Prevalence of periapical periodontitis and its association with previous root canal treatment and, root canal obturation length –based on CBCT

Abstract

Background: Root canal obturation length may significantly affect the development of apical periodontitis lesions. This study aimed to investigate the prevalence of periapical periodontitis and its relationship with previous root canal treatment in terms of root canal obturation length.

Materials and Methods: In this cross-sectional observational study, 264 root canal-treated premolars and molars from patients referred to the Faculty of Dentistry at Azad University of Isfahan, who had undergone root canal treatment at least one year prior, were examined using CBCT radiography. A total of 630 canals with previous root canal treatments were selected. The screening protocol involved an initial selection of roots, followed by alignment in three planes (coronal, sagittal, axial) to ensure centrality. The roots were then classified based on the presence of periapical periodontitis and obturation length. Data analysis was conducted using Fisher's exact test and SPSS version 26.

Results: There was no significant difference between quality of obturation length among root treated teeth in all study groups ($p>0.05$). significant difference was observed between the obturation length and the frequency of apical periodontitis. The lesions among canals with proper obturation length were significantly less than canals with under or over obturation ($p<0.001$). but no significant difference was shown in pairwise comparison of each teeth type. (molars-premolars, first- second) ($P>0.05$).

Conclusion: There was a relationship between the length of root canal obturation and the prevalence of apical periodontitis, with a significantly lower presence of lesions in canals with appropriate obturation. However, this relationship was not observed based on the type of teeth.

Keywords: Periapical periodontitis, Cone-Beam Computed Tomography, Root Canal Therapy

Introduction

The purpose of root canal treatment is to cleanse the root canal system, prevent or elliminate periapical infections, and preserve the tooth's function. Its success rate depends on proper diagnosis, effective mechanical and chemical preparation methods, adequate canal obturation (1-3), and proper coronal sealing (4). In some cases, success rates can potentially increase up to 94%. (5). Root canal infections can occur in both previously treated and untreated teeth (6-8). Apical periodontitis often persists due to residual microorganisms, typically detected via radiographic examinations (9-11). The success of endodontic treatment is directly influenced by the quality of root canal obturation, including obturation density and length (ensuring it is not more than 2 mm short from the radiographic apex or beyond the root apex) (12-15).

Imaging techniques used to evaluate the presence of periapical lesions include periapical radiography, panoramic radiography, and cone beam computed tomography (CBCT). Conventional periapical radiography has several limitations. In normal radiography, a two-dimensional image is made of a three-dimensional object, and the same third-dimension compression in the image may hide important anatomy or pathological changes and lead to the failure to diagnose the periapical lesion and, ultimately, to the failure of the treatment. To prepare an ideal image, a parallel technique should be used in periapical radiography, which is rarely possible due to the conditions of the oral cavity. In addition, the possibility of superimposing anatomical structures on the image is another disadvantage of two-dimensional imaging (16). Despite all the shortcomings of two-dimensional imaging, the need to use new technologies in imaging is felt more than ever.

CBCT (cone beam computer tomography) technology is a new generation of CT, which provides 3D data with less cost and received dose than conventional CT. CBCT can provide a three-dimensional view of the target area, and this ability of CBCT to show lesions in several dimensions can solve the main defect of periapical radiography. It is apparently the most accurate method for identifying periapical lesions (17). CBCT, by reconstructing axial, sagittal, and coronal plane as well as diagonal shows all aspects of anatomy and pathology of the image (18).

As mentioned in previous studies, to achieve success in endodontic treatment with a favorable prognosis, it is considered necessary to observe four things. These include examining the presence of periapical lesions before treatment (19), use of the rubber dam (21,20), density and quality of canal obturation (23,22) ,and the quality of crown restoration (24). Ray et al. examined how the quality of root fillings and coronal restorations impacts the periapical status of treated teeth. They observed that teeth with good quality root fillings (GE) and good coronal restorations (GR) had a success rate of apical periodontitis index of 91.4% , compared to teeth with poor root fillings (PE) and poor coronal restorations (PR), which showed an API rate of 18.1%(12). Similarly, Falakakoglu et al. conducted a retrospective cone-beam computed tomography study to assess apical periodontitis in relation to the quality of root canal fillings and coronal restoration in a Turkish subpopulation. They reported that the quality of root canal obturation, adequate coronal restoration, and the type of crown restoration are factors related to apical periodontitis (25). It has also been stated in several different studies that the main reason for the occurrence of periapical periodontitis is the improper quality of root canal obturation (26, 27). Considering the risks of apical periodontitis and the need for retreatment in patients with symptoms of this lesion, the purpose of this study was to determine the prevalence of periapical periodontitis and its relationship with previous root canal treatment in terms of length of root canal obturation based on CBCT findings.

Materials and Methods

In this cross-sectional observational study of the analytical type, the 264 root-treated premolar teeth and molars in patients referred to the Faculty of Dentistry of the Azad University of Isfahan (Khorasgan) were examined by CBCT radiography. The study focused on teeth that had undergone root canal treatment at least one year ago, selected CBCT images had to include at least one premolar or molar that had undergone root canal treatment, with a minimum of one year since the procedure. The study excluded third molars, untreatable roots, impacted teeth, primary teeth, permanent teeth with immature apices, images with artifacts, as well as cases with fractured files, perforations, root fractures, resorptions, teeth without crown restorations, and maxillary molars missing the second mesiobuccal canal (MB2).

All images were prepared by the Sirona Germany system with high resolution and exposure conditions kv 85-100, mAs 5-7, and total filtration < 5/2 mm, focal point equal to 0.5 mm2 and scan time 14 seconds and then checked and measured in sidexis 3D software .

Finally ,630 canals with previous root canal treatment were selected by a trained final-year dental student under the supervision of a radiologist. The screening protocol, which included the initial selection of roots, followed by root alignment in three planes (coronal, sagittal, and axial) to have a centrality in three planes, followed by root classification accordingto the parameters to be evaluated, was performed.

All samples were analyzed in coronal, sagittal, and axial dental planes. Each root was classified according to the following parameters observed in each of the planes: (25)

-Presence/absence of periapical radiolucency

-Length of obturation, which was classified as below;

Under obturation: if it is 2 mm short of the radiographic apex

Suitable: in case of obturation up to 0-2 mm from the radiographic apex

Over obturation: in case of obturation beyond the apex

The obtained data were analyzed using Fisher's exact test and SPSS26 software, and the error level was considered 0.05.

Results

Apical periodontitis lesion was observed in 99 canals (15.7%) and the most common canal with a lesion was the mesiobuccal canal of the maxillary first molar (37.4%). maxillary first molar had the most lesion (33.3%) (Figure 1).

The comparison of obturation length quality between maxillary and mandibular premolars and molars showed no significant differences, as indicated by Fisher's exact test. There was no significant difference between the obturation lengths of maxillary and mandibular first premolars (p=1.00), first molars (p=0.200), second premolars (p=0.533), or second molars (p=0.370). Similarly, no significant difference was found between all maxillary and mandibular molars (p=0.064) or premolars (p=0.698) (Table 1).

In terms of apical periodontitis frequency, Fisher's exact test revealed no significant difference between maxillary and mandibular teeth. This included comparisons of first premolars (p=0.586), first molars (p=0.778), second premolars (p=1.00), and second molars (p=0.494). No significant difference was observed between all maxillary and mandibular premolars (p=0.515) or molars (p=0.926).

However, a significant relationship was found between obturation length and the presence of apical periodontitis lesions (p<0.001). Canals with proper obturation had significantly fewer lesions compared to those with underfilled or overfilled obturation (Table 2).

Discussion

The results of the present study showed that 15.7% of the examined canals had have apical periodontitis lesions. In the study of Çalışkan et al. (28), periapical lesions were 72%; in the study of Omoregie et al. (29), 30.1%; in the study of Safi et al. (30), 15.9% and Tavares et al. (31) 33%. The different prevalence in various populations can be attributed to factors such as cultural differences, hygiene, and dentists' expertise. The present study reported the highest prevalence of apical periodontitis in maxillary first molar teeth, followed by mandibular first molars, mandibular second molars, maxillary second molars, and maxillary premolars. Mandibular premolars showed the lowest prevalence of apical periodontitis. Apical periodontitis was also not observed in the mandibular first premolar.

According to the results of the present study, the highest frequency of apical periodontitis was found in first molar teeth with under obturation, and there was a significant relationship between improper obturation in terms of length of obturation and chronic apical periodontitis lesion. Considering the higher occurrence of apical periodontitis in upper and lower first molar teeth, it can be stated that apical periodontitis in first molar teeth with under obturation is much higher than in other teeth. Of course, it should be mentioned that one of the other reasons for the abundance of periapical lesions in the maxillary first molar in the study is the possibility of the presence of the second mesiobuccal canal in this tooth and the lack of proper and effective cleaning by the dentist (32, 33).

In a study by Falakaloglu et al (25), there was a significant relationship between apical periodontitis and root canal length obturation. They founded that apical periodontitis was much more common in first molar teeth than in other restored teeth, and have concluded that the proper obturation length of the teeth will be effective in preventing the occurrence of apical periodontitis, which is align with the results of the present study. In the study of Bürklein et al. (34), the prevalence of apical periodontitis lesions in re-rooted teeth was significantly high, and this amount in over obturation root canals, 27%, and teeth with obturation length of less than 2mm 4.4%, teeth without root treatment had 2.9% lesions. Also, the incidence of apical periodontitis in molar teeth was significantly higher than in other teeth.

According to the results of the current study, the obturation length is related to the incidence of apical periodontitis, so the lowest incidence of apical periodontitis was observed in teeth with

proper obturation but this rate was 5 times higher in teeth with short obturation than with proper obturation, and the length of long obturation also had a ratio of 3 to 1 with proper obturation in the incidence of apical periodontitis, which is consistent with the results of other studies (7, 35, 36).

Insufficient root treatment generally causes a higher risk of apical periodontitis. Improper root canal treatment includes methods such as incomplete cleaning and shaping, use of poor disinfection techniques, complex canal anatomy, and failure to use rubber dams (37).

The results of a study by Sousa Gomide et al. (38) showed that the length of canal obturation can affect apical periodontitis, and the frequency of apical periodontitis in molar teeth is significantly higher than in other groups of teeth. In the study of Bratiet al.(39), apical periodontitis with a high probability in the second mesiobuccal canal of maxillary first molar teeth that did not undergo root canal treatment was more than in other teeth.

Obviously, over-filled obturation also leads to stimulation and attraction of inflammatory cells to the periapical tissues and leads to the occurrence of periapical periodontitis (40). In their study, Ricucci et al. stated that to prevent the occurrence of periapical periodontitis in patients undergoing root canal treatment, root canal length obturation should be performed appropriately to prevent this lesion (40).

Since CBCT provides better results in evaluating periapical periodontitis and the quality and manner of canal obturation. Also, the baculolingual dimension in the sagittal root obturation section can only be seen in the CBCT scan (41). In 80% of the roots, the apical hole is up to 3.8 mm shorter than the anatomical apex and is often located in the buccal or lingual part of the root (42). Therefore, many short obturation are not seen in periapical radiographs; the present study was conducted using radiographic images due to the limitation of AP assessment (36). Of course, CBCT is more expensive, and the patient is exposed to more radiation.

Conclusion

Maxillary molars, especially in mesiobuccal canals, showed the highest prevalence of apical periodontitis. There was a relationship between the length of root canal obturation and the prevalence of apical periodontitis, with a significantly lower presence of lesions in canals with appropriate obturation compared to those with under- and over-obturation. However, this relationship was not observed based on the type of teeth.

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Table 1. comparison of the filling length frequency in the maxillary premolar and molar teeth

Tooth	Root canal length filling	Maxillary premolar	Madibullar premolar	P value	Maxillary molar	Mandibular molar	P value
		No (%)	No (%)		No (%)	No (%)	
first	Good	72 (97.3)	22 (100.0)	1.00	139 (95.9)	135 (91.2)	0.200
	Short	2 (2.7)	0 (0.0)		5 (3.4)	12 (8.1)	
	length	0 (0.0)	0 (0.0)		1 (0.7)	1 (0.7)	
Second	Good	67 (95.7)	32 (91.4)	0.533	63 (98.4)	68 (94.4)	0.37
	Short	1 (1.4)	2 (5.7)		1 (1.6)	2 (5.6)	
	length	2 (2.9)	1 (2.9)		0 (0.0)	0 (0.0)	

Table 2. The relationship between filling length and apical periodontitis in maxillary premolars and molars

Apical periodontitis	Suitable	Under obturation	over obturation	P value
	No (%)	No (%)	No (%)	
No	520 (87.0)	8 (29.6)	3 (60.0)	< 0.001
Yes	78 (13.0)	19 (70.4)	2 (40.0)	

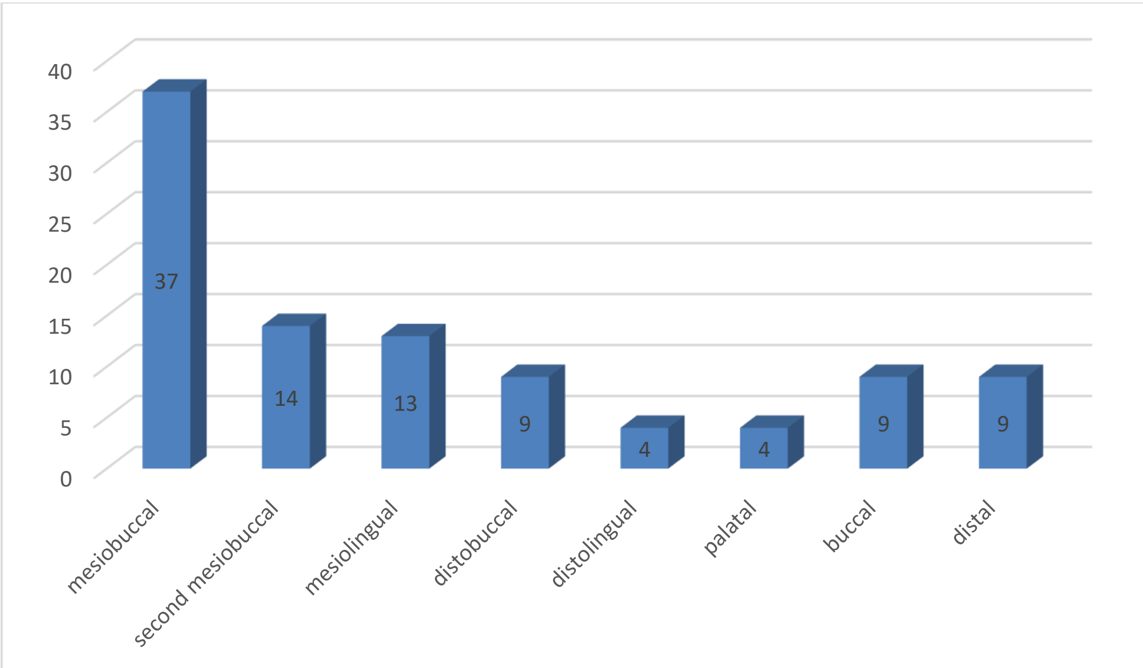

Figure 1. Frequency distribution of canal lesioned tooth in root-treated maxillary premolars andmolars, mandibular premolars and molars.

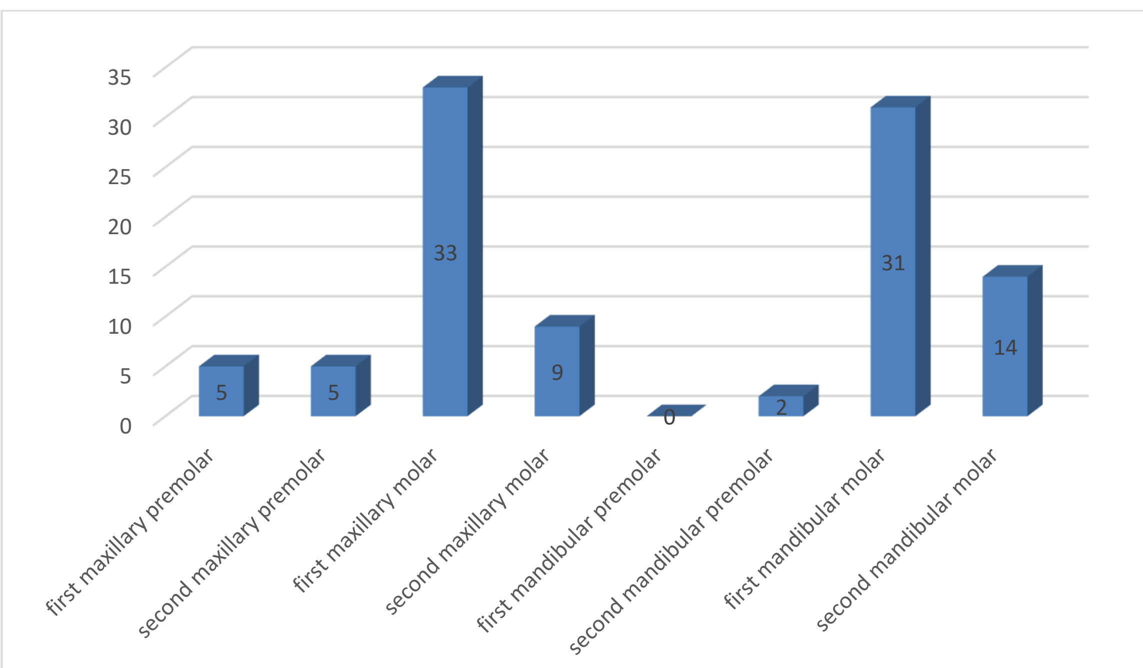

figure 2. Frequency distribution of tooth lesioned in root-treated maxillary premolars and molars, mandibular premolars and molars.