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Original Research Article

Assessment of pulpal calcifications in relation to deep carious lesions among the Visakhapatnam population: A cross-sectional study

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Abstract

Background: Pulpal calcifications are frequent findings in dental radiographs, especially in teeth affected by chronic irritation such as deep carious lesions. These calcifications may complicate endodontic procedures and serve as indicators of pulpal pathology.
Aim & Objective: To evaluate the prevalence and distribution of pulpal calcifications in deep carious teeth and determine their association with patient age, gender, tooth type, and dental arch sextant.
Materials and Methods: A cross-sectional radiographic study was conducted on 1,200 teeth from 800 patients aged 18–65 years presenting with deep carious lesions. Standardized intraoral periapical radiographs were evaluated for the presence of coronal and radicular pulpal calcifications. Demographic data including age, gender, tooth type, and arch location were recorded. Statistical analysis was performed using SPSS v23.0. Chi-square tests and logistic regression were applied to assess associations between pulpal calcifications and clinical parameters.
Results: Pulpal calcifications were identified in 463 out of 1,200 examined teeth, corresponding to an overall prevalence of 38.6%. Among the types of calcifications observed, coronal calcifications (22%) were more commonly detected than radicular calcifications (12%), indicating a higher tendency for mineral deposition within the pulp chamber. Statistical analysis revealed a significant association between the presence of calcification and both age ($p = 0.001$) and tooth type ($p < 0.01$), suggesting these factors strongly influence occurrence. However, no significant correlation was found with gender or arch/sextant location, indicating these variables played a minimal role.
Conclusion: Pulpal calcifications are prevalent in teeth with deep caries, especially in older individuals and molars. Understanding their distribution can help clinicians anticipate and manage challenges during endodontic therapy.

Keywords: Pulpal calcifications, Deep caries, Pulp stones, Root canal, Dental radiography.

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1. Introduction

Pulpal calcifications, including both localized pulp stones and diffuse calcifications within the root canal system, are relatively common findings during routine radiographic examinations carried out in endodontic practice.[1] Their clinical significance arises from the challenges they pose in root canal therapy. These calcifications may obscure canal orifices, hinder instrumentation, and increase the likelihood of procedural mishaps such as ledge formation, perforation, or instrument separation. Additionally, their presence often prolongs chairside treatment time and may adversely affect the prognosis of endodontic procedures if not carefully managed.[2]

Although pulpal calcifications are usually asymptomatic and detected incidentally, their development is frequently linked to long-standing irritants. Reported contributing factors include extensive carious lesions, traumatic injuries, restorative interventions, orthodontic movement, and the

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natural aging process.[3] Among these, deep dental caries is considered one of the most consistent etiological factors. Chronic irritation from carious lesions initiates inflammatory changes within the pulp, leading to degenerative processes and dystrophic mineralization. Over time, this can result in the formation of calcified masses either in the coronal pulp chamber or within the radicular canals.[4]

Despite the established association between pulpal calcification and deep caries, there remains a paucity of data regarding the prevalence, type (coronal versus radicular), and distribution pattern of calcifications in different populations. Variability in prevalence has been reported across ethnic, demographic, and clinical settings, indicating the influence of genetic and environmental factors.[5] Furthermore, information on correlations with age, gender, tooth type, and arch location is limited but crucial, as such factors may determine the likelihood of encountering pulp stones during endodontic treatment.

In light of these gaps, the present investigation was designed to assess the prevalence and distribution of pulpal calcifications in teeth affected by deep carious lesions and to explore their possible associations with demographic and tooth-related parameters.

2. Materials and Methods

2.1. Study design

A cross-sectional observational radiographic study was carried out in the Department of Conservative Dentistry and Endodontics, GITAM Dental College and Hospital, following approval from the institutional ethical committee (Research Proposal No: IRRB/GDCH 2024/FR-05-06). The study aimed to evaluate the prevalence and distribution of pulpal calcifications in teeth presenting with deep carious lesions.

2.2. Sample size and selection

The sample size was determined using G*Power 3.0 software, with statistical parameters set at 80% power, 95% confidence interval, and a significance level of 0.05. Based on this calculation, a total of 800 patients were recruited for the study. The participants, aged between 18 and 65 years, were randomly selected from individuals reporting to the outpatient clinic of the Department of Conservative Dentistry and Endodontics. From these patients, 1,200 teeth diagnosed with deep carious lesions were included for evaluation. Clinical examination of all patients was conducted under proper illumination using a mouth mirror and dental explorer to identify carious involvement. Deep carious lesions were operationally defined as those extending into the innermost one-third of dentin, as confirmed through visual and tactile assessment. Teeth meeting these criteria were subsequently subjected to radiographic examination in order to assess the presence, type, and distribution of pulpal calcifications.

The study included teeth with deep carious lesions involving the dentin, maintaining an intact crown form, and free from any fractures, cracks, or developmental anomalies. Teeth exhibiting non-carious progressive tissue loss (such as attrition, abrasion, erosion, or abfraction) or with a history of trauma, previous restorations, endodontic treatment, or systemic disorders known to affect pulp calcification (including renal diseases, endocrine abnormalities, or genetic conditions) were excluded.

2.3. Radiographic evaluation

Radiographic assessment was carried out using standardized periapical and bitewing images under consistent exposure conditions. For each case, demographic details, including the patient's age and gender, were recorded. The tooth type was documented as maxillary or mandibular, and further classified into anterior, premolar, or molar. Pulpal calcifications were identified as distinct radiopaque structures within the pulp chamber or root canal space and evaluated based on their location (coronal pulp, radicular pulp, or both). All radiographs were examined independently by two calibrated evaluators.

Pulpal calcifications were classified as:

1. Coronal calcifications (pulp stones): Discrete radiopaque masses within the pulp chamber
2. Radicular calcifications: Diffuse or linear radiopacities along the root canal system

In cases of diagnostic disagreement, a third examiner was consulted for consensus.

2.4. Data collection and grouping

Demographic variables including patient age (grouped as 18–30, 31–45, and 46–65 years), gender, tooth type (anterior, premolar, molar), arch (maxillary or mandibular), and sextant location (anterior, right posterior, left posterior) were recorded for each tooth evaluated.

2.5. Statistical analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS version 23.0. Descriptive statistics were used to calculate prevalence percentages. The Chi-square test was used to assess the association between pulpal calcification and categorical variables. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Prevalence of pulpal calcifications

Out of the total 1,200 teeth examined, 463 teeth (38.6%) exhibited pulpal calcifications. Coronal calcifications were observed in 264 teeth (22.0%), radicular calcifications in 144 teeth (12.0%), and both coronal and radicular calcifications in 55 teeth (4.6%). The remaining 737 teeth (61.4%) showed no evidence of calcification (**Table 1**).

Table 1: Prevalence of pulpal calcifications

Type of calcification	Number of teeth	Percentage (%)
Coronal only	264	22.0%
Radicular only	144	12.0%
Both coronal & radicular	55	4.6%
No calcification	737	61.4%
Total	1,200	100%

3.2. Association with age

The prevalence of pulpal calcifications increased significantly with age (p = 0.001). In the 18–30 age group, only 18.7% of teeth exhibited calcifications, compared to 34.5% in the 31–45 group and 44.5% in the 46–65 group (**Table 2**).

Table 2: Association with age

Age Group	Calcifications absent (%)	Calcifications present (%)	p-value
18–30	260 (81.3%)	60 (18.7%)	0.001 (significant)
31–45	288 (65.5%)	152 (34.5%)	
46–65	244 (55.5%)	196 (44.5%)	

3.3. Association with gender

No statistically significant association was found between gender and the presence of pulpal calcifications (p = 0.52). Males showed a slightly higher prevalence (35.0%) compared to females (33.4%) (**Table 3**).

Table 3: Association with gender

Gender	Calcifications absent (%)	Calcifications present (%)	p-value
Male	416 (65%)	224 (35.0%)	0.52 (not significant)
Female	373 (66.6%)	187 (33.4%)	

3.4. Association with tooth type

There was a statistically significant difference in calcification prevalence among different tooth types (p < 0.01). Molars showed the highest prevalence (44.5%), followed by premolars (28.9%) and anterior teeth (16.7%) (**Table 4**).

Table 4: Association with tooth type

Tooth Type	Calcifications absent (%)	Calcifications present (%)	p-value
Anterior	200 (83.3%)	40 (16.7%)	<0.01 (significant)
Premolar	256 (71.1%)	104 (28.9%)	
Molar	333 (55.5%)	267 (44.5%)	

3.5. Association with arch and sextant

No statistically significant association was found between the arch or dental sextant and pulpal calcification prevalence (p > 0.05). The mandibular arch showed a slightly higher rate (35.2%) than the maxillary (33.3%). Among sextants, the posterior regions showed higher prevalence than anterior teeth (**Table 5**).

Table 5: Association with arch and sextant

Location	Calcifications absent (%)	Calcifications present (%)	p-value
Maxillary	400 (66.7%)	200 (33.3%)	0.61 (not significant)
Mandibular	389 (64.8%)	211 (35.2%)	
Anterior sextant	200 (83.3%)	40 (16.7%)	0.14 (not significant)
Left posterior	304 (63.3%)	176 (36.7%)	
Right posterior	289 (60.2%)	191 (39.8%)	

4. Discussion

Pulpal calcifications are frequently observed during routine endodontic evaluation, particularly in teeth affected by deep carious lesions. In the present investigation of 1,200 teeth, the overall prevalence of pulpal calcifications was found to be 38.6%. This finding is in close agreement with previous studies, which have reported prevalence rates ranging between 20% and 40% in comparable populations.[4,5] Such consistency highlights the significant influence of long-standing irritants in the pulp, with deep carious lesions emerging as a major contributing factor. Chronic pulpal inflammation induced by caries appears to be a central mechanism driving the pathogenesis of calcification.

Coronal calcifications (22%) were more prevalent than radicular calcifications (12%), aligning with findings from Goga et al.[1] and Ranjitkar et al.[2] Coronal pulp stones are easier to detect radiographically due to their size and position within the pulp chamber.[5] Histologically, these calcifications often form around degenerated cells or collagen fibers, resulting from chronic irritation or trauma.[6]

Age was significantly associated with increased calcification prevalence (p = 0.001), with the highest occurrence in the 46–65-year group (44.5%). This correlates with the work of Seltzer and Bender,[7] who demonstrated that aging pulp shows increased fibrosis and mineralization. Bernick and Nedelman[8] also reported regressive changes in pulp tissue with age, including decreased cellularity and vascularity, which predispose to dystrophic mineral deposition.

Gender showed no significant influence (p = 0.52), consistent with the findings of Talla HV et al.[9] and Holcomb and Gregory.[10] However, some studies have reported higher calcification rates in males, possibly due to greater masticatory force or higher incidence of trauma. The present study supports the hypothesis that local factors like caries and operative trauma outweigh gender as determinants.

Tooth type showed a significant influence: molars had the highest prevalence (44.5%), followed by premolars (28.9%) and anteriors (16.7%) (p < 0.01). This agrees with

Hassanabadi et al.[11] and Kannan and Sandhya,[12] who suggested that molars are more susceptible due to their complex anatomy, larger pulp volume, and frequent exposure to carious insults and restorations. Posterior teeth are also more prone to occlusal stress, which may induce calcification.[13]

Arch and sextant-wise distribution showed no statistically significant difference, though posterior teeth showed slightly higher prevalence, echoing findings from Yeluri G et al.[14] and Al-Nazhan.[15] These results suggest that calcification patterns are more tooth-specific than arch- or location-specific.

The strong association between deep caries and calcification reinforces previous findings that pulpal inflammation leads to mineral deposition.[16] Pietrzycka K.[17] described calcified tissue formation around necrotic pulp remnants and blood vessels, triggered by chronic irritation. Additionally, mineralization-related proteins such as osteopontin, bone sialoprotein, and alkaline phosphatase have been implicated in this process.[18,19]

Clinically, pulpal calcifications pose significant challenges during root canal therapy by obscuring the normal anatomy of the pulp chamber and canals. They often lead to canal obliteration, making it difficult to locate or negotiate orifices, and increase the likelihood of procedural complications such as perforation, ledge formation, or instrument separation.[20-22] Successful management of such cases requires the use of advanced adjuncts including magnification with dental operating microscopes, ultrasonic tips for conservative dentin removal, and enhanced illumination to improve visualization. In addition, modern imaging techniques play an essential role in overcoming diagnostic limitations.[23]

While the present study relied on conventional periapical radiography, its two-dimensional nature restricts the accurate identification of smaller or radicular calcifications. Cone-beam computed tomography (CBCT) has been reported to offer superior diagnostic sensitivity in this context. Patel et al.[24] demonstrated that CBCT can reveal subtle calcifications not visible on routine radiographs, thereby improving treatment planning.

5. Limitations

While the current study offers important insights, it has limitations. Being radiographic, it may have underestimated the true prevalence of calcifications, especially microscopic or diffuse types. Additionally, the study excluded systemic and syndromic patients, which could affect generalizability. Future research incorporating CBCT, histological correlation, and systemic parameters would provide a more comprehensive understanding.

6. Conclusion

Pulpal calcifications are commonly associated with deep carious lesions, particularly in older patients and molars, indicating a strong link with chronic pulpal irritation and age-related changes. Their early radiographic detection is essential for anticipating endodontic challenges and improving treatment outcomes.

7. Ethical Approval

IRRB/GDCH2024/FR-05-06.

8. Source of Funding

None.

9. Conflict of Interest

None.

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