FEATURES OF FIXATION OF ZIRCONIUM DIOXIDE PROSTHESES

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Relevance

Prosthetic dentistry of the 21st century is characterized by increasingly high demands for both functional and aesthetic outcomes of dental restorations. Patients today expect not only the restoration of chewing efficiency but also natural appearance, biocompatibility, and long-term durability of prosthetic constructions. In this context, all-ceramic restorations, particularly those based on zirconium dioxide, have gained widespread popularity in clinical practice.

Zirconium dioxide (zirconia) is a high-strength ceramic material that combines excellent mechanical properties with favorable эстетические характеристики. Due to its high fracture toughness, resistance to wear, and chemical stability, zirconia has become a material of choice for crowns, bridges, and implant-supported restorations. In addition, its white color and ability to mimic natural tooth structure make it highly suitable for use in aesthetically demanding zones.

However, despite its advantages, zirconia presents certain challenges, particularly in terms of fixation. Unlike conventional glass ceramics, zirconium dioxide does not contain a glass phase. As a result, traditional adhesive techniques—such as hydrofluoric acid etching followed by silanization—are ineffective. This significantly complicates the process of achieving reliable and durable bonding between zirconia restorations and tooth tissues.

Therefore, the issue of optimizing fixation methods for zirconia prostheses remains highly relevant. The development of effective surface treatment techniques and adhesive protocols is essential for improving the longevity and clinical success of zirconia-based restorations.

Target

The aim of this study was to analyze and summarize the features of fixation of zirconium dioxide prostheses based on available scientific literature. Special attention was given to modern approaches for improving adhesion strength between zirconia surfaces and resin-based cements, as well as to the evaluation of different methods of surface preparation.

Materials and Methods

To achieve the objective of the study, a comprehensive review of scientific literature was conducted. A total of 23 sources were identified and analyzed using the PubMed database. The selected publications originated from 8 countries, including Germany, Switzerland, the Netherlands, England, Japan, China, Canada, and Brazil, reflecting a broad international interest in this topic.

The analyzed studies covered a 15-year period and were distributed as follows:

5 publications from 2007 to 2010;

11 publications from 2011 to 2015;

7 publications from 2016 to 2020.

The literature search was carried out using the following keywords: “zirconium dioxide,” “bond strength,” “surface preparation,” and “chemical methods.” These terms allowed for the identification of studies focusing on adhesion mechanisms, surface treatment techniques, and long-term durability of zirconia restorations.

Particular emphasis was placed on chemical methods of surface modification, as well as combined mechanical and chemical approaches aimed at improving micromechanical retention and chemical bonding. The analysis included evaluation of experimental studies, in vitro tests, and clinical observations related to zirconia fixation.

Results

The analysis of publication frequency demonstrates a sustained and growing interest in the problem of zirconia fixation. Over the years, numerous studies have focused on improving adhesion strength between zirconium dioxide and resin-based

materials, as well as on enhancing the durability of this bond under clinical conditions.

One of the key findings is that the durability of adhesion between zirconia ceramics and polymer-based cements largely depends on the method of surface treatment. Since zirconia lacks a glass phase, conventional etching techniques are ineffective, and alternative methods must be employed.

Among the most widely studied approaches are mechanical surface treatments, such as airborne-particle abrasion (sandblasting). This method increases surface roughness and enhances micromechanical retention. However, excessive abrasion may lead to surface damage and microcracks, potentially compromising the strength of the material.

Chemical methods of surface treatment have also been активно investigated. These include the application of primers containing functional monomers, particularly 10-methacryloyloxydecyl dihydrogen phosphate (MDP). MDP-containing primers have demonstrated a strong chemical affinity for zirconia, forming stable bonds with its surface and significantly improving adhesion strength.

Another approach involves the use of silica coating techniques, such as tribochemical silica coating, which allows subsequent silanization. This method creates a silica layer on the zirconia surface, enabling chemical bonding similar to that achieved with glass ceramics. Studies have shown that this technique can significantly improve bond strength, although it requires specialized equipment.

Laser surface treatment is another innovative method that has been explored in recent years. Laser irradiation can modify the surface morphology of zirconia, increasing roughness and enhancing adhesion. However, the effectiveness of this method depends on the type of laser, parameters used, and zirconia composition.

Despite the variety of methods available, none of them alone provides a completely reliable and long-lasting bond. The most effective results are achieved through a combination of mechanical and chemical treatments. In particular, the use of airborne-particle abrasion followed by application of an MDP-containing primer and resin cement is currently considered the gold standard.

In addition to adhesion strength, many studies have also examined the durability of the bond under conditions simulating the oral environment, including thermal cycling and mechanical loading. These studies indicate that the stability of the bond over time remains a critical issue, as degradation can occur due to hydrolytic processes and mechanical fatigue.

Conclusion

Modern methods of surface preparation of zirconium dioxide ceramics make it possible to significantly increase the bond strength between zirconia and polymer-based cements. However, many of these techniques require specialized equipment and may be costly, limiting their widespread use in everyday clinical practice.

At present, none of the innovative methods can ensure reliable adhesion without the use of primers containing MDP. These primers play a crucial role in establishing chemical bonding and improving the longevity of fixation.

Therefore, the optimal approach to zirconia fixation involves a комплексный протокол, combining mechanical surface treatment with the application of MDP-containing adhesive systems. Further research is needed to develop more accessible, cost-effective, and clinically reliable methods of zirconia surface modification.

In conclusion, improving the fixation of zirconium dioxide prostheses remains an important and актуальная задача in modern prosthetic dentistry. The successful integration of new materials and technologies into clinical practice will contribute to enhanced treatment outcomes, increased longevity of restorations, and improved patient satisfaction.

Literature

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