Osteoporosis: Dental Implications

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ABSTRACT

A dramatic rise in osteoporotic fractures is expected due to increase in the aging population worldwide. Prevention and early detection is the solution to this growing ‘silent disease’.

Osteoporosis affects the maxillofacial structures and may be detected by various techniques, including DXA, CT, etc. Interestingly, changes due to osteoporosis may also be detected on routine dental and panoramic radiographs. The relationship between osteoporosis and oral health and the effects of therapeutics used in the management of osteoporosis on the oral structures are some intriguing problems to the dentist. The future might witness an increasing role of dental professional in identification, prevention and management of patients with osteoporosis.

Keywords: Osteoporosis, Dental radiograph, Bone mineral density, Dental implications.

INTRODUCTION

Osteoporosis is the most prevalent disease of the skeleton. The health care costs of osteoporosis will increase dramatically worldwide as the aging population expands. India, a developing country, has high incidence of osteoporosis and the incidence of osteoporosis, particularly in women occurs among a younger age group than in the developed world. The number of hip fracture worldwide is likely to increase from the estimated 1.7 million in 1990 to a projected 6.3 million in 2050.

Osteoporosis before fracture is termed a ‘silent disease’. Hence, the stress is on early identification of the disease and its prevention. Unfortunately, the techniques available involve special radiographic procedures and are relatively expensive. During the last few decades, numerous research teams have reported oral radiographic findings associated with osteoporosis. If techniques to assess bone density using these radiographs can be refined, they might serve as a good screening tool for detection of osteoporosis. There is growing evidence that therapies of benefit for skeletal osteoporosis are also of benefit for oral osteopenia.

This review will consider the condition of osteoporosis, its implications to the dentist, elaborate on those oral radiographic findings that show promise as predictors of osteoporosis, explore the relationship between skeletal and oral bone loss and the role of treatments for osteoporosis in oral health.

DEFINITION

The World Health Organization in 1994 defined osteoporosis by a bone mineral density (BMD) measured as 2.5 standard deviations below average peak bone density achieved in young adults, matched by gender and race.
risk factors for osteoporosis in addition to age, gender and estrogen deficiency.11

FDA approved indications for BMD tests include:
• Estrogen deficient women at clinical risk of osteoporosis
• Vertebral abnormalities on X-ray suggestive of osteoporosis
• Glucocorticoid treatment equivalent to more than or equal to 7.5 mg prednisone per day or duration of therapy more than 3 months
• Primary hyperparathyroidism.

PREVENTION AND TREATMENT
The strategy to prevent osteoporosis should include, regular physical activity, adequate dietary intake of calcium and vit-D, calcitonin, anabolic steroids, parathormone, fluoride, estrogen and bisphosphonates.11

DENTAL IMPLICATIONS
Radiographic Appearance of Osteoporotic Jaws
Bras et al (1982) observed that cortex at the mandible angle gets distinctly thinner in postmenopausal women. Cortical bone cannot be seen well at the anterior margin of ramus and in the maxilla and is minimal along the alveolar crest.12

Relationship between Systemic and Mandibular Bone Mineral Density
The limited number of studies addressing the issue of the relationship between systemic and mandibular bone density point to a relationship but do not provide conclusive evidence.4
Residual ridge and alveolar bone density showed a significant relationship to total body calcium and regional bone loss in a study conducted by Kribbs et al.13

Research Tools for Intraoral Sites
Studies have used radiographs to assess anatomy and bone density because the costs associated with DXA and QCT techniques as well as access to the equipment limit their usefulness for screening examination by dentists.

MEASUREMENTS FROM INTRAORAL FILMS
Measurement of alveolar bone.

Measurements from Panoramic Films
• Panoramic mandibular index (PMI)
• Morphology of mandibular inferior cortex (MIC)
• Mandibular cortical width (MCW)
• Panoramic analysis (PA)
• Antegonial index (AI)
• Residual ridge height (RRH).

Advanced Methods
• Microdensitometry (MD)
• Digital subtraction radiography

• Computer assisted densitometric image analysis (CADIA)
• Fractal dimension (FD)
• Pixel intensity (PI)
• Computed tomography (CT)
• Dual energy X-ray absorptiometry (DXA)

Measurements from intraoral films mainly involves morphological measurements of trabeculae, alveolar bone density.14

Panoramic Mandibular Index
Benson BW et al (1991)15 defined a radiomorphometric index of mandibular cortical bone mass, the panoramic mandibular index (PMI) which is the ratio between thickness of cortex and the distance between the margins of the mental foramen to the inferior border of the mandible. But PMI is sometimes impossible to measure because of problems in identification of mental foramen.

Morphology of Mandibular Inferior Cortex (MIC): Klemetti (1994)16 classified morphology of mandibular inferior cortex (MIC) by observing the mandible distally from mental foramen as follows:
• Class I: The endosteal margin of the inferior cortex is smooth
• Class II: The endosteal margin shows semilunar defects (lacunar resorption) with formation of endosteal cortical residues, 1 to 3 layers thick
• Class III: The cortex is obviously porous with dense endosteal residues.

A recent study by A. Taguchi et al (2007)17 suggested that postmenopausal women with an eroded cortex have an increased risk of low vertebral BMD or osteoporosis. They also found that GDPs who were trained to analyse panoramic radiographs based on morphology of mandibular cortex were able to identify postmenopausal women with undetected low skeletal BMD.18

Mandibular Cortical Width
Mandibular cortical width (MCW) is a measure of mandibular cortex in the region of mental foramen. A line parallel to the long axis of the mandible is drawn. A line perpendicular to this tangent intersecting the inferior border of mental foramen is constructed along which MCW is measured.

Taguchi A et al (1995) studied the relationship between mandibular bone mass and tooth loss and found significantly greater MCW in women in their seventh decade with 15 or more teeth than those with fewer teeth. Postmenopausal women with a thinner cortical width have been found to have an increased risk of low vertebral BMD.17

In a recent project Osteodent which was collaboration between 5 European centers to determine the method of identifying those individuals at risk of osteoporosis, MCW was found to have better efficacy than MCI in detecting osteoporosis. Those with mandibular cortices 3 mm or less had the highest likelihood of osteoporosis.19
Panoramic Analysis

Panoramic analysis (PA) is used to measure the cortical thickness at the gonial angle. This measurement is taken at the point that bisects the angle formed by two straight lines: The tangent to the basal border of the mandible and the tangent to the posterior border of the mandible. Although Law et al (1996) found that the mean thickness of the cortical bone was less on radiographs from the osteoporotic group, than those from the control group, the difference was not significant.5

Antegonial Index

Antegonial index (AI) was described by Ledgerton et al (1999) as a measurement of 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 the ascending ramus down to the lower border of the mandible. The authors found that precision of AI was almost consistent.20

Residual Ridge Height

Hirai T et al (1993) indicated that osteoporosis strongly affects reduction of the residual ridge in edentulous patients.21

Microdensitometry

Optical density is the level of light transmitted through a selected area on the radiograph and is also referred to as radiodensity. Microdensitometry (MD) value of zero indicates that all the light was transmitted through the radiograph. Radiographs of nonosteoporotic bone would have an optical density closer to zero than osteoporotic bone. A densitometer equipped with software is used to scan radiographs in this method.13

Digital Subtraction Radiography

Digital subtraction radiography was first introduced to dental radiography by Ruttiman and colleagues in 1981.22 Density changes between serial radiographs may be accurately detected using subtraction radiography. The method is useful in detection of periodontal bone density changes.

Computer Assisted Densitometric Image Analysis

Computer assisted densitometric image analysis (CADIA) describes density changes in mineralized oral tissue with ordinal scale data and, in some controlled situations, internal scale data. CADIA is a practical method of measurement of change in bone density occurring in the alveolar crest. CADIA is based on comparison of two serial images that are acquired with standardized projection geometry and equalized for the density differences in the images. The area of change is calculated and the depth of the lesion in the buccolingual direction is measured as the density change between the images. The final CADIA values is the product of the area of change and the average ‘depth’ of the change, and thus represents a volumetric description of the density change.23

Fractal Dimension

The fractal dimension (FD) describes the similarity of an object, such as surface roughness of the trabecular bone over a range of magnification.

FD on periapical radiographs has been used as a simple indicator of complex architecture of the cancellous bone surrounding the dentition. The technique appears to be relatively insensitive to variations in film exposure or alignment, but is affected by the size and shape of regions of interest. FD has also been applied to panoramic radiographs. Measurement of radiographic FD offers a potential means of detecting and quantifying changes in alveolar process bone mineral content.23

Pixel Intensity

Pixel intensity (PI) is a measure of the blackness or whiteness on a scale from zero to 225. Scan areas or scan lines may be analyzed using a computer.

Law et al (1996) measured scan lines between mandibular premolar and molar on panoramic radiographs. They found a statistically significant difference between osteoporotic and non-osteoporotic group.

Computed Tomography

Quantitative computed tomography (CT) is an effective cross-sectional bone densitometric method that is used mainly for measuring BMD of the thoracolumbar spine. Since the technique specifically analyzes trabecular bone, it can provide a true density measurement. Application of the techniques for measurement of BMC, such as quantitative CT (QCT) to jaws is technically difficult because the shape of the bone makes setting the measurement area problematical.11

Iwashita Y (2000) developed an algorithm for the automatic separation of mandibular cortical from cancellous bone.

Dual energy X-ray absorptiometry (DXA) is a highly accurate X-ray technique that has become the standard for measuring bone density in most centers. Though it can be used for measurements of any skeletal site, clinical determination are usually made of the lumbar spine and hip. High equipment cost may inhibit the implementation of this equipment on a larger scale.11,12 DXA has been adapted for intraoral use.

SALIVA AS A BIOMARKER

The best markers currently available for monitoring changes in bone turnover include osteocalcin, for evaluation of osteoblastic activity and pyridroline cross-links for assessment of bone resorption. These have been identified in serum and urine. The interesting possibility of use of salivary biomarkers as diagnostic predictors for osteoporosis has been recently reported.

McGhee JW, Johnson RB (2004) determined salivary D-Pyr and osteocalcin as biomarkers of bone turnover. They suggested a beneficial use of saliva in situations where a large number of patients are to be screened for metabolic bone diseases.
ASSOCIATION BETWEEN OSTEOPOROSIS AND PERIODONTAL DISEASE

Because osteoporosis and periodontal diseases both are clinical entities with multifactorial etiologies, it is difficult to establish a relationship between the two conditions. However, studies have shown strong correlation between severe periodontal disease and skeletal osteoporosis. Also individuals with high mineral values in the skeleton seem to retain their teeth with deep periodontal pockets more easily than those with osteoporosis. In a recent study, low systemic bone density was associated with greater clinical attachment loss among postmenopausal women without subgingival calculus, but no association was found among those with subgingival calculus.26

RELATIONSHIP OF TOOTH LOSS TO BONE MINERAL DENSITY

Older patients with osteoporosis are at an increased risk for tooth loss. It has been suggested that since oral and systemic bone loss appears to have common mechanism at the cellular level, agents that slow osteoporotic bone loss such as estrogen, could slow bone loss in the oral cavity and prevent tooth loss. Taguchi et al (1999) suggested that the loss of posterior teeth may be associated with a decrease not only in alveolar bone height, but also alveolar BMD.27

OSTEOPOROSIS AND DENTAL IMPLANTS

Osteoporosis has been suggested as a risk factor in dental implant failure, but data supporting such a link are limited.28

OSTEOPOROSIS AND TMD

Klemetti et al have reported that the habits and conditions that provoke development of general bone loss in the skeleton may disturb the functional harmony of the masticatory system and thus may increase the possibility of temporomandibular disorders.29 Gruber and Gregg have suggested that early detection and antiresorptive therapy for osteoporosis merit future consideration in TMD therapy.30

COMMON STRATEGIES FOR TREATMENT OF OSTEOPOROSIS AND PERIODONTITIS

Longitudinal studies have demonstrated reduction in risk of tooth loss with hormone replacement therapy. There is limited amount of evidence that calcium supplementation may be beneficial. In clinical trials, bisphosphonate Alendronate has been found to reduce the risk of progressive loss of alveolar bone.3 These management strategies require further validation. Reports of bisphosphonate associated osteonecrosis (BON) of jaw associated with the use of IV bisphosphonates were first published in 2003. Cases of BON also have been reported in individuals taking orally administered nitrogen containing bisphosphonates used for treatment of osteoporosis.31

CONCLUSION

Osteoporosis is a grave social and economic problem for which the dentist has the opportunity to make unique contributions by early identification and by making scientific inquiries into the unanswered questions regarding the associations between periodontal disease and bone loss and effects of treatment of osteoporosis on oral health.

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