Original Article

Pulp Stones as Risk Predictors for Coronary artery disease (CAD)

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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 subjects 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 subjects diagnosed with or, undergoing treatment for CAD. **Materials and 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 subjects including 108 males and 42 females and 150 age and sex-matched controls. Pulp stones were imaged using bitewing radiographs using 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 20 Core system software (SPSS Inc., Chicago, IL, USA) while statistical tests used were unpaired t-test and Z test. Chi-square test was used to check the prevalence of pulp stones in CAD subjects in addition to their arch wise and region wise distribution while p-value less than 0.05 was considered statistically significant. **Results:** CAD subjects exhibited 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 significant difference was found in gender predilection in the study group, although, the control group showed a definite preponderance for the males for development of pulp stones ($p<0.05$). **Conclusion:** CAD subjects 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: Pulp stones; Risk predictors; Coronary Artery Disease **(CAD)**

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] The paucity of data, along with a wide range in ethnicity, compounds the challenge of obtaining pure data from India regarding the prevalence of CAD. Ischemic heart diseases (IHDs) which ranked fifth as the cause of mortality in the 1990 has been proposed as the would be leading cause of mortality in 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 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. They may exist freely within the pulp tissue or, be attached to or, embedded in dentin. [4] 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. [5]

Osteopontin, a new constituent of atherosclerotic plaque,

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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. [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.

Coronary artery disease (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 in the body, also, called as pathological bio-mineralization, is, also, hypothesized to be similar to dental pulp stone formation just like joint calcifications and renal calculi. [16]

Studies indicate that subjects 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, 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, therefore, planned to estimate the prevalence of pulp stones in subjects diagnosed with or, undergoing treatment for CAD.

Materials and Methods

The present study consisted of 300 subjects within an age range of 20-55 years who were divided into 2 groups, the study group and the control group, with the study group consisting of 150 subjects including 108 males and 42 females and the control group comprising of 150 age and sex-matched controls. The control group consisted of subjects in whom CAD was ruled-out on the basis of the absence of associated signs and symptoms, risk factors (family history, central obesity) and related investigations including Electrocardiogram (ECG) and Treadmill test (TMT). The subjects 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 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(A-C)] (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. 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 commoner technique used for intra-oral peri-apical (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 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 dark room using a magnifying glass, a light emitting device (LED) 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.

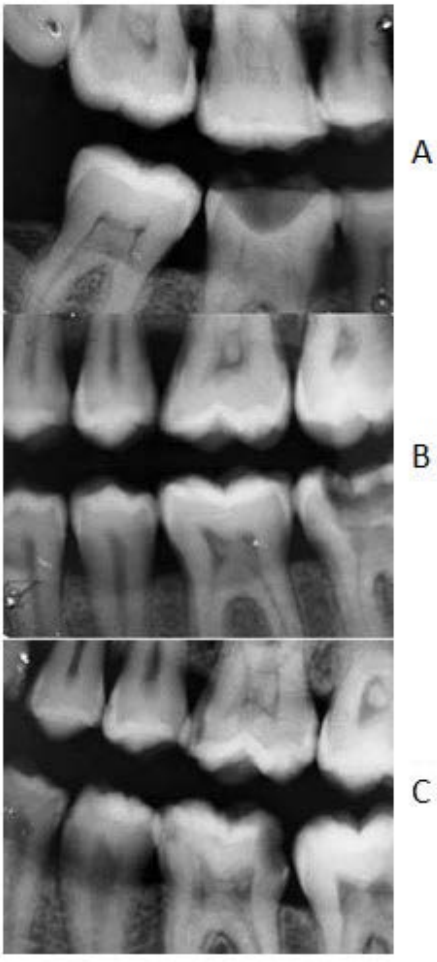

Figure 1: (A-C) Posterior bitewing radiographs revealing pulp stones.

Statistical Analysis

The results obtained were tabulated and subjected to statistical analysis. The statistical analysis was performed using IBM SPSS statistics 20 Core system software (SPSS Inc., Chicago, IL, USA) while statistical tests used were unpaired t-test and Z test. Chi-square test was used to check the prevalence of pulp stones in CAD subjects in addition to their arch wise and region wise distribution while p-value less than 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 as compared to 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 ($p<0.05$) [Table 1 and Table 2]. No difference was found, although, in gender predilection in the study group while 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 while 58.37% of the maxillary teeth as against 41.63% of the mandibular teeth in the control group ($p<0.05$) [Table 4]. Also, 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 case of posterior while 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].

Table 1: Number of subjects showing pulp stones in the study and control groups.

Group	Number (%)	p-value
Study Group	150 (100%)	
Control Group	135 (90%)	p>0.05

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

Group	Number	p-value
Study Group	2217	
Control Group	639	p<0.05

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

Group	Gender (%)		p-value
	Male	Female	
Study Group	100%	100%	p<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-value
	Maxilla	Mandible	
Study Group	51.92%	48.08%	p<0.05
Control Group	58.37%	41.63%	

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

Group	Region (%)		p-value
	Posterior	Anterior	
Study Group	87.42%	12.58%	p<0.05
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-value
	Right	Left	
Study Group	49.57%	50.43%	p>0.05
Control Group	50.70%	49.30%	

Discussion

Pulp stones vary in size ranging from microscopic particles to larger masses that almost completely obliterate the pulp chamber. Amongst 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, Elhers-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]

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. In the present study, it was found that pulp stones were prevalent in 100% of the subjects with CAD. Nayak et al. [15] recorded pulp stones in 15.86% of teeth in subjects with known systemic diseases, primarily, the cardiovascular diseases (CVDs). Ezoddini-Ardakani et al. [6] concluded that 67.3% of the teeth in subjects with ischemic heart diseases (IHDs) had pulp stones. Edds et al. [13] too, reported 74% of the subjects with pulp stones in IHD subjects. Khojastepour et al. [14] reported 68.2% of the subjects with known cardiovascular diseases (CVDs) and 28.2% of subjects without CVD having pulp stones.

Contrary to the findings of the said studies, Hill TJ20 stated that, of the subjects examined between 50-70 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] amongst 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 as compared to 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. 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, also, showed an equal predisposition for both the sexes 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-as well as 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, also, 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 Study

The present study was planned to estimate the prevalence of pulp stones in subjects diagnosed with or, undergoing treatment for CAD. The study consisted of 300 subjects within an age range of 20-55 years who were divided into 2 groups, the study group and the control group, with the study group consisting of 150 subjects including 108 males and 42 females and the control group comprising of 150 age and sex-matched controls. 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, 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 subjects with CAD show higher degree of pulp calcifications. Any study, therefore, on pulp stones, thus, 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. Amongst 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 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. Multi-centre information

compilation from various studies based on similar methodology and with equal representation in relation to different types of population, region-as well as ethnicity-wise, thus, becomes a prerogative in dental and medical research fields to find the exact status and needful required in this arena. This collation of data on the prevalence of pulp stones should include subjects in different age groups with consideration of the underlying systemic status, sex and using similar radiographic techniques to come to valid conclusions in this regard. A careful work-up for undiagnosed and not clinically manifesting CAD is the basis of such research.

Conclusion

CAD subjects 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 multi-centre information compilation for better outcomes that can be used for clinical interests.

Conflict of Interest

The authors disclose that they have no conflicts of interest.

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