



Risk Factors Associated with Pulpal Calculus Formation and Calcifications: An Exploratory Analysis

Rómulo Guillermo López Torres¹

Verónica Alejandra Salame Ortiz², Katherine Lizbeth Sarabia Solis³

^{1,2,3}Universidad Autónoma Regional de Los Andes Ambato. Ecuador

Email: ua.romulolopez@uniandes.edu.ec¹, ua.veronicasalame@uniandes.edu.ec²,
oa.katherinelss10@uniandes.edu.ec³

ORCID ID: 0000-0001-9315-3388¹, 0000-0002-7103-5804², 0009-0003-3006-2798³

*Corresponding author's E-mail: ua.romulolopez@uniandes.edu.ec

Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 11 Sept 2023	Aim: The objective of this study was to identify the factors that contribute to the formation of pulp stones and calcifications through an updated bibliographical investigation. Pulp calculi, composed mainly of calcium deposits and are in the internal part of the dental organs. Material and method: The research was based on a mixed approach, combining qualitative and quantitative elements through the analysis of scientific articles that address the factors associated with the formation of pulp stones in dental organs. A bibliographic review was carried out that included a total of 80 scientific articles published between 2018 and 2022, obtained from recognized scientific databases, such as PubMed, Clinical Key, EBSCO Host, Wiley Online Library, and Springer. Statistics and Result: The results obtained revealed that, according to various authors, the factors that presented a greater predisposition to the formation of pulp stones were the location of the teeth in the maxilla, representing 90% of the cases, compared to 10% in the jaw. Likewise, it was observed that factors such as the presence of dental caries, periodontal disease, trauma and cardiovascular systemic diseases were present in approximately 50% of the cases analyzed.
CC License CC-BY-NC-SA 4.0	Keywords: Dental Organs, Calcifications, Pulp Stones, Calcium Deposits

1. Introduction

Pulp stones are calcifications that occur within the pulp in temporary or permanent dentition and even in dental organs that are not yet erupted. It can be evaluated through the use of diagnostic imaging techniques such as: radiographs (parallelism and bitewing technique) and cone beam computed tomography where the obliteration of the pulp chamber and if calcifications occur in the lumen of the root canals can be observed in detail (Chandran et al., 2021; Falcon et al., 2021). Calcifications may be present in 50% of one or more dental organs. In dystrophic calcifications calcium is deposited in tissues that degenerate, calcium deposition initiates in the mitochondria due to the permeability of the membrane by calcium. The mineralizations present in the pulp can have different forms, depending on their location in the pulp chamber they are presented in the form of spherical or ovoid nodules, sometimes it has the shape of the coronal face of the pulp cavity, in the space of the root canal it is more diffuse in tubular or cylindrical form taking the shape of the root canal (Palatyńska et al., 2022; Hargreaves et al., 2011).

Pulp stones can hinder endodontic treatment by making it impossible to access the root canals of the dental organs because of the physical obstruction. Its presence can cause changes when preparing access to the pulp chamber, becoming a difficult process in the cleaning and shaping of root canal systems specifically in molars (Kuzekanani et al., 2018). Calcifications in the distal ducts of the

molars in the jaw can be totally or partially eliminated is the possible interference with the treatment of the root canal, since they can occlude the pulp chamber and the canal, it will hinder the access and the proper shape of the root canals. Adhered calcifications can deflect or hook the tip of the scanning instruments or even prevent their passage through the root canals (Chen et al., 2020).

Pulp stones are caused by long-lasting local irritants these are associated with factors such as: caries, age, periodontal disease, trauma, systemic diseases, dentinal genetic defects, cardiovascular diseases. There is an irritation of the pulp producing inflammation if not treated can evolve, result in pulp necrosis and calcification (Hseih et al., 2018). According to Ricucci (2014) Tertiary dentinogenesis represents the manifestation of the pulp in response to deep carious lesions or deep restorations. Lesions that occurred below the area with the deepest caries resulted in the death of primary odontoblasts and the deposition of atubular amorphous calcified tissue. In the case of pulp exposures, this amorphous atubular calcified tissue formed the dentin bridge that has been called fibrodentin (Ricucci et al., 2021). In periodontal disease there were changes in the pulp, where the dentinal tubules can react with some type of mineralization. In the study, non-adherent calcifications were found in the root pulps of 68% of teeth diagnosed with irreversible pulpitis, 55.5% of teeth with reversible pulpitis and 54% of teeth with healed pulps.

In young patients, calcifications are associated with the presence of teeth that have caries or restorations, therefore, these factors chronically irritating the pulp lead to the formation of pulp stones. In older adults the aging of the pulp becomes a factor for the presence of calcifications the pulp chamber of the dental organs tends to decrease in size because secondary dentin accumulates in these ducts (Bers et al., 2016). According to the study conducted by Chen. G et al (Chen et al., 2022) The detection of pulp stones was not significantly different between genders or for age groups between 20 and 40 years. Pulp stones were prevalent and evident in the age groups of 41 to 60 years and older than 60 years, especially in teeth with periodontal involvement. Calcified pulp stones were more prevalent in the maxillary arch (10.4%) than in the mandibular arch (6.1%). In the study (Jawahar et al., 2021; Mello et al., 2017) he mentions that calcifications of the pulp are prone to their appearance in patients with cardiovascular diseases since lipids participate in the initiation of hydroxyapatite formation, thus influencing the development of arterial calcification, hypertension and cardiovascular diseases.

2. Materials And Methods

The methodology used in this research is based on an analytical and descriptive approach, which focuses on the review and analysis of scientific articles related to the predisposition of factors that are associated with the formation of pulp stones.

First, an exhaustive bibliographic search was carried out in specialized databases and other relevant sources, such as scientific journals and specialized books. We used specific search terms related to predisposing factors and pulp stone formation.

Subsequently, a rigorous selection of the articles found was carried out, applying previously established inclusion and exclusion criteria. The selected articles were evaluated for their relevance, methodological quality and contribution to the research topic.

Once the final sample of scientific articles was obtained, a detailed analysis of each of them was carried out. We extracted relevant data, such as predisposing factors studied, methods used to assess pulpstone formation, results obtained and study conclusions.

In this analysis process, patterns, trends and relationships between predisposing factors and pulp stone formation were identified. Comparisons and contrasts were made between the selected studies, with the aim of obtaining a comprehensive and comprehensive view of the problem investigated.

It is important to note that this research is based on the review and synthesis of existing scientific literature, so no experiments or primary data collection were conducted. However, the analytical and descriptive approach used allows to obtain a critical and well-founded view of the predisposing factors associated with the formation of pulp stones, thus contributing to the advancement of knowledge in this area.

Inclusion Criteria

- Scientific research papers related to the main topic.
- Research in language: English-Spanish.
- Open-access articles, high-impact journal documents
- Information published between 2018 -2022
- We included case studies, systemic reviews, prospective-observational, retrospective clinical studies that contained keywords for their search such as: pulp stones, pulp calcifications, factors in pulp calcifications

Exclusion Criteria

- Any article that did not come from reliable sources is excluded.
- Undergraduate thesis
- Information in the form of a summary or lecture.

All types of articles in which no factors associated with pulp calcifications were found were excluded, articles in which clinical cases of calcifications were presented and did not involve studies in a specific population that presented any factor present in calcifications were excluded.

3. Results and Discussion

A bibliographic search of scientific articles was carried out using keywords, 80 search articles were found, which 61 were discarded for not meeting established criteria. Finally, when establishing the 19 articles, it was classified taking into account the factors associated with calcifications, of which 10 were selected for the analysis of results.

Table 1. Analysis of selected articles

Author-Year	Participants	Age	Methodology	Results
Jawahar et al. (2021)	70 patients	34-14 years	Radiography Histopathological examination	-(71%) maxillary cases and (29%) mandibular cases. - The presence of caries was observed in 46 cases (65%) and a history with trauma in 24 cases (35%). - Presence of pulp stones in 18 cases with hypertension (25%) and in 16 cases with high serum cholesterol levels (22%).
S. N, Chandran (2021)	300 patients	25-65 years	Use of x-rays	-Group. control 150 healthy patients not with heart disease and Study Group 150 (with heart disease), -Study group 96.24% calcifications, control group 27.59% calcifications in both sexes
G. Chen et al. (2022)	465 patients	41-60 years	Digital panoramic and periapical radiography	-Patients with periodontal disease were classified according to their gender, age and location of their teeth, using panoramic and digital periapical Rx, to determine the presence of pulp stones and calcifications. - We found no correlation between gender and calcification of the pulp cavity - Pulp stones were more prevalent in the maxilla (10.4%) than in the mandible (6.1%). - Present in O.D posterior molars 2nd upper molar (24.9%), 1st upper molar (22.1%), lower frequency mandibular incisors 2.4%.

Risk Factors Associated with Pulpal Calculus Formation and Calcifications: An Exploratory Analysis

Noboa et al. (2020)	1866 teeth	Over 15 years old	Use of x-rays	-Of 1866 teeth, 1017 pieces (55%), showed the presence of pulp nodules. Patients in the fourth or fifth decade of life (61%) outperformed the rest of the decades 39%. - It was observed that pieces with caries - restorations presented a higher percentage (59%) of calcifications in relation to other dental conditions such as periodontal disease 8%, abrasions 19%, trauma 6%, orthodontic forces 2%, healthy teeth 6%
Vargas et al. (2020)	2979 teeth	20 - 69 years	Use of x-rays	-With respect to pulp calcifications, 1639 female patients had a higher percentage (55%), while 1340 male patients had a lower percentage (45%). -Patients with type 1 diabetes have a prevalence of calcifications (2%), while patients with type 2 diabetes have (20%) of calcifications
Chen B. et al. (2020)	144 patients	20- 59 Years	Use of Tomography	-Pulp stones in higher percentage in male than female patients (90.6% 72.9%,) -Pulp stones at different ages with higher prevalence of 20-39 years (86.8%), 60 years (85.3%) under 20 years (83.3%) and 40-59 years (80.3%). -In the maxilla it was presented (36.4%) and mandible 26.6%. There were more cases in first molar (50%), second molar (46.2%), second premolar (19.1%), first premolar (18.8 %). -In female patients 40.48% of cases and in males 23.9%
Kuzekanani et al. (2018)	412 patients	15- 65 years	Use of X-rays	
Labarta et al. (2021)	55 patients	20-55 years	Use of X-rays	-39% of healthy patients did not have pulp stones, while 64% of cases had more cases of patients with cardiovascular disease
Babu J et al. (2020)	300 patients	20-55 Years	Use of x-rays	-Stones in male patients with about 96.24% of men affected by pulp stones compared to 88.88% female
Mello. A et. al. (2017)	197 patients	15-40 years	Use of x-rays	-Calculations 10% showed widening of the periodontal ligament space, 3.1% internal resorption, 10% external resorption, periapical bone rarefaction 10.4%

Source: Authors.

Of the 10 articles selected, the diagnosis for the investigation was pulp stones in the population analyzed, by means of imaging instruments (radiographs) 90% of cases were evidenced while 10% of cases used between tomography and histopathological examination for the study of calcifications. The articles showed the presence of different factors that were involved in the formation of stones and calcifications of the pulp

The following table details the analysis of each of the factors

Table 2: Analysis of associated factors in relation to selected articles

FACTORS ASSOCIATED WITH PULP CALCULI AND CALCIFICATIONS	
Location of Teeth	Maxilla 80% Jaw 20 % X-ray 90% Tomography 5 % Examination 5 % Histopathological Cavities 40% -Restorations Disease 20% Periodontal
Diagnostic Methodology	Dg. Pulp(irreversible pulpitis - reversible pulpitis)10%
Previous diagnosis	Other injuries 30% Heart disease 50%
Systemic Condition	Hypertension 10% Male 20% Female 30% They didn't take Gender account 50%
Gender	

Source: Authors.

According to the location of the teeth present in the articles, 80% are in the maxilla while in the jaw 20% of cases, for the diagnostic method with the highest prevalence x-rays were used in 90% while tomography and histopathological examinations 10%. In the previous diagnosis the factors caries - restorations involved 40%, periodontal disease 20%, pulp diagnoses (irreversible pulpitis - reversible pulpitis) 10%, other traumatism 30%. According to the systemic condition in patients with heart disease involved 50%, patients with hypertension 10%. In the review of scientific articles, 50% of cases did not take gender into account, while in other articles that were also part of the 10 selected articles, 30% in the female gender and 20% in the male gender were taken into account.

In this research of scientific articles, the data collected according to the different authors based on the topic of pulp calcifications have similar and different approaches regarding factors associated with calcifications. Pulp calcifications are inside the teeth according to the research carried out, 80% of the maxilla is found in most teeth and 20% of cases in the jaw, this is also mentioned by Jawahar et al. (2021) in teeth they are found in a higher percentage in the maxilla 71% and in a lower percentage in the jaw 29%. The diagnostic method was the use of periapical radiographs and the presence or absence of pulp calcifications was observed (Palatyńska et al., 2020; Babu et al., 2020; Banubakode et al., (2021; Piza et al., 2020).

(Falcon et al., 2021; Palacios et al., 2020) manifests in his study used cone beam tomography was observed more clearly the obliterated pulp chamber and calcification in the coronal half of the space occupied by the root canal and also used radiographs where a radiopaque shadow could be visualized in ducts of teeth. Unlike the research carried out, about methods that help the diagnosis according to the data obtained through the present research the use of diagnostic instruments, radiographs were given in 90% of cases, while tomography 5% and histopathological examination was only used in 5% of cases. According to the study conducted by (Chen et al., 2022; Jimenez et al., 2020) The detection of pulp stones was not significantly different between genders or for age groups between 20 and 40 years. Pulp stones were prevalent and evident in the age groups of 41 to 60 years and older than 60

years, especially in teeth with periodontal involvement. Unlike the study conducted in which the age range was not taken into account, patients with periodontitis were 20% of cases.

S. N. Chandran (2021) manifest referring to cardiovascular diseases presented calculations in most cases 96.24% calcifications without taking into account the gender of the patients. Unlike Babu SJ et al. (2020) mentions in a certain study group of patients with coronary artery disease It was given in greater predilection 51.92 % of the jaws affected by calcified matter compared to 48.08 % of the mandibular teeth. In addition, there was greater predilection in the male gender of 96.24 % affected by pulp stones compared to 88.88 % of prevalence observed in the female gender. According to Nayak et al., 2020; Jimenez et al., 2020) He observed that teeth with pulp calcifications were located both in the coronal pulp and in the root, presented a change of yellowish or gray coloration, the teeth also had alterations of the periodontal ligament, external resorption 10%, internal resorption was the least frequent alteration 3.1%. There is a consensus among the authors Jawahar et al; G. Chen et al; B. Chen et al, that most of the cases observed in radiographic images occur in the maxilla specifically in first and second molars unlike the rest of the teeth. Chen et al, differs their criteria by finding no relationship to the gender factor in their study, while Jawahar et al and B. Chen et al; if they take into account the two genders with the highest percentage of male patients in relation to the female.

4. Conclusion

Through an exhaustive literature review, the relevance of studying calcifications associated with predisposing factors in their formation has been established. It is essential that dental professionals consider these aspects when diagnosing and treating teeth, relying on imaging studies such as x-rays or tomography to evaluate the presence of calcifications and achieve an accurate diagnosis. It is essential to use the diagnostic methods mentioned above to know the frequency of dental calculi depending on the location of the teeth before proceeding to treatment. It is also important to make a prior diagnosis and observe both the clinical and radiographic aspects to determine if the teeth are related to factors such as restorations, carious lesions, periodontal disease, pulp diagnoses or other traumas that may lead to the formation of calculus or calcifications in the dental pulp.

In addition, the systemic condition of patients may be related to the formation of calcifications, especially in cases of heart disease or hypertension, as well as other systemic pathologies. Considering these systemic conditions is crucial to prevent complications during endodontic treatment and improve case prognosis. The information obtained through the literature review provides a solid foundation for dental professionals to implement more effective preventive and management approaches in relation to dental calcifications. By taking these aspects into account, the planning and execution of endodontic treatments can be optimized, thus improving clinical outcomes and patient satisfaction. In conclusion, the study of dental calcifications and the factors predisposing to their formation is essential for dental professionals. The incorporation of accurate diagnostic methods, consideration of the location of calcifications, evaluation of risk factors and attention to the patient's systemic condition allow to prevent complications and improve results in endodontic treatments.

References:

- Babu, S. J., Swarnalatha, C., Rao, A. P., Kumar, B. B., Tilak, B. P., Naidu, R. B., et al. (2020). Pulp stones as risk predictors for coronary artery disease. *International Journal of Preventive Medicine*, 11(1), 7. [Available from: <https://pubmed.ncbi.nlm.nih.gov/32089807/>]
- Banubakode, T., Karemore, T., Motwani, M., Dhole, A., & Muneshwar, R. (2021). Association of pulp stones among patients with addictive habits – A descriptive cross-sectional study. *Journal of Indian Academy of Oral Medicine and Radiology*, 33(3), 276. [Available from: <https://www.jiaomr.in/article.asp?issn=09721363;year=2021;volume=33;issue=3;spage=276;epage=279;aulast=Karemore>]
- Berès, F., Isaac, J., Mouton, L., Rouzière, S., Berdal, A., Simon, S., et al. (2016). Comparative physicochemical analysis of pulp stone and dentin. *Journal of Endodontics*, 42(3), 432–438.
- Chen, B., Szabo, D., Shen, Y., Zhang, D., Li, X., Ma, J., et al. (2020). Removal of calcifications from distal canals of mandibular molars by a non-instrumental cleaning system: A micro-CT study. *Australian Endodontic Journal*, 46(1), 11–16.

- Chen, G., Huang, L. G., & Yeh, P. C. (2022). Detecting calcified pulp stones in patients with periodontal diseases using digital panoramic and periapical radiographies. *Journal of Dental Sciences*. [Available from: <https://doi.org/10.1016/j.jds.2021.12.010>]
- Falcon, P. A., Falcon, C. Y., Abbasi, F., & Hirschberg, C. S. (2021). Chamberless Endodontic Access for Treatment of Calcified Anterior Central Incisors. *Journal of Endodontics*, 47(2), 322–326. [Available from: <https://doi.org/10.1016/j.joen.2020.10.017>]
- Gonzalez Marrero, Y., Kobayashi, Y., Ihsan, M. S., Pilch, L. A., Chen, L., Jiang, S., et al. (2022). Altered prevalence of pulp diagnoses in diabetes mellitus patients: A retrospective study. *Journal of Endodontics*, 48(2), 208–212.e3. [Available from: <https://pubmed.ncbi.nlm.nih.gov/34780805/>]
- Gulsahi, A., Cebeci, A. I., & Özden, S. (2009). A radiographic assessment of the prevalence of pulp stones in a group of Turkish dental patients. *International Endodontic Journal*, 42(8), 735–739.
- Hargreaves, K. M., Berman, L. H., & Cohen, S. (Eds.). (2011). *Cohen's Pathways of the Pulp + Expertconsult*. Elsevier Health Sciences.
- Hsieh, C. Y., Wu, Y. C., Su, C. C., Chung, M. P., Huang, R. Y., Ting, P. Y., et al. (2018). The prevalence and distribution of radiopaque, calcified pulp stones: A cone-beam computed tomography study in a northern Taiwanese population. *Journal of Dental Sciences*, 13(2), 138–144. [Available from: <https://doi.org/10.1016/j.jds.2017.06.005>]
- Jawahar, G., Rao, G. N., Vennila, A. A., Fathima, S. D., Lawanya, M. K. K., Doss, D. M., et al. (2021). Clinicopathological correlation of pulp stones and its association with hypertension and hyperlipidemia: A hospital-based prevalence study. *Journal of Pharmacy & Bioallied Sciences*, 13(Suppl 2), S1268–S1274. [Available from: http://dx.doi.org/10.4103/jpbs.jpbs_475_21]
- Jimenez, D. S., Celis, P. B. M., Latorre, H. G. H., & Vidal, C. P. B. (2020). Stressors that affect nursing students in their clinical practices. *University and Society*, 12(S(1)), 69–76. [Available from: <https://rus.ucf.edu/cu/index.php/rus/article/view/1753>]
- Jimenez, D. S., Celis, P. B. M., Morales, D. A., & Tello, F. C. (2020). The importance of organizational climate and culture for care in health institutions. *University and Society*, 12(S(1)), 53–60. [Available from: <https://rus.ucf.edu/cu/index.php/rus/article/view/1751>]
- Kuzekanani, M., Haghani, J., Walsh, L. J., & Estabragh, M. A. M. (2018). Pulp stones, prevalence and distribution in an Iranian population. *Journal of Contemporary Dental Practice*, 19(1), 60–65.
- Labarta, A. B., Mancipe Leguizamón, S., Pineda Martínez, C. J., & Sierra, L. G. (2021). Radiographic evaluation of the frequency and distribution of pulp nodules. *Revista Facultad de Odontología, Universidad de Buenos Aires*, 36(82), 57–65. [Available from: <http://revista.odontologia.uba.ar/index.php/rfouba/article/view/79>]
- Mello-Moura, A. C. V., Santos, A. M. A., Bonini, G. A. V. C., Zardetto, C. G. D. C., Moura-Netto, C., & Wanderley, M. T. (2017). Pulp calcification in traumatized Primary Teeth - classification, clinical and radiographic aspects. *Journal of Clinical Pediatric Dentistry*, 41(6), 467–471. [Available from: <https://pubmed.ncbi.nlm.nih.gov/28937901/>]
- Nayak, M., Kumar, J., & Prasad, L. K. (2010). A radiographic correlation between systemic disorders and pulp stones. *Indian Journal of Dental Research*, 21(3), 369–373. [Available from: <https://www.ijdr.in/article.asp?issn=0970-9290;year=2010;volume=21;issue=3;spage=369;epage=373;aulast=Nayak>]
- Noboa, J. E. G., Pacheco, E. S. A., Cardenas, C. V. G., & Pazmiño, A. M. A. (2020). Evolution of MSMEs according to the life cycle. *University and Society*, 12(S(1)), 47–52. [Available from: <https://rus.ucf.edu/cu/index.php/rus/article/view/1750>]
- Palacios, A. J. P., Bustamante, L. J. B., Armijos, V. M. C., & Del Pozo Franco, P. E. (2020). Complementary marriage at the equator. An extension of rights, based on the recognition of equal marriage. *University and Society*, 12(S(1)), 77–86. [Available from: <https://rus.ucf.edu/cu/index.php/rus/article/view/1754>]
- Palatyńska-Ulatowska, A., Fernandes, M. C., Pietrzycka, K., Koprowicz, A., Klimek, L., Souza, R. A., et al. (2022). The pulp stones: Morphological analysis in scanning electron microscopy and spectroscopic chemical quantification. *Medicina*, 58(1), 1–17.
- Piza, I. A. C., Palacios, A. J. P., & Del Pozo Franco, P. E. (2020). Legitimate decisions of the competent authority in the health emergency due to Covid-19. *University and Society*, 12(S(1)), 87–93. [Available from: <https://rus.ucf.edu/cu/index.php/rus/article/view/1755>]
- Ricucci, D., Loghin, S., Lin, L. M., Spångberg, L. S. W., & Tay, F. R. (2014). Is hard tissue formation in the dental pulp after the death of the primary odontoblasts a regenerative or a reparative process? *Journal of Dentistry*, 42(9), 1156–1170.
- Ricucci, D., Siqueira, J. F., & Rôças, I. N. (2021). Pulp Response to Periodontal Disease: Novel Observations Help Clarify the Processes of Tissue Breakdown and Infection. *Journal of Endodontics*, 47(5), 740–754.

- S. N, Chandran A, B. S, S. G, A. M, Muddebihal F, et al. (2021). Pulp Stones: Diagnostic Significance in Early Diagnosis and Radiographic Correlation with Ischemic Heart Diseases. *Indian Journal of Radiology and Imaging*, 31(2), 277–283.
- Vargas, C. V. (2020). Public policies that allow the empowerment of women in the popular and solidarity economy in Ecuador. *University and Society*, 12(S(1)), 276–281. [Available from: <https://rus.ucf.edu.cu/index.php/rus/article/view/1786>]