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Prevalence of periapical radiolucent lesions in endodontically-treated teeth with intraradicular posts: a cross-sectional CBCT study

Badi Alotaibi[1*], Muhammad Qasim Javed[1], Abdullah Alsallomi[2], Hanin Alsalhi[1], Roqayah Aljuailan[1] and Hanan Alharbi[1]

Abstract

Background The literature has reported contradictory findings regarding the association of Intra-radicular posts (IRPs) presence and periapical radiolucent lesions (PRLs) prevalence in endodontically treated teeth (ETT). Considering this, the study aimed to investigate the association between IRPs presence and PRLs prevalence.

Methods A cross-sectional study was conducted to compare PRLs prevalence in ETT with and without IRPs. CBCT images were utilized, and the teeth with at least 2 mm of remaining gutta-percha apical to the post-end were included. Two calibrated assessors assessed the PRLs presence. A stepwise backward binomial logistic regression was conducted to evaluate the effect of age, post presence, gender, tooth position (anterior/posterior), and arch location (maxillary/mandibular) on the likelihood of periapical radiolucency presence. The null hypothesis is that the presence of IRPs does not influence the prevalence of PRLs.

Results Teeth with IRPs showed significantly higher PRLs prevalence. However, there were insignificant differences in PRLs prevalence with respect to IRPs type or remaining gutta-percha length. The model, including all five predictors, demonstrated significant fit ($\chi^2(7) = 22.528, p = .002$), explaining 14.5% of the variance in the presence of radiolucency (Nagelkerke R^2). The Hosmer-Lemeshow test showed no evidence of a lack of fit ($\chi^2(8) = 11.550, p = .172$), supporting the model's adequacy. The model correctly classified 67.3% of cases, with a sensitivity of 54.5%, specificity of 75.4%, positive predictive value (PPV) of 58.3%, and negative predictive value (NPV) of 72.4%. Among the predictors, post presence was the only statistically significant variable ($B = 1.300, p < .001,$]$OR = 3.670, 95\%CI[1.985–6.785]$).

Conclusions A higher prevalence of PRLs was noted among the ETT with IRPs. Within the limitations of this study, we recommend that clinicians should carefully weigh the risks and benefits of using IRPs during the restoration of ETT.

Keywords Coronal restoration, Cone beam computed tomography, Endodontics, Intraradicular posts, Periapical lesions, Treatment outcome

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Introduction

The endodontic treatment (ET) of teeth primarily aims to prevent/cure apical periodontitis regardless of their remaining structure. However, in cases where the tooth structure is substantially compromised owing to caries, failed restorations, or fractures, ET is imperative. The preservation and restoration of root-filled teeth present a great challenge in contemporary dentistry, especially when faced with compromised clinical crowns [1]. Moreover, extensive loss of tooth structure makes the retention of restorations or crowns unfeasible [2, 3]. Consequently, the restoration of extensively damaged teeth requires the establishment of a foundational core for the final restoration. One method for securely retaining restorations in teeth with ET, experiencing substantial tooth structure loss, is using intra-radicular posts. These posts are strategically inserted into filled root canals to facilitate the construction and retention of the prosthetic coronal foundation. It is crucial to emphasize that these posts do not strengthen the roots; rather, they aid in retaining the final restorations [4]. The type of intra-radicular post varies depending on the technique and material, with cast post-and-core and prefabricated posts made of materials such as titanium, stainless steel, zirconium, and carbon or glass fiber [5, 6].

Nonetheless, many challenges are faced when inserting posts into filled root canals, particularly when the root canal filling (RCF) is not sufficiently condensed, potentially leading to its displacement [7]. Furthermore, the literature suggests that the sealing ability of RCF may be compromised in cases where space has been prepared for a post compared to intact RCF [8]. Haereid et al. found that teeth restored with posts had a higher transition hazard from healthy to diseased periapical status [9]. Likewise, other studies have documented the association of the presence of cast posts or metal/non-metal posts with a higher prevalence of periapical radiolucent lesions [10–12]. Conversely, other researchers reported conflicting results regarding endodontic failure rates and periapical status in teeth with or without posts [13, 14].

Additionally, integrating cone-beam computed tomography (CBCT) into endodontics has revolutionized diagnostic capabilities, offering precise three-dimensional examination of dental and maxillofacial hard tissues, including the detection of associated pathologies [15]. Studies exploring the accuracy of CBCT in detecting apical periodontitis have demonstrated its superiority over periapical radiographs [16–18].

Given the current ambiguity in the findings regarding the impact of IRPs on periapical health and the scarcity of relevant CBCT-based studies from the Saudi population, further investigations are warranted to address this knowledge gap. The aim of this study was to evaluate the relationship between the presence of intraradicular posts and the prevalence of periapical radiolucent lesions (PRLs). The null hypothesis was that the presence of intra-radicular posts does not influence the prevalence of periapical radiolucent lesions.

Methods

Ethical approval

Study approval was acquired from the Institutional Review Board, Qassim University, Qassim, Saudi Arabia. (Ref: 21-16-16).

Study design

It was an analytical cross-sectional study.

Study sample and sample size calculation

Sample size (SS) determination was performed based on the prevalence (22%) of PRLs found in endodontically treated teeth with post-retained restorations in the previous study [19]. The G-power SS calculator was utilized for SS calculation [20]. A sample of 94 endodontically treated teeth with post-retained restorations was calculated as the appropriate minimum SS with an effect size of 0.29, confidence level of 5%, and power of 80% [20].

A total of 800 CBCT scans were acquired from the Oral maxillofacial radiology department of Dental College at Qassim University. The CBCT images were taken for the patients attending undergraduate and postgraduate dental clinics at the College of Dentistry, Qassim University, between January 2019 and December 2022 for various diagnostic purposes, including endodontic assessment, oral surgery, implant planning, trauma, and evaluation of maxillofacial pathosis. Importantly, no CBCT scans were performed specifically for this study. Figure 1 depicts the study flow chart.

The inclusion criteria for the study Group (Group A) were high-quality CBCT images of endodontically treated single-rooted teeth with post and core restoration, radiographically acceptable coronal restoration, and ET with adequate quality. The exclusion criteria were distorted or unclear CBCT images, endodontically treated teeth without post and core restorations, radiographically unacceptable coronal restorations, and ET of inadequate quality. The comparison group (Group B) was comprised of randomly selected single-rooted teeth with adequate ET but without an intraradicular post, with the total number of teeth matching the study group selected using a randomization software (Pick Me, by Donation Coder Forum, 2009).

Data acquisition and screening method

All CBCT scans were acquired using a Galileos CBCT machine (Dentsply Sirona, Biensham, Germany) with consistent scan parameters (98Kv, 3-6 mA, scan time/exposure time of 14 s/ 2–5 s, field of view of 15×8.5 cm,

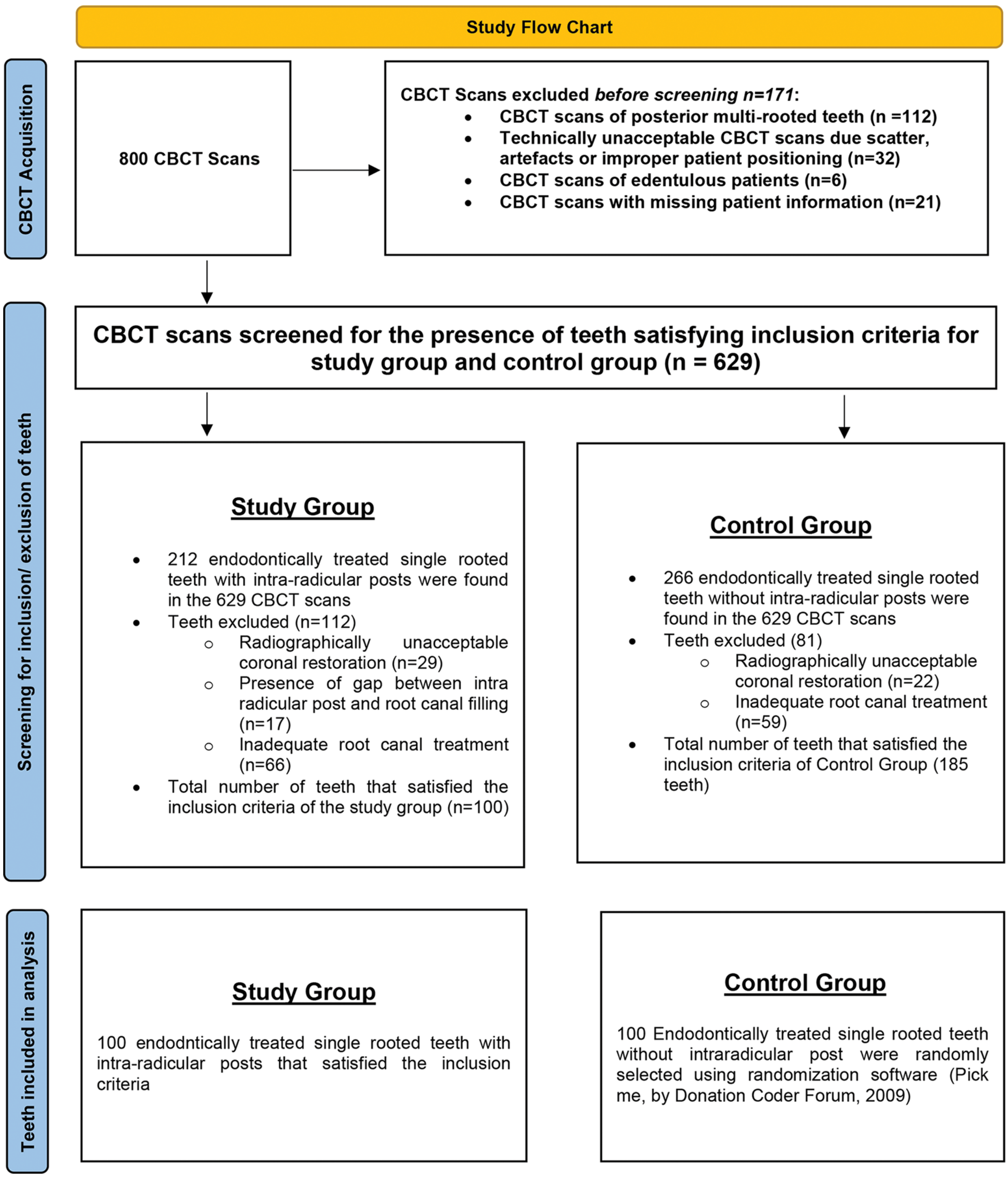

Fig. 1 Study flow chart

voxel size of 0.125 mm). Analysis of the scans was performed using the Sidexis 4 software (Dentsply Sirona, Biensham, Germany). All scans were taken in high-definition mode and were optimized with Metal Artifact Reduction Software (MARS). This algorithm reduces the metal artifacts and controls the contrast-to-noise ratio (CNR) [21]. To assess ET, restoration quality, and post-type, panoramic images were generated by curved multi-planar reformation processing (MPR) [22]. The quality of coronal restoration and ET was evaluated based on established criteria adopted from studies by Tronstad et al. [23] and Van der Veken et al. [22]. An acceptable coronal restoration was defined as being radiographically intact, while an unacceptable restoration showed

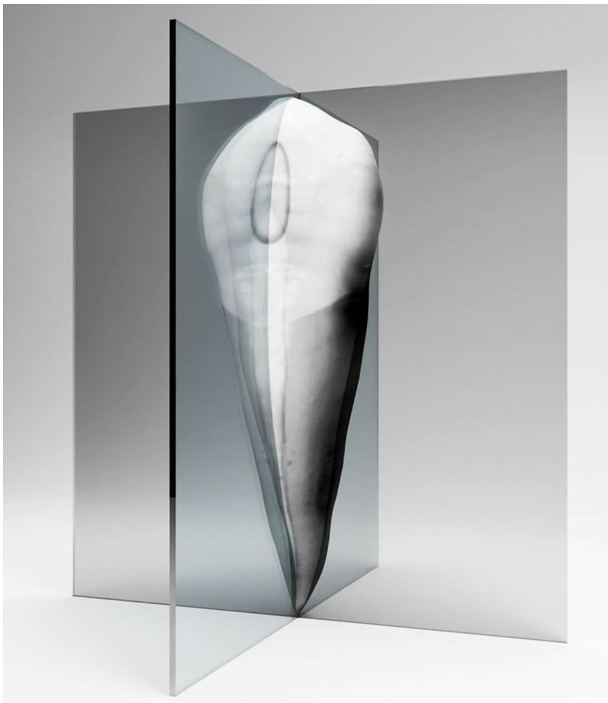

Fig. 2 An illustration of the CBCT slices used in the study (sagittal, coronal)

signs of overhangs, open margins, or recurrent caries. We assessed the adequacy of ET by ensuring it reached within 2 mm of the radiographic apex, with all canal space filled and no voids detected. ET was deemed inadequate if grossly overfilled or terminated over 2 mm short of the radiographic apex. ET was also considered inadequate if it contained voids, lacked proper density, had unfilled canal space, or was poorly condensed. Spaces or gaps indicating beam hardening artifacts were not considered when evaluating the coronal restoration or root ET after consultation with an oral radiologist. The post type was assessed and categorized as follows: *cast post*, a tapered metal post that is attached to a metallic core; *metal post*, flat-ended and parallel-sided/tapered with/without flutes, where the metal post was connected to a metallic or non-metallic core restoration; *fiber post*, a radiolucent post connected to a non-metallic core.

Evaluation of the included teeth

The sagittal and coronal sections were aligned parallel to the root axis. Screenshots were taken at the maximum diameter of the root passing through the apical foramen in both the sagittal and coronal planes. Each root was assessed in two separate slices (coronal and sagittal) (Fig. 2). To ensure examiner blinding of the study group, images were cropped below the cemento-enamel junction, concealing the clinical crown and restorative status. Furthermore, the post (if present) and root canals were blurred to the level of 1 mm from the radiographic apex using Skitch Software (Evernote Corporation, CA, USA) (Figs. 3, 4, 5 and 6). Processed images were assigned a number and exported to Keynote presentation software in a random distribution (Keynote, Apple Inc.). The person who processed and exported the images was not involved in the final evaluation (AA). The blurred scans were blindly evaluated by two endodontists (HA and RA) in a dark room. A periapical lesion was defined as a radiolucency associated with the tooth's radiographic apex, at least twice the width of the periodontal ligament

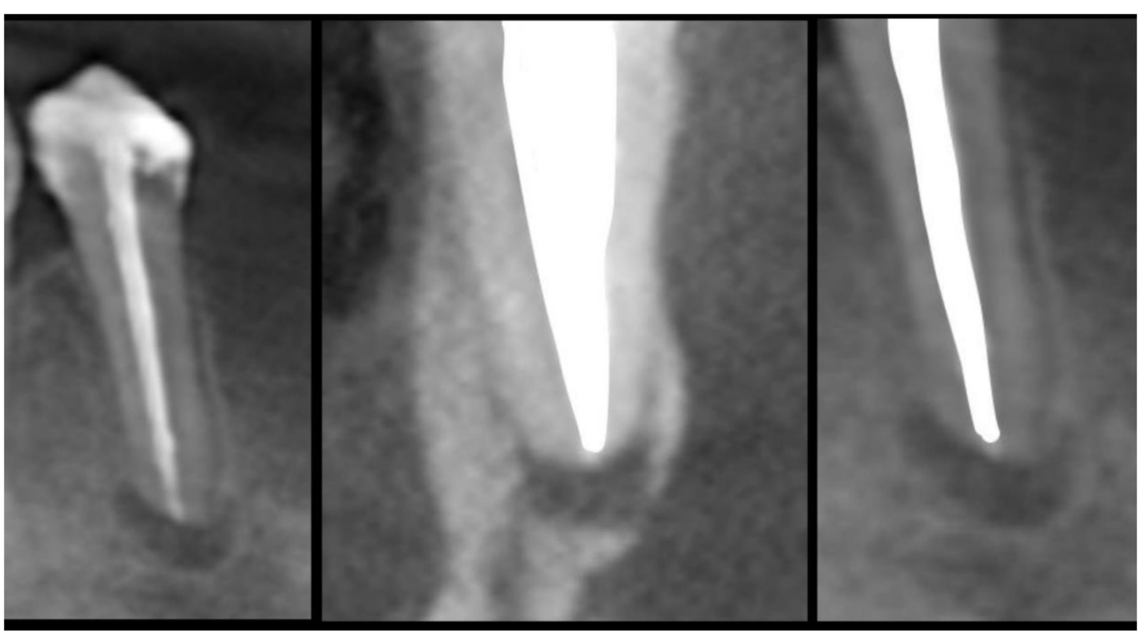

Fig. 3 An example of a tooth without an intra-radicular post with a periapical radiolucent lesion (coronal and sagittal)

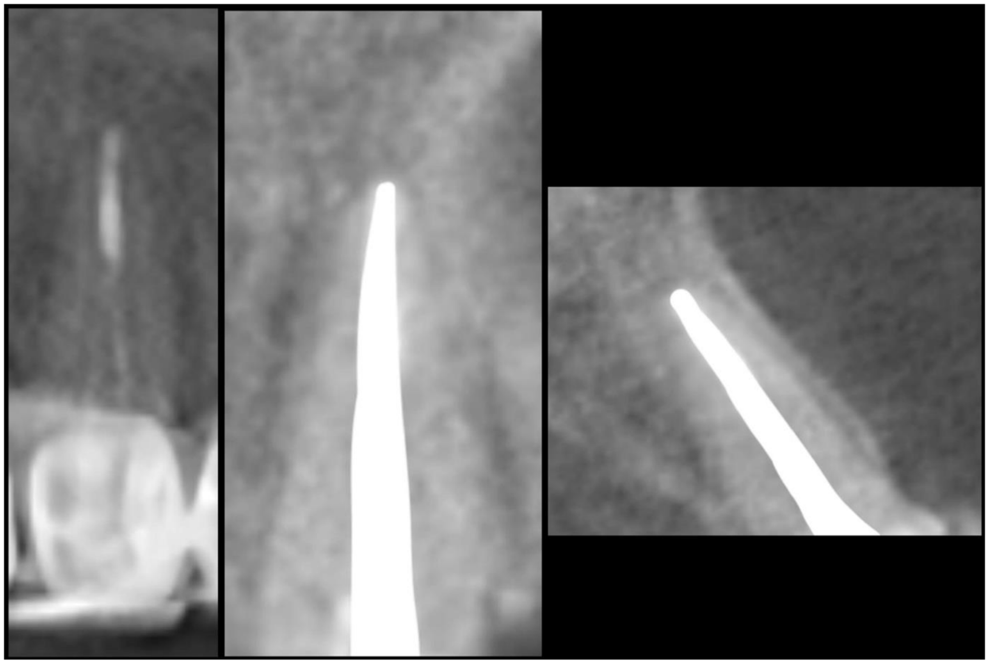

Fig. 4 An example of a tooth with a fiber intra-radicular post without a periapical radiolucent lesion (coronal and sagittal)

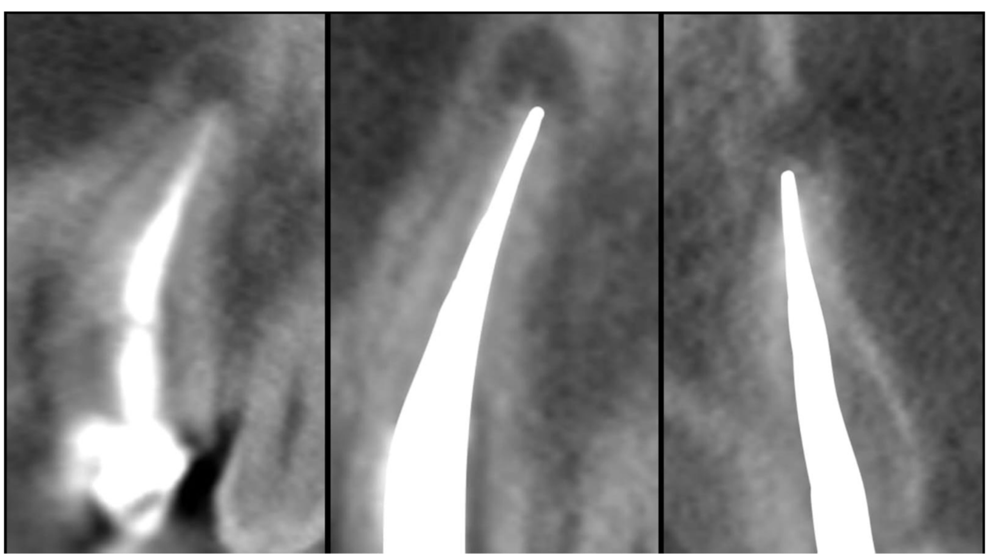

Fig. 5 An example of a tooth with a metal intra-radicular post with a periapical radiolucent lesion (coronal and sagittal)

space [17, 18, 24]. Examiners underwent calibration based on established criteria, with joint training on ten randomly selected scans. Each observer conducted a predefined evaluation to enhance reliability. In cases of discrepancies, the two examiners jointly discussed the images until reaching a consensus. If the two examiners did not reach an agreement, a third conclusive evaluation was performed by an endodontist with over ten years of experience who adhered to the same criteria (Fig. 7).

Data analysis

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS v. 26.0, IBM, Armonk, NY, USA).

Inter- and intra-examiner reliability assessments were performed. Cohen's kappa test was used to determine the consistency between examiners. The findings were evaluated after the initial 50 teeth were examined twice (observations A and B) over a two-week period. The inter-examiner reliability for observations A and B was based on the inter-examiner correlation coefficients for

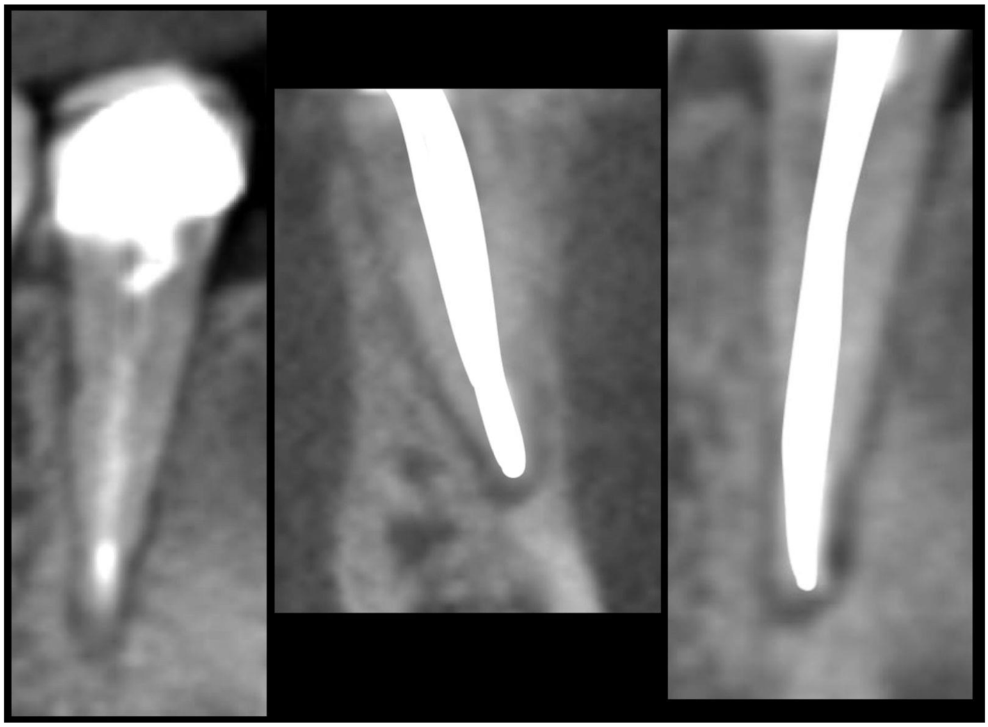

Fig. 6 An example of a tooth with a fiber intra-radicular post with a periapical radiolucent lesion (coronal and sagittal)

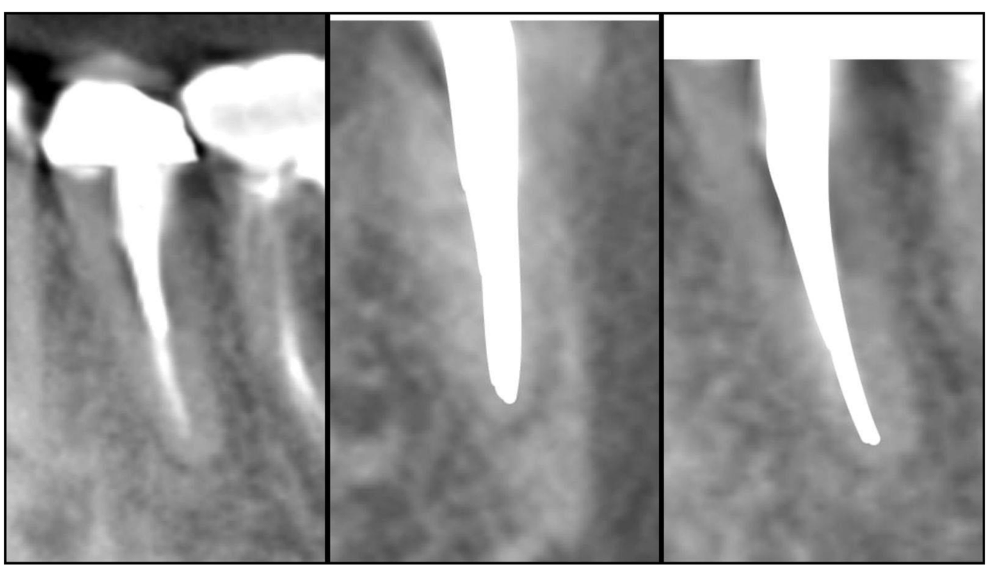

Fig. 7 An example of a tooth with a metal intra-radicular post without a periapical radiolucent lesion (coronal and sagittal). The two independent evaluators disagreed on this case. A third opinion was taken, and the absence of apical periodontitis was decided

the 50 teeth. The reliability of the group and individual observers was determined by the kappa coefficient of agreement and intra-examiner correlation coefficient values, both of which had to exceed 0.60.

The chi-square test was used to compare any differences in the frequency distributions of the following comparisons:

- PRLs between patients treated with and without intra-canal posts.
- PRLs between patients with cast, metal, and fiber posts.
- PRLs between teeth with gutta-percha length more and less than 5 mm.

Table 1 Comparison of periapical radiolucent lesions status between the study group (Root canal-treated teeth with intra-canal post) and the Control Group (Root canal-treated teeth without intra-canal post)

	Periapical radiolucent lesion Present *N*(%)	**Periapical radiolucent lesion Absent *N*(%)**	**Total *N*(%)**	**Chi-Squared Statistic**	***P* Value**
Study group A (Root canal treated teeth with intra-canal post)	54 (54%)	46 (46%)	100 (100%)	18.91	0.000014
Control Group B (Root canal treated teeth without intra-canal post)	24 (24%)	76 (76%)	100 (100%)		
Total	78 (39%)	122 (61%)	200 (100%)		

Table 2 Comparison of intra-canal post-type with the prevalence of periapical radiolucent lesions

	Periapical radiolucent lesion Present *N*(%)	**Periapical radiolucent lesion Absent *N*(%)**	**Total *N*(%)**	**Chi-Squared Statistic**	***P* Value**
Cast post	07 (53.8%)	06 (46.2%)	13 (100%)	0.512	0.774
Metal Post	12 (48%)	13 (52%)	25 (100%)		
Fibre Post	35 (56.5%)	27 (43.5%)	62 (100%)		
Total	54 (54%)	46 (46%)	100 (100%		

Table 3 Comparison of remaining Gutta percha length with the prevalence of periapical radiolucent lesions

	Periapical radiolucent lesion Present *N*(%)	**Periapical radiolucent lesion Absent *N*(%)**	**Total *N*(%)**
Samples with Remaining Gutta percha length 5 mm or less	16 (47.1%)	18 (52.9%)	34 (100%)
Samples with Remaining Gutta percha length > 5 mm	38 (57.6%)	28 (42.4%)	66 (100%)
Total	54 (54%)	46 (46%)	100 (100%)

Table 4 Correlation of length of the remaining gutta-percha with the presence or absence of apical periodontitis

			Gutta-percha length Less than 5 mm/ More than 5 mm	**Periapical radiolucent lesions Present/Absent**
Spearman's rho	Gutta-percha length Less than 5 mm/ More than 5 mm	Correlation Coefficient	1.000	−0.100
		Sig. (2-tailed)		0.322
		N	100	100
	Periapical radiolucent lesion Present/Absent	Correlation Coefficient	−0.100	1.000
		Sig. (2-tailed)	0.322	
		N	100	100

An arbitrary p-value of less than 0.05 was considered to be significant. A stepwise backward binomial logistic regression was conducted to evaluate the effect of age, post presence, gender, tooth position (anterior/posterior), and arch location (maxillary/mandibular) on the likelihood of periapical radiolucency presence.

Results

The Cohen's Kappa test result was 0.80 for intra-examiner reliability and 0.75 for inter-examiner reliability, and both were considered reliable. This study analyzed a sample of 200 teeth. Of these patients, 78 (39%) had PRLs. The proportion of teeth with PRLs was significantly higher in Group A (n=54, 54%) than those in Group B (n=24, 24%; p=.00014), as shown in Table 1.

Of the 100 teeth in which intra-canal posts were placed, 13 were cast, 25 were metal, and 62 were fiber posts. Table 2 shows the occurrence of PRLs in teeth with different posts. There was no significant difference in the frequency distribution of PRLs between the teeth with different types of posts (p=.774).

While 34 samples had a remaining gutta-percha length of less than 5 mm, 66 had a remaining gutta-percha > 5, as shown in Table 3. After applying Spearman's Correlation statistical test, no significant difference was observed, and the coefficient value found was −0.100, which means no correlation (Table 4).

A stepwise backward binomial logistic regression was conducted to evaluate the effect of age, post presence, gender, tooth position (anterior/posterior), and arch location (maxillary/mandibular) on the likelihood of periapical radiolucency presence. Standardized residuals were all within ±2, confirming no significant outliers.

Table 5 Stepwise backward binomial logistic regression predicting the likelihood of periapical radiolucency presence based on Age, Post presence, gender, tooth position, and Arch (step 1: including all five predictors). Stepwise backward binomial logistic regression predicting the likelihood of periapical radiolucency presence based on Age, Post presence, gender, tooth position, and Arch (step 1: including all five predictors)

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Tooth Position(1)	−0.182	0.426	0.182	1	0.670	0.834	0.362	1.922
	Arch (1)	0.003	0.433	0.000	1	0.995	1.003	0.429	2.341
	Age	-	-	2.728	3	0.436	-	-	-
	Age(36–50)	−0.265	0.383	0.481	1	0.488	0.767	0.362	1.624
	Age(51–65)	−0.574	0.418	1.889	1	0.169	0.563	0.248	1.277
	Age(66–80)	-1.023	0.870	1.384	1	0.239	0.360	0.065	1.977
	Gender(1)	−0.353	0.325	1.180	1	0.277	0.703	0.372	1.328
	Post presence(1)	1.300	0.314	17.196	1	< 0.001	3.670	1.985	6.785
	Constant	−0.619	0.408	2.298	1	0.130	0.538	-	-

a. Variable(s) entered on step 1: Tooth Position, Arch, Age, Gender, Post presence. Reference categories - Anterior (0), Maxillary (0), Age group(20–35), Female (0), No post (0)

The model, including all five predictors, demonstrated a significant fit (χ^2 (7) = 22.528, p = .002), explaining 14.5% of the variance in the presence of radiolucency (Nagelkerke R^2). The Hosmer-Lemeshow test showed no evidence of a lack of fit (χ^2 (8) = 11.550, p = .172), supporting the model's adequacy. The model correctly classified 67.3% of cases, with a sensitivity of 54.5%, specificity of 75.4%, positive predictive value (PPV) of 58.3%, and negative predictive value (NPV) of 72.4%.

Among the predictors, IRP presence was the only statistically significant variable (B = 1.300, p < .001, OR = 3.670, 95% CI [1.985–6.785]). This indicates that teeth with posts had 3.68 times higher odds of exhibiting periapical radiolucency than those without posts. Other predictors, including age, gender, tooth position, and arch location, were not statistically significant (all p > .05). The odds ratios for these predictors are presented in Table 5.

Discussion

The present cross-sectional retrospective study investigated the prevalence of PRLs in endodontically treated teeth (ETT) with intra-radicular posts and included only single-rooted teeth with adequate ET and coronal restoration. These teeth were selected to minimize the impact of variables, such as the complex root canal system (RCS) of multi-rooted teeth and subsequent technical challenges during their ET and post-placement, which might lead to the sustenance of microorganisms in RCS.

Compared to previous studies that utilized conventional radiography [9, 11, 14], the present study employed CBCT to assess the periapical status. However, the CBCT periapical index [PAI] [25] was not used during the evaluation, and the threshold for determining the presence or absence of a PRL was double the width of the normal PDL. The width of normal PDL ranges from 0.15 mm to 0.38 mm, with an average width of 0.25 mm [26]. Hence, the double width of the PDL is 0.5 mm, corresponding with a CBCT-PAI score of 1 or more [presence of a lesion] [25]. Since the current study was not an outcome study, the evaluation solely focused on the presence or absence of the PRLs. The findings of the present study suggested the association between intra-radicular post presence and the prevalence of PRLs, contradicting the notion that the presence of an intra-canal post does not affect periapical healing [27]. Other factors, such as the type and length of the post, did not significantly influence the prevalence of PRLs.

The study results revealed that the prevalence of PRLs in ETT with intra-radicular posts was significantly higher than that in teeth without intra-radicular posts. The findings align with the CBCT-based study of Pietrzycka et al., where a significantly higher prevalence of PRLs was reported in ETT with IRP, particularly when an inadequate coronal restoration was present [12]. This highlights the combined influence of IRP placement and coronal restoration quality on periapical health. Likewise, Estrela et al. reported a higher prevalence of PRLs in ETT with IRPs [28]. Accordingly, Bukmir et al. suggested the role of intra-radicular posts as a risk factor for PRL development (OR = 1.57, p < .05) while noting that the quality of coronal restoration may not independently predict the development of PRLs [10]. These contrasting findings regarding coronal restoration quality influence on PRL prevalence may be due to the two-dimensional periapical radiographs used in Bukmirs' study, which might have influenced the identification of teeth with PRLs.

The association between IRP presence and PRL prevalence may be attributed to different biomechanical mechanisms, including technical failures, stress distribution, and microleakage leading to post-treatment disease. The use of rubber dam isolation during post-placement is crucial in preventing leakage and contamination with oral bacteria and may negatively influence the treatment outcome [29–31]. Furthermore, altered stress distribution from intra-radicular posts can lead to mechanical failures like fractures, debonding, or dislodgment. Giok et al. found that metal posts had a higher risk of debonding or loss of retention, thus compromising the seal of ETT [32].

Regarding post type, our study did not find significant differences in PRL prevalence among cast, metal, and fiber posts, challenging the notion that the post type directly correlates with ET success [33, 34]. The results of the current study are consistent with those of Naumann et al., who concluded that the ferrule effect plays a more critical role in restoration success than the post material itself [35]. However, Suleiman et al. reported a superior long-term outcome with custom-made cast post-and-core restorations utilizing gold alloy, especially in teeth with substantial structural loss [36]. Similarly, Giok et al. highlighted the biomechanical advantages of fiber posts due to their modulus of elasticity, which closely matches dentin, reducing stress concentration and fracture risks [32]. In contrast, metal posts were associated with higher rates of debonding and stress concentration, potentially compromising the coronal seal and increasing susceptibility to vertical root fractures [32, 37]. These findings suggest that while IRP type may not directly influence PRL prevalence, its biomechanical implications should inform IRP selection in clinical practice. Moreover, the limited prospective studies highlight the need for further exploration into the impact of IRP type on endodontic treatment outcomes [19].

In the current study, the variables, including age, gender, tooth position, and arch location, did not exhibit a statistically significant association with the development of PRLs ($p > .05$). These findings align with previous research, which collectively points out that procedural and biomechanical factors play a more critical role in PRL development than patient demographics or tooth location [10, 12, 32, 36].

Various factors have been identified in the literature that influence the healing of the periapical tissues after the ET. These factors include but are not limited to the presence and size of PRLs, instrumentation, and apical and coronal seal quality [38, 39]. The imperative role of adequate coronal restoration after ET cannot be overstated, as it prevents postoperative coronal leakage and subsequent root canal re-infection. In cases where the remaining coronal tooth structure is insufficient to retain the coronal restoration, intra-radicular posts become indispensable. Contrary to the long-held belief that the type of permanent coronal restoration does not significantly impact ET outcomes [39, 40], our study emphasizes the importance of the quality of the coronal restoration.

Furthermore, preserving an adequate length of gutta-percha ensures a satisfactory apical seal. This seal is critical in preventing the infiltration of bacteria and contaminants into the root canal, thereby contributing to the success of the ET [27, 41]. The current study adhered to guidelines concerning the optimal length of remaining gutta-percha after the preparation of the post-space. Surprisingly, the length of remaining gutta-percha did not significantly influence the prevalence of PALs, further emphasizing the complexity of factors contributing to treatment outcomes. This is consistent with meta-analyses suggesting that root canals should be filled within 2 mm of the radiographic apex for optimal success rates [42].

The study has limitations since, in cross-sectional research, the data is collected at a specific point in time that does not allow the comparison of the pre-treatment and post-treatment CBCT images. Hence, it can't be ascertained whether the PRL had enlarged or reduced/healed, preventing the establishment of causal relationships. Therefore, PRL presence is not conclusive of ET failure. Another limitation was using only two fixed slices of CBCT to detect PRLs. However, this method can be considered a strength at the same time. If the examiners had been allowed to manipulate the CBCT freely, they would have been able to see whether the tooth had been restored with an intra-radicular post. By masking the clinical crown and root canal, the examiners were blinded to the restorative condition of the tooth, which helped eliminate or reduce bias. Theoretically, two perpendicular slices passing through the radiographic apex also eliminate the anatomical superimposition and make detecting PRLs easier than conventional radiography (Fig. 2). While our study enhances the understanding of periapical health post root canal treatment, caution must be exercised in interpreting results due to the limitations of radiograph-based cross-sectional studies. The multifactorial nature of PRLs, coupled with unmeasured variables, underscores the need for comprehensive, prospective investigations. Additionally, the superior diagnostic accuracy of CBCT over periapical radiography must be weighed against potential artifacts, especially in the presence of metallic posts [17, 43]. Moreover, the findings of the study may not be generalizable as it was conducted in a single center.

Conclusion

In this current cross-sectional CBCT-based study, a higher prevalence of periapical radiolucent lesions was found in endodontically treated teeth with intraradicular posts compared to those without posts. Within the limitations of this study, it is recommended that clinicians should weigh the benefits and potential risks of intraradicular posts when making decisions regarding the restoration of endodontically treated teeth. The limitations of the current study indicate avenues for future research to refine our understanding of factors influencing periapical health after endodontic treatment. Future multi-center and multi-ethnic prospective longitudinal studies and randomized controlled trials are recommended to investigate the association between the presence of intraradicular and endodontic treatment outcome. This will provide more robust evidence.

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Author contributions
Badi Alotaibi: Conceived and designed the study; Performed the experiments; analyzed and interpreted the data; and contributed to drafting the manuscript. Hanin Alsalhi: Roqayah Aljuailan: Analyzed and interpreted the data; and contributed to drafting the manuscript. Hanan Alharbi, Abdullah Alsaloumi: Contributed reagents, materials, analysis tools or data; and contributed to drafting the manuscript. Muhammad Qasim Javed: Conceived and designed the study; contributed to drafting and reviewing the manuscript.

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Data availability
Data will be made available by the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study complies with the Declaration of Helsinki and was performed after the approval was acquired from the Institutional Review Board, Qassim University, Qassim, Saudi Arabia (Ref: 21-16-16). The need for consent to participate was waived by an Institutional Review Board, Qassim University, Saudi Arabia, as it was a retrospective study and data was anonymized.

Competing interests
The authors declare no competing interests.

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