ORIGINAL RESEARCH ARTICLE

Efficacy of Panoramic Radiographic Indices in Diagnosing Osteoporosis in Patients with Confirmed Bone Mineral Density Using DEXA Scan

Nusrat Nazir Makroo, Rayees Ahmad, Tauseefa Jan, Altaf Hussain Chalkoo
Department of Oral Medicine and Radiology, Government Dental College, Srinagar, Jammu and Kashmir, India

Email for correspondence: drnusratnaziromar@gmail.com

ABSTRACT

Background: Osteoporosis has been defined as a skeletal disease characterized by low bone mass, microarchitectural degradation of bone tissue leading to enhanced bone fragility, and a consequent increase in fracture risk. It is known that after the age of 35, the bone mineral density (BMD) of men and women gradually decreases with increasing age. Women tend to lose BMD more rapidly than men, especially after the menopause. Despite its high incidence and severe consequences on the patient's life, osteoporosis often remains unnoticed, until a fracture occurs, due to the absence of pain, patient's lack of information on the subject and frequently because of the limited availability of dual-energy X-ray absorptiometry (DXA) scanners in many areas, due to their high cost. On the contrary, dental care services are much more common and easy to access. Age is a common risk factor for both dental problems and osteoporosis and frequently the elderly who seek dental care may also be at risk of suffering from undetected osteoporosis. It is possible for dentists to screen those patients, through X-ray and clinical dental examination and refer them for a DXA test. **Aims and Objectives:** The present study was conducted to ascertain utility of panoramic radiographs for detecting osteoporotic changes in patients. **Materials and Methods:** Study participants included 80 patients consecutively examined in the dental department of our institution for whom panoramic dental examination was required. These patients were also referred for BMD assessment. BMD of the lumbar spine and femoral neck was measured by dual-energy X-ray absorptiometry. **Results:** The age range of the patients was 30–72 years. The mean age for normal BMD group was 68.30 ± 5.530 years (Mean ± SD) and of the osteoporotic group was 69.15 ± 3.322 years (Mean ± SD). Antegonial index and mental index of normal group and osteoporotic group had *$P \leq$ 0.001, "*t*" test, indicated a significant decrease in relation to osteoporotic group whereas there was no significant correlation between antegonial depth and BMD. **Conclusion:** We conclude that panoramic radiographs have high potential in diagnosing the osteoporosis utilizing different indices such as mental index and antegonial index. Further studies on larger patient groups are needed to ascertain the value of panoramic radiology as an adjunct diagnostic tool in the screening of patients thought to be at high risk of osteoporosis.

Key words: Antegonial angle, antegonial depth, bone mineral density, DEXA scan, mental index

INTRODUCTION

Osteoporosis is a major health problem worldwide, as not only does it deteriorate the quality of life but it may also lead to severe disability and eventually death. Osteoporosis has been defined as a skeletal disease characterized by low bone mass, microarchitectural degradation of

bone tissue leading to enhanced bone fragility, and a consequent increase in fracture risk.[1] The WHO scientific group on the assessment of osteoporosis claims that osteoporosis affects more than 75 million people in the United States, Europe, and Japan and causes more than 8.9 million fractures annually worldwide.[2] It is known that after the age of 35, the bone mineral density (BMD) of men and women gradually decreases with increasing age. Women tend to lose BMD more rapidly than men, especially after the menopause. As a result, osteoporosis is 3 times more common among women than men.[3] However, the loss of bone in the spine and proximal femur with aging is similar in both sexes at advanced age. Such an age-related decrease in bone mineral density (BMD) occurring in both sexes is associated with an increase in fracture prevalence.[4,5] Although studies have shown that there is more of a decrease in BMD in women, the male mortality rate from hip fracture is 2–3 times higher than the female mortality rate.[6] With rising average life expectancy, this issue is becoming increasingly important for public health. Despite its high incidence and severe consequences on the patient's life, osteoporosis often remains unnoticed, until a fracture occurs, due to the absence of pain, patient's lack of information on the subject and frequently because of the limited availability of dual-energy X-ray absorptiometry (DXA) scanners in many areas, due to their high cost. On the contrary, dental care services are much more common and easy to access. Age is a common risk factor for both dental problems and osteoporosis and frequently the elderly who seek dental care may also be at risk of suffering from undetected osteoporosis. It is possible for dentists to screen those patients, through X-ray and clinical dental examination and refer them for a DXA test. Osteoporotic fractures are associated with substantial morbidity and high mortality risk involving spine, hip, forearm, and proximal humerus and among them hip fractures incur the greatest morbidity and mortality, and give rise to the highest direct costs for health services.[7,8] Single- or dual-photon absorptiometry, quantitative computed tomography (QCT), single- or dual-energy X-ray absorptiometry (DXA), and quantitative ultrasound are among the techniques developed to identify individuals with skeletal osteoporosis. DXA is used extensively around the world as it has a high reliability in identifying individuals with low BMD and delivers a low radiation dose.[9]

With the above background, the present study was conducted to ascertain utility of panoramic radiographs for detecting osteoporotic changes in patients.

MATERIALS AND METHODS

Study participants included 80 patients consecutively examined in the dental department of our institution for whom panoramic dental examination was required. These patients were also referred for BMD assessment. BMD of the lumbar spine [Figure 1] and femoral region [Figure 2] was measured by dual-energy X-ray absorptiometry (DXA). DXA results were reported in terms of T-score, which is equivalent to the number of standard deviations below the average value for young adults. Osteoporosis is usually diagnosed by BMD measurements, expressed as a T-score. According to the World Health Organization (WHO) criteria, BMD
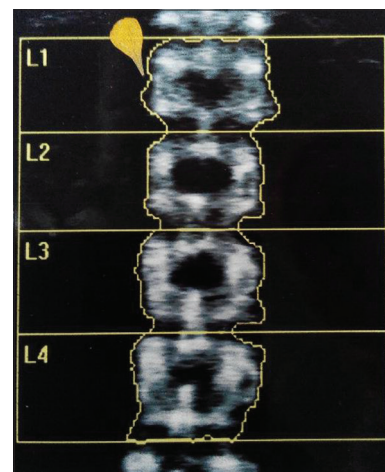

Figure 1: DXA lumber region

Figure 2: DXA femoral region

values are divided into following clinical guidelines: Normal (T-score > 1.0), osteopenia (T-score between 1.0 and 2.5), and osteoporosis (T-score < 2.5).[2] They were divided into control group with normal skeletal BMD (*n* = 40; mean age 68.30 ± 5.530) and osteoporotic group with low skeletal BMD (*n* = 40; mean age 69.15 ± 3.322).

Exclusion criteria were as follows: (1) Postmenopausal disease, osteomalacia, diabetes mellitus, and mandibular bone destruction; (2) patient had a history of malignancy < 5 years before signing informed consent, except for adequately treated basal cell or squamous cell carcinoma or *in situ* cervical cancer; (3) patients with significant renal impairment and liver disorders; (4) patients with a history of smoking, tobacco use, and use of drugs that affect bone metabolism such as estrogen, oral bisphosphonates, and systemic glucocorticoids within the prior 6 months.

All patients who participated gave written informed consent. All dental panoramic radiographs were obtained at the time of BMD measurement with the X-ray unit [Care stream CS 8000C]. OPG with smooth and continuous mandibular inferior cortical bone, well-appreciated mental foramina, and absence of double images/ghost images were selected. Subjects were positioned in the panoramic unit in a way that the vertical line produced by the unit was aligned with the facial midline and the horizontal line (Frankfort plane) was parallel to the floor. Measurement of panoramic mandibular indices such as the mental index [MI], antegonial depth, and antegonial index may be an effective action for the early diagnosis of osteoporosis. The aim of this study was to investigate whether these indexes on the panoramic radiographs are efficacious in identifying postmenopausal women with low femoral bone mineral density (f-BMD) diagnosed using DEXA, that is, whether there is any association between two.

Mental Index (MI)

Mandibular cortical bone thickness was measured bilaterally using MI. To measure MI, the long axis of the mandible was noted and a line parallel to it and tangential to the inferior border of the mental foramen of mandible was established, where the line intersecting the inferior border of the mental foramen was drawn, the perpendicular distance between the two parallel lines was measured by the tools from the NNT software [Figure 3].

Antegonial depth is measured as the distance along a perpendicular line from the deepest point of antegonial notch concavity to the line parallel to the inferior cortical border of the mandible, the distance was measured by the tools from the NNT software [Figure 4].

Antegonial Index

It is the measurement of the cortical width in the region anterior to the Gonion at a point identified by extending a line of best fit on the anterior border of ramus, the perpendicular distance between the two parallel lines was measured by the tools from the NNT software [Figure 5].

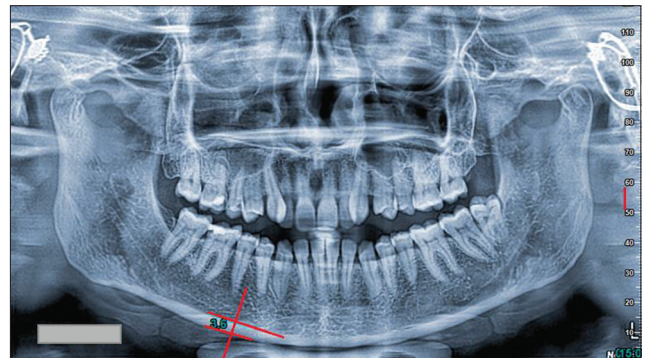The indices were measured and the data were noted.

Figure 3: Mental index (MI) is measured by drawing long axis of the mandible and a line parallel to it and tangential to the inferior border of the mental foramen of mandible was established, where the line intersecting the inferior border of the mental foramen was drawn, the perpendicular distance between the two parallel lines was measured by the tools from the NNT software

Figure 4: Antegonial depth is measured as the distance along a perpendicular line from the deepest point of antegonial notch concavity to the line parallel to the inferior cortical border of the mandible, the distance was measured by the tools from the NNT software

Figure 5: Antegonial index is the measurement of the cortical width in the region anterior to the Gonion at a point identified by extending a line of best fit on the anterior border of ramus, the perpendicular distance between the two parallel lines was measured by the tools from the NNT software

Statistical Analysis

The Microsoft Excel and SPSS 20 software packages were used for data entry and analysis. Data were presented as mean values, standard error of means (SEM), numbers, and percentages. The Student's "*t*"-test was used to determine whether there was a statistical difference between groups in the parameters measured. The correlation between the observers was calculated by Pearson correlation coefficient test. In the entire above tests, "*P*" < 0.05 was accepted as indicating statistical significance.

RESULTS

The age range of the patients was 30–72 years. The mean age for normal BMD group was 68.30 ± 5.530 years (Mean ± SD) and of the osteoporotic group was 69.15 ± 3.322 years (Mean ± SD). Graph 1 shows the mental index of normal group and osteoporotic group. *$P \leq 0.001$, "*t*"-test, indicates a significant decrease in relation to osteoporotic group. Graph 2 shows the antegonial index of normal group and osteoporotic group. *$P \leq 0.001$, "*t*"-test, indicates a significant decrease in relation to osteoporotic group. Graph 3 shows the antegonial depth of normal group and osteoporotic group. *$P > 0.05$, indicates no significant correlation between the two groups.

DISCUSSION

Dental panoramic X-ray or orthopantomogram (OPG) is a routine examination in everyday dental practice. It is estimated that millions of patients undergo dental X-ray examination annually, whereas dental radiological examinations are among the
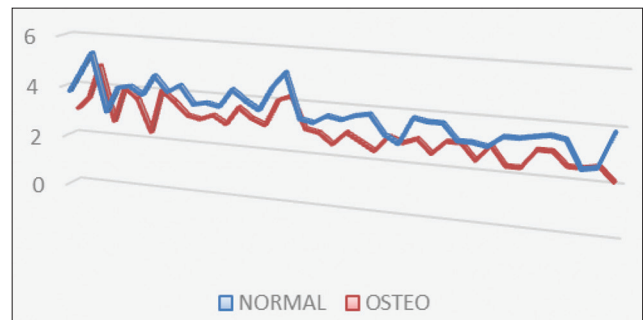
Graph 1: Mental index of normal group and osteoporotic group
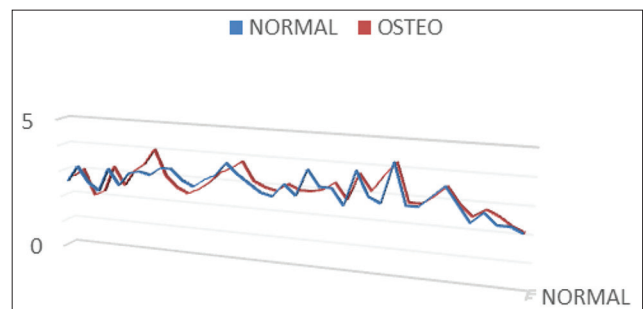
Graph 2: Antegonial index of normal group and osteoporotic group
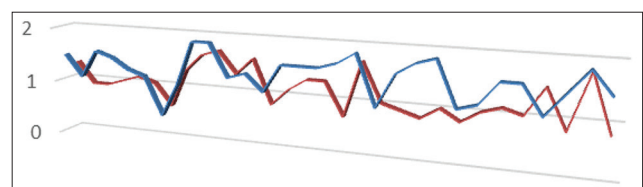
Graph 3: Antegonial depth of normal group and osteoporotic group

most common reason for X-ray exposure.[10] Several indices assessed in OPGs are used in the literature to correlate mandibular changes and BMD.[11-13] For most of them, the cortical margin of the lower jaw is used, as it is more obvious and easy to detect compared to the trabecular bone. Furthermore, the area below the mental foramina is mostly studied, due to (1) the usual lack of muscle attachment there and (2) the fact that the distance between the mental foramen and the inferior margin of the mandibular cortical bone remains relatively stable during the lifespan, irrespective of the alveolar bone resorption following tooth extraction or inflammation. Osteoporosis, which is characterized by compromised bone strength, is frequently not detected until a fracture occurs.[14] Osteoporosis is very common among postmenopausal women, while women of high risk are often asymptomatic.

Therefore, the identification of low bone mass in postmenopausal women should be emphasized as subjects with low BMD are more susceptible to osteoporotic fractures.[15] Early interventions may maximize bone mass retention and enhancement and thus reduce the risk of fracture. Benson *et al.* used the PMI in panoramic radiographs based on cortical bone measurements and also measured the cortical bone thickness in the mental foramen region.[16] They evaluated the MI according to age, race, and sex and observed that mandibular cortical bone thickness decreased with age and the amount of resorption was higher among women. In a study by Horner and Devlin, the PMI values measured in females with osteoporosis on panoramic radiographs were compared with the mandibular Bone mineral density values measured with DXA, and a significant relationship was found between the two.[17] They concluded that PMI could be used as an indicator of mandibular bone density; however, further studies among larger groups are needed. Studies measuring PMI values found that the values that decrease with increasing age are smaller among white individuals than among Black individuals and among women compared with men. They are also smaller in female patients with osteoporosis than in healthy female individuals; this was found to be statistically significant.[7,18] In a study of 112 healthy females and females with osteoporosis, Kribbs observed that the MI is smaller in the group with osteoporosis than in healthy individuals.[19] The present study found that the MI and PMI values in panoramic radiographs of patients with osteoporosis were statistically significant when compared with the values of the control group; cortical bone thickness in these regions was also lower. These results are in agreement with the results of similar studies of different study groups. Ledgerton *et al.* evaluated AI in panoramic radiographs.[20] The present study, which compared the AI measurements of 500 panoramic radiographs in terms of age, dentition, and social class, found a negative relationship with age, and this was interpreted as a possible indicator of skeletal osteopenia. A study of 52 edentulous females found that AI values measured on panoramic films were lower in the group with osteoporosis, and antegonial region measurements are a useful method to identify osteoporosis risk groups.[21] Studies on cortical bone measurements in the antegonial region (AI) have shown that the change in measurement is inversely proportional to age, and the values are smaller in edentulous individuals than in dentate and denture-wearing individuals, and in females than in males. The studies suggested that the decrease in cortical bone thickness in the gonial region, particularly among women, might be associated with osteoporosis.[22] In the present study, we found that antegonial depth of normal group and osteoporotic group had no significant correlation *$P > 0.05$, "t"-test showed no significant correlation between the two group, at the same time, mental index and the antegonial index of normal group and osteoporotic group were significantly correlating with *P 0.001, "t"-test, indicates a significant decrease in relation to osteoporotic group.

CONCLUSION

Low f-BMD and age are major risk factors for osteoporosis. Patients with low f-BMD had thinner mandibular cortex at the mental foramen region (MI) and width in the region anterior to the gonial at a point identified by extending a line of best fit on the anterior border of mandible, (AI) when compared to normal subjects and are more susceptible to fractures. Hence, mandibular inferior cortical width at the mental foramen region and antegonial region could be used for identifying patients with low f-BMD, low radio morphometric indices studied on panoramic radiographs can be used as important criteria for further assessment of bone mineral density, establishing panoramic dental radiographs serve as useful screening tool for early diagnosis of osteoporosis. Further studies are needed to ascertain the value of panoramic radiology as an adjunct diagnostic tool in the screening of patients thought to be at high risk of osteoporosis.

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