



ORIGINAL ARTICLE

## Frequency of posterior teeth that presented with pulpal calcifications after orthodontic treatment; a retrospective radiographic assessment.

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**ABSTRACT... Objective:** To assess the pulpal calcification that was presented on radiographs after the completion of orthodontic treatment. **Study Design:** Retrospective Observational study. **Setting:** Department of Orthodontic, Ayub Medical College Abbottabad. **Period:** October 2023 to November 2023. **Methods:** Following the inclusion and exclusion criteria, the current study was carried out on patients who had reported and registered for orthodontic intervention within the previous five years and had case records from the orthodontics department available. A total of 670 case records were assessed for selecting 191 cases as per sample size. **Results:** Among 191 patients, 30.4% were male and 69.6% were female. The highest percentage belonged to the 14-16 age group (32%), followed by 20-22 (28.3%), 17-19 (26.2%), and 23-25 (12.6%) age groups. Pre-treatment calcification was 17.8% (n=34), rising to 28.3% (n=54) post-treatment. Pulp calcification significantly increased after orthodontic treatment ( $p < 0.05$ ). No significant differences were found between gender and age groups regarding pulp calcification ( $p > 0.05$ ). However, a significant association existed between pulp calcification and treatment duration ( $p < 0.05$ ). The 25-30 months treatment duration had the highest occurrence (n=27), followed by 31-36 months (n=19). Mandibular teeth had a higher prevalence of pulp calcification (53.7%) than maxillary teeth (46.3%), with tooth number 36 having the highest prevalence (25.9%). A significant relationship was observed between the left and right sides of the dental arches, with the left side exhibiting greater tooth calcification (68.5%) than the right side (31.5%). **Conclusions:** The present study concluded that there was an increase in the frequency of pulpal calcifications in the observed posterior teeth after orthodontic treatment. Pulpal calcifications were significantly more prevalent in the posterior teeth of the mandibular arch compared to the maxillary arch. Moreover, the likelihood of pulpal calcification increased over the duration of orthodontic treatment.

**Key words:** Endodontic Complications, Pulp Stones, Pulpal Chamber, Orthodontic Forces.

### INTRODUCTION

Although the pulp is a soft tissue structure the discrete and diffuse calcifications are the two main morphological types of pulpal calcified structures that can be seen in any part of the pulp tissue. However, specific forms are more frequently found in the pulp chamber and the root canal. Pulp stones are calcified lumps that are openly displayed into the pulp or affixed to and entrenched in the radicular and coronal dentin.<sup>1,2</sup> The causes for these calcifications have been narrated in past and recent literature, but the precise etiology is still unknown. Still aging, dystrophic soft-tissue calcifications, genetic predisposition, abnormal blood circulation, chronic irritation from deep caries, restorations,

and orthodontic tooth movements are just a few of the numerous stimuli that can initiate the process of calcification within the pulp.<sup>3,4</sup>

Orthodontic movements have the potential to alter pulpal and periodontal structures and trigger a complicated cascade of tissue reactions.<sup>5</sup> These pulpal reactions are present because of changes in pulpal respiration rate and blood flow. Clinical findings like pulpal calcification root resorption and secondary dentin development are some of the major presentations because of these alterations. These effects may be long-lasting and result in pulpal necrosis and periapical pathologies. A recent study presented that, after receiving orthodontic treatment, newly developed

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pulp calcification rose noticeably (14.5%) on the post-treatment radiographs.<sup>4,6</sup> Although pulpal calcification by itself does not necessitate endodontic therapy, it does make the prognosis worse. Because there is a chance of difficulties or even failures, the American Association of Endodontics (AAE) views executing endodontic procedures in calcified pulps as a very challenging procedure.<sup>7</sup>

Radiography has been used in numerous prevalence investigations to detect pulp calcifications. Since pulp calcifications smaller than 200  $\mu\text{m}$  are not visible on radiographs, 15% of pulp calcifications go unnoticed or underappreciated, according to Moss Salentijn and Klyvert (1983)<sup>8</sup>, meaning that the true prevalence is probably higher. A more accurate assessment can only be with a Cone Beam Computed Tomography (CBCT) or pulp chamber assessment after opening. Both these methods have serious ethical implications hence impractical on a larger population.<sup>1</sup> While some researchers simply represented the rates based on the number of teeth, others provided the prevalence based on the number of patients.<sup>9,10</sup> In the present study we plan to present the results based on the number of patients. As this will be a more clinically relevant presentation.

The significance of the present study is to provide data on a topic that hasn't been addressed on a national level as yet. Another point is to educate the relevant clinicians about orthodontic treatments and pulpal alterations. The present study was conducted to assess the pulpal calcification that was presented on radiographs after the completion of orthodontic treatment. This was done by assessing the radiographic records of orthodontic cases.

## METHODS

The present retrospective, observational study was conducted at the Dental Section of Ayub Medical College, Abbottabad from October 2023 to November 2023. Once Institutes' ethical review board (ERB) approval was taken (RC-EA-2023/173) all patients who had reported and registered for orthodontic intervention in the

last 5 years with available case records for the Orthodontics department were made accessible (670 case records). A sample of 191 was calculated using the "OpenEpi sample size calculator" with a 95% significance level and taking an expected percentage of exposed outcomes i.e. 14.5%.<sup>3</sup>

## Inclusion Criteria

- Patients of any gender and above 14 years of age with intact posterior teeth.
- Patients underwent orthodontic treatment with pre-and post-operative orthopantomogram (OPG).
- Patients who had gone under a minimum of 1 year of orthodontic treatment.

## Exclusion Criteria

- Patients with a history of extraction, filling, root canal treatment, or crowns of posterior teeth.
- Patients having congenitally missing premolars and molars will be excluded.

## Data Collection

After following the inclusion, and exclusion criteria the radiographic records i.e., pre-and post-operative OPGs were assessed for quality for assessments. Once all the patients' records that could be included were identified they were handed over to two consultants. One was an orthodontist and the second was an endodontist because of their clinical relevance. Both the consultants assessed all the included cases OPGs individually filling in the data proforma. Inter-observer variability was assessed to minimize bias in the radiographic observations between the two consultants.

## Data Analysis

The SPSS package (SPSS for Windows, Version 19.0, manufactured by IBM, Chicago) was used to perform the analysis of data. The frequency and distribution of teeth were presented with pulp calcification before and after the orthodontic treatment. The relation of pulp calcification with age, gender, tooth type, and dental arches was assessed using Pearson's Chi-square test. The level of significance was  $P < 0.05$  for all statistical analyses.

### RESULTS

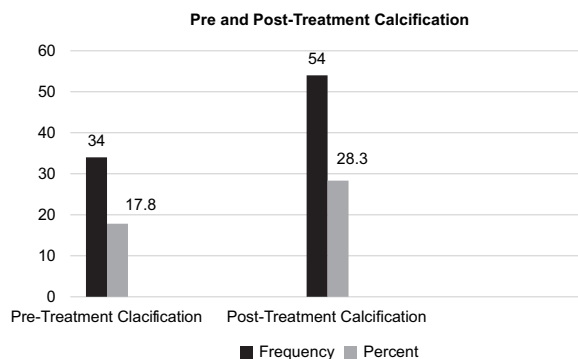
The study's inter-observer correlation coefficients, ranging from 0.92 to 0.94, demonstrated a robust level of agreement among the observers. Furthermore, an impressive 99% agreement rate was observed, indicating a high degree of consensus in the assessments made by the participants.

Out of 191 total patients, 58 (30.4%) were males and 131 (69.6%) were females. The highest percentage was of patients age group 14-16 (n=63, 32%) followed by 20-22 (n=54, 28.3%), 17-19 (n=50, 26.2%), and 24 patients between 23-25 (12.6%). (Table-I)

		Frequency	Percent	
Gender	Male	58	30.4	
	Female	131	69.6	
Age Groups	Years	14-16	63	33
		17-19	50	26.2
		20-22	54	28.3
		23-25	24	12.6

**Table-I. Demographic characteristics of the patients**

A 17.8% (n=34) had pre-treatment calcification which was raised to 28.3% (n=54) post-treatment as shown in Figure-1. The statistical analysis showed that there was an increase (n=20, 10.5%) in pulp calcification after orthodontic treatment (p<0.05).



**Figure-1. Prevalence of pre- and post-treatment calcification**

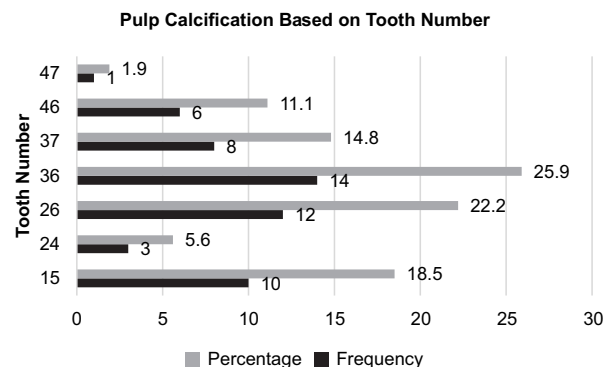
There was no statistically significant difference between patient gender and age groups in terms of pulp calcification (p>0.05). The 17-19 age group had the most tooth calcification (n=17), followed by the 14-16 age group (n=12). However,

a statistically significant difference was present between pulp calcification and treatment duration (p<0.05). A treatment duration of 25-30 months yielded the highest value (n=21), followed by 31-36 months (n=19). (Table-II)

		Pulp Calcification		df	P-Value	
		Yes	No			
Gender of Patients	Male	16	42	1	.889	
	Female	38	95			
Age Groups	Years	14-16	17	46	3	.073
		17-19	19	31		
		20-22	9	45		
		23-25	9	15		
Treatment Duration	Months	12-18	6	23	3	.008
		19-24	2	29		
		25-30	27	56		
		31-36	19	29		

**Table-II. Pulp calcification based on gender, age groups, and treatment duration**

A statistically significant relationship was found between the pulp calcification of maxillary and mandibular teeth (p<0.05). A total of 25 (46.3%) maxillary teeth had pulp calcification reported at the end of orthodontic treatment as compared to 29 (53.7%) mandibular teeth. The highest prevalence was reported for tooth number 36 (25.9%) followed by 26 (22.2%) (Figure-2). Furthermore, a statistically significant relationship was found between the right and left sides of the dental arches (p<0.05). The left side exhibited greater tooth calcification (n=37, 68.5%) as compared to the right side (n=17, 31.5%).



**Figure-2. Pulp calcification based on tooth number**

## DISCUSSION

The study results provide important insights into the prevalence of pulp calcification before and after orthodontic treatment, with a significant increase observed in post-treatment. The findings reveal that there was a 10.5% increase in patients presenting with statistically significant calcification, after orthodontic intervention. The same results were observed in a regional study in India where there was a 14.5% increase in the post-treatment calcification cases.<sup>3</sup> This suggests that orthodontic treatment might have a contributory effect on pulp calcification, potentially warranting careful consideration during treatment planning and post-treatment monitoring. Evidence from the literature states, that orthodontic treatment causes transitory alterations in pulp vitality and responsiveness, with the potential to reduce pulp chamber dimensions.<sup>11-13</sup> Contrary to most study results a case-control study was conducted in Brazil. Which concluded that there was no significant increase in pulpal nodule (type of calcification) formation after orthodontic treatment.<sup>14</sup> These varying results can be because of the ethnicities and nationality variables but most importantly the study designs.<sup>15</sup>

In the present study, no statistical significance was found relating to the patient's gender or age and pulpal calcifications ( $p\text{-value} > 0.05$ ). Which is similar to other studies on the same topic.<sup>14-16</sup> Related to age specifically literature presents varying results as some studies have reported an increase in pulp calcification with age.<sup>17</sup> The explanation that the literature gives is the modifications of pulpal vascular supply and expression of multiple biomarkers during aging. Hence this association needs to be further investigated in future research. The study also presented a very significant finding i.e., in the present study it was found that the frequency of pulpal calcification increased with the duration of orthodontic treatment. This was found to be statistically significant ( $p\text{-value} < 0.05$ ). According to a recent comprehensive analysis, the orthodontic force causes a series of biological responses that can alter the dental pulp, leading to an increase in pulp calcification.<sup>18</sup> Genetic differences in association with orthodontic forces

may be related to the risk of pulp calcification.<sup>19</sup> A recent review found that at least 300 genes are involved in dentin secretion, development, and control.<sup>20</sup> Dentinogenesis involves multiple routes including proteins and extracellular organic matrix, mineralization, and growth factors, although the precise significance of each pathway has yet to be determined. In conclusion at present literature states that orthodontic forces cause changes in the dental pulp, which results in clinical and radiographic alterations. Clinicians must understand these changes to execute orthodontic mechanics safely.<sup>18</sup>

The study findings also indicated a statistically significant relationship between the occurrence of pulp calcification in the maxillary and mandibular teeth, with a higher prevalence reported in mandibular teeth ( $p\text{-value} < 0.05$ ) compared to maxillary teeth. A recent regional study also presented similar results to the present study. However, it needed to be highlighted that this study by Ravishchandran et al.<sup>21</sup> was done to only assess the pulp stones in patients who needed root canal treatment. In the present study, any calcification within the pulp chamber was noted. Contrary to the present study results literature shows that pulp stones are more prevalent in the maxillary molars.<sup>22</sup> In our study, there is no correlation between pulp stones and tooth number (Figure-2). Previous research has found a link between pulp stones and tooth number, with studies indicating increased occurrences in maxillary first and second molars. Some studies even found that molars had a higher prevalence than premolars. Many investigations have revealed a link between dental pulp stones and systemic illnesses. Some studies have found a substantial link between the development of pulp stones and a history of diabetes mellitus, cardiovascular illness, and renal disease. However, this factor was not analyzed in our study.<sup>23,24</sup>

The limitations in the present study that need to be considered in future research are mainly to conduct prospective studies on more specific demographics. Secondly, the study primarily focused on the analysis of pulp calcification, neglecting the potential influence of various

confounding factors, including dietary habits, oral hygiene practices, and genetic predispositions. The omission of these variables might limit the comprehensive understanding of the complex interplay between different factors and their impact on pulp calcification during and after orthodontic treatment.

## CONCLUSION

Within the limitation of our study, the following could be concluded:

- There was an increase in the frequency of pulpal calcifications in the observed posterior teeth after orthodontic treatment.
- Pulpal calcifications were significantly more prevalent in the posterior teeth of the mandibular arch compared to the maxillary.
- The likelihood of pulpal calcification increased over the duration of orthodontic treatment.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.






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### AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Wasim Ijaz	Conceived and designed the study, analyzed and interpreted the data, and wrote the manuscript.	
2	Asim Qureshi	Responsible for data collection and helped in writing the manuscript.	
3	Naveed Iqbal	Analyzed and interpreted the data, Helped in writing the manuscript.	
4	Eizza Niaz	Provided design and data collection.	
5	Abid Hussain	Provided design and data collection.	
6	Ifham Khan Jadoon	Provided design and data collection.	