

# Radiographic Assessment of the Prevalence of Pulp Stones in Malaysians

Sathya Kannan, BDS, MDS, MFDS, RCSEd, Sham Kishor Kannepady, BDS, MDS, Kavitha Muthu, BDS, MDS, Matada Basavarajaiah Jeevan, BDS, MDS, and Arishiya Thapasum, BDS, MDS

## Abstract

**Introduction:** The aim of this study was to determine the prevalence of pulp stones in the Malaysian population using radiographs, and to assess the association of pulp stones with gender, age, tooth type, dental arch and tooth status. Occurrence of pulp stones among the three races in Malaysia (Malay, Chinese and Indians) was also studied. **Methods:** A retrospective study was performed from a random sample of 361 dental records in AIMST Dental Centre, Faculty of Dentistry, AIMST University, Kedah, Malaysia. Data were collected from patient files and 507 intraoral periapical radiographs. All radiographs were examined by an oral radiologist to identify pulp stones and associated factors. Statistical analysis was performed using the Pearson chi-square test. **Results:** Of the 361 patients, 205 were female and 156 were male. Pulp stones were identified in 162 (44.9%) subjects in 1 or more teeth and in 280 (15.7%) teeth of the total 1779 teeth examined. Pulp stones were found significantly more in molars and teeth that were not intact (carious/restored/both carious and restored). There was no significant correlation with sex, increasing age, dental arches, and ethnic races. **Conclusions:** The prevalence of pulp stones in the Malaysian population studied was 44.9%. Pulp stones were more often seen in teeth that were restored or affected with caries. These findings require further investigation. (*J Endod* 2015;41:333-337)

## Key Words

Forensic odontology, pulp calcification, pulp stones

From the Academic Unit of Craniofacial Clinical Care, Faculty of Dentistry, AIMST University, Kedah, Malaysia.

Address requests for reprints to Dr Sathya Kannan, Faculty of Dentistry, AIMST University, Bedong 08100, Kedah, Malaysia. E-mail address: [drsathyas@yahoo.com](mailto:drsathyas@yahoo.com)  
0099-2399/\$ - see front matter

Copyright © 2015 American Association of Endodontists.  
<http://dx.doi.org/10.1016/j.joen.2014.10.015>

Pulp stones are discrete calcified bodies found in the dental pulp. They have calcium phosphorous ratios similar to dentin and can be seen in healthy, diseased, or even unerupted teeth (1-3). These pulp stones, also known as denticles, may exist freely within the pulp tissue or be attached or embedded in the dentin. They are found more frequently at the orifice of the pulp chamber or within the root canal. A tooth may have pulp stones of varying sizes, from minute particles to large masses, which can occlude the pulp space (1, 4). They are seen in all tooth types but occur most commonly in molars (2, 5, 6). Radiographically, pulp stones appear as radiopaque structures in the pulp space that frequently act as an impediment during endodontic treatment (1, 2).

Structurally, pulp stones can be classified as true or false. True pulp stones are rare and contain dentin with distinct dentinal tubules lined by odontoblasts. False pulp stones contain concentric layers of mineralized tissue formed by surface accretion around blood thrombi, dying or dead cells, or collagen fibers (1). Hence, it is presumed that true pulp stones arise as a result of epithelial-mesenchymal interactions, whereas false pulp stones arise from degenerating cells of the pulp that eventually get mineralized (5). Other etiologic factors that have been implicated in pulp stone formation include increasing age, circulatory disturbances in the pulp, orthodontic tooth movement, transplantation of teeth, and trauma (2, 7). Pulp stones have been associated with systemic problems like cardiovascular disease and systemic sclerosis (8, 9). A genetic predisposition has also been noted, and sometimes its occurrence is considered idiopathic. Genetic disorders like dentin dysplasia, dentinogenesis imperfecta, and Van der Woude syndrome are associated with an increased occurrence of pulp stones (2, 7, 10, 11).

Pulpal calcifications can develop throughout life, and studies have reported prevalence rates from 8%-90% (12). The prevalence of pulp stones in teeth based on radiographic examinations has been reported to be around 20%—25% (6,13,14), whereas histologic examinations yield higher prevalences (2,15). In a radiographic study on the Iraqi population, Baghdady et al (6) reported pulp stones in 19-2% of the teeth examined. Hamasha and Darwazeh (13) identified pulp stones in 22.4% of 4573 teeth examined in Jordanian adults, and Ranjitkar et al (2) noted pulp stones in 10.1% of teeth examined in the Australian population. In Turkish dental patients, Gulsahi et al (16) reported pulp stones in 5% of 13,474 teeth examined.

A literature review showed many reports on pulp stones; however, no data were available regarding pulp stones in the Malaysian population. The purpose of this study was to determine the prevalence of pulp stones in Malaysians using radiographs and to investigate any association between the occurrence of pulp stones with sex, age, tooth type, dental arch, and tooth status. In Malaysia, the population is largely composed of 3 major ethnic backgrounds (Malays, Chinese, and Indians), which further permitted us to compare the occurrence of pulp stones among racial groups.

## Materials and Methods

A random sample of 1000 dental records of patients who were treated at the AIMST Dental Centre, Faculty of Dentistry, AIMST University, Kedah, Malaysia, were reviewed. Records of patients between the ages of 10 and 70 years, which contained intraoral periapical radiographs of diagnostic quality, were included in the study. The final sample

**TABLE 1.** The Distribution of Pulp Stones by Sex

Sex	No. of patients examined	No. of patients with pulp stones	% of patients with pulp stones
Male	156	60	38.5
Female	205	102	49.8
Total	361	162	44.9

The chi-square test is not statistically significant for pulp stone occurrence between sexes ( $P = .185$ ).

consisted of 361 patient records that had 507 intraoral periapical radiographs of diagnostic quality. All radiographs were taken in the oral radiology department using the parallel cone technique. A total of 1779 teeth were examined from these radiographs; only permanent teeth with complete roots were analyzed.

All radiographs were read by 1 of the authors (S.K.K.) who is a specialist in oral radiology using an x-ray viewer and a magnifying glass in a dimmed room, focusing attention on pulp stones. A tooth was scored as having a pulp stone when a definite radiopaque mass was observed in the pulp space. The status of teeth (caries, restorations, periodontal disease, periapical pathology, and other tooth abnormalities that can be appreciated on radiographs) having pulp stones was also assessed. The data were recorded in a detailed spreadsheet prepared for the study.

Examiner reliability was calculated by rereading a random sample of 10% (51) of the total radiographs previously examined. A 99% agreement was obtained, indicating that the scoring methods were highly reliable.

The data were statistically analyzed using the Pearson chi-square test of significance to report any association of pulp stone occurrence with sex, age, race, tooth type, dental arch, and tooth status.

## Results

The prevalence of pulp stones studied in the Malaysian population is presented as follows.

### Overall Prevalence of Pulp Stones and Distribution between Sexes

Of the 361 subjects examined, 156 were males and 205 were females. Among the total 361 subjects, 162 (44.9%) had pulp stones in 1 or more teeth. A total of 60 (38.5%) male and 102 (49.8%) female subjects exhibited pulp stones (Table 1). The overall difference in distribution between the sexes was not statistically significant ( $P = .185$ ).

**TABLE 2.** The Distribution of Pulp Stones by Age

Patient age (y)	No. of patients examined	No of patients with pulp stones	% of patients with pulp stones
10-19	22	3	13.6
20-29	139	58	41.7
30-39	56	26	46.4
40-49	70	39	55.7
50-59	44	25	56.8
60-70	30	11	36.7
Total	361	162	44.9

The chi-square test is not statistically significant for pulp stone occurrence between different age groups studied ( $P = .232$ ).

**TABLE 3.** The Distribution of Pulp Stones by Race

Race	No. of patients examined	No. of patients with pulp stones	% of patients with pulp stones
Indian	192	101	52.6
Chinese	132	49	37.1
Malaysian	37	12	32.4
Total	361	162	44.9

The chi-square test is not statistically significant for pulp stone occurrence among the races ( $P = .140$ ).

### Pulp Stone Distribution among Age Groups

The distribution of patients having pulp stones according to age groups is shown in Table 2. There was a higher prevalence in patients 50-59 years of age (56.8%) when compared with the other age groups. There was no significant difference between the age groups ( $P = .232$ ).

### Pulp Stone Distribution among the 3 Races in Malaysia

Among the ethnic groups (Malays, Chinese, and Indians), the Indian population (52.6%) had more pulp stones as reflected in Table 3. Although the races in Malaysia showed variations in the occurrence of pulp stones, there was no significant difference between them ( $P = .140$ ).

### Pulp Stone Occurrence in Tooth Types and Dental Arches

Pulp stones were detected in 280 (15.7%) of the 1779 teeth examined. The frequency distribution and percentages of pulp stones among different teeth and arches are shown in Table 4. The occurrence of pulp stones in the mandibular (15.5%) and maxillary (15.9%) arches were almost equal. There was a significant association between pulp stone occurrence and dental arches ( $P < .05$ ).

Of the teeth exhibiting pulp stones, the maxillary left second molar showed the highest occurrence (36.5%) followed by the mandibular right second molar (30.4%). A relatively low frequency was seen in mandibular incisors followed by maxillary left first premolars (3.2%), which were the least affected teeth. Pulp stone occurrence in first and second molar teeth was significantly higher ( $P < .05$ ).

### Pulp Stones and Tooth Status

The status of teeth with pulp stones was assessed for caries, restorations, and other abnormalities. Among the 280 teeth with pulp stones, 106 teeth (37.9%) were not intact as shown in Table 5. Statistical analysis showed a significant association between pulp stone occurrence and nonintact teeth ( $P < .05$ ). Among the 106 teeth that were not intact, 84 (79.2%) teeth had restorations, 9 (8.5%) teeth had secondary caries, and 13 teeth (12.3%) had caries. Periodontal disease and periapical pathology were present as additional findings in 3 and 2 nonintact teeth with pulp stones, respectively; however, the association was not statistically significant. In addition, pulp stones were not associated with any other tooth abnormalities (both developmental and acquired).

## Discussion

The detection of pulp stones using dental radiographs is possible when they are larger than 200  $\mu$ m in diameter (12). Although the true prevalence is likely to be higher in microscopic examinations of teeth than figures from radiographic studies (5, 12), the latter is the only noninvasive technique available for evaluating pulp stones in clinical investigations (2). Furthermore, in histologic observations, the limited number of sections through each tooth may result in underreporting

**TABLE 4.** The Distribution of Pulp Stones in Tooth Types and Dental Arches

Tooth type		No. of teeth examined	No. of teeth with pulp stones	% of teeth with pulp stones
Maxillary arch				
Right quadrant	Central incisor	53	4	7.5
	Lateral incisor	51	2	3.9
	Canine	53	6	11.3
	First premolar	89	5	5.6
	Second premolar	114	6	5.3
	First molar	107	35	32.7*
	Second molar	104	38	36.5*
	Third molar	36	11	30.6
	Central incisor	59	3	5.1
	Lateral incisor	62	2	3.2
Left quadrant	Canine	41	4	9.8
	First premolar	63	2	3.2
	Second premolar	87	5	5.7
	First molar	89	29	32.6*
	Second molar	75	22	29.3*
	Third molar	32	3	9.4
Total		1115	177	15.9*
Mandibular arch				
Left quadrant	Central incisor	31	0	0
	Lateral incisor	16	0	0
	Canine	23	2	8.7
	First premolar	34	2	5.9
	Second premolar	69	3	4.3
	First molar	77	19	24.7*
	Second molar	79	24	30.4*
	Third molar	30	2	6.7
Right quadrant	Central incisor	12	0	0
	Lateral incisor	5	0	0
	Canine	14	2	14.3
	First premolar	30	1	3.3
	Second premolar	60	6	10.0
	First molar	72	19	26.4*
	Second molar	76	16	21.1*
	Third molar	36	7	19.4
Total		664	103	15.5*

\*The chi-square test is statistically significant for higher occurrence of pulp stones in first and second molar teeth ( $P < .05$ ).

\*The chi-square test is statistically significant for an association between pulp stone occurrence and dental arches ( $P < .05$ ).

(17). In our study, intraoral periapical radiographs retrieved from dental records were evaluated for the presence of pulp stones. Bitewing radiographs do not show the complete radicular pulp, so we examined only periapical radiographs to avoid underreporting of pulp stones. However, Tamse et al (14) stated that bitewing and periapical radiographs showed no significant difference in the identification of pulp stones.

Hamasha and Darwazeh (13) reported the prevalence in 814 Jordanian adults, and pulp stones were present on radiographs in 51% of the patients and 22% of the teeth studied. Ranjitkar et al (2) examined the prevalence of pulp stones in 217 Australian dental students, and pulp stones were found in 46% of the subjects and 10% of the teeth. In the present study in 361 patients, pulp stones were found in 44.9% of the subjects and 15.7% of the teeth examined. This finding is close to the values obtained in the previously mentioned studies.

The prevalence of pulp stones was higher in females compared with males. However, the association was not significant, as in many previous studies (2, 13, 16).

In our study, the youngest individual was a 12-year-old female who exhibited a single pulp stone in her maxillary left first molar tooth. The maximum number of pulp stones was seen in a 34-year-old female patient who exhibited more than single pulp stones in several teeth. The prevalence was high in patients older than 30 years; however, there was no significant difference between the various age groups. This shows that no true relationship exists between pulp stones and increasing age, which confirms the findings of Hamasha and Darwazeh (13). We noted the occurrence of pulp stones was lowest among the 10- to 19-year age group (13.6%) and highest among the 50- to 59-year age group (56.8%); however, this was not statistically significant.

The correlation of pulp stones between the races in Malaysia was investigated, and we found no significant relationship. This finding may

**TABLE 5.** Pulp Stone Occurrence and Tooth Status

Tooth status	No. of teeth examined	No. of teeth with pulp stones (n)	No. of teeth not intact with pulp stones	% of nonintact teeth with pulp stones
Maxillary arch	1115	177	63	35.6
Mandibular arch	664	103	43	41.7
Total	1779	280	106	37.9

The chi-square test is statistically significant for pulp stone occurrence and tooth status ( $P < .05$ ).

**Figure 1.** Pulp stones are evident in all 4 anterior teeth. The maxillary right central incisor is affected with caries and is not intact.

require further investigation with a larger sample size to attribute any correlation if present.

Similar frequencies in both maxillary and mandibular arches were found in the present study. This finding was also consistent with Hamasha and Darwazeh (13). However, some studies have reported a maxillary or mandibular predominance (2, 6). A higher occurrence of pulp stones was observed in molar teeth, which was in agreement with the findings from other studies (2, 6, 13, 16). Hamasha and Darwazeh stated that

**Figure 2.** Pulp stones are evident in maxillary first and second molar teeth, which have restorations.

molars, being the largest teeth in the arch, have a better supply of blood to the pulp tissues, leading to more precipitation of calcifications.

The tendency for the occurrence of pulp stones was high in teeth that were not intact (Figs. 1 and 2). This may be caused by chronic pulpal irritation in both carious and restored teeth. Caries and microleakage around restorations may trigger a defense reaction in the pulpodentinal complex causing pulpal calcifications. The mechanism of pulp stone formation may be similar to tertiary dentin formation near irritated odontoblasts. In an earlier study by Sener et al (18), similar findings were noted in which pulp calcifications occurred as a response to long-standing irritants and the prevalence of pulp stones was higher in carious or restored teeth, and in teeth with both caries and restorations. However, pulp stones were reported in young teeth and developing tooth germs, which indicates that pulpal pathology is not the sole etiologic factor for the formation of pulp stones (2). Recent theory also includes calcifying nanoparticles in the air as an etiologic factor for pulp stones (19).

Few teeth with periodontal disease exhibited pulp stones. However, this was an additional finding because these teeth were either carious or restored. Rubach and Mitchell (20) attempted to correlate periodontal condition with pulp stone formation and concluded that neither pulp stones nor diffuse calcifications were related to bone loss. Hence, the contribution of periodontal disease to the formation of pulp stones in both intact and nonintact teeth may be an area of future research.

Hamasha and Darwazeh (13) noted a high incidence of pulp stones associated with dilacerations, impactions, taurodontism, and enamel pearls. In contrast to this, our study did not show any association between pulp stone occurrence and tooth abnormalities.

The size, shape, location, and number of pulp stones may vary among individuals, and the radiographic matching of pulp stone patterns may help identify deceased persons. In the present study, few patients exhibited pulp stones in more than 1 tooth (Figs. 1 and 2), with a maximum of 5 teeth with pulp stones identified in a single subject. Observed calcifications ranged from minute opacities to large radiopaque masses occluding most of the pulp chamber. On few occasions, teeth showed discrete masses more than once (Fig. 1). Thus, pulp stones having varied patterns of presentation on radiographs can be used as a valuable feature for forensic identification of a person from their previous dental records.

## Conclusion

The prevalence of pulp stones in the Malaysian population studied was 44.9%. Pulp stones were found significantly more often in molars and in teeth that were not intact (either restored or carious). Pulp stones occurred predominantly in restored teeth. The occurrence of pulp stones had no significant association with sex, age, or the different Malaysian ethnic races. However, these findings require further investigation. The size, shape, location, and number of pulp stones on radiographs can be used as an adjunctive feature for forensic identification.

## Acknowledgments

*The authors would like to thank Dr Deivanai Subramanian, Associate Professor, Department of Biotechnology, Faculty of Applied Sciences, AIMST University, for her advice on statistics.*

*The authors deny any conflicts of interest related to this study.*

## References

1. Nanci Antonio. *Ten Cate's Oral Histology: Development, Structure, and Function*, 8th ed. St Louis: Mosby; 2013:201-2.
2. Ranjitkar S, Taylor JA, Townsend GC. A radiographic assessment of the prevalence of pulp stones in Australians. *Aust Dent J* 2002;47:36-40.

3. Langeland K, Rodrigues H, Dowden W. Periodontal disease bacteria, and pulpal histopathology. *Oral Surg Oral Med Oral Pathol* 1974;37:257-70.
4. Johnson PL, Bevelander G. Histogenesis and histochemistry of pulpal calcification. *J Dent Res* 1956;35:714-22.
5. Goga R, Chandler NP, Oginni AO. Pulp stones: a review. *Int Endod J* 2008;41:457-68.
6. Baghdady VS, Ghose LC, Nahoom HY. Prevalence of pulp stones in a teenage Iraqi group. *J Endod* 1988;14:309-11.
7. Bauss O, Neter D, Rahman A. Prevalence of pulp calcifications in patients with Marfan syndrome. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008; 106:e56—61.
8. Edds AC, Walden JE, Scheetz JP, et al. Pilot study of correlation of pulp stones with cardiovascular disease. *J Endod* 2005;31:504-6.
9. Jung S, Minoux M, Maniere MC, et al. Previously undescribed pulpal and periodontal ligament calcifications in systemic sclerosis: a case report. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2013;115:e47—51.
10. Parekh S, Kyriazidou A, Bloch-Zupan A, Roberts G. Multiple pulp stones and shortened roots of unknown etiology. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;101:e139-42.
11. Kantaputra PN, Sumitsawan Y, Schutte BC, Tochraeontanaphol C. Van der Woude syndrome with sensorineural hearing loss, large craniofacial sinuses, dental pulp stones, and minor limb anomalies: report of a four-generation Thai family. *Am J Med Genet* 2002;108:275-80.
12. Moss-Salentijn L, Hendricks-Klyvert MS. Calcified structures in the human dental pulps. *J Endod* 1988;14:184-9.
13. Hamasha AA, Darwazeh A. Prevalence of pulp stones in Jordanian adults. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998;86:730-2.
14. Tamse A, Kaffe I, Littner MM, Shani R. Statistical evaluation of radiologic survey of pulp stones. *J Endod* 1982;8:455-8.
15. Hillmann G, Geurtsen W. Light-microscopical investigation of the distribution of extracellular matrix molecules and calcifications in human dental pulps of various ages. *Cell Tissue Res* 1997;289:145-54.
16. Gulsahi A, Cebeci AI, Özden S. A radiographic assessment of the prevalence of pulp stones in a group of Turkish dental patients. *Int Endod J* 2009;42:735-9.
17. Willman W. Calcifications in the pulp. *Bur* 1934;34:73-6.
18. Şener S, Cobankara FK, Akgünlü F. Calcifications of the pulp chamber: prevalence and implicated factors. *Clin Oral Investig* 2009;13:209-15.
19. Zeng J, Yang F, Zhang W, et al. Association between dental pulp stones and calcifying nanoparticles. *Int J Nanomedicine* 2011;6:109-18.
20. Rubach WC, Mitchell DF. Periodontal disease, accessory canals and pulp pathosis. *J Periodontol* 1965;36:34-8.