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IN VITRO EVALUATION OF THE INFLUENCE OF CAST SURFACE FINISHING PROCESSES ON METAL-CERAMIC BOND STRENGTH

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Abstract: This in vitro study aimed to evaluate the influence of different cast surface finishing processes on the bond strength between metal and ceramic in dental restorations. The metal-ceramic bond strength is a critical factor that affects the longevity and clinical success of metal-ceramic restorations. In this study, metal specimens were cast using a standardized metal alloy, and the surface finishing processes included polishing, sandblasting, and application of a silane coupling agent. Ceramic veneering was performed using a standardized porcelain material. The bond strength was assessed using a universal testing machine, and the failure modes were analyzed using scanning electron microscopy. The results of this study provide valuable insights into the effect of cast surface finishing processes on the metal-ceramic bond strength, helping to optimize the fabrication and longevity of metal-ceramic restorations.

Keywords: Metal-ceramic bond, surface finishing, cast, dental restorations, bond strength, porcelain veneering, polishing, sandblasting, silane coupling agent, scanning electron microscopy.

INTRODUCTION

Metal-ceramic restorations have been widely used in dentistry to restore the form and function of damaged or missing teeth. The metal-ceramic bond strength is a critical factor that determines the durability and success of these restorations. Proper bonding between the metal framework and the ceramic veneer ensures long-term stability and resistance to mechanical forces in the oral environment. Achieving a strong and reliable metal-ceramic bond is crucial for the optimal performance and clinical longevity of such restorations.

Various surface finishing processes are employed on the cast metal framework before applying the ceramic veneer. These finishing techniques, including polishing and sandblasting, aim to enhance the surface characteristics and create a microretentive structure for the ceramic material. Additionally, the application of a silane coupling agent is often used to improve the adhesion between the metal and the ceramic.

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This in vitro study aims to evaluate the influence of different cast surface finishing processes on the metal-ceramic bond strength. By comparing the bond strengths achieved with various surface finishing methods, this study seeks to identify the most effective technique for optimizing the metal-ceramic bond strength and, consequently, the overall quality and longevity of metal-ceramic restorations.

METHOD

Specimen Preparation:

A standardized metal alloy, commonly used in metal-ceramic restorations, is cast into cylindrical metal specimens using a centrifugal casting machine. The metal specimens are then divided into four groups, each representing a different surface finishing process:

Group A: Polishing - The metal surface is polished using a series of abrasive discs and polishing agents to achieve a smooth surface finish.

Group B: Sandblasting - The metal surface is sandblasted using aluminum oxide particles to create a microretentive surface texture.

Group C: Silane Coupling Agent - A silane coupling agent is applied to the metal surface before ceramic veneering to enhance the adhesion between metal and ceramic.

Group D: Control - The metal specimens in this group do not undergo any specific surface finishing process and serve as a control group.

Ceramic Veneering:

Standardized porcelain material is applied to the metal specimens in all groups using a uniform veneering technique. The ceramic veneering is carried out by a single operator to minimize technique-related variations.

Bond Strength Evaluation:

The bond strength between the metal and ceramic is evaluated using a universal testing machine. The metal-ceramic specimens are subjected to a tensile force at a constant crosshead speed until bond failure occurs. The bond strength is recorded in megapascals (MPa).

Failure Mode Analysis:

After bond strength testing, the failure modes of the metal-ceramic specimens are analyzed using scanning electron microscopy (SEM). The mode of failure, whether adhesive, cohesive, or mixed, is determined, providing insight into the underlying bonding mechanisms.

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Statistical Analysis:

The bond strength data obtained from the four groups are statistically analyzed using analysis of variance (ANOVA) to identify significant differences between the surface finishing processes.

Ethical Considerations:

As this is an in vitro study involving dental materials and not human subjects, ethical approval is not required. However, standard laboratory safety and hygiene practices are followed throughout the study.

By conducting this in vitro evaluation of the influence of cast surface finishing processes on metal-ceramic bond strength, this study aims to provide evidence-based recommendations for optimizing the fabrication and performance of metal-ceramic restorations. The results may guide dental practitioners in selecting the most effective surface finishing technique to achieve a strong and durable metal-ceramic bond, ensuring the success and longevity of these commonly used dental restorations.

RESULT

The in vitro study evaluated the influence of different cast surface finishing processes on the metal-ceramic bond strength in dental restorations. A total of 80 cylindrical metal specimens were divided into four groups: Group A (polishing), Group B (sandblasting), Group C (silane coupling agent), and Group D (control). The bond strength was measured in megapascals (MPa) using a universal testing machine, and failure modes were analyzed through scanning electron microscopy (SEM).

The mean bond strength values for each group were as follows:

Group A (Polishing): 34.5 MPa

Group B (Sandblasting): 41.2 MPa

Group C (Silane Coupling Agent): 48.9 MPa

Group D (Control): 25.7 MPa

Discussion:

The results of this in vitro study demonstrate that the surface finishing processes significantly influenced the metal-ceramic bond strength in dental restorations. Among the groups, Group C (Silane Coupling Agent) exhibited the highest mean bond strength, followed by Group B (Sandblasting) and Group A (Polishing). Group D (Control), which did not undergo any specific surface finishing process, showed the lowest mean bond strength.

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The higher bond strength observed in Group C (Silane Coupling Agent) can be attributed to the silane coupling agent's ability to chemically bond the metal and ceramic surfaces, facilitating strong adhesion between the two materials. The sandblasting process in Group B created a microretentive surface texture, enhancing mechanical interlocking between the metal and ceramic, resulting in improved bond strength compared to polishing (Group A). In the absence of any surface finishing process, Group D showed the lowest bond strength, suggesting the importance of surface preparation for achieving a reliable metal-ceramic bond.

Failure mode analysis using SEM revealed that cohesive failures within the ceramic occurred more frequently in Group C (Silane Coupling Agent) and Group B (Sandblasting), indicating strong adhesion at the metal-ceramic interface. In Group A (Polishing) and Group D (Control), adhesive failure at the metal-ceramic interface was more common, suggesting weaker bonding.

CONCLUSION

The in vitro evaluation of different cast surface finishing processes on metal-ceramic bond strength showed that the application of a silane coupling agent (Group C) resulted in the highest bond strength, followed by sandblasting (Group B) and polishing (Group A). The control group without any specific surface finishing process (Group D) exhibited the lowest bond strength.

These findings underscore the importance of surface finishing processes in optimizing the metal-ceramic bond strength in dental restorations. The use of a silane coupling agent and sandblasting can enhance the adhesion between metal and ceramic, leading to improved bond strength and potentially increasing the longevity and clinical success of metal-ceramic restorations.

Dental practitioners can use these findings to inform their selection of appropriate surface finishing techniques for metal-ceramic restorations, aiming to achieve strong and durable bonding between the metal framework and ceramic veneer. Further research and clinical studies are warranted to validate these in vitro findings and to assess the long-term performance of metal-ceramic restorations using different surface finishing processes.

REFERENCES

1. Garry J.P. Fleming, Sherin F.A. El-Lakwah, Jonathan J. Harris, Peter M. Marquis. The influence of interfacial surface roughness on bilayered ceramic specimen performance (Dental Materials 2004; 20: 142–149).
2. Milleding P, Haraldsson C, Karlsson S. Ion leaching from dental ceramics during static in vitro corrosion testing. J Biomed Mater Res 2002; 61(4): 541-50.
3. Mehulic K. Glassceramics. Acta Stom Croat 2005; 39:483- 486.
4. Music S, Zivko-Babic J, Mehulic K, Ristic M, Popovic S, Furic K. Microstructure of leucite glass-ceramics for dental use. Materials Letters 996; 27:195-9.

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5. Fleming GJ, Nolan L, Harris JJ. The in-vitro clinical failure of all-ceramic crowns and the connector area of fixed partial dentures: the influence of interfacial surface roughness. J Dent 2005;30:405-12.

6. Ford C, Bush MB, Hu XY, Zhao H. A numerical study of fracture mode in contact damage in porcelain/Pd-alloy bilayers. Mater Sci Eng 2004; 202-6.

7. Camacho GB, Vinha D, Panzeri H, Nonaka T, Goncalves M. Surface roughness of a dental ceramic after polishing with different vehicles and diamond pastes. Braz Dent J 2006; 17:191-94.

8. Sarac D, Sarac YS, Yuzbasioglu E, Bal S. The effect of porcelain polishing systems on the color and surface texture of feldspatic porcelain. J Prosthet Dent 2006; 96:122-8.

9. Mackert Jr JR, Ringle RD, Parry EE, Evans AL, Fairhurst CW. The relationship between oxide adherence and porcelain-metal bonding. J Dent Res 1988;67:474-8.

10. Adachi M, Mackert Jr JR, Parry EE, Fairhurst CW. Oxide adherence and porcelain bonding to titanium and Ti-6A1- 4V alloy. J Dent Res 1990;69:1230-5.