The Influence of Gender and Age on the Values of Linear Radiomorphometric Indices Measured on the Lower Border of the Mandible

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Summary

Osteopenia (bone loss, first symptom of osteoporosis) can be identified radiographically - by a reduction in radiopacity of bone measuring the bone density or by observation of thinned cortices, porosity of the cortices, or changes in trabecular pattern on dental panoramic radiographs (DPRs). The objective of this study was to measure mental, antegonial and gonial radiomorphometric indices of the mandible on 200 DPRs taking into account age and gender of the participants. Three indices: cortical width at the gonion (GI), antegonion (AI) and below the mental foramen (MI) were measured at the lower border of the mandible, bilaterally on 200 DPRs. The reliability of the measurements ($p= 0.89$ for a dental student, $p=0.93$ for a dentist) and agreement between the observers (= 0.81) were satisfactory. The results of the study revealed significant difference between GI measured on the left and right side of the mandible ($p<0.001$). Male patients demonstrated significantly higher measured values for MI than female patients ($p<0.001$), and finally, female patients older than 65 years showed significantly lower measured AI values than those younger than 65 years. Based on the results of this study, we conclude that the DPR is useful as a simple method of screening patients for evaluation of mandibular bone quality prior to dental treatment.

Key words: *linear radiomorphometric index, osteopenia, mandible.*

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Introduction

In human beings, the loss of bone mass with increasing age is a universally observed phenomenon. Human bones begin to decrease in density and increase in porosity at about the third decade of life (1, 2).

Osteoporosis is a term used to describe a significant age-related deficiency in bone mass with potential structural failure (3, 4).

Many different bone-mass measuring techniques are used for the diagnosis of bone structure changes: absorptiometry (5-12), quantitative computed tomography (CT) (13-15) and neutron activation analysis (16, 17). However they increase the treatment cost and involve expensive measurement equipment.

Osteopenia (bone loss, first symptom of osteoporosis) can be identified radiographically - by a reduction in radiopacity of bone (measurement of bone density (18, 19)) and by observation of thinned cortices, porosity of the cortices, or changes in trabecular pattern on panoramic radiographs.

Radiographic assessment of 'bone quality' has applications in implantology and in research, assessing the relationship between oral bone loss and osteoporosis (20, 21).

The objective of this study was to measure radiomorphometric indices of the mandible on 200 panoramic radiographs taking into account age and gender of participants.

Materials and methods

The sample

The patient sample was selected from a group of patients at the Department of Prosthodontics and Department of Periodontics, School of Dental Medicine, University of Zagreb. A total number of 200 patients were routinely screened by dental PR prior to the treatment. The Ethics Committee of the Dental School had approved this study, as the patients were exposed to X-rays, needed for diagnosis and future treatment. Voluntary written informed consent was obtained from each patient.

Finally, only 183 DPRs were included in the statistical analysis. Seventeen DPRs were excluded because of the poor quality of DPR, which disabled radiomophometric assessment or because of the different type of panoramic equipment used.

There were 73 male patients (mean age 46; range 21 to 87 years) and 110 female patients (mean age 45; range 15 to 80 years).

Of the 183 patients, 52 were totally edentulous and 94 had some teeth remaining, anterior to the first premolars in the mandible (Kennedy class I) and 37 had all the teeth in the mandible.

Radiographic examination

DPR was performed with a constant current of 16 mA and an exposure time of 16 sec; the kV varied between 65 and 78 kV (Siemens, Orthopos, Germany). Images were recorded using Kodak film. All films were processed together in an automatic dark chamber processor (D(rr Dental XR 24 Nova) for 12 minutes.

Linear radiomorphometric indices assessment

To assess radiomorphometric indices of the mandible, the DPRs were viewed using a flat viewbox in a room with subdued light. Measurements were made using a x 4 magnifying loupe (Getaldus, Zagreb, Croatia) and a precise calliper with precision of 0.1 mm (MEBA, Zagreb, Croatia).

The following radiomorphometric indices were measured on DPRs: cortical thickness below the mental foramen (MI), gonion index (GI) and antegonial index (AI) on both sides of the mandible.

The methods of measuring GI (22), AI (23) and MI (24) have been previously described.

Observer training

One dentist and one dental student (after a thorough introductory lecture) assessed the radiomorphometric indices on all dental PRs and the measurement was repeated after an interval of one week. No significant difference was noted between the first and second measurement ($p= 0.89$ for the dental student, $p=0.93$ for the dentist; paired t test). The weighted kappa statistics showed satisfactory agreement between the observers (= 0.81). As the reliability of the measurements and the agreement were satisfactory, the assessment of the dentist were con-

sidered for statistical analysis, as she was more consistent between the first and the second measurements.

Statistical analysis

The data were analysed using the SPSS 10.0 statistical package (descriptive statistics, testing the normality of the distribution, non-parametric statistics).

Kruskal-Wallis test was used to compare linear morphometric measurement variables within gender and within the age of the patients ($p<0.05$).

Sign test was used to compare the same linear morphometric measurement variables on the left and right side of the mandible ($p<0.001$).

Results

Our study group of patients was not selected on the basis of any radiographic or medical criteria, which would define an individual as 'normal' or 'osteoporotic' and was not chosen from any particular dental speciality. The group, therefore, represented a typical range of female and male patients in the age range from 15 to 87 years, who had undergone a dental PR examination as part of prosthetic or periodontal treatment.

One-sample Kolmogorov-Smirnov test revealed that all the morphometric measurement variables were not distributed normally ($p<0.001$). Therefore, non-parametric tests were used for testing the statistically significant differences.

All the morphometric measurements were made on both the left and right sides of the mandible. The mean values (x) and their standard deviations (SD) for all the measured radiomorphometric indices (AI, MI and GI) on the left and right side of the mandible are shown in Figure 1.

Non-parametric Sign test showed statistically significant difference between GI measured on the left and right side of the mandible (Figure 1, Table 1) ($p<0,001$).

Therefore, the mean of the MI and AI measurements on the right and left side of the mandible was used in all further statistical analyses.

The mean (x) and standard deviations (SD) for variables AI, MI, GIR (on the right side of the mandible) and GIL (on the left side of the mandible) depending on the gender of the patients are shown in Figures 2-5.

The mean values of AI, MI and GIR measured in the females were lower than the mean values of AI, MI and GIR measured in the males (Figures 2-4).

The mean value of GIL measured in the females was higher than the same value measured in the males (Figure 5).

Non-parametric Kruskal-Wallis test demonstrated statistically significant difference for the measured MI dependent on the gender of the patients ($p<0.001$, Table 2).

The 183 patients were divided into 7 different groups dependent on age. The mean values (x) and standard deviations (SD) for all the measured morphometric indices (AI, MI, GIR and GIL) are shown in Table 3.

Non-parametric Kruskal-Wallis test did not demonstrate statistically significant difference for the measured MI, AI, GIR and GIL dependent on the different age group of the patients ($p>0.05$).

When the patients were separated according to gender into two different age groups (Group 1 - female/male patients up to 65 years; Group 2 - female/male patients of 65 years or more statistically significant difference appeared in the female group for the antegonial thickness of the mandible ($p<0.001$) (Figure 6, Table 4).

At the same time, there was no statistically significant difference between those two age groups in males ($p>0.05$) (Figure 6).

Discussion

All measurements taken in this study were not corrected for the magnification inherent in panoramic radiography. All radiographs were produced using the same type of panoramic equipment with nominal magnification factor 1.2 (17 panoramic radiographs were excluded because of the different type of panoramic equipment used) (25, 26).

Clearly, any researchers using the measurements presented here would need to modify them appro-

priately to permit comparison with data obtained using different panoramic equipment.

The majority of the studies on mineral bone changes in the mandible, as well as in the skeleton, take into consideration only the female population in pre- meno- and post-menopause, with or without signs of systemic osteoporosis.

Our study group represented a typical range of female and male patients with the need of prosthodontic or periodontal treatment.

All the measurements of linear radiomorphometric indices were made on both the left and right sides of the mandible. Although Ledgerton et al. found no significant differences between the measurements on the left and right sides of the mandible measuring GI, AI and MI ($p>0.05$) (23), the results of our study have shown statistically significant difference between the measurements of GI on the left and right side of the mandible in our sample group ($p<0.001$). The GI values measured for the left and right side of the mandible were therefore included in our further statistical analysis.

Ledgerton et al. (23) also reported negative correlation of GI, MI and AI with age in a British female population. In their study gonion cortical bone demonstrated a very gradual thinning with age until the sixth decade when its value dropped quite sharply. The results of our study also demonstrated sharp decreasing of some values of radiomorphometric indices (AI) in the female population at the age of 65 ($p<0.001$).

Analysis of variance in Ledgerton's study demonstrated significant differences between the younger (<50 years) and older (>60 years) age groups for all three cortical width indices ($p<0,001$) (23). The results of Ledgerton's study confirm some previous reports (22, 27-29).

The results of our study revealed statistically significant difference for the measured MI between males and females ($p<0.001$). The females demonstrated lower values of MI measurements than the males which could be attributed to the constitutional differences between the sexes.

Contrary to Ledgerton's results (23), the only statistical difference depending on the age of the patients in our study was found when the patients were separated according to gender into two different age groups (those younger than 65 years and those of 65 years or more). Statistically significant difference appeared in the female group for AI measurement ($p<0.001$). These were expected results as it is well known that the female population in the middle sixties are about 10 years into the post-menopause process and hormonal changes have stimulated bone resorption, even in the lower parts of the mandible.

It could also be argued why statistical difference was found only at AI. The cortical thickness at both the AI and GI might be influenced by the local effects of muscle attachments, and this factor might influence their usefulness as indicators of skeletal osteopenia.

On the other hand, local muscle attachments, of course, cannot be an influential factor for MI.

Conclusion

The results revealed the significantly difference between GI measured on the left and right side of the mandible ($p<0.001$).

Male patients demonstrated significantly higher measured values for MI than the female patients ($p<0.001$).

Female patients 65 years and over showed significantly lower measured AI values than those younger than 65 years.

Based on the results of this study, we conclude that the dental PR is useful as a simple method of screening patients for evaluation of mandibular bone quality prior to dental treatment.

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