Pulp Stones as Risk Predictors for Coronary Artery Disease: An Intriguing, Prevalence Study

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Abstract

Context and Aim: Coronary artery disease (CAD) has been recorded as the leading cause of morbidity and mortality worldwide. Studies indicate that participants with CAD show higher degree of pulp calcifications. Localized pulp calcifications are microscopically apparent in more than half of the teeth in young adolescents. However, pulp stones extending to the entire dentition are infrequent and need further evaluation to predict the risk of other probabilities of associated diseases. The present study was planned to estimate the prevalence of pulp stones in participants diagnosed with or undergoing treatment for CAD. Materials and Methods: The present study consisted of 300 participants within an age range of 20–55 years who were divided into the study group consisting of 150 participants, including 108 males and 42 females and 150 age- and sex-matched controls. Pulp stones were imaged using bitewing radiographs using the paralleling technique under standard conditions. The radiographs were interpreted separately by two experienced radiologists. Statistical Analysis Used: The statistical analysis was performed using IBM SPSS statistics version 20 Core system software (SPSS Inc., Chicago, IL, USA), whereas statistical tests used were unpaired t-test and Z-test. The Chi-square test was used to check the prevalence of pulp stones in CAD participants in addition to their arch-wise and region-wise distribution while value of $P < 0.05$ was considered statistically significant. Results: CAD participants exhibited the 100% prevalence of pulp stones while posterior teeth were predominantly affected ($P < 0.05$). Furthermore, pulp stones were significantly higher in the maxilla than in the mandible in both the groups ($P < 0.05$). No statistically significant difference was found in gender predilection in the study group, although the control group showed a definite preponderance for the males for the development of pulp stones ($P < 0.05$). Conclusion: CAD participants have a high chance of being affected with pulp stones. Higher prevalence of this entity in multiple teeth may warrant such an individual, in the presence of other compounding risk factors, as a candidate for CAD to be ruled out.

Keywords: Coronary artery disease, pulp stones, risk predictors

INTRODUCTION

Coronary artery disease (CAD) is caused by atherosclerosis of the coronary arteries leading to a reduction in blood flow to the heart. It is one of the leading causes of death worldwide. The paucity of data and a wide range in the ethnicity of the residing populace in the country compounds the challenge of obtaining a wholesome data from India regarding the prevalence of CAD. Furthermore, ischemic heart diseases (IHDs) which ranked fifth in the leading causes of mortality in the 1990 have been proposed to emerge as the leading cause of mortality by the 2020. This shows the significance this set of diseases carries demanding a comprehensive revision of the preventive and treatment programs to put a check on the leading cause of morbidity in future. Zachariah et al. reported that 11% of the population in urban India and 7% in rural parts are afflicted by this disease. Pulp stones or denticles are nodular, calcified
masses appearing within the pulp of the healthy, diseased, and even the unerupted teeth. They may exist freely within the pulp tissue or be attached to or embedded in dentin. Various theories regarding the etiological factors behind the occurrence of pulp stones have been put forth, including age, genetic susceptibility, pulpal degeneration, circulatory disturbances in the pulp, inductive interaction between the pulpal tissue and the epithelium and orthodontic tooth movements apart from a plethora of other factors, and the unidentified, idiopathic ones. Osteopontin, a new constituent of atherosclerotic plaque, apparently plays a role in plaque calcification. Just as osteopontin produced by macrophages plays the chief role in the production of calcification centers within the necrotic areas of the various body tissues, including the necrotic areas of breast cancer-affected tissues, calcifications have been observed in renal and carotid arteries as well. Kajander and Ciftçioglu stated that nanobacteria are known to produce biologic apatite over their cellular covering which is similar to renal calculi and calcified tissues leading to a hypothesis that this might be explained as a common factor between both pulp stones and the atheromatous plaques seen in CAD. CAD has been recorded as the leading cause of morbidity and mortality worldwide. Arteriosclerosis is the most common cause of CAD and IHDs, including angina pectoris, myocardial infarction (MI), and also cerebrovascular diseases as stroke and peripheral artery diseases. Therefore, finding a method for early diagnosis of IHDs before the actual development of a clinical disease becomes all the more important. Numerous studies have shown association between the formation of pulp stones and atheromatous plaques in the vessels. The mechanism of apatite formation in the body, also called as pathological biomineralization, is similar to dental pulp stone formation just like joint calcifications and renal calculi. Studies indicate that participants with CAD show higher degree of pulp calcifications. Localized pulp calcifications are microscopically apparent in more than half of the teeth in young adolescents. However, pulp stones extending to the entire dentition are infrequent and need further evaluation to predict the risk of other probabilities of associated diseases. The present study was, therefore, planned to estimate the prevalence of pulp stones in participants diagnosed with or undergoing treatment for CAD.

**Materials and Methods**

The present study consisted of 300 participants within an age range of 20–55 years who were divided into two groups, namely the study group and the control group, with the study group consisting of 150 participants, including 108 males and 42 females and the control group comprising 150 age- and sex-matched controls. The control group consisted of participants in whom CAD was ruled out on the basis of the absence of associated signs and symptoms, risk factors (family history and central obesity), and related investigations, including (electrocardiogram and treadmill test). The participants who were either recently diagnosed with or under treatment for CAD and having at least one fully erupted, noncarious, nonrestored molar (excluding third molars) were included in the study. The patients who had a known history of gout and renal disorders or who were under treatment for the same, those who were suffering from syndromes having pulp stones as one of the known criteria, including Ehlers–Danlos syndrome, pregnant females and those who were undergoing or had radiotherapy treatment in the past were excluded from the study because of an obvious possibility of increased pulp stones in such conditions. Ethical approval was obtained from the Institutional Ethics Committees before the start of the study. Pulp stones were imaged using bitewing radiographs [Figure 1] (conventional radiography) using the paralleling technique under standard conditions. Bitewing radiography was used to have both the maxillary and mandibular teeth in single images which eased the comparison as well as reduced the number of exposures that would have been required if intraoral periapical (IOPA) radiography would have been used. Paralleling technique was used because of its reproducibility as well as the ideal imaging obtained without there being the possibility of errors introduced due to variations in angulations affecting the length and the proximal overlaps of the images as seen with the bisecting angle technique which is the other more common technique used for IOPA radiography. The equipment used for taking radiographs was Gnatus IOPA Unit (Medico-Odontologicos Ltd., Brazil) with MC4 master control at 70 KVp tube voltage and 7 mA tube current with

![Figure 1: Posterior bitewing radiographs taken in different patients revealing pulp stones](image)
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a round collimator and long cone with 1 mm of external and around 3.81 mm of total filtration. The radiographic films used were Kodak E-speed, size 2 films (31 mm into 41 mm). An XCP-RINN-Greene Stabe disposable film holder was used for taking bitewing radiographs. The radiographs were interpreted separately by two experienced radiologists who inspected them independently in the darkroom using a magnifying glass, a light emitting device view box with sufficient light source and with complete blockage of peripheral light. Pulp stones evident in teeth were characterized as complete radiopaque masses and were marked as either present or absent. Both the radiologists had the same opinion 93% of times, whereas in the rest 7% of the cases, variation was ruled out after a joint discussion.

Statistical analysis used

The results obtained was tabulated and subjected to statistical analysis. The statistical analysis was performed using IBM SPSS statistics version 20 Core system software (SPSS Inc., Chicago, IL, USA), whereas statistical tests used were unpaired t-test and Z-test. The Chi-square test was used to check the prevalence of pulp stones in CAD participants in addition to their arch-wise and region-wise distribution while the value of \( P < 0.05 \) was considered statistically significant.

RESULTS

The present study revealed 100% prevalence of pulp stones in the study group, whereas 90% of the participants in the control group were also afflicted with pulp stones; although, the total number of pulp calcifications observed were lesser in number in the control group as compared to that of the study group with the total number of pulp stones observed in the control group being 639 as against 2217 pulp stones that were observed in the study group, and the results were found to be statistically significant (\( P < 0.05 \)) [Tables 1 and 2]. No difference was found, though, in gender predilection in the study group, whereas the control group revealed a statistically significant predilection for the males with around 96.24% of the males afflicted with pulp stones as against 88.88% prevalence observed in the females (\( P < 0.05 \)) [Table 3]. Furthermore, maxillary teeth had a statistically significant predilection for the development of pulp stones in both the study as well as the control groups with 51.92% of the maxillary teeth afflicted with pulp stoned as against 48.08% of the mandibular teeth in the study group whereas 58.37% of the maxillary teeth as against 41.63% of the mandibular teeth in the control group (\( P < 0.05 \)) [Table 4]. Furthermore, the prevalence of pulp stones in both the groups was found to be more in the posterior than in the anterior teeth with around 87.42% of posterior teeth afflicted with pulp stones in the study group as against 12.58% of the anterior teeth. Similarly, in the control group, the corresponding values were 85.92% in the case of posterior teeth, whereas 14.08% in case of anterior teeth (\( P < 0.05 \)) [Table 5]. The results in relation to the predilection for the side of the jaw affected were, though, found to be statistically insignificant in the present study (\( P > 0.05 \)) [Table 6].

DISCUSSION

Pulp stones vary in size ranging from microscopic particles to larger masses that almost completely obliterate the pulp chamber. Among them, only the larger pulp stones are radiographically apparent while those which are either small in size or relatively less calcified and in the initial stages of calcification are not routinely detected by the conventional radiological procedures of diagnostics.[8] Various and more common syndromes that are associated with generalized formation of pulp stones include the so-recognized Elfin-Facies syndrome, Ehlers–Danlos syndrome Type I, and Saethre–Chotzen syndrome to name a few in addition to the odontal syndrome, tumoral calcinosis, dentin dysplasia Type II, familial expansile osteolysis, and osteogenesis imperfecta Type 1.[20] Urbanization may have improved living standards, but studies also show increase in the risks of morbidity and mortality associated with cardiovascular diseases (CVDs) being one of the leading causes of morbidity and mortality in the present scenario. The risk factors might vary from the region-to-region underlying the significance of the rest 7% of the cases, variation was ruled out after a joint discussion.

**Table 1: Number of participants showing pulp stones in the study and control groups**

| Group       | n (%) | P   |
|-------------|-------|-----|
| Study group | 150 (100) | >0.05 |
| Control group | 135 (90) |     |

**Table 2: Distribution of total number of pulp stones in the study and control groups**

| Group       | n | P   |
|-------------|---|-----|
| Study group | 2217 | <0.05 |
| Control group | 639 |     |

**Table 3: Gender-wise prevalence of total number of pulp stones in the study and control groups**

| Group       | Gender (%) | P   |
|-------------|------------|-----|
|             | Male | Female |     |
| Study group | 100  | 100    | <0.05 |
| Control group | 96.24 | 88.88 |     |

**Table 4: Arch-wise prevalence of total number of pulp stones in the study and control groups**

| Group       | Arch (%) | P   |
|-------------|----------|-----|
|             | Maxilla | Mandible |     |
| Study group | 51.92   | 48.08 | <0.05 |
| Control group | 58.37 | 41.63 |     |
crystals in generating inflammation within the arteries and also playing a major role in acute MIs leading to the sudden death of the patients. The base of all calcifications, including joint calcifications, renal calculi, atherosclerotic plaques as well as pulp stones is made up of calcium phosphate crystals which elicit an acute immunological response and the eventual sequel leading to widespread morbidity and mortality. Zeng et al. elaborated that calcifying nanoparticles (CNPs), also called nanobacteria, probably pave the way to an explanation for pathological calcifications since they have been documented in the blood and blood products. The production of nucleate hydroxyapatite crystals by CNPs has been put forth as a key factor of these pathological calcifications seen in gall stones, joint calcifications, renal calculi, atherosclerotic plaques, and pulp stones. Furthermore, they concluded that two different peculiarities of CNPs described as concentric circles and satellite-like aggregations eventually turn out into such pathological calcifications seen. Most of the prevalence studies have identified pulp stones using radiographic criteria in concordance with the one used in the present study. In the present study, it was found that pulp stones were prevalent in 100% of the participants with CAD. Nayak et al. recorded pulp stones in 15.86% of teeth in participants with known systemic diseases, primarily, the CVDs. Ezoddini-Ardakani et al. concluded that 67.3% of the teeth in participants with IHDS had pulp stones. Edds et al. too, reported 74% of the participants with pulp stones in IHD participants. Khojastepour et al. reported 68.2% of the participants with known CVDs and 28.2% of participants without CVD having pulp stones. The study group, in the present study, showed an equal predisposition for both the sexes for the development of pulp stones. Hill stated that of the participants examined between 50 and 70 years, 66% exhibited pulp stones without known evidence or history of other systemic diseases similar to the study conducted by Khojastepour et al. Ravaneshad et al. reported pulp stones in 46.9% in the Iranian adult population. A study conducted by al-Hadi Hamasha and Darwazeh among Jordanian adults, reported a lesser prevalence with 22% of the teeth examined having pulp stones. Ranjitkar et al. who confirmed the same with the results obtained from their studies. The present study evidenced more number of pulp stones in the posterior (molar) teeth than in the anterior teeth in accordance with the study conducted by Nayak et al. who reported significantly higher number of pulp stones in the maxilla (12.36%) than in the mandible (5.95%) and similarly, Ranjitkar et al., Siisman et al., and Turkal et al. who confirmed the same with the results obtained from their studies. The present study evidenced more number of pulp stones in the posterior (molar) teeth than in the anterior teeth in accordance with the results of the studies conducted by Gulsahi et al. with around 87.42% of the posterior teeth afflicted with pulp stones in the study group as against 12.58% of the anterior teeth. Similarly, in the control group, the corresponding values were 85.92% in case of posterior while 14.08% in case of the anterior teeth. al-Hadi Hamasha and Darwazeh put forth a hypothesis based on the observations made from their study that since the posterior (molar) teeth were the largest, the blood supply would be increased in them, increasing the probability for more calcifications that are observed in the posterior teeth. To conclude, a careful radiographic workup and a multidisciplinary approach are of paramount importance not only for the successful treatment in cases of generalized pulp stones but also to predict the possibility of other associated systemic disorders that might have predisposed the participants to have this kind of, till recognized, rare and less critically acclaimed clinical entity.

### Table 5: Prevalence of pulp stones in the posterior and anterior teeth in the study and control groups

| Group      | Region (%) | P    |
|------------|------------|------|
|            | Posterior  | Anterior |<0.05 |
| Study group| 87.42      | 12.58  |      |
| Control group| 85.92     | 14.08  |      |

### Table 6: Side-wise prevalence of total number of pulp stones in the study and control groups

| Group      | Side (%) | P    |
|------------|----------|------|
|            | Right    | Left |<0.05 |
| Study group| 49.57    | 50.43|      |
| Control group| 50.70   | 49.30|      |

### Conclusion

CAD participants have high chances of being affected with pulp stones. Higher prevalence of this entity in multiple teeth may warrant such an individual, in the presence of other compounding risk factors, as a candidate for CAD to be ruled out. General population statistics show that pulp stones have a higher predilection for maxilla as well as females. Much research with authentic region-wise documentation specifically
carried out within the ethnic populations must become a prerogative in the dental and medical research fields to find the exact status and needful required in this arena of clinically oriented research programs. Not only should the need for the studies in this relation be emphasized but also there must be uniformity in the methodology and hence that the desired data might be obtained which would facilitate multicenter information compilation for better outcomes that can be used for clinical interests.

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**Conflicts of interest**

There are no conflicts of interest.

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