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Frequency and risk factors of root resorption in endodontic practice

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Abstract

Introduction: The frequency of root resorption and correlated factors in patients were seen at the Endodontics Clinic of the Universidade Federal da Bahia. **Objective:** To evaluate the clinical and radiographic features of endodontic root resorption, considering that it is important to further our knowledge about root resorption frequency and pathogenesis. **Material and methods:** A cross-sectional study was conducted with a representative sample of 120 teeth indicated for endodontic treatment. Clinical and radiographic evaluation was accomplished to detect the presence and type of root resorption, etiology, presence of caries, dental trauma, and periapical lesion. Gender and affected teeth were also collected. The data were analyzed by the χ^2 test, Fisher's exact test, and multiple logistic regression ($p < 0.05$). **Results:** A total of 53 teeth presented with root resorption. Female and the maxillary incisors were the most affected. Inflammatory root resorption was the most prevalent resorption type ($p = 0.0013$), and the apical third was the most affected portion ($p = 0.001$). **Conclusion:** There was a significant occurrence of external inflammatory root resorption in the apical third of the root. A large follow-up of these patients is necessary for preventing undesirable tooth loss.

Introduction

Root resorption is characterized by loss of mineralized tissue of the root, due to the release of acids resulting from the action of clastic cells [9], and occurs physiologically in deciduous teeth, thus allowing the eruption of permanent successor teeth. However, when this resorption occurs in permanent teeth, it involves a pathological process that can lead to premature loss of the affected teeth, with irreversible damages if left untreated [5]. As such, it represents a great challenge to clinicians.

Certain risk factors have been identified as possible causes of root resorption, including dental trauma, orthodontic therapy, internal bleaching, dental surgery at the enamel-cementum junction, or a consequence of different clinical situations, such as pulp, periodontal and/or periradicular infectious processes [5].

This kind of lesion afflicting the mineralized tissue of the tooth is directly related to endodontic procedures, resulting from its involvement with pulp necrosis, since it allows microorganisms to access the root canal system [19]. According to the nature of the process, root resorption can be classified as inflammatory or replacement resorption and may involve internal resorption (when initiating in the root canal) or external resorption (when originating at the enamel-cementum border of the root surface) [5].

Root resorption is generally asymptomatic and diagnosed by clinical and radiographic examinations, especially periapical radiographs. Internal resorption is characterized radiographically by the expansion of the pulp cavity with regular and rounded contours [7]. In external resorption, a radiolucent area with an irregular border can be seen in different thirds of the root. In teeth with severe resorption, the apex anatomy may be modified, making it difficult to establish the length of instrumentation and filling of the root canal [15].

Although studies in the literature report on the prevalence of the development of root resorption in permanent teeth and factors associated with it, little is known about the correlation of these factors in influencing inflammatory tooth resorption [13]. Since the occurrence of this type of resorption is highly frequent in endodontic clinical practice, the study of this phenomenon is considerably important to the diagnosis and planning of dental care.

Epidemiological studies have great relevance, because their results show the main problems that afflict the population. Consequently, these data can establish preventive programs to make the population aware of the need to seek immediate

treatment, and to alert the professional to the importance of scheduling follow-ups [18].

Thus, this study aimed to evaluate the clinical and radiographic features of endodontic root resorption, considering that it is important to further our knowledge about root resorption frequency and pathogenesis.

Material and methods

This study was reviewed and approved by the Ethical Committee on Human Research of Faculty of Dentistry, Universidade Federal da Bahia, Salvador, Bahia, Brazil (protocol number 1.288.375), and has been conducted in accordance with the World Medical Association's Declaration of Helsinki.

The investigation was conducted with patients referred for endodontic treatment between April 2015 and January 2016. All patients and guardians were informed of the risks and benefits of the procedure and signed an informed consent form. The final sample was composed of 120 teeth with complete root and apex formation of 110 patients aged between 11 and 78 years old (mean = 33). Patients who had primary teeth and were younger than 7 years old were excluded from this study. The patient's medical history included the following information: age, gender, affected teeth, and etiology of the resorption.

The resorptions were investigated radiographically. Ultra-speed film (Kodak, São José dos Campos, SP, Brazil) was used to obtain periapical radiographs for radiographic analysis at 55 kVp and 15 mA. All the radiographs were performed using intraoral positioners and the paralleling technique. They were analyzed by two examiners, under optimal conditions, and using a white-light illuminator (Biotron, Santa Rita do Sapucaí, MG, Brazil).

The resorptions detected were classified according to their mechanism of maintenance and evolution, type, and location, based on the criteria proposed by Consolaro [5]:

According to the affected surface: internal, external or internal-external;

According to the third of the affected root: apical, cervical or middle third;

According to the mechanism of maintenance: inflammatory or replacement resorption.

The data were analyzed with Minitab® 14.20 software (State College, PA, United States). Fisher's exact test was used to verify the prevalence of type, location, and etiology of the root resorption. The significance level was set up at $p < 0.05$.

Results

Of the 120 teeth evaluated, 53 had root resorption, corresponding to 44% of all the radiographically investigated teeth. Hence, the study sample comprised 53 patients (32 females and 21 males) with 53 teeth affected by resorption and closed apex. The age of the patients ranged from 11 to 78 years old. Resorptions occurred most frequently in patients between 31 and 40 years old ($n = 14$). Eleven patients were in the 41-50-year age range, and 20 patients were under 30 years old at the time of treatment.

Most of the affected teeth were maxillary central incisors ($n = 28$), followed by maxillary lateral incisors ($n = 8$), maxillary premolars ($n = 7$), maxillary canines ($n = 4$), mandibular premolars ($n = 3$), mandibular lateral incisors ($n = 2$), and mandibular canines ($n = 1$).

In reference to etiology, resorption-associated factors like caries lesions ($n = 27$) and dental trauma ($n = 26$) were observed. As regards the root resorption mechanism of maintenance, the inflammatory type was the most prevalent, followed by only three cases of replacement resorption ($P = 0.0013$), and the apical third was the most commonly affected portion, followed by the middle third ($n = 18$) ($p = 0.001$).

Concerning the affected surface, most of the teeth presented with external root resorption ($n = 48$), four teeth exhibited internal root resorption, and only one tooth was found to have internal-external root resorption.

Statistically significant associations were found between root resorption and gender ($p < 0.05$), and between root resorption and etiologic factors (presence of caries with pulp involvement and traumatized teeth) ($p < 0.001$) (Table I).

Table I - Analysis of variables related to root resorption

Variable		Resorption n (%)	p-value
Gender	Male	21 (40)	0.61
	Female	32 (60)	
Etiological factor	Dental caries	27 (51)	0.001
	Dental trauma	26 (49)	
Mechanism of maintenance	Inflammatory	50 (94)	0.000
	Replacement	3 (6)	
Root third	Cervical	0	0.000
	Middle	18 (31)	
	Apical	35 (66)	
Type of resorption	Internal	4 (7%)	0.28
	External	48 (91%)	
	Internal-external	1 (2%)	

Discussion

Root resorption is characterized by a progressive loss of hard dental tissue, and it is associated with inflammation, infection or local trauma [8]. There are several studies on the relation of trauma and resorption, but few researches have found epidemiological data reporting a correlation between caries and resorption [2, 4, 13, 16, 18].

It is known that periapical lesions caused by microorganisms from caries with pulp involvement are aggressive enough to initiate root resorption. A study was conducted to determine the prevalence of inflammatory pathological root resorption and associated factors in the primary mandibular molars of children from 3 to 12 years old, and concluded that caries with pulp involvement, pulpotomy, pulpectomy and the absence of a restoration were associated with a higher (16.2%) occurrence of inflammatory root resorption in primary molars [19].

Statistically significant associations were not found regarding etiology. In reference to dental trauma, the injury of support tissues increases the tendency of root resorption. Moreover, treatment late after the occurrence of dental trauma can impair the prognosis and result in a developmental process leading to external inflammatory resorption, especially in luxated teeth [11, 13]. The development of external inflammatory resorption is related to severity of the injury, patient age, stage of root formation and time of pulp extirpation. When endodontic treatment is delayed, pulpal infection associated with periodontal ligament damage may result in the progression of inflammatory external resorption [2, 14].

Inflammatory root resorption has been studied extensively, since it represents an asymptomatic lesion that is complex to diagnose and treat. Periapical radiography generates a two-dimensional image and has limitations regarding the detection of the affected root surface and its extension. In this study, 53 of the 120 teeth evaluated were found to have root resorption, as detected by radiographic analysis.

The detection of apical inflammatory root resorption associated with periapical lesion has been improved by cone beam computed tomography (CBCT), but analysis by scanning electron microscopy (SEM) is still the reference standard for imaging methods, because it is more effective in visualizing resorptions [8]. Nonetheless, indication of CBCT should be judicious in endodontic clinical practice and as a complementary method of analysis in cases in which clinical and radiographic examinations were not enough to establish the diagnosis. There

are two major reasons: firstly, tomographic images require a greater dose of radiation than periapical radiograph images; second, they are costly.

In this study, the resorptions were more prevalent in female (60%) than male (40%) patients. However, no other studies in the literature were found showing any significant relation between gender and resorption [6, 17]. Although there is no association between root resorption and systemic factors, cases of patients with controlled or uncontrolled systemic diseases should be carefully selected and published to enrich the literature with evidence that root resorptions are not among the clinical signs and symptoms of systemic diseases [1, 17].

The age of the patients with root resorption ranged from 11 to 78. Resorptions occurred most frequently in patients in the 31-40-year-old range (14 patients), and 20 patients were under 30 at the time of endodontic treatment. Previous investigations have shown that root resorption is more common in young patients, and its incidence also increases in proportion to the time elapsed between the local factor (cavity, trauma, orthodontic movement or presence of periapical lesions) and the onset of treatment [11, 18]. The longer the time until treatment is initiated, the worse the prognosis of the involved teeth. Thus, if pulp necrosis is not diagnosed early, certain irritants, such as inflammation and infection, may promote the emergence and progression of external inflammatory resorption.

The high frequency of root resorption in anterior teeth observed in this study may be related to the prevalence of traumatic injuries as the causative etiological factor. This finding has been corroborated by several authors [2, 13, 14, 18].

Some researchers have shown a strong relationship between replacement root resorption and traumatic injuries, such as avulsion and severe dental luxation [4, 11, 16]. This was confirmed in our study, seeing that the only three teeth with replacement root resorption were associated with these severe traumatic dental injuries.

In this study, apical inflammatory root resorption was the most prevalent type of root resorption (n = 31), followed by the one of the middle third (n = 14), but no case was found in the cervical third (n = 0). This can be explained by the major etiological factors found. In chronic periapical lesions and in contaminated dental trauma, the resorption process is maintained by inflammatory mediators that stimulate clastic cells and gradually resorb the dentin surface free of cementoblasts and odontoblasts in the apical region [5].

Only four teeth were detected with internal root resorption, one in the apical third and three in

the middle third. These findings were determined with conventional periapical radiographs. However, several studies have shown that the two-dimensional nature of these images makes periapical radiography inaccurate for determining the location, severity, and type of resorption [3, 10, 12]. CBCT generates images in the axial, coronal, and sagittal directions, allowing three-dimensional visualization of dental structures. This facilitates the diagnosis of initial resorptions. CBCT also exhibits the highest sensitivity and accuracy for detecting external and internal inflammatory resorption, compared with periapical radiography.

Gabor *et al.* [10] evaluated the prevalence of internal resorption by SEM images of extracted teeth and concluded that these lesions were frequently detected in teeth with pulpitis and pulp necrosis, but that they are not likely detected by conventional clinical or radiographic methods, because of their small size. The high frequency of these lesions (concavities) also offers another reason to irrigate canals thoroughly with sodium hypochlorite during treatment, thus eliminating microorganisms in the root canal system more effectively.

Clinical studies describing the prevalence of root resorptions and their associated etiological factors are of great relevance to make the population aware of the need to seek immediate treatment, and to alert the professional to the importance of scheduling follow-ups.

Conclusion

The prevalence of root resorption was correlated to dental caries and dental trauma, and apical inflammatory root resorption was the most prevalent type. The high number of teeth developing resorptions may have resulted from late presentation for care. Bearing this in mind, both the population and dentists must be alerted to the importance of follow-ups, so that the diagnosis of these lesions and their respective treatment may be improved.

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