

# The Effect of Different Oral Root Canal Filling Materials on the Expression of Inflammatory Factors and Protease Related Molecules in Gingival Crevicular Fluid in Patient with Posterior Tooth Anatomy Defects

Efecto de Diferentes Materiales de Obturación del Canal Radicular Oral sobre la Expresión de Factores Inflamatorios y Moléculas Relacionadas con Proteasas en el Fluido Crevicular Gingival en Pacientes con Defectos de la Anatomía de los Dientes Posteriores

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**SUMMARY:** The objective of this study was to investigate the effects of different oral root canal filling materials on the expression of inflammatory factors and protease related molecules in gingival crevicular fluid (GCF). A total of 90 patients with posterior tooth defects who underwent root canal therapy in our hospital were selected. They were divided into an observation group (group A) and a control group (group B) based on different root canal filling materials, with 45 teeth in each group. The group A patients were repaired with fiber post, composite resin combined with zirconia ceramic crown, while the group B patients were repaired with metal post core combined with metal ceramic crown. The clinical effect, periodontal index, restoration success rate, mastication efficiency, periodontal index, restoration effect, and the levels of GCF and Alkaline phosphatase (ALP) before and after restoration were compared between the two groups. The clinical efficacy of the group A was better than that of the group B patients. The success rate of repair and chewing efficiency in the group A were higher than those in the group B. The completeness rate, color matching rate, edge fit rate, edge coloring qualification rate, and gingival qualification rate of the group A patients were higher than those of the group B patients. After repair, the levels of GCF and ALP in both groups of patients were higher than before repair, and the group B was raised than the group A. The PLI, GI, and SBI indices of the group A patients were reduced than those of the group B patients. The application of fiber post, composite resin combined with zirconia porcelain crown restoration in patients with posterior tooth defects after root canal treatment can improve the success rate, chewing efficiency, and restoration effect, with little impact on changes in GCF and ALP levels in the body.

**KEY WORDS:** Composite resin; Fiber post; Repair effect; Tooth anatomy defect; Zirconia porcelain crown.

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## INTRODUCTION

Root canal therapy (RCT) has become a routine method for the treatment of dental pulp necrosis and root infection, and it is also the best method for clinical treatment of dental caries (Aldegheishem *et al.*, 2022). After root canal treatment, the teeth often lose the nourishment of the nerve in the dental pulp and the dentin collagen decreases, which leads to the increase of tooth brittleness, which is very easy to cause tooth fracture, and the defect of the affected tooth is larger and the tooth tissue remains less after root canal treatment, affecting the normal masticatory function (Rathke *et al.*, 2022). Therefore, it is necessary to protect

the remaining teeth of patients through adequate dental restoration. In the restoration of posterior tooth defects after root canal treatment, the selection of restoration materials is very important, such as cast metal, resin and all-ceramic (Eren *et al.*, 2021). The restoration of damaged teeth with metal post ceramic crown is a common method in clinic, but the metal material is too rigid and the metal post ceramic crown is easy to break, which will affect the service life of the affected tooth restoration (AlHelal *et al.*, 2022). The fiber post and composite resin combined with zirconia ceramic crown restoration has the characteristics of high

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strength and large elastic modulus, so it is not easy to cause tooth fracture; it is therefore widely used in the restoration of posterior tooth defects in oral clinic (Mello *et al.*, 2020). Based on this, we explored the effects of different oral root canal filling materials on the expression of inflammatory factors and protease-related molecules in gingival crevicular fluid (GCF), so as to provide reference value for clinic.

## MATERIAL AND METHOD

**General information.** In this study 90 patients with posterior tooth defects after root canal treatment in our hospital, from January 2022 to March 2023 were divided into observation group (group A) (n = 45) and control group (group B) (n = 45). In group A, there were 25 males and 20 females, with an average age of (40.32 ± 8.85) years, including 30 upper teeth and 15 lower teeth, while in group B, there were 24 males and 21 females, with an average age of (41.24 ± 7.53) years, including 28 upper teeth and 17 lower teeth. There was no difference in the general data between the two groups (P > 0.05). This research was ethically approved by the Ethics Committee of our hospital, adhering to the Declaration of Helsinki principles. Written informed consent was obtained from all participants after fully explaining the study's purpose, procedures, risks, and benefits, ensuring voluntary participation and data confidentiality. Participant safety and comfort were prioritized, with provisions for withdrawal at any time without affecting their subsequent care. Data were anonymized and securely managed to uphold privacy standards.

**Inclusion criteria:** 1. 20 years old ≤ age ≤ 70 years old; 2. Patients with complete RCT without obvious discomfort; 3. Patients without fistula and healthy periodontal tissue; 4. Patients with residual dental tissue thickness greater than 2mm after preparation. **Exclusion criteria:** 1. Patients with allergy to repair materials. 2. Patients with a lack of clinical data. 3. Patients with periapical shadow or no significant decrease in original shadow area. 4. Patients with severe systemic organic lesions.

**Methods.** First of all, the teeth of the two groups were treated with systematic RCT, which were repaired by the same group of stomatologists. Before restoration, the patients' RCT was fully understood by X-ray images. After root canal treatment, all patients were followed up for one week after clinical observation. The patients had no chief complaint symptoms and no obvious abnormality in routine examination of the affected teeth.

**Observation group.** The patients in the group A were repaired with fiber post, composite resin and zirconia ceramic

crown. The post was set up according to the thickness and length of the root of the patient, and then the glass fiber post was inserted into the root canal to determine that the post and dentin were polished and fixed for 50 seconds after being completely seated, and the post and dentin were treated. After the root canal was routinely disinfected with medical alcohol, the fixed fiber post was injected into the root canal with re-curing adhesive, and the crown core was piled with composite resin. After the abutment grinding surface and routine tooth preparation were carried out according to the anatomical structure of the palate and lip and tongue surface of the patient, the zirconia porcelain crown was made according to the plaster model and tried on. After completion of the repair, the patient was asked to return to the hospital one year later.

**Control group.** The patients in the group B were repaired with metal post and core combined with metal ceramic crown. The patients were treated with metal post-core implantation according to the same group A, followed by routine tooth preparation, and selected plaster model to make metal ceramic crown and try it on, and then colorimetric, anastomotic and fixed. After completion of the repair, the patient was asked to return to the hospital one year later.

## Observation index

### Success rate of repair and masticatory efficiency (Rodrigues *et al.*, 2020).

1. Success rate of repair: the curative effect of the repair was evaluated one year after the completion of the repair. Success: Patient had no symptoms, the masticatory function of the affected teeth was normal, the occlusal relationship was normal, the gums were not red and swollen, there was no percussion pain, and the fiber post and core was not broken, loosened or detached. X-ray examination showed that the root was not absorbed, there was no lesion around the apical, the root continued to develop and the apical was closed. If any of the above did not conform, this would be regarded as a failure.
2. Masticatory efficiency: the masticatory efficiency of the patient was evaluated 1 year after the restoration was completed, and the patient was instructed to pour 3G peanuts into the mouth and chew quickly for 20 seconds, during which the peanut residue should not be swallowed, spit the peanut residue into a cup, diluted the water to 1000ml, and stirred evenly. The masticatory efficiency of denture restoration was measured by 721 spectrophotometer (Shanghai No. 3 Analytical instrument Factory).

**Repair effect.** The effect of restoration was evaluated according to the standard of American Department of Public Health (PHS) (Li *et al.*, 2021). It was evaluated from five

aspects: restoration integrity rate, color matching rate, edge fit rate, edge staining qualified rate and gingival qualified rate.

**GCF condition.** The GCF of the two groups of patients was collected before and 1 year after restoration, and the special filter paper strip was weighed with an electronic balance. After cleaning and blow-drying, the filter paper strip was slowly placed into the gingival sulcus of the patient along the long axis of the tooth, and then taken out for 30 seconds. The quality difference before and after the two times was the patient's GCF level. The level of alkaline phosphatase (ALP) in GCF was detected by ELISA. The kit was purchased from Shanghai Yinggong Biotechnology Co., Ltd., and the operation was completed strictly according to the instructions of the kit.

**Periodontal index (Çanakçı *et al.*, 2021).** The plaque index (PLI) of the two groups was measured by plaque indicator, strictly according to the instructions, and the number of red teeth was recorded in detail. The score ranged from 0 to 5. The higher the score, the more serious the plaque. According to the condition of gingival bleeding, the gingival sulcus bleeding index (SBI) score was 0-5. The higher the score, the more serious the gingival bleeding. The gingival index (GI) score was 0-5 according to the actual gingival condition of the patient. The higher the score, the more serious the gingival inflammation.

**Statistical method.** SPSS20.0 was used for statistical analysis, and the counting data were compared by c2 test or Fisher exact test. The measurement data were expressed by mean ± standard deviation (), and the comparison was made by t test.

**RESULTS**

The clinical efficacy between the two groups. The clinical effect of the group A was better than that of the group B (P < 0.05) (Table I).

The repair success rate and masticatory efficiency between the two groups. The success rate of repair and masticatory efficiency in group A were raised than those in group B (P < 0.05) (Table II).

The repair effects between the two groups. The restoration integrity rate, color matching rate, edge fit rate, edge staining qualified rate and gingival qualified rate in group A were higher than those in group B (P < 0.05) (Table III).

GCF and ALP were compared between the two groups. Before repair, there was no difference in the levels of GCF and ALP between the two groups, but after repair, those in group A were higher than those in group B (P < 0.05) (Table IV).

Table I. The clinical efficacy between the two groups [n (%)].

| Group    | Number of affected teeth | Excellent  | Good       | Bad       | Good rate  |
|----------|--------------------------|------------|------------|-----------|------------|
| A        | 45                       | 25 (55.56) | 18 (40.00) | 2 (4.44)  | 43 (95.56) |
| B        | 45                       | 22 (48.89) | 14 (31.11) | 9 (20.00) | 36 (80.00) |
| $\chi^2$ |                          |            |            |           | 5.075      |
| P        |                          |            |            |           | 0.024      |

Table II. The repair success rate and masticatory efficiency between the two groups.

| Group      | n  | Success rate of repair [n (%)] | Masticatory efficiency |
|------------|----|--------------------------------|------------------------|
| A          | 45 | 43 (95.56)                     | 0.87±0.10              |
| B          | 45 | 36 (80.00)                     | 0.78±0.12              |
| $\chi^2/t$ |    | 5.075                          | 3.865                  |
| P          |    | 0.024                          | 0.000                  |

Table III. The repair effects between the two groups [n(%)].

| Group    | n  | Restoration integrity rate | Color matching rate | Edge fit rate | Qualified rate of edge coloring | Gingival qualified rate |
|----------|----|----------------------------|---------------------|---------------|---------------------------------|-------------------------|
| A        | 45 | 45 (100.00)                | 43 (95.56)          | 44 (97.78)    | 42 (93.33)                      | 43 (95.56)              |
| B        | 45 | 39 (86.67)                 | 37 (82.22)          | 36 (80.00)    | 35 (77.78)                      | 34 (75.56)              |
| $\chi^2$ |    | -                          | 4.050               | 7.200         | 4.406                           | 7.283                   |
| P        |    | 0.026                      | 0.044               | 0.007         | 0.036                           | 0.007                   |

Table IV. GCF and ALP were compared between the two groups.

| Group | n  | GCF (mg)      |              | ALP (μIU)     |               |
|-------|----|---------------|--------------|---------------|---------------|
|       |    | Before repair | After repair | Before repair | After repair  |
| A     | 45 | 3.42±1.15     | 3.65±1.03    | 438.52±42.58  | 448.82±35.26  |
| B     | 45 | 3.56±1.22     | 4.35±1.35*   | 440.52±38.62  | 485.62±45.87* |
| t     |    | -0.560        | -2.765       | -0.233        | -4.267        |
| P     |    | 0.577         | 0.007        | 0.816         | 0.000         |

Note: compared with before restoration: \*P<0.05

The periodontal index between the two groups after restoration. The indexes of PLI, GI and SBI in group A were lower than those in group B ( $P < 0.05$ ) (Table V).

Table V. The periodontal index between the two groups after restoration.

| Group    | Number of affected teeth | PLI       | GI        | SBI       |
|----------|--------------------------|-----------|-----------|-----------|
| A        | 45                       | 0.84±0.25 | 0.75±0.22 | 1.15±0.37 |
| B        | 45                       | 1.35±0.54 | 1.28±0.38 | 1.56±0.58 |
| <i>t</i> |                          | -5.749    | -8.097    | -3.998    |
| <i>P</i> |                          | 0.000     | 0.000     | 0.000     |

## DISCUSSION

Following root canal treatment the integrity of the teeth is destroyed due to a wide range of tooth defects, and its strength is reduced. In addition, due to the loss of the nourishment of the nerve in the dental pulp, the pulp cells stop the normal metabolism and the dentin collagen decreases, which leads to the increase of tooth brittleness, which is easy to break or split the affected teeth. Therefore, after root canal treatment teeth need to be repaired to improve their long-term prognosis (Zou *et al.*, 2018). Clinical studies have found that the repair methods of patients with posterior tooth defects and the quality of the filling body will directly affect the health status of the affected teeth and local periodontal tissue (Xu *et al.*, 2021). Therefore, it is very important to choose a reasonable and effective repair method to improve the prognosis of patients. Here, the patients in group A were repaired with fiber post and composite resin combined with zirconia ceramic crown, while those in group B were repaired with metal post and core combined with metal ceramic crown. The therapeutic effects of the above two different materials in patients with posterior tooth defects after root canal treatment were compared.

Because metal has good physical properties, it can be easily cast and machined to complete accurate shape, and it has the advantages of high strength and low price, so it has been widely used in oral clinical treatment of tooth defects. But, many studies have shown (Al Jeaidi, 2021) as a restoration of posterior tooth defect, metal ceramic crown has some disadvantages, such as poor permeability, lack of aesthetics, easy to cause gingival inflammation and so on (Alshammary *et al.*, 2021). The glass fiber post is made of the same glass fiber neatly arranged and bonded, and has high tension, which can meet the physical properties required by patients with posterior tooth defects. Zirconia is a kind of oxide ceramic material, which does not contain metal inside. However, it has the characteristics of wear resistance, high temperature resistance and bending resistance comparable to metal materials (Haridy *et al.*, 2022). In this study, it was found that the clinical effect of the group A was better than that of the group B, and the success rate and masticatory efficiency of group A were higher than those of group B, suggesting that compared with metal post-core combined with

metal ceramic crown restoration, fiber post and composite resin combined with zirconia ceramic crown restoration has a higher success rate and can effectively restore the masticatory function of patients and also meet their daily masticatory needs. This may be related to the material characteristics of glass fiber post. The elastic modulus of glass fiber post is close to, or even higher than that of human dentin, which can reduce the stress value of dentin to the maximum extent. Thus, the bite force of patients during daily chewing and bite is evenly distributed along the long axis of the whole post, which is beneficial to the conduction of stress to the root surface (Doshi *et al.*, 2019), avoiding the imbalance of restored teeth caused by uneven stress, reducing the incidence of root fracture, and improving the success rate of restoration and masticatory efficiency. However, the elastic modulus of metal is too high, which is higher than that of dentin. After metal post restoration, it is easy to lead to stress concentration in the tip and middle part of the root, and the teeth are subjected to excessive bite force, which leads to root fracture, thus affecting the success rate of restoration and masticatory efficiency.

With the development of dental restoration technology and the continuous updating of restoration materials, patients are no longer satisfied with the recovery of the basic function of their affected teeth, but also have certain requirements for dental comfort and aesthetics among others. It was found that the restoration integrity rate, color matching rate, marginal fit rate, marginal staining qualified rate and gingival qualified rate in group A were higher than those in group B, while PLI, GI and SBI indexes in group A were lower than those in group B. It is suggested that compared with metal post-core combined with metal ceramic crown restoration, fiber post and composite resin combined with zirconia ceramic crown restoration can not only meet the functional needs of patients, but also take care of the comfort and beauty of patients. The reasons are as follows: 1) the fiber resin has strong plasticity, and the fiber post and composite resin combined with zirconia ceramic crown can be molded according to the residual properties and characteristics of the affected teeth. I can also ensure that the restoration can closely fill the defects of the occlusal surface, pulp cavity and buccal neck, and enhance the restoration integrity rate and edge tightness rate of the restoration. Because of its metal composition and low plasticity, the metal restoration cannot be compatible with the adhesive, and the close combination between the metal post and the dental tissue and the post restoration material cannot be achieved, which affects the integrity and edge tightness of the restoration (Abed Kahnamouei *et al.*, 2019); 2) The glass fiber post zirconia

ceramic crown restoration is insoluble in alkaline material and has good biocompatibility, which can greatly reduce gingival stimulation and effectively avoid gingival allergy, swelling, bleeding and other symptoms. At the same time, the restoration has low heat conduction and has a good protective effect on periodontal and dental pulp tissue, thus significantly improving the gingival qualified rate after restoration (Li *et al.*, 2022); 3) Furthermore, the glass fiber post zirconia ceramic crown restoration has no metal bottom layer, has a strong sense of permeability and has good light transmissibility. The color of the restoration is closer to the color of natural teeth and similar to that of adjacent teeth, meeting the aesthetic requirements of patients and significantly improving the color matching rate and edge coloring qualified rate after restoration. On the other hand, the color of metal alloy teeth is stiff, there is chromatic aberration, and the metal material is easy to precipitate free metal ions, causing gingival black staining, thus affecting the effect of restoration (Sharma *et al.*, 2022).

GCF is a fluid in the gingival sulcus, which plays an important role in maintaining gingival sulcus health, antimicrobials and promoting antibody activation, and is closely related to oral defense function (Zhou & Wang, 2018). Under normal circumstances, the amount of GCF in the gingival sulcus is relatively small, but when there is periodontal tissue disease, the secretion of GCF will increase greatly, and the increase of GCF exudation is an important indication of early gingival inflammation. ALP is one of many enzymes in GCF. When the periodontal tissue is stimulated by inflammation, the cell membrane permeability increases or breaks, and a large amount of ALP is released, thus the ALP level reflects the severity of periodontal disease to some extent and can be used as an index for the diagnosis of periodontitis and gingivitis (Ulgey *et al.*, 2020). After repair, the levels of GCF and ALP in the two groups were higher raised those before repair, and the levels in group B were raised than those in group A. It is suggested that compared with metal post-core combined with metal ceramic crown restoration, fiber post and composite resin combined with zirconia ceramic crown has less effect on gingival and marginal stimulation. This may be due to glass fiber post zirconia ceramic crown restoration is neutral in the mouth, insoluble in saliva and other acidic and alkaline substances, and has a high biocompatibility and coordination with the surrounding tissue structure. Allergy can be ruled out. In addition, the edge of the glass fiber post zirconia ceramic crown is close to the shoulder, the shape is continuous and smooth, and has a close contact with the teeth, so it will not affect the periodontal health of the affected teeth (Venkataraman *et al.*, 2021). However, metal restoration has a certain degree of metal instability and a certain degree of corrosion, which will cause different degrees of stimulation

to the human body, cause allergic reactions, and often cause symptoms such as gingival inflammation of patients' teeth, so as to improve the levels of GCF and ALP in patients (Amini *et al.*, 2021).

To sum up, fiber post, composite resin combined with zirconia ceramic crown restoration can significantly improve the success rate, masticatory efficiency and effect of posterior tooth defect after root canal treatment, but has little effect on the changes of GCF and ALP levels.

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YU, L.; SHAN, W.; SHI, Y. & SU, T. Efecto de diferentes materiales de obturación del canal radicular oral sobre la expresión de factores inflamatorios y moléculas relacionadas con proteasas en el fluido crevicular gingival en pacientes con defectos de la anatomía de los dientes posteriores. *Int. J. Morphol.*, 42(5):1458-1463, 2024.

**RESUMEN:** El objetivo de este estudio fue investigar los efectos de diferentes materiales de obturación del canal radicular sobre la expresión de factores inflamatorios y moléculas relacionadas con proteasas en el fluido crevicular gingival (GCF). Se seleccionaron un total de 90 pacientes con defectos de los dientes posteriores que se sometieron a tratamiento de canal en nuestro hospital. Se dividieron en un grupo de observación (grupo A) y un grupo control (grupo B) basado en diferentes materiales de obturación del canal radicular, con 45 dientes en cada grupo. Los dientes de los pacientes del grupo A fueron reparados con poste de fibra, resina compuesta combinada con corona de cerámica de circonio, mientras que los dientes de los pacientes del grupo B fueron reparados con núcleo de poste de metal combinado con corona de cerámica de metal. Se compararon en los dos grupos el efecto clínico, el índice periodontal, la tasa de éxito de la restauración, la eficiencia de la masticación, el índice periodontal, el efecto de la restauración y los niveles de GCF y fosfatasa alcalina (ALP) antes y después de la restauración. La eficacia clínica del grupo A fue mejor que la de los pacientes del grupo B. La tasa de éxito de la reparación y la eficiencia de la masticación en el grupo A fueron mayores que las del grupo B. La tasa de integridad, la tasa de coincidencia de colores, la tasa de ajuste de los bordes, la tasa de calificación de la coloración de los bordes y la tasa de calificación gingival de los pacientes del grupo A fueron mayores que las de los pacientes del grupo B. Después de la reparación, los niveles de GCF y ALP en ambos grupos de pacientes fueron más altos que antes de la reparación, y el grupo B aumentó más que el grupo A. Los índices PLI, GI y SBI de los pacientes del grupo A fueron más reducidos que los pacientes del grupo B. La aplicación de poste de fibra, resina compuesta combinada con restauración de corona de porcelana de circonio en pacientes con defectos de dientes posteriores después del tratamiento de canal puede mejorar la tasa de éxito, la eficiencia de la masticación y el efecto de la restauración, con poco impacto en los cambios en los niveles de GCF y ALP en el cuerpo.

**PALABRAS CLAVE:** Resina compuesta; Poste de fibra; Efecto reparador; Defecto de la anatomía del diente; Corona de porcelana de circonitas.

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