BMD group	N	CI mean	SD	Lower 95% CI	Upper 95% CI	Minimum	Maximum
OST 1	28	2.6821	1.1291	2.2443	3.1200	1.10	5.60
OST 2	85	3.4318	1.3651	3.1373	3.7262	0.60	7.30
OST 3	17	4.2353	1.2170	3.6096	4.8610	1.90	6.10
Total	130	3.3754	1.3667	3.1382	3.6125	0.60	7.30

Table 3. Cortical thickness (CI) below foramen mentale in different T-score groups (T-score 1 - T-score 3)

T-score group	N	CI mean	SD	Lower 95% CI	Upper 95% CI	Minimum	Maximum
T-score 1	29	2.6517	1.1208	2.2254	3.0780	1.10	5.60
T-score 2	64	3.2750	1.3157	2.9463	3.6037	0.60	6.00
T-score 3	37	4.1162	1.2973	3.6837	4.5488	1.90	7.30
Total	130	3.3754	1.3667	3.1382	3.6125	0.60	7.30

Table 4. Pearson Correlation Coefficent of radiomorphometric parametrs of mandible and bone mineral density in the lumbar spine (N=130)

Radiomorphometric meassurements of mandible	*Pearson* Corr. Coeff.	p value
Cortical thickness below *foramen mentale* (mm)	0.478	<0.001
Cortical thickness at the angle of mandible (mm)	0.493	<0.001

dible (p<0.01). These results mainly confirm that panoramic x-ray images yield suitable information for diagnosing the risk of osteoporosis. If the inferior mandibular cortex is low, there is a tendency of high probability of osteoporosis. In the current study we have demonstrated that there was a significant relationship between the mineral density of the lumbar spine and mandibular cortex radiographic changes.

CONCLUSIONS

In the present study we found significant difference (p<0.01) between bone mineral density of the lumbar spine and cortical bone height of mandible below *foramen mentale* and at the angle of the jaw. Positive correlation between osteoporotic and mandibular radiographic changes was observed.

REFERENCES

1. Lerouxel E, Libouban H, Moreau MF, Baslé, Audran M, Chappard D. Mandibular bone loss in an animal model of male osteoporosis (orchidectomized rat): a radiographic and densitometric study. *Osteoporos Int* 2004;15:814-19.
2. Wactawski-Wende J, Grossi SG, Trevisan M, Genco RJ, Tezal M, Dunford RG, et al. The role of osteopenia in oral bone loss and periodontal disease. *J Periodontol* 1996;67:1076-184.
3. Jeffcoat MK, Lewis CE, Reddy MS, Wang CY, Redford M. Post-menopausal bone loss and its relationship to oral bone loss. *Periodontol 2000* 2000;23:94-102.
4. Southard KA, Southard TE, Schlechte JA, Meis PA. The relationship between the density of the alveolar processes and that of post-cranial bone. *J Dent Res* 2000;79:964-9.
5. Miller PD, Bonnick SL. Clinical application of bone densitometry. In: Favus MJ (ed). Primer on the metabolic bone diseases and disorders of mineral metabolism. Philadelphia: Lippincott Williams & Wilkins; 1999. p. 152-9.
6. White SC. Oral radiographic predictors of osteoporosis. *Dentomaxillofac Radiol* 2002;31:84-92
7. Bollen AM, Taguchi A, Hujoel PP, Hollender LG. Case-control study on self-reported fractures and mandibular cortical bone. *Oral surg Oral Med Oral Radiol Endod* 2000;90:518-24.
8. Balcikonyte E, Balciuniene I, Alekna V. Panoramic radiographs in assessment of the bone mineral density. *Stomatologija. Baltic Dent Maxillofac J* 2004;6:17-9.
9. Mohajery M, Brooks SL. Oral radiographs in the detection of early sighs of osteoporosis. *Oral Surg Oral Med Oral Pathol* 1992;73:112-7.
10. Lindsay R, Cosman F. Prevention of osteoporosis. In: Favus MJ , editor. Primer on the metabolic bone diseases and disorders of mineral metabolism. Philadelphia: Lippincott Williams & Wilkins; 1999. p. 264-70.
11. Drozdzowska B, Pluskiewicz W, Tarnawska B. Panoramic-based mandibular indices in relation to mandibular bone mineral density and skeletal status assessed by dual energy X-ray absortiometry and quantitative ultrasound. *Dentomaxillofac Radiol* 2002;31:361-7.
12. Ledgerton D, Horner K, Devlin H, Worthington H. Radiomorphometric indices of the mandible in a British female population. *Dentomaxillofac Radiol* 1999;28:173-81.
13. Landis JR, Koch GG. The measurement of observer agreement for categorial data. *Biometrics* 1977;33:159-74.
14. Tamulaitienė M, Alekna V. Osteoporozės diagnostika kaulų mineralų tankio tyrimo metodu. Metodinės rekomendacijos. Vilnius; 2000.
15. Tezal M, Wactawski-Wende J, Grossi SG, Ho AW, Dunford R, Genco RJ. The relationship between bone mineral density and periodontitis in postmenopausal women. *J Periodontol* 2000; 71:1492-8.
16. von Wowern N. Bone mass of mandibles. In vitro and in vivo analyses. *Dan Med Bull* 1986;33:23-44.
17. Kassem M, Melton LJ, Riggs BL. The type I/ type II model for involution osteoporosis. In: Marcus R, Fedman D, Kelsey J, editors. Osteoporosis.1st ed. San Diego: Academic Press; 1996. p. 691-702.
18. Horner K, Devlin H. The relationship between mandibular bone mineral density and panoramic radiographic measurements. *J Dent* 1998;26:337-43.
19. Balcikonyte E, Balciuniene I, Alekna V. Bone Mineral Density and Radiographic Mandibular Body Height. *Stomatologija. Baltic Dent Maxillofac J* 2003;5: 137-40.
20. Balčikonytė E, Alekna V, Tamulaitienė M. Dantų skaičiaus priklausomybė nuo juosmeninės stuburo dalies ksulų mineralų tankio. *Gerontologija* 2007:8:165-170.
21. Devlin H, Horner K. Mandibular radiomorphometric indices in the diagnosis of reduced skeletal bone mineral density. *Osteoporos Int* 2002;13:373-8.

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