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Radiographical examination of pulp stone distribution by cone beam computed tomography

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ABSTRACT

Aims: The present study aimed to ascertain the association between pulp stone production and tooth type, jaw, arch orientation, and dental status in a Turkish subpopulation in the southern region of Turkiye by analyzing cone beam computed tomography images.

Methods: The study included a retrospective examination of cone beam computed tomography images obtained at Gaziantep Private Dental Clinic and Gaziantep University Faculty of Dentistry between 2014 and 2020 for various purposes, and a recording of teeth with pulp calcification in the pulp chamber. The study did not include any teeth that had root canal therapy or porcelain crowns. Data was gathered from radiographs of people in the 19-90 age range. In all, 1676 teeth had pulp stones found in them. To compare proportions, two proportion z-tests were employed.

Results: Male individuals possessed 774 teeth with pulp stones, while female individuals possessed 902 teeth with the same condition. The prevalence of pulp stones in first and second molar teeth (1092, 65.16%) is statistically farther than central and lateral incisors (238, 4.2%), canine (207, 12.35%) and premolar (139, 8.29%). The rate of pulp calcifications is statistically higher; in intact (1065, 63.54%) teeth compared to the teeth with filling materials (443, 26.43%) and teeth with caries (173, 10.32%); in the maxilla (874, 52.15%) compared to mandible (802, 47.85%). Pulp stone occurrence was higher on the right side (888, 52.98%) than on the left side (788, 47.02) ($p<0.05$).

Conclusion: Our results indicate that the type of tooth, the jaw in which it is situated, and its orientation all influence the incidence of pulp stones. Future researches with a sizable sample size are required to ascertain the impact of pulpal irritations on the development of pulp calcifications.

Keywords: Pulp stone, cone beam computed tomography, Turkish subpopulation

INTRODUCTION

A pulp stone is a calcified mass within the pulp that can be found in primary, permanent, healthy and carious teeth, unerupted teeth, and can be seen in a single tooth or all teeth.[1,2] Histologically, two types of stones have been identified: those with round or oval, smooth surfaces and concentric laminations; and those that do not take a definite shape, lack laminations, and have jagged surfaces.[3] Their sizes vary from small microscopic particles to large masses that nearly destroy the pulp chamber. During a radiographic assessment, pulp stones can be observed as radiopaque substances of different forms and dimensions.[4]

Le May & Kaqueler[5] used electron probe microanalysis to determine the mineral content of human pulp stones and showed that the stones are constituted of two main elements, calcium, and phosphorus. Other elements were found as fluorine, sodium, magnesium, and trace concentrations of potassium, chlorine, manganese, zinc, and iron.[5]

It has been argued that some idiopathic toothaches may be provoked by pulp stones.[6] The general approach is that pulp calcification is not pathological, which obviates the need for routine endodontic treatment unless there are additional signs and symptoms in the patient's history.[7]

In particular, stones located widely and in the center of the pulp chamber pose an obstacle in determining the location of the canal opening. Bound stones may prevent the root canal files from moving on a straight path and may cause the file to wear out or break.[8] Stones can be removed using drills or ultrasonic tools to allow easy visualization of the working area.[9] If a stone is adhered to the root canal dentine and an endodontic file can be passed past the stone, it can be removed with careful preparation.[10] Nevertheless when magnification, adequate access, and the right tools are employed during root canal therapy, pulp stones don't provide much of a clinical challenge.

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Pulp calcification is detected in radiographic and histological examinations.[11] However, radiographic examinations have some limitations. For calcification to be detected on radiography, it must have a certain size (>200µm) and degree of mineralization.[12] It is not possible to clearly determine the extent of calcification by radiography, and there is a possibility that radiographic images may be interpreted relatively differently by different observers. Nevertheless, despite all these limitations, radiographs are used as a method that can detect calcification clinically and non-invasively.[7]

This study aims to evaluate the pulp calcifications seen in the anterior, premolar, and molar teeth in a group of Turkish sub-society by radiographic examination method, according to tooth type, gender, crown condition, arch, and jaw direction.

METHODS

The Declaration of Helsinki's guiding principles were followed in the conduct of this investigation. This study was approved by the Ethics Committee at Gaziantep University Faculty of Dentistry (Date: 15.11.2023, Decision No: 2023/416). In the study, teeth with pulp calcification in the pulp chamber were recorded from cone beam computed tomography images that were retrospectively evaluated from 2014 to 2020 at Gaziantep Private Dental Clinic and Gaziantep University Faculty of Dentistry. The images were taken for various purposes, such as missing canals, implant operation, and pre-surgical assessment.

Exclusion criteria are as follows: teeth with root canal filling, post or metal crown, teeth with root resorption, un-erupted teeth, maxillary and mandibular third molar teeth images, low quality, and cone beam computed tomography (CBCT) images with an artifact. Each subject had at least one fully erupted permanent tooth. The apex of each examined tooth was fully formed.

CBCT images obtained from a private clinic were acquired with an Orthophos CBCT device using the settings (8×8 cm FOV, standard 85 kV, 0.4 mm voxel size, and 7 mA) and the samples were viewed using imaging software (Sirona Galaxis Galileos Viewer Version 1.9.2, Sirona Dental Systems, GmbH, Bensheim, Germany) in a dark room. An LCD monitor (HP Compaq LE2002x, HP, Texas, USA) with a resolution of 2560x1600 pixels was used for viewing. CBCT images obtained from university records were received with Planmeca ProMax 3D (Planmeca, Helsinki, Finland), and the X-ray parameters were as follows: 90 kVp, 4-10 mA, 8x8 field of view, and 200 µm voxel size. Planmeca Promax 3D (Planmeca, Helsinki, Finland) and data were analyzed using Planmeca Romexis Viewer (Romexis software version 2.8.1) (Planmeca OY, Helsinki, Finland) by a 17-inch monitor (L1752SE Series, LG Corporations, South Korea) with a resolution of 1280×1024 pixels in a dark environment. While the radiolucent image in the root canal and pulp chamber was evaluated as normal, when a radiopaque mass was observed, it was noted as a pulp stone (Figure A, B, C). During the evaluation, two endodontic specialists with at least seven years of experience reviewed the images. Before the examination, two experts examined 30 randomly selected images in detail for calibration purposes. In case of disagreement, CBCT images were reanalyzed until a consensus was reached.

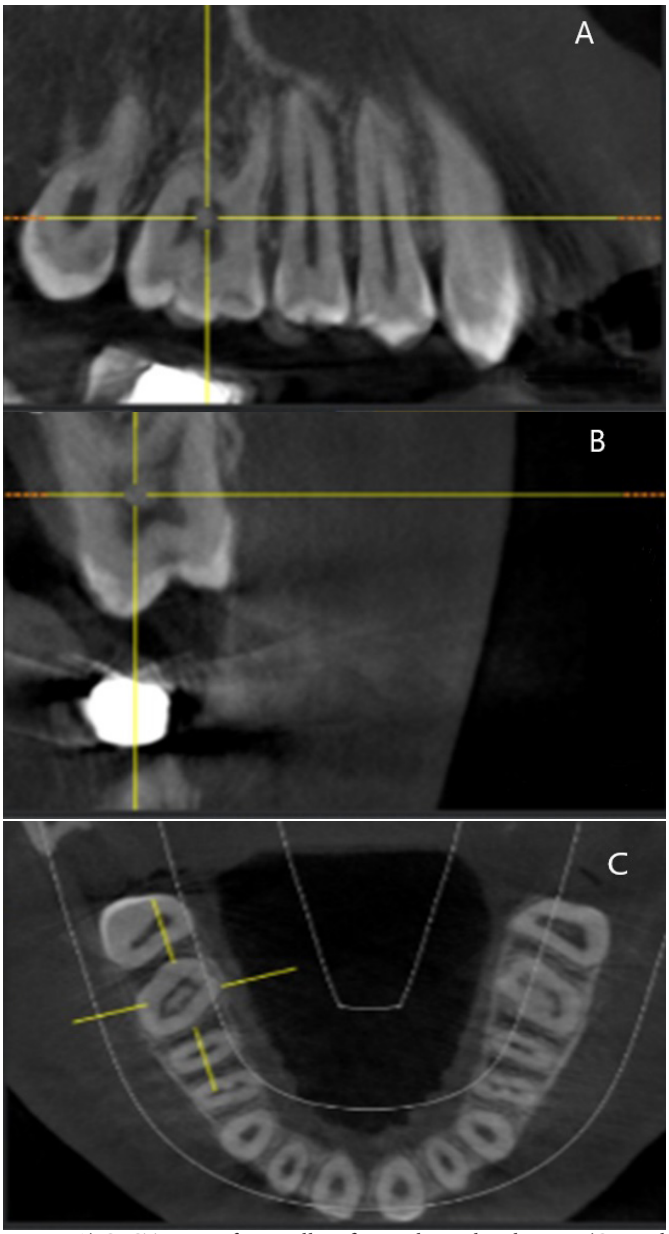

Figure. A) CBCT image of a maxillary first molar with pulp stone (Coronal slice), B) CBCT image of the tooth (Sagittal slice), C) CBCT image of the tooth (Axial slice)

CBCT: Cone beam computed tomography

Statistical Analysis

For numerical variables, mean and standard deviation are provided, while frequency and percentage analysis are attained for categorical variables in descriptive statistics of the study's data. To compare proportions, a two-proportion z-test was employed. Analyses were performed using the SPSS 22.0 software. A cutoff point of $p<0.05$ was chosen for significance.

RESULTS

A total of 1676 teeth with pulp stones were assessed, 774 in those of males and 902 in those of females. The average age of the samples examined in the study was 50.17 years old (Table 1). While the incidence of pulp stones was higher in molar

teeth (1092, 65.16%) than in premolars (139, 8.29%), canines (207, 12.35%) and anterior incisors (238, 4.2%) (p<0.0001); fewer pulp stones were found in the premolar tooth group (139, 8.29%) compared to the canine (207, 12.35%) (p=0.0001) and anterior tooth (238, 4.2%) (p<0.0001) groups. There was no statistically significant difference between canine and anterior teeth (p=0.1145) (Table 2). Teeth with intact crowns (1065, 63.54%) were more prevalent than teeth with caries (173, 10.32%) and filled teeth (443, 26.43%) (p<0.0001); a significantly higher rate of pulp stones was found in teeth with restoration than in teeth with caries (p<0.0001) (Table 3); in the upper jaw region (874, 52.15%) compared to the lower jaw (802, 47.85%) (p = 0.0128). Statistically more pulp stones were detected on the right side (888, 52.98%) compared to the left side (788, 47.02) (p=0.0006).

Table 1. Descriptive definition of age values

Mean	50.17
Standard deviation	13.34
Minimim	16
Maximum	90

Table 2. The prevalence of pulp stone according to gender, arch, side and dental status

	Teeth with pulp stone	
Variables	**n**	**%**
Gender		
Male	774	(46.18)
Female	902	(53.82)
Arch		
Maxilla	874	(52.15)
Mandible	802	(47.85)
Side		
Right	888	(52.98)
Left	788	(47.02)
Tooth type		
Molar	1092	(65.16)
Premolar	139	(8.29)
Canine	207	(12.35)
Anterior	238	(14.2)

Table 3. Distribution pulp stones by status of teeth

Variables	Pulp stone	n (%)
Restorated teeth	Present	443 (26.43)
	Absent	1233 (73.57)
Carious teeth	Present	173 (10.32)
	Absent	1503 (89.68)
Intact teeth	Present	1065 (63.54)
	Absent	611 (36.46)

DISCUSSION

Pulp stones that are localized to occupy any area of the root canal system or pulp chamber can challenge clinicians to some extent during endodontic treatment. Gathering information about the prevalence of such structures that may impede rapid and convenient preparation will provide the preliminary information to physicians before treatment.[13] Considering past studies in the literature, it can be seen that the prevalence of pulp stones is in a very wide range, from 8% to 90%.[14]

Examining a limited number of sections from teeth in histological methods may result in incomplete reporting.[7] Therefore, dental radiography techniques have been utilized for a long time. Panoramic, periapical, bite-wing, and CBCT are among the methods used to detect the presence of pulp. Panoramic radiography is beneficial in that it can examine all teeth simultaneously with a single exposure and uses minimal ionizing radiation.[15] On the other hand, the disadvantages of these techniques are that pulp stones cannot be visually observed in two-dimensional radiographs due to the overlap of the alveolar bone and that images are taken from a limited number of tooth groups.[16]

Regarding modern endodontic clinical practices, CBCT is known as the current imaging system that provides opportunities such as evaluating the root canal morphologies of all teeth separately in different planes and determining calcifications. This new imaging method eliminates the problem of overlapping tissues, with the possibility of obtaining high-resolution and high-quality images.[17] In this study, the use of dental tomography, whose accuracy has been proven, was preferred in determining the pulp stones in the root canal lumen and pulp chamber.

According to our study's findings, more pulp stones were found in women. This outcome is similar to the past studies.[18,19,20] A previous study stated that bruxism is frequently seen in women and that this condition may lead to pulp stone formation due to long-term irritation.[1] However, Ranjitkar et al.[21] and Hamasha et al.[22] demonstrated that similar rates of pulp stones were observed in both genders. The reasons for the different results of the study findings may be geographical differences, obtaining images by different methods, and non-overlapping sample age averages.

When the pulp stone rates between the jaws were examined, the rate of pulp stone occurrence in the maxilla was higher than in the mandible, consistent with the results of many studies.[13,18-20,23] This finding could be attributed to the fact that the dense cortical structure of the mandible prevents the penetration of blood vessels and the mandible has less blood supply than the maxilla.

In terms of tooth types, the results of our study coincide with most of the studies in the literature in terms of their results. In general, more pulp stones occur in molar teeth than in the premolar and anterior tooth groups. Situations such as the eruption of molar teeth in the mouth in the first stage of life and their exposure to chewing forces, their volume being quite large and therefore high blood supply have been suggested as the reason for this situation.[24]

Hsieh,[23] Şişman,[20] and Çolak et al.[18] compared the number of teeth with pulp stones in the right and left regions, and they found statistically similar results. Mirah et al.'s[13] study supports our study, and pulp stone formations were detected more on the right side. A potential explanation for this result could be the predominant use of the right side during chewing.

According to the findings of the current study, the rate of pulp stone in teeth with intact crowns is much higher compared to both filled and decayed teeth. Silva et al.[25] emphasized that calcification was more common in teeth with deep fillings and Sezgin et al.[19] emphasized that calcification was more common in teeth with medium-depth fillings. Taşsöker et al.[26] stated that the prevalence of pulp stones in teeth with intact crowns was statistically lower than in teeth with caries and restorations. In this sense, our study and other studies are not compatible with each other. The total number of teeth with pulp stones in the records we examined is much higher than in other studies. In addition, case reports[27,28] of generalized pulp stones seen in many intact teeth show that; irritation may not be a definitive factor for calcification.

Although the predisposing factors in the formation of pulp stones are not clear, their correlation with some systemic diseases[29] and syndromes[30] has been reported in previous studies. The first limitation of this study is that systemic data of the individuals included in the study are not available.

There is no record of information about the duration of dental restorations and caries since our research was planned as a cross-sectional study. To address this limitation, we recommend conducting prospective studies examining long-term follow-up information.

In the literature, nanobacteria were reported to be associated with pulp stones.[31] This issue might be better understood by undertaking further investigations through the classification of teeth as the present study and detecting pulp stones and nanobacteria in each group.

Our study represents a subpopulation of the Turkish society. It is recommended that more reliable results can be obtained with future multi-center studies with large sample size and evaluating data from different regions.

CONCLUSION

In wake of the current study's limitations, it can be concluded that women, molar teeth and intact teeth have more common incidence of pulp stones formation. Besides, pulp stone distribution is higher in the upper jaw and right region. Clinicians should, therefore, carefully examine the presence of pulp stones in teeth planned for root canal therapy before the operation.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was initiated with the approval of the Gaziantep University Ethics Committee (Date: 15.11.2023, Decision No: 2023/416).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflicts of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Sener S, Cobankara FK, Akgünlü F. Calcifications of the pulp chamber: prevalence and implicated factors. *Clin Oral Investig.* 2009;13(2):209-215.
2. Gulsahi A, Cebeci AI, Ozden S. A radiographic assessment of the prevalence of pulp stones in a group of Turkish dental patients. *Int Endod J.* 2009;42(8):735-739.
3. Pashley DH, Liewehr FR. Structure and Functions of the Dentin-Pulp Complex. In: S Cohen, KM Hargreaves, eds. Pathways of the Pulp, 9th edn. St. Louis, MO, USA: Mosby Elsevier; 2006:502-504.
4. Bevelander G, Johnson PL. Histogenesis and histochemistry of pulpal calcification. *J Dent Res.* 1956;35:714-722.
5. Le May O, Kaqueler JC. Electron probe micro-analysis of human dental pulp stones. *Scanning Microscopy.* 1993;7:262-267.
6. Wahab, M. H. A. Pulp stones and dental pain. *Saudi Dent J.* 1989; 1(2):65-66.
7. Goga R, Chandler NP, Oginni AO. Pulp stones: a review. *Int Endod J.* 2008;41(6):457-468.
8. Pashley DH, Walton RE, Slavkin HC. Histology and physiology of the dental pulp. In: JI Ingle, LK Bakland, eds. Endodontics, 5th edn. Hamilton, ON, Canada: BC Decker Inc; 2022:43-45.
9. Pitt Ford TR, Rhodes JS, Pitt Ford HE. Endodontics Problem-Solving in Clinical Practice. London, UK: Martin Dunitz Ltd; 2002:85.
10. Pitt Ford TR, Mitchell PJC. Problems in endodontic treatment. In: TR Pitt Ford, ed. Harty's Endodontics in Clinical Practice, 5th edition. Edinburgh: Wright; 2004:241.
11. Deva V, Mogoantă L, Manolea H, Pancă OA, Vătu M, Vătăman M. Radiological and microscopic aspects of the denticles. *Rom J Morphol Embryol.* 2006;47(3):263-268.
12. Moss-Salentijn L, Hendricks-Klyvert M. Calcified structures in human dental pulps. *J Endod.* 1989;14(4):184-189.
13. Mirah MA, Bafail A, Shaheen S, et al. Assessment of pulp stones among western Saudi populations: a cross-sectional study. *Cureus.* 2023;15(9):e46056
14. Sayegh FS, Reed AJ. Calcification in the dental pulp. *Oral Surg Oral Med Oral Pathol.* 1986;25(6):873-882.

15. Horsley SH, Beckstrom B, Clark SJ, Scheetz JP, Khan Z, Far man AG. Prevalence of carotid and pulp calcifications: a corre lation using digital panoramic radiographs. *Int J Comput Assist Radiol Surg*. 2009;4(2):169-173.

16. Chien HH, Chen CS. The applications and limitations of conventional radiographic imaging techniques. *Clinic Maxillary Sinus Elevation Surg.* 2014:9-30.

17. Patel S, Durack C, Abella F, Shemesh H, Roig M, Lemberg K. Cone beam computed tomography in endodontics-a review. *Int Endod J*. 2015;48(1):3-15.

18. Colak H, Celebi AA, Hamidi MM, Bayraktar Y, Çolak, T, Uzgur R. Assessment of the prevalence of pulp stones in a sample of Turkish Central Anatolian population. *Scientific World J*. 2012;2012.

19. Sezgin GP, Kaplan SS, Kaplan T. Evaluation of the relation between the pulp stones and direct restorations using cone beam computed tomography in a Turkish subpopulation. *Restorative Dent Endod*. 2021;46(3):e34.

20. Şişman Y, Aktan AM, Tarım-Ertas E, Çiftçi ME, Şekerci AE. The prevalence of pulp stones in a Turkish population. A radiographic survey. *Med Oral Patologia Oral Cirugia Bucal*. 2012;17(2):e212.

21. Ranjitkar S, Taylor JA, Townsend GC. A radiographic assessment of the prevalence of pulp stones in Australians. *Australian Dent J*. 2002;47(1):36-40.

22. Al-Hadi Hamasha A, Darwazeh A. Prevalence of pulp stones in Jordanian adults. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1998;86(6):730-732.

23. Hsieh CY, Wu YC, Su CC, et al. The prevalence and distribution of radiopaque, calcified pulp stones: A cone-beam computed tomography study in a northern Taiwanese population. *J Dent Sci*. 2018;13(2):138-144.

24. Tamse A, Kaffe I, Littner MM, Shani R. Statistical evaluation of radiologic survey of pulp stones. *J Endod*. 1982;8(10):455-458.

25. da Silva EJNL, Prado MC, Queiroz PM, et al. Assessing pulp stones by cone-beam computed tomography. *Clin Oral Investig*. 2017;21(7):2327-2333.

26. Taşsöker M, Magat G, Sener S. A comparative study of cone-beam computed tomography and digital panoramic radiography for detecting pulp stones. *Imag Sci Dent*. 2018;48(3):201-212.

27. Donta C, Kavvad ia K, Panopoulos P, Douzgou S. Generalized pulp stones: report of a case with 6 year follow-up. *Int Endod J*. 2011;44(10):976-982.

28. Bahetwar SK, Pandey RK. An unusual case report of generalized pulp stones in young permanent dentition. *Contemp Clin Dent*. 2010;1(4):281-283.

29. Srivastava KC, Shrivastava D, Nagarajappa AK, et al. Assessing the prevalence and association of pulp stones with cardiovascular diseases and diabetes mellitus in the Saudi Arabian population-a CBCT based study. *Int J Environ Res Public Health*. 2020;17(24):9293

30. Pope FM, Komorowska A, Lee KW, et al. Ehlers Danlos syndrome type I with novel dental features. *J Oral Pathol Med*. 1992;21(9):418-421.

31. Ciftcioglu N, Ciftcioglu V, Vali H, et al. Sedimentary rocks in our mouth: dental pulp stones made by nanobacteria. *Instruments Methods Missions Astrobiology*. 1998;3441:130-136.