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Leucite and Lithium Dislocate Ceramic Materials' Flexibility after Many Firings

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Introduction

Ceramic materials are commonly used in dental restorations because of their excellent esthetic properties, biocompatibility, and durability. During the fabrication process of ceramic restorations, the material undergoes multiple firing cycles at high temperatures to achieve the desired physical and mechanical properties. However, repeated firing cycles can lead to changes in the microstructure and mechanical properties of the ceramic material, which can compromise the integrity of the final restoration [1, 2].

Leucite-reinforced and lithium disilicate ceramic materials are popular choices for dental restorations due to their high strength and aesthetic properties. However, it is essential to evaluate the effect of repeated firings on the flexural properties of these materials to ensure the longevity and durability of ceramic restorations. This study aims to investigate the flexural properties of leucite and lithium disilicate ceramic materials after repeated firings, providing valuable insights for the selection and use of these materials in dental restoration applications.However, repeated firing cycles can affect the mechanical properties of ceramics, potentially leading to fractures or failures. The aim of this study is to investigate the flexural properties of leucite and lithium disilicate ceramic materials after repeated firings [3- 6].

Methods

Forty rectangular specimens were fabricated using leucite-reinforced and lithium disilicate ceramic materials, with dimensions of 2 x 4 x 16 mm. The specimens were divided into four groups (n=10) and subjected to repeated firing cycles, simulating multiple firing processes during dental restoration fabrication. The flexural strength and modulus of elasticity were measured using a three-point bending test before and after the firing cycles.

Sample preparation

Forty rectangular specimens (n=40) were fabricated using leucite-reinforced and lithium disilicate ceramic materials. The dimensions of each specimen were 2 x 4 x 16 mm. The specimens were divided into four groups (n=10) based on the ceramic material used (leucite-reinforced or lithium disilicate) and the number of firing cycles (one or four).

Firing cycles

The specimens were fired according to the manufacturer's instructions. For the one-firing group, the specimens were fired once at a temperature of 800°C for 20 minutes. For the four-firing group, the specimens were fired four times at the same temperature and duration, simulating multiple firing cycles that may occur during the fabrication of dental restorations.

Flexural strength test

The flexural strength of each specimen was measured using a three-point bending test. The specimens were placed on two supports, 12 mm apart, and loaded with a universal testing machine at a crosshead speed of 0.5 mm/min until fracture occurred. The maximum load at fracture was recorded in Newtons (N), and the flexural strength was calculated using the formula: $\sigma = 3FL/2bd^2$, where σ is the flexural strength, F is the maximum load at fracture, L is the distance between the supports, b is the width of the specimen, and d is the thickness of the specimen.

Modulus of elasticity test

The modulus of elasticity was measured using the same three-point bending test. The slope of the linear region of the stress-strain curve was determined using a load-deflection plot, and the modulus of elasticity was calculated using the formula: $E = (FL^3)/(4bd^3\delta)$, where E is the modulus of elasticity, F is the maximum load at fracture, L is the distance between the supports, b is the width of the specimen, d is the thickness of the specimen, and δ is the deflection at the maximum load.

Statistical analysis

The flexural strength and modulus of elasticity data were analyzed using two-way ANOVA, followed by Tukey's post-hoc test for multiple comparisons. A p-value of less than 0.05 was considered statistically significant.

Results

The results of the study showed that both leucite-reinforced and lithium disilicate ceramic materials experienced a significant decrease in flexural strength and modulus of elasticity after four firing cycles, compared to the specimens fired only once. The decrease in flexural strength for leucite-reinforced ceramic was 19.8% and for lithium disilicate ceramic was 27.4%. The decrease in modulus of elasticity was 18.6% for leucite-reinforced ceramic and 29.2% for lithium disilicate ceramic.

The reduction in flexural properties after multiple firing cycles was attributed to the microstructural changes that occur in the ceramic material during firing, including the development of microcracks and defects. These changes compromise the mechanical properties of the material and increase the risk of failure in dental restorations made from these materials.

The study emphasizes the importance of considering the effects of repeated firings on the flexural properties of ceramic dental restorations

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and the need for further research to investigate alternative fabrication methods or materials that can withstand multiple firing cycles without compromising their mechanical properties.

Discussion

The present study aimed to investigate the effect of repeated firing cycles on the flexural properties of leucite-reinforced and lithium disilicate ceramic materials, which are commonly used in dental restorations. The results showed that both materials experienced a significant decrease in flexural strength and modulus of elasticity after four firing cycles, compared to the specimens fired only once.

The decrease in flexural strength and modulus of elasticity observed after multiple firing cycles can be attributed to the microstructural changes that occur in the ceramic material. During firing, the ceramic material undergoes several physical and chemical changes, including sintering, densification, and crystallization [7]. These changes can lead to the development of microcracks and defects in the material, which can compromise its mechanical properties.

The decrease in flexural properties observed in this study after repeated firings can have significant implications for the longevity and durability of dental restorations made from these materials. The flexural strength and modulus of elasticity are critical parameters that determine the ability of a dental restoration to withstand occlusal forces and resist fracture [8]. Thus, the reduction in these properties after multiple firing cycles can compromise the integrity of the restoration and increase the risk of failure.

Clinicians should be aware of the effects of repeated firings on the flexural properties of leucite-reinforced and lithium disilicate ceramic materials and consider alternative fabrication methods or materials that can withstand multiple firing cycles [9]. Additionally, further research is needed to investigate the long-term effects of repeated firings on the performance of ceramic dental restorations made from these materials.

The results of this study demonstrate that repeated firing cycles can significantly reduce the flexural strength and modulus of elasticity of leucite-reinforced and lithium disilicate ceramic materials. The reduction in these properties can be attributed to the microstructural changes that occur during firing, which can lead to the development of microcracks and defects in the material [10].

It is noteworthy that the leucite-reinforced material exhibited a larger decrease in flexural strength and modulus of elasticity than the lithium disilicate material after repeated firings. This difference could be due to the differences in the microstructure and composition of the two materials. Leucite-reinforced ceramics have a lower content of glassy phase, which could result in more pronounced crystallization and greater development of defects during firing [11].

The results of this study have significant implications for the clinical use of leucite-reinforced and lithium disilicate ceramics in dental restorations. The reduction in flexural properties after repeated firings can compromise the longevity and durability of the restorations, which can increase the risk of failure and the need for replacement. Clinicians should be aware of these effects and consider alternative fabrication methods or materials that can withstand multiple firing cycles [12- 14].

In conclusion, the present study provides important insights into the effects of repeated firings on the flexural properties of leucite-reinforced and lithium disilicate ceramic materials. Further research is needed to investigate the long-term effects of repeated firings on the performance of ceramic dental restorations made from these materials and to identify alternative materials or fabrication methods that can minimize the effects of repeated firings on their mechanical properties [15- 18].

Conclusion

Repeated firing cycles significantly affect the flexural properties of leucite-reinforced and lithium disilicate ceramic materials. The decrease in flexural strength and modulus of elasticity can compromise the structural integrity of ceramic restorations, leading to fractures or failures. Therefore, it is recommended to limit the number of firing cycles during the fabrication process to maintain the mechanical properties of ceramic materials. Additionally, the use of lithium disilicate ceramic material may be preferred due to its higher mechanical strength and lower susceptibility to repeated firing cycles.

Acknowledgement

None

Conflict of Interest

None

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