



## Prevalence of Pulpal Stones in a Saudi Subpopulation

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### ABSTRACT

**Introduction:** The aim of the study was to determine how prevalent pulpal stones are in the Saudi subpopulation utilizing periapical radiographs, and also to see if there is any correlation between pulpal stone and age, sex, position in the dental arch or any other dental condition or irritant. **Methods:** A sample of 700 patients were randomly selected from the dental records available in the database at College of Dentistry, University of Hail. The final sample was 298 dental patient records, 1306 teeth were examined from 1052 periapical radiographs, both parallel and bisecting techniques were included. All radiographs were examined by two examiners. Data were analyzed using (SPSS) utilizing Chi-square analysis. Any difference was considered significant if the  $p \leq 0.05$ . **Results:** Of the 298 patients, 153 were males and 145 were females. We assessed a total of 1306 teeth for the presence of pulp stones. The overall prevalence of pulp stones in the whole study population was 28% and the prevalence based on the number of teeth examined was found to be 12%. The prevalence of pulpal stones was noted to be higher in molars, and in non-intact teeth. **Conclusion:** The prevalence of pulp stones in the Saudi subpopulation studied was 28% in patients, and 12% in all teeth. Pulp stones prevailed more in carious and restored teeth. Aging was associated with an increase in pulpal stones incidence. Sex predilection, however, didn't have any influence on the occurrence of pulpal stones.

**Keywords:** Pulp stones, Primary teeth, Odontoblasts

### INTRODUCTION

Pulp stones can be defined as foci of calcification that were in any portion of the pulp both in permanent and primary teeth. These can be found in sound teeth, carious teeth and even seen in unerupted teeth [1,2]. Structurally, the pulp stones can be classified into three types, true stone which is composed of normal tubular dentine that is lined by a number of odontoblasts, second type is false, where the pulp stones formation is from mineralized degenerated pulp cells, and the third is the amorphous type which is different in shape and has more irregularities than the false type, The True type is further classified to free and attached types [3,4].

Pulp stones are commonly detected during the routine radiographic examination as radiopaque ovoid or circular mass within the pulp chamber and can vary in number and size in a single tooth. In number, it has been reported to be from 1 to 12 or more in a single tooth, varies in shape and size, from a microscopic particle to a large macroscopic mass obliterating the chamber [4-7]. They are more prevalent and occur more often in the coronal part of pulp compared with the radicular portion [8].

The prevalence of pulpal stones ranges between 8% up to 90%, however, any stone less than 200  $\mu\text{m}$  is not possible to detect on radiographs, therefore the real incidence of pulpal stones could be much higher [6,9-11]. The prevalence of pulpal stones is associated with aging and with various factors like long-standing chronic irritants to the pulp including caries, periodontal diseases, operative procedures, orthodontic tooth movement, genetic predisposition, and any other factor [6,7,12-19]. Studies vary regarding the occurrence between males and females, some reported females having

more pulp stones while other studies haven't shown any difference between the two genders [12,15,16,20-23]. The aim of the study was to find the prevalence of pulp stones in permanent teeth utilizing periapical radiographs and to explore for any correlation between pulp stone and age, sex, position in the dental arch or any dental condition or irritant.

### MATERIALS AND METHODS

This was a retrospective study with a sample of 700 that were randomly selected from the dental records available in the database at College of Dentistry, University of Hail. Inclusion criteria included all periapical radiographs of high diagnostic quality for patients older than 15 years of age. Only permanent teeth with closed apices were included, thus any primary tooth or immature permanent were excluded. The final sample was 298 dental patient records, 1306 teeth were examined from 1052 periapical radiographs, both parallel and bisecting techniques were included. All radiographs were examined by two examiners. Pulp stone was scored when a clear radiopaque mass was identified in the pulp or the canal space. The status of each tooth was evaluated from both the patient file and radiograph for that specific tooth. All data were recorded in separate sheets manually, files numbers were recorded, then the result was compared between the two examiners, verification was done by going through the files numbers that had different results, after verification they were uploaded in a combined excel sheet. Different results were found in 12 files, thus there was a 96% agreement between the two examiners which indicates a highly reliable investigating method. Data were analyzed using (SPSS) utilizing Chi-square analysis. Any difference was considered significant if the  $p \leq 0.05$ .

### RESULTS

Our study was done in 298 participants of both genders which involved 145 females and 153 males. We assessed a total of 1306 teeth for the presence of pulp stones. The mean age of the participants was found to be  $35.3 \pm 11.95$  of which females' mean age was  $33.73 \pm 11.30$  and males' age was  $36.9 \pm 12.37$  (Table 1). The overall prevalence of pulp stones in the whole study population was 28% (n=84) (Figure 1) and the prevalence based on the number of teeth examined was found to be 12% (n=158) (Figure 2).

Table 1 Mean age of the participants

Gender	N	Mean	Std. Deviation
Female	145	33.7	11.3
Male	153	36.9	12.37
Total	298	35.3	11.95

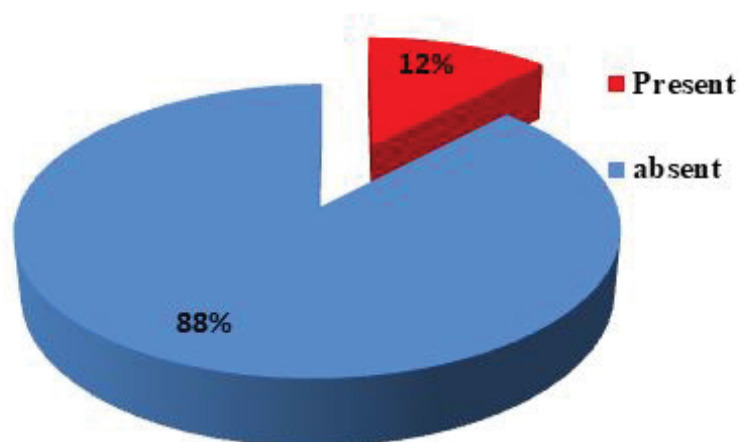


Figure 1 Prevalence of pulp stones (all teeth examined)

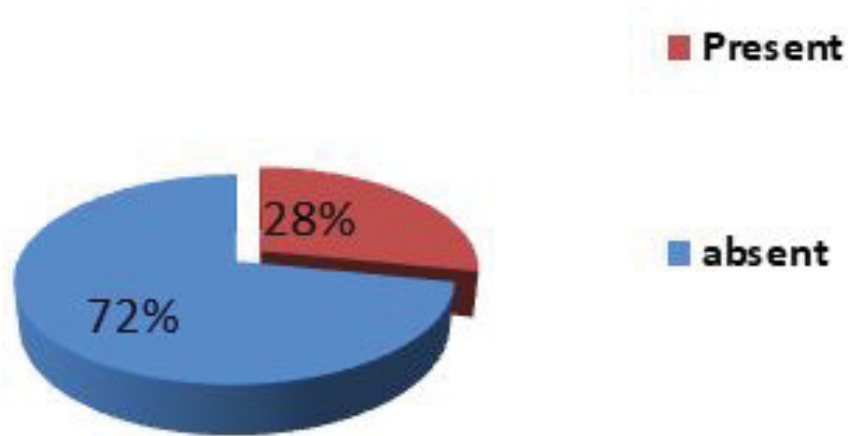


Figure 2 Prevalence of pulp stones (according to individuals)

Amongst the females, the prevalence of pulp stones was about 26.2% (n=38) and in males, it was about 30.1% (n=46). When the association of prevalence of pulp stones with both gender was assessed, it was found that there was no statistically significant association seen,  $p > 0.05$  (Table 2).

Table 2 Prevalence of pulp stone according to gender

Gender		Pulp Stone		Total	Chi-Square Value	p-value
		Absent	Present			
Female	N	107	38	145	0.548	0.52
	%	73.80%	26.20%	100.00%		
Male	N	107	46	153		
	%	69.90%	30.10%	100.00%		
Total	N	214	84	298		
	%	71.80%	28.20%	100.00%		

In males, we examined 676 teeth for pulp stones and found out that 88 (13.01%) teeth had the presence of pulp stones in any form. Whereas the prevalence was 11.11% (n=70) in the female when 630 teeth were assessed for the presence of pulp stones. This also showed no significant association between genders with the presence of pulp stones (Table 3).

Table 3 Prevalence of pulp stones according to teeth examined and their relationship based on gender

Gender	Teeth Examined		Teeth with Pulp Stones		Chi-square	p-value
	N	%	N	%		
Male	676	51.76%	88	13.01%	8.36	0.399
Female	630	48.24%	70	11.11%		
Total	1306	100.00%	158	12.09%		

When the prevalence of pulp stones based on age was assessed, it was found that the 2 participants (15.4%) who belonged to the age group of 10-19 years had the presence of pulp stones. The prevalence was found to be 20.4%, 23.7%, 41.8%, 35% and 50% in the age groups of 20-29, 30-39, 40-49, 50-59 and >60 years of age groups respectively. We observed that the prevalence increased or was more as the age increased. In short, the prevalence was more in higher age groups (age groups of >40 years) and lower in lower age groups (10-19 and 20-29 years) and it's showed a statistically significant association  $p < 0.05$  (Table 4).

Table 4 Relationship of age with the prevalence of pulp stones

Age of the Participants (in years)		Pulp Stone Prevalence			Total	Chi-square Value	p-value
		Absent	Present				
10-19	n	11	2	13	14.165	0.015*	
	%	84.60%	15.40%	100.00%			
20-29	n	74	19	93			
	%	79.60%	20.40%	100.00%			
30-39	n	71	22	93			
	%	76.30%	23.70%	100.00%			
40-49	n	39	28	67			
	%	58.20%	41.80%	100.00%			
50-59	n	13	7	20			
	%	65.00%	35.00%	100.00%			
>60	n	6	6	12			
	%	50.00%	50.00%	100.00%			
Total	n	214	84	298			
	%	71.80%	28.20%	100.00%			

When each tooth type in both arches was assessed for the presence of pulp stones, it was found that in the maxillary arch, the central incisors (C) showed the prevalence of 3.89% and in mandible, it was 5.12%. The maxillary lateral incisor (L) showed a prevalence of 0% and the same tooth in the mandibular arch had a prevalence of 9.3%. Another interesting finding in our assessment was that the prevalence of pulp stones in canines (CN) of both arches was 0%. First premolars (1<sup>st</sup> P) showed a prevalence of 5.06% and 1.8% in maxillary and mandibular arches respectively (Table 5). The prevalence of pulp stones in 2nd premolars (2<sup>nd</sup> P) was 3.9% in maxilla and 3.37% in the mandible. Among all tooth types, the highest prevalence was seen in 1st molars. The maxillary 1<sup>st</sup> Molars (1<sup>st</sup> M) showed a prevalence of 29.33% and in mandible the same tooth had a prevalence of 25.95%. In the second molars (2<sup>nd</sup> M) there was a prevalence of 19.28% in the maxilla and 13.63% in the mandible. The third molars (3<sup>rd</sup> M) showed 19.56% and 5.45% prevalence of pulp stones in maxilla and mandible respectively (Table 5). When the association of presence of pulp stones with different types of teeth in both arches was assessed (Inter tooth relationship in the same arch), it was observed that all the molars (first, second and third) in maxillary arch had a higher prevalence of pulp stones when compared to central, lateral, canine and premolars. This association was statistically significant,  $p < 0.001$  (Table 5). The third molars of maxillary arches had a higher prevalence than the mandibular arch and it was statistically significant,  $p < 0.05$  (Table 5).

Table 5 Prevalence of pulp stones based on each tooth type in different arches and its relationship

	Teeth Examined	C		L		CN		1 <sup>st</sup> P		2 <sup>nd</sup> P		1 <sup>st</sup> M		2 <sup>nd</sup> M		3 <sup>rd</sup> M		Total		Chi-square Value	P-value
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%		
Maxilla	Pulp stone absent	74	96.10%	50	100.00%	46	100.00%	75	94.94%	123	96.10%	106	70.67%	113	80.72%	37	80.44%	624	87.16%	76.514	<0001
	Pulp stone present	3	3.90%	0	0.00%	0	0.00%	4	5.06%	5	3.90%	44	29.33%	27	19.28%	9	19.56%	92	12.84%		
Mandible	Pulp stone absent	37	94.88%	39	90.70%	30	100.00%	52	98.20%	103	96.27%	97	74.05%	114	86.37%	52	94.55%	524	88.81%	47.33	>0.05
	Pulp stone present	2	5.12%	4	9.30%	0	0.00%	1	1.80%	4	3.73%	34	25.95%	18	13.63%	3	5.45%	66	11.19%		
Inter arch relationship of each tooth type	Chi-square value	0.095		4.86		NA		0.878		0.004		0.39		1.57		4.76		0.84			
	p-value	0.757		<0.05		NA		0.348		0.946		0.528		0.21		<0.05		0.359			

We also assessed the relationship of the prevalence of pulp stones with carious, restored, crowned and sound/intact teeth. Our analysis showed that there was no statistically significant relationship observed in the intra arch and inter arch assessment of the prevalence of pulp stones with the presence of caries (carious tooth) (Table 6).

**Table 6 Relationship of prevalence pulp stones with carious teeth based on arch and tooth type**

	Carious Teeth	C		L		CN		1 <sup>st</sup> P		2 <sup>nd</sup> P		1 <sup>st</sup> M		2 <sup>nd</sup> M		3 <sup>rd</sup> M		Total		Chi-square value	p-value
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%		
Maxilla	Pulp stone absent	2	66.66%	0	0.00%	0	0.00%	3	75.00%	3	60.00%	33	75.00%	23	82.70%	7	77.78%	71	77.20%	1.009	0.961
	Pulp stone present	1	33.33%	0	0.00%	0	0.00%	1	25.00%	2	40.00%	11	25.00%	4	17.30%	2	22.22%	21	22.80%		
Mandible	Pulp stone absent	2	5.12%	4	9.30%	0	0.00%	1	1.80%	3	75.00%	26	76.48%	12	66.67%	3	100.00%	51	77.28%	2.955	0.814
	Pulp stone present	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	25.00%	8	23.52%	6	33.33%	0	0.00%	15	22.72%		
Inter arch relationship of each tooth type	Chi-square value	0.833		NA		NA		0.3125		0.225		0.352		1.283		0.8		0.233			
	p-value	0.361		NA		NA		0.576		0.635		0.552		0.257		0.371		0.629			

When the relationship of the presence of restoration (restored tooth) with the prevalence of pulp stones between each tooth type was assessed, it showed no statistically significant association in both arches. The inter-arch relationship of each tooth type also showed no significant relationship (Table 7).

**Table 7 Relationship of prevalence pulp stones with restored teeth based on arch and tooth type**

	Restored Tooth	C		L		CN		1 <sup>st</sup> P		2 <sup>nd</sup> P		1 <sup>st</sup> M		2 <sup>nd</sup> M		3 <sup>rd</sup> M		Total		Chi-square Value	p-value
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%		
Maxilla	Pulp stone absent	3	100.00%	0	0.00%	0	0.00%	3	75.00%	4	80.00%	34	77.28%	22	81.49%	9	100.00%	75	81.53%	3.36	0.643
	Pulp stone present	0	0.00%	0	0.00%	0	0.00%	1	25.00%	1	20.00%	10	22.72%	5	18.51%	0	0.00%	17	18.47%		
Mandible	Pulp stone absent	2	100.00%	4	100.00%	0	0.00%	1	100.00%	3	75.00%	24	70.59%	16	88.89%	3	100.00%	53	80.31%	5.391	0.494
	Pulp stone present	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	25.00%	10	29.41%	2	11.11%	0	0.00%	13	19.69%		
Inter arch relationship of each tooth type	Chi-square value	NA		NA		NA		0.312		0.032		0.449		0.4511		NA		0.037			
	p-value	NA		NA		NA		0.576		0.857		0.502		0.501		NA		0.8472			

Similarly, crowned teeth also showed no statistically significant relationship with the prevalence of pulp stones both in intra-arch and inter arch assessment (Table 8).

**Table 8 Relationship of prevalence pulp stones with crowned teeth based on arch and tooth type**

	Crowned Tooth	C		L		CN		1 <sup>st</sup> P		2 <sup>nd</sup> P		1 <sup>st</sup> M		2 <sup>nd</sup> M		3 <sup>rd</sup> M		Total		Chi-square Value	P value
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%		
Maxilla	Pulp stone absent	3	100.00%	0	0.00%	0	0.00%	4	100.00%	5	100.00%	44	100.00%	25	92.60%	9	100.00%	90	97.83%	4.54	0.336
	Pulp stone present	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	7.40%	0	0.00%	2	2.17%		
Mandible	Pulp stone absent	2	100.00%	4	100.00%	0	0.00%	1	100.00%	4	100.00%	33	97.06%	18	100.00%	3	100.00%	65	98.50%	0.955	0.987
	Pulp stone present	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	2.940%	0	0.00%	0	0.00%	1	0.15%		
Inter arch relationship of each tooth type	Chi-square value	NA		NA		NA		NA		NA		1.31		1.395		NA		0.089			
	P value	NA		NA		NA		NA		NA		0.2522		0.237		NA		0.764			

When the distribution of pulp stones based on the type was assessed, it was found that in maxilla out of 92, 73 were coronal pulp stones and 19 were radicular pulp stones. In maxillary molars 7 were radicular and 37 were coronal pulp stones. Similarly, second molars in maxilla had 21 coronal and 6 radicular pulp stones. Whereas in mandibular first

molars 26 were coronal and 8 were radicular pulp stones. The details of pulp stones comparison based on arch and tooth type are depicted in (Figure 3).

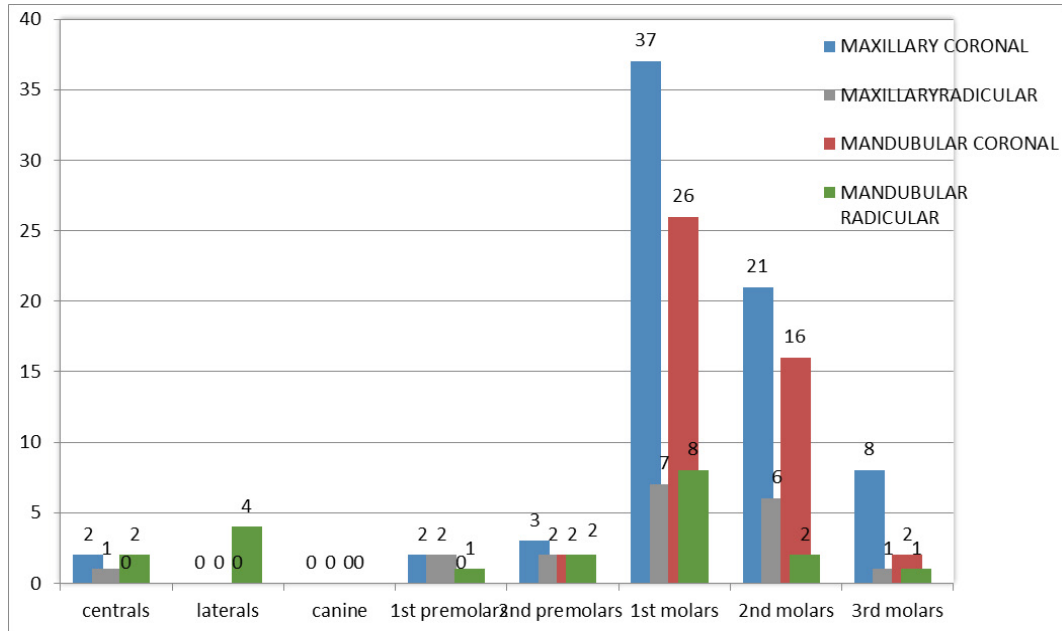


Figure 3 Distribution according to the type of pulp stones based on arch and tooth type

When the distribution of pulp stones among different categories of teeth integrity status, it was found to be high in non-intact teeth (44%), caries being the number one reason (23%, followed by restorations (19%) (Figure 4).

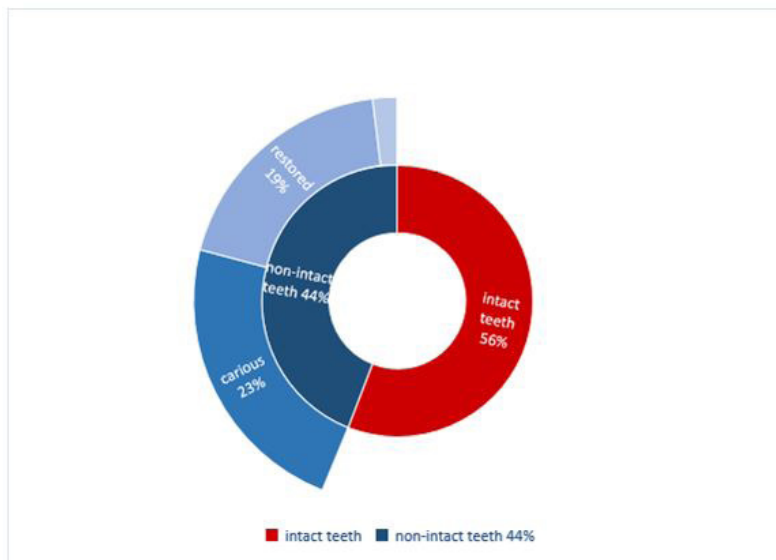


Figure 4 Teeth with pulp stones percentage based on teeth integrity

DISCUSSION

Literature Review

The detection of pulpal stone using a dental radiograph is not possible unless they reach a size larger than 200 microns, therefore the actual prevalence of pulpal stones is more at the microscopic level than the radiographic one [3,6,9-11].

In our study, we included only the periapical radiographs for the exploration for the presence of any pulpal stone, thus we can include both the coronal and radicular types in the study.

Hamasha and Darwazeh did study involved 814 patients in Jordan, the pulp stone prevalence was 51% in patients and 22% in teeth [15]. Ranjitkar, et al., [23] examined 217 patients, they found that 46% of the patients had pulpal stones, and there were 10% of teeth have pulp stone. Saad Al-Nazhan and Saleh Al-Shamrani did a study that includes 600 patients, by bitewing radiographs for all molars and premolars they reported a 10% prevalence of pulpal stones in the teeth [24].

Turkal, et al., have done a study to find the prevalence and the distribution of pulpal stones in posterior teeth by utilizing (OPGs). The results showed that the prevalence was 12.7% in patients and 2.1% for teeth individually. Maxilla was higher for each tooth than mandible. Pulpal stone was found higher on the right side than the left side. Pulpal stone was higher in females than in males [25]. Patil, et al., have done a study by using CBCT of 428 patients covering 2982 teeth to evaluate all teeth, they reported that the prevalence was 50.93% in all the patients, and 13.34% in all teeth [26].

In this study, we examined 298 patients, and we found that there is at least one pulpal stone in 28% of the patients, and in 12% of teeth (Figures 1 and 2). This finding agrees with other studies [6,15,21,23,24,26]. Pulpal stones were slightly more prevalent in males. However, it was not a significant association (Tables 2 and 3). This result agrees with some studies [15,23,27] and disagrees with others [21,26,28].

#### **Age Association**

The youngest patient in this study who had at least one pulpal stone was a 16-year-old male, while the highest reported number of pulpal stones in a single patient was 8, which was seen in a 49 years old male patient. The prevalence was more as the age increased. We found that it was more in the higher age groups (age groups of >40 years) and lower in the lower age groups 10-19 and 20-29 years, the highest being the (>60) group(50%), and the lowest being the 10-19 age group( 15.4%) (Table 4). These findings showed a statistically significant association between pulpal stones and increasing age, this is in agreement with the findings of others [13,20,29,30]. This might be related to the fact that there is decrease in the pulp cell number and the amount of the connective tissue as the age increases [20,30].

#### **Maxilla versus Mandible**

We didn't find any significant differences between maxilla and mandible (Table 5). This result also found in a previous study [15]. However, there are other studies that disagree with this finding [6,23].

#### **Why it's always the First Molar?**

The prevalence of pulpal stones was noted to be higher in molars when compared with other teeth (Table 5), and this was consistent with other studies [6,15,23,27,31]. Among molars, the most prevalent tooth to have pulpal stones in this study was the 1<sup>st</sup> molars (Table 5), this confirms what other studies found [6,21,24,28]. A probable explanation is the first molars erupt earlier compared to other permanent teeth, which make them more susceptible to irritating factors, at least in terms of time [32]. Hamasha and Darwazeh stated that molar teeth, have a better blood supply, leading to more precipitation of calcification in pulpal tissues [15].

#### **Teeth Integrity Relationship**

The prevalence of pulpal stones in this study was high in teeth that had caries or a restoration (Figure 4). Sener, et al., [2] found that pulpal stones occurred as a result of chronic irritation, and pulp stones prevalence in the teeth that were not intact was high. It was stated by several investigators that any irritation to the pulp such as Caries or restorative procedures, will have their effect on the pulp [13,16,20,21,28]. One study examined 470 histologically sectioned teeth to measure the degree of pulpal response that elicited by cutting procedures and to different types of restorative materials. They noted a correlation between the incidence of pulpal stones and an increase in the post-operative extraction time interval [16], carious lesions found to be associated with an increase in the incidence of pulpal stones [6,13]. However, Tamse [2] and Stafne [28] didn't find any significant association between carious and restored teeth with higher incidence of pulpal stones. Also, one study found that existing pulp pathology is not an indicator of pulpal stone formation, and they reported that even young permanent and developing teeth germs could have pulpal stones

[23]. Calcifying nanoparticles found in the air is a recent theory suggesting that they could be an etiological factor for pulpal stone formation [33].

In this study, we noted that the prevalence of pulpal stones in non-intact teeth was 44% and among the different reasons caries and restoration were the main observed for the teeth to lose their integrity (Figure 4).

### Clinical Implications

In clinical practice, the only difficulty or problem that could encounter the practitioner is in endodontic treatment [34]. The attached stones might prevent an easy exploration of the canals and instrumentation [35]. Interestingly, Seltzer and Bender [36] have reported pain of an idiopathic origin; pulpal stones could be the causative for that pain. However, pulpal stones are considered to be a symptom or a sign, rather than being a cause for any changes in the pulpal tissues [11]. Therefore, the presence of pulpal stone solely, shouldn't be dealt with as a pathosis requiring endodontic therapy.

### CONCLUSION

The overall prevalence of pulp stones in the Saudi subpopulation studied was 28%, and 12% among teeth examined. Pulp stones' prevalence was more in carious and restored teeth. Aging was associated with an increase in pulpal stones incidence. Sex predilection, however, didn't have any influence on the occurrence of pulpal stones. Molars in both arches had much higher prevalence than other teeth, first molars being the highest. One difficulty that was encountered is how exactly to score the pulpal stones occurrence, thus we are suggesting the development of a systematic scoring index to be universally applied in future studies, for a better comparison between different studies in different races and countries. A valid scoring system will improve the way that we are looking at these discrete calcifications, by further subdividing them based on different shapes and sizes, it will be very useful for defining certain characteristics and traits for certain races, be also integrated in forensic studies in the future.

### DECLARATIONS

#### Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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