

A Radiographic Study of the Association between Apical Periodontitis and Technical Quality of Intraradicular Posts and Root Canal Fillings: A Cross-sectional Study in Qassim Region, Saudi Arabia

Abstract

Objectives: This study evaluates the association between the apical periodontitis (AP) and quality of intraradicular posts and the quality of root fillings assessed radiographically in Qassim region, Saudi Arabia. **Materials and Methods:** Digital periapical radiographs of 327 teeth with post-retained restoration were retrieved randomly from the Qassim University screening clinic's digital archives and evaluated. The quality of the intraradicular post and root filling was evaluated according to the optimum criteria. The presence of AP was assessed based on the periapical index scoring system. The relation between the post technical quality, the quality of root filling, and AP was determined. The data were analyzed using Chi-square test and logistic regression. **Results:** AP was found in 22% of the investigated teeth. Adequate root fillings were found in 69% of roots, and 14% of these cases were associated with AP. In roots with root filling classified as inadequate, 38% had AP with a statistically significant association between the root filling length and the presence of AP ($P < 0.001$). The most frequently used posts were prefabricated metallic posts (57%). Teeth restored with cast posts and prefabricated metallic posts exhibited AP with a frequency of 42.3% and 25.4%, respectively, and teeth with nonmetallic posts had significantly fewer cases of AP (12.0%) with a statistically significant association between the post type and the presence of AP ($P = 0.016$). **Conclusion:** Both the quality of the root filling and the intraradicular post type were correlated significantly with the presence of AP. The technical quality of root fillings and intraradicular posts was adequate. Nevertheless, the use of threaded posts is still a common practice in this study population.

Keywords: Apical periodontitis, cross-sectional study, epidemiology, intraradicular post, periapical radiographs, root canal treatment

**Ra'fat Ibrahim Farah,
Abdulrahman Sulaiman Aldakhili,
Ayoub Sulaiman Alnasser**

Department of Prosthodontics,
College of Dentistry, Qassim
University, Al-Mulaydah,
Qassim, Saudi Arabia

Introduction

The intraradicular post is an extension of the foundation restoration into the root of structurally compromised endodontically treated teeth and provides anchorage for the foundation restoration as well as support.^[1] To achieve these mechanical functions, the post must possess optimum technical quality with the maximum length to enhance the restoration retention and improve the resistance of the laterally directed forces by distributing these forces over as large a post dentin interface as possible to minimize stress concentration and avoid the risk of coronal restoration failure or tooth fracture. Furthermore, the post should have an adequate width to ensure post strength and structural durability as well as to prevent post deformation or fracture and therefore restoration failure. These optimal post design qualities should be achieved

within the anatomical limitations of the root morphology and without jeopardizing periapical tissue health or the longevity of the tooth by deteriorating the quality of apical seal or weakening the remaining tooth structure.^[2-4]

Unfortunately, the literature contains contradictory findings regarding the effects of post placement on periapical tissue health. Some reports^[5-7] have demonstrated that teeth with radicular posts are significantly more associated with periapical lesions than teeth without posts. These reports justify this association due to canal recontamination and the displacement of the remaining filling material during post space preparation, which can lead to apical leakage and therefore adversely affect periapical health. This justification is supported by many *in vitro* studies^[8-12] that found that the removal of a part of the root

Address for correspondence:
Dr. Ra'fat Ibrahim Farah,
Department of Prosthodontics,
College of Dentistry, Qassim
University, Al-Mulaydah,
Qassim P. O. Box 6700,
Saudi Arabia.
E-mail: dr.rafat.farah@
qudent.org

Access this article online

Website:
www.contempclindent.org

DOI: 10.4103/ccd.ccd_605_17

Quick Response Code:



How to cite this article: Farah RI, Aldakhili AS, Alnasser AS. A radiographic study of the association between apical periodontitis and technical quality of intraradicular posts and root canal fillings: A cross-sectional study in Qassim Region, Saudi Arabia. *Contemp Clin Dent* 2017;8:579-86.

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

filling material for post space preparation can reduce the root filling sealing ability, which results in microleakage of bacteria and irritants and accordingly periapical infections/reinfections.

However, other reports^[13,14] have concluded that posts do not have any negative effects on the success of endodontic therapy and therefore periapical health. These studies demonstrated that the quality of endodontic treatment was significantly more important to the health of the periapical tissue than the presence of a post. Moreover, *in vitro* microleakage studies may be not relevant for drawing clinical conclusions, in particular, because these *in vitro* tests are considered to be exhibit more microleakage than occurs in real clinical situations.^[15] Furthermore, the rate of microleakage that is harmful to periapical tissue has not yet been determined.^[6,16]

Due to extensive studies on this subject in different populations, it is generally accepted that the technical quality of a root filling has a significant impact on the health of periapical tissue.^[17-21] However, only a few (rare) clinical studies^[22] have focused on the technical quality of intraradicular posts and their impact on periapical tissue health. Therefore, this cross-sectional study investigates the relation between periapical health status and the technical quality of both intraradicular posts and root fillings assessed radiographically in endodontically treated teeth restored with post-retained restorations in a population in Qassim region of Saudi Arabia.

Materials and Methods

Sample selection

This study includes randomly selected digital periapical radiograph images for patients, who attended the Qassim University's dental clinics for dental treatment between February 2015 and June 2016. These radiographs were taken in screening clinic for a periodic checkup or for a dental overview before starting the dental treatment in the university center and were labeled in the patients' record as preoperative radiographs. These preoperative radiographs as a rule in the university's dental clinics are usually taken using the long-cone paralleling technique with the Rinn positioning device (DENTSPLY International Inc. Islandia, NY, USA) because the paralleling technique provides more consistent and reliable information about the extent of apical pathosis than bisecting angle technique.^[23] The inclusion for selected radiographs should have at least one intraradicular post placed within a root canal filled with radiopaque root filling material and are satisfactory from a diagnostic viewpoint, showing the whole tooth in interest with clearly defined periapical region surrounded by 2–3 mm visible normal tissue in an optimal contrast and density with no cone-cuts, distortion, or obscuring structure. Radiographs that have signs of periodontal-endodontic lesions, root perforation, root resorption, periapical surgery,

apexogenesis, apexification, or radiographs with poor quality with nonassessable periapical status or incomplete endodontic treatment with no radiopaque root canal filling present inside the root canal system were excluded from this study. The study was conducted in full accordance with the World Medical Association Declaration of Helsinki, and ethical approval was granted by the Ethics Committee at College of Dentistry, Qassim University (EA/42/2016).

Radiograph evaluation

The periapical radiographic images were retrieved randomly from the digital archives, viewed, and analyzed using imaging software (DIGORA® for Windows 2.7; SOREDEX, Tuusula, Finland). All radiographs were examined and interpreted by an experienced examiner. An intra-examiner reliability test was performed by computing Cohen's kappa (κ) to secure the comparable results. All (κ) values exceeded 0.80. The examiner evaluated the radiographs based on the six criteria [Table 1]. All radiographs were examined at $\times 1.5$ magnification on the same 21-inch LCD monitor resolution (1920 \times 1200 at 60 Hz) in a darkened room, and the same ambient conditions were sustained during all the radiographic evaluation. Each original digital image was manipulated by the investigator to enhance the contrast and brightness of the image to give the subjectively clearest image of the root canal and periapical tissue as recommended by Akdeniz and Soğur.^[24] To obtain accurate measurements, images were calibrated using the calibration function available in the software before measurements were done to obtain post, crown, root, remaining root filling lengths, and filling length relative to the radiographic apex [Figure 1]. The periapical index [PAI] scoring system proposed by Orstavik *et al.*^[25] was used to evaluate the periapical condition roots with PAI score 1 or 2 were classified as having healthy (normal) periapical status while roots classified with apical periodontitis (AP) had a PAI score of 3, 4, or 5.

Statistical analysis

All statistical analyses have been performed using the SPSS software (SPSS 22 for Windows; IBM Corporation, Armonk, NY, USA). Descriptive statistics were obtained, and Chi-square tests (univariate approach) have been applied to detect any significant differences in the periapical status associated with intraradicular post type, its technical quality, length or remaining root filling, gender, tooth group, and the quality of the endodontic treatment. Logistic regression (multivariate approach) has been further used to study the relationship between the explanatory (independent) variables and the periapical status. $P < 0.05$ has been considered statistically significant.

Results

The total number of periapical radiographs examined was 234 and included a total of 327 teeth with the intraradicular posts. Of the 327 teeth, only 19% belonged to female

Table 1: Parameters and criteria recorded from periapical radiographs on the quality of intraradicular post, root canal filling, and periapical health status

Parameters	Criteria	Definition
Post design type and configuration	Prefabricated metallic posts	Include: Passive (nonthreaded tapered or parallel), active (threaded)
	Prefabricated nonmetallic posts	Include: Carbon, glass, and quartz fiber-reinforced posts
	Cast post	One piece cast post and core
The quality of endodontic filling	Adequate	Root filling ends 0-2 mm short of the radiographic apex
	Inadequate-overfilled	Root filling beyond the radiographic apex
	Inadequate-underfilled	Root filling ends ≤ 2 mm short of the radiographic apex
The ratio of post length to crown length	Adequate	Post-to-crown length ratio $\geq 1:1$
	Inadequate	Post-to-crown length ratio $< 1:1$
The ratio of post length to root length	Adequate	Post length extended $\geq 2/3$ of the root length
	Inadequate	Post extended $< 2/3$ of the root length
Length of remaining root filling	Adequate	Length of remaining gutta-percha apical to the post end = 4-5 mm
	Inadequate over-removal	length of remaining gutta-percha apical to the post end < 4 mm
	Inadequate under-removal	length of remaining gutta-percha apical to the post end > 5 mm
Periapical health status*	Normal periapical conditions	1 - Normal periapical structures 2 - Small changes in bone structure
	AP	3 - Changes in bone structure with some mineral loss 4 - Periodontitis with well-defined radiolucent area 5 - Severe periodontitis with exacerbating features

*According to periapical index [PAI] scoring system proposed by Orstavik *et al.*^[25] AP: Apical periodontitis

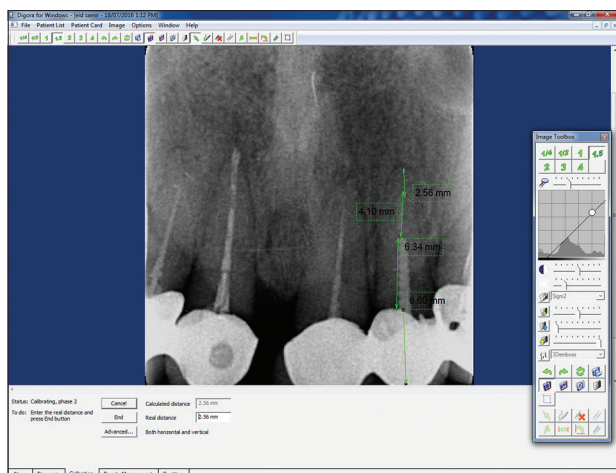


Figure 1: Screenshot of Digora® software showing the required length measurements obtained from periapical radiograph

patients; the most frequent tooth group was that of the upper anterior with 32%. A descriptive analysis of the study sample is given in [Table 2]. The overall prevalence of the AP (PAI score 3, 4 or 5) was 22% (72 of 327). Root canal fillings classified as adequate were nearly 69% of the evaluated roots while the ones which were inadequately treated were 31% root canal fillings classified as adequately treated had AP in 14% of the cases compared with 38% in teeth classified as inadequately root filled. A Chi-square test for association showed a statistically significant association between the quality of root canal filling and the AP, $\chi^2[2] = 22.706$, $P < 0.001$; with a moderately strong association, $\phi = 0.264$.

The results showed that the most frequently used posts were prefabricated metallic post (57%); 96% of them were

threaded posts, followed by fiber posts (35%). Eight percent of roots had cast post and showed the highest prevalence of AP (42%); on the other hand, only 12% of the roots with fiber posts had AP. There was a statistically significant association between the post type and periapical pathosis $\chi^2[3] = 17.144$, $P = 0.001$, according to the Chi-square test.

Periapical radiographic image analysis regarding the length of intraradicular posts (adequate/inadequate) according to both optimum post length criteria used in the study revealed that the posts' length was equal or longer than the crown in nearly 83% of the cases. However, the guideline that the post should be equal or longer than 2/3 of the root was not seen in 47.7% of the measured posts. The measurement of remaining root filling length also showed the inadequate removal of root filling in 52% of the roots.

The results were further adjusted using logistic regression to ascertain the effects of intraradicular post type, its technical quality, and quality of root filling on the likelihood that the teeth have AP. The logistic regression model was statistically significant, $\chi^2[7] = 32.762$, $P < 0.001$. The model explained the 14.6% (Nagelkerke R^2) of the variance in the presence of AP and correctly classified the 78.0% of cases. Of the five predictor variables, only two were statistically significant: post type and quality of root filling [Table 3]. Post type had significant association with AP ($P = 0.016$). Cast post had 4.459 (95% confidence interval [CI]: 1.605, 12.392) times higher odds to exhibit the AP than the fiber post. Teeth with prefabricated metallic posts with the AP were 1.747 (95% CI: 0.799, 3.819) times than that of the fiber posts. Teeth with adequate root canal filling were associated with a significantly reduced likelihood of exhibiting AP ($P < 0.001$) [Table 3].

Table 2: Descriptive analysis of study variables and the relation to periapical health (n=327)

Variables	Category	Total number	Percentage	Periapical condition			P [†]
				Normal	AP	Percentage	
Gender	Male	265	81	210	55	20.8	0.254
	Female	62	19	45	17	27.4	
Teeth group	Anteriors (upper, lower)	121 (109, 12)	37.0 (33.3, 3.7)	99	22	18.2	0.390
	Premolars (upper, lower)	126 (69, 57)	38.5 (21.1, 17.4)	94	32	25.4	
	Molars (upper, lower)	80 (23, 57)	24.5 (7.0, 17.5)	62	18	22.5	
Post type	Prefabricated metallic post	185	56.6	138	47	25.4	0.001*
	Cast post	26	8	15	11	42.3	
	Prefabricated nonmetallic post	116	35.5	102	14	12	
Root filling quality	Adequate	225	68.8	192	33	14.67	<0.001*
	Inadequate	102	31.2	63	39	38.2	
Post length: Root length ratio	Adequate	156	47.7	132	24	15.4	0.006*
	Inadequate	171	52.3	123	48	28.1	
Post length: Crown length ratio	Adequate	271	82.9	218	53	19.6	0.018*
	Inadequate	56	17.1	37	19	33.9	
Length of remaining root filling	Adequate	140	42.8	121	19	13.6	0.006*
	Over-removal	17	5.2	12	5	29.4	
	Inadequate-removal	170	52	122	48	28.2	

[†]According to Chi-square test, *indicates statistically significant difference ($P<0.05$). AP: Apical periodontitis

Table 3: Logistic regression analysis of study variables in relation to apical periodontitis in teeth with post-retained restorations

Variables	Frequency	OR	95% CI		P
			Lower	Upper	
Post type					
Prefabricated metallic post	185	1.747	0.799	3.819	0.016
Cast post	26	4.459	1.605	12.392	
Prefabricated nonmetallic post	116	1	Reference		
Root filling quality					
Adequate	225	0.331	0.181	0.605	<0.001
Inadequate	102	1	Reference		
Post length: Root length ratio					
Adequate	156	1.169	0.312	4.387	0.817
Inadequate	171	1	Reference		
Post length: Crown length ratio					
Adequate	271	0.827	0.392	1.744	0.617
Inadequate	56	1	Reference		
Length of remaining root filling					
Adequate	140	0.687	0.183	2.577	0.851
Over-removal	17	0.806	0.166	3.916	
Inadequate-removal	170	1	Reference		

Nagelkerke $R^2=0.146$. OR: Odds ratio, CI: Confidence interval

Discussion

Digital periapical radiographs of endodontically treated teeth restored with intraradicular posts were randomly selected from the Qassim University's dental center records and assessed for the incidence of different post types and optimum criteria for both the intraradicular post and root filling. There was additionally an investigation of whether there was a relation between these qualities and the periapical tissue health evaluated using the well-established PAI scoring system. Like many other previous

epidemiological studies,^[5,17,21,22,26] this study was based only on radiographic evaluation of the study population.

Patients visit Qassim University's dental center from numerous cities in Qassim province and its surrounding areas due to the strategic location of the dental center, the reputation of the university's dental service, and the free dental service provided. This situation eliminates the risk of only including patients previously treated by a limited number of practitioners. However, this study sample included only 19% of female participants because of the

newly installed digital radiography system in the females' clinics. It accordingly does not reflect the gender difference in the interest of obtaining dental care or a gender bias in the selection of the study participants. Therefore, this convenience sample may not be representative of the entire Qassim population.

Enhanced digital periapical radiographs were used in this study rather than panoramic radiographs, which have been more commonly used in previous similar epidemiological studies,^[17,18,27,28] are more readily available, and afford a more comprehensive overview of patients (a large volume of patient data could be readily gathered). Enhanced digital periapical radiographs have a higher sensitivity in detecting periapical osteolytic lesions, especially in the anterior region. Moreover, enhanced digital radiographs are superior when it comes to reliably detecting the root filling quality and diagnosing initial periapical lesions compared with conventional radiographs and unprocessed digital radiographs.^[24,29,30] All of the radiographs evaluated in this investigation were judged to be of high diagnostic value and were examined on a computer monitor with magnification.

The maxillary anterior teeth had the highest prevalence of post-retained restoration (33.4%), followed by the upper premolars (21.1%), the lower premolars (17.5%), the lower molars (17.0%), and the upper molars (7.0%). These results are consistent with previous reports.^[31,32] However, Jamani *et al.*^[22] found that maxillary premolars had the highest prevalence of post-retained restorations (28.93%), followed by the mandibular premolars and the maxillary molars. The lowest prevalence of post-retained restoration occurred in the lower anterior (3.6%), and almost identical percentages have also been reported in similar prevalence studies.^[22,31] At the tooth level, the posts were most commonly present in the upper central incisor followed by the upper laterals and the upper second premolar. Teeth that were most commonly associated with periapical lesions and inadequate root fillings were the upper first and second premolars (frequencies of 29.2% and 28.4%, respectively).

Among the evaluated teeth, 22% were associated with AP, which is consistent with data reported in other studies: Boucher *et al.*^[5] (29%), Kvist *et al.*^[6] (16%), Grieve and McAndrew^[31] (22%), and Tronstad *et al.*^[13] (29%). Furthermore, this figure is significantly lower than that reported by Saunders *et al.*^[33] and Jamani *et al.*^[22] These authors showed that investigated teeth with post-retained restorations had evidence of periapical pathology in 77% and 54% of cases, respectively.

Sixty-nine percent of the investigated root fillings were found to be adequate in terms of technical quality based on their radiographic length (i.e., within 0–2 mm of the radiographic apex). This fraction is higher than in most previous reports, which found percentages ranging from 21% to 54%. In addition, two recent studies^[21,34] performed

on quality of root filling in the Saudi population reported very low percentages of adequate root canal fillings (21%–23%). We note, however, that comparisons of results should be performed carefully due to differences in health-care systems, methodologies, and other factors.^[35] Even so, this significant discrepancy may be justified in two ways: methodological and sample selection issues account for a high percentage of teeth being categorized in the adequate root filling group. In terms of sample selection, only the roots restored with posts were evaluated, and only wide, straight root canals in multirrooted teeth were used for post placement (distal and palatal canals). Such canals are associated with fewer technical difficulties associated with achieving an optimal root filling.^[6] In previous reports, all filled canals were evaluated. In addition, we excluded teeth with no radiopaque root filling within the root canal, but in other studies, these teeth were considered to be inadequately root filled. Such teeth may account for up to a 16.7% increase in the population of the inadequate root filling group in these reports. For methodological reasons, our radiographic assessment of root filling quality was primarily based on the length of the root fillings; in other studies, both density (homogeneity) and length were used to evaluate the root filling.

Signs of AP were found 14.7% of teeth with adequate length root fillings. This finding was significantly different, as indicated by Chi-square test, from the rates of AP in post-restored teeth with overfilled and underfilled root canals (38.5% and 38.2%, respectively). Furthermore, the probability of radiographic detection of AP in teeth with inadequate root fillings was three times higher than for teeth with adequate root fillings, according to the logistic regression model. This finding indicates a strong correlation between the length of the root filling and periapical tissue health and accordingly endodontic treatment success. This result is similar to the conclusions confirmed by previous reports.^[17-21,28,36]

In this study, the most commonly used posts were prefabricated metal posts (56.5%), and most of them (96%) were threaded posts. On the other hand, cast posts were used only in 8% of cases. This situation is inconsistent with the studies of Dawson *et al.*^[27] and Nimigean *et al.*^[37] In those investigations, the commonly used posts were cast posts (in 43.7% and 69.6% of cases, respectively), and threaded posts were used only in 30.4% and 5.8% of cases, respectively. The majority of the modern dental literature recommends avoiding the use of threaded posts.^[1] These posts are considered to be the worst stress producers, and they exhibit a failure rate (through root fracture) of 7% compared with 3% for cemented posts. Clinical studies have reported that teeth restored using tapered threaded posts have lower survival rates than teeth restored using cemented posts.^[38,39] Unfortunately, these posts are the most commonly used posts in this study population. Furthermore, fiber posts, which can be bonded to dentin, can be used to

improve the distribution of forces applied along the root, thereby decreasing the risk of root fracture and contributing to the reinforcement of the remaining tooth structure.^[1,39] Fiber posts were present in 35.5% of teeth in the study population.

A significant association has been demonstrated between post type and AP. Cast posts exhibit the highest odds ratio (OR) for AP (OR: 4.459; 95% CI: 1.605, 12.392), followed by prefabricated metal posts (OR: 1.747; CI: 799–3.819) compared with fiber posts. Teeth restored with cast posts and threaded posts exhibit significantly worse periapical health (PAI score) compared with teeth restored using fiber posts. This finding might be explained by the fact that the first fiber posts used to be cemented by dentin-bonded resin cement. These resin cement possess a better sealing ability than conventional cement and prevent microleakage of microorganisms and their by-products to the root canal system.^[40] Resin cements accordingly increase the probability of periapical healing and/or maintenance of periapical health compared with conventional cement used for metal posts. This microleakage is aggravated by poor adaptation of the posts with the canal wall, particularly in prefabricated posts (threaded posts), which exhibited gross microleakage between these posts and canal wall in a previous study.^[41] The condition of the restored tooth indicates that the use of a metallic post rather than a fiber post may play a major role in this result. Despite the good sealing ability in cast posts, even with conventional cements, due to close adaptation of the custom-made post with the canal wall, poor sealing ability of provisional post which may remain *in situ* for several weeks before cementation of the definitive cast post can be the weak link in this type of posts and may lead to bacterial invasion reinfection/recontamination of root canal system, resulting in the high prevalence of AP in this type of posts.^[12,41,42]

Regarding the technical quality of posts, only the post length compared with the crown and root length and the length of the remaining root filling were considered in this study; the width of the intraradicular posts was not considered to be a factor. Posts that were longer than the crown were present in nearly 80% of the examined radiographs, which is consistent with one of the optimum post length guidelines. These guidelines state that the post length should be equal to or more than the crown length.^[2] This high percentage reflects awareness of biomechanical importance of the post length in this study population and is better than previous studies^[22,43] where only (33%–57%) of the posts investigated had a post to crown length ratio of 1:1 or more.

It is important to note that the posts that are third-fourth of the root length or more are 24%–30% more retentive than those that are equal to the crown height, and longer posts are more retentive and exhibit better stress distribution and fracture resistance.^[2] Therefore, from the standpoint of post retention and resistance of the root to fracture, it

appears that posts should be third-fourth of the root length. However, unfortunately, only 43.4% of the posts in the study population complied with this rule, which can be justified when a tooth has an average or below average root length and the post occupies two-third or more of the root length. This clinical scenario may lead to excessive removal of root filling and therefore the loss of apical seal. However, in this study, 52% of cases had more than 5 mm of root filling remaining, which indicates that there was leeway for extra post length in the investigated posts.

The importance of preservation of the apical seal presents another important criterion in the post space design, which is the amount of remaining root filling. Guidelines state that length of the remaining root filling should be in the range of 4–5 mm; in short roots, the absolute minimal root filling length should be not <3 mm to preserve the apical seal.^[2,6] This rule was followed in 41.5% cases, and only 3.4% of the roots investigated had remaining root fillings of <5 mm, which is similar to the figure provided in previous reports.^[22,43] The majority of the cases (52%) had inadequate removal of root filling, and this figure is consistent with the findings of Jamani *et al.*^[22] (70.71%). This situation again highlights the biomechanical importance of post length and the notion that the post should be as long as possible without comprising the apical seal; more than half of the intraradicular posts in this study were shorter than desired. The effect of both the post length and the amount of remaining root filling on periapical health status in this study were statistically insignificant according to the regression model. In previous report,^[6] roots with posts in which the remaining root filling was shorter than 3 mm exhibited a statistically significant higher frequency of AP, which was not shown in this study. This situation can be justified by the fact that only nine roots in this study had <4 mm of remaining root filling, and this small number had little weight on the results of the statistical analysis.

Finally, it is important to draw attention to the inherent shortcomings of radiograph-based cross-sectional epidemiological studies: It is impossible to draw causality from them,^[44] which is also complicated by the dynamic and complex multifactorial nature of AP. Furthermore, periapical status is affected by many factors, such as the preoperative status of the pulp and periapical tissues, the complexity of root canal system, the course of the root canal treatment procedures itself (e.g., cleaning and shaping protocols, canal disinfection, aseptic techniques and irrigation protocol, and proper isolation protocol during both endodontic treatment and post placement), and the quality of the coronal restoration.^[36,45] All of these factors may influence the development of AP in the root filled teeth; most of these factors cannot be reliably measured and recorded by simple two-dimensional radiographic images. In addition, it is impossible to detect lesions limited to the cancellous bone and the microbiological status of the root

canals, which suggests the incomplete diagnostic value of these radiographs.^[46] Even within these limitations, this study and similar studies provide valuable information and insights into the technical quality of different restorative procedures in different populations and help to pinpoint areas that need improvement. Moreover, the results of this study support the findings of many other studies, which demonstrate that the technical quality of root fillings is the most important contributing factor for successful root canal treatment.

Conclusion

Within the limitations of this radiographic-based, cross-sectional study in the selected Saudi population, one can conclude that both the root filling length and the intraradicular post type are correlated significantly with periapical health status. Roots that presented acceptable root filling lengths were associated with a lower prevalence of periapical pathology. Roots with metallic posts (cast and prefabricated posts) were associated with a periapical pathology significantly more frequently than roots with prefabricated nonmetallic posts (fiber posts).

The technical quality of root fillings and intraradicular posts was found to exceed that of other similar epidemiological studies. However, the quality was still not optimal. Furthermore, the use of threaded posts is unacceptable and should be avoided in modern dental practice. Unfortunately, this use is still a common practice in this study population. Therefore, improvements are necessary such as up-to-date dental education and training in both dental schools and at the level of the general dental practitioner.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- Dietschi D, Bouillaguet S, Sadan A. Restoration of the endodontically treated tooth. In: Hargreaves KM, Berman LH, editors. *Cohen's Pathways of the Pulp Expert Consult*. 10th ed. St. Louis, MO: Mosby/Elsevier; 2016. p. 818-48.
- Abou-Rass M, Donovan TE. The restoration of endodontically treated teeth. *J Calif Dent Assoc* 1993;21:61-7.
- Rosenstiel SF, Land MF, Fujimoto J. *Contemporary Fixed Prosthodontics*. 5th ed. St. Louis, MO: Mosby/Elsevier; 2016. p. 383-4.
- Robbins JW. Restoration of the endodontically treated tooth. *Dent Clin North Am* 2002;46:367-84.
- Boucher Y, Matossian L, Rilliard F, Machtou P. Radiographic evaluation of the prevalence and technical quality of root canal treatment in a French subpopulation. *Int Endod J* 2002;35:229-38.
- Kvist T, Rydin E, Reit C. The relative frequency of periapical lesions in teeth with root canal-retained posts. *J Endod* 1989;15:578-80.
- Eckerbom M, Magnusson T, Martinsson T. Prevalence of apical periodontitis, crowned teeth and teeth with posts in a Swedish population. *Endod Dent Traumatol* 1991;7:214-20.
- Abramovitz L, Lev R, Fuss Z, Metzger Z. The unpredictability of seal after post space preparation: A fluid transport study. *J Endod* 2001;27:292-5.
- Neagle RL. The effect of dowel preparation on the apical seal of endodontically treated teeth. *Oral Surg Oral Med Oral Pathol* 1969;28:739-45.
- Gish SP, Drake DR, Walton RE, Wilcox L. Coronal leakage: Bacterial penetration through obturated canals following post preparation. *J Am Dent Assoc* 1994;125:1369-72.
- Corrêa Pesce AL, González López S, González Rodríguez MP. Effect of post space preparation on apical seal: Influence of time interval and sealer. *Med Oral Patol Oral Cir Bucal* 2007;12:E464-8.
- Fox K, Gutteridge DL. An *in vitro* study of coronal microleakage in root-canal-treated teeth restored by the post and core technique. *Int Endod J* 1997;30:361-8.
- Tronstad L, Asbjørnsen K, Døving L, Pedersen I, Eriksen HM. Influence of coronal restorations on the periapical health of endodontically treated teeth. *Endod Dent Traumatol* 2000;16:218-21.
- Rosalem CG, Mattos CM, Guerra SM. Association between intra-radicular posts and periapical lesions in endodontically treated teeth. *J Appl Oral Sci* 2007;15:225-9.
- Pashley DH. Clinical considerations of microleakage. *J Endod* 1990;16:70-7.
- Kwan EH, Harrington GW. The effect of immediate post preparation on apical seal. *J Endod* 1981;7:325-9.
- Sunay H, Tanalp J, Dikbas I, Bayirli G. Cross-sectional evaluation of the periapical status and quality of root canal treatment in a selected population of urban Turkish adults. *Int Endod J* 2007;40:139-45.
- Loftus JJ, Keating AP, McCartan BE. Periapical status and quality of endodontic treatment in an adult Irish population. *Int Endod J* 2005;38:81-6.
- Hommez GM, Coppens CR, De Moor RJ. Periapical health related to the quality of coronal restorations and root fillings. *Int Endod J* 2002;35:680-9.
- Craveiro MA, Fontana CE, de Martin AS, Bueno CE. Influence of coronal restoration and root canal filling quality on periapical status: Clinical and radiographic evaluation. *J Endod* 2015;41:836-40.
- Alfouzani K, Baskaradoss JK, Geevarghese A, Alzahrani M, Alhezaimi K. Radiographic diagnosis of periapical status and quality of root canal fillings in a Saudi Arabian subpopulation. *Oral Health Prev Dent* 2016;14:241-8.
- Jamani KD, Aqrabawi J, Fayyad MA. A radiographic study of the relationship between technical quality of coronaradicular posts and periapical status in a Jordanian population. *J Oral Sci* 2005;47:123-8.
- Forsberg J, Halse A. Radiographic simulation of a periapical lesion comparing the paralleling and the bisecting-angle techniques. *Int Endod J* 1994;27:133-8.
- Akdeniz BG, Soğur E. An *ex vivo* comparison of conventional and digital radiography for perceived image quality of root fillings. *Int Endod J* 2005;38:397-401.
- Orstavik D, Kerekes K, Eriksen HM. The periapical index: A scoring system for radiographic assessment of apical periodontitis. *Endod Dent Traumatol* 1986;2:20-34.
- Mukhaimer R, Hussein E, Orafi I. Prevalence of apical periodontitis and quality of root canal treatment in an adult Palestinian sub-population. *Saudi Dent J* 2012;24:149-55.
- Dawson VS, Petersson K, Wolf E, Åkerman S. Periapical status of root-filled teeth restored with composite, amalgam, or full

- crown restorations: A Cross-sectional study of a Swedish adult population. *J Endod* 2016;42:1326-33.
28. De Moor RJ, Hommez GM, De Boever JG, Delmé KI, Martens GE. Periapical health related to the quality of root canal treatment in a Belgian population. *Int Endod J* 2000;33:113-20.
 29. Nair MK, Nair UP. Digital and advanced imaging in endodontics: A review. *J Endod* 2007;33:1-6.
 30. van der Stelt PF. Better imaging: The advantages of digital radiography. *J Am Dent Assoc* 2008;139 Suppl:7S-13S.
 31. Grieve AR, McAndrew R. A radiographic study of post-retained crowns in patients attending a dental hospital. *Br Dent J* 1993;174:197-201.
 32. Turner CH. Post-retained crown failure: A survey. *Dent Update* 1982;9:221, 224-6, 228-9.
 33. Saunders WP, Saunders EM, Sadiq J, Cruickshank E. Technical standard of root canal treatment in an adult Scottish sub-population. *Br Dent J* 1997;182:382-6.
 34. Balto H, Al Khalifah Sh, Al Mugairin S, Al Deeb M, Al-Madi E. Technical quality of root fillings performed by undergraduate students in Saudi Arabia. *Int Endod J* 2010;43:292-300.
 35. Eriksen HM, Kirkevang LL, Petersson K. Endodontic epidemiology and treatment outcome: General considerations. *Endod Topics* 2002;2:1-9.
 36. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. *J Endod* 1990;16:498-504.
 37. Nimigean VR, Buşinciu L, Nimigean V. A radiographic study regarding post retained restorations. *Rom J Morphol Embryol* 2012;53:775-9.
 38. Morgano SM, Rodrigues AH, Sabrosa CE. Restoration of endodontically treated teeth. *Dent Clin North Am* 2004;48:vi, 397-416.
 39. Baba NZ, Goodacre CJ. Restoration of endodontically treated teeth: Contemporary concepts and future perspectives. *Endod Topics* 2014;31:68-83.
 40. Nissan J, Rosner O, Gross O, Pilo R, Lin S. Coronal leakage in endodontically treated teeth restored with posts and complete crowns using different luting agent combinations. *Quintessence Int* 2011;42:317-22.
 41. Ravanshad S, Ghoreeshi N. An *in vitro* study of coronal microleakage in endodontically-treated teeth restored with posts. *Aust Endod J* 2003;29:128-33.
 42. Slutzky-Goldberg I, Slutzky H, Gorfil C, Smidt A. Restoration of endodontically treated teeth review and treatment recommendations. *Int J Dent* 2009;2009:150251.
 43. Al-Hamad KQ, Al-Omari M, Al-Wahadni A, Darwazeh A. Radiographic assessment of post-retained crowns in an adult Jordanian population. *J Contemp Dent Pract* 2006;7:29-36.
 44. Sidaravicius B, Aleksejuniene J, Eriksen HM. Endodontic treatment and prevalence of apical periodontitis in an adult population of Vilnius, Lithuania. *Endod Dent Traumatol* 1999;15:210-5.
 45. Ng YL, Mann V, Gulabivala K. A prospective study of the factors affecting outcomes of nonsurgical root canal treatment: Part 1: Periapical health. *Int Endod J* 2011;44:583-609.
 46. Huumonen S, Ørstavik D. Radiological aspects of apical periodontitis. *Endod Topics* 2002;1:3-25.