The distance from the intraradicular post tip to the dental apex influences the degree of apical periodontitis

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ABSTRACT

Objective: The objective of the present study was to investigate the relation between the distance from the intraradicular post tip to the radiographic apex (D) and the degree of apical periodontitis (AP). **Methods:** Full mouth periapical radiographs (n=14) were randomly selected from patients of the clinic of orthodontics of Centro Universitário do Maranhão (São Luiz/MA, Brazil). The sample was composed by the first 270 teeth presenting posts (convenience sample). The radiographic analysis was performed using the Periapical Index (PAI). An ordinal regression was used to test the null hypothesis that the degree of AP does not change according to D. The odds ratio (OR) with an confidence interval of 95% (CI 95%) was calculated to estimate the risk of occurring PAI scores 4 and 5 in the teeth with D≤5 mm. **Results:** A significative relation between D and PAI was found. Teeth with lower values of D were more prone to present greater values of PAI (R^2_N =0.167, p<0.05). The risk of teeth with D≤5 mm to present PAI scores 4 and 5 was 2.82 times bigger (OR = 2.82, p<0.001, CI 95%: 1.6-4.76). **Conclusion:** The distance from the intraradicular post to the dental apex had influenced over the degree of AP. The closer the post was from the apex, the higher was the degree of apical periodontitis. Teeth with D≤5 mm showed a 3-fold greater chance of presenting high indices of apical periodontitis.

Keywords: Periapical periodontitis. Root canal filling. Endodontics.

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Introduction

Apical Periodontitis (AP) is the result of inflammatory and immunological tissue response to the presence of microorganisms and their by-products in the root canal system.[1] Root canal treatment aims to eliminate or minimize bacterial population enabling periapical tissue to repair.

Despite this aim, several cross-sectional epidemiological studies have reported 40 to 65% prevalence of AP in endodontically treated teeth.[2,3,4] Friedman[5] suggested that this high prevalence reflects the real outcome of root canal treatment and indicates that AP constitutes a public health problem affecting a large part of the population. The majority of these reports correlate the periapical status to the quality of the root canal treatment, following criteria including root filling density, remaining apical root canal filling and the occurrence of overfilling.[6,7,8] Moreover, despite of the root filling quality, other factors have been correlated with the periapical condition after root canal treatment, such as the quality of coronal restoration[9] and the distance between the tip of the intraradicular post and the residual gutta percha filling.[10]

Endodontically treated teeth are frequently restored using intraradicular posts aimed at retaining the restoration and distributing the force throughout the root.[11] However, for post placement, removal of part of the root filling is required, which can compromise the root canal seal resulting in possible leakage of bacteria and/or toxins. According to Metzger et al,[12] and Mavec et al,[13] the seal is proportional to the length of the remaining filling. Although the association between the length of residual gutta-percha and the occurrence of AP is well documented, assessment of the quality of the residual root canal filling is generally performed by the endodontist rather than the restorative dentist. In the daily routine of oral rehabilitation, restorative dentists usually rely on the distance from the intraradicular post tip to the radiographic root apex in order to assess which would be the most appropriate post length for the case. However, the question of whether the distance from the intraradicular post to the root apex could be related to the degree of AP has never been investigated. This information could be of great value to the restorative dentist, since the occurrence of AP after post placement could be reliably predicted using a very simple measurement tool.

Thus, this study was conducted to test the null hypothesis that no relation exists between the distance from the intraradicular post tip to the radiographic root apex of the tooth (D) and the degree of apical periodontitis determined by the Periapical index (PAI).

Materials and Methods

The study was approved by the Research Ethics Committee of the Federal University of Maranhão (UFMA), under protocol number 42/07.

Periapical radiographs of the entire mouth (14 radiographs) from patients attending the orthodontics clinic of the University Center of Maranhão (São Luis, MA, Brazil) were used as a pool for sample selection. The first 270 teeth with intraradicular posts displaying some degree of AP were selected. The Periapical Index (PAI) was used for radiograph analysis, as proposed by Orstavik et al,[14] which consists of categorizing periapical status into one of five scores: 1, normal periapical structures; 2, small changes in bone structure; 3, changes in bone structure with some mineral loss; 4, periodontitis with well defined radiolucent area; and 5, severe periodontitis with exacerbating features. Only teeth with a score ≥2 were included in the study, since a score of 1 represents teeth with no radiographic signs of apical inflammation. In cases of multirooted teeth, the root presenting the greatest score was considered. Third molars were not included in the study. Besides the degree of AP, the variables shown in Table 1 were also recorded.

Table 1. Distribution frequency of radiographs presenting apical periodontitis.

Categories		Frequency	
		n	%
Sex	Female	93	34.4
	Male	177	65.6
Age range	20-29	27	10.0
	30-39	87	32.3
	40-49	84	31.1
	50-59	54	20.0
	60-69	6	2.2
	≥70	12	4.4
Arch	**Teeth**		
Maxilla	Anterior	79	29.3
	Premolar	42	15.6
	Molar	32	11.9
Mandible	Anterior	7	2.6
	Premolar	27	10.0
	Molar	83	30.7

The distance (in mm) from the most apical part of the post and the root apex on the radiographs (D) was recorded with the aid of a millimetric scale (Trident Ltda, Itapuí, SP, Brazil) and further scored for statistical analysis as follows: Distances greater than 7 mm (>7), greater than 5 mm and smaller than or equal to 7 mm (>5 ≤7), greater than 3 mm and smaller than or equal to 5 mm (>3 ≤5) and smaller than or equal to 3 mm (≤ 3).

An endodontist and a radiologist, both with ten years of clinical experience each, examined the radiographs. Prior to radiographic evaluation, both examiners were calibrated while evaluating 30 radiographs which were not included in the study. The inter-observer agreement was considered adequate, as determined by the Kappa coefficient (0.92); thus, the observers performed their own analysis independently. All radiographs were examined in a dark room using a liquid crystal negatoscope (Kaiser, Germany) with a magnifying lens (3x) (Intex, USA).

In order to categorize the sample, the distribution frequency of the remaining independent variables (sex, age range, tooth groups and arch) was determined according to PAI and the Pearson Chi square test was used to certify that PAI scores were not associated with the independent variables, sex, age range and arch.

Since two categorical variables (D and PAI) were obtained, an ordinal regression (PASW Statistics 17.0, Inc., Chicago, IL, USA) was used to test the null hypothesis that D is not related to the PAI index.

An apical residual canal filling remnant of 5 mm is commonly recommended.[15] Thus, the odds ratio (OR) with 95% confidence interval (95% CI) was calculated to verify the odds of a D<5 mm result in higher PAI (scores 4 and 5).

The level of significance for rejecting the null hypothesis was $p<0.05$.

Results

The frequency distribution according to sex, age range, tooth group and arch is shown in Table 1. Analysis verified that none of the independent variables (sex, age range and arch) influenced the PAI score distribution (Pearson Chi-square test, $p>0.05$).

Ordinal regression demonstrated that D is significantly associated with PAI ($p<0.05$), since teeth with larger distances from the post tip to the apex are more likely to be associated with lower PAI (Fig 1). However, the variability in PAI scores is partially explained by the variation in D, according to Nagelkerke's R^2 (R^2_N=0.167). Analyzing Table 2, it is possible to numerically observe the inverse relationship between D and PAI. At line D>7 mm, for instance, the cumulative percentage for lower PAI scores (2 and 3) was 69.7%, whereas the remaining percentage (30.3%) was linked to higher PAI scores (4 and 5). On the other hand, at line D≤3 mm, the cumulative percentage for lower scores (2 and 3) was 22.0% while the remaining percentage for higher PAI scores (4 and 5) was superior (78.0%). Thus, higher PAI scores were significantly more linked to lower D values, whereas lower PAI scores were related to higher D values (Fig 1).

Table 3 displays the frequency of teeth classified as D≤5 mm and D>5 mm and their relation with the degree of AP. Teeth categorized as D≤5 mm showed a 2.82 odds ratio of being classified as PAI 4 or 5 scores (OR=2.82, 95%CI=1.82-4.759, p=0.0001).

Discussion

Various epidemiological studies concerning AP have used either panoramic[3,16] or periapical radiographs[17,18,19] to provide information on the periapical status. It is well known that greater exam accuracy can be obtained with the use of periapical radiographs rather than the

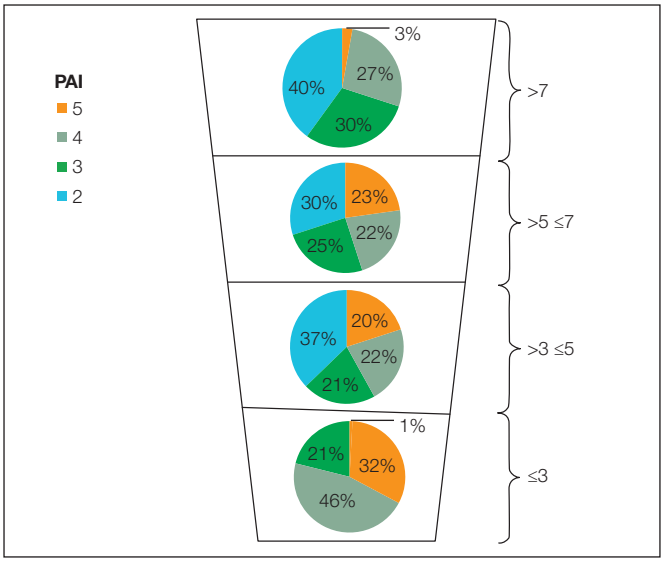

Figure 1. Percentages of higher and lower PAI categories. Observe the inverse relation between the distance from the intraradicular post to the radiographic apex and the PAI scores. PAI scores significantly increased as the distance from the post to the apex decreased.

Table 2. Frequency distribution of the number, percentage and cumulative percentage {n [%] (Pat)} of teeth according to the distance from the post tip to the apex (D) and the PAI score (R^2_N =0.167, p<0.05).

D \ PAI	2	3	4	5	
>7	13 [39.4] (39.4)	10 [30.3] (69.7)	9 [27.30] (97.0)	1 [3.0] (100.0)	33 [100.0]
>5 ≤7	17 [30.4] (30.4)	14 [25.0] (55.4)	12 [21.4] (76.8)	13 [23.2] (100.0)	56 [100.0]
>3 ≤5	25 [37.3] (37.3)	14 [20.9] (58.2)	15 [22.4] (80.6)	13 [19.4] (100.0)	67 [100.0]
≤3	1 [0.9] (0.9)	24 [21.1] (22.0)	53 [46.5] (68.5)	36 [31.5] (100.0)	114 [100.0]

Table 3. Odds Ratio (OR) with 95% confidence interval (CI) estimating the risk of PAI 4 and 5 related to distance from the intraradicular post tip to the radiographic apex (n=270).

Distance post - apex	Total No. of teeth	PAI		OR (95%CI)	P-value
		4 and 5 (%)	2 and 3 (%)		
≤5	181	117 (64.6)	64 (35.4)	2.82 (1.671-4.759)	0.0001
>5	89	35 (39.3)	54 (60.7)		

panoramic counterparts.[20] Periapical radiographs provide more image details and less radiographic distortion.[21] However, cone beam tomography has been suggested as a more sensitive exam to track periapical changes.[20,22] Although the increase in accuracy by cone beam tomography was nearly 20%, as demonstrated by previous reports,[20,22] periapical radiographs are still the most widely used method to evaluate the periapical status after root canal treatment,[23] due to their low cost and easy clinical application.

The question of whether the results of studies with transversal design are able to express the real outcome of periapical status has been discussed, since radiographs project a static image of a dynamic process and, therefore, no information is provided regarding the status of AP regression or progression. Nonetheless, the studies by Petersson[24] and Kirkevang et al[25] demonstrated that the relation between the number of teeth with regressed AP and newly developed cases in the same population after 10 years was similar. This means that in studies using a transverse design, the apparent static information does not influence the outcome, given that new AP cases will develop and others will regress, maintaining the relation.

In the present study, periapical status was categorized using the Periapical Index (PAI) and further correlated to the distance from the post tip to the apex (D). Due to its good accuracy and reproducibility,[14] PAI is the most frequently used measuring tool to verify the prevalence of AP.[3,18,25] Although it is capable of providing information regarding the severity of the periapical lesion, the index is generally used as a reference to determine categories, such as treatment success and failure. Thus, any radiographic or clinical findings are usually correlated to either endodontic success or failure and no information is provided concerning their relation with the degree of severity of AP.[2,25] However, in this study, in order to track for a possible relationship between the distance from the post tip to apex and the degree of AP, an ordinal regression test was used. This test allows for correlation between groups of variables with more than two categories each. Thus, for statistical analysis, the absolute D values obtained in the periapical radiographs were allocated to one of four categories, based on a previous report.[12]

The results of the present study demonstrated that the remaining length from the post tip to the radiographic root apex significantly influenced the degree of AP in an inverse relationship; i.e., the shorter the distance from the post tip to root apex, the greater the severity of AP (Fig 1). This is an important finding, since an elevated prevalence of post-restored endodontically treated teeth has been reported in several epidemiologic studies.[26,27,28] Thus, when planning a post-retained restoration, clinicians should rely on the results of the present study to avoid severely influencing the outcome of root canal treatment.

Kvist et al[29] observed a higher prevalence of AP in endodontically treated teeth with remaining apical filling less than 3 mm in length. This study is in line with their results, since the D value observed is directly related to the length of the remaining root canal filling material. Although some studies were unable to detect a relationship between the frequency of periapical lesions and the presence of the intraradicular post,[26,27] none of these investigated the influence of the distance from the post tip to the root apex. This is the first study to directly correlate the degree of periapical inflammation to the remaining apical intraradicular post-free canal length.

Even though a significant relationship between D and PAI was observed in the present study, the variation in the PAI score is only partially explained (16.7%) by the variation in post length (R^2_N =0.167). This could be due to the reported prevalence of other radiographic findings influencing the periapical conditions. The quality of root canal filling, the presence of coronal restorations, the length of remaining apical filling, the occurrence of overfilling, have been reported to influence the periapical status.[7,23,29] Thus, the observation of a low R^2 in the present correlation is comprehensible, since other factors that were not studied in this work could also have influenced PAI variation.

Furthermore, the frequency distribution and the Chi square test performed ensured that the data source was not influenced by demographic variables, such as sex, age range or arch, which might cause bias in the subsequent ordinal regression performed.

Following endodontic treatment, the placement of a post-retained restoration is usually required. In order to create a clear cutoff point for clinicians, the D value was dichotomized into ≤5 mm and >5 mm to calculate the odds ratio of D≤5 mm being allocated to higher PAI scores (4 and 5). It was observed that teeth with intraradicular posts show a 3-fold greater chance of being categorized as presenting elevated PAI scores (4 and 5) when the 5 mm apical remnant is not respected (OR=2.82, 95%CI=1.82-4.759, p=0.0001). It is known that short apical fillings result in poorer sealing ability.[12] Although not consistently proven, lower root canal sealing ability would negatively influence the regression of AP after root canal treatment. Furthermore, it is likely that most of the root canals in this study had their intraradicular post not definitively cemented immediately after filling, which, according to Solano at al,[30] contributes to greater leakage compared to those immediately cemented. In addition, Grecca et al[31] confirmed that the presence of residual root canal filling delays, but cannot prevent bacterial invasion into the root canal.

It is well-known that various factors can influence the survival of post-retained endodontically treated teeth.[32] Analysis of the results of the present study demonstrated that the remaining apical post-free canal length significantly influenced the degree of PAI and should be considered by clinicians and restorative dentists during intraradicular post placement.

Conclusions

Within the limits of the method and given the results obtained in this study, it can be concluded that the radiographic appearance of periapical periodontitis was intimately linked to the distance between the intraradicular post tip and the radiographic root apex; the closer to the apex, the higher the periapical index. Teeth with distances from the post tip to root apex less than or equal to 5 mm showed almost three times the odds of being categorized as presenting severe degrees of apical periodontitis.

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