

## Correlation between Pulp Stones and Gall Bladder Stones: A Radiographic Retrospective Case–Control Study

### Abstract

**Background:** Calcifications can occur in the dental pulp as discrete bodies known as pulp stones. Their etiology remains obscure. They were believed to be formed as a result of local irritating factors within the pulp; however, a few authors now suggest that they may be a part of systemic biomineralization process that affects many body parts such as kidneys, gall bladder, joints, arteries as well as pulp leading to formation of stones. **Aim:** This retrospective case–control study was taken up to (i) determine the prevalence of pulp stones as well as pulp chamber narrowing in patients with gallbladder stones as well as the controls (ii) whether any correlation exists between the prevalence of pulp stones and gallbladder stones so as to test the hypothesis that pulp stones and gallbladder stones may be a part of a common systemic calcification process. **Setting and Design:** This retrospective case–control study was conducted in the Department of Gastroenterology and Department of Radiodiagnosis, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar. A total of 200 individuals were taken up for the study. Group I consisted of 100 patients (cases) with confirmed diagnosis of gallbladder stones. Group II included the control group in which individuals who were the close relatives of the patients with gall bladder stones were taken ( $n = 100$ ), so as to eliminate the common confounding factors in these two groups such as diet, air, water, environment, genes, and age, which could affect the formation of pulp stones could not be the reason for the formation of pulp stones. **Materials and Methods:** Standard bitewing radiographs were taken for all the patients in each group and presence or absence of pulp chamber narrowing and pulp stones were observed. **Statistical Analysis Used:** McNemar's statistical test was used to find the difference between the two groups, and the  $P$  value was determined. Coefficient of association using the Phi coefficient was used to determine if there was any association between the two groups. **Results:** In Group I, 37% of the patients with gallbladder stones showed the presence of pulp stones; whereas in the Group II which was the control, 57% of individuals showed the presence of pulp stones. McNemar's test of significance calculated with one-degree freedom (1-df) showed that  $P = 0.01$ , thereby showing that there was a significant difference between these two groups. **Conclusion:** According to the study, a negative correlation between pulp stones and gallbladder stones was found and they are not related to each other.

**Keywords:** *Bitewing radiographs, calcifications, gallbladder stones, pulp chamber narrowing*

### Introduction

Calcification is a process in which calcium builds up in body tissue, causing the tissue to harden. This can be a normal or abnormal process. Ninety-nine percent of calcium entering the body is deposited in bones and teeth. The remaining calcium dissolves in the blood. The upturn of deposition of calcium salts can be ensued in other parts of the body as well, such as in kidneys, gallbladder, arteries, and joints.<sup>[1]</sup>

When pathological calcification occurs in nonviable or dying tissues, it is known as dystrophic calcification. It may occur

despite normal serum level of calcium and in the absence of derangements in calcium metabolism. In contrast, the deposition of calcium salts in vital tissues is known as metastatic calcification, and it almost always reflects some derangement in calcium metabolism, leading to hypercalcemia.<sup>[2]</sup>

Dental pulp calcifications date back to 1921 when it was first mentioned by Norman and Johnson as dental pulp nodules, a term which was later modified to denticles.<sup>[3]</sup> Pulp calcifications are not clinically identified and are incidentally noted on intraoral radiographs as radiopaque bodies enclosed in the pulp chamber or the root canals with their numbers varying from

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1 to 12 or more.<sup>[4]</sup> Kronfeld and Boyle<sup>[5]</sup> classified pulp stones histologically into “true” or “false” forms. The true pulp stones are more irregular in shape and are lined by odontoblasts. They are composed of dentine, whereas the degenerating cells of the pulp which mineralize, form false pulp stones.<sup>[4,6]</sup> The third type of pulp stones, “diffuse” or “amorphous” type is also seen in close association with the blood vessels.<sup>[4]</sup>

Pulp has high reparative potential and once irritated it tries to overhaul itself leading to pulp stone formation. However, various studies<sup>[4,7]</sup> have quoted that factors such as pulp degeneration, age, epithelial rests in the pulp tissue, operative procedures, impaired blood supply of the pulp, periodontal disease, orthodontic treatment, long-standing irritants such as caries, deep fillings, abrasion, genetic factors, and certain syndromes such as Van der Woude syndrome might be implicated in pulp stone formation. However, the exact mechanism and etiology of pulp stones are still unknown.

At the ultrastructure level, various studies on pulp stones have reported similarity in nature of pulp stones and various other systemic stones. Ninomiya *et al.*<sup>[8]</sup> found an even distribution of Type I collagen throughout the pulp stones, while osteopontin was found to play an integral part in the calcification front as it was found in the peripheral area of pulp stones. Hirota *et al.*<sup>[9]</sup> found similar occurrence of osteopontin in their immune histochemical study on atherosclerotic plaque and urinary stones.

These observations proposed a relationship between pulp stones, arterial stones, and urinary bladder stones. Thus, various authors<sup>[9-11]</sup> have suggested a hypothesis that pulp stones may be a part of systemic biomineralization process, affecting many tissues of the body such as kidneys, urinary bladder, gall bladder, arteries, joints, etc.

To test this hypothesis, a study was conducted to determine whether any association exists between the prevalence of pulp stones and renal stones and it was observed that a positive correlation existed between the prevalence of pulp stones and renal stones, thereby suggesting that pulp stones and kidney stones could be part of common pathological condition affecting various organs in the body.<sup>[12]</sup>

The aim of this retrospective case–control study was to determine the prevalence of pulp stones in patients with gallbladder stones (cases) as well in the control population and to find whether any association exists between the two.

## Materials and Methods

This retrospective case–control study was conducted in the Department of Gastroenterology and Department of Radiodiagnosis, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar. Ethical clearance for the study was obtained from the Institutional Ethical Committee. The study was conducted over a period of 8 months (i.e., March 2017–November 2017).

On inquiry, it was found that an average of 100 patients visited daily the outpatient department (OPD) of the Department of Gastroenterology and about 20 patients with gallbladder diseases were detected. Out of these 20 patients, five patients daily were confirmed for gallbladder stones through ultrasound in the Department of Radiodiagnosis of the institution. The patients with gallbladder disease were numbered 1, 2, 3, 4, and 5 in the order they visited the OPD and out of these two numbers were selected randomly by the lottery method. Patients from the Department of Gastroenterology with provisional diagnosis of gallbladder disease were selected for random sampling because all the patient records were registered in the gastro department and patients were supposed to come there for treatment and follow-up; hence, it facilitated the study. It was decided to select randomly two out of five patients daily.

The two randomly selected patients on each day were subjected to further ultrasound investigation. Those with the confirmed ultrasound diagnosis of gallbladder stone were included in the study. This procedure was repeated till the random sample of 170 was obtained and out of these only those patients were selected for the study (and constituted Group I), who fulfilled the following selection criteria:

### Patient selection criteria

#### *Group I: Patients with gallbladder stones*

Patients aged between 17 and 45 years (both males and females) having no history of any systemic illness except gallbladder stones and no dental history of any periodontal surgeries, orthodontic treatment, dental trauma, or other anomalies were selected.

Out of 170 selected patients, only 100 patients (58 males and 42 females) fulfilled the selection criteria and formed Group I. A sample size of 100 was found to be adequate, as a similar study with nearly same sample size has been published in literature.<sup>[13]</sup>

### Criteria for selecting teeth for bitewing radiograph

- All the maxillary and mandibular molars and premolars (as there are high chances of pulp stones formation in posterior teeth<sup>[4]</sup>), which satisfy the following criteria were selected for bitewing radiograph.

Teeth should be sound, free of caries, cracks, fracture, and previous restorations. There should not be any evidence of periodontal diseases, orthodontic treatment, attrition, abrasion, or erosion.

#### *Group II: Control group*

From all the 100 patients selected in Group I, information was gathered regarding his/her close relatives. The criteria for selecting a close relative of the patient included as follows:

Persons preferably siblings (aged 17–45 years), who had been living with the patients for >10 years. This was done

to limit the influence of confounding factors such as food, water, air, and genes to a minimum so that they served as controls. They should not have any history of systemic illness and dental history of any periodontal surgeries, orthodontic treatment, dental trauma, or other anomalies.

All the maxillary and mandibular molars and premolars of selected individuals (as there are high chances of pulp stones formation in posterior teeth), which satisfied the inclusion criteria already mentioned in Group I were selected for bitewing radiograph.

At least one control was selected per case, and hence, Group II included 100 individuals out of which 47 were females and 53 males.

### Bitewing radiographs

Standard bitewing radiographs of the selected teeth of the individuals in Group I and Group II (inclusion criteria of teeth selection already explained above) were taken with XCP bitewing instrument (Rinn Corporation, Elgin, IL, USA) using E-speed dental radiographic film (Eastman Kodak Company, Rochester, NY, USA) in the Department of Radiodiagnosis. A total of 200 bitewing radiographs of 1554 posterior teeth were taken for all 100 patients of group I. In the Group II also 200 bitewing radiographs were taken for 1556 teeth of the selected 100 controls.

All the radiographs were taken with standardized radiological safety protocols which included thyroid collar and lead apron for pregnant females or patients in whom radiographs were contraindicated.

### Evaluation of bitewing radiographs

All the bitewing radiographs were checked by three authors and interexaminer variability was tested. The radiographed were examined under the  $\times 2$  magnification in a darkened room, using a light box with an even diffuse light source, with peripheral light blocked to determine the presence of pulp chamber narrowing as well as pulp stones in the pulp chamber and root canals. The number of teeth varied for each individual.

Narrowing of pulp chamber was defined as notable reduction in the size of pulp chamber and determined as present or absent. Pulp stones were identified as definite radiopaque masses inside the pulp chambers or root canals of the teeth and determined as present or absent. The percentage of pulp stones and pulp chamber narrowing was calculated in both the groups and the results obtained were put to statistical analysis. Examiner reliability was calculated through replicate observations derived from double determination in all samples. Concordances for replicate identification of pulp stones and dental status were 98.5% indicating that scoring methods were highly reliable.

### Statistical analysis

McNemar's statistical test was done to find whether there was any difference in two groups in relation to the

percentage of pulp stones and pulp chamber narrowing. In addition, Coefficient of association test was done to find if the two groups are associated or not.

## Results

### Pulp chamber narrowing

Pulp chamber narrowing was seen in 52 patients with gallbladder stones (Group I) and was absent in 48 patients. When the presence of pulp chamber narrowing was assessed in their close relative's pulp chamber narrowing was found in 80 individuals and were absent in 20 [Table 1]. For the statistical testing of results, the nature of the measurement (nominal scale) suggested the use of nonparametric test called McNemar's test, which uses shift (present→absent or absent→present).

### Statistical analysis

McNemar's test of significance showed that there is highly significant difference between the two groups with  $P < 0.001$ . Coefficient of association between the two groups was calculated using the Phi coefficient ( $r_{\phi} = 0.03810$ ). Since, the value of phi coefficient is very less, close to 0 so it can be considered that there was no association between the two groups but still we did test of significance on this phi coefficient and it was found that  $P > 0.50$  showing that there is no association between the two groups. Hence, there was no association between the pulp chamber narrowing in the patients with gallbladder stones and their close relatives. Therefore, the role of confounding factors such as genetics, food, environment, and water playing an important role in the etiology of pulp chamber narrowing is absent. Since the presence of pulp chamber narrowing was low in the patients with gallstones, it might be concluded that gallstones and pulp stones may not be related to each other.

### Pulp stones

When pulp stones were calculated, it was found that 37 patients with gallbladder stones (Group I) showed pulp stones in their teeth whereas in 63 patients they were absent. When the presence of pulp stones was assessed in their close relatives (Group II) in 57 individuals pulp stones were seen but they were absent in 43 patients [Table 2].

### Statistical analysis

McNemar's test of significance showed that there is highly significant difference between the two groups with  $P < 0.01$ . Coefficient of association between the two groups was calculated using the Phi coefficient ( $r_{\phi}$ ) indicating that there was no association between the two groups ( $r_{\phi} = 0.0381$ ). Hence, there was no association between the pulp chamber narrowing in the patients with gallbladder stones and their close relatives. Therefore, the role of confounding factors such as genetics, food, environment, and water playing an important role in the etiology of pulp chamber narrowing is absent. Since the presence of pulp stones was lower in



**Table 1: Comparison of the presence of pulp chamber narrowing in two groups**

Patients with gall bladder stones	Relatives of patients with gall bladder stones (control)		Total
	Pulp chamber narrowing absent	Pulp chamber narrowing present	
Pulp chamber narrowing present	12	40	52
Pulp chamber narrowing absent	8	40	48
Total	20	80	100

Mc Nemar's Test. Test statistic (Chi square) calculated value with (1 d.f.) = 14.019 and the p value ( $< 0.001$ ). Very highly significant difference was seen between the two groups. Coefficient of association between the two groups was calculated, Phi coefficient was ( $r_{\phi} = 0.0381$ ). Significance of this Phi coefficient was tested. The calculated value of test statistic (Chi square) was 0.303 with the associated p value greater than 0.50 ( $P > 0.50$ ). So, there is no association between the two groups

**Table 2: Comparison of the presence of pulp stones in the two groups**

Patients with gallbladder stone	Relatives of patients with gallbladder stone (control)		Total
	Pulp stone absent	Pulp stone present	
Pulp stone present	15	22	37
Pulp stone absent	28	35	63
Total	43	57	100

Mc Nemar's test. Test statistic (Chi-square) calculated value with (1 df)=7.22 and the P value ( $< 0.01$ ). Highly significant difference was observed between the two groups. Coefficient of association between the two groups was calculated, Phi coefficient  $r_{\phi} = 0.0381$ . Significance of this Phi coefficient was tested and the calculated value of test statistic (Chi-square) was 0.0294 with the associated  $P > 0.80$ . Hence, there is no association between the two groups

patients with gallbladder stones, it may be conclude that gallbladder stones and pulp stones are not related.

## Discussion

Pulp stones are foci of calcification in dental pulp. They vary in size ranging from microscopic particles to larger masses that almost obliterate the pulp chamber with only the larger masses being radiographically visible. Small calcified structures with diameter smaller than 200  $\mu\text{m}$  cannot be detected on the radiographs.<sup>[14]</sup> Therefore, the radiographic studies tend to underreport the incidence of pulpal calcifications owing to the small size of the calcifications. The prevalence stationed on most radiographic studies are 20%–25%;<sup>[15]</sup> however, histological studies proclaim much higher prevalence rates of pulp stones.<sup>[13]</sup> Similar results were stated by Willman,<sup>[16]</sup> who examined 164 teeth from patients of different ages and found histologically some form of calcifications in 87.2% of these, whereas pulp stones were visible radiographically in only 14% of the specimens.

In addition, literature reviewed on the use of bitewing or periapical radiographs revealed no significant difference in the results between these techniques for the detection of pulpal stones.<sup>[13]</sup>

In the present study, we found the prevalence of pulp stones in controls to be around 57% [Table 1]. These findings are in accordance with those of al-Hadi Hamasha and Darwazeh,<sup>[15]</sup> who reported a 51.4% prevalence of pulp stones in their radiographic study conducted on Jordanian adults. Similar results were reported in a study by Ranjitkar *et al.*,<sup>[17]</sup> who found a 46.1% prevalence of patients with pulp stones in Australian population.

Diseases of gallbladder are common and constitute a major economic health burden on the community which has increased significantly over the last three decades. Gallstones form a significant part of all the gallbladder diseases. The prevalence of gallstones in the North Indian population has been found to be 4.15% with the prevalence being more in females than in males.<sup>[18]</sup> According to various studies, ultrasonography has been determined as the best diagnostic method to determine gallstones.<sup>[18]</sup> In this study, all the patients with ultrasound diagnosis of gallstones were selected.

The results in current study showed that prevalence of pulp stones in patients with gallstones was 37% [Table 2]. The prevalence of pulp stones in controls to be 57%. The prevalence of pulp stones in patients with gallbladder stones was significantly lower than found in control group. Similar findings were reported by Bains *et al.*<sup>[19]</sup> that the prevalence of pulp stones was 10% in patients with cholelithiasis which was lower than the overall 41.8% prevalence of pulp stones.

These results are not in accordance to our hypothesis that the gallbladder stones and pulp stones are associated with each other and are a part of systemic illness resulting in complex biomineralization process affecting various tissues of the body. Earlier similar findings were reported in a study by Stafne and Szabo,<sup>[20]</sup> who suggested that pulp stones are not directly responsible for the production of gallstones.

This could be explained by the difference in chemical nature of gallbladder stones and the pulp stones. Aoba *et al.*<sup>[21]</sup> studied the mineral phase of pulp calcification using X-ray energy dispersive spectrometry and chemical analysis and found that calcium salts are deposited in the form of apatite, possibly carbonate containing apatite.

However, chemical analysis of gallstones from different regions of India by Chandran *et al.*, 2007<sup>[22]</sup> showed that all types of gallbladder stones are chiefly made of cholesterol (approximately 50% of dry weight of the stone powder). Gallstones were believed to form when the concentration of cholesterol exceeded that which can be held in a micellar solution with bile acids and

phospholipids. Supersaturation of cholesterol is believed to be due to abnormal production of bile from liver.

Since a negative correlation was found between the prevalence of pulp stones and gallbladder stones our hypothesis that that pulp stones may be a part of common systemic biomineralization process affecting gallbladder and pulp was rejected. Although a positive association between pulp stones and gallbladder stones was not found in the present study, it seems to be of compelling clinical attention. Further, large-scale, multi-institutional studies are encouraged to authorize any positive relation between pulp stones, gallbladder stones, and other systemic calcifications. The radiographic method used for the determination of pulp chamber narrowing and pulp stones limits the scope of this study as it's a two-dimensional analysis. Also, the research on this topic is limited and more studies are needed.

## Conclusion

This study did not reveal a positive correlation between pulp stones and gallbladder stones, more number of such studies with a wider scope including the histological evaluation and cone beam computed tomography three-dimensional analysis should be encouraged. Similarly, large-scale, multi-institutional studies should also be conducted to find out the relationship between pulp stones and calcifications in the other parts of the body such as joints, large arteries, kidneys, and urinary bladder so as to determine if pulp stones are a part of systemic biomineralization process or not.

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## Conflicts of interest

There are no conflicts of interest.

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