A Radiographic Correlation between Renal and Pulp Stones

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ABSTRACT

Aim: *The purpose of this study was to determine the correlation between pulp stones and renal stones. This study also aimed to report associations between the presence of pulp stone and gender, age, tooth type, dental arches and sides.*

Patients and Methods: *Data were collected through examination of bitewing radiographs of 116 kidney stone patients and a similar number of age-matched controls, referred to the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Erciyes University. Two oral radiologists examined the radiographs to identify pulp stones. The Chi-squared and Mann Whitney U tests were used to investigate the correlations between the presence of pulp chamber calcification and age, gender, dental status and kidney stone.*

Results: *Pulp chamber opacities were detected in 199 (19.3%) out of the 1031 examined teeth, and in 84 (72.4%) out of the 116 kidney stone patients. There was no statistically significant difference between the study and control group (*$p = 0.882$*). The occurrence of pulp stones was significantly higher in molars than premolars and similar prevalences were found between dental arches and sides.*

Conclusion: *In this study, no correlation was found between the presence of pulp stones and kidney stones in the investigated group. Therefore, the presence of pulp stones does not seem to be correlated with that of kidney stones.*

Keywords: Bitewing radiograph, kidney stones, pulp stones

Correlación Radiográfica entre los Cálculos Renales y Pulpares

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RESUMEN

Objetivo: *El propósito de este estudio fue determinar la correlación entre los cálculos pulpares y los cálculos renales. Este estudio también tiene por objeto reportar las asociaciones entre la presencia de cálculos pulpares y el género, edad, tipo de diente, arcadas dentarias y los laterales.*

Pacientes y métodos: *Los datos fueron recogidos mediante examen de radiografías de aleta mordida de 116 pacientes con cálculos en el riñón y un número similar de los controles pareados por edad, remitidos al Departamento de Radiología Oral y Maxilofacial de la Facultad de Odontología de la Universi-dad Erciyes. Dos radiólogos orales examinaron las radiografías para identificar los cálculos pulpares. Pruebas de Chi-cuadrado y pruebas U de Mann-Whitney fueron utilizadas para investigar las correlaciones entre la presencia de calcificaciones en la cámara pulpar por un lado, y la edad, género, estado dental y cálculos renales, por otro.*

Resultados: *Se detectaron opacidades de la cámara pulpar en 199 (19.3%) de los 1031 dientes examinados, y 84 (72.4%) de los 116 pacientes con cálculos renales. No hubo ninguna diferencia estadísticamente significativa entre el grupo de estudio y el de control (*$p = 0.882$*). La presencia de cálculos pulpares fue significativamente más alta en los molares que en los premolares, y prevalencias similares fueron encontradas entre las arcadas dentarias y los laterales.*

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Conclusión: *En este estudio, no se encontró correlación entre la presencia de cálculos pulpares y cálculos renales en el grupo investigado. Por lo tanto, la presencia de cálculos pulpares no parece correlacionarse con la de cálculos renales.*

Palabras claves: Radiografía de aleta mordida, cálculos renales, cálculos pulpares

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INTRODUCTION

Pulp stones are calcified bodies in the dental pulps of the teeth in the primary and permanent dentition (1). Their locations are more common in the coronal than in the radicular portions of the pulp and they may exist freely within the dental pulp tissue or attached to, or embedded in dentin of healthy, diseased or unerupted teeth (2). Pulp stones vary in size from small microscopic particles to large masses that almost occlude the pulp chamber and a single tooth may have one to 12 stones or more with different sizes (3).

Studies related to the prevalence of pulp stones, based on radiographic examinations, have been reported with various percentages [ranging from 8% to 95%] (1, 4–9). Since these calcifications generally do not cause pulp disease or subjective symptoms, apart from the obvious endodontic problem of hindering access to root canals and their shaping (10), it is still not clear if they present pathological or biological variation (11).

Although the exact cause for the formation of pulpal calcifications is not exactly clear, there are many aetiological factors that have been claimed to cause pulp stone formation, such as: idiopathic conditions, epithelial rests in the pulp tissue, age, gender, orthodontic tooth movement, caries, operative procedures and ageing (1, 2, 4, 12). Besides, genetic diseases such as dentin dysplasia, dentinogenesis imperfect or Vander Waude syndrome, systemic problems like cardiovascular diseases, diabetes and renal disease have been reported as predisposing factors (9, 13). In the literature, pulpal calcification is reported as a common dental finding in patients with end-stage renal disease (ESRD) and transplanted patients. Also, a strong correlation was observed between the chronicity of the renal disease and the pulp narrowing in premolar and molar teeth (14, 15).

Nephrolithiasis is a relatively common disease in Western countries. The lifetime prevalence is between 5 and 10% in the United States of America [USA] (16) and the prevalence is increasing worldwide (17). As a consequence of the polygenic origin and multifactorial character of lithiasis, calculus formation is a complex process. Although important advances have been made during the last decades in describing kidney stone formation, many questions concerning calculus pathogenesis still remain unanswered. It is becoming apparent that renal stone disease is commonly associated with Type 2 diabetes, obesity, dyslipidaemia, hypertension and cardiovascular diseases (18, 19). Nephrolithiasis is also accepted as a predisposing factor to pulpal calcification (13). To date, in the literature, the presence of pulp stones detected in an individual with kidney stones has not been reported. Therefore, the aim of this present study was to determine the prevalence of pulp stone formation detected on bitewing radiographs and to investigate a correlation between the presence of pulp stones in a sample of patients with kidney stones. We also aimed to report correlations among the presence of pulpal calcifications and age, gender, tooth type, dental arches and sides, compared with age-matched controls.

SUBJECTS AND METHODS

One hundred and sixteen patients with kidney stones who were treated at the Urology Department of Erciyes University and Kayseri Research and Training Hospital and had recent medical records with kidney stones, and 116 patients as a control group were referred for participation in order to investigate by bitewing radiograph for the presence of pulp stones. History of renal colic, with confirmed haematuria and voiding of the calculus or radiographic evidence of stone(s), or previous surgical and endoscopic removal of stone(s) were used to diagnose nephrolithiasis. All patients participating in the study were informed about the aim of the study and consent obtained for evaluation of pulp stones by bitewing radiographs. The study was approved by the Ethics Committee on Human Rights Related to Research involving Human Subjects, Faculty of Dentistry, Erciyes University, Kayseri, Turkey.

Care has been taken in order to choose an age-matched control group, since age is considered to be an important factor in the formation of pulp stones.

Bitewing radiography processing and evaluation

All bitewing radiographs were taken at the Erciyes University, Faculty of Dentistry, Department of Dentomaxillofacial Radiology, Kayseri, Turkey, with Trophy X-ray unit by using Insight Films (Eastman, Kodak, Rochester, NY) with bitewing film holders. The films were processed in an automatic film processor using fresh Kodak RP X-OMAT processing solutions (Eastman, Kodak).

Each radiograph was viewed in subdued ambient light using transmitted light from a standard view box under a magnifying lens by two independent investigators who have experience and research in this field separately. Two experienced dentists interpreted all radiographs and evaluated

the presence of pulp stones twice during a 14-day period. Only the maxillary and mandibular molars (wisdom teeth were excluded) and premolars were included. Subjects with crowns or bridges that prevented adequate vision of the pulp chamber were not included in the study sample. Considering that teeth with deep fillings and carietic lesions are more inclined to have pulp stones, only teeth which were non-carious and unrestored, or those with shallow fillings, were included.

A tooth was recorded as having a pulp stone only when a definitive radiopaque mass was identified in the pulp chamber. The teeth were categorized into teeth with pulp calcification and teeth without pulp chamber calcification. When the pulp chamber was completely radiolucent, the tooth was scored as having no pulp chamber calcification.

Statistical analysis

The prevalence of pulp stones was calculated as the percentage of the total number of subjects. Statistical evaluation was performed using the Statistical Package for Social Sciences v 15.0 (SPSS Inc. Chicago, Illinois, USA). The frequency of distribution was calculated by descriptive statistics. The Chi-squared and Mann Whitney U tests were used to investigate the correlations between the presence of pulp chamber calcification and age, gender, dental status and kidney stone.

RESULTS

A total of 232 patients were included for this study. Patients with kidney stones were between 20 and 74 years with a mean age of 42 years. The control group was between the age of 20 and 69 years with a mean age of 40 years. Care was taken in order to choose an age-matched control group, and patients over 20 years were included in the study; younger patients (age < 20 years) were not included in the control group because kidney stone subjects start at age 20 years. Table 1 shows the distribution of patients' ages according to groups. No correlation was detected between patient age and the presence of pulp chamber calcifications ($p > 0.05$) in this subpopulation group because the younger patients (age < 20 years) were not taken into account. Mann-Whitney U test did not show any significant difference between the ages of kidney stone patients and the control group ($p = 0.085$). Since age increase is accepted to be related to pulp stone prevalence, this finding is meaningful for our controlled study design.

For the kidney stone patients group, pulp chamber opacities were detected in 199 (19.3%) out of the 1031 examined teeth, and pulp chamber opacities were detected in 84 (72.4%) out of the 116 patients examined. For the control group, pulp chamber opacities were detected in 86 (74.1%) out of the 116 patients examined. There was no statistically significant difference between the study and control group ($p = 0.882$).

A significant relationship was observed for the presence of pulp chamber calcifications between genders on the basis of tooth number included in the study [$p < 0.001$] (Table 2).

Table 2: Number of teeth with pulp stone according to gender ($p < 0.001$)

Pulp chamber calcification	Female		Male		Total	
Absent	1024	76.4%	1186	81.6%	2210	79.1%
Present	317	23.6%	268	18.4%	585	20.9%
Total	**1341**	**100%**	**1454**	**100%**	**2795**	**100%**

The prevalence was significantly greater in women than men ($p < 0.001$). Table 3 shows the distribution of the numbers and the percentages of patients with pulp chamber calcifications for both genders.

Table 3: Number of patients with pulp stone according to gender

Pulp chamber calcification	Kidney stone n (%)		Control n (%)	
	Female	Male	Female	Male
Absent	6 (16.70%)	26 (32.50%)	16 (22.90%)	14 (30.40%)
Present	30 (83.30%)	54 (67.50%)	54 (77.10%)	32 (69.60%)

On the basis of tooth number, there was no significant difference in pulp stone prevalence between maxilla (19%) and mandible (21%) for the kidney stone patients ($p = 0.435$) and for the control group. Table 4 shows the distribution of tooth numbers and percentages among maxilla and the mandible.

Prevalence of pulp stone was evident in 20% on the right and 21% on the left side for the study group. Prevalence of pulp stone was evident in 21% on the right and 22% on the left side for the control group. For both groups, statistically similar frequencies were found between sides ($p = 0.671$). Table 5 shows the distribution of tooth number according to occurrence between sides.

Among the types of teeth examined, the prevalence of pulp stones in the first premolar teeth was 4% and 5% for the

Table 1: Patients' ages (in years) according to groups

	Mean	Maximum	Minimum	Median	Percentile 25	Percentile 75
Kidney stone	42	74	20	44	34	49
Control	40	69	20	39	35	44

Table 4: Tooth numbers and percentages among the maxilla and the mandible

	Pulp stone			Control		
	Mandible	**Maxilla**	**Total**	**Mandible**	**Maxilla**	**Total**
Pulp stone absent	514 79.0%	473 80.9%	987 79.9%	643 80.8%	580 76.0%	1223 78.4%
Pulp stone present	137 21.0%	112 19.1%	249 20.1%	153 19.2%	183 24.0%	336 21.6%
Total	**651 100%**	**585 100%**	**1236 100%**	**796 100%**	**763 100%**	**1559 100%**

Table 5: Tooth number with and without pulp stones according to occurrence between sides

	Pulp stone		Control	
Pulp chamber calcification	**Left**	**Right**	**Left**	**Right**
Absent	484	503	611	612
Present	126	123	174	162
Prevalence	21%	20%	22%	21%

second premolar. There was no statically significant difference among premolars ($p = 0.713$). First premolar teeth were the least commonly affected teeth in both arches and genders. The prevalence was 45% for the first molar teeth and 34% for the second molars. There was a statistically significant difference between the prevalence among molar teeth ($p = 0.008$). While first molars were the most commonly affected teeth in both arches [46%] ($p < 0.001$), second molars were the second most commonly affected teeth in the mouth. Table 6 shows the distribution of tooth types according to pulp stone prevalence for both groups.

In the study group, 22 patients (19.0%) had only one tooth with a pulp chamber calcification, while 62 patients (53.4%) had more than one tooth with pulp chamber calcifications. Six patients (5.2%) had eight teeth with pulp chamber calcifications (Table 7).

DISCUSSION

Pulp stones are often incidental findings on dental radiographs and in the literature the incidence of pulp stones has been investigated in many studies using radiographic criteria (4, 5, 8, 9, 20, 21) or histological sections (22). The detection of pulp stones can be observed by dental radiograph when their sizes are bigger than 200 μm. Therefore, although the prevalence is likely to be higher when detected from the radiographic studies, radiographs are the only way of evaluating pulp stones non-invasively in clinical research (1, 5, 13). In the studies, panoramic, bitewing and periapical radiographs were used and it was stated that periapical and bitewing radiographic techniques did not show significant differences in the diagnosis of pulpal calcification (8, 11, 23). For this study, the bitewing radiographic technique with standard film holders was preferred, since, in the paralleling technique, a more standard picture can be obtained by having the central beam perpendicular to the long axis of the teeth (4).

In the literature, there are conflicting results on the correlation between systemic disorders and pulp stones.

Table 6: Distribution of pulp stones according to tooth type

	Kidney stone group				Control			
Pulp chamber calcification	**First molar**	**First premolar**	**Second molar**	**Second premolar**	**First molar**	**First premolar**	**Second molar**	**Second premolar**
Absent	133	343	207	304	182	390	269	382
Present	110	15	108	16	173	24	118	21
Prevalence	45%	4%	34%	5%	49%	6%	30%	5%

Table 7: Distribution of teeth numbers with pulp stones between genders

	Number of individuals having different numbers of teeth with pulp chamber calcifications									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Female	6 5.2%	6 5.2%	9 7.8%	5 4.3%	5 4.3%	0 0.0%	2 1.7%	0 0.0%	3 2.6%	36 31.0%
Male	26 22.4%	16 13.8%	19 16.4%	2 1.7%	6 5.2%	3 2.6%	4 3.4%	1 0.9%	3 2.6%	80 69.0%
Total	**32 27.6%**	**22 19.0%**	**28 24.1%**	**7 6.0%**	**11 9.5%**	**3 2.6%**	**6 5.2%**	**1 0.9%**	**6 5.2%**	**116 100%**

While Maranhao de Moura and de Paiva (24), Bernick and Nedelman (25), Nayak *et al* (13) and Edds *et al* (20) reported increased pulp stones in subjects with cardiovascular patients, Krell *et al* (26) showed no similar changes in pulpal arterioles in atherosclerotic monkeys. The same conflicting results are currently reported for the diabetic patients. In their study, Russell (27) and Nayak *et al* (13) detected that Type II diabetic patients had more pulp stones than the control group (13), while in another histopathological study by Bissada and Sharawy, there were no vascular changes found in the dental pulp of both study and control groups (28).

The prevalence of nephrolithiasis is increasing in the USA (29) and the prevalence is found to be 11.1% in Turkey (30) and varies between 2 and 20% worldwide (18). When compared with the general population, kidney stone is associated with a higher prevalence of chronic diseases and adverse cardiovascular outcomes (19, 31, 32). In the literature, pulpal calcification is reported to be common in patients with ESRD and transplanted patients. A strong correlation between the chronicity of the renal disease and pulp narrowing has been observed (14, 15). In our study, no statistically significant difference was found in the prevalence of pulp stones between the study and control groups ($p = 0.882$).

On the basis of the number of patients, we found the rate of prevalence to be 72.4% in the kidney stone patients and 74.1% in the control group, which was higher than the reported prevalence in our previous study (1). In our previous study, the mean age was 25 years and in the current study, it was 42 years. Therefore, this may explain the higher prevalence in the current study, since the prevalence and complexity of pulpal calcification increase with age (3, 25). In previous studies which examined the teeth, the prevalence of pulp stones was reported as 14.8% (4), 22.4% (8) and 10.1% (5). In the present study, however, we found that the prevalence of pulp stones was 19.3% in 199 of 1031 teeth examined for the kidney stone patients and no statistically significant difference was found between the study and control groups ($p = 0.882$). This current finding is consistent with the prevalence reported in the literature.

The prevalence of pulp stones noted in females and males in this study agrees with previous studies (1, 4, 9, 33). Pulp stones were more frequently encountered in females than in males, with significant differences between the genders ($p < 0.001$). Ranjitkar *et al* (5) suggested that chronic pulp irritation might lead to pulp stone formation and, since bruxism is a longstanding chronic irritation to dentition and it is more prevalent in women, this may be a possible explanation for the difference in the rates of pulp stone formation between the genders. When we compare the arches in aspect of pulp stone formation, there are studies indicating higher frequency of pulp stones in the maxilla (1, 5) and some studies indicating higher frequency in the mandible (4, 8). However, in the current study, there was no significant difference in pulp stone prevalence between the maxilla (19%) and mandible (21%) for the kidney stone patients ($p = 0.435$) and for the control group which is consistent with the finding of the study conducted by Moss-Salentijin and Hendricks-Klyvert (34). In the present study, the frequency of pulp stones was similar on the right and left side for both groups. However, Nayak *et al* (13) found higher prevalence on the right side and Ranjitkar *et al* (5) on the left side.

The prevalence of pulp stones in the present study was found to be higher in the first molars than in the second molars and premolars; this finding also confirms the results of other studies (1, 2, 4, 5, 8, 13, 21). This result may be related to the fact that the molars are the largest teeth in the arch, provide a better supply of blood to the pulp tissue and have the strongest chewing force in the arch. Besides, since the first molar teeth are the first erupting teeth in the oral cavity, the longer duration of these teeth in the oral cavity means longer chewing forces acting on them and may be another explanation. These may lead to greater precipitation for calcification (1).

The aetiological factors for the formation of pulp stones are not well understood. Age, gender, systemic disease and long-term irritation such as deep caries and restorations have been proposed as possible implicated factors in the development of pulpal calcifications (20, 26). Although the currently held clinical view is that pulp stones have no clinical significance, they lead to complications when endodontic therapy is needed; their large size in the pulp chamber may block access to canal orifices and alter the internal anatomy, and attached stones may deflect or engage the tip of exploring instruments, preventing their easy passage down the canal (2).

In conclusion, there is a positive correlation between pulpal calcification and systemic disorders such as cardiovascular disease (6, 20, 24), Type II diabetes (13) and renal disease (14, 15) in the literature. No correlation was found between kidney stones and pulp stones in the investigated group. Although dental radiography is an easy screening method which shows the presence of pulp stones, these calcifications do not seem to be correlated with the presence of kidney stones.

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