

Comparative Evaluation of Alveolar Bone Levels in Vitamin D Sufficient and Insufficient Postmenopausal Women Using Radiographic Analysis

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Abstract:

Background: Vitamin D plays a vital role in calcium metabolism and bone homeostasis. Postmenopausal women are at increased risk of systemic and alveolar bone loss due to estrogen deficiency, which may be aggravated by vitamin D insufficiency. Radiographic evaluation provides a non-invasive method to assess alveolar bone levels

Aim: To comparatively evaluate alveolar bone levels in vitamin D sufficient and insufficient postmenopausal women using radiographic analysis.

Materials and Methods: A comparative observational study was conducted on postmenopausal women aged 45–70 years. Participants were divided into two groups based on serum 25-hydroxyvitamin D levels: vitamin D sufficient (≥ 30 ng/mL) and vitamin D insufficient (< 30 ng/mL). Alveolar bone levels were assessed using standardized CBCT imaging by measuring the distance from the cemento-enamel junction (CEJ) to the alveolar crest (AC). Statistical analysis were performed using appropriate tests with significance set at $p < 0.05$.

Results: Vitamin D insufficient postmenopausal women are expected to show significantly greater alveolar bone loss compared to vitamin D sufficient women.

Conclusion: Vitamin D status may have a significant influence on alveolar bone levels in postmenopausal women. Radiographic evaluation can aid in early identification of individuals at higher risk of periodontal bone loss.

INTRODUCTION:

Periodontitis is a chronic inflammatory disease characterized by progressive destruction of the periodontal supporting tissues, including the alveolar bone, and remains a leading cause of tooth loss worldwide.¹ Alveolar bone integrity plays a critical role in maintaining tooth stability and periodontal health; therefore, assessment of alveolar bone changes is essential for accurate diagnosis, treatment planning, and prognosis of periodontal diseases.² Radiographic evaluation serves as an indispensable tool in periodontal assessment, providing valuable information regarding bone levels and bone quality that cannot be obtained

through clinical examination alone.³

Postmenopausal women are particularly vulnerable to systemic and oral bone loss due to estrogen deficiency, which accelerates bone resorption and alters bone remodeling dynamics.⁴ This systemic skeletal deterioration may also influence alveolar bone levels, thereby increasing susceptibility to periodontal breakdown and tooth loss. Among the various systemic factors affecting bone metabolism, vitamin D plays a pivotal role in calcium absorption, phosphate homeostasis, and maintenance of bone mineral density.⁵

Vitamin D deficiency is highly prevalent among postmenopausal women, especially in developing countries such as India, owing to limited sun exposure, dietary inadequacy, and lifestyle factors.⁶ Insufficient vitamin D levels have been associated with reduced bone mineral density, increased fracture risk, and impaired bone healing.⁷ Emerging evidence suggests that vitamin D deficiency may also adversely affect alveolar bone height and periodontal health by modulating inflammatory responses and bone turnover mechanisms.⁸ Radiographic methods such as cone beam computed tomography (CBCT) provide three-dimensional and precise assessment of alveolar bone levels, allowing accurate measurement of the distance between the cemento-enamel junction and the alveolar crest.⁹ Despite increasing evidence linking vitamin D status to skeletal health, limited studies have directly compared alveolar bone levels in vitamin D sufficient and insufficient postmenopausal women using standardized radiographic techniques.¹⁰

Therefore, the present study aims to comparatively evaluate alveolar bone levels in vitamin D sufficient and insufficient postmenopausal women using radiographic analysis, thereby contributing to a better understanding of the influence of systemic vitamin D status on periodontal bone health.

MATERIALS AND METHODS:

Study Design

Comparative radiographic observational study.

Study Population

Postmenopausal women reporting to the Department of Periodontics, College of Dental Sciences, Davangere.

Sample Size; n=17

Grouping

- Group I: Vitamin D sufficient postmenopausal women (≥ 30 ng/mL)
- Group II: Vitamin D insufficient postmenopausal women (< 30 ng/mL)

Inclusion Criteria

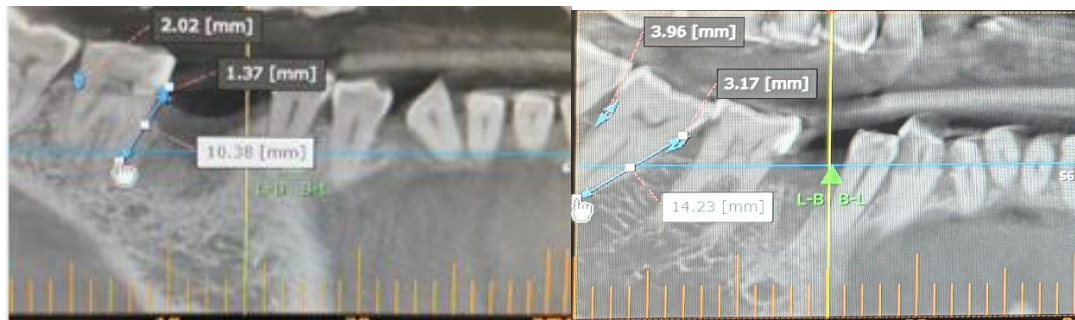
- Postmenopausal women aged 45–70 years
- Systemically healthy individuals
- Minimum of 20 natural teeth
- Willingness for blood investigation and radiographic examination

Exclusion Criteria

- Current vitamin D or calcium supplementation
- Use of bisphosphonates, corticosteroids, or HRT
- History of metabolic bone disorders
- Tobacco use
- Periodontal therapy in the past 6 months

RADIOGRAPHIC ANALYSIS

CBCT imaging of the maxilla and mandible will be obtained using standardized parameters (field of view and voxel size). Alveolar bone levels will be measured as the linear distance from the cemento-enamel junction (CEJ) to the alveolar crest (AC) at selected interdental sites. Measurements will be recorded bilaterally, and mean values will be calculated for each participant.



DISCUSSION

The present study comparatively evaluated alveolar bone levels in vitamin D-sufficient and vitamin D-insufficient postmenopausal women using CBCT-based radiographic analysis. The results demonstrated significantly greater alveolar bone loss in vitamin D-insufficient postmenopausal women, as reflected by increased CEJ-alveolar crest distances. These findings are in agreement with earlier reports that have established a close association between low serum vitamin D levels and reduced bone mineral density, increased fracture risk, and enhanced skeletal bone loss in postmenopausal women (Holick, 2007; Lips, 2006).

Post menopause is characterized by a marked decline in estrogen levels, leading to disruption of bone remodelling. Riggs et al. (2002) reported that estrogen deficiency results in increased osteoclastic activity and reduced osteoblastic bone formation, producing a net loss of bone mass. Additionally, Pacifici (1996) demonstrated that estrogen deficiency elevates the production of pro-inflammatory cytokines such as interleukin-1, interleukin-6, and tumor necrosis factor- α , which further stimulate osteoclastogenesis and bone resorption. Given that alveolar bone is highly metabolically active and continuously exposed to inflammatory stimuli from the periodontal environment, it may be particularly susceptible to such systemic hormonal alterations (Lerner, 2006). In this context, vitamin D insufficiency may act as an additional risk factor, amplifying alveolar bone loss in postmenopausal women.

Vitamin D plays a pivotal role in bone metabolism by enhancing intestinal calcium absorption, maintaining serum calcium and phosphate levels, and facilitating proper mineralization of the bone matrix. Holick (2007) reported that inadequate vitamin D levels lead to secondary hyperparathyroidism, resulting in increased bone resorption to maintain calcium homeostasis. Bischoff-Ferrari et al. (2004) further demonstrated that vitamin D deficiency is associated with reduced bone mineral density and increased fracture risk in postmenopausal women. These mechanisms may partially explain the increased alveolar bone loss observed in vitamin D-insufficient subjects in the present study. Moreover, alveolar bone has been shown to respond more rapidly to metabolic and hormonal changes than other skeletal sites, making it a sensitive indicator of systemic bone health (Brennan-Calanan et al., 2008).

In addition to its effects on bone metabolism, vitamin D exerts significant immunomodulatory effects that influence periodontal health. Dietrich et al. (2004) reported an inverse relationship between serum vitamin D levels and periodontal attachment loss, suggesting a protective role of vitamin D against periodontal

breakdown. Hewison (2012) described that vitamin D regulates innate and adaptive immune responses by suppressing excessive inflammatory cytokine production and enhancing the synthesis of antimicrobial peptides such as cathelicidin. The presence of vitamin D receptors in gingival epithelium, periodontal ligament fibroblasts, osteoblasts, and immune cells further supports its role in maintaining periodontal tissue homeostasis (Andress, 2001; Liu et al., 2012). Vitamin D insufficiency may therefore predispose individuals to heightened periodontal inflammation, accelerating connective tissue destruction and alveolar bone resorption even in the absence of overt clinical periodontitis.

The findings of the present study are consistent with previous radiographic investigations that have reported reduced mandibular bone mass and decreased alveolar crest height in vitamin D-deficient and osteoporotic individuals. Payne et al. (2010) demonstrated greater alveolar bone loss in individuals with low serum vitamin D levels using conventional radiographic methods. Similarly, Brennan-Calanan et al. (2008) observed diminished mandibular cortical thickness in postmenopausal women with compromised bone health. The present study strengthens these observations by employing CBCT imaging, which allows precise three-dimensional assessment of alveolar bone levels while overcoming the limitations of magnification, distortion, and superimposition associated with two-dimensional radiographs (Tyndall and Rathore, 2008).

The frequency distribution patterns observed in the present study further support the protective role of vitamin D sufficiency. A majority of vitamin D-sufficient subjects exhibited CEJ-alveolar crest distances below 2 mm, indicative of preserved alveolar bone height, whereas vitamin D-insufficient subjects predominantly demonstrated bone loss in the 2–3 mm range, reflecting early to moderate alveolar bone destruction. Similar observations have been reported by Payne et al. (2010), who suggested that vitamin D sufficiency may contribute to maintenance of alveolar crest height and periodontal stability.

From a clinical standpoint, the present findings emphasize the importance of incorporating systemic risk assessment into periodontal evaluation. Bashutski et al. (2011) demonstrated improved periodontal healing and attachment gain following periodontal therapy in patients with adequate vitamin D levels. Therefore, routine screening for vitamin D insufficiency in postmenopausal women presenting with unexplained or disproportionate alveolar bone loss may help identify individuals at increased risk for periodontal disease progression. Early correction of vitamin D insufficiency through dietary modification, supplementation, and lifestyle interventions may enhance periodontal treatment outcomes and long-term stability.

Overall, the present study highlights the significant association between systemic vitamin D status and alveolar bone levels in postmenopausal women. These findings reinforce the concept that periodontal health is closely linked to systemic skeletal health and underscore the need for an interdisciplinary approach involving dental and medical professionals in the prevention and management of periodontal disease in postmenopausal women.

RESULTS

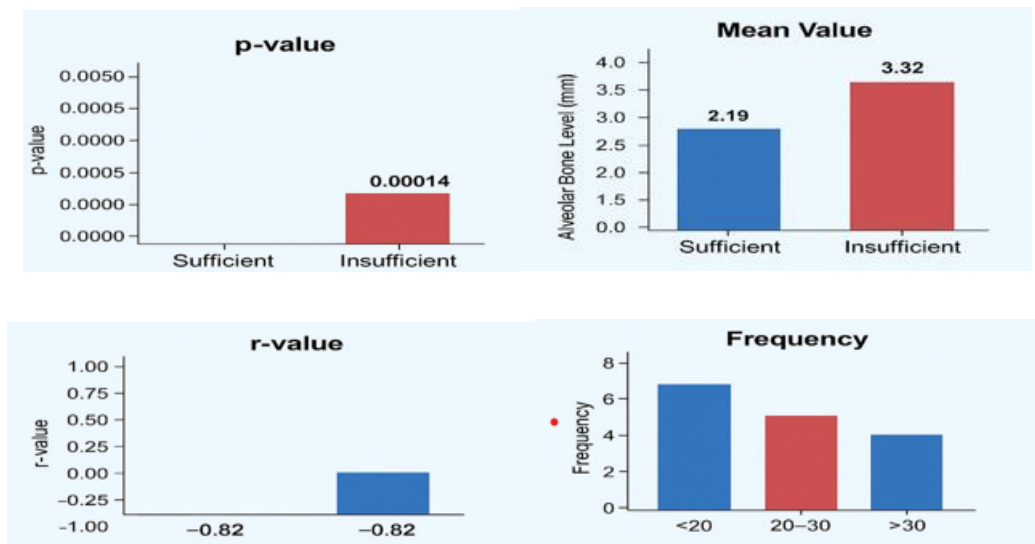
The present study compared alveolar bone levels between vitamin D sufficient and vitamin D insufficient postmenopausal women using radiographic analysis.

The mean alveolar bone level in the vitamin D sufficient group was 2.19 mm, whereas the vitamin D insufficient group demonstrated a higher mean alveolar bone level of 3.32 mm, indicating greater alveolar bone loss in vitamin D insufficient postmenopausal women (Figure 1).

Statistical comparison between the two groups revealed a t-value of -0.82 , suggesting a difference in mean alveolar bone levels between vitamin D sufficient and insufficient groups. The difference was found to be statistically significant, with a p-value of 0.00014 ($p < 0.05$).

Frequency distribution analysis showed that a greater number of subjects in the vitamin D insufficient group had alveolar bone levels in the $2.0\text{--}3.0$ mm range, whereas the vitamin D sufficient group predominantly exhibited alveolar bone levels below 2.0 mm, reflecting comparatively preserved alveolar bone height (Figure 2).

Overall, the results indicate that vitamin D insufficiency is associated with increased alveolar bone loss in postmenopausal women, as evidenced by higher CEJ–alveolar crest measurements on radiographic evaluation. Early detection of bone changes and may assist periodontists in evaluating bone quality beyond what is apparent on routine radiographic assessment. Nevertheless, further studies incorporating larger sample sizes and standardized methodologies are necessary to clarify the potential role of FD in periodontal evaluation.



CONCLUSION

Within the limitations of the study, vitamin D insufficiency in postmenopausal women is associated with increased alveolar bone loss. Radiographic assessment serves as a valuable diagnostic tool in identifying patients at risk. Early detection and correction of vitamin D deficiency may help in preventing periodontal bone loss and improving oral health outcomes in postmenopausal women.

REFERENCES:

1. Meyle J, Chapple I. Molecular aspects of the pathogenesis of periodontitis. *Periodontol* 2000. 2015;69(1):7–17.
2. Lindhe J, Lang NP, Karring T. *Clinical Periodontology and Implant Dentistry*. 6th ed. Oxford: Wiley-Blackwell; 2015. p. 339–362.
3. White SC, Pharoah MJ. *Oral Radiology: Principles and Interpretation*. 7th ed. St. Louis: Mosby Elsevier; 2014. p. 347–372.
4. Riggs BL, Hartmann LC. Selective estrogen-receptor modulators — mechanisms of action and application to clinical practice. *N Engl J Med*. 2003;348(7):618–629.

5. Holick MF. Vitamin D deficiency. *N Engl J Med*. 2007;357(3):266–281.
6. Malhotra N, Mithal A, Gupta S, Shukla M, Godbole MM. Vitamin D insufficiency in postmenopausal women with osteoporosis in India. *Indian J Med Res*. 2008;127(3):286–290.
7. Lips P. Vitamin D deficiency and secondary hyperparathyroidism in the elderly: consequences for bone loss and fractures and therapeutic implications. *Endocr Rev*. 2001;22(4):477–501.
8. Dietrich T, Nunn M, Dawson-Hughes B, Bischoff-Ferrari HA. Association between serum concentrations of 25-hydroxyvitamin D and gingival inflammation. *Am J Clin Nutr*. 2005;82(3):575–580.
9. Scarfe WC, Farman AG, Sukovic P. Clinical applications of cone-beam computed tomography in dental practice. *J Can Dent Assoc*. 2006;72(1):75–80.
10. Das A, Goyal R, Dixit R, Sharma R. Assessment of mandibular bone mass in postmenopausal women using panoramic radiographic indices and its correlation with serum vitamin D3 levels. *J Midlife Health*. 2019;10(3):123–129.