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Original Article

Factors associated with decision-making for replacing the temporary coronal restoration after endodontic treatment

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Aim: This study aimed to evaluate the decision-making by patients to replace temporary restorations with permanent restorations after endodontic treatment and to verify the associated factors and evaluate the quality/integrity of the temporary restorative material within one month. **Methods:** This is a cross-sectional study using non-probabilistic sampling which analyzed patients after one month of endodontic treatment. The self-administered questionnaire contained sociodemographic, treatment decision-making and endodontic treatment questions. The restoration present in the mouth was evaluated in the clinical oral examination. The Poisson Regression test was used to verify the prevalence ratio. **Results:** The prevalence failure to perform permanent restorations was 61.1% of patients, and 42.7% reported not having adhered. The reasons are lack of time and not knowing the importance of replacing the restoration with a definitive one. The glass ionomer temporary restorative frequency was higher among those who chose not to replace the temporary restoration with a permanent one (PR=5.19; 95%CI 2.10-12.33). In addition, there was an association between the quality of the restorative material and the type of material, and the best clinical quality of the restoration was statistically associated with glass ionomer and composite resin. **Conclusions:** The findings show the importance of guidance by the dental surgeon in helping patients decide to replace their temporary restoration.

Keywords: Definitive Dental Restoration. Temporary Restoration. Endodontics.

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Introduction

The careful performance of the chemical-mechanical preparation, filling and sealing the root canals are among the stages of endodontic treatment. If there are failures in one of these stages, the treatment case may fail[1]. It is also important to point out that the immediate coronary and quality sealing directly influences the longevity of the endodontic treatment and survival of these elements[2-4]. The final restoration can be direct or indirect, depending on the amount of coronal structure and the type of cavity that the element shows, promoting a shield at the mouth of the root canal to prevent bacterial microleakage and enhance and protect the tooth structure[5].

Provisional restorations are usually made with materials that meet the marginal integrity requirements and establish masticatory function for a short time until the final restoration can be performed. Some studies highlight that one of the causes which can lead to root canal therapy failure is the fluid pathway from the oral cavity to the tooth through the temporary restorative material called coronary microleakage[6]. These microleakages can promote recontamination of the root canal system and a new periapical pathology requiring further intervention.

Therefore, endodontically treated teeth should be restored with definitive materials as soon as possible to avoid this type of failure. If a final coronal restoration is not possible, selecting a good quality temporary restorative material is a crucial factor[2,6,7]. Temporary restorations may be necessary when the cavity is extensive and there is the loss of dental structure with the indication of indirect restorations[8]. Thus, if it is not possible to perform a definitive restoration immediately after the endodontic treatment, it is essential to select a temporary material with more excellent color stability and resistance to different liquid pigments to optimize the aesthetics of the restorations[9]. Therefore, the objectives of provisional restorations are to meet requirements such as marginal integrity and to establish masticatory function for a certain period until the final restoration is performed[10]. Then, the endodontic treatment is only considered finished once this final restoration is performed. Patients must be educated about the need to change the provisional restorative material for a permanent restoration and the possible consequences if the procedure is neglected[11].

Thus, this research aimed to evaluate the adherence of patients to replace the temporary restorations after endodontic treatment for permanent restorations and the associated factors, as well as to assess the quality/integrity of the provisional restorative material within one month.

Materials and Methods

The study was submitted to the Research Ethics Committee of the Faculty and approved on April 10, 2019 (3.257.716, CAAE 11117319.0.0000.5319). All participants filled out the Consent Form to participate in the research, according to Resolution number 466/12.

Study design and sample

This study implemented a cross-sectional design. The study was sampled by convenience, with all patients who returned for dental care one month after completing endodontic treatment on permanent teeth in a postgraduate center in the period of four months (December 2019 to March 2020), regardless of age. The study population was 239 patients. Only 38 patients did not return for the post-endodontic revision, with a loss of 16%.

Data collection

Data collection was carried out during the post-endodontic review consultation after one month. An oral clinical examination evaluated the endodontically treated tooth and the self-application of a questionnaire between December 2019 and March 2020.

The instrument used was a self-application questionnaire on sociodemographic questions such as gender, age, marital status, education level, family income, occupation, and city of residence. Treatment decision-making if the restoration was final, with no reason to make the final restoration, type of permanent restorative material and place of performing the final restoration were also collected. The questions related to endodontic treatment were taken from the patients' medical records and included endodontically-treated tooth, endodontic filling date and type of provisional material used. The oral clinical examination evaluated the patients' adherence to the restoration and the temporary restoration quality in the mouth.

Variables

The outcome variable of this study was "non-adherence to permanent restoration after endodontic treatment" after one month. The variable was constructed and evaluated as follows: 'yes' represents the performance of the final restoration (= 0), and 'no' represents the failure to perform the final restoration during the allotted time period (= 1).

Exposure variables were: 1. Sociodemographic: gender (male / female); age group (14-29 / 30-45 / 46-71 years); marital status (Single, widowed, divorced / married, common-law marriage); level of education (elementary and high school / higher education and postgraduate); family income (up to 1 minimum monthly salary / 2 to 10 minimum monthly salaries); occupation (employee / unemployed, retired); city of residence (Passo Fundo / other municipalities in the interior of the state). 2. Restoration decision-making: a reason for not getting the final restoration (I did not know it was important to do it so soon / I did not have time / I did not have money / I do not have access to the service); type of temporary restorative material (composite resin and glass ionomer/Cotosol®); place of the final restoration (public service / private service). 3. Provisional restoration - integrity, infiltration, fracture and loss - the quality of the provisional restoration was defined according to the criteria of the World Dental Federation / FDI[12], however, observing the item that refers to Functional Properties, and only evaluating the topic Material fracture and retention (5 evaluation items):

1. Clinically excellent / very good - no fractures or cracks; 2. Clinically good - small fracture lines; 3. Clinically sufficient / satisfactory - two or more or extensive fracture line and/or splinter (not affecting marginal integrity); 4. Clinically unsatisfactory - splinter fractures that cause damage to marginal integrity, volume fracture with or without a partial loss (less than half of the restoration). Or fracture with partial loss of material (less than half of the restoration); 5. Weak satisfactory - loss of restoration (partial or complete) or multiple fractures. For statistical analysis purposes, items 1 and 2 were defined as Clinically satisfactory restorations and items 3, 4 and 5 as Clinically unsatisfactory and unsatisfactory restorations.

Examiner training and calibration

A pilot test was conducted on ten patients to test the methodology used and the possible difficulties encountered by the participants and the researcher. The questionnaires were analyzed after conducting the data collection for the pilot test, and the instrument's questions were observed, which is considered adequate for this study. A specialist in endodontics performed all clinical examinations and established uniform standards and determined acceptable levels of internal examiner consciousness. Next, 8 hours of training was performed with intact restorations of images and failures: infiltrated with wear and fractures, according to the criteria of the "Functional Properties" of the FDI[12]. The Kappa concordance test ($p<0.05$) was subsequently performed to test the intra-examiner agreement. The Kappa results' agreement in the clinical examination in verifying the quality of the restoration was 85%, which is considered a good to excellent agreement.

Analysis of results

The data obtained were organized in Excel form and exported to the IBM SPSS® statistical software program (Statistical Package for the Social Sciences, version 20.0, Armonk, New York). Descriptive analyzes of all variables were performed to present their relative and absolute frequencies.

Pearson's chi-squared test was used in the bivariate analyzes. Crude and adjusted Poisson regression with robust variance was used in the multivariable analysis to obtain the Prevalence Ratios (PR) and respective 95% confidence intervals (95% CI). For the confusion adjustment, all exploratory variables that entered the model had a p-value <0.20, but only those with a p-value <0.05 remained in the adjusted analysis.

Results

Of the patients who took part in the study, 47.7% are female and 52.35 are male, with a mean age of 40 years (SD ± 15.34), a minimum age of 15 years, and a maximum age of 70 years. Sociodemographic characteristics about marital status, income, education, occupation and city of residence are shown in Table 1.

The majority of endodontically-treated teeth were upper posterior (50.2%), followed by lower posterior teeth (28.9%), and finally upper and lower anterior teeth (20.9%). The temporary materials used were glass ionomer cement (61.9%), followed by composite resin (20.5%) and provisional restorative / coltosol® (17.6%).

Table 1. Distribution of the variable of all patients returned one month after endodontic treatment, Brazil, 2020 (n = 239).

Variables	N	%
Gender		
Female	114	47,7
Male	125	52,3
Age Group		
15-29 years	64	26,8
30-45 years	85	35,6
46-70 years	90	37,7
Marital status		
Single / widowed / divorced	104	43,5
Married / common-law marriage	135	56,5
Education level		
Elementary / High School	161	67,4
Higher education / postgraduate	78	32,6
Family income		
Up to 2 minimum wages	101	42,3
3 to 10 minimum wages	138	57,7
Occupation		
Employee / Retired	202	84,5
Unemployed	37	15,5
City		
Passo Fundo	99	41,4
Others municipalities (interior)	140	58,6
Endodontically treated teeth		
Upper and lower anterior teeth	50	20,9
Upper posterior teeth	120	50,2
Lower posterior teeth	69	28,9
Temporary restoration material		
Composite resin	49	20,5
Glass ionomer cement	148	61,9
Temporary restorative (Coltosol®)	42	17,6
Final restoration		
No	146	61,1
Yes	93	38,9
Place where permanent restoration was performed (n = 93)		
Public service	72	77,4
Private service	21	22,6
Restoration material (n=93)		
Composite resin	93	100,0

Of the 239 patients, 61.1% did not make the final restoration after the endodontic treatment. Of the 38.9% who carried out the exchange of final restoration, 77.4% did in public service, and the restorative material was composite for 100%.

Table 2 shows only the patients (61.1%) who did not adhere to the definitive restoration. Of these, most reported a lack of time (26.4%), followed by not knowing the importance of exchanging provisional for permanent material (16.3%). Furthermore, when evaluating the clinical quality of the temporary restoration in these patients who did not make a final restoration, it is observed that clinically satisfactory restorations represented 26.4%. In comparison, the unsatisfactory restorations were 61.1%.

Table 2. Distribution of the frequencies of the variables of patients who did not adhere to the definitive restoration after endodontic treatment, Brazil, 2020 (n = 146).

Variables	N	%
Reason for non-realization		
I didn't know it was necessary to do	39	16,3
There was no time	63	26,4
Had no money	3	1,3
Did not have access to the service	41	17,2
Quality of provisional restoration		
Satisfactory	63	26,4
Unsatisfactory	83	61,1

Table 3 shows the analysis of the prevalence of non-adherence to permanent restoration after one month of endodontic treatment. The prevalence of maintenance of provisional restorations for those who did not adhere to permanent restoration was 58.2% in the youngest, 81.2% in the posterior teeth, and 67.1% in the individuals who had their teeth restored with glass ionomer cement and 24.7% whose provisional restorative material was Coltosol®.

Table 3. Crude and adjusted prevalence (%) and Prevalence Ratio (PR) of non-adherence to definitive restoration after endodontic treatment, Brazil, 2020 (n = 239).

	Prevalence	P-Value*	Crude PR (IC95%)	P-Value**	Adjusted RP (IC95%)	P-Value**
Gender						
Female	45,9					
Male	54,1	0,285	-	-	-	-
Age						
15-50 years	58,2		1,00		1,00	
51-70 years	41,8	0,065	1,33 (0,86;2,07)	0,199	1,31 (0,84;2,03)	0,228
City						
Passo Fundo	39,7					
Others municipalities	60,3	0,297	-	-	-	-

Continue

Continuation						
Marital Status						
Single/widowed/ separated	41,8	0,293				
Married/common-law marriage	58,2		-	-	-	-
Eduaction						
Elementary/High School	67,1					
Higher education/ postgraduate	32,9	0,518	-	-	-	-
Family income						
Up to 1 minimum wage	43,2					
Two or more minimum wages	56,8	0,415	-	-	-	-
Occupation						
Employee/Retired	84,2					
Unemployed	15,8	0,519	-	-	-	-
Tooth						
Upper and lower anterior teeth	18,5		1,00		1,00	
Upper and lower posterior teeth	81,5	0,160	1,24 (0,77;1,98)	0,375	1,13 (0,71;1,82)	0,589
Temporary Material						
Composite resin	8,2		1,00		1,00	
Glass ionomer cement	67,1	***<0,001***	5,28 (2,23;2,52)	***<0,001***	5,19 (2,10;12,33)	***<0,001***
Coltosol®	24,7		2,36 (1,01;5,51)	***0,046***	2,37 (0,01;5,54)	0,056

* Pearson's chi-square test (p <0.20)** Teste de Wald (p<0,05)
PR - Prevalence Ratio; 95% CI - 95% confidence interval.
It is adjusted for the variables: age group, groups of teeth and temporary material.

All variables associated with the crude analysis (age group, groups of teeth and restored material at p<0.20) entered the multivariate model to perform the Poisson Regression. After adjusting for confusion, the variables age group and groups of teeth left the model (p>0.05), with only the type of restorative material remaining. The probability of the provisional glass ionomer restorative material was higher among those who decided not to exchange the restoration for the final one (PR=5.19; 95%CI 2.10-12.33).

A bivariate analysis was performed to verify the association between the type of provisional material (grouping the glass ionomer and the composite resin together; and Coltosol® separately) and not completing the permanent restoration with the variable quality of the temporary restorative material. After the analysis, a statistically significant association was observed between the quality of the material and the type of restorative material variables. The best quality of the restoration was statistically associated with glass ionomer and composite resin (p<0.001) (Table 4).

Table 4. Bivariate analysis between the temporary material, the reason for not performing the definitive restoration and the clinical quality of the provisional restoration of patients who did not adhere to the final restoration after endodontic treatment, Brazil, 2020 (n = 136).

Variables	Clinical quality of the restoration				*P
	Satisfactory		Unsatisfactory		
	N	%	N	%	
Temporary materials					***<0,001***
Glass ionomer / composite resin	88	56,0	54	65,1	
Temporary material (Coltosol®)	7	11,1	29	34,9	
Reason for not performing the final restoration					0,285
Lack of money and access	38	63,3	45	54,2	
Lack of time	25	39,7	38	45,8	

* Pearson's chi-square test (p <0.05) - statistically significant

Discussion

Adhesion of the temporary restoration exchange after endodontic treatment by patients was assessed in the present study. Their sociodemographic characteristics, the type of provisional restorative material, and in the case of non-adhesion of the exchange, the integrity of these restorations was evaluated after one month. Most patients were male, employed or retired and had the temporary glass ionomer cement restoration.

It was observed that more than half of patients did not undergo the final restoration after the endodontic treatment. Among the justifications, the majority reported a lack of time, followed by not knowing the importance of exchanging provisional material for the permanent one. Still, of those who carried out the exchange of the final restoration, the vast majority performed it in some public service, and the restorative material in all of them was composite resin.

According to Sadaf[4] (2020), it is possible to increase the survival rate of an endodontically-treated tooth with a well-performed coronary restoration. In a retrospective study evaluating private clinical data in Germany, approximately 86% of the 795 endodontically-treated tooth restorations with an average follow-up of 4.5 years were considered successful, and the annual failure rate was minimal[13]. Authors agree that the survival of endodontically-treated teeth is associated with permanent coronal restorations[14].

Factors such as the restorative material used, cusp coverage and direct or indirect procedure can also affect the performance of endodontic restorations over time. The materials most used as temporary restorers in the present study were glass ionomer cement and composite resin[7]. Soares et al.[7] (2018) recommend using a cement 1-2 mm glass ionomer to cover root canal filling to reduce stress inside the pulp chamber and in the furcation area of the posterior teeth. They also recommend using some bulk filler composite resins to minimize deflection of the cusp and the stress concentration in weakened regions.

In this study, it was observed that two-thirds had pigmented, infiltrated, fractured provisional restorations and/or there was no such restoration of the patients who did not adhere. Thus, the quality of the temporary restoration was found to be associated with the type of material. Those with the worst quality were those who had the Coltosol® provisional material related to those who had temporary restoration with ionomer cement of glass and composite resin. Endodontically-treated teeth lose substantial structure due to previous restorations, dental caries and the preparation of access for endodontic treatment. Thus, the restoration of these teeth is complex and their long-term prognosis is directly related to the quality of the final restoration[15]. An excellent temporary restorative material must prevent the root canal system from being contaminated by saliva, fluids and microorganisms[16]. The composite resin and glass ionomer cement adhere to the tooth structure, preventing the infiltration of oral fluids at the cement-tooth interface[17].

In a retrospective study evaluating 220 endodontically-treated permanent molars, the authors observed that composite restorations had a longer average survival time than those constructed with amalgam. Furthermore, the amount of remaining tooth structure was the most significant factor for the longevity of the restorations[18]. However, Stenhagen et al.[19] (2020) assessed the choice of coronary restorations for endodontically-treated teeth, examined the survival of restorations and the coronary restoration on the success of endodontic treatment. However, no significant correlations were found between the type of coronary restoration and the quality of endodontic treatment.

In the present study, there was a greater probability with the type of provisional material after logistic regression analysis of the adhesion of the restorative material, influencing the failure to perform the permanent restoration. Glass ionomer cement is similar to the tooth in terms of color, texture, adaptation, and durability, which may have influenced patients not to change it. The glass ionomer properties are biocompatibility, physical-chemical adhesion to enamel, dentin and cement and having a similar thermal expansion coefficient to the natural dental structure[20-22]. Although the glass ionomer cement was the most efficient between the moment of root canal filling and the evaluation consultation, one study investigated the association between the type of coronary restoration and the survival of endodontically treated teeth. The results of the study showed that the survival of endodontically-treated teeth was significantly longer when restored with molten restorations, amalgam restorations or composite restorations than teeth restored with provisional materials[14]. In another retrospective study investigating the influence of endodontic retreatment in the choice of definitive restoration, extensive restorations involving the insertion of pins and indirect crowns' manufacture had a higher retreatment rate[23].

Solubility, thermal expansion, porosity and contraction are significant variables in the clinical performance of provisional materials[24,25]; however, there are other factors capable of altering the sealing of these restorations, including: improper procedures and techniques; inadequate adaptation of the material to the cavity by carelessness or haste; maintenance of impurities between the cavity and the temporary restoration; cavity depth; and the number of dentinal tubules on the tooth surface[26]. Thus, endodontic treatment must be completed with an adequate coronary seal; in some

cases, it is necessary to use provisional restorative materials due to time limitations or more extensive rehabilitation treatments. Materials should be replaced with better adherence to permanent restorations as soon as possible. It is up to the professional to explain the importance and potential implications, such as the doubtful prognosis of the treatment performed.

One of the limitations of this study was the absence of the return of some patients for consultation after one month of endodontic treatment. This fact led to sample loss in the study, which may seem that these patients did not consider it essential for the consultation, and perhaps the replacement of the restoration was also neglected, which could result in higher non-adherence prevalence. Another limitation was concerning the study's design being cross-sectional and not establishing a cause-effect relationship because it does not longitudinally follow the endodontic prognosis of patients inferring accurate long-term findings.

The findings of this study highlight the importance of the clinician in helping and instructing patients in making decisions regarding the fundamental need to replace the provisional restoration with the permanent one after filling the root canal. The lack of adequate and precise information generates doubts. In the absence of visible flaws in the provisional restoration, the decision to substitute the temporary restorations for the permanent one is often neglected. However, even with minor imperfections in the temporary restorations which are invisible to patients, such as pigmentation and slight fracture, there may be recontamination of the root canal system, leading to unsuccessful treatment. Although the present study is one of the few carried out with this methodology, other studies with methodological control and longer follow-up are necessary. More specific and practical materials and protocols should be created in the final coronary seal of endodontic treatment, considering its importance and lack of awareness of patients to replace the temporary material for the final restoration.

In conclusion, this study observed a low prevalence of adherence to perform the permanent restoration after one month of the endodontic treatment. Two-thirds of the patients did not do it, presenting the provisional restorations with infiltrations, pigmented, fractured material and/or with an absence of the material. It was also observed that the worst quality of the temporary restorations was directly related to the type of temporary material after endodontics, suggesting a poor long-term prognosis.

Place or institution where the work was developed, city and country: Meridional Faculty/IMED, Passo Fundo, Rio Grande do Sul, Brazil

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Author's participation: Fornari BS worked in structuring the article, designed the method, preparation of database and analysis of results. Solda C worked in project design, in data collection and entering the database. Dotto L worked in discussion of the methodology, in the statistical analysis. Rigo L worked in review of the English language and the final wording of article.

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