ORIGINAL ARTICLE

Early diagnosis of osteoporosis in male and female patients between 30 and 75 years using orthopantomography

Tejavathi Nagaraj[1], T. V. Bhavana[1], Leena James[2], Rahul Dev Goswami[1], N. Sreelakshmi[1], Noori Ghouse[1]

[1]Department of Oral Medicine and Radiology, Sri Rajiv Gandhi Dental College & Hospital, Cholanagar, Bengaluru, Karnataka, India, [2]Department of Oral Medicine, Sri Rajiv Gandhi Dental College & Hospital, Cholanagar, Bengaluru, Karnataka, India

Abstract

Background: Osteoporosis is a systemic bone disease that is characterized by a generalized reduction of the bone mass. This bone disease exhibits microarchitectural degradation/disintegration of the bone scaffold that leads to increased bone fragility and more prone to fracture. Dental radiographs are one of the commonly used imaging modalities for teeth and jaw pathology.

Aims and Objectives: The aim of this study was to assess the mandibular bone quality in panoramic radiographs for an initial evaluation of osteoporosis in male and female patients between 30 and 75 years using mental index (MI), which measures the cortical bone thickness of mandible.

Materials and Methods: Hundred digital panoramic radiographs were screened. MI was used to evaluate the mandibular cortical bone thickness bilaterally. In males and females average MI scores were then assessed by using the *t*-sample independent test.

Results: The study was statistically significant with $P < 0.001$ which showed differences of mandibular bone quality between the groups based on MI measurements.

Conclusion: Using MI for assessment of mandibular bone quality in panoramic radiograph showed a significant difference between males and females. Correlation between MI and age showed elderly females were most affected by osteoporosis. Thus, panoramic radiographs can act as a diagnostic aid for early detection of osteoporosis.

Introduction

Early detection of osteoporosis is important to detect fracture risk, especially in more susceptible group that is in the elderly and postmenopausal females. Osteoporosis is a systemic bone disease that is characterized by generalized decrease of the bone mass and deterioration of bone microarchitecture.[1-3] It is one of the most common disorders of the elderly and is estimated that 75 million people in Europe, Japan, and the United States are affected.[2] It is a significant health problem for middle-aged women, coinciding with menopause.[4] Although changes in the bone mass and calcium metabolism are evident in the premenopausal period, menopause marks the beginning of bone loss that continues until the end of life and is a main cause of osteoporotic fractures in elderly women.[1,5] Apart from the hormonal risk factor, there are other risk factors for osteoporosis, particularly: Family history, insufficient calcium intake, lack of moderate physical exercise,

toxic habits such as smoking and excessive consumption of alcohol or medications, especially glucocorticoids.[1,5] As a consequence of osteoporosis, pathological fractures occur, which is a serious health and economic problem; hence, the early diagnosis of this pathology is important. However in developing countries, the expenses of the examination are quite a major problem. Panoramic radiograph which is used widely in dentistry can be easily available for early detection of osteoporosis with minimal expense.[1,3,5] Cortical thickness measurement can be one of the way to detect osteoporosis in patients. Panoramic Radiography is frequently and commonly used as a diagnostic tool for detection of teeth and jaw anomalies, due to its potential to secure comprehensive image of the maxillofacial structures in routine dental practice.[1,3,5] Osteoporosis is one of the systemic diseases that can show as a characteristic image on panoramic radiograph. Cortical thinning and more radiolucent trabecular areas are characteristic changes of this disease. In osteoporotic

patients the success rate of dental care depends on quantity and quality of the jaw bone.[6] The bone marrow density (BMD) score plays an important role in diagnosing osteoporosis. But, especially in developing countries BMD tests are very expensive, and therefore not commonly used as an early diagnostic tool for fracture risks.[1,6] Thus most of the researchers have an opinion that panoramic radiograph could be a better and early assessing tool in female patients with low BMD scores.[1,3,5]

Materials and Methods

Hundred digital panoramic radiographs of equal number of male and female patients within the age range of 30-75 years who were advised radiographs for various purposes were collected from the Department of Oral Medicine and Radiology, Sri Rajiv Gandhi Dental College and Hospital, Bangalore. The digital panoramic radiographs were obtained using the Orthophos XG machine (digital panoramic machine) with a tube voltage of 64 kV, tube current 16mA and exposure time of 14.1 s. MI was measured in millimeters using sidexis software program (Sirona). The radiographs were randomly selected based on the inclusion criteria like smooth and continuous mandibular inferior cortical bone, well appreciated mental foramina, and absence of double images/ghost images. Mandibular cortical bone thickness was measured bilaterally using MI. To measure MI, 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, and by using calipers available in sidexis software programed the mandibular cortical width was measured as shown in Figure 1. The mean cortical thickness of the mandible bilaterally was interpreted as mental index (MI).

After applying tests of homogeneity of variance mean MI value was obtained for individual radiograph and grouped into males and females. For each group the standard deviation, mean value and variance were calculated and *t*-test independent was used to examine the groups. MI was set as the dependent variable and gender and age were marked as independent variables. Later in both of the groups the average MI score were then obtained using *t*-sample independent test.
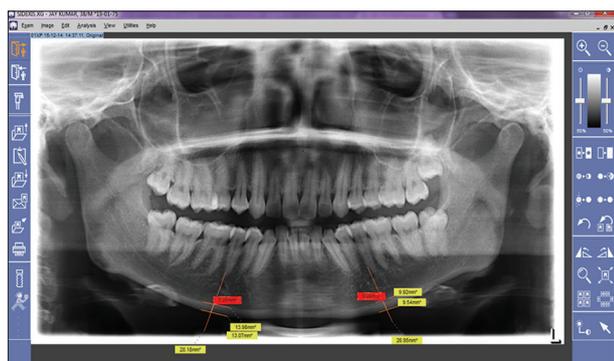

Figure 1: Pantomograph showing the measurements of mental index using sidexis software

Results

In normal healthy individuals MI varies from 5 to 6 mm, whereas in osteoporotic patients MI will be <3 mm thickness of cortical bone. Hundred panoramic radiographs, of equal number of male and female patients were screened. Out of 50 female radiographs 25 radiographs (50%) had MI score < (below) 4 mm, while the other 25 radiographs (50%) had MI score > (above) 4 mm. out of 50 male radiographs two radiographs (4%) of male patients had MI score < (below) 4 mm, while the rest 48 radiographs (50%) had MI score > (above) 4 mm. Table 1 shows the gender distribution and MI value. Table 2 shows the result of MI value of both the groups using *t*-independent test. Correlation between MI and age is shown in Graph 1. The mean MI value obtained was 4.167 mm for female group and 5.626 mm for male group. The difference in MI value between male and female groups with a p < 0.001 was obtained and was highly significant.

Discussion

In human beings, due to the increasing age there will be a loss of bone mass which is a universally observed phenomenon. In human bones, density decreases and porosity of bone increases which begins at about the third decade of human's life. Radiological assessment of the effect of generalized mineral reduction of skeleton, osteoporosis affecting the jawbones has been studied very extensively. There is marked association between osteoporosis and oral bone loss, this proposal was made by Greon in early 1960.[7]

Osteoporosis is the most common among the elderly individuals who visit the dentists more often for their dental problems and dentist being the only healthcare professional who can detect osteoporosis as early as possible by routine radiographs. Osteoporosis is defined as a disease characterized by microarchitectural deterioration of bone tissue and low bone

Table 1: Distribution of patients according to gender and MI value

Gender	MI (n (%))		χ^2 value	*P* value
	<4.00	≥4.00		
Male	2 (4.0)	48 (96.0)	26.839	<0.001***
Female	25 (50.0)	25 (50.0)		

MI: Mental index, ***: Highly significant
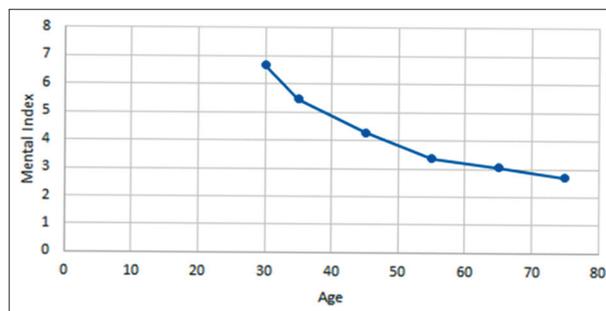
Graph 1: Correlation between mental index and age

Table 2: The mean MI value and examination result of both group

Gender	N	Mean	SD	Median	Minimum	Maximum	Mean different	SE	t value	P value
Male	50	5.626	0.838	5.660	3.44	7.46	1.459	1.3991	10.432	<0.001***
Female	50	4.167	1.120	3.780	2.17	7.83				

SD: Standard deviation, SE: Standard error, MI: Mental index, ***: Highly significant

mass.[2,3,8] It is associated with a high risk of fractures, morbidity for affected patients, consequent pain, and as well as high costs to public health services. In determining the fracture risk low bone mass plays an important role, many considerable works have been carried out on developing means of recognizing individuals with low bone mass at an early stage, so that helps in therapeutic intervention which may limit the disease process.

Genetic factors, particularly gender, affects bone mass. Sexual hormones in males and females are different. However, both of them affect bone growth. Estrogen in females and testosterone in males encourage bone growth.[9] Humans have peak bone mass at the age of 30-35 years in females and 40 years in males and which increases persistently up to this age.[10] Unlike males, the aging process in females comes earlier. The menstruation cycle ends when the reproductive age in females is over at the age of 45-50 and at this age sexual hormone rapidly decreases, this period is known as menopause. Decreased/reduced level of estrogen has played a very important role in menopausal females leading to a decreased bone mass.[11] Osteoporosis can be prevented with help of estrogen which has the effect on osteoclast wherein the stimulation effect on specific cytokines will be inhibited. Reduced level of estrogen leads to increased sensitivity of osteoclast to parathyroid hormone and also affects synthesis of the active vitamin D in renal tubules and finally leads to decreased calcium absorption.[12]

Previous studies have reported that the reduced bone mineral density affected the architectural properties of mandibular bone, densitometric, and morphometric changes in the osteoporotic patients.

Bone status at various sites can be examined using following methods:
1. Single photon absorptiometry
2. Dual photon absorptiometry
3. Quantitative ultrasound, or quantitative computed tomography
4. Dual-energy X-ray absorptiometry.[13,14]

The panoramic radiographs are most commonly used for routine examination in dentistry and early detection of osteoporosis through the radiographic changes in mandible could play a role in diagnosis and hence the dentist will be in a position to detect such patients in early stage, which changes the treatment plan and direct such patients for proper management.[13,14]

There is evidence that a huge number of dental panoramic radiographs, offering greater opportunities for studying bones, are taken every year due its low exposure and cost effectiveness.[15] The present study therefore utilizes panoramic radiographs. It is statistically possible to show positive correlations and dependencies between the mineral density of the skeleton and changes in the mandibular cortex shown on panoramic X-ray images. These findings were partly successful due to standardization of head positioning, which in normal practice is very difficult as the images are taken by different practitioners at different times. All the radiographs, in which the incisors were too wide or narrowed, were repeated as these radiographs were considered to be distorted. The present study suggests that if the inferior mandibular cortical thickness is low, the tendency toward osteoporosis is high which was more commonly seen in females. The cortical thicknesses with significant difference ($P < 0.001$) were seen in males and females at the age of 40-60 years in this study. Thinner cortex was seen in females when compared with male group. A study on Japanese population showed a value of 2.8 mm and less which was of different threshold and those patients was referred for bone mineral density investigation.[14]

The diagnosis of osteoporosis can be done by assessing the changes in BMD. In all post-menopausal women BMD testing can reduce the risk of the fracture and complications arising from osteoporosis, but it is still difficult to achieve in clinical practice due to various hurdles such as high cost, limited expertise, and also limited facilities.[16]

There were studies showing that panoramic radiographs of menopausal women showed cortical bone thinning.[13] Cortical thinning on mandible is due to the Haversian canal widening. One of the technique that can be used for assessing the bone quality is by MI, by the measurement of mandibular cortical thickness.[17]

One area of future research would be to look at the thickness of cortical layers longitudinally to see whether any signs of osteoporosis could be detected. Longitudinal studies of mandibular bone density may also be fruitful than cross-sectional studies in the evaluation of the role of dental radiography in assessing patients for osteoporosis.[18] However, to analyze bone density in dental panoramic radiographs there are newly proposed systems like kernel-based support vector machine (SVM) and utilizing an automatic approach such as histogram based automatic clustering algorithm with a SVM will be useful.[19,20]

The present study has few drawbacks such as not involving factors that might alter jaw bone quality, such as medication, smoking, regular exercise, systemic disease, alcoholism, and others.

Conclusion

Many human diseases go undiagnosed in their early stages but by the help of routine examination if the diseases are diagnosed

earlier, then the prognosis of the disease will be better. The present study showed that females are more prone to osteoporosis when compared to males and this can be detected using routine panoramic radiographs. Radiographs of osteoporotic patients showed a decreased MI value compared to healthy individuals. This study was initiated to establish the importance of a preliminary diagnostic modality that may be useful to dental practitioners caring for patients at high risk for osteoporosis, because it has been associated with tooth loss, excessive residual ridge resorption, delayed healing after tooth removal, referred dental pain caused by thinned walls of the maxillary sinus, and periodontal disease. So, panoramic radiographs can be used for early detection of osteoporosis in both males and females.

Clinical significance

By using MI in panoramic radiographs cortical bone thickness can be measured. These measurements help in the evaluation of mandibular cortical thickness and assessing mandibular bone quality among both the genders which showed a significant difference which is of relevance in early diagnosis and treatment planning in elderly individuals.

References

1. Hardanti S, Azhari, Oscandar F. Description of mandibular bone quality based on measurements of cortical thickness using mental index of male and female patients between 40-60 years old. Imaging Sci Dent 2011;41:151-3.
2. White SC. Oral radiographic predictors of osteoporosis. Dentomaxillofac Radiol 2002;31:84-92.
3. Peychevac S, Lalabonovav H, Daskalov H. Early detection of osteoporosis in patients over 55 using orthopantomography. J IMAB 2012;18:229-31.
4. Guiglia R, Di Fede O, Lo Russo L, Sprini D, Rini GB, Campisi G. Osteoporosis, jawbones and periodontal disease. Med Oral Patol Oral Cir Bucal 2013;18:e93-9.
5. López-López J, Estrugo-Devesa A, Jane-Salas E, Ayuso-Montero R, Gómez-Vaquero C. Early diagnosis of osteoporosis by means of orthopantomograms and oral x-rays: a systematic review. Med Oral Patol Oral Cir Bucal 2011;16:e905-13.
6. Nackaerts O, Jacobs R, Devlin H, Pavitt S, Bleyen E, Yan B, *et al.* Osteoporosis detection using intraoral densitometry. Dentomaxillofac Radiol 2008;37:282-7.
7. Groen JJ, Duyvensz F, Halsted JA. Diffuse alveolar atrophy of the jaw (non-inflammatory form of paradental disease) and pre-senile osteoporosis. Gerontol Clin (Basel) 1960;2:68-86.
8. Gillespie T rd, Gillespie MP. Osteoporosis. Radiol Clin North Am 1991;29:77-84.
9. Sherwood L. Human Physiology: From Cells to Systems. 7th ed. Belmont: Brooks/Cole; 2010. p. 706-7.
10. Devlin H, Horner K. Mandibular radiomorphometric indices in the diagnosis of reduced skeletal bone mineral density. Osteoporos Int 2002;13:373-8.
11. Bozic M, Ihan Hren N. Osteoporosis and mandibles. Dentomaxillofac Radiol 2006;35:178-84.
12. Ganong WF. Review of Medical Physiology. 22nd ed. New York: McGraw Hill Medical; 2005. p. 386-7.
13. White SC, Rudolph DJ. Alterations of the trabecular pattern of the jaws in patients with osteoporosis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;88:628-35.
14. Lenchik L, Sartoris DJ. Current concepts in osteoporosis. AJR Am J Roentgenol 1997;168:905-11.
15. Taguchi A. Triage screening for osteoporosis in dental clinics using panoramic radiographs. Oral Dis 2010;16:316-27.
16. Miliuniene E, Alekna V, Peciuliene V, Tamulaitiene M, Maneliene R. Relationship between mandibular cortical bone height and bone mineral density of lumbar spine. Stomatologija 2008;10:72-5.
17. Watanabe PC, Issa JP, Oliveira TM, Monteiro SA, Iyomasa MM, Regalo SC, *et al*. Morphodigital study of the mandibular trabecular bone in panoramic radiographs. Int J Morphol 2007;25:875-80.
18. Mohajery M, Brooks SL. Oral radiographs in the detection of early signs of osteoporosis. Oral Surg Oral Med Oral Pathol 1992;73:112-7.
19. Kavitha MS, Asano A, Taguchi A, Kurita T, Sanada M. Diagnosis of osteoporosis from dental panoramic radiographs using the support vector machine method in a computer-aided system. BMC Med Imaging 2012;12:1.
20. Kavitha MS, Asano A, Taguchi A, Heo MS. The combination of a histogram-based clustering algorithm and support vector machine for the diagnosis of osteoporosis. Imaging Sci Dent 2013;43:153-61.

How to cite this article: Nagaraj T, Bhavana TV, James L, Goswami RD, Sreelakshmi N, Noori. Early diagnosis of osteoporosis in male and female patients between 30 and 75 years using orthopantomography. J Adv Clin Res Insights 2015;2:160-163.