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Comparison of the Effects of High Inlays Made from Different Materials on the Restoration of Posterior Teeth After Root Canal Treatment

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Abstract

Objective: To compare the effects of zirconia high inlays and glass ceramic high inlays in the restoration of posterior teeth after root canal treatment. **Methods:** From April 2023 to August 2024, 90 patients who received posterior tooth root canal treatment were selected as research subjects. According to different treatment plans, patients were divided into two groups: one group used zirconia high inlays for restoration (zirconia group, 45 cases), and the other group used glass ceramic high inlays for restoration (glass ceramic group, 45 cases). The oral health status and restoration outcomes of the two groups were compared. **Results:** After 3 months of treatment in both groups, the GI and PLI scores of the zirconia group were lower than those of the glass ceramic group ($P < 0.05$). There was no significant difference in the integrity of the restorations between the two groups ($P > 0.05$). The pass rate of color matching in the glass ceramic group was higher than that in the zirconia group ($P < 0.05$), while the pass rates of marginal adaptation and gingival health in the glass ceramic group were lower than those in the zirconia group ($P < 0.05$). **Conclusion:** In the restoration of posterior teeth after root canal treatment, when comparing the repair effects of zirconia onlays and glass ceramic onlays, zirconia onlays are more conducive to maintaining oral health, with higher pass rates in marginal adaptation and gingival health. However, the glass ceramic group has a higher pass rate in color matching. Meanwhile, both types of restorations have good integrity.

Keywords

Zirconia high inlays; glass ceramic high inlays; posterior tooth root canal treatment; dental restoration; effect

After root canal treatment, the dental tissue becomes fragile due to the loss of pulp nutrition supply, making it prone to fractures and reduced masticatory function [1, 2]. Timely and effective dental restoration is crucial for restoring tooth function and prolonging the lifespan of the affected tooth [3]. High inlays, as a conservative form of dental restoration, cover the weak areas of the tooth and distribute bite forces, making them a common choice for posterior tooth restoration after root canal treatment. Zirconia high inlays and glass ceramic high inlays are currently the two most widely used all-ceramic restorations in clinical practice. Zirconia materials are known for their excellent mechanical strength and fracture toughness, making them particularly suitable for high-load occlusal areas of posterior teeth; while glass ceramics, with their good translucency and enamel-like aesthetic effects, can achieve a more natural appearance while meeting functional requirements. Existing studies mostly focus on the performance evaluation of a single type of material or compare the mechanical properties of the two through in vitro experiments, but lack long-term clinical observation data [4, 5]. Especially in the special anatomical environment of posterior teeth after root canal treatment, there is no systematic comparative analysis of the key efficacy indicators of the two high inlays. This

study aims to compare the clinical outcomes of zirconia high inlays and glass ceramic high inlays in the restoration of posterior teeth after root canal treatment through a prospective clinical trial. The results are reported as follows.

1. Materials and Methods

1.1 General information

From April 2023 to August 2024, 90 patients who underwent root canal treatment for posterior teeth were selected as the research subjects. They were divided into two groups according to different treatment plans: one group received zirconia onlay restoration (zirconia group, 45 cases), and the other group received glass ceramic onlay restoration (glass ceramic group, 45 cases). In the zirconia group, the age ranged from 30 to 55 years, with an average of (41.26 ± 4.39) years; there were 21 males and 24 females. Regarding the position of the posterior teeth, 20 cases were on the left side, and 25 cases were on the right side. In the glass ceramic group, the age ranged from 29 to 54 years, with an average of (40.53 ± 4.28) years; there were 23 males and 22 females. Regarding the position of the posterior teeth, 22 cases were on the left side, and 23 cases were on the right side. The comparison of baseline information between the two groups showed no significant difference ($P > 0.05$), indicating that they were balanced and comparable. This study has been reviewed and approved by the Medical Ethics Committee.

1.2 Inclusion criteria and exclusion criteria

Inclusion criteria: age ≥ 18 years; receiving root canal treatment due to posterior tooth caries, dental defects, or pulp disease; sufficient retention and resistance form available in the remaining dental tissue; stable occlusion, no severe bruxism; patient voluntarily participates in the study and signs the informed consent form.
Exclusion criteria: individuals with periodontal or adjacent tissue lesions; pregnant or lactating women; those with diabetes or osteoporosis; and those unable to undergo regular follow-ups.

1.3 Methods

The methods for root canal preparation and filling are as follows: EDTA is used to prepare and patency the root canal, followed by further patency with a #10 K file, while determining the required working length. Then, M3 nickel-titanium files are used to complete the root canal preparation. During the process of changing files, the root canal needs to be irrigated to remove part of the root canal smear layer, after which the root canal is dried, and finally, gutta-percha points are used for root canal filling.

Impression taking and restoration fabrication: The Sirona CEREC CAD/CAM system is used for intraoral scanning. After designing the onlay morphology, the experimental group selects zirconia ceramic blocks for cutting and shaping, which are then sintered in a sintering furnace and polished to completion; the control group selects glass ceramic blocks for cutting and shaping, followed by polishing to completion.

Try-in and bonding: The restoration is tried in and adjusted to achieve proper occlusion and marginal adaptation. The tooth structure is etched, a bonding agent is applied, and after light curing for 20 seconds, a resin adhesive is used to bond the restoration. Excess adhesive is removed, and light curing is performed again for 40 seconds.

1.4 Observation indicators

(1) Oral health. The oral health status of both groups before treatment and 3 months after treatment was quantitatively evaluated using the Gingival Index (GI) and Plaque Index (PLI). The GI is divided into four grades based on the severity of gingival inflammation: no inflammation (0 points), mild inflammation (1 point), moderate inflammation (2 points), and severe inflammation (3 points). The PLI is divided into four grades according to the degree of plaque accumulation: none, small amount, moderate amount, and large amount, with corresponding scores of 0 points, 1 point, 2 points, and 3 points in sequence.
(2) Restoration effect. The compliance rates of the restorations in both groups were evaluated in four dimensions: integrity, color matching, marginal adaptation, and gingival health status.

1.5 Statistical processing

Statistical software SPSS 26.0 was used to analyze the data. Count indicators were expressed as the number of cases/percentage (n/%), and the chi-square test was applied. Measurement indicators were expressed as the mean ± standard deviation, and the t-test was used. A P value < 0.05 indicated that the difference was statistically significant.

2. Results

2.1 Compare the oral health status of the two groups

After 3 months of treatment in both groups, the GI and PLI scores of the zirconia group were lower than those of the glass ceramic group ($P < 0.05$) (see Table 1).

Table 1. Comparison of the oral health status of the two groups ($\bar{x} \pm s$, Score)

Grouping	Number of cases	GI		PLI	
		Before treatment	After three months of treatment	Before treatment	After three months of treatment
Glass-ceramic group	45	2.26±0.41	0.95±0.27	2.17±0.23	0.83±0.16
Zirconia Group	45	2.30±0.38	0.82±0.24	2.12±0.19	0.70±0.12
t	-	0.480	2.414	1.124	4.360
P	-	0.632	0.018	0.264	0.000

2.2 Compare the repair effects of the two groups

The integrity of the two groups of restorations was compared ($P > 0.05$); the color matching rate of the glass ceramic group was higher than that of the zirconia group ($P < 0.05$), while the marginal fit rate and gingival health status of the glass ceramic group were lower than those of the zirconia group ($P < 0.05$) (see Table 2).

Table 2. Comparison of the repair effects of the two groups (n, %)

Grouping	Number of cases	Integrity	Color matching degree	Edge compatibility	Gum health status
Glass-ceramic group	45	45 (100.00)	45 (100.00)	41 (91.11)	39 (86.67)
Zirconia Group	45	45 (100.00)	41 (91.11)	45 (100.00)	44 (97.78)
χ^2	-	-	4.186	4.186	3.873
P	-	-	0.041	0.041	0.049

3. Discussion

After root canal treatment of the posterior teeth, the tooth structure becomes brittle due to dehydration and significant damage, leading to a significant decrease in fracture resistance. High inlays are considered an ideal choice for such cases as they cover the cusps, distribute stress, and preserve the maximum amount of healthy tooth structure. Currently, zirconia high inlays are favored for their superior mechanical strength, while glass ceramic high inlays excel in aesthetic biomimetic effects. Clinically, personalized selection should be based on the patient's occlusion, aesthetic needs, and tooth condition. Both options are efficient and reliable methods for restoring the form and function of the tooth.

This study aimed to investigate the effects of zirconia onlays and glass ceramic onlays on patients' oral health status and restoration outcomes in the restoration of posterior teeth after root canal treatment. The results showed that 3 months after treatment in both groups, the GI and PLI scores of the zirconia group were lower than those of the glass ceramic group ($P < 0.05$). There was no significant difference in the integrity of the restorations between the two groups ($P > 0.05$); the pass rate of color matching in the glass ceramic group was higher than that in the zirconia group ($P < 0.05$), while the pass rates of marginal adaptation and gingival health status in the glass ceramic group were lower than those in the zirconia group ($P < 0.05$). The differences in the restoration effects of the two types of onlays stem from the inherent correlation between material properties and clinical performance. Zirconia ceramics have high strength and excellent chemical stability, and their CAD/CAM processing precision is high, which can form a more closely fitting marginal seal, reduce the risk of microleakage and secondary caries, and thus be more conducive to maintaining oral health [8]. At the same time, the surface of zirconia is smooth and has excellent biocompatibility, which causes little irritation to the gums and reduces the incidence of gingival inflammation, resulting

in higher pass rates of marginal adaptation and gingival health [9]. Due to the glass phase component in glass ceramics, their translucency is close to that of natural tooth enamel, and more natural color transitions can be achieved through staining technology, so their color matching is better [10]. The integrity of both types of restorations is good, which benefits from the wear resistance of ceramic materials themselves and the progress of bonding technology. However, zirconia shows more stable performance when bearing the occlusal force of posterior teeth due to its higher mechanical strength. In clinical selection, it is necessary to balance functional needs and aesthetic demands, and take into account material properties and the conditions of the affected teeth.

In summary, when comparing the restorative outcomes of zirconia high inlays and glass ceramic high inlays after posterior root canal treatment, zirconia high inlays are more beneficial for maintaining oral health status, with higher marginal adaptation and gingival health qualification rates. However, the glass ceramic group has a higher qualification rate for color matching. Both types of restorations have good integrity.

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