

Influence of filling quality on the periapical status of endodontically treated teeth

Influência da qualidade da obturação no status periapical de dentes tratados endodonticamente

Michel Sena Fernandes Faria LIMA^a , Pedro Paulo Alves SÁ^a , Stéphanie Quadros TONELLI^a ,
Fábio Fernandes Borém BRUZINGA^a , Eduardo NUNES^a , Frank Ferreira SILVEIRA^{a*}

^aPontifícia Universidade Católica de Minas Gerais - PUC Minas, Departamento de Odontologia, Belo Horizonte, MG, Brasil

How to cite: Lima MSFF, Sá PPA, Tonelli SQ, Bruzinga FFB, Nunes E, Silveira FF. Influence of filling quality on the periapical status of endodontically treated teeth. Rev Odontol UNESP. 2024;53:e20240019. <https://doi.org/10.1590/1807-2577.01924>

Resumo

Objetivo: Avaliar a qualidade radiográfica de tratamentos endodônticos e suas respectivas restaurações coronárias, correlacionando-os ao *status* periapical. **Material e método:** A qualidade da obturação de quatrocentos e dezesseis dentes foi criteriosamente avaliada em três parâmetros radiográficos: i) limite apical, ii) homogeneidade e iii) conicidade, sendo E0, E1 e E2. E0 e E1 corresponderam a acentuado e suave desvio da normalidade, respectivamente; enquanto E2 correspondeu ao padrão-ouro. Em função da combinação dos escores atribuídos, a obturação foi classificada em perfeita (PF), com três escores E2; satisfatória (ST), com dois escores E2; ou deficiente (DF), com um ou nenhum escore E2. Além disso, o status periapical foi considerado como periodonto sadio; espessamento do ligamento periodontal e presença de periodontite apical. Restaurações coronárias foram classificadas quanto à presença e tipo de restauração. As associações entre as variáveis foram analisadas através do teste de Correlação de Spearman ($p < 0.05$). **Resultado:** Duzentos e vinte e um dentes apresentaram obturação DF (53.1%). O limite apical foi o parâmetro com maior número de E0, perfazendo 38,94% dos escores atribuídos. Individualmente, os parâmetros observados não apresentaram associação estatisticamente significativa com o status periapical ($p > 0.05$); entretanto, o mesmo associou-se significativamente com a qualidade geral da obturação ($p = 0.021$). **Conclusão:** As obturações apresentaram baixo padrão de qualidade, sendo o parâmetro mais crítico, influenciando o *status* periapical de toda a amostra.

Descritores: Endodontia; obturação do canal radicular; periodontite periapical; radiografia.

Abstract

Objective: To evaluate the radiographic quality of endodontic treatments and their respective coronal restorations, correlating it with periapical status. **Material and method:** The root filling quality of four hundred and sixteen teeth was carefully evaluated regarding three radiographic parameters: i) apical extension, ii) homogeneity and iii) taper, being E0, E1 and E2. E0 and E1 corresponding to sharp and mild deviation from normality, respectively; while E2 corresponding to the gold standard. Due to the combination of the assigned scores, filling was classified as perfect (PF), with three E2 scores; satisfactory (ST), with two E2 scores; or deficient (DF), with one or no E2 score. In addition, periapical status was considered to be a healthy periodontium; thickening of the periodontal ligament and presence of apical periodontitis. Coronary restorations were classified according to the presence and type of restoration. Associations between variables were analyzed using Spearman's Correlation test ($p < 0.05$). **Result:** Two hundred and twenty-one teeth had DF filling (53.1%). The apical extension was the parameter with the highest number of E0, accounting for 38.94% of assigned scores. Individually, the observed parameters did not show statistically significant association with periapical status ($p > 0.05$); however, it was significantly associated with the general filling quality ($p = 0.021$). **Conclusion:** Fillings presented low quality standard, being the most critical parameter, negatively influencing the periapical status of the entire sample.

Descriptors: Endodontics; root canal obturation; periapical periodontitis; radiography.



INTRODUCTION

Endodontic therapy has great demand in the routine of dental offices. Even with the increase in preventive dentistry, the need for this type of treatment remains due to deep carious lesions, infiltration in old coronary restorations or dental trauma¹. In addition, the increase in the life expectancy of populations in general and the desire to preserve natural teeth as much as possible, result in decrease in the number of tooth extractions, leading to higher prevalence of endodontically treated teeth in elderly patients².

There are many factors that indicate the success or failure of treatment. Radiographically, the radiolucent periapical appearance is associated with teeth that require endodontic treatment³. This radiolucency, present due to apical periodontitis, has strong association with the inadequate technical filling quality. The success of endodontic treatment is due to the correct cleaning, shaping and filling of the root canal system, procedures that are necessary for the healing of periapical tissues^{4,5}.

The periapical lesion is the way in which the periapex reacts to the colonization of the root canal by microorganisms. When the endodontic treatment fails, it means that some of the cleaning, shaping and filling procedures of the root canal system failed to perform its function correctly, with the presence of persistent microorganisms^{2,6}.

Successful endodontic treatment remains a challenge for endodontics, despite the existence of a protocol for its implementation. Although there are still doubts, studies have addressed the relationship between absence or poor adaptation of the coronary restoration and endodontic failure^{4,6}.

The aim of this study was to evaluate endodontically treated teeth through previously performed periapical radiographs, correlating the periapical status with the filling quality in terms of apical extension, homogeneity and taper, presence and type of coronal restoration, in patients treated by undergraduate dental students in a school clinic.

MATERIAL AND METHOD

To carry out this study, digital periapical radiographs were collected from patients who received dental care at PUC Minas Periodontics clinics in 2018. All radiographs were located in Radiocef Studio®, the radiographic database used by the institution. As inclusion criteria, periapical radiographs of endodontically treated teeth were selected, in which it was possible to evaluate the entire tooth structure, the periodontal ligament and adjacent alveolar bone.

Initially, radiographs were collected from 274 patients. Of these, 41 did not have radiographs in the database and 93 did not have endodontically treated teeth, resulting in 140 patients (50 men and 90 women) qualified for evaluation. Periapical radiographs were selected and mounted in Microsoft® PowerPoint® file, in order to analyze one tooth per slide. When the radiograph had more than one tooth that met the criteria for analysis, slides were created with the same images, so that each tooth was evaluated separately. In total, the file consisted of 416 slides.

In the radiographic evaluation, the filling quality was analyzed in terms of Apical Extension, Homogeneity and Taper, using criteria according to Santos et al.⁷ (Table 1). Subsequently, the following criteria were added in the evaluation: periapical status, presence or absence of coronary restoration and type of coronary restoration (Table 2). In multi-rooted teeth or teeth with more than one root canal, each one was evaluated separately, considering only the worst evaluated canal for each parameter, giving the value found for the tooth as a whole.

Table 1. Assessment according to Santos et al.⁷ regarding apical extension, homogeneity and taper

Radiographic Parameters	Definition	Score	Root Filling Quality
Apical extension	Overfilling or underfilling > 1.5 mm from the radiographic apex	0	Perfect Three scores 2
	Root filling ending at the radiographic apex	1	
	Root filling ending 0.5 – 1.5 from the radiographic apex (Gold standard)	2	
Homogeneity	Inhomogeneous root filling with several visible voids	0	Satisfactory Two scores 2
	Root filling with only one visible void	1	
	No voids present in the root filling or between root filling and root canal walls (Gold standard)	2	
Taper	Root filling with accentuated strangulation	0	Deficient One or no score 2
	Root filling with slight strangulation or reduced taper	1	
	Root filling with continuous taper from the orifice to the apex (Gold standard)	2	

To perform the analysis, two experienced endodontists performed calibration to obtain result of relative reliability. In this calibration, 20 radiographs were randomly selected and evaluated twice by evaluators, following the same criteria of the study. Evaluations were carried out with an interval of 15 days, so that remnants of the first evaluation could not compromise calibration. Subsequently, intra- and inter-examiner reliability was determined using Spearman's Rank Correlation Coefficient (Table 3).

Table 2. Assessment of periapical status, presence and type of coronary restoration

Radiographic Parameter	Score	Definition
Periapical Status	0	Presence of periapical lesion
	1	Thickening of the periapical ligament
	2	Healthy periodontal ligament
Coronary Restoration	0	Absent
	1	Present
Type of Coronary Restoration	0	Restoration without radiopacity
	1	Direct Composite Resin
	2	Two materials of different radiopacities filling the cavity
	3	Full Crown
	4	Intraradicular retainer only
	5	Intraradicular retainer and full crown

Finally, radiographs were evaluated in dark room for better visualization of the projected image. An average of 50 radiographs per day were evaluated to avoiding fatigue and wrong assessments.

This study was conducted after submitting the project to the Ethics Research Committee of the Pontifícia Universidade Católica de Minas Gerais, with approval No. 3.040.554.

Table 3. Calibration results obtained using Spearman's Coefficient

Parameter	Observer 1	Observer 2	Inter-Examiner Agreement
Apical Extension	0.960	0.891	0.813
Homogeneity	0.807	0.672	0.672
Taper	0.814	0.915	0.880
Periapical Status	0.919	0.772	0.730

RESULT

For this study, 416 teeth obtained from 140 patients were evaluated, 28.1% belonging to male patients and 71.9% to female patients.

The numbers obtained in evaluations are shown in Table 4. The apical extension was the endodontic parameter with the highest number of E2, obtaining 55.1%. In contrast, it was also the parameter with the highest number of E0, obtaining 38.9%. Teeth with filling ending at the apex, corresponding to E1, were present in 6% of evaluations.

In the homogeneity parameter, filling was homogeneous, with no visible voids, in 53.9% of evaluated teeth. It presented only one visible void in 24% of teeth and several visible voids or porosities in 22.1% of evaluations.

The highest number of E1 was given to the taper parameter, with 49.5% of evaluations. This score corresponds to fillings with mild strangulation or reduced taper. It presented conical-progressive pattern in 34.2% of teeth and marked strangulation in 16.3% of evaluations.

Table 4. Results obtained in the radiographic evaluation regarding parameters evaluated

Variable	Absolute number	Relative number (%)	Cumulative frequency (%)
Apical extension			
Overfilling or underfilling > 1.5 mm	162	38.9	38.9
Filling ending at apex	25	6.0	44.9
Filling 0.5-1.5 mm from the apex (ideal)	229	55.1	100.0
Homogeneity			
Porosity and several visible voids	92	22.1	22.1
Only one visible void	100	24.0	46.1
No visible void	224	53.9	100
Taper			
Accentuated strangulation	68	16.3	16.3
Mild strangulation or reduced taper	206	49.5	65.8
Continuous taper to apex	142	34.2	100
Periapical status			
Presence of periapical lesion	66	15.9	15.9
Thickening of the periodontal ligament	104	25.0	40.9
Healthy periodontal ligament	246	59.1	100
Coronary restoration			
Absent	46	11.1	11.1
Present	370	88.9	100
Type of restoration			
Restoration without radiopacity	4	1.1	1.1
Direct composite resin	84	22.7	23.8
Two materials of different radiopacities	28	7.6	31.4
Full crown	53	14.3	45.7
Intraradicular retainer only	32	8.6	54.3
Intraradicular retainer and full crown	169	45.7	100
Root Filling Quality			
Perfect	63	15,2	15,2
Satisfactory	132	31,7	46,9
Deficient	221	53,1	100

For the periapical status, 59.1% had healthy ligament. Thickening of the periapical periodontal ligament was observed in 25% of evaluations, which was even greater in 15.9%, being considered periapical lesion.

They were also evaluated for the presence or absence of coronary restoration. Of 416 teeth evaluated, 88.9% had coronal restoration, being absent in 11.1%.

Regarding the type of restoration present in the 370 teeth, most were full crown with intraradicular retainer, with 45.7% of cases, followed by direct composite resin, with 22.7% of cases, full crown with 14.3% of cases, only intraradicular retainer with 8.6% of cases, two materials of different radiopacities with 7.6% of cases and restoration without radiopacity with 1.1% of cases.

In Table 5, it is possible to observe the correlation between endodontic filling and coronal restoration parameters with the periapical status. Of endodontic parameters, individually, there was no statistically significant association. When the overall filling quality was correlated with the periapical status, the P-value obtained was 0.021, showing statistically significant association.

Table 5. Correlation using the Spearman's Coefficient between the evaluated parameters and the Periapical Status

	Periapical Status	
	r_s	P value
Apical extension	0.068	0.167
Homogeneity	0.093	0.057
Taper	0.074	0.132
Overall filling quality	0.113	0.021*
Presence of coronary restoration	- 0.005	0.918
Type of coronary restoration	- 0.036	0.490

*symbolizes statistically significant values. P value obtained by the Spearman Correlation test.

When correlating presence of coronary restoration and type, correlation was inversely proportional to periapical status, with r_s -0.005 for the presence of restoration and -0.036 for the type of restoration. The P values obtained were, respectively, 0.918 and 0.490, not showing statistically significant results.

DISCUSSION

In the present study, higher prevalence of female patients was observed, corresponding to 72.59% of evaluated teeth. When endodontically treated teeth and apical periodontitis were correlated, an index of 40.9% was found in this study, indicating that these treatments failed.

This is a study that only involved the collection and analysis of images present in a radiographic database, in which radiographs were saved at a given time and subsequently evaluated; therefore, it was not possible to follow up on the evolution of the case presented in each radiographic image. In the same way that a "gold standard" endodontic treatment performed on a tooth that presented apical periodontitis could, over time, lead to the regression of the lesion, inadequate treatment could lead to inadequate periapical status.

The fit of coronal restorations would be best evaluated using interproximal radiographs. As these images were not available, only the presence and type of coronary restoration were evaluated. The type of restoration was evaluated according to the radiopacity of the restorative material and the restoration contour.

Apical periodontitis is more present both in filling with presence of voids and in inadequate apical extension⁸. Therefore, it is important that the endodontic treatment is performed aiming at obtaining the "gold standard" in the three parameters: apical extension, homogeneity and taper⁷. In literature, some numbers related to success regarding the apical extension were found.

With filling ending from 1 to 3 mm from the apex, a 92% success rate was obtained⁹. When using 0 to 2 mm, the value obtained was from 49.5 to 90.4%. When filling ended up to > 2 mm from the radiographic apex, success rate from 42.6% to 63.64% was obtained. In cases where canals were overfilled, success rate ranged from 0% to 53%^{5,10-13}. In the current study, canals that had apical extension of 0.5 to 2 mm from the radiographic apex had 61.57% success rate. Canals in which filling ended exactly at the radiographic apex had 52% success rate, while canals overfilled or filling ended > 2 mm from the apex had 56.79% success rate.

Homogeneity also influenced the success of endodontic treatment⁸. In studies found, homogeneous filling presented 40.3% - 80.5% success rate. The presence of voids reduced this number to 16.6% - 57.7%^{5,11-13}. In this study, canals with homogeneous filling presented 63.39% success rate. The presence of voids decreased this number to 54%, while canals with multiple voids had 54.35% success rate.

Regarding the taper, in one study, fillings that presented progressive conical shape had success rate of 40.5%. In the case of another shape of the canal filling, such as parallel walls or funneling, the number dropped to 20.3%¹³. In the current study, fillings with progressive conical shape had success rate of 61.57%. In the case of reduced taper, success rate was 60.19%, reducing to 51.47% when there was strangulation.

It is important to emphasize that a quality multidisciplinary treatment is performed, so that endodontic and restorative treatments are successful.

CONCLUSION

The overall quality of root canal fillings showed low quality standard, negatively influencing the periapical status in the entire sample. There was no specific critical parameter that influenced this result, and each one of them is equally important for the success of the endodontic treatment. There was no relationship between presence or type of coronary restoration and periapical status.

AUTHORS' CONTRIBUTION

Michel Sena Fernandes Faria Lima – Data Curation, Visualization, Writing – original draft.

Pedro Paulo Alves Sá – Data Curation, Visualization, Writing – original draft.

Stéphanie Quadros Tonelli – Investigation, Formal Analysis, Project administration.

Fábio Fernandes Borém Bruzina – Formal Analysis.

Eduardo Nunes – Methodology, Writing – review & editing.

Frank Ferreira Silveira – Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing.

ACKNOWLEDGMENTS

We would like to thank the entire team of the Departamento de Odontologia da Pontifícia Universidade Católica de Minas Gerais, especially Professor Ana Maria Abras da Fonseca for her support and for making the radiographic database of patients available as needed to carry out this research.

FUNDING

None.

REFERENCES

1. Elsayed RO, Abu-bakr NH, Ibrahim YE. Quality of root canal treatment performed by undergraduate dental students at the University of Khartoum, Sudan. *Aust Endod J*. 2011;37(2):56-60. <http://doi.org/10.1111/j.1747-4477.2010.00273.x>. PMID:21771183.
2. Connert T, Truckenmüller M, ElAyouti A, Eggmann F, Krastl G, Löst C, et al. Changes in periapical status, quality of root fillings and estimated endodontic treatment need in a similar urban German population 20 years later. *Clin Oral Investig*. 2019;23(3):1373-82. <http://doi.org/10.1007/s00784-018-2566-z>. PMID:30022270.
3. Kirkevang LL, Hörsted-Bindslev P, Ørstavik D, Wenzel A. A comparison of the quality of root canal treatment in two Danish subpopulations examined 1974-75 and 1997-98. *Int Endod J*. 2001;34(8):607-12. <http://doi.org/10.1046/j.1365-2591.2001.00436.x>. PMID:11762497.
4. Gillen BM, Looney SW, Gu LS, Loushine BA, Weller RN, Loushine RJ, et al. Impact of the quality of coronal restoration versus the quality of root canal fillings on success of root canal treatment: a systematic review and meta-analysis. *J Endod*. 2011;37(7):895-902. <http://doi.org/10.1016/j.joen.2011.04.002>. PMID:21689541.
5. Kielbassa AM, Frank W, Madaus T. Radiologic assessment of quality of root canal fillings and periapical status in an Austrian subpopulation – an observational study. *PLoS One*. 2017;12(5):e0176724. <http://doi.org/10.1371/journal.pone.0176724>. PMID:28464019.
6. Koch M, Wolf E, Tegelberg Å, Petersson K. Effect of education intervention on the quality and long-term outcomes of root canal treatment in general practice. *Int Endod J*. 2015;48(7):680-9. <http://doi.org/10.1111/iej.12367>. PMID:25112721.
7. Santos SMC, Soares JA, Costa GM, Brito-Júnior M, Moreira NA, Magalhães CS. Radiographic parameters of quality of root canal fillings and periapical status: a retrospective cohort study. *J Endod*. 2010;36(12):1932-7. <http://doi.org/10.1016/j.joen.2010.08.050>. PMID:21092808.
8. İlgüy D, İlgüy M, Fişekçioğlu E, Ersan N, Tanalp J, Dölekoğlu S. Assessment of root canal treatment outcomes performed by Turkish dental students: results after two years. *J Dent Educ*. 2013;77(4):502-9. <http://doi.org/10.1002/j.0022-0337.2013.77.4.tb05496.x>. PMID:23576596.
9. Kerekes K. Radiographic assessment of an endodontic treatment method. *J Endod*. 1978;4(7):210-3. [http://doi.org/10.1016/S0099-2399\(78\)80185-X](http://doi.org/10.1016/S0099-2399(78)80185-X). PMID:283184.
10. Craveiro MA, Fontana CE, de Martin AS, Bueno CES. Influence of coronal restoration and root canal filling quality on periapical status: clinical and radiographic evaluation. *J Endod*. 2015;41(6):836-40. <http://doi.org/10.1016/j.joen.2015.02.017>. PMID:25799533.
11. Dugas NN, Lawrence HP, Teplitsky PE, Pharoah MJ, Friedman S. Periapical health and treatment quality assessment of root-filled teeth in two Canadian populations. *Int Endod J*. 2003;36(3):181-92. <http://doi.org/10.1046/j.1365-2591.2003.00640.x>. PMID:12657144.
12. Schulte A, Pieper K, Charalabidou O, Stoll R, Stachniss V. Prevalence and quality of root canal fillings in a German adult population. *Clin Oral Investig*. 1998;2(2):67-72. <http://doi.org/10.1007/s007840050047>. PMID:15490778.
13. Tarim Ertas E, Ertas H, Sisman Y, Sagsen B, Er O. Radiographic assessment of the technical quality and periapical health of root-filled teeth performed by general practitioners in a Turkish subpopulation. *ScientificWorldJournal*. 2013;2013(1):514841. <http://doi.org/10.1155/2013/514841>. PMID:23431255.

CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

***CORRESPONDING AUTHOR**

Frank Ferreira Silveira, Pontifícia Universidade Católica de Minas Gerais - PUC Minas, Departamento de Odontologia, Av. Dom José Gaspar, 500, Prédio 46, Coração Eucarístico, 30535-610 Belo Horizonte - MG, Brasil, e-mail: frankfoui@uol.com.br

Received: July 26, 2024

Accepted: August 8, 2024