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Classification of cases of pre-eruptive intra-coronal resorption

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ABSTRACT

Introduction

Resorption mechanisms triggered in teeth can lead to lesions, especially in impacted dentition. Evidence of these lesions can be detected via radiographic imaging and are often classified as pre-eruptive intra-coronal resorption (PIR). These external resorptive lesions do not typically present with symptoms of pain or discomfort, however, it is hypothesized that these cases may progress and affect more than ⅔of the dental width.

Methods

This case series investigated 15 panoramic radiographs of patients who presented with abnormal radiolucent intra-coronal zones or PIR lesions within unerupted teeth. Once the affected teeth were confirmed, an observer scored the PIR lesion according to an established classification system which assessed the landmarks and ratio in which resorption occurred. Statistical correlations between the severity of resorption and sex, age and affected teeth were assessed.

Results

Twenty cases of PIR lesions were observed amongst the 15 subjects investigated with 75% of cases being located in the maxillary teeth. In 70% of cases the lesions mostly presented in molars and premolars. Resorption was detected in the dentin or near the pulp of the tooth in 95% of cases with the majority of PIR cases exhibiting lesions in > $^{2}/_{3}$ of the dentine. Most cases exhibited high severity resorption.

Conclusion

Further understanding of the progression and diagnosis of this defect can assist experts in understanding its aetiology and advice on the most effective treatment plan for patients.

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External resorption, unerupted teeth, resorption classification

INTRODUCTION

Pre-eruptive intra-coronal resorption (PIR) is described as a resorptive defect, occurring in the crown of unerupted or impacted teeth, usually along the dento-enamel junction.[1] The defect is detected radiologically as a radiolucent region close to the central or mesial aspect of the coronal dentine.[2] Pre-eruptive intra-coronal resorption is typically asymptomatic; however, pain and swelling can be present. Therefore, cases of PIR are inadvertently detected incidentally during routine radiographs.[3]

The prevalence of PIR is reported to range from 2% to 8% among patients and from 0.6% to 2% among teeth.[4] Pre-eruptive intra-coronal resorption primarily affects the first maxillary molar followed by the second and third mandibular molars. However, higher rates are found in maxillary molars and canines and mandibular molars of older patients.[5] The prevalence of PIR may be affected by the radiographic tool used as detection is variable among different imaging modalities. Intra-oral radiography and cone beam computed tomography (CBCT) scanning are considered more reliable detection tools compared to others.[5,6] The skill of the investigator may also affect PIR diagnosis as the lesion is more perceptible to senior, experienced professionals.

The prevalence of PIR has no sexual predominance; however, age may play a role as there is an increased rate of erupted teeth in older demographics. Various studies examine younger patients for the presence of PIR using radiographic investigation. However, there is limited research regarding the presence and classification of PIR among the adult population.[1-3,6-8] The aetiology surrounding the development of this pre-eruptive anomaly is uncertain. Researchers have theorised that PIR lesions may be the presentation and development of occlusal caries prior to eruption.[1,9] Once erupted, microorganisms then have an opportunity to invade the affected tooth causing exaggerated destruction to the existing defect.[1,4] The relation between PIR and caries is highly speculated due to their close resemblance and clinical presentation, and are sometimes referred to as "pre-eruptive caries" in combination with the preferred term of "pre-eruptive dentin defect".[10] Researchers have also proposed that PIR may be influenced by ectopic positioning of teeth. This may affect the eruption of the affected tooth and place pressure on surrounding teeth.[11] These adverse effects may initiate erosion of the tooth, leading to PIR or occlusal caries. Instances of PIR spreading beyond the coronal dentine have been documented, with some patients exhibiting root involvement and more than two-thirds of coronal dentine affected. Resorption has also been reported to extend to more than two-thirds of dentin thickness in nearly half of PIR cases.[7] Progressive cases of resorption can lead to

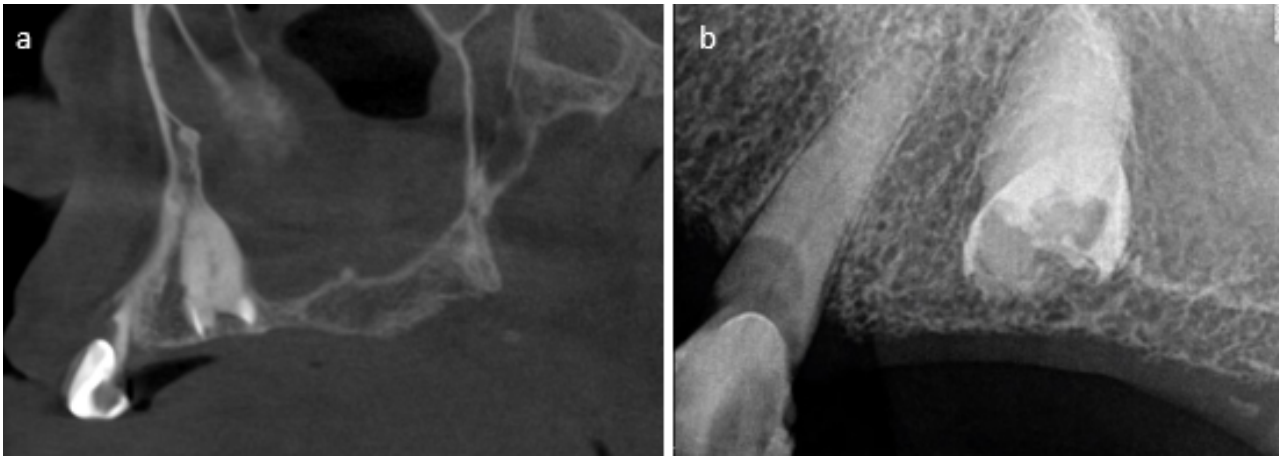

Figure 1: A sagittal CBCT image **(a)** and intra-oral radiograph **(b)** shows resorption of a left maxillary 2nd premolar.

symptoms of pain and discomfort in patients. Therefore, it is crucial to conduct additional research on the detection of PIR using dental radiographs. The aim of this study was to categorise cases of PIR according to standardised methods of classification already established. This research can provide valuable insight into the defect and analysing its correlation to factors such as patient age, affected teeth and medical history. The classification of resorption can assist in creating effective treatment options for patients before any symptoms occur.

MATERIALS AND METHODS

Cases exhibiting radiological signs of PIR on panoramic radiographs between December 2007 and June 2023 were selected from a digital radiological database. Radiographs were analysed using Cliniview© software (for radiographs taken on an Instrumentarium unit) and Sidexis© software (for radiographs taken on a Sirona unit). Subjects were chosen as they presented with unexplained radiolucent lesions in the coronal aspect, enamel and/or root dentine of both maxillary and mandibular unerupted teeth. Only affected teeth that did not penetrate the occlusal surface of the gingiva and have not entered the oral cavity were classified as unerupted and could therefore be classified as PIR. The demographics of the patients were documented and included patient age, sex and medical history, if present. Cases exhibiting PIR in erupted teeth were excluded from the study.

Once the presence of radiolucent lesions was identified in unerupted teeth and PIR was confirmed, the lesions were graded according to the classification system compiled by Yüksel et al.[5] This classification system assessed the landmarks on the tooth which was affected (enamel, dentine and/or root). Along with the landmark involved, the ratio of the area of dentine that the resorptive defect occupied in relation to the area of the dentine as a whole was also observed and graded accordingly ($<^1/_3$, $^1/_3$- $^2/_3$, $>^2/_3$). The combinations of all three landmarks and ratios led to 15 PIR scores which were employed for each case of PIR in the current study. Where available, CBCT scans were used to confirm the PIR scoring or at least the presence of intact enamel, although this was not done for all subjects as accessibility to CBCT scans are limited (Figure 1). Any correlation between the PIR cases and the systemic medical history of the patients was evaluated. Additionally, variations in PIR cases were documented. The severity of PIR cases were assessed according to the landmark affected and the ratio of resorption exhibited in the dentine. Therefore, cases with resorption in the enamel and/or $<^1/_3$ of the dentine were considered low severity. Cases involving resorption of $^1/_3$- $^2/_3$ of the dentine with or without enamel involvement were earmarked as moderate severity. While resorption in $>^2/_3$ of dentine and/or the root was noted as high severity. Correlations between the frequency of cases, sex, the average age and the affected tooth and the severity of PIR resorption was evaluated using a Chi-square test. Differences between males and females and sides were assessed using a t-test.

The observations and grading were conducted by a qualified dentist with 20 years of experience in oral and maxillofacial radiology. Ethical approval was obtained from the Faculty of Health Sciences Research Ethics Committee (132/2024).

RESULTS

Twenty PIR lesions were observed among the 15 subjects. The average age of the patients was 39 years (range: 11-75) and consisted of 8 males and 7 females. Among the subjects in the study, 40% were diagnosed with hypertension, while the remaining subjects were generally healthy. The occurrence of PIR lesions were predominantly found in the maxillary dentition, accounting for 75% (n=15) of lesions. In the maxilla, the central incisors, canines, 2nd premolar and 3rd molar were affected by PIR (Figure 2). Additionally, 60% (n=12) of all lesions were observed on the left side of the jaws. PIR lesions were seen to predominantly affect molars and premolars which resulted in 70% (n=14) of all lesions with the 3rd maxillary molar having been affected in 50% (n=7) of these cases (Figure 2). This was followed by the affected canines and incisors which resulted in 30% (n=6) of all lesions with affected maxillary canines contributing to 67% (n=4) of these cases.

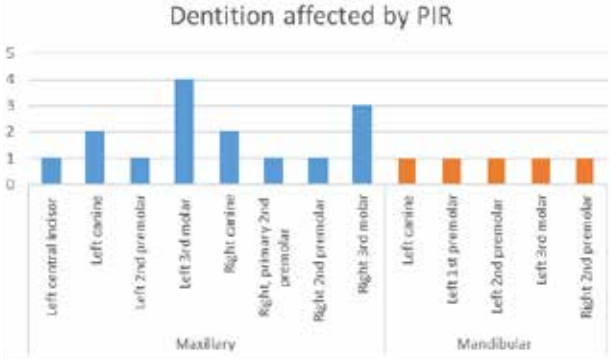

Figure 2: Number of mandibular and maxillary teeth affected by PIR lesions.

Pre-eruptive intra-coronal resorption affected the dentin or pulp in the majority of cases 95% (n=19). Lesions within the dentin eroded >$^{2}/_{3}$ of the dentinal width in 35% (n=7) of cases, as seen in Table 1. In 65% (n=13) of cases, PIR was observed in the enamel, while 60% (n=12) of cases showed resorption in both the enamel and dentine. Root resorption was present in 40% (n=8) of cases. PIR lesions affecting >$^{2}/_{3}$ of the dentine, the enamel and between $^{1}/_{3}$-$^{2}/_{3}$ of dentine (Figure 3) as well as dentine and <$^{1}/_{3}$ of the root (Figure 4) had the highest incidence of PIR scoring among the affected teeth (Table 1).

Table I: Subject demographics and PIR scoring of affected teeth
Key: M: Male, F: Female

Age	Sex	Medical history	PIR scoring	Affected tooth/teeth
11	M	Healthy	Enamel	Left mandibular first premolar
			Enamel and dentine <$^{1}/_{3}$	Left mandibular 2nd premolar Right mandibular 2nd premolar
15	M	-	Dentine and root <$^{1}/_{3}$	Right maxillary 3rd molar
			Dentine $^{1}/_{3}$ - $^{2}/_{3}$	Right, primary maxillary 2nd premolar
20	F	-	Dentine and root <$^{1}/_{3}$	Left maxillary canine
20	M	-	Enamel and dentine >$^{2}/_{3}$	Left maxillary central incisor
23	M	Healthy	Enamel and dentine >$^{2}/_{3}$	Right maxillary 2nd premolar
24	F	Healthy	Dentine >$^{2}/_{3}$	Left maxillary 3rd molar
39	F	Healthy	Dentine and root <$^{1}/_{3}$	Left maxillary 3rd molar
39	M	Hypertension and diabetes	Enamel and dentine $^{1}/_{3}$ - $^{2}/_{3}$	Left maxillary 3rd molar
40	F	Healthy	Enamel and dentine $^{1}/_{3}$ - $^{2}/_{3}$	Left mandibular canine
40	M	Healthy	Enamel, dentine and root $^{1}/_{3}$ - $^{2}/_{3}$	Right maxillary 3rd molar
56	M	Hypertension	Enamel, dentine and root >$^{1}/_{3}$	Right maxillary 3rd molar
59	F	Hypertension, diabetes and high cholesterol	Enamel, dentine and root <$^{1}/_{3}$	Right maxillary canine
62	F	Hypertension and high cholesterol	Enamel, dentine and root >$^{2}/_{3}$	Left mandibular 3rd molar
			Enamel, dentine and root <$^{1}/_{3}$	Left maxillary 2nd premolar
64	M	Hypertension, diabetes and high cholesterol	Enamel and dentine $^{1}/_{3}$ - $^{2}/_{3}$	Left maxillary 3rd molar
75	F	Hypertension	Dentine > $^{1}/_{3}$ - $^{2}/_{3}$	Right maxillary canine Left maxillary canine

Figure 3: Cropped panoramic radiograph depicting a right maxillary 3rd molar with resorption of enamel and dentine between ⅓⅓of the dentine.

Figure 4: Cropped panoramic radiograph depicting a 3rd maxillary molar with resorption of dentine and <⅓of the root.

The majority of cases (65%) presented with high severity of resorption involving the root and/or >$^2/_3$ of the dentine. Only one adolescent subject (11 years) exhibited low severity resorption in the enamel and <$^1/_3$ of the dentine. While the average age of subjects who demonstrated moderate and high severity resulted in 40 and 44 years, respectively. A t-test comparing the mean ages between moderate and high severity groups indicated no significant difference in age (p=0.72). While 44.44% of female subjects presented with high severity resorption, a Chi-square comparing the number of males and females per severity group indicated no significant differences (p=0.26). Chi-square tests comparing the cases observed on the left and right sides per severity group and the tooth involved per severity group showed no significant differences with a p-value of 0.72 and 0.18, respectively. However, a significant difference was exhibited between mandibular and maxillary teeth involvement per severity group (p<0.01) as 60% of maxillary teeth presented with high severity resorption. It is also noted that twice the number of hypertensive subjects presented with high severity resorption compared to those with moderate severity.

DISCUSSION

Pre-eruptive intra-coronal resorption is caused by the resorption of calcified tissue which results in a radiolucent defect detectable on radiographs. The presence of osteoclasts and multinucleated giant cells has been reported in samples of teeth affected by PIR.[2] This, along with observations of scalloping along the perimeter of the PIR lesion, which was also observed in the current study, is indicative of a resorptive process rather than a carious lesion. Although the cause of such resorptions is uncertain, the mechanism of resorption can determine the progression of PIR lesions and indicate possible aetiologies. Resorptive cells such as osteoclasts and macrophages from neighbouring teeth are said to travel through fissures in the dental follicle and enamel or cementum.[2,7,12,13] Resorption caused by these cells remains undetected and asymptomatic prior to eruption, which explains the often "incidental" discovery of PIR lesions on radiographs. Once the affected tooth erupts, microbes within the oral cavity invade the lesion, leading to further deterioration of the tooth. The affected tooth presents comparably to normal caries, which is a more commonly diagnosed pathology. The absence of bacteria in these defects suggests that their aetiopathogenesis is different.[2]

Although there is little evidence that may indicate PIR is related to the systemic history of the patient, many have theorised there could be a correlation due to the unknown aetiology of the defect, while other studies dispute its association.[7] The subjects in the current study did not present with any major systemic pathology that would result in adverse resorptive lesions in the dentition, with a history of hypertension documented for 40% (n=6) of the patients, while the majority of patients were relatively healthy. However, twice the number of patients (n=4) with a history of hypertension exhibited highly severe resorption as opposed to those who presented with moderate severity. Similarly, the study by Yüksel et al reports cases of hypertension and diabetes in 7.3% (n=12) and 6.1% (n=10) of subjects respectively, while the majority of patients did not exhibit systemic disease.5 These findings suggest that further research is needed regarding the involvement of systemic disease in the causation of PIR lesions or its correlation to the incidence of PIR in adult patients.

External resorption and developmental abnormalities are among some of the common local factors speculated to cause PIR lesions, along with ectopic eruption or positioning of teeth.[2,11,14] Reports suggest that ectopically positioned teeth cause additional pressure to the tooth or surrounding teeth, resulting in occlusal fissures in the dentine.[7] A substantial correlation was seen between the presence of PIR lesions and ectopic positioning, with lesions expanding to more than $^2/_3$ of the width of the dentin thickness.[7]

Due to this progression, PIR lesions are sometimes referred to as "pre-eruptive caries". Similarly, to PIR lesions, occult caries require radiographic or clinical diagnosis, with as many as 50% of cases remaining undetected.9 Occult caries also present in patients of an older age range with 50% of cases arising from patients who are 20 years old, which may be due to later eruption. Forty percent (n=6) of subjects in the current study were 24 years and younger, with many of the older patients having exhibited additional cases of occult caries, which may support this claim. However, there is a greater chance that teeth affected by PIR have already been treated or extracted during earlier examination in older populations which may translate to a decreased incidence in older subjects who have received dental care previously.15 Further histopathological investigation of PIR cases confirms the presence of chronic inflammation and haemorrhagic necrosis, whereas investigation of occult caries revealed a low likelihood of lesions arising following infection or demineralisation. These reports suggest a strong contrast between PIR and caries defects.[6,16-19]

Research indicates that PIR tends to occur more frequently in older patients, particularly affecting maxillary molars, canines and mandibular molars. This pattern was also observed as the predominant trend across all age groups in the present study. Possible reasons for this trend in older subjects could be due to the fact these teeth remain impacted for longer periods compared to the rest of the dentition. There is also a significant difference in the rate of PIR in mandibular third molars compared to maxillary third molars which may be due to the frequent extraction of mandibular third molars in patients who experience symptoms related to the impacted tooth.5 However, there are scarce histological and microbial findings that these occult lesions exhibited resorption in their pre-erupted state. Although radiographic evidence has supported these claims in studies that have compared radiographs of affected teeth before and after eruption.[6, 20]

Due to the affected teeth being impacted, detectability through intra-oral examinations is impossible and radiographic diagnosis is needed. Although panoramic radiographs provide fair visualisation, they do not perform as efficiently compared to other modalities such as intra-oral radiographs.[6,7] While CBCT scans provide the most accurate assessment of the positioning and dimensions of the width of the lesion, however, this diagnostic may not be as accessible as plain radiography.5 A study comparing the prevalence of PIR using both panoramic and bitewing radiographs shows a discrepancy of 6% subject prevalence and less than 2% tooth prevalence, with bitewing radiographs proving to be a more effective mode of detecting PIR cases.[7]

Resorption is prominently seen in impacted maxillary molars and premolars which are not distinctive during radiographic rendering which makes diagnosing these pre-eruptive

defects difficult and can be the reason behind inconsistencies in the prevalence of PIR between studies. However, additional factors may contribute to these differences including differences in the sample sizes, demographic and geographical location, as well as the level of experience of the observer identifying PIR cases. A study by Yüksel et al reported that dental professionals with more than 20 years of endodontic experience have a high proficiency and are more inclined to detect resorptive lesions on radiographs when compared to specialists with less experience.[5] This, in turn, may affect the diagnosis of PIR cases, especially when paired with radiographic tools which provide poor visualisation.

Treatment options for patients with PIR are administered according to the size and progression of the lesion. We can conclude from the current study that the locality of resorption can extend from the coronal dentition to the root and pulp and resorption can be static or active.[8] The current study also observed a high incidence of cases with high severity resorption which may indicate a need for suitable intervention. Clinical studies have revealed that surgical exposure and restoration were needed in large, active lesions and monitoring and restoration were administered for small, static PIR lesions.[2,17] Tooth extraction seems to be the most effective treatment option for large lesions. Although preventive, non-invasive measures which limit the rate of resorption and the size of the lesion such as restoration, root canal therapy, monitoring and observation of small static lesions, are favoured.[2,17] These passive treatment options at the early stages of lesion development also avoid the progression of resorption and fracturing of the tooth, as well as the need for invasive therapy such as extraction.

The rate of eruption should also be monitored in PIR cases, as erupted teeth are prone to fissure caries and oral microbes which can exacerbate the advancement of lesions, resulting in the patient presenting with symptoms of pain and discomfort.6 Therefore, treatment plans need to be revised and assessed according to the size and development of the PIR lesion and the rate of eruption with the immediate administration of preventive therapy such as restoration, before invasive extraction options. This also includes the importance of early detection and surveillance during the pre-eruptive stages, especially of the coronal dentin. The use of CBCT scans provides valuable details regarding the locality and width of PIR lesions and is the optimal tool for diagnosis. These records also assist in generating effective treatment regimens and monitoring thereof.

Further awareness of the pre-eruptive defect and research regarding the prevalence of resorption in various demographic groups is needed to understand the cause of these lesions and develop early detection mechanisms for patients. Treatment of these lesions before symptoms arise is necessary for creating optimal patient care and preventing invasive therapy options.

Limitations

CBCT scans of the subjects could not be utilised in all cases as a control in this study for the validation of the presence and scoring of the PIR lesion, due to the lack of availability of CBCT scans.

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Author contributions

JN: Formal analysis, investigation, writing – original draft preparation.
CS: Conceptualisation, writing – review and editing.
AU: Conceptualisation, investigation, writing – review and editing.

Conflict of interest

The authors have no conflict of interest to declare.

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