Scientific Reports

https://doi.org/10.1038/s41598-025-30796-7

Article in Press

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Received: 29 August 2025

Accepted: 27 November 2025

Published online: 04 December 2025

Cite this article as: Ustaoğlu G., Göller Bulut D. & Aydin B. Association of tonsillolith characteristics with periodontal bone loss and dental pathologies: A retrospective study based on cone-beam computed tomography. *Sci Rep* (2025). https://doi.org/10.1038/s41598-025-30796-7

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Association of Tonsillolith Characteristics with Periodontal Bone Loss and Dental Pathologies: A Retrospective Study Based on Cone-Beam Computed Tomography

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Ethics Approval Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Bolu Abant Izzet Baysal University Local Ethics Committee (Approval Number: 2025/328).

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Funding Statement

The authors received no funding for this work.

Conflict of Interest Disclosure

The authors declare that there are no conflicts of interest.

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Clinical Trial Registration

Not applicable.

Abstract

Tonsilloliths are frequently detected as incidental findings, and their microbial similarity to periodontal biofilms suggests potential clinical significance, although robust CBCT-based evidence supporting this association has been limited. This retrospective study evaluated the association between the presence, size, and number of tonsilloliths detected on cone-beam computed tomography (CBCT) images and periodontal bone loss, furcation involvement, and other dental pathologies. CBCT scans of 342 systemically healthy patients obtained between November 2020 and October 2024 were retrospectively evaluated. Participants were divided into two equal groups (n = 171) according to the presence of tonsilloliths, and each scan was assessed for tonsillolith characteristics and dental findings. Periodontal bone loss was determined from cementoenamel junction–alveolar crest distances and categorized into three severity levels. Tonsilloliths were most frequently located on the right side or bilaterally, with a mean size of 3.98 ± 1.78 mm. The tonsillolith group had a significantly higher mean number of missing teeth ($p = 0.040$), while no significant differences were noted for decayed, restored teeth, or apical periodontitis. Bone loss between 1/3 and 2/3 of the optimal bone height and bone loss more than 2/3 of the optimal bone height were more prevalent in the tonsillolith group ($p < 0.001$). Tonsillolith size positively correlated with bone loss severity ($\rho = 0.274$, $p < 0.001$), and larger tonsilloliths were significantly associated with furcation defects ($p < 0.001$). Tonsillolith presence and size may be linked to advanced

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periodontal bone loss and tooth loss, highlighting the potential role of CBCT in interdisciplinary periodontal assessment.

Key words: Cone-Beam Computed Tomography, Dental plaque, Furcation defect, Periodontal bone loss, Tonsilloliths.

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Introduction

Tonsilloliths are dystrophic calcifications that develop within the crypts of the palatine tonsils due to the accumulation of organic debris such as desquamated epithelial cells, microorganisms, and food particles, subsequently undergoing mineralization[1]. Although often asymptomatic and incidentally detected, particularly during dental radiographic evaluations, larger tonsilloliths can cause clinical symptoms including halitosis, chronic sore throat, recurrent tonsillitis, and discomfort [2,3]. Therefore, the detection rate, number, size, location, calcification level, and other characteristics of tonsilloliths should be precisely understood.

The exact etiology and pathophysiological mechanisms underlying tonsillolith formation remain unclear; however, chronic tonsillar inflammation and the presence of polymicrobial biofilms are thought to play pivotal roles [4]. Recent studies have highlighted a notable overlap between the microbial composition of tonsilloliths and dental plaque-associated biofilms[5]. Bacteria commonly identified in both include Actinomyces, Fusobacterium, Eubacterium, Porphyromonas, Prevotella,

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Selenomonas, and Tannerella species, all of which are known contributors to periodontal disease [6,7]. This microbial similarity suggests a possible link between tonsillolith formation and the persistence of dental plaque-related pathologies, such as periodontitis and apical periodontitis[8].

Furthermore, a longitudinal evaluation of tonsilloliths using computed tomography (CT) has demonstrated dynamic changes in calcification over time, supporting the hypothesis that these entities may reflect an ongoing physiological process aimed at eliminating foreign material from the tonsillar environment[9]. While CT imaging offers a higher sensitivity for detecting tonsilloliths, with detection rates approaching 50%[10,11], panoramic radiography remains a widely employed modality in dental practice due to its broad anatomical coverage, low cost, and reduced radiation exposure. However, the detection rate of tonsilloliths via panoramic radiographs remains relatively low, reported between 0.74% and 13.4%[12,13]. This limitation may partly be due to tonsilloliths often lying outside the tomographic focal plane, as well as image distortion, superimposition, and ghost images. Therefore, panoramic radiography cannot be considered a reliable screening tool for tonsillolith detection in the general dental population.

CBCT images that allow us to examine a 3-dimensional image of the maxillofacial region, and provide the facility of acquiring high-quality multiplanar images using lower doses of radiation in comparison with CT[14], has been recommended for the imaging of tonsilloliths[15]. It can thus permit a more accurate diagnosis, enabling effective treatment planning. Palatine tonsilloliths can be detected with CBCT as small radiopacities in the medial part of the ramus mandible and the lateral wall of the oropharyngeal airway. The density of these calcifications is similar to cortical bone[9,16].

Considering the radiographic visibility and shared microbial etiology with periodontal conditions, investigating the relationship between tonsilloliths and dental plaque-related diseases may provide valuable insight into their clinical significance. This study aimed to assess the prevalence, number,

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and size of tonsilloliths and to investigate their potential associations with periodontal bone loss, furcation involvement, and other dental pathologies such as the number of decayed, missing, restored teeth, and apical periodontitis using CBCT images.

Materials and Methods

This retrospective study was conducted in accordance with the ethical principles of the Declaration of Helsinki. It was approved by the Ethics Committee of XX University (Decision No: 2025/328). The study population consisted of patients who visited the Department of Maxillofacial Radiology at the Faculty of Dentistry, XX University, between November 2020 and October 2024 for routine dental examinations.

Prior to clinical CBCT imaging, patients were informed of all potential risks related to the procedure, and written informed consent was obtained, including confirmation that their identifying information would not be used. Patients under 18 years of age, those with a history of maxillofacial surgery or trauma, and those with low-quality radiographic images were excluded. Furthermore, only systemically healthy individuals without any systemic diseases or medications known to affect bone metabolism, and with similar oral hygiene habits based on clinical records, were included in the study.

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A priori power analysis (α = 0.05, effect size = 0.28, power = 0.80) indicated that a minimum of 153 participants was required[5]. A total of 342 cone beam computed tomography (CBCT) scans were retrospectively analyzed, including 171 individuals with radiographic evidence of tonsilloliths (tonsillitis-positive group) and 171 individuals without tonsilloliths (tonsillitis-negative group).

CBCT images were acquired using the I-CAT 3D Imaging System (Imaging Sciences International, Hatfield, PA, USA), with scanning parameters of 5 mA, 120 kVp, 16 × 10–13 cm FOV, and 0.3 mm3 voxel size. CBCT images taken for the purposes of imaging the maxilla, mandible, and maxillary sinus (sinus lift surgery planning) before implant treatments planned for both jaws, evaluating hard tissue pathology in the temporomandibular

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joint, evaluating before planning double jaw surgery in case of various skeletal disorders, and evaluating impacted teeth in both maxilla and mandible (third molars, supernumerary teeth) were examined. All CBCT scans included in this study were obtained exclusively for clinically justified diagnostic purposes in accordance with the International Commission on Radiological Protection (ICRP) principles of justification and optimization. No additional imaging was performed for research purposes. Images were examined by İ-CAT vision Q imaging software, with 0.3 mm intervals.

Tonsilloliths were defined as radiopaque calcifications located between the medial aspect of the mandibular ramus and the lateral wall of the oropharyngeal airway in axial views and confirmed in sagittal and coronal planes (Figure 1). The location (left, right, bilateral), morphology (single, multiple), and number were recorded. The maximum linear diameter of tonsilloliths was recorded. In cases with multiple tonsilloliths, the maximum linear diameter was recorded from the largest tonsillolith detected on CBCT images.

All CBCT images were anonymized and independently assessed in a quiet room with subdued lighting and appropriate screen-viewing distance by two experienced dentomaxillofacial radiologists (D.G.B. and B.A.). Evaluations were conducted by consensus. To assess intraobserver reliability, 30 randomly selected scans were re-evaluated by one radiologist, with intraobserver agreement calculated as 99% for the presence and pattern of calcifications and 98.2% for linear measurements.

In addition to tonsillolith evaluation, CBCT images were examined for radiographic evidence of decayed, missing, and restored teeth; apical periodontitis; furcation defects; and periodontal bone loss. Furcation bone loss was evaluated qualitatively on CBCT images. The presence of radiolucency within the furcation area was recorded as an indicator of furcation involvement, without linear measurement. Periodontal bone loss was evaluated based on the criteria of Dias et al. [17] Bone loss was defined as a distance of ≥ 2 mm between the cementoenamel junction (CEJ) and the alveolar crest. When evaluating the extent of bone loss, the cervical,

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middle and apical third levels of the total root length were taken as a basis and classified as follows:

- Healthy
- Bone loss less than 1/3 of the optimal bone height
- Bone loss between 1/3 and 2/3 of the optimal bone height
- Bone loss more than 2/3 of the optimal bone height (Figure 2) [5].

These values were calculated for all teeth showing bone loss in each CBCT image, and the average percentage of alveolar bone loss was determined per individual.

Statistical analysis

All statistical analyses were performed using SPSS version 21 statistical software (SPSS, Chicago, Illinois, USA).

The distribution of parameters was analyzed by Kolmogorov-Smirnov. The study data were presented as minimum, maximum, mean, standard deviation, median, frequency (%). Mann- Whitney U test was used to compare quantitative data and chi-square test was used to compare categorical variables. The relationships between categorical variables were also assessed using Spearman's correlation coefficient. For comparisons between patients with and without furcation defects, the Mann–Whitney U test was used, and results were expressed as mean ranks. The significance level was set at $p < 0.05$.

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Results

A total of 342 individuals were included in the study, comprising 171 patients diagnosed with tonsilloliths (mean age: 46.22 ± 13.376; 93 males and 78 females) and 171 individuals in the control group (mean age: 45.37 ± 14.193; 81 males and 90 females). No statistically significant differences were observed between the two groups with respect to age ($p = 0.573$) or gender distribution ($p = 0.234$). Age distribution was also comparable between sexes in both the tonsillolith ($p = 0.892$) and control

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groups ($p = 0.132$). Additionally, within the tonsillolith group, there was no significant association between the presence of tonsillolith and gender ($p = 0.234$). Descriptive analysis showed that the mean number of decayed teeth was 0.67 ± 1.041, missing teeth 7.80 ± 6.772, restored teeth 4.94 ± 4.051 and teeth with apical periodontitis 0.66 ± 1.032 in the total sample. The mean tonsillolith size was 3.98 ± 1.78 mm (Table 1).

No gender difference was found in tonsillolith size and number (p=0.171 and p=0.576, respectively). There was no significant correlation between the number of tonsilloliths and age (rho=0.146, p=0.057) and the size of tonsillolith and age (rho=0.035, p=0.652) (Table 2).

25.7% of tonsilloliths were observed on the left side, 37.4% on the right side and 36.9% were bilateral (Figure 3). When intergroup comparisons were conducted in the Table 3, the mean number of missing teeth was significantly higher in the tonsillolith group (8.59 ± 7.077) compared to the control group (7.01 ± 6.375) ($p = 0.040$). No statistically significant differences were identified between the groups in terms of the number of decayed teeth ($p = 0.616$), restored teeth ($p = 0.432$), or the presence of apical periodontitis ($p = 0.616$).

Subgroup analysis by age revealed a statistically significant difference in the number of missing teeth within the 41–60 years age group, where the tonsillolith group demonstrated a higher mean value (10.37 ± 6.915) than the controls (7.92 ± 5.449) ($p = 0.032$). No significant intergroup differences were noted in other age categories or for other dental parameters (Table 4). Assessment of the relationship between tonsillolith laterality (right, left, or bilateral) and furcation defects did not reveal a statistically significant association ($p = 0.296$). Similarly, no significant relationship was observed between tonsillolith location and the degree of periodontal bone loss ($p = 0.876$) (Table 5).

The relationship between periodontal bone loss and the presence of tonsilloliths is shown in Figure 4. The number of patients with periodontal bone loss between 1/3 and 2/3 and more than 2/3 of the optimal bone level is significantly higher in patients with tonsilloliths ($p<0.001$).

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However, in Table 6, correlation analyses demonstrated a statistically significant positive relationship between the size of the tonsilloliths and the severity of periodontal bone loss (Spearman's rho = 0.274, $p < 0.001$). Conversely, no significant correlation was found between the number of tonsilloliths and periodontal bone loss levels ($p = 0.429$). Furthermore, patients with furcation defects exhibited significantly larger tonsilloliths compared to those without such defects (mean rank: 94.25 vs. 82.09; $p < 0.001$). However, the number of tonsilloliths was not significantly different between patients with and without furcation involvement ($p = 0.117$) (Table 7).

Discussion

Although tonsillitis is generally asymptomatic, it is noteworthy both as an indicator of oral hygiene and as a potential microbial reservoir for oral infections. These structures, which can harbor anaerobic bacterial species, can create microenvironmental conditions that may be associated with periodontal and dental infections[3,18,19].

Furthermore, recurrent episodes of chronic tonsillitis are known to increase the depth of the tonsillar crypts, facilitating the accumulation of calcified material in these areas. These anatomical and microbial changes may indirectly influence inflammatory processes in the oral cavity. Chronic tonsillar inflammation may contribute to periodontal disease through shared microbial and inflammatory pathways. Persistent tonsillar infection can act as a reservoir for anaerobic pathogens such as *P. gingivalis* and *Fusobacterium* species, which promote periodontal tissue destruction and alveolar bone loss[20]. These pathogens release proteolytic enzymes and volatile sulfur compounds that can penetrate epithelial barriers and enhance mineral deposition through dystrophic calcification. Moreover, the chronic inflammatory microenvironment within the tonsillar crypts may increase local calcium and phosphate ion concentrations, facilitating the formation of calcified masses similar to subgingival calculus[21]. Conversely, ongoing periodontal inflammation may serve as a microbial reservoir that sustains tonsillar colonization, forming a bidirectional inflammatory loop

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between the oral cavity and the oropharyngeal region[22,23]. This shared pathophysiology may explain why larger tonsilloliths were associated with greater bone loss and furcation involvement in the present study. Given the reported microbial similarities between tonsillitis and dental plaque, these structures may potentially facilitate the harborage of periodontal pathogens, thus perpetuate local inflammation and contributing to the chronicity of periodontal infections[5,8].

The present study demonstrated three statistically significant relationships that collectively support a potential association between tonsilloliths and periodontal pathology. The number of missing teeth was significantly higher in individuals with tonsilloliths, suggesting that chronic inflammatory or microbial processes related to these calcifications may contribute to cumulative tooth loss. Moreover, a positive correlation was found between the size of tonsilloliths and the severity of periodontal bone loss, indicating that larger calcifications might develop in a more inflamed or compromised periodontal environment. In addition, patients with furcation defects had significantly larger tonsilloliths than those without such lesions, suggesting that advanced periodontal destruction and deep intra-radicular spaces may favor the persistence or growth of tonsilloliths. Taken together, these findings suggest a bidirectional relationship in which chronic periodontal inflammation could facilitate tonsillolith formation, while tonsilloliths themselves may act as microbial reservoirs that perpetuate periodontal tissue breakdown. In addition, shared risk factors such as poor oral hygiene, inadequate plaque control, and persistent low-grade inflammation may contribute to both tonsillolith development and progressive periodontal bone loss, supporting a common microbial–inflammatory pathway.

The incidence of tonsilloliths increases significantly, particularly in older age groups, individuals with a history of chronic tonsillitis, and populations with upper respiratory tract diseases such as sinusitis. A study evaluating 3,516 cases reported a significantly higher incidence of tonsilloliths in patients with nasal septum deviation (NSD) and/or chronic sinusitis,

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suggesting that local inflammation may facilitate the calcification process by altering the oropharynx microbiota [24]. In our study, although most of the CBCT field of view occasionally extended to the nasal cavity and paranasal sinuses, these anatomical regions were not systematically evaluated. This was because not all the CBCT scans included the entire nasal cavity, and scans obtained for dental and periodontal purposes, rather than for sinonasal assessment, and the image quality and coverage of these regions were not consistently diagnostic across all cases. Therefore, including nasal or sinus parameters could have introduced measurement bias. Future studies designed explicitly with standardized sinonasal imaging protocols could more accurately investigate the potential relationship among chronic sinusitis, nasal septal deviation, and tonsillolith formation. A study following up tonsillolith cases revealed that tonsilloliths are dynamic structures that can grow, change position, or disappear entirely over time. This study reported that 12% of tonsilloliths disappeared over time, with changes in size and position observed, and that 84% showed increased calcification density. The average annual size increase was 0.61 mm, while the average displacement was 1.38 mm[10]. This mobility and dimensional change indicate that tonsilloliths should be considered as areas of active inflammation rather than static structures.

When we examined the limited number of studies in literature evaluating the relationship between tonsillar inflammation and periodontal pathologies, we concluded that the two pathologies generally affect each other's prognosis. In their clinical study, Georgalas et al. [18] examined a total of 158 patients presenting with peritonsillar abscess (PTA) and a control group of 112 patients presenting for tonsillectomy due to recurrent tonsillitis in terms of their periodontal status using the WHO Community Periodontal Treatment Needs Index (CPITN), and they found a higher incidence of periodontal disease in patients with peritonsillar abscess compared to patients with recurrent tonsillitis. They suggested that treatment of periodontal disease may have a prophylactic effect against peritonsillar abscesses.

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Kryukov et al. [25] examined biomaterials taken from periodontal pockets in patients with concurrent chronic tonsillitis and periodontal disease and found highly pathogenic flora (P. gingivalis, A. actinomycetemcomitans, T. forsythia, and P. intermedia) in 74.3% of cases. They concluded that there is a relationship between the presence of an inflammatory process in the periodontal region and the severity of chronic tonsillitis, and that chronic tonsillitis and periodontitis negatively impact each other's course. Therefore, they recommended that otolaryngologists and dentists should work together with a concurrent and integrated approach in the treatment of patients with chronic tonsillitis and periodontal disease.

In one of the limited studies evaluating the relationship between the presence of tonsilloliths and periodontal pathologies, in a pilot study conducted by Oda et al. [8] on CT scans of 608 patients, analysis using panoramic and CT images revealed a positive correlation between the number of tonsilloliths and periodontal bone loss. Periodontal bone loss was more pronounced in individuals with multiple tonsilloliths. The number of tonsilloliths was reported to be significantly associated with bone defects, particularly in individuals aged 60–89. However, the size and calcification level of tonsilloliths were not found to be statistically significantly associated with periodontal bone loss. In contrast, in the present study, no significant correlation was found between the number of tonsilloliths and the degree of periodontal bone loss, whereas a positive correlation was observed between tonsillolith size and the degree of periodontal bone loss.

A study by Gurbuz et al. [5] in which they evaluated the relationship between the presence of tonsilloliths and dental and periodontal status using panoramic radiography, also supports this relationship. Tonsilloliths were detected in 16.4% of 859 patients; the number of missing teeth, the incidence of apical periodontitis, and the rate of periodontal bone loss were significantly higher in individuals with tonsilloliths than in those without tonsilloliths. Similarly, in the present study, the number of missing teeth and the degree of periodontal bone loss were higher in individuals with

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tonsilloliths than in the control group. These findings demonstrate that the presence of tonsilloliths is not merely a microbial reservoir but is directly related to clinical dental and periodontal pathologies. Unlike periodontal bone loss, apical lesions did not show a significant association with tonsilloliths in this study. This finding suggests that the potential interaction between tonsilloliths and oral inflammation may primarily involve periodontal tissues rather than periapical pathology.

Studies presented in the literature support the relationship between the presence of tonsilloliths and periodontal pathology. Because this study, which evaluated bone loss using CBCT, was retrospective, the results do not provide information on clinical periodontal status. However, a study by Zhang et al. [26] reported a correlation between CBCT and clinical examination results. This study has several limitations. Because it was based on retrospective CBCT records obtained for dental diagnostic purposes, potential selection bias cannot be excluded, and causal relationships cannot be established. Moreover, detailed information regarding participants' body constitution and lifestyle habits (e.g., smoking, alcohol use, oral hygiene routines) was not available, limiting the possibility of multivariable adjustment.

Although age–sex matching was performed to reduce major demographic imbalance, this approach provides only partial control and cannot replace multivariable adjustment. Because key confounders such as smoking status, and oral hygiene habits were unavailable in this retrospective dataset, residual confounding cannot be excluded. Future prospective studies with standardized sampling, comprehensive data collection, and multivariable modeling are warranted to validate and confirm these findings. From a clinical perspective, tonsilloliths are frequently encountered as incidental findings in CBCT scans. When clearly visible, radiologists should report these calcifications as part of their routine findings, as documentation may prompt further assessment of oral or pharyngeal health. Although most tonsilloliths are asymptomatic and do not require specific treatment, their identification can guide clinicians to

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consider associated conditions such as chronic tonsillitis, halitosis, or periodontal inflammation. Timely referral to dental or otolaryngological evaluation may therefore contribute to early management and prevention of secondary complications.

Conclusion

The presence and size of tonsilloliths were significantly associated with greater periodontal bone loss, tooth loss, and furcation involvement. Given the potential association between tonsilloliths and periodontal infections, dentists are advised to evaluate these structures during routine examinations carefully. Patients with multiple tonsilloliths should receive a more detailed periodontal health assessment and, if necessary, a multidisciplinary approach. Collaboration with an otolaryngologist may be beneficial in monitoring the oral and peritonsillar regions in patients with a history of chronic tonsillitis or sinusitis.

ADDITIONAL INFORMATION AND DECLARATIONS

Acknowledgements

Not applicable.

Funding

The authors received no funding for this work.

Competing Interests

The authors declare there are no competing interests.

Author Contributions

• G.U conceived and designed the experiments, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.

• D.G.B conceived and designed the experiments, performed the experiments, analyzed the data, authored or reviewed drafts of the article, and approved the final draft.

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• B.A conceived and designed the experiments, performed the experiments, and approved the final draft.

Human Ethics

This study received ethical approval from the XX University Non-Interventional Clinical Research Ethics Committee (Approval No: 2025/328) and was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Data Availability

“The data of the current study are available from the corresponding author on reasonable request.”

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Table 1. Descriptive statistics of study parameters

	Minimum	Maximum	mean±SD	Median
Decayed tooth ,*n*	0	9	0.67±1.04	0
Missing tooth, *n*	0	27	7.80±6,77	6
Restorated tooth, *n*	0	21	4,94±4,05	5
Apical periodontitis, *n*	0	9	0.66±1.03	0
Tonsillolith size, mm	1	9,69	3,98±1,78	3,30
Tonsillolith number	1	25	3.26±3.48	2

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n: number; SD: Standard deviation

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Table 2. Tonsillolith Characteristics by Gender and Correlation with Age

Variable	Males	Females	p-value
Mean tonsillolith size (mm)	4.15 ± 1.94	3.77 ± 1.56	0.171
Mean number of tonsilloliths	3.35 ± 3.88	3.15 ± 2.95	0.576
	Spearman rho		
Correlation between age and number of tonsilloliths	0.146		0.057
Correlation between age and size of tonsilloliths	0.035		0.652

Significance level is $p<0.05$.

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Table 3. Descriptive statistics of study parameters according to the presence of tonsillolith

	Tonsillolith		**Control**		
	min-max	**mean±SD**	**min-max**	**mean±SD**	***P* value**
Decayed tooth ,n	0-4	0.69±0.97	0-9	0.65±1.10	0.616
Missing tooth, n	0-26	8.59±7.07	0-27	7.01±6,37	0.040*
Restorated tooth, n	0-16	4.78±4.05	0-21	5.11±4.05	0.432
Apical periodontitis, n	0-4	0.71±0.98	0-9	0.65±1.10	0.616

Mann-Whitney U test. *Significance level is p<0.05.n: number;
SD: Standard deviation

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Table 4. Descriptive statistics of study parameters according to the presence of tonsillolith in the age groups

	Tonsillolith	Control	
	mean±SD	**mean±SD**	***P* value**
18-40 years			
Decayed tooth ,n	0,91±1,08	0.76±1.16	0.887
Missing tooth, n	3,04±4,36	3,13±3,88	0.644
Restorated tooth,	4,02±3,40	4,69±3,95	0.430
Apical	0.91±1.08	0.76±1.39	0.220
Tonsillolith size,	3,84±1,83		
41-60 years			
Decayed tooth ,n	0.62±0,89	0,55±0,85	0.130
Missing tooth, n	10,37±6.9	7,92±5,44	0.032*
Restorated tooth,	4.76±4.22	5.36±3.77	0.270
Apical	0.62±0.98	0.55±0.85	0.893
Tonsillolith size,	4.010±1.7		
>60 years			
Decayed tooth ,n	0.55±0.59	0.63±0,89	0.345
Missing tooth, n	12,18±5.9	13,50±7,01	0.662
Restorated tooth,	6.45±4.21	5.47±4.90	0.280
Apical	0.55±0.59	0.63±0.89	0.983
Tonsillolith size,	4.13±1.94		

Mann-Whitney U test. *Significance level is p<0.05; n: number; SD:

Table 5. Relationship between the tonsillolith location and furcation defect and periodontal bone loss

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	Tonsillolith location			P value
	Right n(%)	**Left n(%)**	**Bilateral n(%)**	
Furcation defect				
Absent	41 (35.3)	34 (29.3)	41(35.3)	0.296
Present	23 (41.8)	10 (18.2)	22 (40)	
Periodontal bone loss				
0	5 (38.5)	3 (23.7)	5(38.5)	
1	23 (34.8)	19 (28.8)	24 (36.4)	0.876
2	23 (34.8)	17 (25.8)	26 (39.4)	
3	13 (50)	5 (19.2)	8 (30.8)	

Significance level is p<0.05.

0; Healthy

1; Bone loss less than 1/3 of the optimal bone height

2; Bone loss between 1/3 and 2/3 of the optimal bone height

3; Bone loss more than 2/3 of the optimal bone height

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Table 6. Spearman correlation coefficients between tonsillolith characteristics and periodontal variables

	Spearman	
	rho	*P*
Number of Tonsillolith - Periodontal bone loss level	0.061	0.429
Size of Tonsillolith - Periodontal bone loss level	0.274	<0.001**

**Correlation is significant at the 0.01 level (2-tailed).
*Significance level is P<0.05.

Table 7. Comparison of tonsillolith characteristics according to the presence of furcation defects (Mann–Whitney U test)

	Mann-Whitney U test	
Presence of Furcation defect - Number of Tonsillolith	Mean Rank	*p*
No furcation defect	73.28	0.117
Furcation defect	112.82	
Presence of Furcation defect - Size of Tonsillolith		
No furcation defect	82.09	<0.001*
Furcation defect	94.25	

Significance level is p<0.05.

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Figure Legends:

Figure 1. Appearance of tonsilloliths in sagittal (a), coronal(b), and axial (c) CBCT slices

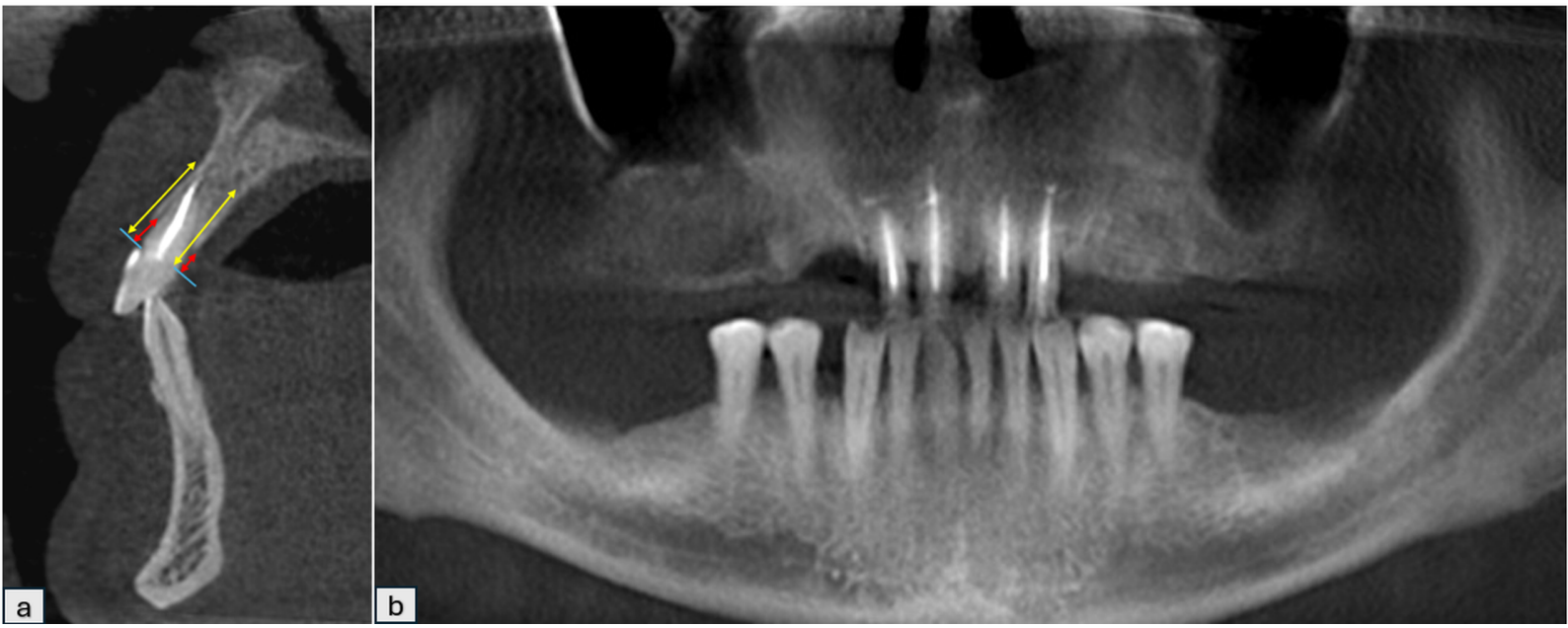
Figure 2. (a) Methods for assessing periodontal bone defects caused by periodontitis on CBCT slice. The alveolar bone defect caused by periodontitis is evaluated on a CBCT slice (in cross-sectional slice) by measuring the distance between the cement-enamel junction (**blue line**) and the alveolar crest (**red arrows**) and between the cement-enamel junction and the root apex (**yellow arrows**) at buccal and palatal sites on each tooth. The alveolar bone defect caused by periodontitis of each subject is calculated as the average of the cement-enamel junction-alveolar crest/cement-enamel junction-apex of all teeth. **(b)** Appearance of periodontal bone loss in panoramic radiograph in CBCT.

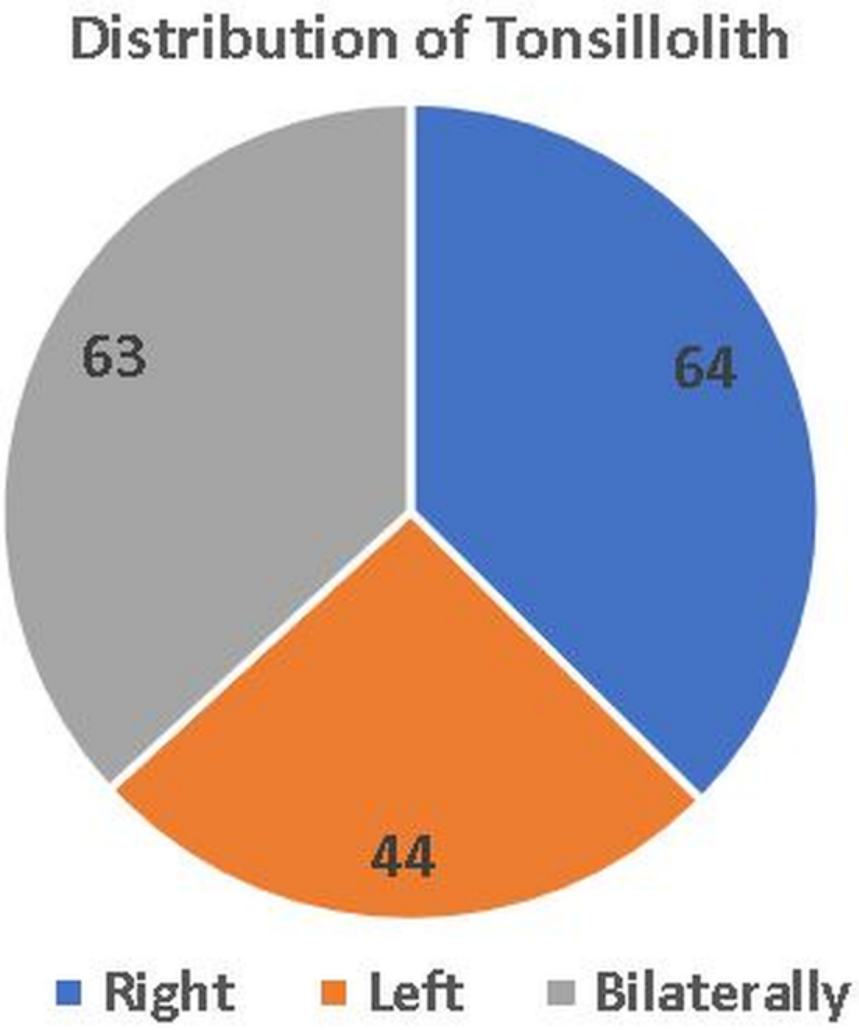
Figure 3. Distribution of tonsilloliths by side

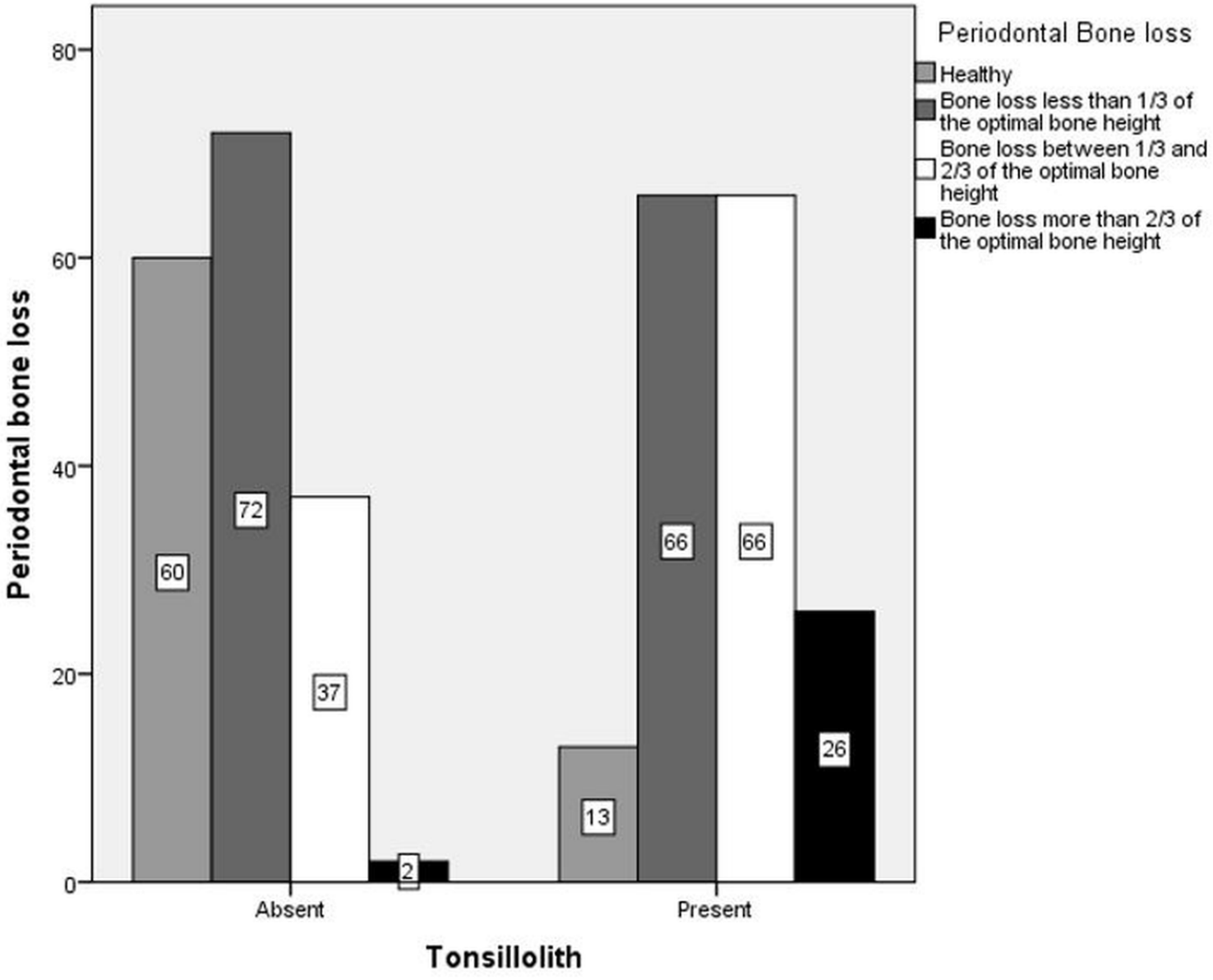
Figure 4. Relationship between periodontal bone loss and the presence of tonsilloliths

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a
b
c


a
b


Distribution of Tonsillolith
63
64
44
Right
Left
Bilaterally


Periodontal Bone loss
Healthy
Bone loss less than 1/3 of the optimal bone height
Bone loss between 1/3 and 2/3 of the optimal bone height
Bone loss more than 2/3 of the optimal bone height
Periodontal bone loss
80
60
40
20
0
60
72
37
2
13
66
66
26
Absent
Present
Tonsillolith