

Prevalence and Risk Factors of Apical Periodontitis in Endodontically Treated Teeth in a Selected Population of Brazilian Adults

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The aim of this study was to assess the prevalence and risk factors of apical periodontitis in endodontically treated teeth in a selected population of Brazilian adults. A total of 1,372 periapical radiographs of endodontically treated teeth were analyzed based on the quality of root filling, status of coronal restoration and presence of posts associated with apical periodontitis (AP). Data were analyzed statistically using odds ratio, confidence intervals and chi-square test. The prevalence of AP with adequate endodontic treatment was low (16.5%). This percentage dropped to 12.1% in cases with adequate root filling and adequate coronal restoration. Teeth with adequate endodontic treatment and poor coronal restoration had an AP prevalence of 27.9%. AP increased to 71.7% in teeth with poor endodontic treatment associated with poor coronal restoration. When poor endodontic treatment was combined with adequate coronal restoration, AP prevalence was 61.8%. The prevalence of AP was low when associated with high technical quality of root canal treatment. Poor coronal restoration increased the risk of AP even when endodontic treatment was adequate (OR=2.80; 95%CI=1.87-4.22). The presence of intracanal posts had no influence on AP prevalence.

Key Words: apical periodontitis, endodontic treatment, coronal restoration, endodontic epidemiology.

INTRODUCTION

Apical periodontitis (AP) often appears as a response to intraradicular or extraradicular infection. Acceptance of endodontic therapeutic protocol to treat a disease has usually been based on pathological and clinical findings, frequently aided by radiographic exam.

The modern knowledge has shown that the logical clinical experience is not sufficient to show the best manner to establish preventive and therapeutic conducts. Several parameters are essential to study a disease, including its distribution, prevalence, severity and risk factors. Epidemiological studies in different populations contribute with scientific observations of factors associated with the disease at issue, such as treatment and outcomes (1).

Some studies (2-5) have correlated different factors with the prevalence of AP, especially the quality of root canal filling and coronal restoration and the presence of intracanal post. Ray and Trope (2) examined the radiographs of 1,010 endodontically treated teeth and observed absence of periapical pathology in 61.07% of the cases. These authors concluded that the technical quality of the coronal restoration was significantly more important than the technical quality of the endodontic treatment for apical periodontal health. Kirkevang et al. (3) evaluated the radiographs of 773 root-filled teeth to investigate the quality of endodontic treatments and coronal restorations as well as its association with the periodontal status and reported an AP prevalence of 52.3%. Inadequate root canal filling and coronal restoration were associated with an increased

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AP incidence. Tronstad et al. (4) examined the radiographs of 1,001 root-filled teeth and found a success rate of 67.4%. Technical quality of endodontic treatment was found to be more important than the technical quality of the coronal restoration. Hommez et al. (5) reported that the technical quality of coronal restorations and root fillings influenced the periapical health.

According to Eriksen et al. (1), the results from analytical epidemiology together with the knowledge from experimental and clinical studies indicate the quality of root canal filling as a key prognostic factor.

Considering the importance of epidemiological studies, the purpose of this study was to assess the prevalence and risk factors of AP in endodontically treated teeth in a selected population of Brazilian adults.

MATERIAL AND METHODS

Radiographic Selection

This cross-sectional study was based on a full-mouth radiographic survey of randomly selected endodontically treated teeth (except third molars) of patient charts from the Brazilian Dental Association (Postgraduate Course in Endodontics, Goiânia, GO, Brazil). The sample consisted of 1,372 endodontically treated teeth observed by periapical radiographs taken using the parallelism technique and all films being developed by a specialized radiological clinic. The inclusion criteria were: i) radiographs should be from patients attending the clinic of the Postgraduate Course in Endodontics and ii) endodontic treatments should have been done within the last 10 years by postgraduate students. Patient age ranged from 18 to 60 years. The study design was independently reviewed and approved by the local Ethics in Research Committee.

Radiographic Image Interpretation

Three independent and skilful endodontists with over 5 years of clinical experience examined the radiographs after thoroughly discussing the established interpretation criteria (described in a following paragraph). The observers were also aware of others criteria used in different studies (6-7).

Seventy radiographs (approximate 5% of total) were initially examined by the observers for calibration and standardization of the evaluation criteria. When a

consensus was not reached after two observers examined the radiographs, the third observer made the final decision. The radiographs were examined in a darkened room using a lightbox (Medalight, LP-300, Universal Electronics Ind., NY, USA), mounted in cardboard slits to block of environment light emanating from the lightbox and viewed under $\times 3$ magnification. The criteria for radiographic analysis, modified from previous studies (2-4) were the following:

Endodontic Treatment: Adequate - root canal space was completely filled, with the filling material ending 1-2 mm from the radiograph apex; *Poor* - the filling material was poorly condensed within the root canal space (transversally and longitudinally), with the filling mass ending >2 mm from the radiograph apex.

Coronal Restoration: Adequate - permanent restoration was intact radiographically; *Poor* - permanent restoration presented signs of overhangs, recurrent decay or marginal gaps.

Intracanal Post: Absence - no intracanal post; *Presence*: an intracanal post was present, independently of type (prefabricated or cast), length or diameter.

Apical Periodontitis: Absence - normal periapical anatomic structures (intact periodontal ligament space and lamina dura); *Presence* - radiographic alterations in the periapical region (changes in the periodontal ligament space, loss of integrity of the lamina dura, mild to severe changes in bone structure with well-defined radiolucent areas).

Statistical Analysis

AP prevalence was calculated considering the radiographic quality of the root canal filling and coronal restoration, as well as the presence of intracanal post. Chi-square test was used to identify association between risk factors and AP. Odds ratio (OR) and 95% confidence interval (CI) were also calculated for each association. Significance level was set at $p < 0.05$.

RESULTS

A total of 1,372 periapical radiographs of endodontically treated teeth were evaluated. Endodontic treatment and coronal restorations were rated as adequate in 781 (56.9%) and 881 (64.2%) cases, respectively. There was no evidence of an intracanal post in 768 cases (56.0%).

AP prevalence was analyzed according to radiographic aspects of treatment risk factors (Table 1). AP prevalence was significantly higher in teeth with poor endodontic treatment (66.3%) than in teeth with adequate root canal filling (16.5%) ($p=0.00$). Prevalence of AP was also higher in teeth with poor coronal restoration (52.1%) than in teeth with adequate coronal restoration (30.1%) ($p=0.00$). No significant difference in AP was observed when intracanal posts were either present (35.8%) or absent (39.7%) ($p=0.134$).

Poor endodontic treatment was highly associated with the presence of AP (OR=9.96; 95% CI= 7.66-12.95). Likewise, poor coronal restoration was also a risk factor for AP (OR=2.53; 95% CI= 2.00-3.20). Poor

coronal restorations had a detrimental effect even in teeth with root canal filling considered as adequate.

In teeth with adequate endodontic treatment, AP prevalence was higher in cases with poor coronal restorations (27.9%) compared to those that were adequately restored (12.1%) ($p=0.00$). Similar results were found for teeth with poor endodontic treatment that presented either poor restoration (AP prevalence of 71.7%) or adequate coronal restoration (AP prevalence of 61.8%) ($p=0.011$). Combined analyses of endodontic treatment and coronal restoration indicated that poor restoration is a risk factor for AP whenever teeth have either adequate (OR=2.80; 95% CI= 1.87-4.22) or poor endodontic treatment (OR=1.57; 95% CI= 1.09-2.25).

Table 1. Prevalence of apical periodontitis as influenced by the quality of the endodontic treatment and coronal restoration, and the presence of intracanal post (n=1,372).

Factor	n (%)	Prevalence of apical periodontitis n (%)	p (Chi-square test)	OR (CI 95%)
<i>Endodontic Treatment</i>				
Adequate	781 (56.9)	129 (16.5)	0.000	9.96 (7.66-12.95)
Poor	591 (43.1)	392 (66.3)		
<i>Coronal Restoration</i>				
Adequate	881 (64.2)	265 (30.1)	0.000	2.53 (2.00 - 3.20)
Poor	491 (35.8)	256 (52.1)		
<i>Intracanal Post</i>				
Absent	768 (56.0)	305 (39.7)	0.134	0.85 (0.67 - 1.06)
Present	604 (44.0)	216 (35.8)		
Endodontic Treatment x Coronal Restoration				
<i>Adequate Endodontic Treatment (n=781)</i>				
Adequate coronal restoration	562 (72.0)	68 (12.1)	0.000	2.80 (1.87 - 4.22)
Poor coronal restoration	219 (28.0)	61 (27.9)		
<i>Poor Endodontic Treatment (n=591)</i>				
Adequate coronal restoration	319 (54.0)	197 (61.8)	0.011	1.57 (1.09 - 2.25)
Poor coronal restoration	272 (46.0)	195 (71.7)		

DISCUSSION

Endodontic epidemiological studies conducted with different populations worldwide have shown that the periapical health status is related to factors like quality of root canal filling, coronal restoration and presence of intracanal post (1-5,8-17). Therefore, root canal obturation represents an important phase of endodontic treatment, which is completed with the placement of an adequate coronal restoration.

It has also been shown that higher endodontic treatment failure rates are related to inadequate root canal obturation (3-5). Hence, the best strategy to reduce significantly the number of microorganisms in endodontic infections is a combination of steps that include effective root canal preparation and disinfection, use of proper intracanal medication and three-dimensional filling of the entire root canal system and coronal chamber. All these factors enhance the prognosis of AP treatment.

Using a cross-sectional model, this study evaluated the prevalence and risk factors of AP in endodontically treated teeth in a selected population of Brazilian adults on the basis of a radiographic survey. Considering as parameters the prevalence of AP and its risk factors, and not its severity or extension, the observers followed only the criteria described in the Material and Methods section. Moreover, score systems have been used to assess the severity, development or healing of AP and also to make a comparison between the present findings and those of other studies. One of the score systems used was the Periapical Index (PAI) described by Ørstavik et al. (7), which presents good accuracy and reproducibility.

In the present study, the prevalence of AP associated with adequate endodontic treatment was only 16.5%. This is a low rate compared to those found in other epidemiological studies, ranging from 20 to 52% (1-5,8-17). The discrepancies observed between the results of different studies might be explained by the following aspects: i) lack of homogeneity of the populations being compared; ii) lack of standardization of the methods of radiographic assessment; iii) use of teeth or individuals as referential; iv) quality of endodontic treatment rated by either general dentists or endodontists; and v) different levels of endodontic practice and infection control in the different populations.

Explanations for the results obtained in the current study, which led to positive estimates, should be

clarified. The time interval included in this investigation provided a good estimative of quality of endodontic treatment and indicated that root canal fillings and coronal restorations had been done according to modern scientific, biological and technological knowledge. These factors contribute to enhance the estimation of endodontic treatment prognosis and may justify the lower rate of AP found in the current investigation. Another factor that influenced these results was the good technical quality of the postgraduate students that performed the endodontic treatments.

Some aspects relative to AP should be taken into consideration. By definition, AP consists in the inflammation of the periodontal tissues at the root apex and presents distinct pathological stages of development. Nair et al. (18), analyzing 256 human periapical lesions, found that 35% of them were diagnosed as periapical abscess, 50% as granuloma and 15% as cysts (9% apical true cysts, 6% apical pocket cysts). Pocket cysts may heal after root canal treatment, but true cysts are less likely to be eliminated by conventional endodontics. The etiological factors involved in AP include intraradicular and extraradicular infection, and foreign-body reactions.

The critical factor for endodontic success is the elimination of microorganisms from the root canal system by means of the association of procedures, i.e., cleaning, enlarging, shaping, use of antimicrobial intracanal medications and quality of root canal filling and coronal restoration. Previous studies have reported high success rates of endodontic treatment depending on the preoperative status of the pulp and periapical tissues (19,20). Sjögren et al. (19) evaluated the factors that would affect the long-term outcomes of root canal therapy 8 to 10 years after the treatment. The success rate for cases with vital or nonvital pulps, but having no periapical radiolucency, exceeded 96%, whereas 86% of the cases with pulp necrosis and periapical radiolucency showed apical healing. From all periapical lesions present on previously root-filled teeth, only 62% healed after retreatment. Kojima et al. (20) analyzed by cumulative meta-analysis the success rate of root canal filling as well as the effect of underextension, overextension and flush filling on outcome. The cumulative success rate for treatment of teeth with vital pulp was higher than that of teeth with nonvital pulp, which might be related to the fact that the pulp space of nonvital teeth is often infected. There was higher success rate with flush filling, as confirmed by the radiographic examination of

both vital and nonvital teeth.

AP prevalence in teeth with adequate endodontic treatment and adequate coronal restoration was 12.1%, while AP prevalence in teeth with poor endodontic treatment and poor coronal restoration was 71.7%.

The outcomes of the present study also showed that poor coronal restoration increase the risk of AP even when endodontic treatment is adequate (OR=2.80; 95% CI=1.87-4.22), which agrees with previous studies (4,5). Tronstad et al. (4) affirmed that the technical quality of the endodontic treatment is the most important factor for periapical health status. Hommez et al. (5) evaluated the impact of the quality of coronal restorations scored on a clinical and radiographic basis and the quality of root fillings on periapical health. Data suggested that coronal leakage may not be of such clinical impact as indicated by previous studies, provided endodontic treatment procedures are carefully performed.

On the other hand, Ray and Trope (2) found different results and showed that the quality of coronal restoration is more important to apical periodontal health than the quality of root canal filling.

In the present study, 61.8% of the teeth with poor root canal filling and adequate coronal restoration had AP. When both unfavorable conditions were present (poor root canal filling and poor coronal restoration), AP prevalence increased to 71.7%. When both favorable conditions were combined (i.e., adequate endodontic and coronal sealing), the rate of AP was remarkably lower (12.1%). These results are in accordance with those of Tronstad et al. (4).

Segura-Egea et al. (13) evaluated the periapical status and quality of root filling and coronal restoration in a Spanish adult population and found that adequate root filling had a more substantial impact on the outcome of endodontic treatment than the quality of coronal restoration. Jiménez-Pinzón et al. (12) reported that the prevalence of root-filled teeth with AP was higher (64.5%) in a Spanish adult population compared to other epidemiological studies (1,10,11,13,14). The authors (12) justified these results as being due to inappropriate techniques applied by some Spanish dentists. Skudutyte-Rysstad and Eriksen (16) determined the prevalence of AP and the quality of root fillings in 35-year-old Oslo citizens and changes over a 30-year period. Twenty-three percent of the individuals examined had root-filled teeth and 16% had at least one tooth with AP. There was an increase in the proportion of root-filled teeth with AP

from 18% in 1973 to 43% in 2003.

Siqueira et al. (14) determined the periradicular status related to the quality of coronal restorations and root canal fillings in 1,139 patients of the School of Dentistry of Estácio de Sá University, Rio de Janeiro, Brazil. The overall success rate of root-filled teeth was 49.7%. The differences between the success rate of that study (14) and the one of the present study can be attributed to the diversity of the studied populations, inclusion criteria, radiographic analysis criteria, inter-observer divergences and knowledge of operators' skills and expertise. In our study, the inclusion criteria comprehended selection of radiographs from patients attending the clinic of a Postgraduate Course in Endodontics and having endodontic treatments performed within the last 10 years by postgraduate students.

Kirkevang et al. (17) verified the risk factor for developing AP in a general population from Denmark. Presence of root canal fillings, coronal fillings, crowns and carious lesions indicates that the person is at higher risk factors for developing AP. The most decisive risk factor for developing AP were the presence of crowns and coronal fillings, especially inadequate ones. Presence of a root filling increased the risk of developing AP, whereas the quality of a root filling was insignificant.

Another interesting fact observed in the present study was that the presence of an intracanal post did not influence the risk of AP (39.7% of cases in the absence of post *versus* 35.8% when post was present). This is in agreement with the results of previous investigations, which did not find significant difference in the frequency of periapical lesions in endodontically treated roots with or without posts (4,15).

Eriksen et al. (1) reported from the review of epidemiological studies that the technical quality of the root fillings should be considered the most important determinant for endodontic success.

It is important to be aware of the limitations of radiographic assessment as a study method. One of these limitations involves the evaluation of the quality of root canal filling and coronal restoration based on a two-dimensional image of three-dimensional structures. The radiographic appearance of the filled root canal space has been considered a method to evaluate its quality of sealing. Radiographic images have been used to indicate the presence of periapical infection or coronal leakage, consisting of an important diagnostic resource. Previous studies have also employed periapical radiographs

with the same purpose of this study (2-5,15).

Extrapolation of these data to the general Brazilian population must be done with caution, considering all methodological implications and limitations. Further research is essential to evaluate the prevalence, severity and development of AP, as well as to create new indices that offer new guidelines to the endodontic treatment, especially concerning the protocol for management of endodontic infections. The use of radiographic images to detect AP requires attention. The use advanced radiographic techniques, such as dental CT, in Endodontics certainly can aid in the identification of periapical lesions with higher accuracy.

The findings of the present investigation showed that the prevalence of AP was low when associated with high technical quality of root canal treatment. Poor coronal restoration increased the risk of AP even when endodontic treatment was adequate. The presence of intracanal posts had no influence on the risk of AP.

RESUMO

O objetivo deste estudo foi avaliar a prevalência e os fatores de risco da periodontite apical (PA) em dentes com tratamento endodôntico em seleta população adulta do Brasil. Um total de 1.372 radiografias periapicais de dentes com tratamento endodôntico foi analisado, considerando-se a qualidade da obturação, o estado da restauração coronária e a presença de pinos intrarradiculares, associados com a PA. Os dados foram analisados estatisticamente empregando-se *odds ratio*, intervalos de confiança e teste do qui-quadrado. A prevalência de PA associada a tratamento endodôntico adequado foi baixa (16,5%). Este número reduziu-se a 12,1% quando se considerou obturação e restauração coronária adequadas. Os dentes com tratamento endodôntico adequado, porém com restauração coronária inadequada apresentaram prevalência de PA igual a 27,9%. A PA aumentou para 71,7% nos dentes com tratamento endodôntico e restauração coronária inadequados. Quando o tratamento endodôntico inadequado foi combinado com restaurações coronárias adequadas encontrou-se 61,8% de PA. A prevalência de PA foi baixa quando associada com a elevada qualidade técnica do tratamento endodôntico. A restauração coronária deficiente aumentou o risco de PA mesmo na presença de adequado tratamento endodôntico. A presença de pinos intrarradiculares não influenciou a prevalência de PA.

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