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The Relationship of Dental Pulp Stone with Cardiovascular and Renal Disease: A Cross Sectional Study

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ABSTRACT

Calcification of bodily tissues can occur by pathological or physiological means due to deposition of calcium. Normally, calcium deposits in teeth and bone, but ectopic areas in the body such as kidneys, vascular system and joints may precipitate calcium due to imbalance in the metabolism of calcium results hypercalcemia is known as metastatic calcification. **Objective:** To determine the association of pulp stones with cardiovascular and renal disease. **Methods:** Through non-probability sampling, cross-sectional study was carried out over the course of six months at the Department of Operative Dentistry and Endodontics, DUHS, Karachi.The current study comprised 150 patients, both male and female, between the ages of 30 and 60, who had teeth with pulp stones; individuals without pulp stones were not included. The chi-square test was utilized to evaluate the relationship between dental pulp stones and the existence of cardiovascular and renal disorders, and SPSS was used for data analysis. **Results:** Females were mostly affected as compare to males (63%).The mean age of the patients was noted as 42.2 years.A significant association between dental pulp stones cardiovascular and renal disease was documented. (p=0.001). **Conclusion:** A significant association was observed between CVD and pulp stones (p-value 0.001) and also significant association was established between PS and RS (p-value 0.001).

INTRODUCTION

Dental pulp stones develop as calcified growths that exist inside the dental pulp tissue before being spotted accidentally through radiographic imaging [1]. The specific origins of dental pulp stones remain unknown even though researchers link their development to dental caries as well as aging and restorations and systemic conditions [2]. Research investigations now focus on possible connections between dental pulp stones and both cardiovascular conditions and renal system disorders [3]. A case-control study assessed the correlation between various systemic conditions and the occurrence of pulp canal calcification [4]. Pulp Stones can be seen as free, attached, and embedded in the pulp chamber's dentinal surface, and they are more frequently found in the coronal than in the radicular sections of the pulp. Pulp stones are categorized as real, false, and dispersed based on their structure. They can be either microscopic particles or massive masses that nearly fill the pulp chamber [5].Some factors, including genetic predisposition, orthodontic tooth movement, circulation disturbance in pulp, age,

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interactions between the pulp tissue and the epithelium, idiopathic factors, and long-standing irritants like caries, deep restorations, and chronic inflammation, have been linked to the formation of stones, even though the precise cause of pulp calcification is unknown [6]. Pathophysiology of pulp stones are multifactorial, such as movement of tooth due to orthodontic treatment purpose, decrease the blood supply to the pulp, aging factors, and persistent includes like caries, shallow to deep restorations or abrasion, periodontal disorders, chronic inflammation and genetic predisposition and particular syndromes such as Van der wound syndromes have been serve as an etiologic feature of PS [7, 8]. The prevalence of pulp stones, radiographically shows different percentages (8% to 95%). Pulp stone most commonly present in female than male [9]. Various research studies examined how pulp stones link to cardiovascular diseases (CVDs). Systematic research including seven observational studies with 3,770 participants showed that individuals with pulp stones faced a 1.70 times greater risk for coronary or carotid artery calcified atherosclerotic plaques (95% CI: 1.21–2.38) [10]. Even though the evidence seemed consistent the studies maintained minimal certainty and demonstrated various biases which impacted both confounding variables and measurement accuracy [11]. A study investigating both pulp stones and Carotid Artery Calcifications (CACs) revealed that these conditions showed statistically important relationship to each other. Research revealed pulp stones affect 4.6% of patients and showed no association patterns with CACs (p = 0.714) [12]. Research investigations have evaluated the connection between pulp stones and renal diseases. An analysis of 70 dental patients revealed that those with renal stones were more than three times as likely to have pulp stones (OR: 3.78, 95 percent CI: 1.35–11.50; with a p=0.014) as those without renal stones. The occurrence of pulp stones rose progressively in older individuals [13]. Research showed that kidney stone patients contained pulp stones at a rate of 49.4% but individuals without kidney stones developed pulp stones in 36.4% of cases. The study indicated that kidney stones were more common when three or more teeth had dental pulp stones (p=0.143), but this relationship was not evident when one or two teeth had pulp stones [14]. Multiple research projects analyze how dental pulp stones link to cardiovascular along with renal illnesses yet their results remain inconsistent. The research shows both potential connections between dental pulp stones and systemic conditions and also demonstrates substantial correlations between these entities. Multiple factors affecting studies include diverse designs, different sample sizes, diagnostic specification differences and distinct population profiles.

Finding the prevalence and association of dental pulp stones in individuals with cardiovascular and renal diseases is the goal of the current investigation.

METHODS

At the Dr. Ishrat-ul-Ebad Khan Institute of oral Health Sciences, Dow University of Health Sciences, Karachi, the Department of Operative Dentistry and Endodontics carried out this cross-sectional study. After getting ethical approval from research ethics committee of the Dow University (IRB-3033/DUHS/Approval/2023/200). Data was collected in time duration of six months (from 1-9-2023 to 28-02-2024) through non-probability consecutive sampling. Sample size was calculated on the basis of prevalence of pulp stones found about 9% by taking confidence interval 95% and margin of error 5% and calculated by Raosoft sample size calculator we have sample of 126 and we have increased it up to 150 including missing and non-responders etc. [21]. Inclusion criteria was based on 150 patients, aged 30-60 years, both gender, with Patient having teeth with pulp stone were incorporated in the current study. Pediatric patients, pregnant patients, teeth with heavy restoration and patients with other co-morbidity were excluded from the present study. Written informed consent was taken from all the patients included in this study. The subject of this study was presented to operative department for routine dental problem with panoramic radiographs. Their radiographs were evaluated for total number of teeth with presences of PS and obliteration of pulp chamber. The results were record as "yes" or "no". Detected PS was chosen for further query for medical history related to CVD and Renal disease. Past record like ECG, past blood pressure record, ultrasonography was evaluating the patient with positive medical history of CVD and renal disease. The statistical analysis of the gathered data was done using SPSS version 26. Age was one of the quantitative variables whose mean and standard deviation were assessed. Pulp stone prevalence in patients with CVD and renal illness, as well as patient gender, were qualitative variables for which frequency and percentage were computed. To determine if illness kind and pulp stone were related, the chi-square test was used. The p-value was deemed significant when it was less than 0.05. Panoramic radiograph showing pulp stones within the pulp chambers of molar teeth (figure 1).

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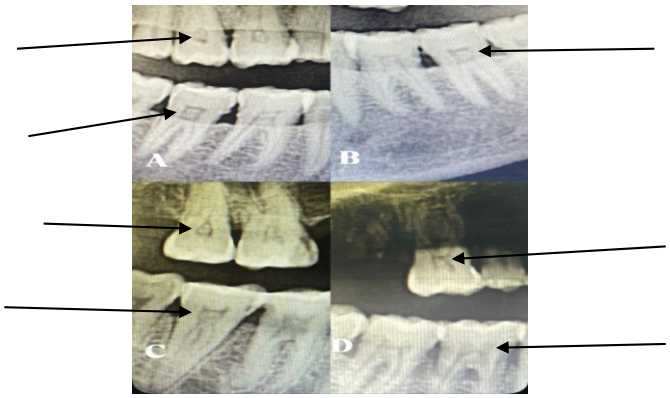

Figure 1: On the Panoramic Radiograph, Pulp Stones were seen Inside the Molars' Pulp Chambers

Panoramic radiograph displaying multiple free pulp stones in the pulp chambers of upper and lower teeth (figure 2).

Figure 2: The Panoramic Radiograph from the Upper and Lower Jaw Teeth Shows many Free Pulp Stones inside the Pulp Chambers

RESULTS

There were 150 participants in this research. The patients were stuck between the ages of 30-60, by an average age of 42.2 ± 14.06 years. The sample comprised 56 males (37%) and 94 females (63%). Among the participants, 47 individuals (31%) were diagnosed with Cardiovascular Disease (CVD), while 22 individuals (15%) had renal disease (Table 1).

Table 1: Demographic and Clinical Parameters

Variables	Mean ± SD/ Frequency (%)
Age (Years)	
Mean	42.2 ± 14.06
Gender	
Male	56 (37%)
Female	94 (63%)
CVD	47 (31%)
Renal Disease	22 (15%)
Pulp Stone without Systemic Diseases	81 (54%)

Pulp stones are linked to systemic disorders such as cardiovascular disease and renal ailments, as seen in Table 2. The results showed that among individuals 47 had dental pulp stones with CVD while 22 individuals had pulp stones with renal diseases. In contrast, 81 individuals were having pulp stones but without any systemic disorder. Renal and cardiovascular illnesses were shown to be statistically significantly associated with dental pulp stones (p=0.001).The chi-square test indicated significant association between dental pulp stones, CVD and renal disease (p=0.001). These findings suggest that while pulp stones are prevalent in the studied population, their relationship with cardiovascular and renal diseases remains conclusive based on statistical analysis (Table 2).

Table 2: Association of Disease Type with Pulp Stone

Dental Pulp	CVD (Yes)	CVD (No)	p-Value
Pulp stones	47	103	0.001
Dental Pulp	**Renal Diseases (Yes)**	**Renal Diseases (No)**	**p-Value**
Pulp stones	22	128	0.001

DISCUSSION

Pulp stones, often called denticles, can result from calcification of the tooth pulp.Thus, pulpal calcification was denoted by the phrase "pulp stone" in the current investigation.Numerous factors, including genetic predisposition, orthodontic tooth movement, circulation disturbance in pulp, age, interactions between pulp tissue and the epithelium, idiopathic factors, and long-standing irritants like caries, deep restorations, and chronic inflammation, have been linked to the formation of stones, even though the precise cause of pulp calcification is unknown [15]. Since several systemic disorders, such RS and CVD, are impacted by calcium imbalance, PS is one of the subjects that has lately been studied in relation to these conditions. The radiographic technique which was used on in this study is a better radiographic method than the periapical and panoramic techniques, since distortion can occur in the picture in the latter, while the centre beam in the paralleling approach can be positioned perpendicular to the teeth's long axis to provide a more uniform image. Dentin dysplasia and dentinogenesis imperfecta are two examples of systemic or hereditary illnesses that often cause pulp calcifications throughout the dentition [16]. Predisposing variables for pulpal calcification have been identified as diseases such as hypercalcemia, gout, and renal lithiasis that are related to calcium metabolism.Many authors have found correlations between calcification of dental pulp stone, CVD and renal disease.Organic matrix components of human pulp stone were investigated under immune histochemistry by using antibiotics against type I collagen and non-collagenous protein (for example osteo-pontin, osteo-nectin and osteocalcin) which are involved in calcification of matrix.Type I collagen is evenly distributed in dental pulp stone as a main component and powerful immunostaining against the osteo-pontin that surrounded of the stone is also detected.Osteo-pontin found in other ectopic calcification in the body as well such as, stone in the kidney, atherosclerotic plaques, and dental calculus [17].Goga R reviewed the prevalence, formation, classification, and clinical significance of pulp stones in

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dental practice [16].This minerals substance is same in calcified tissue (pulp stone), renal calculi and calcification of atherosclerotic plaque.Nanobacteria are an active center of calcified mineral.Hence, this is also the relationship of PS with CVD (atheromatous plaque) and Renal disease (renal calculi) [17]. A systemic review study done by Chalikkandy SN *et al.*, showed that renal failure frequently results in accelerated Cardiovascular Disease (CVD) [18].Chronic Kidney Disease (CKD) causes hypertension and dyslipidemia, which later worsen renal failure.The Prevention and treatment of cardiovascular disease are main cogitation for the management of the individual for further complications.Different research investigations discovered elevated rates of dental pulp stones exist in heart disease patients. According to a systematic review by Banka A *et al.*, with meta-analysis dental pulp stone patients presented 1.70 times greater chance of developing coronary or carotid artery atherosclerotic plaques [19]. A pilot research by Altındağ A *et al.*, indicated that CVD patients presented pulp stones in 74% of cases compared to 39% for volunteers who did not have CVD which raises the possibility of this connection [20, 21]. Research studies have produced similar results to those of the present investigation by detecting meaningful statistical connection.The assessment of pulp stones and carotid artery calcifications revealed no statistically significant link (p=0.714), suggesting that pulp stones are not a reliable indicator of the onset of cardiovascular disease [22].Although studies currently suggest a link between pulp stones and systemic diseases they did not identify any meaningful relationship during this assessment.Subsequent studies with well-established protocols and larger participant populations will help resolve this relationship. A number of theories are put up in the literature to explain the genesis of PS.The patient's ageing process was the subject of the initial hypothesis [23, 24].Complete obstruction of neurovascular supply may happen in severe situations. However, elevated blood levels of calcium and phosphate, which may indicate metabolic dysfunctions, are the most likely cause of PS and other body calcifications. According to some research, PS is a local expression of constitutional metabolic dysfunctions brought on by hypercalcemia, and it has the same pathophysiology as coronary artery calcifications accordingly, it has been demonstrated that coronary artery calcifications and an elevated risk of cardiovascular morbidity and death are linked to the rise in calcium phosphate crystals in blood vessels.

CONCLUSIONS

The studied population revealed high dental pulp stone frequency and such findings link with cardiovascular and renal conditions as significant association was observed in CVD and renal stones (p-value 0.001).Longitudinal research must be conducted in the future to determine the clinical importance of pulp stones.

Authors Contribution

Conceptualization: RZ
Methodology: RZ, AK
Formal analysis: RZ, AAJ, MT, SAJ
Writing, review and editing: RZ, FURQ, GR, AAJ, MT, SAJ
All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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