Radiographic Detection of Postmenopausal Osteoporosis Using Dental Panoramic Imaging among Bangladeshi Women

Fatema Begum[1], Tahmina Begum[2], Mst Meher Afroz[3], Rifat Sultana[4], Nafisa Jesmin[5], Samir Banik[6]

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*Corresponding author

ABSTRACT

Background: Osteoporosis is a major public health concern among postmenopausal women, particularly in low-resource settings where access to bone densitometry is limited. Dental panoramic radiography may offer a simple, cost-effective alternative for early identification of women at risk of low bone mass. **Objective:** To assess mandibular cortical morphology and radio morphometric indices on panoramic radiographs for detecting radiographic features of osteoporosis among postmenopausal Bangladeshi women. **Methods & Materials:** This cross-sectional descriptive study was conducted at the Department of Oral and Maxillofacial Radiology, Dhaka Dental College Hospital from July, 2022 to June, 2023. Panoramic radiographs of 50 randomly selected postmenopausal women aged 50–80 years were evaluated. The Mandibular Cortical Index (MCI), Mental Index (MI), and Panoramic Mandibular Index (PMI) were measured using standard methods. **Results:** Normal mandibular cortices (C1) were observed in 32.0% of participants, while 28.0% had moderately eroded cortices (C2) and 40.0% exhibited severely eroded cortices (C3). Nearly half (46.0%) had MI values below 3 mm, and 62.0% had PMI values below 0.30. Based on combined indices, 38.0% of the women were categorized as having radiographic features suggestive of osteoporosis. **Conclusion:** A substantial proportion of postmenopausal Bangladeshi women demonstrated radiographic indicators of osteoporosis. Panoramic imaging offers potential as an adjunctive, low-cost tool for early detection of osteoporosis, particularly in regions where advanced diagnostic facilities are unavailable.

Keywords: *Postmenopausal osteoporosis, Dental panoramic radiography, Mandibular cortical index, Mental index*

1. *Junior Consultant, Department of Obstetrics & Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh (ORCID: 0009-0002-8927-179X)*
2. *Assistant Professor, Department of Obstetrics & Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh*
3. *Senior Consultant, Department of Obstetrics & Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh*
4. *Junior Consultant, Department of Obstetrics & Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh*
5. *Assistant Professor, Department of Radiology & Imaging, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh*
6. *Assistant Professor, Department of Radiology & Imaging, Dhaka Dental College, Dhaka, Bangladesh*

INTRODUCTION

Osteoporosis is a skeletal, systemic chronic condition which is marked by loss of bone mass and bone microarchitecture resulting in loss of bone fragility and predisposition to fracture [1,2]. According to the World Health Organization (WHO), osteoporosis is quantitatively defined as bone mineral density (BMD) 2.5 standard deviations or less when compared to the norm of the young adult age, which is measured by dual-energy X-ray absorptiometry (DEXA) [1]. Even though the disease is silent, it ends in fracture of bones which is the first and most devastating clinical manifestation of the disease. These fractures have significant personal and social effects, such as chronic pain, loss of mobility, and dependence in their daily functioning [3]. The fact that osteoporosis presents silently and is often not diagnosed early enough and has not been screened sufficiently has made it to become a leading public health issue in both low and high-income countries. Osteoporosis and associated with low bone mineral density (LBMD) have increased in burden worldwide, as demographic ageing has increased. The Global Burden of Disease Study estimated that LBMD has over 438,000 deaths and over 16 million disability-adjusted life-years (DALYs) in 2019, nearly doubling the burden in 1990 [2]. Osteoporosis is a condition that is currently estimated to impact 200 million individuals across the globe, with one out of every three females and one out of every five males over the age of 50 years having a good chance of having an osteoporosis related fracture at some point in their lives [1,3]. Hip fractures are considered the most damaging of the consequences and nowadays one-year mortality rates vary between 20% and 30% of the population regardless of modern orthopedic and rehabilitative treatment [4]. These fractures are extending significant socioeconomic pressure due to the long hospitalization, institutionalization, and productivity loss [5]. Preventive measures and early detection of people at risk although there has been a breakthrough in pharmacological management is paramount in minimizing the fracture load in the world. The issue in South and South-East Asia is augmented by ageing of population, lack of nutritional adequacy and lack of screening opportunities [6]. Women of South Asian ancestry are particularly susceptible because of reduced skeletal structure, reduced peak bone mass and widespread vitamin D deficiency, which in combination with each other makes them vulnerable to premature bone loss and fragility fractures [6]. The country, Bangladesh, which is a lower-middle-income country with a fast-growing ageing population of women, represents this emerging crisis. It has been estimated that the number of women above 50 years of age will grow significantly in the next few decades and recent statistics have shown that osteoporosis and osteopenia is very common among the Bangladeshi women [7,9]. According to Begum and others, 50% of all over 50-year-old women living in Bangladesh exhibited low bone mass through the use of the DEXA scanner, and the same data were also found in rural and urban regions, indicating that socioeconomic disparities have played a limited protective role [8]. Ali et al. confirmed these results by heel quantitative ultrasound and they discovered that 45% of women aged above 50 years had suboptimal bone quality especially women who had a low body mass index (BMI), who consumed insufficient calcium in their diets and did not engage in physical activity [7]. According to the results of recent local and regional studies, the epidemiological processes related to osteoporosis in Bangladesh are similar to those in neighbouring South Asia countries

like India and Nepal where prevalence rates and lack of awareness remain high [6,9]. The Kha et al. study in Bangladesh indicated that 63% of postmenopausal women had osteopenia or osteoporosis and that there were significant correlations between age and parity as well as the nutritional status and physical inactivity [9]. However, in contrast to most of the developed environments, there is practically no population-based screening initiatives, and the access to the diagnostic gold standard, DEXA, in Bangladesh is restricted to the tertiary centres in urban areas. As a result, most women are yet to be diagnosed until they have fractures. Estrogen deficiency after menopause is the leading pathophysiologic process involved in postmenopausal osteoporosis that initiates an increase of bone resorption as compared to bone formation leading to a rapid loss of trabecular bone volume and structural integrity [10]. Nonetheless, in the Bangladeshi setting, hormonal deterioration is not merely one of a number of convergent factors that increase bone loss. Deficiencies in nutrients are widespread and national dietary surveys have continued to record unacceptable calcium consumption and prevalence of vitamin D deficiency in women [11,13]. A survey by Ahmed et al. found that 78% of the postmenopausal women in tertiary care hospitals in Dhaka were deficient in vitamin D and this was strongly linked with reduced lumbar and femur neck BMD [12]. Similarly, Islam et al. (2010) showed that supplementation with calcium and vitamin D increased levels of serum 25(OH)D and bone density in Bangladeshi women which confirms the fact that these nutritional risk factors can be modified [11]. To worsen these shortcomings are the lifestyle factors including low amount of sun exposure, the customary mode of dressing, reduced levels of physical activity, and multiparity, which all lead to cumulative bone demineralization [9]. All this makes postmenopausal Bangladeshi women especially vulnerable to undiagnosed low bone mass and fragility fracture [7,14]. Nevertheless, osteoporosis is undiagnosed and underreported in Bangladesh with no cost-effective diagnostic methods and poor knowledge of the community [6]. There is growing interest in the use of more convenient modalities of identifying the precursors of bone loss as DEXA facilities are only available in specialised centres. A potential adjunctive tool in identifying postmenopausal women potentially at risk of osteoporosis has been suggested to be dental panoramic radiography, as one of the routine imaging modalities in dental and maxillofacial practice [7]. The radiomorphmetric indices of the mandibular cortex including the mandibular cortical index (MCI), mental index (MI), and panoramic mandibular index (PMI) have demonstrated strong correlations with systemic BMD in various groups of people. Since panoramic imaging is highly available, and relatively cheap particularly in the urban dental set ups in Bangladesh, an assessment of its diagnostic utility in the detection of osteoporosis can offer a pragmatic and generalizable intervention in the early detection of risk. Thus, the current research will evaluate the radiographic appearance of the mandibular cortex using dental panoramic records in postmenopausal Bangladeshi women and establish the percentages of women who show radiographic signs of osteoporosis. Through this, this work aims at adding to the accumulating evidence that dental panoramic radiography has the potential to be a low-cost adjunct to early detection of osteoporosis in resource-constrained environments.

METHODS & MATERIALS

The study is a cross-sectional descriptive study that was done in the Department of Oral and Maxillofacial Radiology, Dhaka Dental College Hospital, Dhaka, Bangladesh from July, 2022 to June, 2023. The radiology department provided a random sample of 50 postmenopausal women between the age of 50 and 80 years to obtain panoramic radiographs. Women were chosen as postmenopausal when their menstrual period was gone or at least a few months and they were clinically deemed to be at the postmenopausal phase. The radiographs of sufficient quality, with clearly visualised mandibular inferior cortices and mental foramina on both sides were included. All the images were obtained with the help of the Gendex Orthoralix 9200 panoramic X-ray unit according to the standard exposure procedure of the department and analyzed and measured through VixWin Platinum software to evaluate the morphology and thickness of the mandibular inferior cortex. In every radiograph, the bilateral visual inspection of mandibular cortical shape was assessed based on the Mandibular Cortical Index (MCI, Klemetti index) and classified into C1, C2, or C3. With category C1, the endosteal margin of the mandibular cortex is flat and sharp, indicating a normal cortex; category C2 indicates semilunar defects or endosteal cortical residues, indicating mild to moderate erosion; and category C3 indicates erosion of the cortical layer which is gross and with noticeable porous characteristics, indicative of osteopenia. The mental index (MI) which is a measure of mandibular cortical width in the area of the mental foramen was determined by first locating the mental foramen, then drawing a tangent along the anterior border of the mandible, and subsequently a line perpendicular to this tangent which passed through the centre of the mental foramen; the cortical width was measured at this point of the line crossing the inferior cortex. Panoramic mandibular index (PMI) was obtained as the ratio of cortical width at the area of mental foramen (MI) to the distance between the lower end of the mandible and the lower end of the mental foramen (MI/h). To describe it, MI values lower than 3 mm and PMI values lower than 0.3 were regarded as indicative of decreased mandibular cortical thickness; and values above it were regarded as within the normal range. The MCI group of each of the participants, MI, and PMI were noted and a combined radiographic evaluation was conducted to categorize the women into having or not having features that indicated osteoporosis. Measurement on digital images on a calibrated monitor was done at a standardised magnification by a trained dental radiology observer. The summary of the data was done using descriptive statistics and the findings are displayed in form of frequencies and percentages.

RESULTS

The distribution of mandibular cortical morphology showed that 32.0% of women demonstrated a normal cortex (C1), while 28.0% exhibited mild to moderate endosteal erosion (C2). The largest proportion, 40.0%, presented with severely eroded and porous cortices (C3), indicating that nearly half of the study population showed cortical features commonly associated with low bone mass (*Table I*).

Table I
Distribution of Mandibular Cortical Shape (Mandibular Cortical Index, MCI).

Cortical shape category	n	%
C1: Sharp and even endosteal margin (normal)	16	32.0
C2: Mild to moderately eroded cortex	14	28.0
C3: Severely eroded, porous cortex	20	40.0
Total	50	100.0

The mental index assessment revealed that 54.0% of participants had a cortical width of 3 mm or greater, whereas 46.0% had MI values below 3 mm. Nearly half the sample demonstrated reduced cortical width at the mental foramen region, a radiographic feature suggestive of diminished mandibular bone mass (*Table II*).

Table II
Mental Index (MI) Categories Among Postmenopausal Women (*n* = 50).

Mental index category	n	%
MI ≥ 3 mm	27	54.0
MI < 3 mm	23	46.0
Total	50	100.0

Panoramic mandibular index values showed that only 38.0% of women had PMI measurements of 0.30 or greater. The majority, 62.0%, had PMI values below 0.30, indicating a high proportion of participants with reduced mandibular cortical thickness relative to mandibular height—an additional marker consistent with low bone density (*Table III*).

Table III
Panoramic Mandibular Index (PMI) Categories Among Postmenopausal Women (*n* = 50).

Panoramic mandibular index category	n	%
PMI ≥ 0.30	19	38.0
PMI < 0.30	31	62.0
Total	50	100.0

The combined radiographic assessment categorized 62.0% of women as non-osteoporotic based on cortical morphology and mandibular indices, while 38.0% were classified as osteoporotic (*Table IV*).

Table IV
Overall Radiographic Classification Based on Mandibular Indices (*n* = 50).

Radiographic classification*	n	%
Non-osteoporotic	31	62.0
Osteoporotic	19	38.0
Total	50	100.0

*Note. *"Osteoporotic" defined as presence of C3 cortical category and, or MI < 3 mm and, or PMI < 0.30 on panoramic radiography.*

DISCUSSION

The current research estimated the usefulness of dental panoramic radiography in screening postmenopausal osteoporosis in Bangladeshi women using three mandibular indices, including Mandibular Cortical Index (MCI), Mental Index (MI) and Panoramic Mandibular Index (PMI). The results showed that 40.0% of the respondents had a severely eroded porous cortical margin (C3), 28.0% had mild to moderate cortical erosion (C2), and only 32.0% had normal cortical outline (C1). This implies that almost two-thirds of the study population had radiographic signs of cortical atrophy, which is an indication of poor mandibular bone quality. Similar distributions have been seen in other international studies which supports the validity of cortical morphology as a proxy measure of systemic bone loss. As an example, Popic et al. found out that C3 pattern was demonstrated by 57.4% of osteoporotic women, and the C2 and C3 categories were also very high in the postmenopausal women (Munhoz et al., Grocholewicz et al.) [15-17]. Likewise, Nemati et al. discovered that the level of cortical erosion above age and duration of menopause was increasing in a progressive manner which suggests that mandibular cortical alterations are closely related to the systemic skeletal demineralization [18]. This trend was also supported by the Mental Index (MI) and Panoramic Mandibular Index (PMI). The current analysis found that 46.0% of women had a MI value of less than 3 mm and 62.0% had a PMI value of less than 0.30, which are typical values of lowered cortical bone mass. This data is consistent with the results of Mudda et al., who have mentioned much lower MI and PMI scores in postmenopausal women than in those before menopause in Indian women [19]. Grocholewicz et al. have obtained the same mean MI and PMI values (3.31 mm and 0.33, respectively), which confirms that a low percentage of mandibular cortical width and mandibular height are also expected radiographic findings of low bone mineral density [17]. In a number of other studies, such as Popica and Balto and others, statistically significant correlations were reported between MI, PMI and the scores of bone mineral density by DEXA [15,20]. It is worth noting that Balto et al. reported that PMI cutoff of 0.41 would have high sensitivity and specificity to osteoporosis, whereas Carmo and Medeiros were able to confirm that MI below 3 mm would be highly predictive of low lumbar and femoral BMD [20,21]. The fact that these results are comparable with the results of the current Bangladeshi cohort highlights the relevance of mandibular indices as stable radiographic variables in ethnic and geographic backgrounds. A combination of the three indices showed that 38.0% of women were in the radiographic features of osteoporosis, and 62.0% were between the non-osteoporotic. This percentage of radiographic osteoporosis is in agreement with other findings made in other countries. According to Gaur et al., a concomitant measure of MCI, MI, and PMI was found to have a sensitivity and specificity of 100 and 88.8%, respectively, with respect to the use of DEXA [22]. On the same note, Valerio et al. also presented a significant inter-group variation in all the three indices ($p < 0.05$) and indicated that the combined panoramic indices could better identify low bone density cases at the early stages [23]. Balto et al. also validated the usefulness of multi-index analysis in a larger Saudi cohort, and multi-

index analysis demonstrated significantly better diagnostic performance than the indices used individually [20]. Kolte et al. and Abdinian and Milaei also found statistically significant correlations between MCI, MI, and PMI, which is why it is beneficial to use multi-parameter assessment to correctly classify osteoporotic risk [24,25]. The incidence of cortical erosion (C2 and C3), low MI and PMI values, and a combined 38% rate of radiographic osteoporosis, all of which are evident in this case, all indicate the presence of a significant undetected low bone mass in postmenopausal Bangladeshi women. This observation is especially applicable in an environment where there is a lack of DEXA facilities, and more affordable screening methods are urgently required. Likewise, other studies done in Europe, the Middle East, South Asia have also made similar conclusions that dental panoramic imaging has a promising role to play in screening osteoporosis [26-28]. The consistency of these results in the various populations favors the possibility of using panoramic radiography as a screening tool beforehand in a dental or radiology department, particularly in resource-deprived areas. Hence, the present study adds more insights to the existing body of research that regular dental panoramic imaging, by evaluating mandibular cortical morphology and radiomorphmetric indices, can be a useful low-cost supplemental procedure used in the timely detection of postmenopausal females who have a potential risk of osteoporosis.

LIMITATIONS

The current research had the following weaknesses because the sample size used was very small, and no confirmatory bone mineral density (BMD) test had been done with DEXA thus limiting the scope of diagnostic sensitivity and specificity. Furthermore, it was also descriptive and single-centered, which did not allow generalizing the results to the whole population of the country.

CONCLUSION

In this study, the proportion of postmenopausal Bangladeshi women whose radiographic features are indicative of osteoporosis when assessed by dental panoramic radiography was found to be significant. The large proportions of severely eroded mandibular cortices (C3), low mental index (MI < 3 mm), and low panoramic mandibular index (PMI < 0.30) suggest that the weight of undetected low bone mass is high in this group. The fact that these findings have been similar to those of other researchers worldwide also indicates that dental panoramic radiograph, which is regularly taken in clinical practices, can be used as a beneficial ailment to diagnose osteoporosis at an early stage in resource-strained conditions.

RECOMMENDATION

More multicentric, large-scale research, that is using DEXA validation, is necessary to establish the diagnostic validity of mandibular indices in screening osteoporosis. Education of dental practitioners on how to detect cortical erosion and low mandibular indices on panoramic views might help improve the detection of cases at an early stage. It is possible that a cost-effective public health measure involving the screening of postmenopausal women in Bangladesh with opportunistic radiographic osteoporosis through routine dental and radiology practice.

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CONFLICT OF INTEREST

None declared

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee

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