Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 5608- 5616
Received 16 February 2021; Accepted 08 March 2021.

Assessment of Bone Mineral Density and Periodontal Status in Pre and Post-Menopausal Women – A Clinical, Radio Graphical and Ultrasound Study

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Abstract:

Background: Periodontitis resulting in alveolar bone loss is a prominent feature of periodontal disease. Severe osteoporosis or osteopenia can be suspected as an aggravating factor for periodontal destruction. The purpose of this study is to assess the relationship between BMD and periodontal health in three different study groups.

Materials and Methodology: BMD in terms of T-score and Interproximal alveolar bone loss were assessed in 60 females of age between 42-60 years and categorized into 3 groups as 20 pre menopausal women with healthy periodontium (Group A), 20 pre menopausal women with generalized chronic periodontitis (Group B) and 20 post menopausal women with generalized chronic periodontitis (Group C). Number of teeth, gingival index, plaque index, probing depth, clinical attachment level were also recorded.

Results: The BMD and T-score of calcaneal bone were found to be low in Group C when compared to Group A and B which was statistically significant. This indicates that subjects with significantly higher mean age showed increased periodontal destruction with less BMD.

Conclusion: Postmenopausal women with generalized chronic periodontitis exhibited severe periodontal destruction with less BMD. Hence, it is suggested that periodontitis may be a risk indicator for osteoporosis in postmenopausal women and vice versa.

Key Words: Alveoloar Bone, BMD, Pre & Post-Menopausal, Osteoporosis

Introduction:

Periodontitis is an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms or groups of specific microorganisms resulting in progressive destruction of the periodontal ligament and alveolar bone with pocket formation, recession or both.[1] The vast majority of periodontal diseases result from bacterial infections which are the primary etiologic agents. The loss of soft tissue attachment and resorption of alveolar bone as a result of bacterial infections can lead to tooth loss and edentulousness which in turn result in resorption of the remaining residual ridge and continued loss of jaw bone.[2]

There are specific bacterias associated with destructive periodontal disease. It has also been shown that without a susceptible host the periodontal pathogens are necessary but not sufficient for disease to occur.[3]The host response to periodontal pathogens is very important and it differs from one individual to an

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another. Several systemic diseases or conditions can alter the host response thereby affecting the disease prevalence progression and severity.[4]

Among the various systemic conditions osteoporosis is one of the most important health concerns which affects a large number of men and women with the incidence increasing with advancing age. Osteoporosis is a physiological, gender and an age-related condition resulting from bone mineral content (BMC) loss and structural changes in bones. Women at peak attainment of age achieve less BMC and BMD than males. The rate of bone mineral loss with aging is approximately twice as high in women than men. Post-menopausal osteoporosis is a heterogeneous disorder that begins after natural or surgical menopause and leads to increased rates of fracture within 15 to 20 years from the cessation of ovarian function if not treated. Age-related cortical bone loss begins by the age of 40. On average 0.3% to 0.5% bone loss per year occurs in both men and women. In women at menopause 2% to 3% loss of cortical bone occurs per year for the next 8 to 10 years. Trabecular bone loss usually occurs 5 to 10 years before a cortical loss and is lost at a rate of 4% to 8% per year in 5 to 8 years following menopause. Over several decades the skeletal mass maybe half of that established at peak attainment.[5]

Osteoporosis is well known in post-menopausal women with maximum bone loss occurring in the first 5 years following menopause. Both osteoporosis and chronic periodontitis are slowly progressive diseases sharing many features. Osteoporosis with a prevalence as high as 30% is a silent killer and related features contribute to the significant amount of morbidity and mortality in older patients as it may be an indicator of several associated chronic illnesses and ill health. Bone loss is also a hallmark of periodontitis, an inflammatory disease characterized by loss of connective tissue and alveolar bone and is one of the major reasons for the loss of teeth in adults.[4] While the pathogenesis of periodontitis and osteoporosis differs, these diseases have several risk factors in common. These include an increased prevalence with increasing age, smoking and deleterious influences of diseases or medications that may interfere with healing.[6]

Osteoporosis increases the risk of periodontal disease. It has been hypothesized that osteoporosis may cause decreased alveolar bone density which may in turn be more susceptible to resorption by the effect of coexisting or subsequent periodontal infection and inflammation[6]. Understanding the association between osteoporosis and chronic periodontitis could be useful if their prevention and treatment are interrelated.[7]

Currently accepted periodontal disease classification recognizes the influence of endogenously produced sex hormones on the periodontium. Under the broad category of dental plaque-induced gingival diseases modified by systemic factors associated with endocrine system are classified as puberty, menstrual cycle and pregnancy-associated gingivitis.

It has been hypothesized that a decreased alveolar bone density is more susceptible to resorption by the effect of coexisting or subsequent periodontal infection and inflammation due to osteoporosis. However, there is limited literature to address the relationship between osteoporosis and periodontal inflammation.[8]

Hence, here an attempt is made to compare clinically and radiographically, the bone mineral density among pre and postmenopausal women with and without generalized chronic periodontitis.

Aims and Objectives of the Study:

1. To assess bone mineral density in pre and post-menopausal women.
2. To assess periodontitis in pre and post-menopausal women.
3. To assess association between bone mineral density and periodontitis in pre and post-menopausal women.
4. To ascertain that the systemic bone loss could be a risk indicator of alveolar bone loss.

Methodology

Source of Data:

A total of 60 pre and post-menopausal women of age group 42 to 60 years were categorized into three groups. Group A, B and C. Group A includes 20 pre-menopausal women with healthy periodontium and 20 each in group B and C with pre and post-menopausal women with generalized chronic periodontitis respectively. The participants were recruited from the regular outpatient department of periodontics, Sharavathi dental college and hospital, Shivamogga, Karnataka. Study included Pre-menopausal women with healthy periodontium, not pregnant or lactating, pre and post-menopausal women generalized chronic

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periodontitis of age range 42 to 60yrs with the presence of minimum 12 natural teeth. Exclusion criteria included patients who had a history of antibiotic use, long-term steroid medication, hormone replacement therapy and calcium supplements for last 3 months or periodontal treatment 6 months before the study or with systemic conditions known to affect periodontal status, immuno-compromised individuals, the use of contrast agents or participation in nuclear medicine studies seven days before BMD assessment, early onset of menopause before 42 years of age, who were under treatment for osteoporosis, pregnant and lactating women. Clinical examination was done by a single examiner using William's graduated periodontal probe with detailed medical and dental history. Gingival index, Plaque index, Clinical attachment level and Pocket depth were recorded. Inter proximal alveolar bone loss were recorded using intra oral periapical and posterior bitewing radiograph using RVG and Grid, Bone mineral density were recorded using Quantitative ultrasound study. (QUS)

Radiographic examination:

Interproximal alveolar bone was determined from six intraoral periapical radiographs and two posterior bitewing radiographs. A grid calibrated in millimeters was superimposed on the radiographs using Corel DRAW software. The interproximal alveolar bone loss was measured from the cement enamel junction to most coronal aspect of interproximal alveolar bone on the mesial and distal aspects of all teeth except for 3rd molars.

Ultrasound parameters for assessment of calcaneal bone

A typical ultrasonometer consist of high frequency ultrasound transmitter, (Tx) receiver (Rx), liquid crystal display (LCD), foot positioner, water filled membranes, calf support, strap and a toe peg. Measurements were performed with patient seated with left foot placed on the foot positioner. The LCD consists of a menu for the measurement of patient data and display of results. Foot positioner keeps the patient's foot stationary during the measurement. The membranes are filled with water to provide coupling of the ultrasound signal from the transducer to the heel. Calf support aligns the heel with the transducer and the strap holds the leg and calf in the proper position. Toe peg helps the patient to keep the foot stationary and keep the heel aligned with transducers during measurement.

Patient was seated with left foot placed on the foot positioner of device for measurement of Stiffness index (SI). The heel was surrounded by warm water encapsulated in inflated membranes because water is the optimum medium for the transmission of ultrasound. A transducer on one side of the heel (Tx) converted an electrical signal into sound wave which passed through water membranes and the patient's heel. A transducer at a fixed distance on the opposite side of the heel (Rx) received the sound wave and converted it to an electrical signal that was analyzed by the ultrasonometer program. The ultrasonometer device measured the speed of sound (SOS, m/second) and the frequency-dependent broadband ultrasound attenuation (BUA, dB/MHz) and combined them to form a clinical measure called stiffness index

Stiffness index (SI)

$SI = [(0.67 \times BUA) + (0.28 \times SOS)] - 420$

The normalized and scaled dependent broadband ultrasound attenuation (BUA) and the speed of sound (SOS) values contributed equally to the resulting SI over the adult age range. The SI was then used to create T-score by comparing with reference figures for a healthy young adult.

Statistical analysis

The mean values of age, number of teeth, gingival index, plaque index, clinical attachment level, interproximal bone loss and T-score were compared within the groups by one-way ANOVA. Individual percentage was estimated among the groups with respect to osteoporosis. Pair wise comparisons done by Tukeys honest posthoc procedures Karl Pearson's correlation / Spearman's rank correlation. Pearson correlation coefficients (r) done between various parameters.

Results

On comparison of mean age between healthy periodontium and periodontitis group it was statistically

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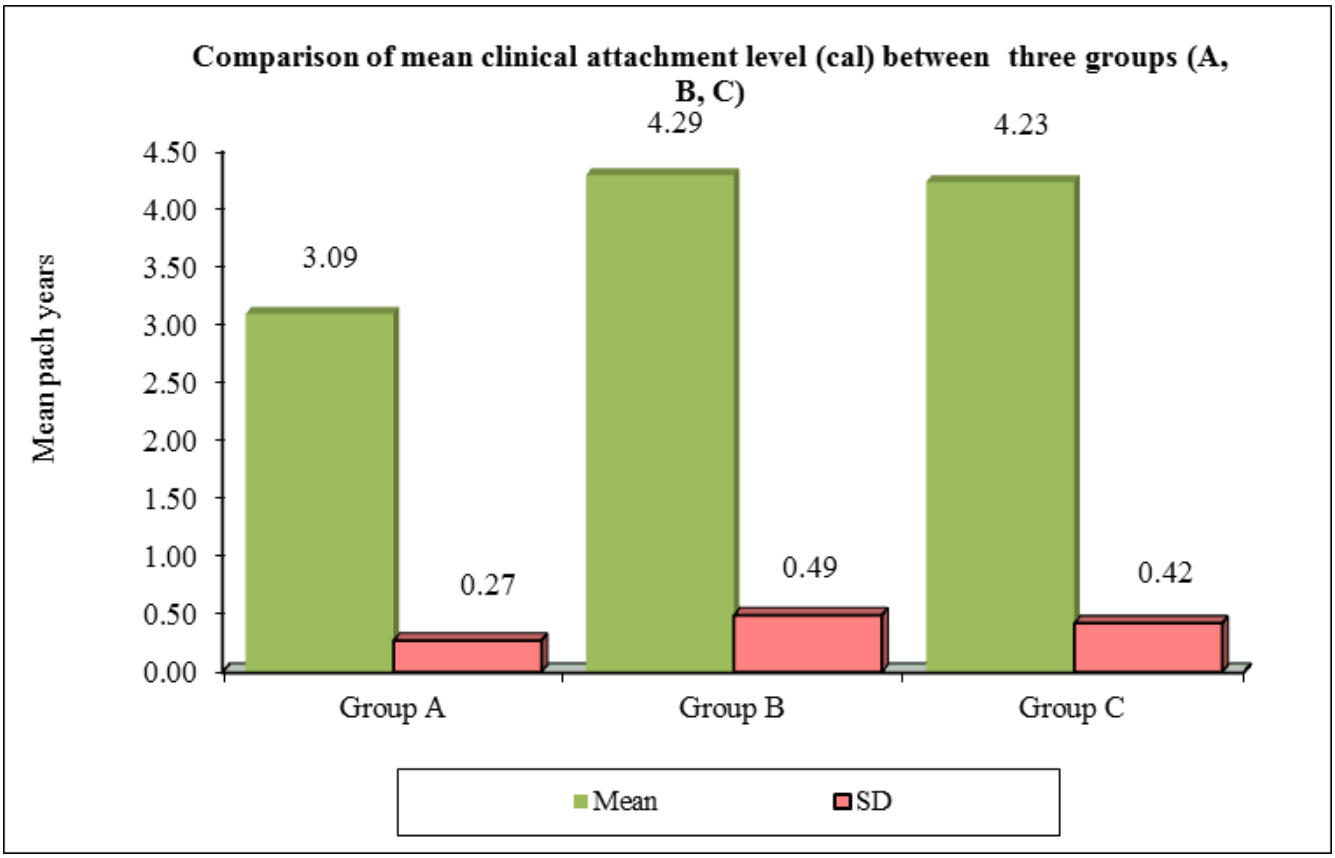
significant (p=0.0001).On comparing Group A with B and Group A with C, the Mean interproximal alveolar bone loss was statistically significant whereas Group B with C the indices showed values that were not statistically significant. The T score was not statistically significant when Group B was compared with Group C but Group A with B and C showed significant results. Pearson correlation coefficients (r) between various parameters measured in group C showed a statistically significant positive correlation between Clinical attachment level (CAL) with Probing pocket depth, Interproximal alveolar bone with Plaque index, T-score with Plaque index and T-score with Interproximal alveolar bone loss.

Table: 1 Comparison of mean clinical attachment level (CAL) by one way ANOVA between three groups (A, B, C)

Groups	n	Clinical attachment level		
		Mean	SD	SE
Group A	20	3.09	0.27	0.06
Group B	20	4.29	0.49	0.11
Group C	20	4.23	0.42	0.09
F-value	56.4957			
P-value	0.0001*			
Pair wise comparisons by Tukeys honest posthoc procedures				
Group A vs Group B	P=0.0001*			
Group A vs Group C	P=0.0001*			
Group B vs Group C	P=0.9075			

*p<0.05 indicates significant



Graph 1

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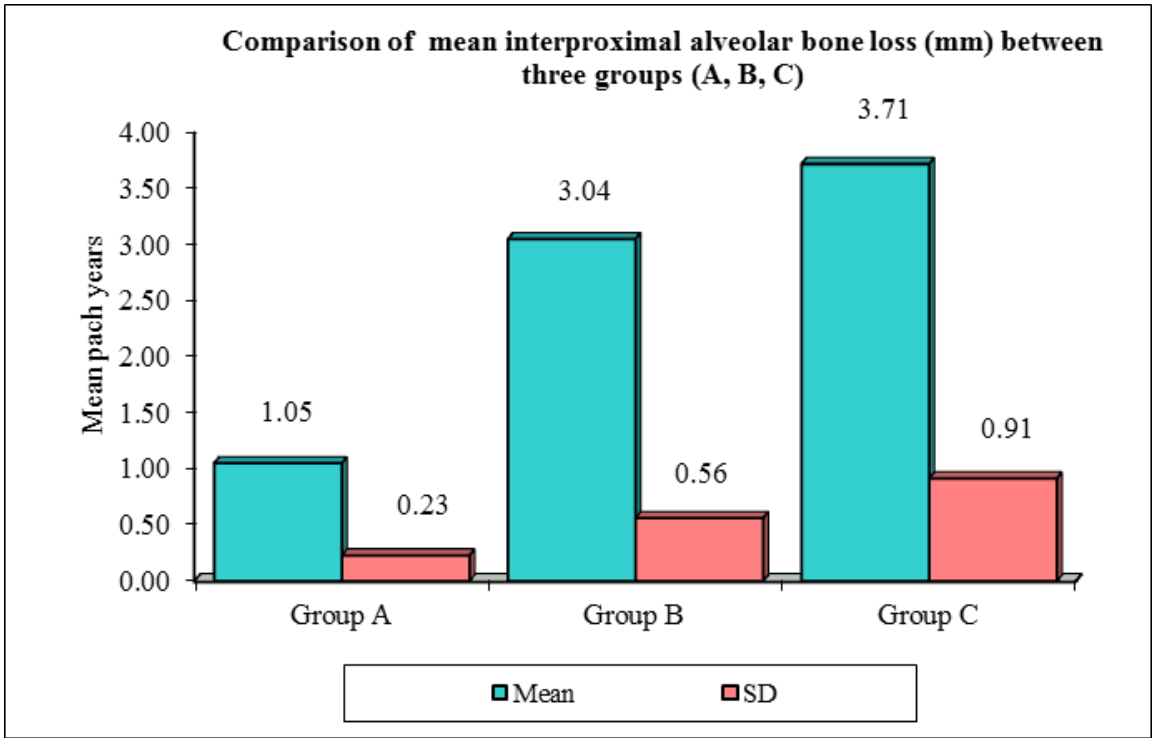
Table: 2 Comparison of mean interproximal alveolar bone loss (mm) by one way ANOVA between three groups (A, B, C)

Groups	n	Inter proximal alveolar bone loss (mm)		
		Mean	SD	SE
Group A	20	1.049	0.229	0.051
Group B	20	3.044	0.561	0.125
Group C	20	3.713	0.914	0.204
F-value	95.8634			
P-value	0.0001*			
Pair wise comparisons by Tukeys honest posthoc procedures				
Group A vs Group B	P=0.0001*			
Group A vs Group C	P=0.0001*			
Group B vs Group C	P=0.6861			

*p<0.05 indicates significant



Graph 2

Table: 3 Comparison of mean T-score by one way ANOVA between three groups (A, B, C)

Groups	n	T-score		
		Mean	SD	SE
Group A	20	-0.29	0.84	0.19
Group B	20	-2.00	0.79	0.18
Group C	20	-2.08	0.95	0.21
F-value	27.5836			
P-value	0.0001*			
Pair wise comparisons by Tukeys honest posthoc procedures				
Group A vs Group B	P=0.0001*			
Group A vs Group C	P=0.0001*			
Group B vs Group C	P=0.9075			

*p<0.05 indicates significant

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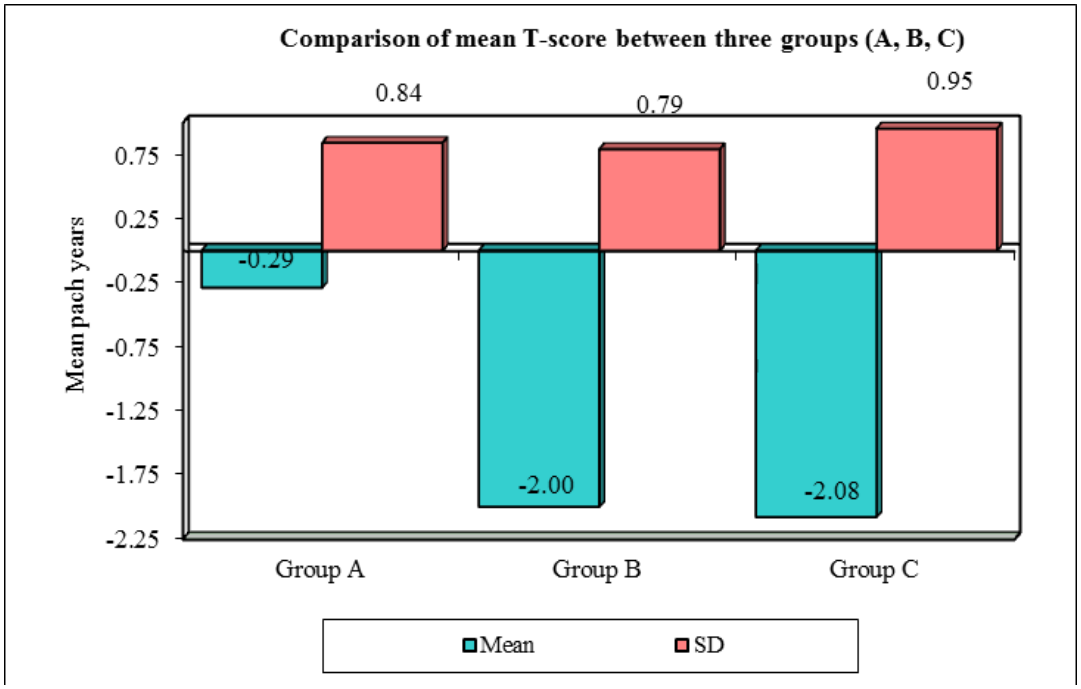

Graph 3

Discussion

There is increasing evidence that osteoporosis and the underlying loss of bone mass characteristic of periodontal disease and tooth loss. Periodontitis has long been defined as infection-mediated destruction of the alveolar bone and soft tissue attachment to the tooth, responsible for more tooth loss in adult populations. Current evidence including several prospective studies supports an association of osteoporosis with the onset and progression of periodontal disease in humans. The majority of studies have shown low bone mass to be independently associated with loss of alveolar crest height and tooth loss[9].

Post-menopausal women undergo hormonal changes such as estrogen deficiency which further increase in IL-6, IL-1α, IL-1 β, and TNF-α[24-27]. Several studies[10-14] have attempted to determine the relationship between osteoporosis or low bone density and periodontitis.

Though the earlier studies have focused on the estimation of BMD among pre-and postmenopausal women with and without generalized chronic periodontitis, here an attempt is made to compare pre and post-menopausal chronic periodontitis women with premenopausal women having healthy periodontium to find out the influence of osteoporosis on the periodontium.

Periodontitis is infection-induced inflammation of the structures around the tooth resulting in loss of its soft tissue attachment and surrounding bone mass finally resulting in tooth loss.[30] Various factors like oral hygiene, diabetes, smoking and poor general health affect periodontal status.

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Osteoporosis being a systemic disease leads to loss of bone stock not only from the spine and appendicular skeleton but also from alveolar bone. Thus osteoporosis is expected to hasten the process of bone loss in chronic periodontitis.

In the present study mean age was found to be highest in the postmenopausal group with chronic periodontitis than pre-menopausal periodontitis women and healthy group. The age range was between 42 and 60 years since in Indian women, the most common prevalence of menopause is suspected to be between this age group. The study conducted by **Dutta et al** [21] also found that postmenopausal chronic generalized periodontitis women fell into the age range of 45 and 55 years which was approximately similar to the present study. This could be due to intrinsic alterations in human marrow stromal cells (hMSCs) with aging contributing to impaired osteoblast function and an age-related impairment in bone formation.

The result of the present study showed a significant difference in the mean number of teeth present in a post and pre-menopausal with periodontitis women and pre-menopausal women with healthy periodontium. Similar results were observed in a study conducted by **Kribb et al**[22] who compared patients with and

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without osteoporosis and observed less number of teeth present in postmenopausal women as compared to premenopausal women. Age-related teeth loss and osteoporotic bone changes in postmenopausal women would be suspected for the presence of less number of teeth.

The result of the present study showed a significantly high difference in mean probing depth (PD) and CAL in a post and pre-menopausal with periodontitis than pre-menopausal women with healthy periodontium. Estrogen deficiency in menopausal age leads to an increase in the production of IL-1, TNF-alfa, and IL-6 which in turn increases the progression of periodontitis. Similar findings reported by **Reinhardt et al** [20] who found increased clinical attachment loss in osteoporotic women with estrogen deficiency.

In the present study, comparision of the clinical parameters such as PD, CAL with BMD in Group C showed a decrease in BMD and an increase in CAL and PD. This was similar to the study conducted by **Shen et al** [31] who also found an increased attachment loss in osteoporotic sites in postmenopausal women suggesting that osteoporosis may act as a risk factor for periodontitis. Osteoporosis was not only the major etiological factor as greater probing depth, recession and attachment loss were noted at sites with poor plaque control in the present study.

A significantly higher difference in the mean interproximal alveolar bone loss in Group C were noted than in Groups B and A. Similar results were observed by **Payne et al** [20] and **Streckfus et al**[23] who also found more alveolar bone loss in postmenopausal women with estrogen deficiency. The estrogen deficiency increases osteoclast (OC) formation by increasing hematopoietic progenitors and providing a large recruited OC precursor pool. The up-regulated formation and activation of OCs lead to cortical porosity and enlarged resorption areas in trabecular surfaces. Furthermore, the surface concentration of receptor activator of nuclear factor kappa-B ligand (RANKL) per cell is increased in postmenopausal women compared to premenopausal women by two to threefold for MSCs, T-cells, B-cells, and total RANKL expressing cells.

A consistent inverse association between BMD and CAL in pre and post-menopausal women with periodontitis was observed in the present study. **Brennan *et al***[17] also found a significant correlation between CAL and BMD of the total forearm, wrist site *T*-score, anteroposterior spine, and whole body. Imbalanced bone remodeling associated with osteoporosis can lead to a net loss of bone density throughout the skeleton including the oral cavity. Low BMD provides a host system that is increasingly susceptible to infectious destruction of periodontal tissue, hence leading to increased attachment loss.

The present study showed CAL was >4 mm in pre and post-menopausal women with periodontitis. Similar results were found in **Masanori Iwasaki et al study**[32] which indicates that low systemic BMD was associated with severe CAL loss in postmenopausal women. Estrogen deficiency, which plays a pathogenic role in women with postmenopausal osteoporosis, also leads to the progression of alveolar bone loss through inflammation-induced bone resorption.

Out of 20 postmenopausal women in Group C the proportion of osteopenia and osteoporosis were found to be 30% and 50% slightly higher than Group B. This is similar to studies of Suresh **et al**[16] who also showed higher proportions of osteopenia than osteoporosis in postmenopausal women. The trabecular bone in the postmenopausal woman is lost earlier and more rapidly than cortical bone due to estrogen deficiency. This shows that there may be an association between systemic osteopenia and periodontal status in postmenopausal women.[30,31,32,]

Conclusion

The choice of the calcaneus bone as a measurement site through QUS method is validated by the fact that it contains 75–90% cancellous bone which is eight times more metabolically active than cortical bone. Age and disease related bone loss is more rapidly apparent at sites where there is a high percentage of cancellous bone. The occurrence of osteopenia and osteoporosis of calcaneus bone in postmenopausal women with periodontitis suggests that there is association between bone mineral density and periodontitis and that the severity and extent of alveolar bone loss in postmenopausal women may be a risk indicator for systemic bone loss. Routine periodontal screening is necessary in the early detection of bone changes, disease status and treatment modalitis.

Additional long-term studies are needed to determine and evaluate the nature of the association between skeletal bone mineral density and alveolar bone loss, over a longer period of time.

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Received 16 February 2021; Accepted 08 March 2021.

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