Original Study

THE INFLUENCE OF AGE,GENDER AND DENTAL STATUS ON THE MANDIBULAR RADIOMORPHOMETRIC AND MORPHOLOGICAL INDICES

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Abstract

Aim: Thickness of mandibular inferior cortex is an interesting measurement for diagnosis patients with osteoporosis. Therefore it can be used for screening people with low bone density as a quick and easy way. The aim of this study was to measure some indices in digital panoramic radiography for evaluation mandible of patients referred to a private clinic and examine the relationship between them and parameters such as age, gender and dental status.

Materials and Method: Four indices (MI, PMI, MCI and M/M) were measured on 270 digital panoramic radiographs (from 134 women and 136 men) with Foxit Reader Bidirectional (v.3). Data about patient's age, gender and dental status were gathered and by using statistical analysis (T-test, Anova, One-Way, and Chi-square) statistical relationship between indices and these 3 parameters were evaluated.

Results: MI and M/M reduced significantly with age. PMI, M/M and MCI had a significant relationship with gender ($P<0.05$). M/M and MCI showed significant reduction with increased number of missing teeth ($P<0.05$). Quantitative indices (MI, PMI and M/M) had a significant relationship with MCI ($P<0.05$).

Conclusion: In general, a series of more practical indices for evaluating bone density such as cortical thickness and morphology can be influenced by age, gender and dental status. Therefore, all indicators are not reliable for screening reduced bone density.

Keywords: Mandible, Osteoporosis, Panoramic radiography.

Introduction

Osteoporosis is the most common metabolic bone disease which increases the risk of bone fracture due to reduction of bone mass and weakening the microscopic structure of skeleton. Established osteoporosis is not possible to return to normal condition, but in many cases it can be prevented with early intervention.[1] As age increases, progressive changes occur throughout the body, including osteoporotic.[2] This disease can be diagnosed by panoramic radiography in dental clinics.[3]

Results of the prosthetic treatment depend on the condition of jaw bones. A successful removable denture needs a certain amount of the underlying bone for stability during mastication.[4] Success rate of some dental procedures like dental implants is directly related to the quality of the jaw bone. Having appropriate and enough bone around an implant is necessary for desirable bone formation and stability during the healing period. Reduced bone density of the body skeleton such as the spine, metacarpal and radius can associate with advanced periodontal disease, severe bone loss of alveolar ridge and tooth loss after menopause.[5] A continuous reconstruction of mandibular cortex can be seen depending on the oral health, age and sex.[6]

Among the existing methods for measuring bone density, quantitative CT of the spine is the most sensitive diagnostic way for osteopenia, but Dual Energy X-Ray Absorptiometry of the lumbar spine or pelvic is the method of choice in most patients. These techniques cannot be used as screening method due to high cost and limited accessibility.[7]

The simplest and cheapest method is radiomorphometry which means the use of indices of bone morphology in radiographs.[7] According to many researchers, there is a significant correlation between changes in the density of overall skeleton and mandibular bone density.[8] Some radiomorphometric indices of mandible which can be evaluated on panoramic radiographs have significant relationship in bone density reduction. But the important point is that these indices can be affected by age, sex and dental status. Since panoramic radiographs routinely are ordered, we can use them to assess mandibular indices. This study aimed to assess the relationship between the mandible radiomorphometric indices and age, sex and dental status.
Radiomorphometric indices:

1. MI (Mental Index)[9] or IC (Inferior Cortex)[1] or MCW (Mandibular Cortical Width):[10] thickness of mandibular lower cortex in the area of mental foramen which is a quantitative index. It can also be used to assess bone quality.[10]
2. MCI (Mandibular cortical index): the only mandibular qualitative index which was introduced by Klemetti for the first time.[11] Mandibular lower cortex at the distal aspect of mental foramen is used to classify MCI index.[12] [Figure 1A; 1B and 1C]
3. PMI: According to the Benson and colleagues[13] PMI is thickness of mandibular inferior cortex in mental foramen area. It can also be used for assessing bone quality.

MCI is used for describing the shape of mandibular inferior cortex. MCI and PMI are 2 indices which are

used in studies routinely. PMI is used to assess bone quality.[9]

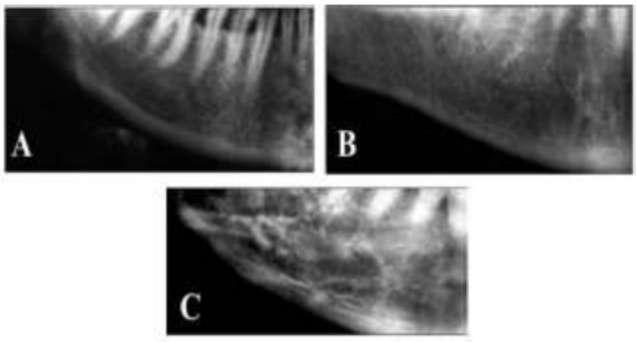

Figure 1: Mandibular Cortical Index (MCI) Classification:
A] C1 – Sharp endosteal cortical margin
B] C2 – Semilunar defect of endosteal margin (resorption cavities)
C] C3 – Porous endosteal margin with thick cortical residues.

4. M/M ratio: Ratio of total mandibular height to distance from the center of mental foramen to mandibular inferior border which represents mandibular alveolar bone loss.[12] [Figure 4]

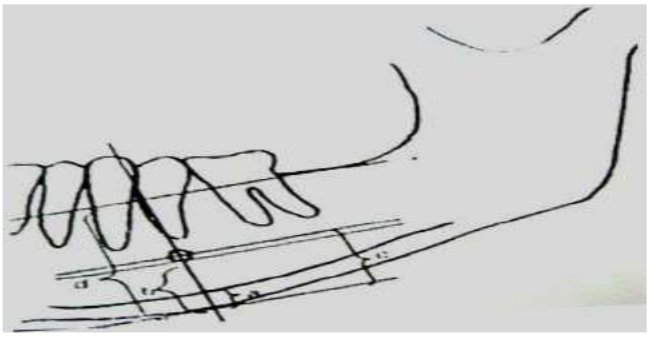

Figure 2: Method of measuring M/M and PMI in panoramic radiography

For measuring M/M ratio, a line is drawn parallel to mandibular long axis and tangent to lower border of jaw. Then another line is depicted perpendicular to this tangent which cuts center of mental foramen. Total mandibular height in mental foramen is determined. Then the following measurements are performed:

a) Mandibular cortical thickness
b) Distance from the inferior mandibular border to the inferior border of mental foramen (a / b: PMI)
c) Distance from the inferior mandibular border to the center of mental foramen
d) Total mandibular height at mental foramen (d / c: M/M) [2]

Materials and Methods

We asked patients who were referred to a private office for using their panoramic radiographs. After obtaining informed consent, a questionnaire containing demographic information such as age, presence of systemic problems such as anemia, diseases of the gastrointestinal tract, frequent diarrhea, anorexia, chronic renal failure which affects the bones and using drugs was filled by the patients.[14] Patient who had any of the above diseases were excluded from the study. All radiographs were taken by an oral and maxillofacial radiologist using unique device (Cranex D, Finland) to control technical errors. Exposure factors (mA, kvp) were adjusted automatically by the device and based on patient size. Radiograph having appropriate density and contrast and those which were for patients older than 20 years old, taking no drugs and with no disease that affects bone structure were selected. An expert oral and maxillofacial radiologist without information of patient's gender and age depicted margins of the mandible, superior border of alveolar crest in the mental foramen area, upper edge of the inferior mandibular cortex and Mental foramen in each panoramic in a semi-dark room and by using Microsoft Office Word 2010 and recorded classification of (C1, C2 and C3) according Toklemetti *et al*.[27] Afterwards all Microsoft Office Words were converted to PDF files. Then the operator entered the amounts of PMI, M / M and MCI from both sides of each radiograph to Microsoft Office Excel 2010 by Foxit Reader software (version 3) and with 0.1 mm accuracy measurements. In cases which mental foramen could be seen bilaterally, measurements were recorded bilaterally, then the average value was measured. In cases which mental foramen was visible only in one side, we used the measurements from that side in analysis.

Dental status of patients was evaluated and classified according to operator preference:

1. Full dentition (dentate)
2. Having all teeth except molars (partially dentate)
3. Having no tooth (Edentulous)

Patients were divided into 5 groups based on their age:

1. 20-29 years old
2. 30-39
3. 40-49
4. 50-59
5. More than 60 years old

Statistical analysis was performed after data collection was completed.

Results

In this study, panoramic radiographs from 400 patients were collected. After reviewing quality of images and patients' health status, 270 radiographs were selected from 136 males (50.4%) and 134 females (49.6%).

Patients were classified into 5 groups according to their age. They were between 20 and 86 years old. The average age of patients was 35.9 ± 13.4 years (mean age was 32.9 ± 12.1 years for women, and 38.8 ± 13.9 years for men). Most of the patients (120 persons, 44.4%) were between 29-20 years old and 18 patients (6.7%) were older than 60. [Chart 1]

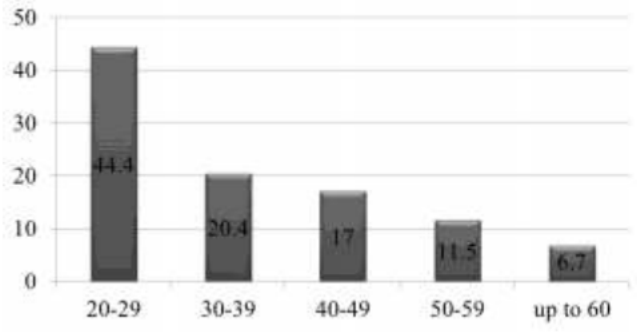

Chart 1: Patients' distribution regarded to age.

According to dental status, patients were divided in the 3 groups and the most frequent dental status was full dentition in 201 patients (74.4%) chart 2 and chart 3 show patients' dental status based on gender.

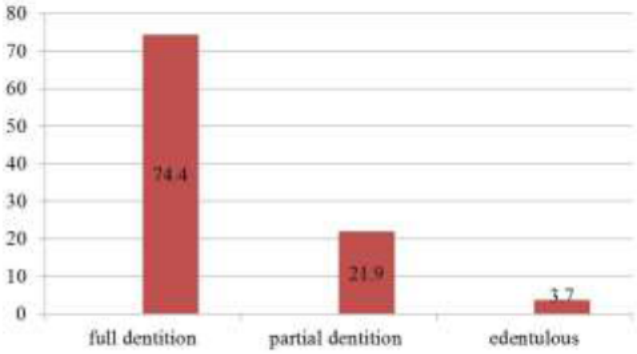

Chart 2: Patient's distribution regard to dental status.

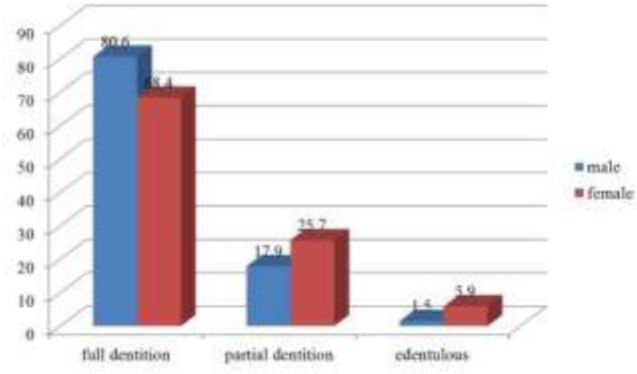

Chart 3: Patient's dental status distribution in males and females.

After data collection, mean and standard deviation of quantitative variables were defined regarding to age, gender, dental status and MCI index which is described in details here:

MI index

Results showed a statistically significant difference between the MI index between groups with different ages (P=0.017). MI index showed an increase from group of 20-29 years old to group of 40-49 years old. The index showed a downward trend after 50 years old.

Results showed no statistically significant differences in MI based on gender (P=0.668) and dental status (P=0.104).

There was a statistically significant difference between the MI and MCI (P=0.017). MI showed a downward trend from C1 to C2 and from C2 to C3.

PMI ratio

Results indicated that there is no statistically significant difference in the PMI between specimens based on age (P=0.638), but a statistically significant difference was found in PMI regarded to gender (P<001). Females had higher levels of PMI compared to males.

PMI did not differ between patients regarding to dental status (P=0.072).

There was a statistically significant difference between the PMI and the MCI (P=0.003). PMI declined from C1 to C2 and from C2 to C3.

M/M ratio

Results showed a statistically significant difference in M/M ratio between different age categories and dental health status. Patients with more missing teeth showed lower values of M/M ratio (P<001). Also there was a statistically significant difference in M/M ratio between males and females (P=0.001), women had more M/M ratio in comparison with men.

M/M ratio had a statistically significant difference with MCI (P=0.004). M/M showed decrease from C1 to C2 and from C2 to C3.

MCI

The findings showed that there was no significant correlation between the MCI and age (P=0.09), but there was a significant relationship between dental status and MCI (P=0.021) so that the frequency of C2 and C3 was more in partial and fully edentulous patients. Such relationship was seen between MCI and gender (P<0.001) which means changes from C1 to C2 and frequency of C2 were more in males and most of females belonged to C1 group.

Discussion

In this study, 270 radiographs from 134 females and 136 males were examined which 74.4% of them had full dentition. MI and M/M showed a significant correlation with age in this study (P<0.05). PMI, the M/M and MCI were significantly correlated with gender (P<0.05). Decreasing in M/M and MCI had significant relationship with increase in the number of missing teeth (P<0.05). MI, PMI and M/M had significant relationship with MCI (P<0.05).

The average age of women and men in our study were 32.9 ± 12.1 and 38.8 ± 13.9 years old, respectively; which represents that females are younger than males. 80.6% of females and 68.4% of males had full dentitions.

The results of this study showed that the overall thickness of the cortex decreases with age. On the other hand, MI increased until fourth decade of life and then started to decrease.

In studies conducted by Raghdaa *et al*.,[15] Yang *et al*.,[16] Knezovic *et al*.,[17] Ledgerton *et al*.,[18] Pal *et al*. and Govindraju *et al*.,[19], a negative relationship between MI and age was found; that means as age increased, the amount of MI decreased.

Results of our study were in contrast with an article by Musa[9] which did not find significant relationship between MI and age.

A significant relationship was not found between cortical thickness and gender (P>0.05); that was in contrast with the results of other studies[9] which found significant relationship between MI and gender so that smaller amounts of the MI were seen in females.

No significant correlation in indices was found regarding to dental status and cortical thickness. According to Taguchi *et al*.[20] thickness of lower mandibular cortex was associated with tooth loss in females.

Similar to our findings, no significant relationship was found between MI and dental in other studies.[3,27,29] Bras and colleagues[21] concluded that thickness of lower mandibular cortex is not related to dental status. In contrast, in a study by Ledgerton and colleagues,[18] a significant relationship was found between MI with dental status so that patients with partial or full edentulism showed lower values of this index.

Results showed that the MI has a significant relationship with MCI so that with reducing MI, chance of having C2 and C3 groups of MCI increased. In a study by Govindraju *et al*.[2] MI was higher in C1 and C2 groups than C3.

M/M reduced significantly with age increasing, tooth loss and increased class of MCI. (P<0.05) This index was higher in females than males. In this regard, one must consider lower average age of females than males, and different dental status between genders.

In this study no significant relationship was found between PMI and age (P>0.05). Other studies showed apposite results[13] which concluded that as patients' age increase the values of PMI decrease. In a study by Taguchi and colleagues[20] a significant relationship between the PMI and age was observed but PMI increased until sixth decade of life, then it began to decrease. Yûzûgûllû and colleagues[22] could not find a significant relationship between the PMI and the age.

PMI showed a statistically significant difference between males and females (P<0.05) so that females had higher amounts of PMI.

Similar results were found by Hastar *et al*.,[23] but females showed lower amounts of this index unlike results of our study, which can be related to lower age average of them in our study. In studies carried out by Yûzûgûllû *et al*.[22] and Raghdaa *et al*.[15] no relationship was found between gender and PMI.

No significant relationship was found between PMI and dental status (P<0.05) similar to study by Pal *et al*.[19] and in contrast with studies conducted by Hastar *et al*.[23] and Ledgerton *et al*.[18]

In this study there was a significant relationship between the PMI and MCI in which with going from C1 to C3, the amount of PMI declined. In a study by Ledgerton and colleagues[10] there was a significant relationship between the PMI and MCI in which as the class of MCI increased, values of PMI decreased.

The prevalence of MCI class 2 was more than 1 and C3 had the lowest prevalence in our study like Ledgerton (C2> C1> C3). Yûzûgûllû *et al*.[22] only observed C2 and C3 in their studies which can be due to age of samples because both studies had been done on the elderly. Since there were no patients with Class C1 in those studies and the youngest patient was 40 years old, and because we observed that number of patients in C2 and C3 increase with age, then it can be understood that the first signs of bone loss happen in around 30 years old.[18] In a study by Hastar and colleagues[23] MCI C1 was more than C2 and C3, respectively. This difference can be attributed to the distribution of dental status and age. C2 and C3 classes of MCI were found in males more than females which can be related to the higher average age of men. Dental status was also important in this results.

In studies conducted by KnezovicZlataric *et al*.,[17] Uysal *et al*.[24] a significant relationship was found between MCI and gender so that C3 was observed more in women.

In this evaluation, MCI class increased with increased missing teeth, similar to studies by Ledgerton *et al*.[18] it became clear that age has no effect on the classes of MCI which was in contrast with the results from Uysal *et al*.,[24] Yûzûgûllû *et al*.,[22] Ledgerton *et al*.,[18] KnezovicZlataric *et al*.,[17] This contrast can be due to the variety of age and race of these studies.

Conclusion

MI and M/M showed a significant correlation with age in this study (P<0.05). PMI, the M/M and MCI were significantly correlated with gender (P<0.05). Decrease in M/M and MCI had a significant relationship with increase in the number of missing teeth (P<0.05). MI, PMI and M/M had a significant relationship with MCI (P<0.05). In general, a series of more practical indices for evaluating bone density such as cortical thickness and morphology can be influenced by age, gender and dental status. Therefore, all indicators are not reliable for screening reduced bone density.

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