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IMPACT OF RHEUMATOLOGIC DISEASES ON ALVEOLAR BONE DENSITY IN CHRONIC GENERALIZED PERIODONTITIS

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Rheumatic diseases are frequently accompanied by systemic inflammatory changes that impair bone metabolism and accelerate periodontal tissue destruction. Evaluating the relationship between skeletal bone loss and alveolar bone changes is important for improving the diagnosis and management of patients with combined rheumatic and periodontal disorders. This study included 102 patients with rheumatic diseases and chronic generalized periodontitis who underwent clinical and radiographic evaluation of bone status. Progressive bone loss was observed with increasing severity of periodontal disease, affecting both horizontal and vertical dimensions of the alveolar bone. The greatest reduction in bone mineral density occurred in the central region of bone lesions, while advanced disease was characterized by extensive multidirectional destruction extending beyond the alveolar process. These findings demonstrate a strong association between systemic reduction in bone mineral density and the severity of periodontal destruction, emphasizing the value of radiographic bone density assessment for the early identification of patients at increased risk of progressive bone loss and supporting an interdisciplinary approach to their clinical management.

Key words: rheumatic diseases, periodontal bone loss, bone mineral density, alveolar bone, systemic inflammation.

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ВПЛИВ РЕВМАТОЛОГІЧНИХ ЗАХВОРЮВАНЬ НА МІНЕРАЛЬНУ ЩІЛЬНІСТЬ КІСТКОВОЇ ТКАНИНИ АЛЬВЕОЛЯРНОГО ВІДРОСТКА ПРИ ХРОНІЧНОМУ ГЕНЕРАЛІЗОВАНОМУ ПАРОДОНТИТІ

Ревматичні захворювання часто супроводжуються системними запальними змінами, що порушують метаболізм кісткової тканини та прискорюють руйнування тканин пародонту. Дослідження взаємозв'язку між зниженням мінеральної щільності кісткової тканини скелета та змінами альвеолярної кістки має важливе значення для вдосконалення діагностики та лікування пацієнтів із супутньою ревматичною та пародонтологічною патологією. До дослідження було включено 102 пацієнти з ревматичними захворюваннями та хронічним генералізованим пародонтитом, яким було проведено клінічну та рентгенологічну оцінку стану кісткової тканини. У міру збільшення тяжкості захворювання пародонту виявлено прогресуюче зменшення об'єму кісткової тканини, що зачіпає як горизонтальні, так і вертикальні відділи альвеолярної кістки. Найбільш виражене зниження мінеральної щільності кісткової тканини відзначено в центральній зоні кісткових дефектів, тоді як при тяжкому перебігу захворювання спостерігалася поширена різноспрямована деструкція, що виходила за межі альвеолярного відростка. Отримані результати свідчать про тісний зв'язок між системним зниженням мінеральної щільності кісткової тканини та вираженістю пародонтальної деструкції, підтверджують діагностичну цінність рентгенологічної оцінки щільності кісткової тканини для раннього виявлення пацієнтів із високим ризиком прогресування кісткової втрати та обґрунтовують необхідність міждисциплінарного підходу до їхнього лікування.

Ключові слова: ревматичні захворювання, пародонтальна деструкція, мінеральна щільність кісткової тканини, альвеолярна кістка, системне запалення.

Rheumatic diseases comprise a heterogeneous group of pathological conditions frequently characterized by systemic inflammatory reactions, immune-mediated mechanisms, and long-term endocrine and metabolic alterations that directly influence bone tissue remodeling [4]. In these diseases, the balance between osteoblast and osteoclast activity is disturbed, and pro-inflammatory mediators such as interleukin-1 (IL-1), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) increase bone resorption, leading to systemic osteoporosis [2, 4]. Metabolic disturbances associated with rheumatic diseases tend to manifest more rapidly and severely in the mandibular alveolar process, as this region exhibits a high rate of bone remodeling and increased susceptibility to inflammatory stimuli. Inflammatory mechanisms of bone loss, including RANK/RANKL-mediated osteoclast activation, are more pronounced in regions of active bone remodeling, such as periodontal and alveolar bone [14].

For this reason, patients with rheumatic diseases and concomitant chronic generalized periodontitis typically exhibit a more severe clinical course, with destructive changes extending over a wider area. Shared inflammatory pathways involving cytokines such as IL-1, TNF-α, and IL-6 contribute to bone loss in both periarticular bone affected by rheumatic disease and periodontal tissues [3, 11].

Radiographic densitometric assessment of bone mineral density (BMD) is an important diagnostic approach for objectively evaluating pathological changes in bone tissue in patients with rheumatic diseases and chronic generalized periodontitis (CGP). Dual-energy X-ray densitometry (DEXA), the most widely used method for measuring BMD, is the gold-standard technique for diagnosing systemic bone loss, including osteopenia and osteoporosis, and is commonly applied in clinical practice to quantify skeletal changes associated with inflammatory bone

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diseases such as rheumatoid arthritis [5, 8]. Although DEXA primarily assesses systemic skeletal sites (e.g., spine, hip), evidence suggests that reduced systemic BMD is associated with greater alveolar bone loss and may act as a risk indicator for periodontal disease progression, indicating shared pathogenic pathways between systemic bone disorders and periodontitis [9, 15]. Furthermore, studies report correlations between low skeletal BMD and periodontal parameters such as clinical attachment loss and alveolar bone height, reinforcing the clinical relevance of BMD measurement in patients with combined systemic and oral inflammatory conditions [1, 7]. Therefore, combining radiographic densitometry with periodontal assessment enhances the objective identification of bone loss patterns and supports comprehensive diagnostic evaluation in patients with rheumatic disease complicated by chronic periodontitis [15]. Despite these insights, there is limited research examining the relationship between systemic bone mineral density and the severity of alveolar bone loss specifically in patients with rheumatic diseases and chronic generalized periodontitis.

The purpose of the study was to evaluate the relationship between systemic bone mineral density, assessed by DEXA, and the severity of alveolar bone loss in patients with rheumatic diseases and chronic generalized periodontitis.

Material and methods. A total of 102 patients diagnosed with rheumatic disease and chronic generalized periodontitis (CGP) were enrolled in the study. The patients were treated at the Azerbaijan Medical University Teaching Therapeutic Clinic and the Teaching Dental Clinic from February 2025 to April 2026. The cohort included 75 females (73.5 %) and 27 males (26.5 %), with a mean age of 45.7±10.2 years. Patients were categorized by CGP severity: 39 patients (38.2 %) mild, 38 patients (37.3 %) moderate, and 25 patients (24.5 %) severe.Patients were eligible if they had a confirmed diagnosis of RA or SLE and chronic generalized periodontitis. Individuals with other metabolic bone disorders, recent fractures, or medications affecting bone metabolism (other than standard RA/SLE therapy) were excluded.

BMD of the alveolar process and the body of the jaws was assessed using X-ray densitometry. Dual-energy X-ray absorptiometry was performed with a (Hologic Discovery W, Hologic Inc., USA) densitometer. BMD measurements were taken at multiple sites, including the central, peripheral, and surrounding regions of osteoporotic foci within the jawbone.

Data were analyzed using SPSS version 26.0, IBM Corp., US. Continuous variables were expressed as mean ± standard deviation. Differences between groups were evaluated using one-way ANOVA followed by post hoc tests. A p-value<0.05 was considered statistically significant.

This study was conducted in accordance with ethical and bioethical principles governing biomedical research involving human participants. Prior to the initiation of the study, the research protocol was reviewed and approved by the University Bioethics (Ethics) Committee.

Approval was obtained from the Bioethics Committee of Azerbaijan medical University (Protocol No.: AMU/EC-2025-046/O) The study was carried out in accordance with the principles of the Declaration of Helsinki and complied with internationally accepted ethical standards for medical research involving human subjects, as well as relevant institutional and national regulations.

All participants provided informed consent prior to enrollment in the study. Written informed consent was obtained from each participant after providing detailed information about the purpose of the study, study procedures, potential risks and benefits, confidentiality of personal data, and the participants' right to withdraw from the study at any time without consequences.

Results of the study. The mean disease duration was 6.12±2.58 years (range 3.4–11.9). Rheumatoid arthritis (RA) was diagnosed in 69 patients (67.6 %), and systemic lupus erythematosus (SLE) in 33 patients (32.4 %). Sixty-five patients (63.7 %) were receiving active rheumatologic therapy, whereas 37 patients (36.3 %) were untreated. Only 9 patients (8.8 %) were current smokers (Table 1).

Table 1

Baseline Clinical and Demographic Characteristics of the Study Population (n=102)

Characteristic	Value
Age (years), mean ±SD	45.7±10.2
Female/male, n (%)	75 (73.5 %) / 27 (26.5 %)
Disease duration (years), mean±SD	6.12±2.58 (3.4–11.9)
Rheumatoid arthritis, n (%)	69 (67.6 %)
Systemic lupus erythematosus (SLE), n (%)	33 (32.4 %)
Patients receiving rheumatologic treatment, n (%)	65 (63.7 %)
Patients not receiving rheumatologic treatment, n (%)	37 (36.3 %)
Smokers, n (%)	9 (8.8 %)
Non-smokers, n (%)	93 (91.2 %)
Mild CGP, n (%)	39 (38.2 %)
Moderate CGP, n (%)	38 (37.3 %)
Severe CGP, n (%)	25 (24.5 %)

Radiological examination in patients with mild CGP revealed initial alveolar bone loss limited to the coronal third of the root length (<15 %). The cortical plate remained largely preserved, with localized areas of thinning or early disruption.

The study demonstrated that in patients with rheumatic disease, periodontal destruction occurs in horizontal, vertical, and mixed patterns, with the intensity of these changes strongly correlated with disease severity. Analysis of the cancellous bone in the region of individual teeth revealed that horizontal bone destruction was present in all patients with mild CGP (Fig. 1). The measurements of mean bone density along the alveolar and middle horizontal levels showed minimal variability. In the mild CGP group, vertical bone destruction was observed in 21 patients, while mixed-form (horizontal+ vertical) destruction was present in only 9 patients.

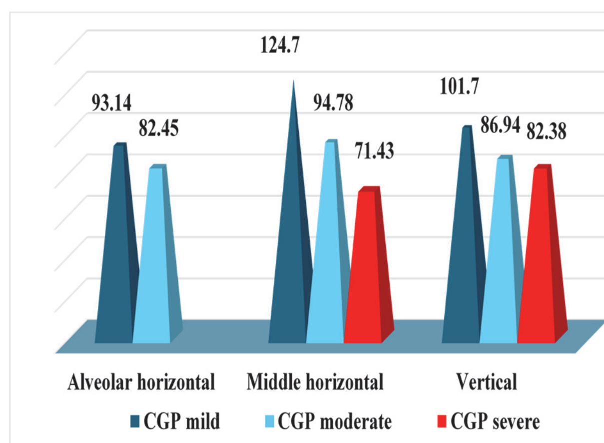

Fig. 1. Radiographic changes observed during horizontal bone destruction in patients with rheumatic disease.

In mild cases, when vertical bone destruction was observed, the variability of bone mineral density (BMD) along the alveolar horizontal level (in the direction of the destructive focus) ranged from 54.25±2.26 to 71.81±2.32 units. Along the middle horizontal level, BMD was estimated at 119.8±4.84 units. Variability in the vertical measurements was minimal. In patients with moderate chronic generalized periodontitis, BMD values were 56.7±2.84 units along the alveolar horizontal level and 88.2±3.79 units along the middle horizontal level. Severe CGP cases showed a further reduction in BMD, with middle horizontal measurements of 48.6±1.49 units and vertical measurements of 59.5±1.99 units (Fig 2).

These findings indicate that the severity of CGP is closely associated with progressive decreases in BMD, particularly along both horizontal and vertical dimensions of the alveolar bone, reflecting the progressive nature of alveolar destruction.

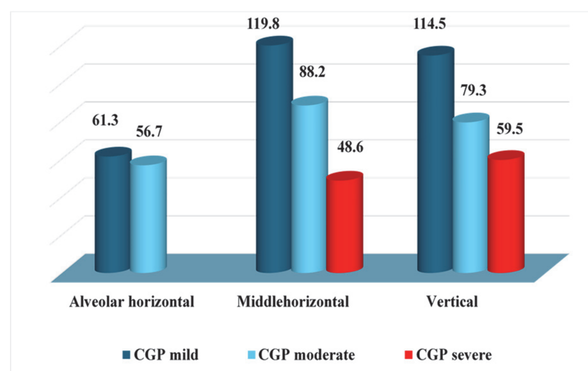

Fig. 2. Radiographic changes observed during vertical bone destruction in patients with rheumatic disease.

This dynamic demonstrates that mixed bone destruction becomes more aggressive with disease progression, with progressive, multi-directional reduction in bone volume and density. The largest reductions in middle horizontal and vertical dimensions reflect systemic destruction of key periodontal structural components.

Bone resorption was predominantly horizontal in pattern, with irregular and uneven contours, reflecting early inflammatory activity. In our study, this assessment was used to analyze the degree of mineral density reduction in the central, peripheral, and surrounding areas of osteoporotic foci. In patients with mild to moderate CGP, radiographic analysis revealed osteoporotic foci predominantly localized to the alveolar processes. The lesions were most commonly round, oval, or teardrop-shaped, with well-defined margins in the majority of cases. Less frequently, the foci exhibited a stellate configuration, and the contours were slightly blurred. These findings indicate early to moderate bone demineralization localized to regions of active bone remodeling. In patients with severe CGP, osteoporotic foci were not limited to the alveolar processes but extended to the body of the jaws, reflecting progressive systemic and local bone loss. These lesions were generally hourglass- or palette-shaped, and the margins were consistently poorly defined, indicating advanced osteoclastic activity and bone resorption. The results are presented in Table 2.

Table 2

Comparison of regional bone mineral density in alveolar bone lesions among patients with different severities of chronic generalized periodontitis

BMD at the area of involvement	CGP mild (n=39)	CGP moderate (n=38)	CGP severe (n=25)
Center of the lesion	54.51±0.34	48.32±0.81 $p<0.05$	33.74±0,79 $p<0.05$
Peripheral part of the lesion	71.37±0.23	63.15±1.46 $p<0.05$	54.83±0.84 $p<0.05$
Surrounding the lesion	84.10±0.58	81.73±1.13 $p>0.05$	73.85±1.59 $p<0.05$

The destructive process primarily occurs in the central area of the bone lesion. In patients with mild chronic generalized periodontitis (CGP), the mineral density of the central zone was 54.51±0.34 units, whereas in the moderate form this value decreased to 48.32±0.81 units, and in the severe form it sharply declined to 33.74±0.79 units. A similar trend was observed in the peripheral part of the lesion. In the mild form, the bone mineral density of the peripheral region was 71.37±0.23 units; in the moderate form it decreased to 63.15±1.46 units, and in the severe form it fell to 54.83±0.84 units. Although the area surrounding the bone lesion is considered a relatively healthier zone, significant changes also occur there as CGP progresses. In the mild form, the bone mineral density of the surrounding area was 84.10 ± 0.58 units; in the moderate form it declined to 81.73±1.13 units, and in the severe form it decreased markedly to 73.85±1.59 units.

Discussion. The present study demonstrated a significant association between reduced systemic bone mineral density and increased severity of alveolar bone loss in patients with rheumatic diseases and chronic generalized periodontitis. These findings support the concept that systemic inflammatory disorders adversely affect both skeletal and periodontal tissues through common pathogenic mechanisms, including chronic immune activation and enhanced osteoclast-mediated bone resorption.

Our results are consistent with previous studies reporting that pro-inflammatory cytokines, particularly interleukin-1, interleukin-6, and tumor necrosis factor-alpha, promote excessive bone resorption by stimulating the receptor activator of nuclear factor kappa-B ligand signaling pathway, thereby contributing to generalized osteoporosis and periodontal destruction [3, 14]. The observed decrease in bone mineral density among patients with more advanced periodontitis further confirms the close relationship between systemic and local bone metabolism described in earlier investigations [15].

The present findings also agree with reports demonstrating that reduced skeletal bone mineral density is associated with greater alveolar bone loss and clinical attachment loss in patients with inflammatory diseases [9, 12]. Although dual-energy X-ray absorptiometry is primarily used for the assessment of systemic skeletal sites, our results suggest that its findings may provide valuable information regarding the risk of periodontal bone destruction in patients with rheumatic diseases. This observation is in accordance with previous studies emphasizing the diagnostic value of combining bone mineral density assessment with comprehensive periodontal examination [1, 6].

The clinical significance of this study lies in highlighting the need for interdisciplinary management of patients with rheumatic diseases. Early identification of reduced bone mineral density may facilitate timely preventive and therapeutic interventions aimed at reducing periodontal tissue destruction and preserving oral function. Nevertheless, several limitations should be acknowledged, including the relatively small sample size and the cross-sectional design, which preclude establishing causal relationships. Prospective longitudinal studies with larger cohorts are warranted to clarify the temporal relationship between systemic bone loss and periodontal disease progression and to evaluate the effectiveness of targeted therapeutic strategies.

Conclusion

Rheumatic diseases significantly exacerbate alveolar bone loss in patients with CGP. Progressive reductions in bone mineral density were observed across alveolar horizontal, middle horizontal, and vertical dimensions, with the most pronounced loss in central lesion zones. Mild CGP showed localized BMD reduction, while moderate and severe cases demonstrated extensive, multi-directional bone loss, reflecting the combined impact of systemic osteoporosis and local inflammatory activity. Densitometry effectively quantified alveolar bone changes, revealing a strong correlation between CGP severity and BMD decline. These findings highlight the importance of early periodontal assessment and integrated management in patients with rheumatic conditions to prevent accelerated bone destruction and preserve periodontal and systemic bone integrity. Prospects for further research. Further research should focus on prospective longitudinal studies involving larger patient populations to clarify the temporal relationship between systemic bone mineral density reduction and the progression of periodontal destruction in patients with rheumatic diseases. Future investigations should also evaluate the influence of different antirheumatic treatment strategies on alveolar bone preservation and periodontal outcomes, as well as identify clinical and imaging biomarkers that may improve early diagnosis, risk stratification, and individualized management of these patients.

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Conflict of interest. The authors have no conflicts of interest to declare.

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