



Periapical Status of Endodontically Treated Teeth in Relation to the Quality of Root Canal Filling and Coronal Restoration: A Radiographic Study

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ABSTRACT

The goal of this study was to evaluate the effect of root canal filling and coronal restoration quality on endodontically treated teeth periapical status using radiographs of the examined teeth. The present research is a cross-sectional observational study. 1000 radiographs of endodontically treated teeth restored with permanent restorations will be randomly selected from the school of dentistry database, University of Ha'il, Saudi Arabia. The quality of the root canal filling and coronal restoration will be co-related with the periapical status of endodontically treated tooth. The collected data will be analysed by SPSS program version 28. To evaluate statistical significance between different parameters, the chi-squared and Fisher's exact tests will be utilized. P 0.05 will be used as the significance level.

KeyWords: Technical quality of root canal treatment; Coronal restoration; Periapical status; Hail region; Saudi arabia

BACKGROUND

Infection of the pulp can spread to include the periapical space, leading to periapical diseases such as periapical periodontitis and acute and chronic apical abscess [1]. On the other hand, periodontal infections may also spread to affect the pulp, leading to a pulp reaction called Endo-Perio disease or primary periodontal disease, with secondary endodontic involvement [2]. Therefore, the goals of root canal treatment are to remove the inflamed and necrotic pulp tissue, microorganism's elimination from the canal system, and prevent recurrence of infection [3].

If this is achieved it can restore and maintain the function and appearance of the teeth [4]. When root canal treatment is performed in accordance with the highest standards, the success

rate can reach more than 90% [5-7] and in the range of 75% to 80% with the existence of periapical lesion [8-11].

Periapical lesions caused by pulpal infections are one of the most commonly seen pathologies in the dental field. Therefore, the ultimate objective of endodontic therapy is to eradicate or diminish the microbial burden inside the root canal system by chemomechanical debridement followed by root canal filling [12]. Several studies, however, have shown that apical periodontitis is still on the rise, despite technological advancements in root canal treatment methods [13,14]. Thus, the presence or absence of such lesions can be used as an evaluating tool of the success and failure of endodontic treatment [15].

The frequency of properly filled root canals in relation to

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healthy periapical zones have been studied in various parts of the world. Epidemiological statistics from these investigations have revealed varying treatment results, with a prevalence of insufficient root canal fillings of up to 72.4% and apical periodontitis in 87.0% of these teeth [16]. Without a doubt, the effectiveness of endodontic treatment is not solely dependent on the quality of root canal therapy. Besides properly executed root canal fillings, adequate quality of the associated restorations appears to be a critical condition for preventing reinfection and favorably affecting apical periodontitis healing [17-19], hence boosting endodontic success and tooth survival [20].

A previous study on the department for the causes of endodontic treatment failure found that coronal leakage caused by a poor coronal restoration responsible for 15% of the failed case [21] Ray and trope suggested that the coronal restoration quality carries even a more critical role than the obturation in the outcome of root canal treatment [17]. However, there has been some controversy regarding the extent of the effect of crown restoration on the success rate of endodontic treatment [22]. Such data encourage clinicians to reconsider their dental practice whether to place a high quality permanent restoration immediately to avoid the highly possible leakage associated with the placement of temporary restoration [23-26].

The evaluation of periapical status in diverse populations is significant because it may help define treatment needs and evaluate the effects of various endodontic treatments on treatment results. As a result, several methodologies and criteria have been used to document the prevalence of apical periodontitis in different nations. One of the methods to assess the quality of root canal and coronal fillings in addition to the status of periapical tissues surrounding the tooth is radiographs on examined teeth [27]. Several radiographic parameters for the efficacy of endodontic treatment are widely acknowledged. Healing of recent osseous rarefaction, normal periodontal ligament space, normal lamina dura, no indications of resorption, and a thick and homogenous 3D obturation of the root canal system, including a suitable coronal repair [11,19-20] are examples of these. Because of the etiological influence of microbial infection [28], clinically achievable elements include total bacterial eradication (or at least a large decrease) of viable pathogenic microorganisms from the root canal [29].

Periodic studies of the incidence of apical pathosis in distinct populations may aid in defining treatment needs in a given location and correlating treatment outcomes to other parameters. So far, no investigation on the occurrence of apical periodontitis in endodontically treated teeth and its relationship with root canal therapy and final coronal restoration has been undertaken in the Hail region of Saudi Arabia. Therefore, the

Table 1: Parameters recorded on endodontically treated teeth.

Definition	Criteria	Parameters
Quality of root canal treatment		
Length	Acceptable	"Root canal filling 0-2 mm short from the radiographic apex".
	Unacceptable	"Root canal filling beyond the radiographic apex or root canal filling >2mm from the radiographic apex".
Homogeneity	Acceptable	"Homogeneous root canal filling, good condensation, no visible voids".
	Unacceptable	"Non-homogeneous root canal filling, poor condensation or voids present".

present study aimed to assess the periapical status of endodontically treated teeth in relation to both technical quality of root canal obturation and coronal restoration. In addition to that, the current study will determine which has more effect on the overall success rate. This data will aid in determining the overall need for dental treatment in Saudi Arabia's Hail area.

MATERIALS AND METHODS

The Ethical Committee of the College of Dentistry at the University of Hail authorised this descriptive observational cross-sectional study.

1000 radiographs of endodontically treated teeth restored with permanent restorations were randomly selected from the school of dentistry database, University of Ha'il, Saudi Arabia. Each sample was examined by one examiner using the available assistant tools such as computer magnification and contrast changing. The observers completed a calibration training consisting of 50 randomly selected panoramic radiographs prior to the evaluation. The kappa test was used to determine the inter observer agreement. In the event of a disagreement, the radiographs were evaluated and debated by all two observers until a consensus was accomplished. The agreement ratio was 80% followed by a meeting to discuss the 20% difference until a complete agreement was obtained.

The inclusion criteria were permanent teeth with fully developed root apices and no fractures, resorption or root caries. Teeth restored with post and core, apexogenesis or apexification were excluded to achieve standardization of the results.

Teeth were categorised into four groups according to their canal filling and coronal filling quality as:

1. Good endodontic filling (GE)
2. Poor endodontic filling (PE)
3. Good restoration (GR)
4. Poor Restoration (PR)

Following on that, based on the periapical index of the samples, teeth were categorized into two groups:

1. Absence of Periapical Lesion (APL)
2. Presence of Periapical Lesion (PPL)

Endodontic filling based on their obturation length, homogeneity and the taper shape as either acceptable or unacceptable. The restoration is either a crown or coronal restoration.

Examination parameters are mentioned in [Table 1](#).

Taper	Acceptable	"Consistent and uniform taper from the coronal to apical area with a reflection of the original shape of the canal".
	Unacceptable	"Non-consistent taper".
Coronal status		
Intra-coronal restoration	Acceptable	"Any permanent restoration that appeared intact radiographically".
	Unacceptable	"Any permanent restoration with detectable radiographic signs of overhangs, open margins, or recurrent caries".
extra-coronal restoration	Crown	

Periapical status

The scales of PAI are as follow:

1. Normal periapical structure,
2. Small changes in bone structures,
3. Changes in bone structure with mineral loss
4. Periodontitis with well-defined radiolucent area, and
5. Severe periodontitis with exacerbating features.

Scales 1 and 2 are considered as normal "absence of periapical lesion (APL)"

Scales 3,4 and 5 are considered as abnormal "presence of periapical lesion (PPL)"

Statistical Analysis

The collected data were analysed by SPSS program version 28. To evaluate statistical significance between different parameters, the chi-squared and Fisher's exact tests were utilised. P 0.05 was used as the significance level.

RESULTS

In this study, 1000 endodontically treated were evaluated. 577

were maxillary teeth (57.7%) while 423 teeth were mandibular (42.3%). Out of the 1000 samples, molars were the most frequently treated teeth (n=487, 48.7%) followed by premolars (n=308, 30.8%), while anterior were the least samples (n=205, 20.5%). **Table 2** shows the results in detail including the periapical status and related parameters. A P<0.05 is considered as a significant difference. **Table 3** shows periapical index data.

Table 2: Periapical status and related criteria

p-values	PPL		APL		Total	Variables
	%	n	%	n		
0.055	27%	156	73%	421	577(57.7%)	Maxilla
	27.90%	118	72.10%	305	423(42.3%)	Mandible
0.003	34.60%	71	65.40%	134	205	Anterior
	25.50%	203	74.50%	592	795	Posterior
	38.40%	63	61.60%	101	164	U/Anterior
	19.50%	8	80.50%	33	41	L/Anterior
0.011	21.70%	40	78.30%	144	184	U/Premolar
	21%	26	79%	98	124	L/premolar
	23.50%	54	76.50%	176	230	U/Molar
	32.30%	83	67.70%	174	257	L/Molar
0	20.10%	110	79.90%	437	547	Acceptable
	36.20%	164	63.80%	289	453	Unacceptable
0	18.50%	66	81.50%	290	356	Acceptable
	32.30%	208	67.70%	436	644	Unacceptable
0	19.80%	81	80.20%	329	410	Acceptable
	32.70%	193	67.30%	397	590	Unacceptable
0	12.70%	20	87.30%	137	157	Acceptable restoration
	29.60%	138	70.40%	329	467	Unacceptable restoration
	27.50%	46	72.50%	121	167	Acceptable crown
	33.50%	70	66.50%	139	209	Unacceptable crown

Table 3: Periapical index of the sam

variable		Index				
		1	2	3	4	5
Dental arch	Maxilla	178	244	133	18	4
	Mandible	126	179	91	26	1
Tooth region	Anterior	53	82	60	10	0
	Posterior	251	341	164	34	5
	U/Anterior	39	63	53	9	0
Tooth type	L/Anterior	14	19	7	1	0
	U/Premolar	64	80	35	4	1
	L/premolar	33	65	24	2	0
	U/Molar	76	100	47	5	2
Filling length	L/Molar	78	96	58	23	2
	Acceptable	207	230	91	16	3
Filling Homogeneity	Unacceptable	97	193	133	28	2
	Acceptable	155	135	57	8	1
Filling Taper	Unacceptable	149	288	167	36	4
	Acceptable	171	158	70	9	2
Restoration	Unacceptable	133	256	154	35	3
	Acceptable resto- ration	84	53	17	2	1
	Unacceptable restoration	119	210	113	22	3
	Acceptable crown	53	69	35	9	1
	Unacceptable crown	48	91	59	11	0

DISCUSSION

The present study evaluated the effect of root canal filling and coronal restoration quality on the periapical status of endodontically treated teeth. Periapical lesions caused by pulpal infections are one of the most commonly seen pathologies in the dental field. The presence or absence of such lesions can be used as an evaluating tool of the success and failure of endodontic treatments [15]. Coronal restoration quality carries even a more important role than the obturation in the outcome of root canal treatment [17].

One of the methods to assess the quality of root canal and coronal fillings in addition to the status of periapical tissues surrounding the tooth is radiographs on examined teeth [27]. Decades ago, apical periodontitis radiography was the only imaging modality accessible to diagnose apical periodontitis [30]. However, radiographic diagnosis of periapical periodontitis from panoramic radiographs may underestimate its true prevalence due to certain limitations of this method of assessment [31-32]. Such limitations include the evaluation of a 3D subject with a 2D image. On the other hand, other studies used similar radiographs for the same purpose of this study [33-34]. Previous endodontic epidemiology researches varied greatly in terms of investigation methodologies, sample selection, study design, and the criteria of the assessment. As a result, despite the fact that the bulk of these researches are based on radiographic investigation, a direct comparison is plainly problematic.

The current study is a cross-sectional design study. This cross-sectional study has the disadvantage that radiographic images were evaluated at a given time point while no information was available on when endodontic treatments were performed. Therefore, it is impossible to determine if a periapical

lesion has healed or has persisted, although some studies have demonstrated a high degree of reliability in cross-sectional studies to measure long term success after endodontic treatment. To overcome this disadvantage, a large sample size of 1000 teeth were included.

Low quality RCFs, as seen by radiographic data, contribute to a rise in apical periodontitis [35]. Furthermore, the filling of root canal system is the major hazard factor for apical periodontitis [36]. There are other researches that support this discovery [35-39]. Poor root canal filling quality was linked to periradicular radiolucencies in the current investigation. The quality of root canal therapy is regarded as an important determinant in the health of periradicular tissues [40].

The prevalence of apical periodontitis in the present study was 27.4%, which is higher than in previous similar studies [34,41]. In our study, root canal treatment and coronal restorations were inadequate more often than usual, which justify the high percentage of apical periodontitis. Several studies, which have focused on the effects of endodontic treatment quality on peri-radicular structures, have supported these claims [41,42].

The present findings showed there was no significant difference regarding the presence of apical periodontitis between maxillary (27%) and mandibular teeth (27.9%). This agrees with Kamberi et al., [42] findings. Based on teeth region, apical periodontitis was observed to be more common in anterior root filled teeth (34.6%) than those in posterior root filled teeth (25.5%). This was contrary to previous similar studies. Saryilmaz et al., [32] justified that posterior teeth have more complex anatomy than anterior teeth. Anterior teeth variations that could complicate the root canal treatment include "curvatures, an extra canal that could be missed, The canal divides in medial or apical third, stones and calcification" [43]. In addition to that, our large sample size may include such anterior teeth

with periapical lesions more than other similar studies.

Ng YL, et al. [44] have established the necessity to enhance the adequate length of extension of the gutta-percha inside root canal system as well as the technical quality of root canal therapy in order to enhance the periapical health of endodontically treated teeth. In terms of root canal filling length, Kojima et al [45] found a considerable influence in success rates between over as well as under filled root canal fillings in a meta-analytic research. They came to the conclusion that the root canal filling's length should be within 2 mm of the radiographic apex. A previous study on the department suggested that the first cause of endodontic treatment failure was underfilling obturation [21]. Overfilling on the other hand associated with chronic inflammatory response of periapical tissues [46]. The prevalence of apical periodontitis was observed in 36.2% of the selected population with root filled teeth with inadequate length with a significant difference than those with adequate length, which was similar to that reported in Spain [47]. The current study's findings supported previous findings [39,40,45] that the apical level of the root canal filling is substantially linked with periradicular state. At the same time, periradicular radiolucencies were found in 20% of the teeth with technically satisfactory root canal filling. Even if some of these lesions were healing at the time of examination, this result shows that the quality of root canal filling is not the main determinant of periradicular condition. Microorganisms in the root canal during root canal filling or subsequent contamination have been found to enhance the chance of treatment failure [48,49].

The present study and Segura-Egea [47] study also agreed on that regarding teeth with non-homogenous obturation. Non-homogenous obturation that usually shows voids within the obturation or between filling and canal walls offer a great environment for bacteria to reactivate cause treatment failure [50,51].

The degree of smoothness and taper continuity is another factor for evaluating root canal fills. Because root canal taper is a more subjective criterion, only a few publications on the issue have been published. This study showed that there was a significant difference between teeth with unacceptable taper obturation (32.7%) and those with good taper filling (19.8%) regarding the presence of an apical lesion. In a Yemeni population, inadequate taper filling also carried a significant difference [52].

One of the characteristics clearly connected with periradicular radiolucencies is the quality of the seal produced by coronal restorations [38-40,44-45]. Coronal restoration, in conjunction with the root canal filling, has been proposed as an obstacle penetration of the bacterial into the periapical area. Furthermore, the quality of coronal restoration is more significant for periapical health than the quality of root canal treatment as reported by Ray and Trope and Chugal et al., [17,26]. The present study showed (33.5% and 29.6%) apical lesion associated with Unacceptable crown and Unacceptable coronal restoration prospectively with a significant difference. According to our findings, the kind of restoration might be a risk factor for periapical lesions. The majority of the endodontically treated teeth were filled, which agreeing to the findings is not the greatest treatment for avoiding apical periodontitis. The study found

that teeth with indirect coronal restorations had much lower rates of apical periodontitis than teeth with direct filling type of restorations, and that the lack of any form of restoration was most usually related to apical periodontitis. Contrary to that, other studies showed there was no significant difference regarding the coronal restoration effect on the periapical status of the tooth and the quality of RCT remains the most important factor [41,53].

Treatment failure is likely due to a variety of factors. As a result, it's necessary to pay more attention to the factors that contribute to poor root canal treatment and restoration quality.

CONCLUSION

Despite the limitations of the research, it is possible to conclude that apical periodontitis is quite common in the Saudi Subpopulation. The majority of periradicular radiolucencies are related with root canal treated teeth, and radiological evidence of apical periodontitis can be seen in half of all root canal treated teeth. The general technical quality of root canal fillings is poor, which is dependable with the treatment's unsatisfactory prognosis. Significant efforts are necessary to raise endodontic treatment standards.

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AUTHORS' CONTRIBUTIONS

SAM, AAM contributed to the research concept, study design, data collection, statistical analysis, writing the original draft and reviewing and editing the final manuscript. RAR, GDS and RHS contributed to the research concept, data collection and reviewing the original draft. All authors read and approved the final manuscript.

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AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from University of Ha'il, college of Dentistry, Saudi Arabia, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of University of Ha'il, college of dentistry, Saudi Arabia.

ETHICS APPROVAL AND CONSENT PARTICIPATE

The Medical Ethics Committee of college of Dentistry, University of Hail, Saudi Arabia, approved the protocol of this study. All methods were performed in accordance with the declaration of Helsinki.

INFORMED CONSENT

Informed consent was waived by the ethics committee of college of Dentistry, University of Hail due to retrospective nature

of the study.

CONSENT FOR PUBLICATION

“Not Applicable”.

COMPETING INTERESTS

The authors declare no competing interests.

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