Assessment of the Relation of Mandibular Cortical Index and Gonial Angle Size in an Adult Iranian Population Using Digital Panoramic Radiography

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Abstract

***Objectives*:** This study sought to assess the relation of mandibular cortical index (MCI) with age, gender and gonial angle size in an Iranian adult population using digital panoramic radiography.

***Methods*:** We evaluated 370 digital panoramic radiographs of patients and divided them into five 10-year age groups. Each radiograph was assigned to low (≤120°) or high (≥125°) angle groups in terms of the gonial angle size. The MCI class was also determined for each individual. The multinomial logistic regression was used to assess statistical differences.

***Results*:** The MCI class was significantly different between males and females and MCI class 3 had higher prevalence among older individuals. There was no statistically significant difference in distribution of MCI classes between individuals with high and low gonial angles.

***Conclusion*:** Age-related changes in MCI support its potential use for detection of skeletal osteopenia.

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Received: 01.05.2016
Accepted: 14.11.2016

***Key Words*:** Mandible; Radiography, Panoramic; Cortical Bone

How to cite:
Mirbeigi S, Tavakoli E, Sabaghzadegan Y, Ezoddiniardakani F, Moshfeghi M. Assessment of the Relation of Mandibular Cortical Index and Amount of Gonial Angle in an Adult Iranian Population Using Digital Panoramic Radiography. J Dent Sch 2016; 34(4): 244-52.

Introduction

Differences exist in trabeculation and density of bone in different individuals, which do not necessarily reflect bone mineral status (1,2). Estimating the quality of bone merely based on the trabecular or radiographic density is often misleading due to the effect of factors such as the soft tissue shadow or higher exposure settings (3).

Alveolar bone metabolism after tooth extraction is influenced by the surgical procedure (4), denture pressure (5-7) and some other factors affecting bone metabolism in general (8,9). In 1997, a reliable method was introduced by Klemetti and Kolmakow (3) for assessment of bone quality prior to implant placement. The MCI also known as the Klemetti index has been proposed for assessment of osteopenia/osteoporosis of the mandibular cortex on panoramic radiographs (1,10). The mandibular bone mineral density is correlated with skeletal bone mineral density (1,11). Dentists play an important role in detection of patients suspected for osteopenia by assessing the mandibular bone density. In case of detecting mandibular osteopenia, they should refer the patient for dual-energy X-ray absorptiometry (DXA)(12).

The smaller the gonial angle, the stronger the bite force (13-15). Evidence shows that increased bite force enhances the quality and quantity (volume) of bone (16). Similar previous studies on bone morphometric changes on panoramic radiographs have mainly focused on age, sex, menopause status and edentulism of patients and only a few studies have tended to morphological differences such as the size of gonial angle (1,2,5,12). Thus, this study sought to assess the correlation of MCI class with age, gender and gonial angle size in an Iranian adult population using digital panoramic radiography. Also, the MCI class and gonial angle size were determined in a sample of Iranian population in the age range of 20-69 years.

Methods

A total of 370 digital panoramic radiographs of patients presenting to the School of Dentistry of Yazd University of Medical Sciences during 2011-2013 were evaluated. Patients with at least eight teeth in each jaw with no history of denture use or fracture who had high quality panoramic radiographs for assessment of mandibular cortex were included in this study. Radiographs had been requested for diagnostic and therapeutic purposes. All digital panoramic radiographs were taken with Proline X panoramic X-ray unit (Planmeca, Helsinki, Finland) with maximum exposure settings of 80 kV, 12 mA and 18 seconds of exposure time. The exposure settings were adjusted depending on patient conditions. Radiographs were saved and observed by an oral and maxillofacial radiologist on a 17-inch flat medical monitor (LG, Seoul, South Korea) under standard viewing conditions. The gonial angle size was measured on each panoramic radiograph using Romexis software (Planmeca, Helsinki, Finland) (17). Values ≤120° were assigned to low and values ≥125° were assigned to high angle group. Values in-between these two limits were excluded from the study (18). To assess the effect of age, patients were divided into five age groups of 19-29, 30-39, 40-49, 50-59 and 60-69 years. Classification of MCI in patients was done according to Klemetti *et al* (19). By assessing the inferior cortex of the mandible distal to the mental foramina, each radiograph was assigned to one of the following classes:

MCI class 1. Smooth and clear endosteal margin of the inferior cortex of the mandible in both sides

MCI class 2. Semilunar defects in endosteal cortical residues (one to three layers) in one or both sides

MCI class 3. The inferior cortex of the mandible is clearly porous in one or both sides (19).

To assess the intraobserver reliability, the MCI class was determined again in 50% of the individuals after two months and the kappa coefficient was calculated.

Data were analyzed using SPSS version 17 (SPSS Inc., Chicago, IL, USA). The multinomial logistic regression was used for statistical analysis.

Results

A total of 370 digital panoramic radiographs of 185 females and 185 males with a mean age of 42.5±12.7 years (range 19-69 years)

were evaluated. The mean size of gonial angle was 123.67±7.4°. This value was 124.21±7.7° in males and 123.1±7.2° in females.

Among different age groups, the highest mean gonial angle size (124.35°) belonged to the age group of 40-49 years and the lowest mean gonial angle size (122.93°) belonged to the age group of 60-69 years. Tables 1 and 2 show the mean values of gonial angle size based on sex and age.

Table 1- The mean size of gonial angle in males and females

Gender	Number	Mean size of gonial angle (degrees)	Standard Deviation
Females	185	124.24	7.205
Males	185	123.11	7.716
Total	370	123.67	7.476

For determination of intraobserver reliability for MCI classification, the Kappa coefficient was calculated to be 0.65 indicative of good reliability (20). In our study, 71.6% of individuals had MCI class 1, 21.1% had MCI class 2 and 7.3% had MCI class 3. Patients with MCI class 3 were mostly in the age range of 60-69 years, and individuals in the age groups of 19-29 years and 30-39 years had the lowest frequency of MCI class 3.

Table 2- The mean size of gonial angle in different age groups

Age group (years)	Number	Mean size of gonial angle (degrees)	Standard Deviation
19-29	75	124.93	8.604
30-39	75	124.16	7.557
40-49	74	124.35	8.392
50-59	72	122.98	6.562
60-69	74	123.93	5.964
Total	370	123.67	7.476

The frequency of MCI class 3 was higher in females. Tables 3 and 4 present the frequency distribution of MCI classes based on the individuals' age and gender. Table 5 shows the MCI class of individuals based on the size of their gonial angle. The multinomial logistic regression found no significant association between the size of gonial angle and MCI class (Table 6).

Table 3- The frequency distribution of MCI classes in different age groups

Age (years)/MCI class	MCI class 1		MCI class 2		MCI class 3		Total
	Number	(%)	Number	(%)	Number	(%)	Number
19-29	73	97.3	2	2.7	0	0	75
30-39	72	96	3	4	0	0	75
40-49	63	85.1	9	2.2	2	2.7	74
50-59	38	52.8	27	37.5	7	9.7	72
60-69	19	25.7	37	50	18	24.3	74
Total	265	71.6	78	21.1	27	7.3	370

Table 4- The frequency distribution of MCI classes in males and females

Gender/MCI class	MCI class 1		MCI class 2		MCI class 3		Total	
	Number	(%)	Number	(%)	Number	(%)	Number	(%)
Males	142	76.8	39	21.1	4	2.2	185	50
Females	123	66.5	39	21.1	23	12.4	185	50
Total	265	71.6	78	21.1	27	7.3	370	100

Table 5- The frequency distribution of MCI classes based on the size of gonial angle

Size of gonial angle/MCI class	MCI class 1 Number	(%)	MCI class 2 Number	(%)	MCI class 3 Number	(%)	Total Number	(%)
Gonial angle≤120°	135	74.1	37	20.3	10	5.4	182	50
Gonial angle≥125°	130	69.1	41	21.8	17	9	188	50
Total	256	69.1	78	21	27	7.2	370	100

Table 6- The multinomial logistic regression of MCI class 3 for gender, age and size of gonial angle

MCI class 3	Standard Error	*P* value
19-29	0.780	0.000
30-39	0.664	0.000
40-49	0.829	0.000
50-59	0.571	0.002
Male	0.617	0.000
Low gonial angle	0.506	0.110

Multinomial regression analysis showed that although there were statistically significant differences for age and sex, the gonial angle size was not correlated with MCI class 3.

Discussion

The participants evaluated in the current study were true representatives of a typical Iranian adult population since they were selected among those presenting to the Oral and Maxillofacial Radiology Department of School of Dentistry, Yazd University of Medical Sciences from different departments.

Similar to any other bone in the human body, muscle attachments of the jaws cause functional tension and by reinforcement of bone, they prevent mineral loss and bone resorption (3). Inferior and buccal cortices of the mandible are areas under strong muscle tension (1,2).

The MCI classification is based on the thickness and resorption of the inferior cortex of the mandible on panoramic radiographs (19). Panoramic radiography is extensively used in dentistry for assessment of teeth and their supporting bone. Since previous studies have found a correlation between the mandibular bone mineral density and that of lumbar and hip bones, patients diagnosed with mandibular osteopenia should be referred for bone densitometry with the use of more advanced techniques (21-23). The reproducibility of this index has reported to be 98% in a study by Klementti *et al* (19). The kappa coefficient in our study was calculated to be 0.65, which indicates good intraobserver reliability (24). Our study showed that 71.6% of individuals had MCI class 1, 21.1% had MCI class 2 and 7.3% had MCI class 3. All cases of MCI class 3 were older than 40 years. Number of MCI class 3 cases was significantly higher among females than males (23 versus 4 cases). Also, number of MCI class 3 cases among older age groups was significantly different from that in younger age groups. Similarly, Osato *et al*. (18) reported higher cases of MCI class 3 in females. Knezović Zlatarić *et al*. (25) assessed the MCI in 48 to 52 year-olds wearing removable dentures. They found no female patients with MCI class 1 among

their study population. They did not find any significant difference in the frequency of MCI class 2 between males and females. The frequency of MCI class 3 significantly increased in older females. This finding shows the effect of age on bone loss. Since the first signs of bone loss appear at the age of 30 years, these results are justifiable (26). Haseter *et al*. (27) assessed the MCI in 60-88 year-olds with and without osteoporosis and found that MCI was significantly influenced by gender. The frequency of MCI class 1 was higher in males than females and MCI class 2 and 3 had a higher frequency in females than males. Patients with MCI class 3 were all females. The frequency of MCI class 1, 2 and 3 was 28.6%, 68.5% and 2.8% in females and 78.2%, 21.8% and 0% in males, respectively. In their study, 3.2% of osteoporotic patients had MCI class 3, 71.4% had MCI class 2 and 25.4% had MCI class 1. No case of MCI class 3 was found and this may be due to the fact that 93.7% of osteoporotic patients were females.

In studies by Ledgerton *et al*, (12) and Klementti *et al*, (19) the relative frequency of MCI classes was equal in the age group of 45-54 years but Taghuchi *et al*, (23) in their study on 32-68 year-old Japanese females reported higher frequency of MCI class 1. The controversy in the results of the afore-mentioned studies may be attributed to ethnic differences or variations in the interpretation and classifications of MCI.

In general, MCI class 3 is more common among edentulous patients, post-menopausal women and patients with removable prosthesis (19,23,25,28). In our study, size of gonial angle was not correlated with the MCI class but Osato *et al*. (18) found higher frequency of MCI class 2 in males with smaller gonial angles. Individuals with a smaller gonial angle have greater muscle strength (bite force) and more complex mandibular remodeling. They explained that higher frequency of MCI class 2 in males with small gonial angle might be due to difficulties in differentiating MCI class 1 and 2 (1). Huumonen *et al*. (17) found larger gonial angles in females and stated that smaller gonial angles in males are responsible for their greater bite force. Xie and Ainamo (15) Durla *et al*, (29) and Karoshah *et al*. (30) reported the same results. In the current study, no significant difference was found in the size of gonial angle between males and females. Our results in this regard were in line with those of Ohm and Silness (31) Raustia and Salonen (32) and Ayoub *et al* (33). Ceylan *et al*. (34) reported that gender could not be the only reason for the differences in the size of gonial angle.

In our study, aging had no effect on the size of gonial angle, which is in line with the results of Osato *et al* (18). However, some studies have shown that by an increase in age and occurrence of edentulism, the gonial angle becomes larger (35,36). Such controversial results may be attributed to the cause of edentulism because patients evaluated in our study and in the study by Osato *et al*. (18) were dentate and were not wearing denture. Studies have shown that in edentulous ridges, decreased function results in bone loss (1).

In a study by Haseter *et al*, (27) the MCI classes showed significant variations in different dental states. Most MCI class 3 patients were partially edentulous. These

results confirm the hypothesis that absence of complete occlusion (partial edentulism) negatively affects the mandibular cortex and increases the MCI class.

Gulsahi *et al*. (37) reported that age was the most influential parameter on MCI class and older age increased the likelihood and frequency of MCI class 3. These results are in agreement with our findings. In their study, dental status was the second most influential factor on MCI class. In edentulous patients, the frequency of MCI class 3 was 3.27 times higher than that in dentate patients. In contrast to our study, they found no correlation between the MCI class and gender.

Conclusion

Within the limitations of this study, the results showed that although significant associations existed between the MCI class and gender and age, no such a correlation was found between the MCI class and size of gonial angle. Age and gender in dentate patients had smaller effects on the size of gonial angle compared to the MCI. On the other hand, no association was found between the size of gonial angle and the MCI class.

Acknowledgement

This study was part of a thesis (#3093) for a DDS degree in Shahid Beheshti University, School of Dentistry. Authors would like to thank the research deputy of this university for their support.

Conflict of interest: "None Declared"

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