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Research Article

Assessment of Periodontal Disease and the Presence of Pulp Stone: Retrospective Radiologic Study

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Abstract

Aim: To evaluate the relationship between the severity of periodontal disease and the presence of pulp stones using panoramic radiographies.

Material and Methods: The study included 96 individuals aged 18-45 years. The patients were divided into four groups as control (periodontally healthy), gingivitis, stage 1-2 periodontitis and stage 3-4 periodontitis. The patients' panoramic radiographs and dental examination records were evaluated retrospectively and any pulp stones were recorded. The Chi-square test was used to determine the relationship between the presence of pulp stones and other parameters.

Results: Evaluating the findings on a patient basis, the highest pulp stones were seen in the stage 3-4 (79.2%) group, and the least pulp stones were observed in the control group (20.8%). There was a statistically significant difference between the control group and the gingivitis group ($p=0.017$), the control group and the stage 3-4 group ($p<0.001$), and the stage 1-2 and stage 3-4 groups ($p=0.001$). On a tooth basis, the most pulp stones were observed in the stage 3-4 (14.9%) group, and the least pulp stones were observed in the control group (1.7%).

Conclusion: The severity of periodontitis was associated with increased pulp stones. The diagnosis and treatment of patients with endodontic-periodontal problems should be carefully planned accordingly. The presence of pulp stones, which can complicate accessing root canals in endodontic treatment, should be comprehensively investigated.

Keywords: Pulp stone, periodontitis, panoramic radiography, periodontal disease, calcification

INTRODUCTION

The pulp and periodontium are anatomically connected through the apical foramen and lateral or accessory canals. Human and animal studies have shown that pathologic changes in dental pulp can cause periodontal changes (1). However, it is not yet established whether periodontal disease can cause pulpal disease. Previously, it was believed that blood flowed from the pulp to the periodontium and that inflammation spread via venous blood; therefore, it was presumed that periodontal disease did not affect the dental pulp. More recent studies have shown that chronic periodontitis was associated with pathologic changes in the pulp, including inflammatory changes, localized necrosis, root resorption, calcification, and secondary dentin formation. These changes occur due to the reverse flow of inflammatory substances through the lateral and accessory canals (1,2).

Pulp stones are calcified masses in the dental pulps of healthy, diseased, and unerupted teeth (3). They may exist freely within the pulp or be attached to or embedded in dentin (4). Although its etiology is not fully understood, several factors have been associated with pulp stone formation, including inductive interactions between epithelium and pulp, pulp degeneration, orthodontic tooth movement, pulp circulation disorders, idiopathic factors, trauma, periodontal disease, genetic predisposition, age, deep fillings, caries, chronic inflammation, anemia, acromegaly, certain medications, atherosclerosis, and

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Marfan syndrome (5,6).

Periodontitis has been reported to negatively affect pulpal circulation due to bone loss and increased pocket depth (7). In reference to literature indicating that pulpal circulation disorders are effective in pulp stone formation, this study investigated the prevalence of pulp stones among individuals with periodontal disease (7).

Pulp stones can be detected using radiographic and histologic methods (7). Histologic examination gives accurate and clear results, but is not clinically applicable due to its invasive nature (8). The pulp stone must have reached a certain size (>200 μm) and mineralization to be detected on radiography. Radiographic examination is often preferred because it is the only method that can non-invasively detect pulp stone in clinical studies (7).

In a study that radiographically investigated the effect of aggressive periodontitis on pulp, the prevalence of pulp stones was found to be higher in the aggressive periodontitis group compared with the periodontally healthy control group (9). We believe that other periodontal diseases can also induce pulp stone formation due to damage to neighboring structures. Therefore, in this study, we aimed to compare the prevalence of pulp stones in individuals with different periodontal disease and periodontally healthy individuals.

MATERIAL AND METHOD

Study groups

This study was approved by the Ethics Committee of Recep Tayyip Erdoğan University. The study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013. The purpose and content of the research were explained to the individuals included in the study, and voluntary consent forms were signed.

The study included patients aged 18-45 years without systemic diseases who presented to the Recep Tayyip Erdoğan University Faculty of Dentistry between January 2014 and June 2020. Power analysis revealed that at least 96 subjects were required for a study with four groups for an effect size of 40%, a confidence interval of 95%, and 90% power.

We retrospectively examined patient files and recorded periodontal parameters (plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing depth (PD), clinical attachment loss (CAL), and panoramic radiographs. The subjects were divided into four groups according to the 2017 classification of periodontal diseases (10). The groups were defined as follows: control group (group 1, n = 24), periodontally healthy, no CAL, PD ≤3 mm, minimal BOP (≤10%), no radiographic bone loss; gingivitis group (group 2, n = 24), no CAL, PD ≤3 mm, BOP ≥10%, no radiographic bone loss; periodontitis stage 1-2 group (group 3, n = 24), interdental CAL ≤4 mm, PD ≤5 mm, radiographic bone loss ≤ coronal 1/3, no tooth loss due to periodontal disease; periodontitis stage 3-4 group (group 4, n = 24), interdental CAL ≥5 mm, PD ≥6 mm, history of multiple tooth loss, presence of deep periodontal lesions extending to the apical portion of the root.

The exclusion criteria were as follows: panoramic radiographs with poor image quality, history of tooth clenching (due to potentially causing pulp stone formation), orthodontic treatment, systemic disease (e.g. hypercalcemia, gout, cardiovascular disease), inability to radiographically evaluate the pulp chamber (e.g. due to caries, filling, crown restoration).

Radiographic examination

All panoramic radiographs were obtained using a Planmeca Promax 2D S2 (Planmeca Oy; Helsinki, Finland) device with parameters of 66 kVp, 8 mA, 16.6 s. The maxillary and mandibular first and second premolars and first and second molars were evaluated for pulp stones. Pulp stones were defined as distinct radiopaque masses inside the pulp cavity and evaluated as "1" (present) or "0" (absent) (Figure 1).

Figure 1. Pulp stones observed in patients with stage 3-4 periodontitis (pulp stones in teeth marked with *)

The presence of pulp stones was checked by an oral and maxillofacial radiologist with 10+ years' experience (T.E.K). Twenty percent (n = 20) of the radiographs were re-evaluated to determine the intra-observer agreement.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software (IBM Corp., version 23.0, Armonk, USA). $P<0.05$ was considered statistically significant. The chi-square test was performed to compare the prevalence of pulp stones per tooth between the groups according to sex and the severity of periodontal disease. For evaluation of intra-agreement, Cohen's kappa was used.

RESULTS

The study included a total of 96 patients and 1269 teeth. The mean age of the patients was 32 years. Among the subjects, 61 were female and 35 were male. When the

images were re-evaluated, it was seen that Cohen kappa was quite good according to the statistics (k = 0.872). The patients' periodontal parameters are presented in Table 1.

Table 1. All groups' probing pocket depth (PPD), clinical attachment loss (CAL), bleeding in probing (BOP), plaque index (PI), and gingival index (GI) values

	Group 1 (n=24)	Group 2 (n=24)	Group 3 (n=24)	Group 4 (n=24)
PI	0.37±0.17	1.79±0.36	2.22±0.42	2.31±0.51
GI	0.11±0.05	1.77±0.34	1.97±0.37	2.27±0.64
BOP	6.27±2.27	69.87±14.95	75.87±15.45	79.86±12.26
PPD	1.35±0.38	2.17±0.34	3.03±0.40	4.27±0.51
CAL	0±0	0±0	3.38±0.46	4.80±0.70

The highest values of PI, GI, BOP, PPD and CAL parameters were observed at group 4, respectively the values were 2.31±0.51, 2.27±0.64, 79.86±12.26, 4.27±0.51, 4.80±0.70. The lowest values of these parameters were observed at group 1, respectively the values were 0.37±0.17, 0.11±0.05, 6.27±2.27, 1.35±0.38, 0±0. On a patient basis, pulp stones were the most common in group 4 (79.2%) and the least common in group 1 (20.8%) (Table 2).

Table 2. Frequency of pulp stones in all groups according to the number of patients

Dependent variable	Present	Absent	Total	X^2	p
Group 1	5 (20.8%)	19 (79.2%)	24	5.69	0.017*
Group 2	13 (54.2%)	11 (45.8%)	24		
Group 1	5 (20.8%)	19 (79.2%)	24	0.95	0.330
Group 3	8 (33.3%)	16 (66.7%)	24		
Group 1	5 (20.8%)	19 (79.2%)	24	16.33	<0.001*
Group 4	19 (79.2%)	5 (20.8%)	24		
Group 2	13 (54.2%)	11 (45.8%)	24	2.12	0.146
Group 3	8 (33.3%)	16 (66.7%)	24		
Group 2	13 (54.2%)	11 (45.8%)	24	3.37	0.066
Group 4	19 (79.2%)	5 (20.8%)	24		
Group 3	8 (33.3%)	16 (66.7%)	24	10.24	0.001*
Group 4	19 (79.2%)	5 (20.8)	24		

*Statistically significant at p<0.05

An intergroup comparison revealed a significant difference between groups 1 and 2 (p=0.017), groups 1 and 4 (p<0.001), and groups 3 and 4 (p=0.001) (Table 2). On a tooth basis, pulp stones were the most common in group 4 (14.9%) and the least common in group 1 (1.7%) (Table 3).

Table 2. Frequency of pulp stones in all groups according to the number of teeth

Dependent variable	Present	Absent	Total	X^2	p
Group 1	6 (1.7%)	343 (98.3%)	349	23.76	<0.001*
Group 2	32 (10.8%)	265 (89.2%)	297		
Group 1	6 (1.7%)	343 (98.3%)	349	7.31	0.007*
Group 3	17 (5.6%)	284 (94.4%)	301		
Group 1	6 (1.7%)	343 (98.3%)	349	39.36	<0.001*
Group 4	48 (14.9%)	274 (75.1%)	322		
Group 2	32 (10.8%)	265 (89.2%)	297	5.22	0.022*
Group 3	17 (5.6%)	284 (94.4%)	301		
Group 2	32 (10.8%)	265 (89.2%)	297	2.34	0.126
Group 4	48 (14.9%)	274 (75.1%)	322		
Group 3	17 (5.6%)	284 (94.4%)	301	14.27	<0.001*
Group 4	48 (14.9%)	274 (75.1%)	322		

*Statistically significant at p<0.05

We further analyzed our results based on sex. For women, pulp stones were the most common in group 4 (69.2%) and the least common in group 1 (17.6%). For men, pulp stones were the most common in group 4 (90.9%) and the least common in group 3 (21.4%) (Table 4).

Table 4. Frequency of pulp stones in groups according to sex

Dependent variable	Pulp stone	Female	Male	Total	X^2	p
Group 1	Present	3 (17.6%)	2 (28.6%)	5	0.36	0.549
	Absent	14 (82.4%)	5 (71.4%)	19		
Group 2	Present	10 (47.6%)	3 (100%)	13	2.90	0.089
	Absent	11 (52.4%)	0 (0%)	11		
Group 3	Present	5 (50%)	3 (21.4%)	8	2.14	0.143
	Absent	5 (50%)	11 (78.6%)	16		
Group 4	Present	9 (69.2%)	10 (90.9%)	19	1.70	0.193
	Absent	4 (30.8%)	1 (9.1%)	5		

*Statistically significant at p<0.05

DISCUSSION

The communication between pulp and periodontium has developmental, iatrogenic, and pathologic components, but the major communication canals are the accessory canals and the apical foramen (2). Clinical evidence suggests that periodontal disease affects dental pulp mainly via its anatomic relationship and circulation. Periodontal disease causes inflammatory lesions in apical and radicular areas of pulp. Usually, the communication with the periodontal

lesion is via the lateral canals, potentially leading to secondary pulpitis (1).

Studies show that pulp stone formation is associated with various systemic diseases and syndromes, including type1 diabetes, osteitis deformans, kidney diseases, cardiovascular diseases, dentinal dysplasia, Marfan syndrome, van der Woude syndrome, Saethre-Chotzen syndrome, elfin facies, and familial expansile osteolysis (4,11-13). Hence, we excluded individuals with systemic diseases.

In the literature, it has been indicated that periapical radiography, bitewing radiography, and cone-beam computed tomography offer more accurate results than panoramic radiography in the detection of pulp stones (9). However, since our study was a retrospective study and we have panoramic radiographs of all patients, the presence of pulp stone was evaluated by a panoramic imaging method. In this study, panoramic radiographs that were taken for routine dental examination were used when evaluating pulp stones. Additional radiographs were not taken to prevent unnecessary radiation exposure. Another advantage of panoramic radiography is the overall coverage of the dental arches. Current technology also allows enlarging images with minimal quality loss. Image quality is also dependent on using the correct device settings and the experience of the X-ray technician (5). The radiographs included in the study were assessed by radiologists for image quality and correct positioning.

The literature indicates that the prevalence of pulp stones increases with age (14,15). Therefore, we chose patients from similar age groups.

Turkish studies report varying prevalence rates for pulp stones. Şener et al. (16) reported that 4.8% of teeth and 38% of all patients had pulp stones. Sisman et al. (17) found these rates as 15% and 57.6%, Gulsahi et al. (14) as 5% and 12%, Colak et al. (15) as 27.8% and 63.6%, and Ilday et al. (5) as 0.5% and 3.5%, respectively. In our study, 46.8% of patients and 8.1% of teeth had pulp stones, and pulp stones were most common in group 4 (79.2%) and the least common in group 1 (20.8%). Our results support the hypothesis that pulp degeneration is associated with periodontal disease (2,18,19). The variance between the studies can be ascribed to differences in populations, radiography methods, evaluated teeth, and the experience of the examiner.

Several studies have investigated the relationship between pulp stones and sex. Ilday et al. (5) reported that pulp stones were significantly more common among men. Gulsahi et al. (14), Kannan et al. (20), and Sisman et al. (17) found no significant correlation between sex and pulp stones. Colak et al. (15) indicated that pulp stones were more common among women. In our study, we found no significant relationship between sex and pulp stones in any of the groups.

Gutman evaluated 102 molars and found that 28.4% of all samples had accessory canals in the furcation region (21). Zuza et al. reported 37 of 40 third molars had accessory canals in the furcation region (22). In their study, Dammaschke et al. detected accessory foramina in 79% of permanent molars (23). Communication between the pulp chamber and the external surface was determined through dentin tubules. The high prevalence of accessory canals in the furcation region and root surface is prominent in the relationship between periodontal and endodontic diseases (24).

The literature reports that the prevalence of pulp stones is different for every tooth, and several studies found that pulp stones were more common in molars (14,15,17,25). We also found that pulp stones were the most common in molars. This may be because molar teeth are more likely to sustain damage due to being the first permanent teeth to erupt and increased occlusal load, and that molars may have more accessory canals in the furcation region.

Histologic studies suggest that individuals with periodontal disease have increased dystrophic calcification (19, 26). One study radiographically examined the relationship between pulp stones and periodontal disease and found more pulp stones among subjects with aggressive periodontitis than in controls (9). In our study, pulp stones were the most common in group 4 and the least common in group 1. We think that the reason for this is that pulpal blood flow was negatively affected due to the damage in surrounding tissues because increased bone loss and probing depth associated with periodontal disease, and exposed root surface due to attachment loss may become vulnerable to more pathologic changes in pulp. Periodontal disease can result in several degenerative changes in the dental pulp, including odontoblastic degeneration, fibrosis, reticular atrophy, hyperemia, calcifications (pulp stones, diffuse calcifications), inflammation, and necrosis (26).

In this study, panoramic radiographs of individuals with different periodontal disease were evaluated retrospectively. Further studies, examining the prevalence of pulp stones in a larger population using periapical radiography or tomography, which would provide more detailed examination possibilities, can elicit more comprehensive data.

CONCLUSION

Our results indicate that pulp stones were more common among people with advanced periodontal disease than healthy controls. Physicians should consider the presence of pulp stones, which may complicate accessing root canals and the pulp chamber, during endodontic treatment in individuals with periodontal disease.

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