



## Reliability of Different Mandibular Radio morphometric Indices in Prediction of Osteoporosis and Osteopenia

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### ABSTRACT

**Purpose:** This study aimed to evaluate the value of quantitative and qualitative mandibular radio morphometric indices, as recorded from panoramic imaging, in prediction and diagnosis of osteoporosis and osteopenia. **Materials and methods:** Forty postmenopausal women their age between 45 and 65 years previously diagnosed as having osteoporosis as confirmed by DEXA scans were selected. DEXA and Orthopantomogram (OPG) were applied on all the patients. Panoramic mandibular index (PMI), Mental index (MI), gonial index (GI), and mandibular cortical index (MCI) were dignified and matched with the scores obtained from DEXA scan. **Results:** There was significant correlation between DEXA results with panoramic indices in the normal, osteopenia and osteoporotic groups. **Conclusion:** By increasing the age and the postmenopausal duration, MCW and PMI decrease, therefore, dentists and dent maxillofacial radiologists could act in a particular manner in early diagnosis of low BMD and help to refer high-danger patients for precise evaluation.

### INTRODUCTION

Osteoporosis is a systemic disease characterized by decreased bone density and more risk of bone breakage. It is the most famous metabolic bone disease in the adults, especially in postmenopausal women<sup>(1)</sup>.

Osteoporosis is a disease characterized by low bone density and structural weakening of bone tissue, with a following increase in bone brittleness and liability to fracture. It considered to be a silent disease

### KEYWORDS

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that entails significant social and economic burdens. Osteoporotic fragility fractures take place as a results of low-level trauma <sup>(2)</sup>. Different factors that may mark the risk of breakability fracture include the usage of oral or systemic glucocorticoids, age, sex, earlier fractures, and family history of osteoporosis<sup>(3)</sup>.

It is recognized that after the age of thirty five the bone mineral density (BMD) of men and women progressively decreases with increasing age. Women tend to lose BMD more quickly than men, particularly after the end of menstruation, so osteoporosis occurs three intervals more common among women than men. The cause is being abnormal bone desorption level by the destructive bone cell, and bone deposition by the bone forming cells. So the most common sites of such fractures are vertebral column, hip and wrist <sup>(4)</sup>.

Osteoporosis is commonly associated with decreased bone mass making them more prone to bone pain, deformity, and osteoporotic fractures hence increasing the fracture incidence. Number of cases of osteoporosis is on a rising scale because of increase in life expectancy <sup>(5)</sup>.

Osteopenia denotes to bone mineral density (BMD) that is lesser than normal highest bone mineral density but not low insufficient to be categorized as osteoporosis. Osteopenia raises the possibility of osteoporosis and osteoporotic fractures <sup>(6)</sup>.

The most common cause for bone loss in osteopenia /osteoporosis is very little levels of estrogen hormone. Estrogen shows a vital role in constructing and conserving your bones <sup>(7-9)</sup>.

Osteoporosis is usually diagnosed by BMD measurements, at present, it considers the most active and perfect measurement for detecting and observing the disease. BMD assessment by (DEXA) testing is considered the gold standard for fracture hazard prediction. As this test is able to measuring bone mineral content at any site in the body <sup>(10, 11)</sup>. However, besides not being suggested by the WHO

as a triage screening aid for osteopenia/osteoporosis, it has a high commercial cost <sup>(12, 13)</sup>.

Digital panoramic radiography provides relatively low radiation, time and budget saving, and the ability to supply precise measurements. Panoramic radiography and radiomorphometric indices, which are planned by acting linear measurements on mandible of the obtained panoramic radiographic images. Medical literature prospers comparisons of bone mineral density at different skeletal places with panoramic radio morphometric indices demonstrating bone BMD of mandible <sup>(14, 15)</sup>.

## MATERIALS AND METHODS

A blind study was accomplished on forty post-menopausal women age ranged from forty five to sixty five years old. The selection of patients from those referred to the out-patient clinic of Faculty of Dental Medicine for Girls, Al-Azhar University. Department of the Oral Medicine and Periodontology seeking for different dental treatment and in need for panoramic imaging for fulfill either the diagnosis or follow-up the treatment procedures.

Prior to any procedure, all individuals were informed about the nature, and benefits of their participation in the study. A satisfactory written consent was obtained from all the patients denoting their convince about the schedule research program experiment design.

The study individuals be selected affording to inclusion and exclusion criteria:

### Inclusion criteria:

- Women after menopause, their age between 45 and 65 years old.
- Previously diagnosed as having or at a risk for osteoporosis as confirmed by DEXA scan. (test group)
- Normal healthy female patients with no osteoporosis selected as a control patients.

### Exclusion Criteria

- Systemic conditions such as diabetes and renal disorders,
- Women on replacement therapy of hormones.
- Women on Corticosteroid therapy contained by last 3 four weeks.
- Smoking and/or alcohol consumption.

All the selected patients were subjected to Bone Mineral Density examination as follow: BMD (g/cm<sup>2</sup>) measurements were performed on lumbar spines L2 to L4 using (DEXA) <sup>(16)</sup>. The study individuals were classified into 3 skeletal mineral density groups based on WHO criteria: Normal (t score more than or equal -1), osteopenic (t score between -1 & -2.5) and osteoporotic (t score equal or more than -2.5) <sup>(17)</sup>.

### Patients Grouping:-

According to the DEXA analytical results, patients were categorized following the WHO specifications into:

**Group I:** Normal individuals (n= 10 patients) with BMD (T-score >-1 and <+1).

**Group II (A):** Osteopenic patients (n= 8 patients) with (T-score < -1.0 and > -2.5).

**Group II (B):** This group comprised osteoporotic patients (n=22 patients) with T-score equal or more than -2.5.

Digital panoramic radiographs were taken by an orthopantomogram. Orthopantomogram OP-100 panoramic machine that was used with exposure parameter (current of 16 mA and voltage of 75 kV) and duration of exposure 17.6 seconds.

The following Quantitative mandibular radio morphometric indices were measured:

**1. Mandibular cortical width (MCW):** It is thickness of cortical bone of lower jaw at mental

foramen region or a distance from the center of mental foramen to lower border of lower jaw<sup>(18)</sup>.

**2. Panoramic mandibular index (PMI):** It is the ratio between the cortical bone thickness of lower jaw and the distance from the mental foramen to the lower edge of lower jaw <sup>(19)</sup>.

**3. Gonial index (GI):** It measures the thickness of bone of lower cortex in the area opposite to gonial angle <sup>(20)</sup>.

The following Qualitative mandibular radio morphometric indices were measured:

### Mandibular cortical Index (MCI):

According to the classification of Klemetti et al. 1994, MCI is classified as following:

- C1: Normal (endosteal margin of the cortex is equal and harsh on both sides).
- C2: osteopenia (endosteal margin displays semilunar defects (lacunar resorption) on one or both sides).
- C3: osteoporosis (presence of porosity and reduced cortical thickness) <sup>(21)</sup>.

All panoramic measurements were calculated on the right and left mandibular sides and their means were estimated.

### RESULTS

The sample of the present study included 40 patients who were classified as follows: 10 normal and 30 diseased at the age range between 45 and 65 years.

Regarding to DEXA report, the individual being normal bone were 10 (25%), osteopaenic 8(20%) and osteoporotic 22 (55%).

In the linear measurements the mean values showed significant reductions between groups (normal, osteopaenic and osteoporotic) in the following indices (MI, PMI & GI).

Using Chi square to compare MCI with the different BMD conditions. Distribution of various BMD conditions as elicited by T scores and MCI. The test results revealed T score categorization as 10

(25%) being normal. Osteopenia subjects 5 patients with C2 and 3 patients with C3 while osteoporotic having 11 patients with C2 and other 11 patients with C3.(Table1).

**Table (1)** Correlations Between all mandibular radio morphometric indices:

Correlations				
		Rt MI	Rt PMI	Lt PMI
Rt mental index	Pearson Correlation	1 <sup>*,*</sup>	-.721- <sup>*,*</sup>	-.759- <sup>**</sup>
	P value (2-tailed)	<0.005	<0.005	<0.005
Rt Panoramic Mandibular Index	Pearson Correlation	-.721- <sup>*,*</sup>	1	.785 <sup>**</sup>
	P value (2-tailed)	<0.005		<0.005
Lt Panoramic Mandibular Index	Pearson Correlation	-.759- <sup>**</sup>	.785 <sup>**</sup>	1
	P value (2-tailed)	<0.005	<0.005	

		Lt MI	Rt GI	Lt GI	MCI	Bone Mineral Density
Lt mental index	Pearson Correlation	1	.325 <sup>*</sup>	.355 <sup>*</sup>	-.535- <sup>**</sup>	-.743- <sup>**</sup>
	P value (2-tailed)		.041	.025	<0.005	<0.005
Rt gonial index	Pearson Correlation	.325 <sup>*</sup>	1	.822 <sup>**</sup>	-.571- <sup>**</sup>	-.631- <sup>**</sup>
	P value (2-tailed)	.041		<0.005	<0.005	<0.005
Lt gonial index	Pearson Correlation	.355 <sup>*</sup>	.822 <sup>**</sup>	1	-.536- <sup>**</sup>	-.642- <sup>**</sup>
	P value (2-tailed)	.025	<0.005		<0.005	<0.005
mandibular cortical index	Pearson Correlation	-.535- <sup>**</sup>	-.571- <sup>**</sup>	-.536- <sup>**</sup>	1	.765 <sup>**</sup>
	P value (2-tailed)	<0.005	<0.005	<0.005		<0.005
Bone Mineral Density	Pearson Correlation	-.743- <sup>**</sup>	-.631- <sup>**</sup>	-.642- <sup>**</sup>	.765 <sup>**</sup>	1
	P value (2-tailed)	<0.005	<0.005	<0.005	<0.005	

\*\*. Correlation is significant at the 0.05 level (2-tailed).

Pearson's correlation coefficient indicated to positive and significant correlation among each of Rt & Lt MI, Rt & Lt PMI, Rt & Lt GI and MCI.

## DISCUSSION

Panoramic radiographs are mostly used for the diagnosis of oral and dental diseases and relatively inexpensive. As well, they can also offer information on a patient's BMD conditions and can be used as a screening device for detection of osteoporosis.

According to the DEXA analytical results, selected women were categorized into three groups; group I, comprised 10 normal women, group II comprised 30 women diagnosed either having osteopenia or osteoporosis. Group II subdivided into A and B, on which group II (A) comprised 8 women diagnosed as having osteopenia and group II (B) comprised 22 women diagnosed as having osteoporosis.

In the present study, the most commonly used radio morphometric indices namely; Mental Index, Gonial index, panoramic mandibular index and mandibular cortical index were compared with BMD conditions obtained by DEXA scan T-scores of lumbar spines L2 to L4. This was in agreement with recent studies which recently tried to develop methods for using the jaw bones to predict skeletal BMD. They have focused on certain mandibular panoramic indices such as mental index (MI) and panoramic mandibular index (PMI) for the BMD assessment<sup>(22, 23)</sup>.

In osteoporotic patients, the lower cortex of the mandible undergoes osteoporotic changes and its manifestations could be detected on panoramic radiography<sup>(24)</sup>. In the current study, MCW in study groups were 5.5 mm, 4.9 mm, and 4.1 mm, at right side respectively, and 5.5 mm, 5 mm, and 3.7 mm, at left side respectively and being statistically significant, which is being agree with the results of previous studies<sup>(25-28)</sup>. Nevertheless, there are some other studies that show differences between these groups of patients<sup>(29)</sup>.

Inferior mandibular cortex width considered a one of greatest important landmarks in the prediction of osteoporosis<sup>(28)</sup>. The value of MCW in normal and

osteoporotic groups was reported as 3.7 mm and 2.8 mm, respectively, in another study<sup>(27)</sup>. Other study also demonstrated significant differences between the MCW of normal ( $4.1 \pm 0.9$ mm) and of reduced BMD ( $3.2 \pm 0.9$  mm) groups<sup>(30)</sup>. Else study showed that significant correlation ( $r = 0.336$ ) between MCW and the density of heel bone<sup>(31)</sup>.

PMI was recorded in this study as a one of most important quantitative radio morphometric index. PMI showed a statistically significant difference among the three groups. These results are in agreement with previous studies<sup>(27, 32)</sup> while they disagree with the other reports of study<sup>(25, 29)</sup>. In previous study, there was a significant correlation between PMI and heel bone density. Recently, another study showed a positive correlation between PMI & quantitative ultrasound BMD scan of heel bone of both males and females<sup>(33, 34)</sup>.

In the present research, the dissimilarity in the mean values of GI scores across study groups were statistically significant. These findings are supported by other studies<sup>(24, 35, 36)</sup>.

Another study which reported that the cortical thickness at the gonion may be a valuable parameter for estimating metabolic bone damage. Relatively smaller dimensions of cortical width at the gonian region made the measurements of GI difficult in the present study<sup>(19)</sup>. On the contrary, other studies not found significant difference between GI and BMD conditions<sup>(21, 37)</sup>.

MCI is one of the most commonly qualitative parameters, the results of present study showed a significant correlation between the skeletal BMD and MCI. According to the present results, MCI was a reliable index in identifying osteoporosis.

This findings in this study reported postmenopausal women with distinctly thinner and porous mandibular cortices presented with lower BMDs which were in covenant with another. study that reported high rate of temperately eroded cortex on panorama of women aged more than 50 years was

observed<sup>(38)</sup>. This finding was in accordance with the other studies which stated patients with lesser BMD values in mandible, have a far more leaky mandibular cortex<sup>(23, 39)</sup>.

Unlike other quantitative indices, MCI as a qualitative index did not require exact identification of radiographic landmarks and precise measurements. On the contrary, other studies did not show an association between MCI and BMD condition. As different sample sizes, different versions of dental panoramic equipment, image quality of an panoramic view, magnification variations, differences in race, gender, experience of the observers in the diagnosis of MCI, and also, the candidate bone for DEXA examination, could be responsible for the presence of variations among different studies<sup>(29,40,41)</sup>.

## CONCLUSION

By increasing the age and the postmenopausal duration, MCW and PMI decrease, therefore, dentists and dentomaxillofacial radiologists could act in a particular manner in early diagnosis of low BMD and help to refer high-risk patients for precise evaluation.

Limitations of the present study could be attributed to the limited number of the sample size and the availability of the patients having all of the inclusive criteria. Further research is required including a larger sample size to evaluate a more parameters in both jaws as screening tools for osteoporosis.

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