

Influence of Age and Gender on Radiomorphometric Indices of the Mandible in Removable Denture Wearers

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ABSTRACT

The objective of this study was to measure and assess a number of radiomorphometric indices of the mandibular removable denture wearers taking into account age and gender. In a total of 136 dental panoramic radiographs (DPR) the following parameters were evaluated: MI = thickness of the mandibular cortex below the mental foramen, AI = thickness at the antegonion and GI = thickness at gonion; PMI = MI/distance between the low border of the mandible and the low border of the mental foramen, and MCI = mandibular cortical index, based on the assessment of the 3 categories of cortical appearance due to the resorptive changes. There were 40 male patients (mean age 72.7; range 56 to 84 years) and 96 female patients (mean age 69.7; range 48 to 86 years). Patients were grouped according to age into three age groups (1 = less than 65 years; 2 = 65–75 years; 3 = more than 75 years). The results revealed that MI, PMI, AI and GI showed a general downward trend with age for the both sexes until 75 years of age when the mean values of GI, AI and MI begun to fall down sharply for females compared to males. The difference was significant between age groups and gender for GI and AI. Only two categories (C2 and C3) of MCI have been recognized in our study sample, due to the relatively old age groups of patients with removable dentures. However, significantly higher incidence of C3 existed in the oldest group of females.

Introduction

Radiographic assessment of bone 'quality' is of value in denture planning treatment and has been proposed as a means of identifying patients with osteoporosis¹. Large number of methods for the assessment of mandibular bone loss have been proposed. Some of them are recognized techniques like gamma-photon absorptiometry²⁻⁴, X-ray dual-photon absorptiometry⁵⁻⁹, single-photon absorptiometry⁹⁻¹¹, dual-energy absorptiometry¹²⁻¹⁶, quantitative computed tomography¹²⁻¹⁶ and neutron activation analysis^{17,18}, but they increase the treatment cost and demand an expensive measurement equipment.

The success of the prosthodontic treatment is dependent on the state of bone tissue in jaws since successful removable denture wearing requires a certain amount of bone under the denture to provide stability during the mastication.

Therefore, it may be possible for dentists, who undertake dental panoramic radiographs (DPRs) for treatment purposes to recognize patients with low bone mineral density (BMD).

Previous work has established that significant correlation between densities of the skeletal sites (hip, lumbal spine, etc.) and the mandible exists¹⁹⁻²¹.

The objective of this study was to measure a number of radiomorphometric indices of the mandible in removable denture wearers taking into account age and gender.

Materials and Methods

The patient sample was selected from a group of complete and partial removable denture wearers at the Department of Prosthodontic, School of Dental Medicine, University of Zagreb. The total of 136 patients were routinely screened by DPR prior to the treatment. Ethics Com-

mittee of the Dental School has approved this study, as the patients were exposed to X-rays for the need of the diagnosis and future treatment planning.

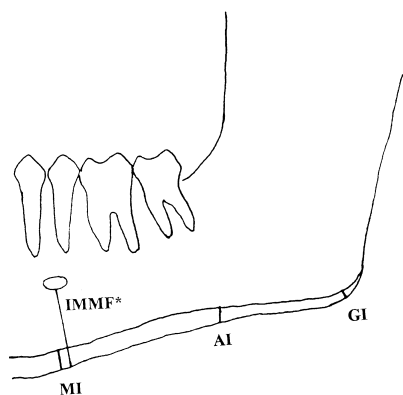
There were 40 male patients (mean age 72.7; range 56 to 84 years) and 96 female patients (mean age 69.7; range 48 to 86 years). Patients were grouped according to age into three age groups (1 = less than 65 years; 2 = 65–75 years; 3 = more than 75 years). Of 136 patients, 72 were totally edentulous and 64 had some teeth remaining only anterior to the second premolars in the mandible.

DPR was performed with a constant current of 16 mA and an exposure time of 16 sec; the kV varied between 68 and 80 kV (Siemens, Orthopos, Germany). Images were recorded using the Kodak film for DPRs. All films were processed together in an automatic dark chamber processor (Dürr Dental XR 24 Nova) for 12 minutes.

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 $\times 4$ magnifying loupe (Getaldus, Zagreb, Croatia) and a precise caliper with the precision of a 0.1 mm (MEBA, Zagreb, Croatia).

The following radiomorphometric indices were measured on DPRs: cortical thickness below the mental foramen (MI), gonion index (GI), antegonial index (AI), panoramic mandibular index (PMI) and mandibular cortical index (MCI) on the right side of the mandible.

The methods of measuring GI²², AI²³, MI²⁴ and PMI²⁵ have been previously described (Figure 1). MCI was assessed according to the criteria defined by Klemetti at al²⁵ (Figure 2). Two different observers measured MI, GI, AI and PMI on randomly selected 10 DPRs and the measurement was repeated after a week interval. No significant difference was



*IMMF – internal margin of mental foramen

Fig. 1. Measurement of MI, AI, GI and PMI (MI/IMMF).

noted between the observers and between the first and the second measurement ($p = 0.935$). The same observers assessed MCI. The weighted kappa statistics showed satisfactory agreement ($\kappa = 0.87$).

Although the reliability of the measurements and the agreement was satisfactory, only one observer measured and classified all parameters.

The data were analyzed with the SPSS 10.0 statistical package (descriptive statistics, cross-tabulations, Chi-square and ANOVA).

Cross-tabulations were performed to investigate the distribution of MCI within each age group and gender. ANOVA was used to compare mean values of the measured indices within age group and gender ($p < 0.05$).

Results

The overall distribution of MI, GI, AI and PMI in this study was normal. The means and the standard errors of mental (MI), gonial (GI) and antegonial (AI) cortical width (mm), as well as PMI related to the age groups and gender of the patients are presented in Figure 3.

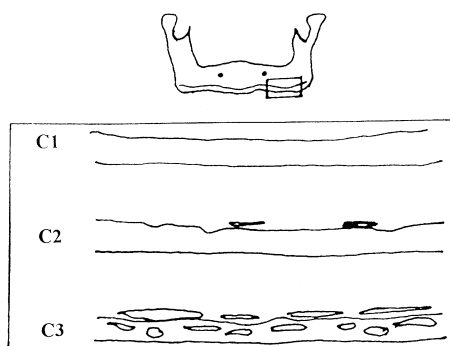


Fig. 2. Diagram illustrating the classification of the endoseal inferior cortex (MCI) on panoramic radiographs into Groups C 1–3.

The mean MI for the studied sample was 4.66 mm (range: 1.9–7.7), the mean GI was 1.46 mm (range: 0.7–2.7), the mean AI was 3.42 mm (range: 1.4–5.9) and the mean value for PMI was 0.37 (range: 0.17–0.58).

The distribution of MCI by age groups is shown in the Figure 4, and the distribution of MCI by gender is shown in the Figure 5. In evaluation of MCI, only two appearance categories were observed, the majority (58.8%) demonstrating type 3 cortices whilst the remainder (41.2%) was demonstrating type 2. None of the patients had category 1 of MCI.

Category C3 of the mandibular cortex (the endosteal margin consists of thick cortical residues and it is clearly porous, Figure 2) demonstrated the highest mean values in the oldest age group (more than 75 years) (Figure 4) and in the female population (Figure 5).

The mean values of four measured indices (MI, GI, AI, PMI) were significantly higher in males than in females, especially in the oldest age group (Figure 3).

Considering AI, MI and GI there was a general downward trend with age for both sexes with lower values for the females, until 75 years when the mean val-

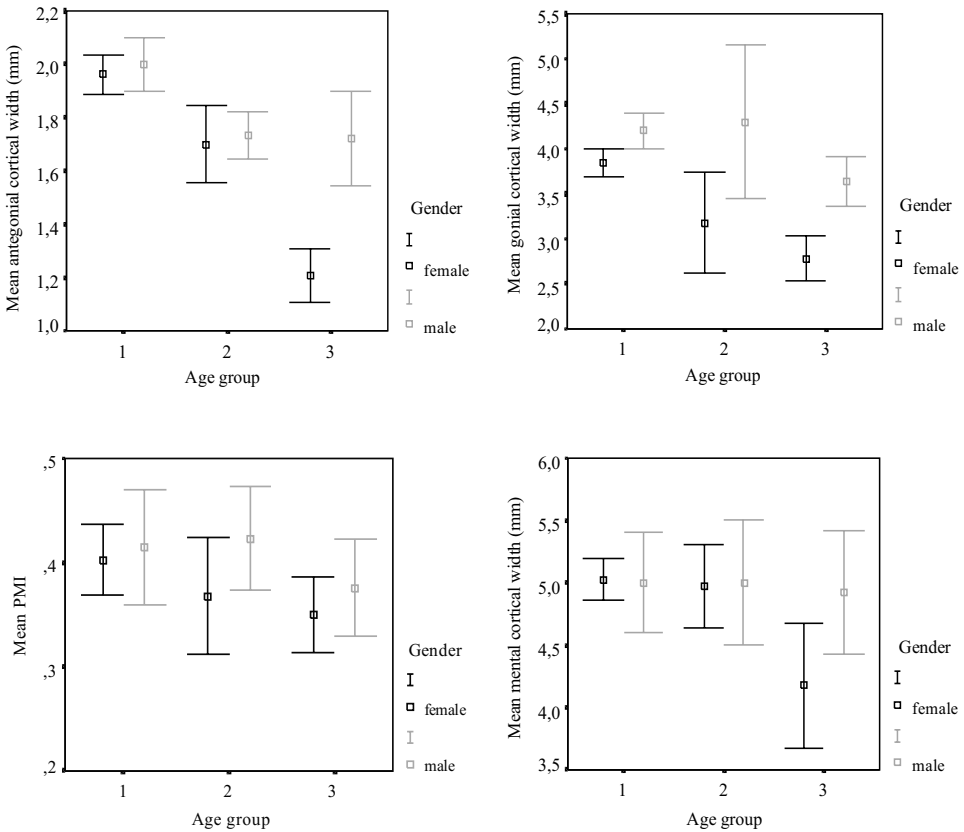


Fig. 3. Means (\pm standard error) of gonial, antegonial, mental and panoramic mandibular index (GI) related to the age and gender of the patients. Age groups: 1 = less than 65 years, 2 = 65–75 years, 3 = more than 75 years.

ues begun to fall down sharply for the females compared to the males. (Figure 3). PMI also demonstrated higher values for males and the general downward trend with age for both sexes (Figure 3).

ANOVA (univariate) demonstrated statistically significant difference for GI between age groups ($F = 4.89$, $p = 0.028$), and gender ($F = 5.78$, $p = 0.021$), but in combination of age and gender ($F = 2.38$, $p = 0.12$) the difference did not reach the significant level. The same was for AI between age groups ($F = 3.98$, $p = 0.048$) and gender (4.38 , $p = 0.035$), but in combination of age and gender, the difference

was significant ($F = 3.1$, $p = 0.49$). MI and PMI demonstrated no significant difference between age groups and gender ($p > 0.05$), although all the values were higher for males in each age group, especially in the oldest age group for MI.

Cross tabulation of MCI by age group demonstrated an age-related pattern, which was confirmed by the chi-squared test for trend ($\chi^2 = 11.2$, $p = 0.048$), as well as gender related pattern ($\chi^2 = 16.7$, $p = 0.028$), with significantly higher frequency of MCI category 3 in the oldest age group and in females.

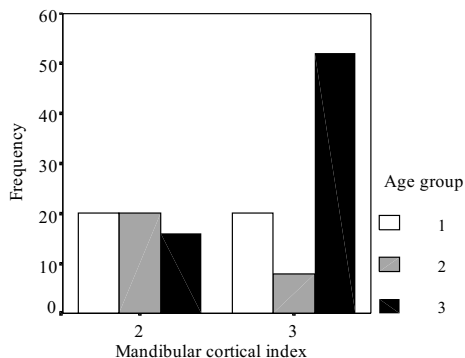


Fig. 4. The frequency of the mandibular cortical indeks categories (C1, 2 and 3) related to age group of patients. Age groups: 1 = less than 65 years, 2 = 65–75 years, 3 = more than 75 years.

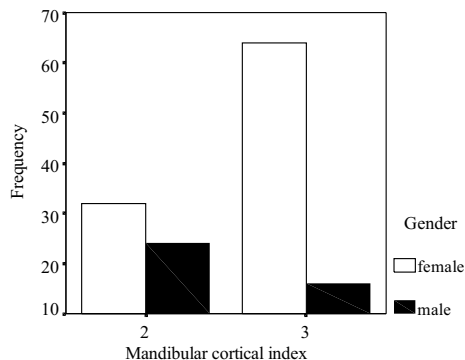


Fig. 5. The frequency of the mandibular cortical indeks categories (C1, 2 and 3) related to gender of patients.

Discussion

The 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 specialty. The group therefore represented a typical range of older female and male patients, drawn from the Department of Prosthodontics within the School of Dental Medicine, University of Zagreb, Croatia, who had undergone a DPR examination as part of the prosthetic treatment.

In this study none of the patients had category 1 of MCI, which was attributed to the relatively aged group of the patients (the youngest had 48 years and next age was 52 years) and it is well known that the first signs of bone loss start at the age of 30 years²⁶.

The results reported by Ledgerton at al.²³ indicated the significant, negative correlation of the quantitative indices (GI, MI, AI and PMI) with age. The results of their study also showed the age-related distribution of MCI, therefore, it was reassuring to see an age-related increase in the numbers of individu-

als with C3 appearances, presumably reflecting age-related bone loss²³, which is also proved by the results of this study (Figures 4 and 5). However, the results of this study, also reflected gender and age bone loss, with C3 showing significantly higher incidence in females of the oldest age group ($p < 0.05$; Figures 4 and 5).

The relative proportions of the three MCI classes on the age groups from 45 to 54 years in Legerton's study²³ were similar to those reported by Klemetti¹⁴ in their study of 355 Finnish women (48–56 years). However, Taguchi at al.²⁷ identified a far greater proportion of C1 cortices in their study of 124 Japanese women in a broad age band (33–68 years). This may reflect ethnic differences or a difference in the interpretation of the definitions of the MCI groups, or could be attributed to the fact that younger age group participated in the study.

It may be that a modification of MCI by dividing C3 into early and late C2 changes would improve the classification because the main discrepancy occurred in those who lay on the border of two categories (C1/C2 of C2/3)²³.

Some previous studies are confirming the negative correlation of GI with

age^{22,23,28–30}, which was also confirmed in this study, both for age and gender ($p < 0,05$; Figure 3).

It could be argued that cortical thickness at both the antegonion (AI) and gonion (GI) might be influenced by the local effects of muscle attachments (m. masseter). This factor might influence their usefulness as indicators of skeletal osteopenia²³. However, the results for AI in this study presented significant difference between age groups and gender and significant difference of gender and age together ($p < 0,05$; Figure 3). This might be due to the factors, such as osteopenia and also to the low force of m. masseter exerting on this region during mastication in the oldest age group and in females.

In contrast, local muscle attachments, of course, cannot be an influential factor for MI²³.

PMI demonstrated similar age-related correlations as those of MI²³. The results of this study showed more sharp downward trend for MI than PMI (Figure 3) and the difference between gender and age groups did not reach statistical significant level for both, MI and PMI ($p > 0.05$). Benson³¹, who first proposed the PMI, measured the right inferior PMI on a group of Texan subjects, concluding that the mean PMI showed a statistically significant difference between the younger and older female age groups, findings which were confirmed in Ledgerton studies²³.

Ledgerton's population mean²³ (0.324 mm) is also very similar to that shown by Benson³¹ for the mean PMI for white females (0.318 mm) and thus differs from the mean value quoted by Klemetti³² for postmenopausal, Finnish females (0.38 mm) and the results of our study for postmenopausal, Croatian females (0.37 mm), a finding which may reflect ethnic differences for the relationship: mental

cortical width / distance between low inferior margin of the mental foramen and the low border of the mandible.

The pattern of change in mean PMI demonstrated throughout the age range also differs from that described by Taguchi³³ who suggested that, in females, PMI demonstrated a gradual increase until the sixth decade and then decreased.

In Ledgerton's study²³, PMI demonstrated a very gradual reduction with age until the sixth decade, when the mean value fell sharply. In this study, reduction of PMI was gradual in all age groups, while the reduction of MI was more sharp in females of the oldest age group (> 75 years). In Ledgerton's³³ cases, ethnic origin and younger age groups than our sample seemed the likeliest reason for differences in age-related patterns of PMI.

Although measurements on DPRs are sometimes questioned due to the dimension changes, it has been recently proved that the measurements are reliable if they do not cross the midline³⁴ and the use of the indices with the relation of the two vertical dimensions is reliable anyhow³⁵.

Conclusions

MI, PMI, AI and GI showed a general downward trend with age for the both sexes until 75 years of age when the mean values of GI, AI and MI began to fall down sharply for females compared to males. The difference was significant between age groups and gender for GI and AI.

Only two categories (C2 and C3) of MCI have been recognized in our study sample, due to the relatively old age groups of patients with removable dentures. However, significantly higher incidence of C3 existed in the oldest group of females.

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UTJECAJ DOBI I SPOLA NA VRIJEDNOST RADIOMORFOMETRIJSKIH INDEKSA DONJE ČELJUSTI U NOSILACA MOBILNIH PROTEZA

SAŽETAK

Svrha ovog istraživanja bila je izmjeriti i procijeniti različite radiomorfometrijske indekse donje čeljusti kod nosilaca mobilnih proteza, ovisno o dobi i spolu. Na 136 ortopantomograma uzeti su u obzir slijedeći parametri: MI = debljina korteksa mandibule ispod foramena mentale, AI = debljina korteksa mandibule na antegonionu, GI = debljina korteksa mandibule na gonionu, PMI = MI/udaljenost između donjeg ruba foramena mentale i donjeg ruba mandibule i MCI = mandibularni kortikalni indeks, teme-

ljen na prosudbi 3 kategorije izgleda korteksa, ovisno o resorpciji. Sudjelovalo je 40 muškaraca (prosječna dob 72,7 godina; raspon 56 do 84 god.) i 96 žena (prosječna dob 69,7 godine; raspon 48 do 86 godina). Pacijenti su prema starosti bili podijeljeni u 3 dobne skupine: 1 = mlađi od 65; 2 = 65–75; 3 = stariji od 75 godina. Dobiveni rezultati pokazali su da je za MI, PMI, AI i GI postojao opći trend prema nižim vrijednostima s povećanjem starosti i kod muškaraca i kod žena do 75 godina, kada su srednje vrijednosti GI, AI i MI počele padati naglo kod žena u usporedbi sa muškim spolom. Razlika je bila statistički značajna za spol i dobnu skupinu kod GI i AI. Zabilježene su samo dvije kategorije (C2 i C3) za MCI kod svih ispitanika, što je pripisano relativnoj starijoj populaciji pacijenata koji nose mobilne proteze. U najstarijoj dobnoj skupini, a najviše kod žena pojavnost kategorije C3 za MCI bila je najveća.