Periapical status and quality of root canal fillings and different coronal restorations

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Abstract

Introduction: The present study aimed to evaluate the influence of the quality of root canal treatment and different coronal restoration materials on the periapical status of endodontically treated teeth.

Methodology: 2498 radiographs were included in this study. For each radiograph, the quality of the root canal treatment was judged as adequate or faulty and the periapical status was judged as healthy or diseased according to a study by Ray & Trope (1995). Radiographs with Fixed Partial Dentures, temporary coronal restoration, a post and core type of restoration, or teeth with caries lesions were excluded from the study. Cases, where no definitive diagnosis could be made, were excluded from the study. Statistical analysis was conducted using SPSS software.

Results: The results showed that teeth with a good endodontic filling (GE) were more likely to have an absence of periradicular Inflammation (API) regardless of the core material OR=2.00 (95% CI 1.78-2.26). Teeth with an amalgam core were more likely to have an API, regardless of the quality of root canal treatment OR=1.11 (95% CI 1.03-1.2). Teeth with an amalgam core and GE had an OR of 1.16 (95% CI 1.04-1.29) to have an API, whilst teeth with a composite core and an GE had an OR of 0.83 (95% CI 0.74-0.94) ($p<0.05$).

Conclusions: GE was found as the major contributing factor for the lack of periradicular pathosis, whilst the core material made little difference in teeth with PE. Teeth with GE and good restoration (GR) seem to benefit from an amalgam core.

Introduction

Endodontic therapy aims to prevent and treat periradicular pathosis [25]. This aim is achieved by the removal of microorganisms from the root canal system and by the sealing of the root canal in such a way that no microorganisms may enter [26].

The existence of a proper coronal seal is one of the prerequisites for a successful root canal treatment, as well as the roentgenographic quality of the canal obturation. [20]

While the placement of a fixed partial denture is the definitive treatment [6], the placement of a leak-proof core is an essential stage in the placement of a definitive restoration [9].

The quality of the coronal restoration has been cited as a major factor in the success of the RCT (root canal treatment). Teeth with a proper coronal restoration had a significantly lower risk of periapical disease [22]. On the contrary, other researchers cited the quality of root canal treatment as the major factor in endodontic success [10]. The abovementioned studies examined teeth with a variety of coronal restorations – from provisional restorations to fixed partial dentures (FPD) [3, 4].

Restoration materials differ in their ability to provide a leak-proof seal.

Amalgam does not adhere to the tooth structure. This may lead to a gap between the tooth structure and the core material [19]. On the other hand, amalgam is somewhat corrosive and this process leads to an expansion of the core material and as a result, reduced coronal leakage over time [16].

Composite resins offer adhesion to dentin and enamel and provide excellent aesthetics. [11]. Composite resin also has great resistance to leakage immediately after placement [13]. However, several studies have suggested significant degradation of bond strength over time [7].

The aim of our study was to evaluate the relationship between the quality of the coronal restoration and the root canal obturation on the radiographic periapical status of endodontically treated teeth.

Materials And Methods

The study was approved by the institutional ethics committee (1933/2018). The study population was based on a national database of radiographs, without a clinical correlation.

The inclusion criteria were radiographs of a permanent tooth with an existence of an RCT and a coronal restoration. Radiographs with a fixed partial denture (FPD), a temporary coronal restoration, a post and core type of restoration or teeth with caries lesions were excluded from the study,

Radiographs where the periapical tissues were not sufficiently visible, radiographs of poor technical quality or radiographs where no definitive judgment as to the quality of the RCT or periapical health could be made were excluded from the study.

For each radiograph, the quality of the root canal treatment was judged as adequate or faulty according to the criteria established by Ray & Trope (1995):

1. Good endodontic filling (GE): if all canals were obturated, no voids were present and the fill of the main gutta-percha point was within 0 to 2mm from the radiographic apex.
2. Poor endodontic filling (PE): if one or more of the criteria in were not met.
3. Good restoration (GR): any permanent restoration that radiographically appeared sealed.
4. Poor restoration (PR): any permanent restoration with radiographic signs of overhangs, open margins or otherwise lack of a proper seal.

The periapical status was judged as healthy or diseased according to the criteria established by Strindberg [27]:

1. Absence of periradicular Inflammation (API): if the contours, width and structure of the periodontal ligament were normal or slightly widened if an excess of filling material was present.
2. Presence of periradicular inflammation (PPF): if one or more of the criteria of success were not fulfilled.

All radiographs were examined by two observers (D.A. and R.K.) that were calibrated by viewing 20 radiographs under the guidance of an experienced endodontist (A.L.) Radiographs used for calibration were excluded from the study. Interobserver Kappa was calculated as 0.89.

Statistical analysis was conducted using SPSS software. Descriptive statistics, Chi-square, and odds ratio for a periapical status were conducted. Significance was set at $p<0.05$.

Results

Of the 2498 radiographs examined 2009 met the inclusion criteria. 306 teeth (15.2%) were anterior (incisor to canine) and 1703 (84.8%) teeth were posterior (premolars and molars), 1420 (70.7%) were classified as GE and 589 (29.3%) were classified as PE. 1155 (55.5%) radiographs exhibited an API whilst 854 (42.5%) had a PPF. As for the core material, 1135 (56.5%) had amalgam cores and 874 (43.5%) had composite cores.

Teeth with a GE were twice more likely to have an API regardless of the core material OR=2.00 (95% CI 1.78-2.26).

Teeth with an PE had an OR of 0.49 (95% CI 0.45-0.54) to have an API ($p<0.05$) regardless of the core material (Table. 1.).

Teeth with an amalgam core were more likely to have an API, regardless of the quality of endodontic treatment OR=1.11 (95% CI 1.03-1.2) whilst teeth with a composite core had an OR of 0.87 (95% CI 0.79-0.96) to have an API ($p<0.05$). (Table.2.)

Teeth with an amalgam core and GE had an OR of 1.16 (95% CI 1.04-1.29) to have an API, whilst teeth with a composite core and an GE had an OR of 0.83 (95% CI 0.74-0.94) ($p<0.05$). (Table.2.)

Teeth with an amalgam core and an PE had an OR of 1.07 (95% CI 0.92-1.23) to have an API versus teeth with a composite core and an PE had an OR of 0.91 (95% CI 0.74-1.19) ($p<0.05$). (Table.2.)

Anterior teeth were less likely to exhibit PPF with an OR of 0.8 (95% CI 0.65-0.98) for an anterior tooth to have a PPF and an OR of 1.04 (95% CI 1.00-1.08) for a posterior tooth ($p<0.05$).

Table. 1. Quality of endodontic treatment and periapical status per core material.

		Core Material		Total
		Amalgam	Composite	
GE	API	564	393	957
	PPF	235	228	463
PE	API	118	80	198
	PPF	218	173	391
Total	API	682	473	1155
	PPF	453	401	854
	Total	1135	874	2009

Posterior teeth were more likely to be restored with an amalgam core with an OR=1.5 (95% CI 1.45-1.60) than anterior teeth with an OR=0.1 (95% CI 0.004-0.03) ($p<0.05$). The quality of endodontic treatment was judged as GE more often in anterior teeth OR=1.11(95% CI 1.04-1.19) than in posterior teeth OR=0.73 (95% CI 0.59-0.92) ($p<0.05$). (Table.2.)

Table.2. Confidence interval for API.

Endo		Odds Ratio for API	95% Confidence Interval		
			Lower	Upper	p value
GE	API	1.392	1.114	1.740	p>0.05°
	Amalgam	1.161	1.046	1.289	p>0.05°
	Composite	0.834	0.740	0.940	p>0.05
PE	API	1.171	0.827	1.656	P<0.05°
	Amalgam	1.069	0.925	1.235	P<0.05°
	Composite	0.913	0.746	1.118	P<0.05°

° - no statistically significant difference (P>0.05).

 - statistically significant difference (P<0.05).

Discussion

Proper sealing of the root canal system, as well as an adequate coronal seal, are major factors in the success of root canal treatment [24]. The proper coronal seal consists of a core build-up, and a cuspal

coverage in the form of a coronal restoration [14]. Several core materials are available with amalgam and composite resin being the two most widely used [17].

The superior mechanical properties of amalgam as well as its ease of use and low cost had established amalgam as the material of choice in dentistry for more than 150 years [12]. In the past decade, health concerns due to mercury release during use and the demand for superior aesthetics led to amalgam's decline and gave rise to the widespread use of composite resins [1].

Composite resins offer adhesion to the dentin and enamel and provide excellent aesthetics due to the ability to produce resin in almost any shade [11]. The adhesive properties of composite resins offer excellent resistance to microleakage immediately after placement [13]. However, several studies have suggested significant degradation of bond strength over time [7] which can lead to extensive microleakage [23]. Furthermore, placement of a composite resin restoration is a technique sensitive procedure and failure of adhesion is often incipient [5] again resulting in microleakage.

Since coronal leakage is a major factor in the failure of endodontic treatments [24] and assuming that composite resins are more prone to microleakage, do composite restorations correlate with more endodontic failures than amalgam?

To eliminate the effect of a prosthodontic restoration and its quality, and to avoid masking of the core material by a radiopaque FPD, only teeth without a definitive restoration were selected for this study, although prosthodontic restoration is recommended for teeth undergoing root canal therapy [2].

The overall rate of periapical disease in the examined population was 34.1%, identical to the data found in the European population [8]. Recent studies report the success rate of endodontic treatment at 86.8–94.9% percent [15]. The difference between the outcome studies and cross-sectional studies may be, at least in part, due to coronal leakage from faulty or failing restorations.

Anterior teeth were less likely to develop apical pathosis than posterior teeth. This finding correlates to the data reported by Loftus J. J. (2005) where the frequency of apical periodontitis in anterior teeth (20.7%) compared with the frequency of apical

periodontitis in posterior teeth (31.7%). The quality of RCT in anterior teeth was more likely to be judged as "good" than in posterior teeth. This can be attributed to the simpler anatomy of anterior teeth and the relative ease of access to the root canal system. Anterior teeth were most commonly restored with a composite resin to provide for an aesthetic restoration.

Teeth with a composite restoration showed a greater tendency to have a periapical lesion. This effect was not statistically significant for teeth with bad RCT ($p > 0.05$) whilst the effect was significant for teeth with an adequate RCT ($p < 0.05$). The quality of RCT is the main factor in the success of root canal treatment, but coronal leakage may be a contributing factor especially in teeth with a well-performed RCT.

In this study, we attempted to evaluate the effect of the core material on the likelihood of developing apical pathosis. The study was a cross-sectional review of a randomly selected group of periapical radiographs without a medical history or a clinical correlation. Much like in Trope's classical study [22], no information was given as to the time since the root canal and restoration were made nor for the dynamics of lesion healing.

Due to the methodological difficulties of cross-sectional studies, such as a lack of a clinical correlation and lack of a follow-up, further study of the cohort population is recommended. That being said, the cross-sectional study design does offer some benefits, such as a larger study population and a study of "real world" endodontic treatments. Whereas prospective clinical studies are often conducted on teeth treated according to the best of clinical practice, most of the population is either unaware of such practices, or cannot afford them [21].

In our study, adequate root canal treatment was found as the major contributing factor for the lack of apical pathosis, whilst the core material made little difference in teeth with poorly performed RCT. Teeth with good root canal treatment seem to benefit from an amalgam core, suggesting that coronal leakage due to poorly made composite resin cores is a factor in endodontic failure.

Conclusions

Amalgam remains the material of choice for coronal restoration of posterior endodontically treated teeth. Good endodontic treatment is significantly related to the absence of periapical pathosis.

Declarations

Funding

None.

Conflict of Interests

The authors deny any conflicts of interest related to this study.

Author Contribution

Denys Abramov prepared the database and wrote the manuscript. Meital Abadi prepared the database.

Roman Kaniewski prepared the database. Alex Lvovsky processed the database and wrote the manuscript.

Ethics Approval

Ethical approval was received by Commission of Helsinki and have the number 1933-2018.

Consent to Participate

Not Applicable.

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