Original Article

Pulp Stones as Risk Predictors for Coronary Artery Disease

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Access this article online

Website: www.ijpvmjournal.net/www.ijpm.ir

DOI: 10.4103/ijpvm.IJPVM_68_19

Quick Response Code:

Abstract

Background: Coronary artery disease (CAD) has been the leading cause of morbidity and mortality worldwide. Studies indicate that patients 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 patients diagnosed with or, undergoing treatment for CAD. **Methods:** The present study consisted of 300 subjects within an age range of 20-55 years who were divided into the study group consisting of 150 patients including 108 males and 42 females as well as 150 age- and sex-matched healthy controls. Pulp stones were imaged using bitewing radiographs using paralleling technique under standard conditions. **Statistical Analysis Used:** The statistical analysis was performed using IBM SPSS statistics 20 Core system software (SPSS Inc., Chicago, IL, USA) while Chi-square test was used to check the prevalence of pulp stones in patients with CAD in addition to their arch-wise and region-wise distribution. *P* value <0.05 was considered statistically significant. **Results:** The present study revealed 100% prevalence of pulp stones in the study group while 90% of the subjects in the control group were also afflicted with pulp stones, though the total number of pulp calcifications observed were lesser in number in the control group compared to the study group ($P < 0.05$). No significant difference was found, although in the gender predilection for the development of pulp stones in the study group while the control group revealed a definite male predilection with around 96.24% of the males afflicted with pulp stones ($P < 0.05$). Furthermore, maxillary teeth had a statistically significant predilection for the development of pulp stones in both the study as well as the control groups ($P < 0.05$). **Conclusions:** The patients with CAD have 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.[1,2] Ischemic heart diseases (IHDs) which ranked fifth as the cause of mortality in 1990 has been proposed as they would be leading cause of mortality in 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 the future.[3] Zachariah *et al*.[2] reported that 11% of 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.[4] Various theories regarding the etiological factors behind the occurrence of pulp stones have been put forth including age, genetic susceptibility, pulpal degeneration, circulatory derangements 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.[5]

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

How to cite this article: Babu SJ, Swarnalatha C, Rao AP, Kumar BB, Tilak BP, Naidu RB, *et al.* Pulp stones as risk predictors for coronary artery disease. Int J Prev Med 2020;11:7.

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.[6-8]

Kajander *et al*.[9] and Ciftcioglu *et al*.[10] 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 and also, cerebrovascular diseases as stroke and peripheral artery diseases.[11] Therefore, finding a method for an 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.[12-15] The mechanism of apatite formation is hypothesized to be the same in the formation of atheromatous plaques in the vessels, dental pulp stone formation as well as joint calcifications and renal calculi.[16]

Studies indicate that patients with CAD show higher degree of pulp calcifications.[17,18] Localized pulp calcifications are microscopically apparent in more than half of the teeth in young adolescents. However, the pulp stones extending to the entire dentition are infrequent and need further evaluation to predict the risk of other probabilities of associated diseases.[19] The present study was planned to estimate the prevalence of pulp stones in patients diagnosed with or, undergoing treatment for CAD so that a definite relation between the two phenomena could be established on an evidence basis.

Methods

The present study consisted of 300 subjects within an age range of 20-55 years who were divided into two groups: the study group and the control group. The study group consists of 150 patients including 108 males and 42 females and the control group including of 150 age- and sex-matched healthy controls. The control group consisted of subjects in whom CAD was ruled out based on the absence of associated signs and symptoms, risk factors (family history and central obesity) and related investigations including Electrocardiogram (ECG) and Treadmill test (TMT). The patients who were either recently diagnosed with or, under treatment for CAD and having at least one fully erupted, non-carious, non-restored 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 Ehler's-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 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 intra-oral peri-apical (IOPA) radiography would have been used. The equipment used for taking radiographs was Gnatus IOPA Unit (Medico-Odontologicos Ltd., Brazil) with MC4 master control at 70KVp tube voltage and 7 mA tube current with 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 × 41 mm). An XCP-RINN-Greene Stabe disposable film holder was used for taking the required bitewing radiographs. The radiographs were interpreted separately by two experienced radiologists who inspected them independently in the dark room using a magnifying glass, a light emitting device (LED) view box with sufficient light source and with complete blockage of

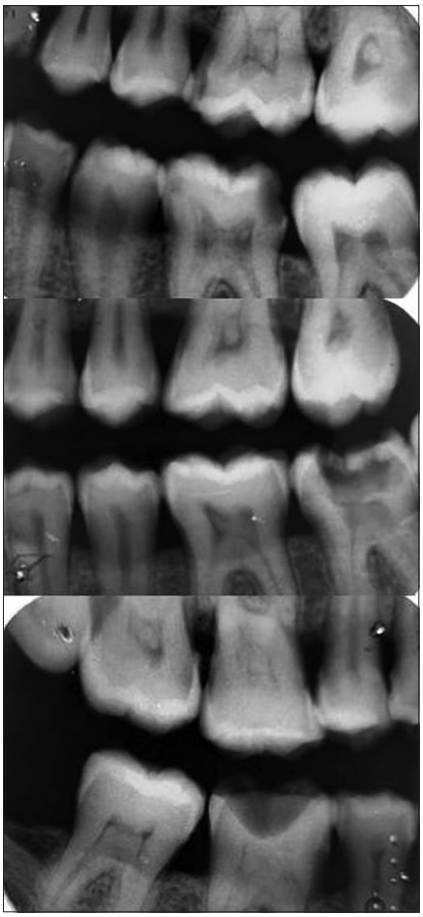

Figure 1: Posterior bitewing radiographs revealing pulp stones

peripheral light while pulp stones evident in teeth were characterized as complete radiopaque masses and marked as either present or, absent.

Statistical analysis used

The statistical analysis was performed using IBM SPSS statistics 20 Core system software (SPSS Inc., Chicago, IL, USA) while Chi-square test was used to check the prevalence of pulp stones in patients with CAD in addition to their arch-wise and region-wise distribution. *P* value <0.05 was considered statistically significant.

Results

The present study revealed 100% prevalence of pulp stones in the study group, whereas 90% of the subjects in the control group were also afflicted with pulp stones, though the total number of pulp calcifications observed in the control group was lesser compared to the study group. The total number of pulp stones observed in the control group was 639 against 2217 pulp stones were observed in the study group and the results were found to be statistically significant ($P < 0.05$). No significant difference was found, although in the gender predilection for the development of pulp stones in the study group while the control group revealed a definite male predilection with around 96.24% of the males afflicted with pulp stones as against 88.88% prevalence observed in the females ($P < 0.05$). 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 while 58.37% of the maxillary teeth as against 41.63% of the mandibular teeth in the control group ($P < 0.05$) [Table 1]. 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 2].

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 commoner 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 oto-dental syndrome tumoral calcinosis, dentin dysplasia Type II, familial expansile osteolysis and osteogenesis imperfecta Type I.[20]

Table 1: 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%	*P*<0.05
Control Group	58.37%	41.63%	

Table 2: Side-wise prevalence of total number of pulp stones in the study and control groups

Group	Side (%)		*P*
	Right	Left	
Study Group	49.57%	50.43%	*P*>0.05
Control Group	50.70%	49.30%	

Urbanization might have improved the living standards of the people but studies also show increase in the risks of morbidity and mortality associated with the cardiovascular diseases (CVDs) being one of the leading causes of morbidity and mortality in the present scenario. The risk factors might vary from region to region underlying the significance of administrative and research units to be increased in impetus in sampling methodology so as to obtain a unified report for the country. Active participation from various levels of health care can insure a robust data on the prevalence of CAD in India.

Cardiologists have confirmed the role of calcium phosphate crystals in generating inflammation within the arteries and also, playing a major role in acute myocardial infarctions (MIs) leading to sudden death of patients.[16] 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*.[21] 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 This study found that pulp stones were prevalent in 100% of the patients with CAD. Nayak *et al*.[15] recorded pulp stones in 15.86% of teeth in patients with known systemic diseases, primarily, the CVDs. Ezoddini-Ardakani *et al*.[6] concluded that 67.3% of the teeth in patients with IHDs had pulp stones. Edds *et al*.[13] too reported 74% of the patients with pulp stones in IHD patients. Khojastepour *et al*.[14] reported 68.2% of the

patients with known CVDs and 28.2% of subjects without CVD having pulp stones.

Contrary to the findings of the said studies, Hill[20] stated that, of the subjects 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*.[14] Ravanshad *et al*.[5] reported pulp stones in 46.9% in adult Iranian population. Also, another study conducted by Al-Hadi Hamasha and Darwazeh,[22] among Jordanian adults, reported a lesser prevalence with 22% of the teeth examined having pulp stones. Ranjitkar *et al*.[23] stated, on the contrary, the prevalence of pulp calcifications in the Australian students to be 100% in accordance with the results of the present study which also observed 90% of the subjects in the control group to be afflicted with pulp stones, though the total number of pulp calcifications observed were lesser in number in the control group compared to the study group. 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. Tamse *et al*.[24] used both peri-apical and bitewing radiographs and found 20.7% of the teeth afflicted with pulp stones.

The study group, in the present study, showed an equal predisposition for both the genders for the development of pulp stones. This collation of data on the prevalence of pulp stones, with its varying rates in subjects in different age groups, underlying systemic status, sex and using different radiographic techniques underlines the scantiness in the literature available in relation to the different types of population, region wise or ethnicity wise.

Furthermore, both the groups in the present study showed a higher prevalence of pulp stones wherein another notable finding was that in relation to the maxillary teeth which seemed to have a definite predilection towards the development of pulp stones. The results of the present study revealed 51.92% of maxillary teeth to be afflicted with pulp stones as against 48.08% of the mandibular teeth in the study group. On the contrary, 58.37% of the maxillary teeth were found with pulp stones as against 41.63% of the mandibular teeth in the control group. This was in close accordance with the study conducted by Nayak *et al*.[15] who reported significantly higher number of pulp stones in the maxilla (12.36%) than in the mandible (5.95%) and with the studies conducted by Ranjitkar *et al*.,[23] Sisman *et al*.[25] and Turkal *et al*.[26] who also confirmed similar findings with the results obtained from their studies.

The present study evidenced more number of pulp stones in the posterior (molar) teeth than in anterior teeth in accordance with the results of the studies conducted by Gulsahi *et al*.[27] 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 case of posterior while 14.08% in case of anterior teeth. Al-Hadi Hamasha and Darwazeh[22] put forth a hypothesis based on the observations made from their study that since 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.

As concluded in the study conducted by Ozkalayci *et al*.,[28] a careful radiographic work-up and a multidisciplinary approach are thus 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 subjects to have this kind of, till recognized, rare and less critically acclaimed clinical entity.

Limitations of the Present Study and Future Research Directions: CAD is one of the leading causes of death worldwide. The paucity of data, along with a wide range in ethnicity, however, compounds the challenge of obtaining pure data regarding the prevalence of CAD. Furthermore, patients who have not developed a frank clinical disease are usually undiagnosed and not subjected for further investigations.

Studies indicate that patients with CAD show higher degree of pulp calcifications. Any study on pulp stones, therefore, has a possibility of excluding such patients who have not yet developed the clinical disease and might lead to a bias. Also, 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 which is rarely done on a war-footing basis and is rather underrated as of purely research interest leading to undiagnosed systemic diseases including undiagnosed or, frank, CAD.

Another important aspect is that 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 are small in size or relatively less calcified and in the initial stages of calcification are not detected by the conventional radiographs and underscore the total number of pulp stones considered in such kind of studies.

The lack of uniformity in the methodology in the studies conducted so far also lead to the introduction of biases as well as a lack of data which can be used for comparative analyses leaving an important lacuna to be filled up in future studies. Multicentre information compilation from various studies based on similar methodology and with equal representation in relation to different types of population, region wise and ethnicity wise, thus becomes a prerogative in dental and medical research fields to find the exact status and needful required in this arena.

Conclusions

CAD patients 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 based on a series of clinical and biochemical tests which have an obvious advantage of detecting changes before the clinical disease sets in and manifests its signs and symptoms. 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 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 to rule out the possibility of biases, so that an authentic data might be obtained which would facilitate multicentre information compilation for better outcomes that can be used for clinical interests.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Received: 20 Mar 19 **Accepted:** 22 Aug 19
Published: 24 Jan 20

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