



cavity or root canal, these stones often narrow or even obstruct the access to the apical point root canal. The calcification of pulp tissue might lead to the failure of root canal therapy and loss of the teeth.<sup>[8]</sup>

Pulp stones have been noted to vary in number from one to 12 or more in a single tooth, their size varying from minute particles to large masses occluding the pulp cavity.<sup>[9,10]</sup> They have been reported to occur more often in coronal pulp<sup>[9]</sup> although they are also found in radicular pulp.<sup>[10,11]</sup>

The frequency of occurrence of pulp stones has been reported to increase with age.<sup>[12,13]</sup> Some studies did not find any difference in occurrence between genders,<sup>[10,13-15]</sup> whereas other studies have found females to have more pulp stones than males.<sup>[15-17]</sup>

The prevalence of PS varies from 8% to 90%, depending on the study type, design and radiographic technique employed.<sup>[18]</sup> Histological method of evaluation is reported to yield higher values than radiographic method.<sup>[10]</sup>

The purposes of this study were to describe the prevalence of pulp stones in a sample of Turkish dental patients using panoramic radiographs and; to explore possible associations between pulp stones and sex, tooth type, dental arch, side and dental status; and to compare the results with published data. This will provide the dental practitioner with information about the types of the teeth which are more likely to exhibit technical difficulties associated with the endodontic treatment of such teeth.

## Materials and Methods

This is a retrospective study carried out in Turkey from July 2009 to August 2011. Before then such studies do not require prior ethical approval in our institution. This information is available in Turkey at <http://www.resmigazete.gov.tr/eskiler/2011/08/20110819.htm>. We designed a descriptive study composed of panoramic radiographs from 8568 patients (4324 women and 4243 man, age range from 15 to 50 years) attending Kirikkale University Dental Faculty Hospital, Kirikkale, Turkey for routine dental examination during the period from July 2009 to August 2011 were reviewed for the presence of pulp stones. Digital panoramic radiographs were taken using PAX-UNI3D (Vatech Co., Králové-Březhrad, Czech Republic) digital radiography systems. All data (age and sex) was obtained from the files. Radiographic interpretation was undertaken by two experienced examiners.

Exclusion criteria included patients who were less than 15 years of age at the time of radiographic examination, records with poor quality radiographs and record with radiographs of only primary teeth. In addition, carious, restored and fractured teeth were not included. The final sample included 6912 patients (3860 females and 3052 males, mean age: 29.0 years from 15 to 50 years).

Inclusion criteria included: A tooth was recorded as having a pulp stone only when a definitive radiopaque mass was identified in the pulp chamber. Each radiograph exhibiting this criterion was re-examined carefully by both examiners twice and a combined decision was made to either consider the tooth is having pulp stones or not. For each patient with pulp stones we recorded the demographic variables (including age, sex), number, location (maxilla or mandible).

The examiners were calibrated by reading 100 radiographs separately; containing 15 different cases of pulps stones before the investigation began. The examiners re-read together a sample of panoramic radiographs containing pulp stones 2 week after the first examination and a 100% agreement was obtained. The observations were entered and analyzed using the computer program, SPSS 12 (SPSS Inc. Chicago, USA). The overall incidence of pulp stones in the patients and their correlations between female and male patients and between the right-side and left-side occurrences were analyzed by using the  $\chi^2$  test. The bilateral incidences of pulp stones were also evaluated. Differences were considered as significant when  $P < 0.05$ .

## Results

Panoramic radiographs of 6912 patients, 3860 females and 3052 males, with age range of 15-50 year and average of 29.4 (8.7) were studied.

Almost equal numbers of maxillary (48437) and mandibular teeth (47803) were examined. Pulp stones were detected in 2009 teeth out of a total of 96240 teeth to give a tooth prevalence of 2.1% [Table 1].

Eight hundred seventy nine patients had at least one tooth with a pulp chamber calcification. Thus the person prevalence was 12.7%.

**Table 1: Frequency of the prevalence of pulp stones amongst different tooth types**

Tooth	Number of teeth examined	Number of teeth with pulp stones	Percentage of pulp stones
<b>Maxilla</b>			
First premolar	12124	7	0.06
Second premolar	12158	8	0.07
First molar	12023	733	6.1
Second molar	12132	683	5.6
Total	48437	1431	3
<b>Mandibula</b>			
First premolar	12267	34	0.28
Second premolar	12311	10	0.08
First molar	11642	274	2.35
Second molar	11583	260	0.54
Total	47803	578	1.21
Total	96240	2009	2.1

**Table 2: The distribution of pulp stone according to dental arches, sex and location**

Location	Female						Male						Total	
	Right	(%)	Left	(%)	Total	(%)	Right	(%)	Left	(%)	Total	(%)	Total	(%)
Maxilla														
First premolar	5	0.25	0	0.00	5	0.25	2	0.10	0	0.00	2	0.10	7	0,35
Second premolar	3	0.15	2	0.10	5	0.25	1	0.05	2	0.10	3	0.15	8	0,40
First molar	336	16.72	184	9.16	520	25.88	134	6.67	79	3.93	213	10.60	733	36,49
Second molar	307	15.28	165	8.21	472	23.49	130	6.47	81	4.03	211	10.50	683	34,00
Mandible														
First premolar	14	0.70	4	0.20	18	0.90	12	0.60	4	0.20	16	0.80	34	1,69
Second premolar	3	0.15	1	0.05	4	0.20	2	0.10	4	0.20	6	0.30	10	0,50
First molar	105	5.23	86	4.28	191	9.51	45	2.24	38	1.89	83	4.13	274	13,64
Second molar	98	4.88	85	4.23	183	9.11	27	1.34	50	2.49	77	3.83	260	12,94
Total	871	43.35	527	26.23	1398	69.59	353	17.57	258	12.84	611	30.41	2009	100.00

**Table 3: The distribution of pulp stone according to dental arches and location**

Location	Right	(%)	Left	(%)	Total	(%)
Maxilla						
First premolar	7	0.35	0	0.00	7	0.35
Second premolar	4	0.20	4	0.20	8	0.40
First molar	470	23.39	263	13.09	733	36.49
Second molar	437	21.75	246	12.24	683	34.00
Mandible						
First premolar	26	1.29	8	0.40	34	1.69
Second premolar	5	0.25	5	0.25	10	0.50
First molar	150	7.47	124	6.17	274	13.64
Second molar	125	6.22	135	6.72	260	12.94
Total	1224	60.93	785	39.07	2009	100

Table 2 presents the distribution and prevalence of pulp stones according to the gender of patients. Pulp stones were detected in 14.2% (574/3680) of female patients and in 10% (305/3052) of male patients with significant difference between the genders ( $P < 0.001$ ) [Table 2].

The distribution of pulp stones among different teeth in the upper and lower arches is shown Table 3. Pulp stones were significantly more common in the maxilla 3% (1431 of 48437 teeth) compared with mandible 1.21% (578 of 47803 teeth). Pulp stones were found in only 0.12% (59/48860) of the premolars and in 4.12% (1950/47380) of the molars examined, with differences in occurrence being statistically significant ( $P < 0.001$ ). The frequency of pulp stones was higher in the first molars than in the second molars in each dental arch and when data for both arches were combined ( $P < 0.001$ ) [Table 4]. However, in the maxilla, pulp stones occurred more frequently in second premolars than first premolars whereas in the mandible, first premolars accounted for more pulp stones than in second premolars. Pulp stones were more prevalent on the right side (1224 teeth, 61%) than on the left side (785 teeth, 39%). Association between increasing age and pulp stones occurrence were not observed [Table 5]. Figure 1 shows examples of pulp stones with different tooth types detected by panoramic radiography.



**Figure 1:** Examples of pulp stones belonging different tooth types on formed panoramic radiography

## Discussion

The data of the present study were collected from the examination of panoramic radiographs from patients who attended Kırıkkale University Dental School (KUDS). Caution was taken in extrapolating the results of the present survey to larger population. This study investigated pulp stones in adults. No attempt was made to include examination of pulp stones in the permanent teeth of children. The results reflect the prevalence of pulp stones only in patients who attended dental clinics at KUDS. However, there is no reason to believe that this group of patients is different from other Turkish adults. No data were found indicate genetic, social and geographical differences in the prevalence of pulp stones among other nations.

Pulp stones (PS) are calcified bodies in the dental pulps of the teeth in the primary and permanent dentition. They can be seen in the pulps of healthy, diseased, and even unerupted teeth.<sup>[2]</sup>

Most publications concerning pulp stones are case reports and only a few have reported the prevalence of this anomaly. The

**Table 4: The occurrence of pulp stones in each tooth type, arch and location**

Location	Maxilla								Mandible								Total
	Right				Left				Right				Left				
	FM	SM	FP	SP	FM	SM	FP	SP	FM	SM	FP	SP	FM	SM	FP	SP	
N	470	437	7	4	263	246	0	4	150	125	26	5	124	135	8	5	2009
N	907		11		509		4		275		31		259		13		2009
N	918				513				306				272				2009
N	1431								578								2009

**Table 5: Distribution pulp stone by age**

Patient	No. of patients	No. of patients with PS	Percent of patients with PS
Age (years)			
15-19	538	30	5.58
20-29	1322	333	25.19
30-39	1071	336	31.37
40-49	715	180	25.17
Total	3646	879	24.11

incidence of pulp stones has been reported to be from 8% to 95% in the permanent dentition.<sup>[5,10,13,16,17,19,20]</sup> The results of the present study on a group of Turkish dental patients has shown an overall prevalence of 12.7% for individuals and 2.1% for all teeth examined teeth. This figure is higher than the results of the study by Renjitker *et al.*<sup>[10]</sup> (10.3%) young Australian adults and less than the study by Hamasha *et al.* among Jordanians<sup>[13]</sup> (22.4%) and Baghdady *et al.*<sup>[5]</sup> (14.8%) among teenage Iraqi group. The variation in the pulp stones prevalence could be explained by variation of the condition among different nations or variation in the sample examined or examination criteria. In a recent study<sup>[17]</sup> performed in Turkish population revealed the prevalence of pulp stones 57.6% which was considerably higher than our study. However, Gulsahi *et al.*<sup>[18]</sup> reported a prevalence of 12% pulp stones in Turkish dental patients which was very close to our findings. These contradictory findings in the same population may be explained with marked differences in the sample size.

In the present study, women presented a higher prevalence of pulps stones than men and these differences were statistically significant ( $P < 0.001$ ). This finding is consistent with other studies previously reported.<sup>[5,16,17,21]</sup> However, according to another studies, significant difference were not observed between genders.<sup>[10,20]</sup> In the literature, bruxism which causes longstanding irritation on the dentition was thought to be the reason of this difference because it is more prevalent in women.

Regarding the location of observed pulp stones in the present study, most of the pulp stones were found to be in the maxillary arch especially the first molar teeth. This finding is consistent with other studies which were performed by of Sisman *et al.*,<sup>[17]</sup> Tamse *et al.*,<sup>[16]</sup> and Ranjitkar *et al.*<sup>[10]</sup> However, Hamasha<sup>[13]</sup> found pulp stones to be more frequent in the mandibular first molar teeth. 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. This may lead to greater precipitation for calcification<sup>[17]</sup>

According to the results of our study, pulp stones occurred more frequently on the right side than on the left side ( $P < 0.001$ ). This result was conflicted with the results of Turkish population<sup>[17]</sup> and Australians.<sup>[10]</sup> The noted inter-study variation may relate to sample size and case selection so further investigations are necessary to clarify the issue.

Earlier studies showed association between advancing age and increasing rate of PS occurrence.<sup>[16,20,22]</sup> In present study age was not found related with pulp stones which was consisting with other reports.<sup>[5,17]</sup> This may be due to the fact that, the majority of the patients were in the second and third decades of their lives and there were no patients older than 50 years in our study. According to our findings showed decrease in prevalence of pulp stones in the 40-49 age range compared to the 30-39 age range. However, this results is questionable whether prevalence and distribution vary across studies, possibly due to variations in study design, sampling procedures and type of radiograph and techniques employed.

As far as the etiology of pulp stones is concerned, much controversy exists. Some factors that have been implicated in pulp stone formation include age,<sup>[12,23]</sup> impaired pulpal blood supply,<sup>[14]</sup> genetic predisposition,<sup>[24]</sup> or long-standing irritants such as caries, deep fillings, or abrasion.<sup>[11,12,25]</sup>

There are conflicting reports in the literature regarding association between presence of pulp calcification and systemic disturbance. In their study Moura and Paiva<sup>[26]</sup> confirmed increased pulpal calcifications in subjects with coronary atherosclerosis upon radiographic examination. Likewise, a pilot study of correlations of pulp stones with cardiovascular disease demonstrated that patients with cardiovascular disease have an increased incidence of pulp stone.<sup>[27]</sup> However, recent study, Horsley *et al.* did not find a strong correlation between

the presence of pulp calcification and carotid calcification.<sup>[23]</sup> Further studies that have longitudinal data on larger samples would help to investigate this association.

At the end of the discussing the findings in detail, it would

be worthwhile describing some limitations and strengths of this study. One of the main limitations would be results from included the method of radiographic assessment which included only panoramic radiographs, did not give a clear picture of the posterior teeth with pulp stones. The presence of pulpal calcification is often determined from bitewing projections due to compared to panoramic radiographs, these radiographs are normally accurate images of the object without major distortion or magnification. Beside these disadvantages, panoramic radiographs show the entire mouth area—all teeth on both upper and lower jaws—on a single X-ray. It would seem apparent that panoramic images would be excellent for screening for pulpal calcifications as all the teeth can be evaluated using the same image.<sup>[23,28,29]</sup>

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